GEOLOGICAL REPORTS
OF
DR. V. K. TING

(Being the Results of Investigations of the Late Dr. V. K. Ting Carried out in the Years 1913-1930 in the Provinces of Hopeh, Shansi, Shantung, Yunnan, Kuangsi, Kueichou, and Szechuan)

WITH 44 TEXT-FIGURES AND
45 PLATES IN SEPARATE COVER

Published by
THE NATIONAL GEOLOGICAL SURVEY OF CHINA
(Under the Ministry of Economic Affairs)

NANKING
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Preface

It was already eleven years since Dr. V. K. Ting, formerly director of the Geological Survey of China, passed away after an accidental poisoning by coal gas in Hunan. Dr. Ting was one of the founders of Chinese geology. He had done extensive field observations on geology especially in the southwestern provinces besides his administrative works in the Geological Survey, in the Peipiao Coal Mining Company, in the Academia Sinica, etc.

Accompanied by Prof. F. Solger, a German geologist, Ting investigated the area along the Chengtai Railway (between Shihchiachuang and Taiyuan) in 1913. This was the first field work of Chinese geologists. In the next year he went to Yunnan and southwestern Szechuan (now Sikang) and explored parts of the almost inaccessible Lolo region. After his resignation from the mayorship of Greater Shanghai he made geological investigations in Kuangsi in 1928. One year later he led a party consisting of Messrs. Y. T. Chao, T. K. Huang, Y. L. Wang and S. Y. Tseng to Szechuan, Kueichou and Yunnan to make geological observations. All the materials collected and data recorded by him during these trips are still of scientific and practical value. But owing to the cautiousness of Dr. Ting in publishing his results, he did not complete his reports and left his field notes and sketches unpublished.

Sometime after the death of Ting, it was decided that the Geological Survey should take charge of the compilation work of Ting's manuscripts. This was, however, not done until 1944 when Dr. W. Y. Ting, brother of V. K. Ting, reminded us again about this matter. The task was then carried on by Drs. T. K. Huang and T. H. Yin with the assistance of Messrs. C. S. Pien, K. Y. Lee and N. Chin. All the sketches and maps were redrawn by the draftsmen. A bibliography was compiled by I. W. Shen. The whole work was completed in the spring of 1946.

During the war time the copious manuscripts and illustrations could hardly be printed in Chungking on account of the shortage of paper and the poor printing technique. We contemplated to print them in India, but this plan was changed following the victory of the war over Japan. Dr. T. K. Huang then brought them to Peiping for printing.

Another serious question arisen when the manuscripts were ready for publication was how to raise funds to cover the printing expenses. Fortunately, former friends and colleagues of Dr. Ting came to our aid and in a few months generous donations were received from: Dr. Chu Chia-hua, Minister of Education, and concurrently President of the Academia Sinica; Mr. Chien Chang-chao, then Chairman of the National Resources Commission; Dr. Hu Shih, Chancellor of the National Peking University; Dr. Wong Wen-hao, General Manager of the Chinese Petroleum Corporation; Mr. C. Y. Hsieh, Director of the Mineral Exploration Bureau; Mr. Wang Yun-wu, then Minister of Economic Affairs; Mr. H. H. Ling, Vice Minister of Communications, and Mr. Cheng Wen Hsüen, General Manager of the Hwainan Mining and Railway Company. To all these gentlemen and their respective and related offices and companies we wish to tender our most cordial gratitude. Our indebtedness to Drs. T. K. Huang and T. H. Yin for their editing and printing work with the assistance of Messrs. C. S. Pien, K. Y. Lee, N. Chin, I. W. Shen, T. C. Tseng, and M. L. Chow is also expressed here.

C. Y. LEE,
Director, Geological Survey of China.
Nanking, June 14, 1947.

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Ven-kiang Ting
Biographical Note

By

WONG WEN-HAO

Ven-kiang Ting was born in 1887 at Huangchiao village, Taihsing district, Kiangsu Province[1]. His brilliant intelligence was early noticed as he has received excellent marks at the first graduate examination at the age of thirteen years. In the examination paper he wrote eloquently on the accomplishment of Emperor Han Wu-ti (140 AD—87 AD) in developing the southwestern area of China. This special interest in the Southwest region seemed to have been prophetic for his later geological work which was chiefly concentrated in Yunnan, Kueichow and neighbouring provinces.

In the beginning of the twentieth century, the younger generation in China earnestly desired to study abroad with the intention of getting the necessary training for the important work in this country. Ting went to Japan in 1902 and became interested in the revolutionary movement which was being prepared by a group of Chinese residents. He shortly realized, however, that China more seriously needed men of technical knowledge who would help in the intellectual and economical development of the country. He tried hard and succeeded in reaching England in 1904. After diligent and successful work in English language and general education he was admitted in 1907 to the geological department of the University of Glasgow to work with Prof. J. W. Gregory. Before entering Glasgow University he travelled on the continent of Europe in 1906-1907 when he became familiar with French and German languages.

After his graduation from Glasgow in 1911, he returned to China. On his own initiative he landed at Saigon and travelled in Yunnan, Kueichow and Hunan provinces in order to make acquaintance with the geographical and geological features of this area to which he later devoted much more work.

In 1912 Ting taught biology in a middle school in Shanghai and wrote in Chinese a good text-book of zoology. He was soon invited by the Ministry of Industry and Commerce in Peking to be Chief of the Geological Section, a position which he took up in February 1913 under Mr. Chang Yi-ou[2], chief of the Mining

1 江蘇泰興縣黃橋 2 張軼歐

Department. In view of the fact that geology was yet a science quite new in China, and there existed too few people who were really able to do any serious work, Ting quickly saw the necessity of training a number of younger men. This work was done jointly with Mr. H. T. Chang[1] a geologist graduated from the University of Tokyo, in Japan. Chang became the director of a Geological School started in July 1913 while Ting himself devoted his time chiefly to field work. He made the geological map of the whole area between Shihchiachuang[2] and Taiyuan[3] and investigated the coal, iron ore and pyrite resources of several districts of Shansi province. In his geological work of this early period he was helped by Dr. F. Solger, a young German geologist who had taught geology for more than two years in the Imperial University of Peking. The Geological Department of the University was stopped in 1912 and the full equipment was loaned to the new Geological School established by the Ministry of Industry and Commerce. Ting intended to engage Solger as the principal professor in this school, but this plan could not be carried out as Solger was taken prisoner by Japanese troops at Tsingtao in 1914 and his place was taken by Dr. Wong Wen-hao[4] who returned from Belgium early in 1913.

Ting's main work was in Yunnan. He arrived in Kunming[5] the capital of the province in February 1914 and started his investigations in Kochiu[6] district well known for tin production. At that time, tin at the total value of ten to twenty millions of dollars was produced every year, although the output has been still further increased later. He went back to Kunming in April and soon left again for the eastern and northern parts of the province chiefly covering Fuming[7], Wuting,[8] Yuanmou[9], Tungchuan[10], Chiaochia[11] and Chutsing[12] districts. He penetrated also in the border of Kueichow province and crossed the River Chinsha-chiang[13] to work in Huili[14] district of Szechuan province. In these extensive travellings which lasted till the winter of 1914, Ting did his best to make geological maps, collect rich fossils and pay special attention to mineral deposits. He also gathered interesting material on the historical development of the local mining and smelting industry. He profited of the opportunity to make also a number of anthropological measurements of the local tribes.

Ting wrote several short papers on mineral deposits, chiefly the copper mines of Tungchuan. He emphasized the difference between the older and modern mining and metallurgical methods and endeavored to prove the necessity of modern-

1 章鴻釗 2 石家莊 3 太原 4 翁文灝 5 昆明 6 箇舊 7 富民 8 武定 9 元謀
10 東川 11 巧家 12 曲靖 13 金沙江 14 會理

ization. As China since long years tradition relied on copper or brass coins as main currency, the deposits of Tungchuan were important in the supply of copper for the whole country since the latter part of the seventeenth century, and since then the industry has been controlled by the central or provincial government.

Ting was back in Peking at the end of 1914. He had to teach palaeontology in the Geological School because at that time this subject could be given by nobody else. He worked hard however to increase the time and opportunity for the practical training of the students. The educational program was thus reorganized so that field excursions became necessary and more extensive. In each excursion students were taught to observe, sketch, collect and map. He set a personal example in the work and both professors and students travelled far in several provinces. In the summer of 1916 each student was given a special area to investigate from which a thesis should be submitted. The graduates of this school including C. C. Wang[1], C. Y. Hsieh[2], L. F. Yih[3], C. C. Liu[4], T. H. Chow[5] etc. were admitted junior members of the Geological Survey which was then reorganized and practically established at that time as a special department under the Ministry of Agriculture and Commerce. Ting was appointed director of the Survey.

Ting insisted on the necessity of separation of work between survey and education. The Geological School of the Ministry was then stopped while a new department of geology was created in the National University of Peking as a proper center of forming new geologists. H. T. Chang and W. H. Wong entered also in the Geological Survey as divisional chiefs, taking no part in the University teaching.

In the earlier period the Geological Survey's work was concentrated on the mineral resources, chiefly coal, iron ores and incidentally antimony. Some Swedish geologists, specially Messrs. J. G. Andersson and F. R. Tegengren, advisers to the Ministry, contributed important parts to the earlier investigation of iron ores. Field observations on coal and other minerals were also extensively made by Chinese geologists and mining engineers utilizing the Geological Survey as the main center of these activities. A summary of all mineral resources was published by W. H. Wong.

Areal mapping was also begun. A sample of special study was the memoir on the geology of the Western Hills of Peking including a geological map on the scale of 1:100,000 published under the authorship of L. F. Yih, but Ting contributed

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1 王竹泉 2 謝家榮 3 葉良輔 4 劉季辰 5 周贊衡

a good part in the preparation and editing. A general mapping of the whole country on the scale of 1 : 1,000,000 was projected and the first folio entitled the Peking-Tsinan Sheet was issued.

The puplication of the Bulletin and Memoirs of the Geological Survey was started in 1920 and continued without interruption to the present. Besides the geological papers, Ting established a special series dealing with the mining industry. The first volume on the general statement of the mineral industry was compiled by Ting and Wong recording events and statistics since the beginning of the Republic.

Ting was an enthusiastic patriot and had wide interest beyond geology. He went to Europe in 1920 together with the well known scholar Liang Chi-chao[1] on the occasion of the peace conference at Versailles. He profited of the occasion to visit the scientific men in different countries and returned to China through the United States of America. Realizing the necessity of more detailed work in palaeontology and stratigraphy in China, he asked Dr. A. W. Grabau, formerly Professor at the Columbia University, to come to Peking in 1920. Grabau was then appointed Palaeontologist of the Geological Survey and Professor at the University of Peking. Ting also recommended Mr. J. S. Lee[2] then graduate from England to the University. Thus without being professor himself, Ting engaged for the University two great professors for palaeontology, petrography and related branches. This is a good example of his devotion to geological science both in education and work.

Palaeontological contributions soon became extensive and important. In order to publish these papers at a necessary standard, Ting started a new set of memoirs Palaeontologia Sinica which has fast grown to become one of the most important palaeontological series in the world.

Up to 1921, the Geological Survey offices were all located at 3, Fengsheng Hutung, Peking. The space was limited and some extension was necessary. Ting raised necessary fund from private contributions to construct a new building for a Library at 9, Ping-ma-ssu, which became since then the main center of the Geological Survey leaving the old buildings of Fengsheng Hutung, as the center for exhibition. Donations were indeed necessary for new buildings and for new publications such as Palaeontologia Sinica as the regular budget of the Survey was very small, scarcely enough to pay the modest salary of the whole staff.

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1 梁啓超 2 李四光

Ting, in spite of the many kinds of work in the organization of the Geological Survey, was never tired of doing field work himself. He studied in great detail the coal field of I-hsien[1] in South Shantung and planned the prospecting work for the Chung-hsing[2] company which has become now one of the most prosperous coal mines in China. He travelled in South Anhui, Kiangsu and Chekiang and prepared a memoir on the geology of the Lower Yangtze which was published by the Hwangpo Conservancy Board in Shanghai. In this memoir, he tried to explain the various changes of the lower course of the Yangtze and to estimate the rate of advance of the shore line.

In studying the main iron ore deposits of the country an area of oolitic hematite ores was discovered by members of the Geological Survey in Hsuanhua[3] and Lungkuan[4] districts in North Chihli (now considered to be part of Chahar). A company was formed for the development of these ores and a blast furnace established at Shihching-shan[5] near Peking in 1920. Ting was one of the directors of this Lungyen[6] Company and contributed some work in studying the iron ores and finding the manganese deposits in Changping[7].

Ting paid particular attention to the development of natural resources in China. In view of supplying fuel to the Railway between Tientsin and Mukden, in 1921 he accepted the position of general Manager of the Peipiao[8] Mining Company for working coal in East Jehol. In order to devote his full energy to this work, he became honorary director of the Geological Survey and asked the Ministry to appoint Wong acting director of the Survey to actually take care of the practical direction. He planned the whole development of the Peipiao mine which produced after two years of preparation almost three thousand tons of coal a day. This is a remarkable example of efficient work when the capacity of production and the modest amount of capital are considered.

Ting was a great admirer of Hsu Hsia-ko[9], a Chinese geographer of the seventeenth century who travelled extensively in the country and left remarkable records of his journeys. Ting specially pointed out that Hsu was the first Chinese who ascertained the true source of the Yangtze River and made surprisingly accurate interpretation of the volcanic phenomena of Yunnan and the karstic topography in Kwangsi. Ting prepared in 1923 a biographical note year by year of the work of Hsu with an atlas of maps showing the main geographical features described by him. A little later Ting obtained also rich data of the recent military affairs and published a book recording the most important military feature of China.[10]

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1 嶧縣 2 中興 3 宣化 4 龍關 5 石景山 6 龍烟 7 昌平 8 北票 9 徐霞客 10 中國軍事近紀

The China Foundation for the Promotion of Education and Culture was established to administer the indemnity fund returned by the United States. Ting was one of the trustees in 1923 and obtained a yearly subvention for the Geological Survey. In 1925 Ting was one of the three Chinese members of the advisory committee for the British part of the indemnity fund. But at that time he was deeply interested in the politics of the country. He felt the necessity of a thorough political reorganisation without which it is even not possible to successively conduct scientific research. He approached General Sun Chuan-fang[1] who was chief of Kiangsu and four neighbouring provinces. He became Mayor of Shanghai and Wusung in 1925. In this position he endeavored to obtain for the Chinese government the control of the mixed local court in Shanghai which was largely under the influence of foreign consuls. His strong determination combined with sincere and eloquent talk has well exemplified the best spirit of the younger generation in China. He created the public health department, reorganized the bureau for public utilities and practically laid down the foundation for a modern municipality in Shanghai. It was he who first recognized the necessity of utilizing the lower course of Huangpu River and by this way extending the area of the great port.

In the north the north-eastern troops under Fengtien leaders, were then all strong and certain commanders attempted to occupy Kiangsu and Anhui. Ting was opposed to these less well-disciplined troops suspected of friendship with some foreign country, and he tried hard to persuade his colleagues to establish modern administration in the area under their control.

In 1927 Sun Chuan-fang refused to cooperate with the revolutionary army of Chiang Kai-shek who came from Canton and fought hard against them in Kiangsi. Hsia Chao[2], Governor of Chekiang, suddenly attacked Shanghai with about thirty thousand soldiers. Ting quickly counter-attacked together with General Li Pao-chang commanding less than three thousand men and was completely victorious. After the death of Hsia his troops were entirely disorganized. Sun Chuan-fang was however soon defeated near Kiukiang[3] and went to Tientsin to beg the leaders of the Fengtien army for military help. Ting being dissatisfied with this policy resigned from his position. The same attitude was taken by Chen Tao-yi[4], Governor of Kiangsu province. Chen Tao-yi began his earlier career as a member of the revolutionary party Tung-men-wei under the leadership of Sun-yat-sen and was well known for his highly honest and patriotic character.

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1 孫傳芳 2 夏超 3 九江 4 陳陶遺

After his resignation from Shanghai Ting had difficulty in providing for the subsistance of his family and had to rely upon loans from friends. After a short time spent in Peking he went in 1928 to Kuangsi province and travelled widely to see tin and coal deposits. In 1929 he together with Wong planned systematic geological observation and mapping in the southwestern provinces for which several parties were to be sent by the Geological Survey. Ting himself led a party and went from Chungking[1] into Kueichow province supported by a fund from Dr. Sun-fok[2] then Minister of Railways who was then much interested in Ting's work. Y. T. Chao[3], the leader of another party who travelled from Suifu[4] into Yunnan was killed by bandits at Hsiasinchang[5] in North Yunnan. This was a very serious blow to Ting, specially so as Chao was one of the best younger geologists highly esteemed by Ting. In spite of the irreparable loss however he continued the work in Kueichow and went to the border of Kuangsi province on the south and made detailed stratigraphical observations of Palaeozoic strata with rich palaeontological collections all along the routes he traversed. This was probably the best field work he did in his whole life, because he had become more mature in his methods, better equipped with stratigraphical knowledge available from elsewhere and specially because he had at that time decided to devote his full energy to scientific work again. He was well assisted by Messrs. T. K. Huang[6] and Y. L. Wang[7], the former extended the observation to a more western area in Kueichow province. For the surveying work he had the help of Mr. S. Y. Tseng[8] who determined the latitude and longitude of a number of places.

After almost one year of field work he returned to Peking where he worked hard to study the maps and sections and make stratigraphical correlation with the palaeontological advises of A. W. Grabau, T. K. Huang, T. H. Yin[9], C. C. Yu[10], and Y. S. Chi[11]. The discussions led by him were indeed a great stimulus to the other scientists who found thus their work the more interesting. It was the intention of Ting to systematically arrange and revise all the geological and palaeontological data obtained from Yunnan, Kueichow and Kuangsi provinces for publication by the Geological Survey.

Meanwhile Ting continued his interest in several other studies. He wrote his plan of Szechuan-Kuangchowan railway and started in collaboration with Wong and Tseng the edition of a new atlas of China in commemoration of the sixtieth anniversary of the establishment of the great daily journal Shen-pao[12]. He

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1 重慶 2 孫科 3 趙亞曾 4 敍州 5 閘心場 6 黃汲清 7 王曰倫 8 曾世英
9 尹贊勳 10 俞建章 11 計榮森 12 申報

attempted to write a systematic history of China beginning from the prehistoric periods. This work was not completed, but a sample can be seen from his article "How China acquired her civilization?" published in the symposium of Chinese culture by Mrs. Zen. In that short paper he strove to prove the real evolution and progress of Chinese civilization in contrast to the older Chinese view which used to attribute better accomplishment to older periods. He had the ambition also to write a review of the physical anthropology of Chinese people for which he collected rich material from other workers besides his own data and prepared elaborate tables of comparison.

Ting became professor at the National Peking University in 1931-1934. He taught general geology and spared no effort in showing that typical features in China well illustrated the phenomena of erosion and deposition, volcanism, earthquake and various other things. He led students on excursions in which geological problems were attacked. Chinese students were thus made familiar with dynamic geology through the typical samples well displaid at this home land. A number of assistants such as C. S. Kao[1] and K. K. Chao[2] were inspired by the example of the enthusiastic professor and determined to continue research work.

The Japanese aggression happening in Manchuria and Jehol since September 1931 and the continued trouble and menace towards the interior of the country caused intense anxiety to the patriotic Chinese in Peking. Many of them specially felt the necessity of better knowledge of the real condition and better leadership of public opinion. A weekly review, Independent Critic[3], was organized by Hu Shih[4], and Ting contributed a number of articles on Japanese politics and finance. He published also in the same review his scattered notes of travelling[5] in June 1932-January 1934 which included his first journey in Yunnan and Kueichow, impressions in the Taihangshan[6], tin mines in Kochiu, copper mines in Tungchuan, native tribes in Yunnan and South Szechuan and brief description of Chinshachiang. He purposely avoided the treatment of geology in these notes, but they are none the less very precious because of the clear and masterful observations therein contained on the physical geography, mining industry and particularly ethnography of the regions traversed.

In 1933 Ting attended the sixteenth session of the International Geological Congress in Washington and New York. He presented two papers on the stratigraphical division of Carboniferous and Permian on the basis of Chinese observations in comparison with other classical sections abroad.

1 高振西 2 趙金科 3 獨立評論 4 胡適 5 漫游散記 6 太行山

After the Congress, he went again to Europe. He revisited Glasgow where he got his scientific education, Sweden to meet his old friend Andersson and proceeded to the Soviet Union where he spent more time in studying geological features and industrial development. He was well helped by the Academy of Science and the United Geological and Prospecting Service of Soviet Russia and visited the oil field of Baku and other places of scientific or economic interest. Some notes have been published in the Independent Critic on his journeys in Russia from which it is clear that he was deeply impressed by the tremendous work of reorganization and construction done by the new generation in the Soviet Union and he sincerely admired the enthusiasm with which such work was accomplished, involving often considerable sacrifice at the beginning, but resulting in great permanent benefit for the nation. In some articles contributed to the Tientsin Journal Ta-kung-pao[1] he expressed his belief in the unification of the country, government control of economic construction, and strong determination in national policy which is to be upheld even at the price of territorial loss. He could not avoid the conclusion that mere superficial economic work could not really succeed without a solid and strong political basis and to have such a basis men of modern knowledge and judgment are absolutely necessary. He deeply felt his own duty toward the country.

As soon as he returned to China, he was requested to accept the position of Secretary General of the Academia Sinica. He hesitated at first and continued his teaching at the National Peking University. He was however earned to accept the offer and began his work in the Academia Sinica in the summer of 1934. His work was well supported by President Tsai Yuan-pei, who gave him complete confidence, and his colleagues such as Mr. Fu Ssu-nien[2]. He resided hereafter in Nanking.

The Academia Sinica was the last institution to which Ting devoted his entire energy. He considerably reduced the general expenditure and redistributed the budget of the research institutes according to their real need. He specially promoted the ethnographical and philological studies in the Southwest, and the biological research along the coast. The Council of Academia Sinica was organized, consisting of a number of prominent Chinese scientists who have to meet once every year. Wong was elected Secretary of the Council.

1 大公報 2 傅斯年

During the whole time while he worked for the Academia Sinica, he refrained from expressing too clearly political opinions in his writings and exerted great care in the improvement and better coordination of scientific work in China. Meanwhile he endeavored to understand the significance and methods of research in every institute of the Academia Sinica and tried to promote still better organization. Thus he invited Dr. Chuang Chang-kung[1] to the directorship of the Institute of Chemistry which was largely reorganized. He did not lose sight of industrial research and encouraged experimental work on the alunite deposits of Chekiang.

At the same time, he studied the languages of local people of the South-west and published in 1935 his memoir[2] containing interpreted collections of local writings.

In 1935 when the Geological Survey had already moved to Nanking and the new building of the Geological Society of China in the same city was completed, Ting decided to build a new house for the central office of the Academia Sinica in order to have better control of the whole institution and to unify the library which was so far scattered among different research institutes.

Ting was also one of the small group of men who promoted the building up of the National Museum in Nanking. As the National Library of Peking has then already been well started through the help of the China Foundation, it was considered well first for constructing the National Museum in the new capital. And through his effort understanding has been reached with the Academia Sinica, Antiquities Exhibition and Geological Survey for contribution of specimens of scientific interest to the new Museum when it will be in due shape.

Ting's ability in the industrial construction work was well appreciated by Generalissimo Chiang Kai-shek. He was thus appointed standing member of the Directing Committee of the National Resources Commission and Chairman of the Preparation Committee for Iron and Steel Works at Ma-an-shan[3], southern Anhui.

In December 1935, he was asked by the Ministry of Railways to inspect the Siangtan[4] coal mines for the locomotives of the Canton-Hankow rail-line and by the Ministry of Education to examine the surroundings of Changsha[5] for the moving southward of the National Tsinghua University. He did the work and studied the geology of Hengshan. He became asphyxiated by coal gas when he

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1 莊長恭 2 爨文叢刻 3 馬鞍山 4 湘潭 5 長沙

was in Hengyang[1] from where he was transported to Changsha. He was visited while in the treatment by Wong and Fu. Despite medical treatment he died in the Yale Hospital of that city on January 5th 1936 at the age of forty nine years.

Apart from the facts above mentioned, Ting was also President of the Geological Society of China, Foreign Correspondent of the Geological Society of London, Honorary Director of the Cenozoic Research Laboratory of the Geological Survey, Chief Editor of Palaeontologia Sinica, one of the Trustees of the Nanking University, the Peiping Union Medical College and the China Foundation.

It is as yet difficult to write a complete biography of Ting because of his wide interests in numerous subjects and manifold activities in scientific, economic, administrative and political life. The present paper only pretends to give a preliminary outline. He had a rapid and brilliant intelligence which permitted him to grasp essential ideas and facts in a short time. He was sincerely patriotic and enthusiastic, doing well the work on every line. He particularly appreciated and encouraged younger generations and through his lead many younger men have been inspired to adopt a career and life work of service. He was a deep believer in science and despised any thought or method that he considered to be not scientific. Thus he never accepted medical advise or treatment of any Chinese doctor of the old school even when he fell ill in his travelling. Although he was by nature interested in political work, he did not blindly believe in any particular doctrine, but he chiefly insisted on the necessity of having good men in the government working with conscience and patriotism. This idea of "good men government" was proposed by him together with Hu Shih and other friends in 1924. By good men he also meant those careful in disposal of public funds and of personal integrity. This was practised by himself as there remained only a few thousand dollars after his death and his wife has to rely only upon the income from his life-insurance.

He had a great linguistic ability. His wide interest and enthusiastic attitude could not but win warm friends among Chinese and foreigners. He was very careful in scientific writing and never ready to publish any thing before he felt completely sure of it. For this reason the larger amount of his geological material remains so far unpublished and much of this material is even better than what he has already published in preliminary notes. The delay was also partly due to palaeontological studies. In such condition it may be hoped that much more light may still come from the study of Ting's field notes, drafted maps and sections when his colleagues as Huang, Yin, etc. will spare enough time to correlate them.

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1 衡陽

Ting was married in 1911. He had no children. He had one elder brother and five younger ones. His last will was written about one year before his death in which he instructed that his home property should be distributed to his brothers, his wife should live on his life insurance income and his geological books should be presented to the Geological Society of China. He wished also that his remains be simply buried in an area not larger than half a mou within the district of his death. All the provisions were carried out accordingly and Ting's body was buried at Tsochialung[1] near Yolushan[2] west of Changsha.

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1 左家壠 2 岳麓山

LIST OF PLATES

22 : KsSA1 Sections for Kuangsi, Figs. 1-35 & Fig. 37.

23 : KsSA2 *Ibid.* Fig. 36 & Figs. 38-68.

24 : KsSB Detailed section of the Mining area of Changpo, Nantan, Kuangsi.

25 : KMA1 A Reconnaissance map of Dr. V. K. Ting's Geological Expedition to the Southwestern Provinces of China (1929-1930) (1).

26 : KMA2 *Ibid.* (2).

27 : KMA3 *Ibid.* (3).

28 : KMA4 *Ibid.* (4).

29 : KMA5 *Ibid.* (5).

30 : KMA6 *Ibid.* (6).

31 : KMA7 *Ibid.* (7).

32 : KMA8 *Ibid.* (8).

33 : KMA9 *Ibid.* (9).

34 : KMA10 *Ibid.* (10).

35 : KMA11 *Ibid.* (11).

36 : KMA12 *Ibid.* (12).

37 : KMA13 *Ibid.* (13).

38 : KMA14 *Ibid.* (14).

39 : KsA1 Sections for maps stated above. Figs. 1-16.

40 : KsA2 *Ibid.* Figs. 17-41.

41 : KsA3 *Ibid.* Figs. 42-71.

42 : HM Geological map along routes in the Szechuan-Yunnan-Kueichou border region by T. K. Huang.

43 : HS1 Sections along routes in the Szechuan-Yunnan-Kueichou border region by T. K. Huang. Figs. 1-19.

44 : HS2 *Ibid.* Figs. 18-42.

45 : HS3 *Ibid.* Figs. 43-61.

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Geological notes in Yunnan and Hueili, etc.

Geological Notes in Yunnan and Hueili and Weining Districts

Edited by T. H. Yin and C. S. Pien

CONTENTS

I. EDITORIAL REMARKS.

Dr. V. K. Ting's first travel in Yunnan dated back to 1911. He debarked at Haiphong on the ninth day of May and arrived at Kunming on the twelfth. During his sojourn in the capital of the province he made observations in its vicinities, and on May 29 he left the city for a long reconnaissance journey across Kueichou and Hunan. Following the old mandarin road he passed through Panchiao, Yanglin, Yilung, Malung, Chutsing and Pingyi and entered Kueichou from west of Yitzukung. No sketches, nor sections, accompany the field notes taken during this journey[1], the first of its kind ever made by a Chinese geologist. Unfortunately, it is impossible for us to give an adequate account of his observations.

Much more extensive is his second travel in Yunnan. He left Peking on December 6, 1913, and arrived at Yunnanfu (now Kunming) on February 13, 1914.

The field work in the Kochiu district was done in the spring of 1914. He returned o Kunming on April 13, where a detailed report on the geology, ore deposit, and mining industry of the district[2] was prepared and mailed to the Minister of Agriculture and Commerce before he left the city for a long tour through Northeastern Yunnan and adjacent regions. The "Geology of Kochiu district" was probably written after his return to Peking a few days before the end of the year. The tin-field of Kochiu was subsequently studied in detail by H. M. Meng, K. Chern and others. From their reports a much advanced knowledge has been gained in the subject. It is nevertheless rejoicing to read this paper which is the harvest of a forty days' survey at a time when geology in China still remained in its bare infancy. The editorial work is confined to corrections of *lapsus calami* and to changes of spelling of Chinese geographical names in accordance with the transliteration system adopted by the Geological Survey; otherwise the original text is respected.

Having spent a few days for necessary arrangements in Kunming, he left on April 24. During the tour of nearly seven months he surveyed a grater or lesser part of the districts of Kunming, Fumin, Wuting, Luchuan, Yuanmu, Hueili (then of Szechuan, now of Sikang), Chiaochia, Tungchuan, Hsuanwei, Weining (in Kueichou), Chanyi, Pingyi, Chutsing, Loping, Malung and Sungming. He returned to Kunming on November 18, and arrived at Peking a few days before the end of the year.

The diary bearing the following dates are mainly from Dr. Ting's own hand:

April 24 — May 20
May 30
June 7 — June 8

1. Dr. Ting compiled a detailed route map for his journey; this is kept in the Library of the Geological Survey of China.
2 Mem. Geol. Surv. China, Ser. B, No. 10, 1937.

June 16 — June 19
June 21
August 5 — September 14
November 6 — November 18

For the remaining dates the diary is compiled by us from his field notes.

May 21 — May 29
May 31 — June 6
June 9 — June 15
June 20
June 22 — August 4
September 15 — November 5.

The generalized geological map prepared by the author on the scale of 1 to 1,267,200 is reproduced in Plate 7:YMC and reduced to 1 to 1,500,000. Plate 1:YMA1 to 5:YMA5 are more detailed maps originally drawn on the scale of 1 to 200,000; they are reduced in printing to that of 1 400,000. To what degree can we trace and reconstruct the author's original conception from materials left to us? This varies within a wide range according to the degree of completeness or incompleteness of the material. This variation should be expressly specified so as to determine the editorial responsibility in case of misrepresentation. With this in view we classify the mapped region into four groups of areas as follows:

Group A 1. Hsuanwei area (Pl. 6:YMB).

Group B 1. Fumin to Chinchiang (Pl. 1:YMA1) and thence to Paikuowan via Hueili (Pl. 2:YMA2);

2. Copper mine area west of Tungchuan (Pl. 2:YMA2);

3. From Tangtang to Tiehkuangshan via Weining (Pl. 3:YMA3);

4. Pingyi area (Pl. 4:YMA4);

5. From Chutsing to Yilung (Pl. 5:YMA5);

Group C 1. From Hueili to Yenching on the Yangtze (Pl. 2:YMA2);

2. From Chanyi to Shuchih via Loping and from Loping to Pichechang (Pl. 5:YMA5);

Group D 1. Tungchuan — Chehai — Yilu — Huanglishu — Kuangshanchang — Tsienshanpo (Pls. 2:YMA2, 3:YMA3, 4:YMA4);

2. From Hsuanwei to Pingyi via Chanyi (Pl. 4:YMA4).

The areas of group A remain essentially what the author had drawn. Those of group B are corrected copies from his colored field sketches. Geological boundaries and other features of the areas of group C can be drawn in most cases from his notes and scattered sketches. But for the remaining, *i.e.,* areas of group D, it is often very difficult to plot on the map what he had put in his note-books.

Nobody realizes better than ourselves that there are, throughout the text and maps, numerous cases of inconsistency and lack of uniformity. They are left as such not unintentionally, with a view to conserving the original presentation of Dr. Ting.

An extensive reconnaissance survey does as much to give rise to problems as it can solve them. Fully realizing the importance of the region traversed by him and of the problems arising from his observations, Dr. Ting planned a second trip to Yunnan. But he was retained by multiple duties from the personal undertaking of this trip. Mr. Y. L. Wang was then sent to Yunnan to carry out the plan. In 1930-31, Mr. Wang restudied many of the sections measured by Dr. Ting and made a rich collection of fossils therefrom. After his return to Peking he transmitted his material to Dr. Ting for a joint authorship of a report on the geology of Yunnan. This report was commenced but far from being finished when the untimely death of the senior author deprived China of one of her most illustrious pioneer scientists. The two papers, one on "The Chutsing Valley and its adjacent plateau" which is inserted in the present memoir as Chapter XVIII and the other on the "Cambrian and Silurian formations of Malung and Chutsing districts, Yunnan" published in 1927, are the only outcome of their collaboration. Were it possible for Mr. Wang to resume the work left by Dr. Ting and to incorporate his own material to the projected report, the final result would indubitably gain in accuracy, details, and systematism. Owing to various circumstances this has not been done.

Geology has made rapid progress during the last three decades. Some of Dr. Ting's views can no longer hold while much precision has been attained in stratigraphy as well as in structural geology. It is obvious that publication of recent works has been handicapped by the war, yet we find the following titles representing some of the published references to which readers are referred for a more up-to-date information on the geology and ore deposits of the areas covered by Dr. Ting.

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II. DR. V. K. TING'S ITINERARY IN YUNNAN.

December 1913

6 left Peking

January 1914

19-31 Shanghai

February

1 Shanghai
2 Left Shanghai
5 Arrive Hongkong
6 Left Hongkong
6- 9 Steamer
9 Haiphong
10 Hanoi
11 Laokai
12 Amichou (Kaiyuanhsien)
13-17 Yunnanfu (Kunminghsien)
18 Amichou
19-24 Kochiu
25-26 Yintung
27 Changchung
28 Hsinshan

March

1- 2 Tienhsin
3- 4 Kafang
5-13 Kochiu
14 Maloko
15 Kochiu
16-17 Kafang
18-21 Kochiu
22-23 Shaoku
24 Liufangchai
25-31 Kochiu

April

1- 7 Kochiu
8-10 Mengtzu
11 Amichou
12 Niaoke
13-23 Yunnanfu
24 Litzuping
25-26 Fuminhsien
27 Chepei
28 Lengtsun
29-30 Wutingchou (Wutinghsien)

May

1 Wutingchou
2 Yinachang
3 Wutingchou
4 Sapushan
5- 6 Luchuanhsien
7 Wutingchou
8 Huachiao
9 Shihlata
10 Lukutsun
11 Asala
12-14 Huanchou
15 Chikuanshan
16 Chüning
17 Pati
18 Chüning
19 Hailo
20 Chinchiang
21 Kiangyi
22 Lushuiho
23 Pochiao (Pulungho)
24 Hsinputzu
25-28 Tunganchou
29-30 Luchang
21 Fengshanying

June

1 Fengshanying
2 Luchang
3- 6 Hueilichou (Hueilihsien)
7 Lungchaoshan

8 Maomaokou
9-10 Peikuowan
11 Yimen
12-13 Tawanying
15 Hueilichou
16 Tankuanyi
17 Chiangchou
18 Kuchu
19 Pototang
20 Chaho
21 Fawo
22-24 Tiehchang
25 Tamaiti
26 Yenching
27-28 Tuopuka
29-30 Tashui

July

1 Tashui
2 Chinglungshan
3 Maolu
4 Changhaitzu
5- 6 Lohsueh
7 Paihsila
8- 9 Tangtan
10-11 Chingkou
12 Tachai
13 Taheiching
14 Erhtaoping
15 Tungchuanfu (Hueichehsien)
16 Jehshuitang
17-19 Tungchuanfu
20 Santaokou
21 Chehai
22 Yilu
23 Paopaochai
24-25 Huanglishu
26 Muchang
27-31 Kuangshanchang

August

1 Kuangshanchang
2 Santaokuai
3 Chuchiaping
4 Chienshanpo
5 Chake
6 Fangmaping
7 Tangtang
8 Chintoupu
9 Tungchangho
10 Weiningchou (Weininghsien)
11-12 Hunshuitang
13 Shangpanfang (Tiehkuangshan)
14 Maku
15 Hunshuitang
16 Yaochan
17-18 Weiningchou
19 Tapingtzu
20 Kotu
21 Hsintienpu
22-24 Tangtang
25 Laipinpu
26-28 Hsuanweichou (Hsuanweihsien)
29 Changchung
30 Houkaitzu
31 Tuchang

September

1 Wenko
2 Waluwa
3 Wenko
4- 5 Tzuying
6- 7 Paochiatsun (Chichia)
8- 9 Peiyintien
10 Paoshan
11 Lungchang
12-13 Hsuanweichou
14 Sungchakuan
15 Sunglin
16-19 Chutsingfu (Chutsinghsien)
20 Tsientsaopa
21 Hungtutsiang
22 Tumu
23 Sawutzu
24 Hsiamakai

25 Yangkaitzu
26-28 Lopinghsien
29 Ayeh
30 Shuchi

October

1- 2 Shuchi
3 Talungtien
4 Suka
5 Lopinghsien
6 Yite
7 Yikung
8 Kukangtai
9 Maokai
10 Lichiaying
11-22 Pichechang
23 Mingchiatsun
24 Tukaitzu
25 Paimashan
26-27 Pingyihsien
28 Yaochan
29 Paishui
30-31 Chanyichou (Chanyihsien)

November

1 Haitzupu
2 Panchuang
3 Ayi
4 Kolangho
5 Chukaitzu
6- 9 Chanyichou
10 Sancha
11-13 Yulungssu
14 Malungchou (Malunghsien)
15-16 Yilung
17 Yanglin
18-30 Yunnanfu

December

1- 5 Yunnanfu
6 Amichou
7 Laokai
8 Hanoi
9-10 Haiphong
11-13 Steamer
13-14 Hongkong
15-18 Steamer
19-21 Shanghai
22 Nanking
24 Peking

III. GEOLOGY OF KOCHIU DISTRICT.

A. Geography

The city of Kochiu is situated in an enclosed valley. On one side (the east side) we have the range of Laoyinshan[1], forming conical peaks and bold perpendicular cliffs, separating the city from that of Mungtzu[2]; on the west side we have the flat-topped, undulating hills. This valley is about 8 kilometers long. To the south it is limited by a low watershed on the other side of which water flows also southward, but instead of emptying itself into the Kochiu river it goes underground, and 2 kilometers further on we have the real watershed whence southward we have the valley of Takou[3] which flows past Kafang[4], Tiensin[5] and Toumuko[6] where it also goes underground. So Kochiu is the meeting place for both the water from the south and the north. These unite to go into an underground

1 老陰山 2 蒙自 3 大溝 4 卡房 5 田心 6 斗母閣

passage just north of the city. Thus if we regard the valley of Kochiu and that of Takou as a single basin then it is clear that within this basin all the water has an underground outlet—a fact of considerable importance when we come to consider the origin of the tin ore.

To the west of the low flat-topped hills of Laoyangshan[1] we have a topography of a totally different kind. There high ridges and sharp peaks at least 500 meters above the Kochiu basin come in view. Between them are the deep narrow gorges—all emptying themselves into the Red River[2]. Going from east to west we have first the Huangshaho[3], then the Chiasaho[4] and finally the Lungchaho[5], all flowing SSW. The highest peak of these ridges is the Chiaotingshan[6] so named on account of its shape. It is 800 meters above the Kochiu basin and can be seen 20 kilometers away. A glance at the map will show that all these ranges have a general direction NNE-SSW. Thus the "Massif de Ko-tiéou" as it has been called by Deprat is by no means the homogeneous mass as he supposed, but is composed of several different elements.

B. Rocks and Landforms

Before entering into the detail of stratigraphy we may first say a few words about the relation between the landforms and the kinds of rock that form them. The Laoyingshan is composed of a dark limestone which is very pure and free from any argillaceous element. It is hard and compact, containing a fair amount of iron, hence it forms the solid mass between Kochiu and Mungtzu usually in the form of conical peaks, but when decomposed, gives rise to a characteristic red clay familiar to all those who have had any thing to do with the tin mines. The thickness of this limestone is at least 400 meters. There is, however, another kind of limestone which has also a considerable thickness and must not be confused with the one described above. This is chiefly found in the S and SW of Kochiu and it has a thickness of at least 350 meters. The upper part of this limestone is blue and compact but as we go down to the lower series it becomes more and more impure often decomposing into a yellow clay (which also contains deposits of tin). This forms also perpendicular cliffs, but it gives rise to gently-outlined, somewhat undulating hills, never acquiring the typical conical form and it can be distinguished from the Laoyinshan limestone also by the fact that it contains far less iron. The Laoyangshan on the other hand is composed chiefly of a yellow clay overlaid by few meters of limestone which is also very impure.

---

1 老陽山 2 紅河 3 黃沙河 4 賈洒河 5 龍岔河 6 轎頂山

The hills between Kochiu and Kafang are also formed by it, so are these on the main road to Linan[1]. The above list practically exhausts the sedimentary rocks of the Kochiu district.

The rock that plays an important part in the landscape is granite which forms all the sharp ridges in the valley of Huangshaho, Chiasaho, and Lungchaho. In addition there are two separate small exposures: one at Chungmenkou[2], the other at Paishapo[3] near Kafang. The typical rock is a pegmatite containing a little tourmaline which, when decomposed, gives rise to a white sand. This is due to the fact that the felspar is thoroughly decomposed, leaving the quartz as sand. In the valley of Huangshaho and westwards it contains more felspar and is also relatively harder hence the sand formed is yellow. Near the village of Hsiashihlung[4] we have a true graphic granite which is also entirely decomposed. Besides, some darker bands are well exposed near the village of Kuchihpai[5], the darker element is probably tourmaline. This often causes the formation of waterfalls in these rivers.

C. Stratigraphy

In the sedimentary series fossils are unfortunately very rare and we have to rely on their field relation and petrographical character. The former is again very much disturbed and their relation is sometimes rather uncertain. Putting all available evidence together I give them the following classification:

1. The Kafang limestone, 350 m
   a. Upper—blue and compact containing irregularly bedded impure coal
   b. Lower—yellowish grey very argillaceous
2. The Yangshan series
   a. Oolitic limestone
   b. Reddish yellow clay
   c. Argillaceous limestone
   d. Black limy shale

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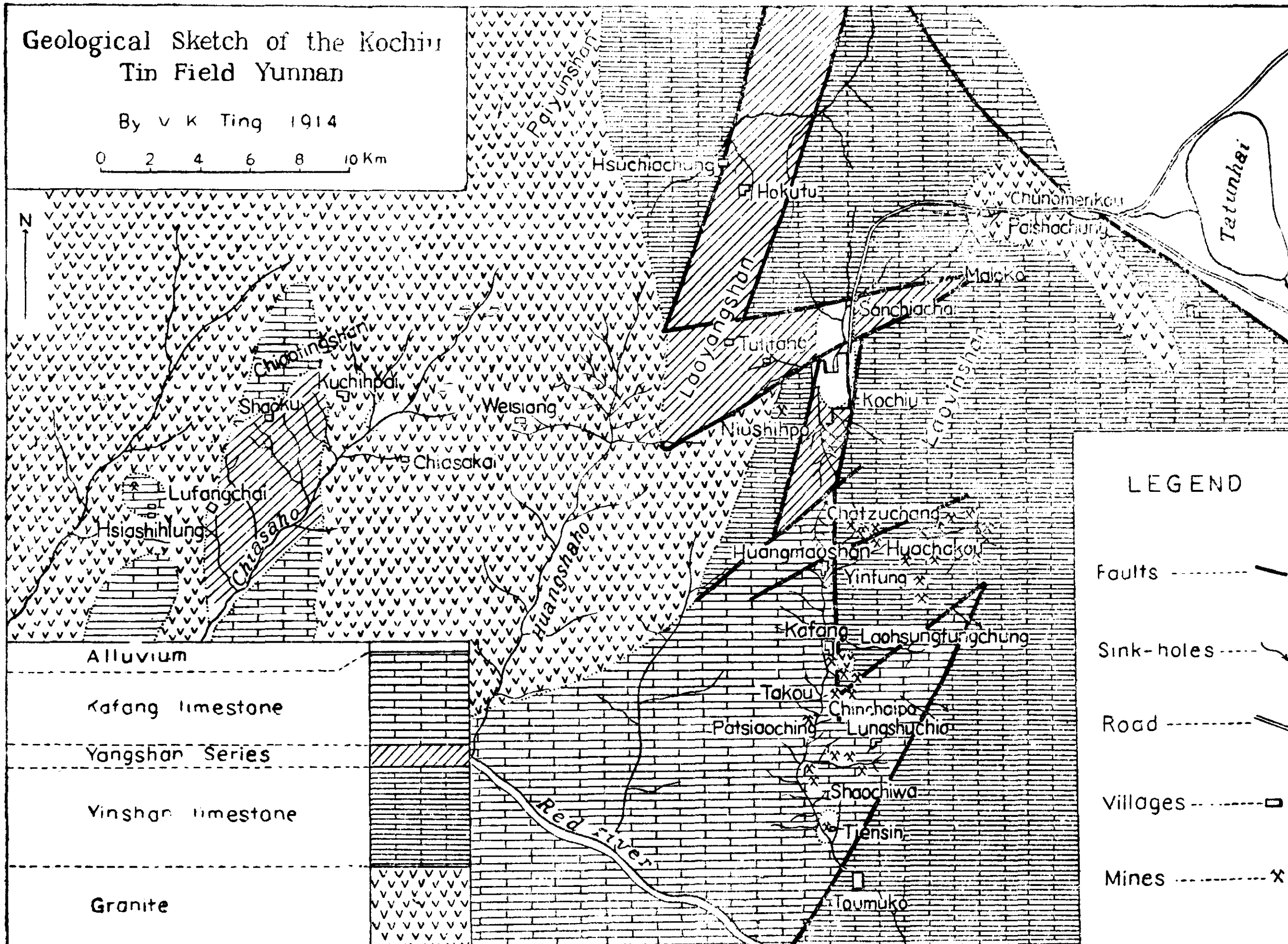
1 臨安（今名建水） 2 冲門口 3 白沙坡 4 峽石龍 5 枯枝白


Geological Sketch of the Kochiu Tin Field Yunnan
By V K Ting 1914
0 2 4 6 8 10 Km
N
Paiyunshan
Hsuchiachung
Hokutu
Chunomenkou
Paishachung
Tatunhai
Maicko
Sanchiacha
Laoyangshan
Tulitang
Kochiu
Laoyinshan
Niushihpo
Chiaoingshan
Kuchihpai
Shaoku
Weisiang
Chiasakai
Lufangchai
Hsiashihlung
Chiasaho
Huangshaho
Chatzuchang
Huangmaoshan
Huachakou
Yintung
Kafang
Laohsungtungchung
Takou
Chinchaipa
Patsiaochiang
Lungshuchio
Shaochiwa
Tiensin
Taumuko
Red River
Alluvium
Kafang limestone
Yangshan Series
Yinshan limestone
Granite
LEGEND
Faults
Sink-holes
Road
Villages
Mines
Fig. 1

e. Coaly slates

Total thickness about 100 meters

3. The Yinshan limestone, 500 meters.

4. Granite

Of the 4 series only the first 2 are conformable; the Kafang limestone certainly passes down to the clay series—this is first seen in the beds near Kafang and in the series which forms the Chiaotingshan where the limestone forms the high peak with the slates and clay at the bases. The relation of series 3 to the first two is however not at all clear, for it is faulted in all directions and I have never seen its lower limit—its upper part being limited only by the eroded surface. The granite is usually on the faulted junction of the Yinshan limestone and the other 2 series and is the youngest of all. No other fossils than some oolites which might be foraminifera are found in series 3 but in the upper Kafang limestone I found a few brachiopods (near Tiensin) and in the hill near Sanchiachai[1]; an imprint is found in the clay which might be *Myophoria.* The oolitic limestone in the upper Yangshan may prove to be *Fusulina* bearing but at present it is difficult to say any thing about their age. Comparing what I saw with the work of Deprat the Yinshan limestone answers well his Uralian and the series 1 and 2 are probably his Triassic (middle and lower respectively). If this identification is correct then the granite is certainly Triassic and Lantenois was right after all. A glance at the map will show their distribution is not at all simple—the Yinshan limestone forms 2 parts: one is the Laoyinshan proper and its prolongations to the south; the other part begins with the Paiyunshan[2] just behind Hsuchiachung[3] but is soon separated by the Laoyangshan and the granite. The space between these two belts is occupied by the Kafang limestone in the south and the Yangshan series in the north. Both the Kafang limestone and the clay series are found in the west in an isolated belt with Chiaotingshan as the northern limit. The limestone forming the isolated hill at Hsiashihlung is so intensely metamorphosed that it is difficult to identify it with certainty but I think it is the same as that of Chiaotingshan. The Yinshan limestone has as a whole a strike running from NNE to SSW, but the other 2 are striking almost N-S. It is to be noted that their strike does not correspond to the direction of the mountain ranges.

D. Tectonics.

Let us now consider the tectonics of the region as a whole. All the beds in the district are without exception intensely disturbed especially the soft Yangshan

1 三家砦 2 白雲山 3 徐家冲

series. There are two main sets of faults almost at right angles to one another. The most important of the first set may be called the Laoyinshan faults which run from the north of Kochiu southward to the village of Chinchaipo[1] almost without interruption. It is continued both north- and south-ward but with some interruptions and in the S, a slight change of direction, being more inclined to NE-SW than before. Parallel to this are the faults on the west side of Kochiu which may be termed Hsuchiachung and Niushihpo[2] faults. They both divide the Yinshan limestone from the Yangshan series but the continuation of the latter also divides the Yinshan limestone from that of Kafang. The second set runs from ENE to WSW and consists of at least 4 parallel faults—the Sanchiachai, Laokochiuchung[3], Huangmaoshan[4], and the Chinchaipo faults. So there must have been at least two sets of forces, one acting in the direction NNW-SSE, the other, WNW-ESE. I think the first of this must be closely associated with the intrusion of granite but the second one is of a much later origin (which will be considered more fully later). There however must have been another older set of forces which caused the NNW-SSE strike in the Yinshan limestone, for I consider this strike to be older even than the intrusion of granite. This probably had already caused unnatural relations between the Yinshan and the other 2 series; when the intrusion of granite took place, the soft Yangshan series was broken through, the Kafang limestone uplifted and metamorphosed, but the harder Yinshan limestone resisted the pressure much better and retained much of its original structure, though in many places contact has changed it profoundly and gives rise to faults.

E. *Physiography*

I know no place where the physiography is more interesting. As I have described before, the Kochiu-Kafang basin is full of underground caves. All the valleys except this run continuously towards SSW. This direction of the drainage is fairly certain to have been formed at the time of the granite intrusion. At that time it is sure that the Kochiu-Kafang basin also formed a continuous river, which likewise emptied itself into the Red River, but when the second set of faults were formed, it is broken up into several parts and acquired its present drainage. But when did this occur? This can be ascertained from the river terraces. Now in the Kafang river there are at least 2 terraces; the first is about 100 meters above the river bed, whilst the second is 100 meters above the first. It is at that time

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1 金釵坡 2 牛屎坡 3 老箇舊冲 4 黃毛山

when the second set of faults were formed, for when the force was applied, the granite and the Yinshan masses resisted much better but the series 1 and 2 gave way altogether and the formation of the Sanchiachai faults etc. were the result. This caused great changes in the drainage and an underground entrance is formed at each fault. Its time may be roughly measured by the height of the terrace.

F. Genesis of Tin Ore

Lastly we may consider the formation of the tin ore. Every body knows that it is associated with the granite, but the exact mode of formation is still badly understood. It was thought that owing to the destruction of the granite that the tin was formed, but this is not very intelligible, for the granite does not contain tin *ore*. Moreover most of the tin ore are mixed with the red clay in the fissures—evidently a *mechanical deposit* from underground water. The tin oxide is generally found in very small grains, showing that it has been mechanically eroded. Again the ore is richest at or near a fault.

At 2 places only I have seen real rock ore; once at Maloko[1], the other time at Hsiashihlung, but then they are very different from the usual clay ore, for it is in the form of crystals in the limestone which is intensely metamorphosed. At these two places the ore is a *contact deposit.* I think *all* the ore must have been formed in this way, but later on owing to the erosion of the metamorphosed limestone it is broken up and re-deposited by underground water in the limestone fissures. In other words it is to the destruction of the metamorphosed limestone not to that of the granite, that the present mines owe their existence. It is interesting to note that the ore from Chiashihlung contains considerable amount of arsenic showing that the magma that formed the granite there was somewhat different. Apart from the known localities Niushihpo and Maloko deserve to be carefully searched.

1 馬落革

IV. 調查烏格地質煤鑛報告書

箇舊調查事竣，本擬即日返省，以往東川(註一)，適錫務公司總理吳君往烏格調查煤鑛，挽與同行。蓋沿鐵路所產之煤，以宜良縣屬之二龍戲珠(註二)爲最佳，然煤含飛質(註三)極鮮，宜於煉焦，而不宜於提煉煤氣，錫務公司以煤氣煉錫，故不適於用，可適用者惟有烏格。初爲烏格公司所有，去年其大部之股票，爲錫務公司所購，該公司原有資本，業已消耗罄盡，現惟恃錫務公司維持，所出之煤，亦僅恃錫務公司爲銷路。

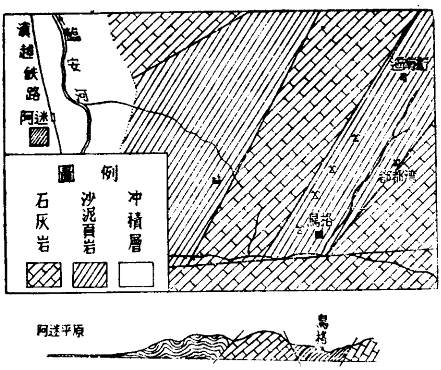

Fig. 2. 第二圖

烏格舊爲夷寨，其地在阿迷州(註四)之西南，距阿迷車站約二十餘里(圖二)，臨安河(註五)自南來，鐵池河(即八達河之上流)會於州城之北。河之左右，成一平原，州城與車站，皆在河之西岸。自阿迷往烏格，過河東行，行三四里，地稍有起伏，爲沙泥頁岩所成，初尚平坦，再行四里，即入一狹谷是爲臨安河之支流，谷側亦爲沙泥頁岩，而地層曲折捲疊，異常複雜，行六七里，至谷盡處，有夷寨在焉，過此復入一寬谷，水自東來，下流亦入於臨安河，河左右之山爲石灰岩所成，河岸則多赭土。沿河右之上岸不十里即達烏格，有谷自東北來，與大河會，谷行沙泥板岩中。其西北爲煤田，寬不過六七里，即與石灰岩遇，左右皆成峭壁，其東北之界限不可知，西南則以烏格之大河爲界，過河即止，地層之走向，爲東北西南，斜向西北土法所開煤井，皆沿煤層斜度而下，自烏格至迤南衛(註六)，皆沙泥頁岩(註七)厚約三百公尺，中含煤四層，以第二層(自下上數)爲最厚，約一公尺有奇，餘則皆在一公尺以內。現時烏格附近各洞，皆已廢歇，惟錫務公司於第一第二兩層內，各開一洞，第一層煤質頗佳然開採不及三十餘步，即爲水掩，蓋第一層地勢最低，其上廢洞林立，故尤易蓄水。第二層高於河身一百公尺有奇，水患較鮮，然洞深二百步，火即不能燃，故現時出煤，亦不甚多，若不亟事改良，注意於通風洩水，則不特永無發達之希望，即欲歲產佳煤數百噸，以供錫務公司之用，恐亦不可得也。

烏格所採之煤，不特各層不同，即一層所出，亦因其開採之地點、方法而異，皆然富於煤氣，能成輕鬆之焦炭。今搜集歷次化驗成分，詳列如下：

	第一號	第二號	第三號	第四號	第五號	第六街	第七號
灰分	20.8	21.3	18.3	28.7	9.0	14.6	23.1
飛質與水氣(註八)	23.6	25.5	23.6	22.7	30.0	30.5	27.8

以上爲錫務公司所化驗。又見有法人龍特納(註九)所化驗者，較此爲詳，茲亦列於下以供參考：

	第一號	第二號	第三號	第四號	第五號	第六號
灰分	41.00	17.00	18.42	18.38	6.00	13.00
飛質	33.50	25.00		21.00	30.00	
水氣	3.00	8.00	7.04	8.80		4.00
熱力			4740	4690		5350

凡龍氏所化驗各煤，均未指明其來自何層，錫務公司所化驗者，則惟第五號知爲第一層新洞所產。若以供煉錫之用，灰分在十分以下，飛質在三十分以上，即爲佳煤。以上列各煤觀之，則若開採得宜，求此應非難事。然以江所見，開鳥格之煤，無論西法土法，其困難蓋有數端。鳥格之煤夾於沙泥頁岩之中，此岩全部寬約六里有奇，過此即與石灰岩(註十)遇，江所見各井，皆在頁岩之西北邊，距石灰岩不過一百公尺有奇，地層走向爲東北，斜向西北，故各井相連，成一直線，則適與走向相合，而其掘發方向，與此線成一直角。由是觀之，則沙泥頁岩之東南部，必無煤層，可斷言也。有煤之地，祇在西北，然寬僅百餘公尺，即與石灰岩遇，不特石灰岩頁岩之間，復有斷層，足爲開採之障礙，且石灰岩之下，究竟有含煤之頁岩與否，仍難斷言，蓋若石灰岩成立時期，較幼於頁岩，則雖有斷層，其下仍當有有煤之希望。否則，鳥格之煤層，僅限於寬廣百餘公尺之長帶，沿帶之東南，廢洞以數十計，類皆傾覆填塞，不復可掘，其空隙穴道，積水極多，尤爲將來開採者之絕大障礙，而鳥格前途，正不可問矣。故欲知鳥格煤田之價值，必先定石灰岩與頁岩之時期，定之之法，言地質者則宜於兩岩中廣搜化石，言採鑛者則宜於石灰岩中開鑿鑽洞。江於第三層煤之上，幸有所獲，他日回京審定，或可爲採鑛者之助，而今日之與鳥格密切關係者，尤宜亟盡其天職，以定開採之方針也。

註一　今名會澤
註二　即宜良嵩明間大煤山煤田
註三　即揮發份
註四　今名開遠
註五　亦名樂築河
註六　亦名矣邦味
註七　相當王竹泉路兆洽之矣邦味頁岩鳥格頁岩及火把冲煤系
註八　即揮發份與水份
註九　或爲 H. Lantenois
註十　東南者相當王路之三疊紀石灰岩西北者相當王路之開遠石灰岩

V. YUNNANFU TO CHINCHIANG (April 24—May 20).

April 24, 1914

Yunnanfu to Litzuping (Pl. 1 : YMA1)

At Yunnanfu[1], barometer 589.1, temperature 21°.3C, at 9 : 35 a.m.

Left Yunnanfu at 11.30 after making an astronomical observation and having troubles with ponies. We went round the northern gate eastward and finally regained the main road. About 12.10 we crossed a foothill of marl to redescend to Wangchiachiao[2] which is on the lake plain. Left at 1.15 and got to Puche[3] at 1.45. At 2, lake plain finishes. First we find marl then limestone, and by 1.15 at Tienshengchiao[4] over the watershed where the river from Shalang[5] flows through a natural cave. Stopped there 15 minutes and left at 3.30. Soon we were at Litzuping[6] where limestone strikes about 350°, bent into folds. West to the village we have the following under the limestone :

Limestone

Marl

Brownish sandy shale

Green hard clayey sandstone

Soft shale

The whole striking 10°-20°, dipping 10° ESE, with a fault along the strike. Stayed in tent.

At Litzuping, barometer 590, temperature 20°.6C, at 5 p. m.

April 25, 1914

Litzuping to Fumin[7]

At Litzuping, barometer 590, temperature 8.6°C at 6 a. m.

Got up at 5 and started at 6.30. Went over a hill to the valley of Shalangho. We have the following series from above down :

Greyish pink limestone, bar. 572.9, St. 55° dip SE

Yellowish sandstone (coarse), bar. 574.1, St. 45°

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1 雲南府 2 王家橋 3 普吉 4 天生橋 5 沙郎 6 李子坪 7 富民

Fine greenish sandstone and yellow shale, bar. 575
Compact grey sandstone bar. 583, St. 50°-70°, dip 35° SE
Soft red marl, bar. 583 to Shalang.

At Shalang, barometer 588, temperature 19°.2, at 9 a. m.

This may be termed the *Litzuping series.*

We arrived then at Hsingpaochang[1], Hsingyeh Co.[2], where I descended into the shaft (there are two) very badly built and dangerous; coolie in front of me had a fall. They started to work three years ago but now practically stopped. The shaft is about 300 feet deep with irregular veins of copper in limestone, associated with white soft clay called *paihuang*[3]. Then we crossed from Muke[4] the Laopienshan[5] to Tunko[6]. The hills on the southwestern side of Muke are formed by red limestone in a mature stage of erosion. On the other hand the sandstone that forms the Laopienshan forms deep gorges. The series:

From top red sandstone, bar. 550.5
Green shale bar. 549.4
Red sandstone
Yellow shale up to bar. 557
Red sandstone with unrecognisable fossils, bar. 572
Yellowish limestone

The col we crossed was bar. 550.5—to the top at least 100 m. more—the village about 572 and the limestone hill 567.9. On the pass the basin of Yunnanfu and Western Hill[7] are visible. The limestone and red shale form a continuous range NE-SW.

Yesterday at Wangchiachiao I saw some copper and was told that it came from Santan[8] in Sungmingchou[9] which is not far from Muke.

The Laopienshan is infertile but wooded with pine and oak. Got to Shakuotsun[10] when dark.

At Fumin, barometer 601.6 at 8.22 p. m.

April 26, 1914

At Fumin, barometer 603.1, temperature 18°.2, at 9 a. m.

Went to Feilaissu[11] with Ma[12]. The series:

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1 興寶廠 2 興業公司 3 白塨 4 母格 5 老偏山 6 屯刻 7 西山 8 散旦 9 嵩明州 10 沙鍋村 11 飛來寺 12 馬生龍(雲村)

Pinkish limestone, bar. 593 and up, St. 313°, dip ENE

Grey sandstone, bar. 593.2, St. 270°, dip nearly vertical

Red clayey sandstone, St. 70°, dip NW

Then went to Fahuassu[1] with Chang[2] and Ma. Had a Mohammedan dinner, very bad and salty. Chang gave me the information that cobalt was found at Sankuoshan[3], eight li north of city of Fumin, and at Tungkuaching[4], twenty li from city, and that it is sold at 14-16 taels per catty. Mining started in the third year of Hsuantung[5] but soon stopped. Copper is said to occur at Laochingshan[6] and Taishuching[7].

April 27, 1914

Fumin to Chepei

At Fumin, barometer 603.2, temperature 17°C, at 8 a. m.

In the morning went with Ma to Panchiangtsun[8] to see the black sand magnetite. Then to Machinying[9] to see the gypsum which occurs in the black shale immediately under the *Feilaissu limestone*. They use the stuff for manure. Then I went across the Fumin valley which has Huangchiamiao[10] as its northern limit. Not far from Yentun[11] on this side of Chingshuiho[12], volcanic rock was exposed in contact with the sandstone and multicoloured shale. They strike 10°-15°. Further on, the whole *Feilaissu series* is exposed especially the red sandstone (St. 120° dip 30° NE), which is well seen from Chingshuiho to Peiyingho[13] whence the shale becomes predominant. In this, we find gypsum at Shihkaotien[14] and along Peiyingho and salt near Chepei[15]. I think the series from top to bottom is as follows (Fig. 3):

Limestone

Volcanic rock

Red sandstone

Coarse micaceous sandstone

Shale

Red sandstone

At Chepei, barometer 595 at 4 p.m.

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1 法華寺 2 張肇興 3 三鍋山 4 冬瓜箐 5 宣統 6 老青山 7 代樹箐 8 半江村 9 馬金營 10 黃家廟 11 烟墩 12 清水河 13 北營河 14 石膏田 15 者北

April 28, 1914

Chepei to Lengtsun

At Chepei, barometer 598.5, temperature 18°.1, at 7 a.m.

Hearing that there is silver mine at Yinchangching[1] and nitrate at Hsiao-ching[2] I intended to go there and hence to Lengtsun[3], but in going up to Kutzushan[4] (bar. 547.6, temperature 26°, at 12) to have a view of the country I find that the limestone is fossiliferous[5]. This was rather contrary to what I expected as it seems that the red sandstone and shale which I called Feilaissu series are older than Permian though salt occurs at Chelao[6], nitrate at Tseli[7] (up Peiying-ho) and gypsum at Shihkaotien and at Machinying. The main strike is sure to be NE-SW and main dip NW. They form the two parallel ranges of hills separating Wutingchou[8] from Fumin. The Shihyangshan[9] seems to be also formed by it. In coming to Mati[10] first I found shale and then

Red sandstone

Coarse micaceous sandstone

Soft shale

Sandstone

I am not sure of their succession but the *Kutzushan limestone* is certainly above the whole series.

At Lengtsun, barometer 590, temperature 26°.6 at p.m.

April 29, 1914

Lengtsun to Wuting

At Lengtsun, barometer 592.2, temperature 17°?C, at 7? a.m.

Left Lengtsun at 7.10 and on the way there is nothing but sandstone with black shale bands and the whole nearly horizontal. The sandstone is often micaceous containing bands looking like altered lava. Then a coarse sandstone is met with dominating the whole route between Lengtsun and Wutingchou. Their

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1 銀廠箐 2 硝井 3 冷村 4 鼓子山

Loc. No. Al, 1-17, According to Y. T. Chao's list the fauna consists of: *Polypora* cf. *koninckiana* Waag. et Wentz., *Productus* sp., *Striatifera compressa* (Waag.), *Marginifera* sp., *Orthothetes* sp., *Pseudophillipsia acuminata* Mansuy.

6 者老 7 則里 8 武定州 9 石羊山 10 馬地

general strike is NE and dip NW. After crossing the Yangliho[1] we come to a plateau with erosion still at its infancy.

The coarse sandstone at Shihpankou[2] is nearly horizontal. At 10.32 I went up a hill where I got a view of Kutzushan and Shihtzushan[3] and made theodolite measurements. There we have variegated marl above sandstone. Going down to Wuting we had a shower and took shelter at Tuchumiao[4].

On the way to Wuting city the sandstone remained horizontal. The plateau character was maintained with a river terrace in the valley.

Saw the magistrate Chang[5] and another Chang[6] who told me many interesting things of the district.

From the district record I learned that brachiopods occur at Kuahsingshan[7], pumice at Tsuning[8], and salt at Chienchiu[9] and Yangchi[10].

At Wuting, barometer 595 at 2.5 p.m.

April 30, 1914

Wuting to Sapushan[11] and back to Wuting

At Wuting, barometer 597.4, temperature 14°.4C, at 7 a.m.

Went to Sapushan and saw three missionaries, Mr. Nichols and Mr. And Mrs. Gowman. The former had been there seven years and had great success among the *Miao*[12] and *Lisu*[13]. The *Huamiao*[14] came from Chaotung[15]. I took some photographs in their ceremonious dresses. They had a school and a Mr. Paulet of Chaotung invented a written language for them. The women wear an embroidered skirt with their hair parted in the middle and plaited into two pig tails, but when she has a son her hair forms a cone in front. They are very poor and came from Kueichou a few generations ago.

In going up to Sapushan the rain came and I had a difficult climb. The series exposed:

Variegated shale
Black shale (sandy and micaceous)
Coarse yellow sandstone

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1 羊理河(陽柳河) 2 石板溝 3 獅子山 4 土主廟 5 張鄰庵 6 張光廷 7 誇興山
8 苴寧 9 見舊 10 羊溪 11 洒普山 12 苗 13 栗蘇 14 花苗 15 昭通

Shale bands intercalated
coarse yellow sandstone

The whole about 200 meters.

Along the valley of the northern branch of Panlungho[1] we have a syncline, the beds dipping rather more steeply to SW on the NW side of the valley. As we went up the hill they became horizontal. In descending, I had a magnificent view of the country to the NE where we also have parallel ranges.

May 1, 1914

Stayed indoors all day. Many Lisus came to see me. I measure ten of them. Their religion is the *Tuchu*[2] (stone tablets on hills) and ancestral worship. They used to marry at 5! The bride stays with her family till about 16 years old then the marriage is consummated. The marriage feast takes place at the so-called marriage which is really a kind of betrothal. They have also *Meijen*[3] whom must be sent from the male side. At funeral they read oral prayers. Their women wear long skirts and only mothers can have their hair done up. They are much oppressed by the *Tushe* Li[4] who is a *Lowu*[5] and treats the Lowu with a different treatment. They are engaged in a law suit against him which has lasted 3 years. Men wear copper bracelets. They have no word for *wan*[6] which is *chitu* namely, ten thousand.

In the afternoon I saw some *Meicha*[7] women selling firewood. They wear a blue head dress tying it from front backwards and with very long ear rings. The hair is done into a pig-tail. Otherwise they dress like Chinese, but with a big belt round their waist.

May 2, 1914

Wuting to Yinachang

At Wuting, barometer 604, temperature 10°.4, at 8 a.m.

Left at 8 for Yinachang via Shihtzushan. At first the sandstone is seen to be nearly horizontal, but near the foot of the hill it dips steeply to SE. The city of Wuting is built on a low hill with a shallow ravine cut in soft sandstone which seems to show there has sliding movement. At bar. 587 we have limestone in which unfortunately no fossil was found. At bar. 576.6 it strikes 33° and dips

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1 槃龍河 2 土主 3 媒人 4 李土舍 5 羅婺 6 萬 7 麥岔

SE, but just above it became horizontal and overlaid by sandstone, which is succeeded by a coarse sandstone overlaid by a fine one breaking up into yellow flakes. At bar. 565.5 we came to a fang[1]. A few steps further we are in a well-built temple.

I went out to make some theodolite measurements and on perpendicular sandstone cliff is a ruin[2] with engraved charatcers[3]. Higher up we have another small house with Chienwen's tablet[4].

On the top we have a fine view of the city and beyond, the NW country was not visible.

I drank some tea with the monk Fayun[5] who is very dirty.

In going down the same series is exposed till we came down to Kanho[6] where is a limestone. On the other side is a series of metamorphic sediments below the limestone. The country is well wooded with pine forest.

Went up a little and then came down to Shenkouching[7]. Up again to Fenshuiling[8] where we have a fine view of Sapushan. Then downward water flows to Tanglang[9]. The topography is well-dissected and in the soft decomposed schists we have cultivated ricefields.

Got to a *Miao* house, Yang by name[10], who is very dirty but gives me a warm reception. I took a photograph of his wife, some measurements and astronomical observations. The women wear no trousers but only a skirt and the hair is tied up with a blue cloth. Those who have children wear a comb. The old man has 3 sons and came originally from Hueilichou.

At Yinachang[11], barometer 564, temperature 21°.4C, at 6 p.m.

May 3, 1914

Yinachang to Wuting

Went back to Wuting via Chiushanching[12] where are several old shafts and furnaces all of which are deserted. The copper ore contains much iron about 10 percent. I have been told that in Aotouching[13] and Laoshan[14] it is much better (said to contain 50% of Cu), but there is too much water. Ore occurs in metamorphosed limestone and schist.

I repeated yesterday's observation at Shihtzushan from the bottom up (see Fig. 3):

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1 坊 2 即朱君閣 3 石門一疊重 4 建文帝碑 5 法雲 6 干河 7 深溝箐 8 分水嶺 9 湯朗 10 苗人楊家 11 迤那廠 12 舊山箐 13 鷔頭箐 14 老山

1. Limestone, 70 m., strike 330°-335°, dip SE
2. Red coarse micaceous sandstone, 10 m.
3. Fine grained yellow shaly sandstone, 20 m.
4. Red coarse sandstone, 10 m.
5. Shale, 10 m., strike NNW, dip ENE
6. Greenish coarse sandstone, 20 m.
7. Shaly beds, 10 m.
8. Very coarse red sandstone, 30 m.
9. Multicoloured shaly sandstone, 40 m.
10. Compact red sandstone, 40 m.

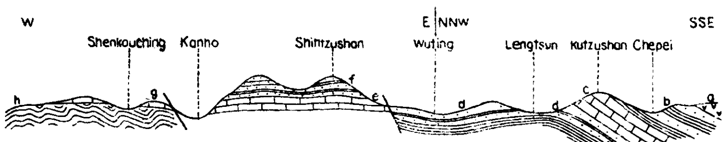

Fig. 3. Section from Chepei to Wuting. a-c. Permian, a. Volcanics, b. sandstone and shale, c. Limestone. d-f. Devonian, d. Sandstone and shale, e. Limestone, f. Sandstone and shale. g. Cambrian limestone, h. Pre-Cambrian metamorphics.

Thus the total thickness of this series is not less than 260 m.

At night a man named Wang[1] came and told me about the mine of Chu-chienmen[2] which is said to contain the best ore. New mines of copper are being opened at Tsochu[3] and Chikuanshan[4], near Huanchou[5].

May 4, 1914

Wuting to Sapushan

In the morning stopped at home to draw the maps. At 12 went to Sapushan to do theodolite work. It rained badly when came down. Striking a different route I found first a crystalline igneous rock above. Below and above the compact sandstone is the sandy shale in which I found *Redlichia* (Fig. 4)[6]. It is therefore Cambrian. The series is similar to that of Shihtzushan.

1 王子英 2 猪槛門 3 左佉 4 雞冠山 5 環州
6 We reproduce two sections of Sapushan drawn by Dr. Ting himself, which are very different one from the other.—Edit.

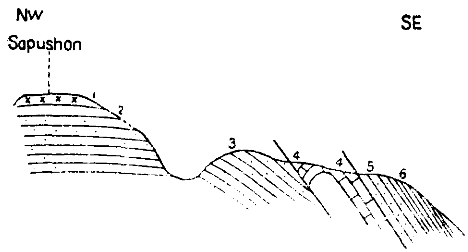

Fig. 4. Section of Sapushan. 1-4. Cambrian, 1. Volcanic rock (cover), 2. Trilobite beds, 3. Compact sandstone, 4. Limestone. 5-6. Devonian, 5. Sandstone, 6. Marl. (variegated).

1. Volcanic rock (cover)
2. *Redlichia* beds (El-35), 20 m.
3. Compact sandstone, 200 m.
4. Limestone
5. Sandstone
6. Multicoloured shale

1-4 are Cambrian and 5-6 are Devonian.

May 5, 1914

Sapushan to Luchuan

At Wuting, barometer 600.5, temperature 16°, at 7.30 p.m.

As I obtained some specimens of brachiopods from Kuahsingshan, I left for Luchuan[1] at 12.30. 18 minutes from the city of Wuting we come to the village of Hsiangshui[2] to the east of which is sandstone striking 63°, dipping NW, with isolated limestone (?) above it. In this sandstone indistinct plants are found.

At bar. 599 it is covered by an igneous rock. At bar. 597.6 we have the same sandstone exposed, striking 10°, dipping NNW. Further on it strikes 0° dipping very steeply east.

At Lungtanching[3] coaly slates with *Lingulipora* strikes 75° dipping SE. A shaft has been put down in search for coal.

At point *A* north of the shaft we have from above downward:

Sandstone

Coaly slates

Multicoloured shale and sandstone

1 祿勸 2 響水 3 龍潭箐

Sandstone

Limestone

The whole seems to be overlaid unconformably by lava.

20 minutes' walk bring us to the crest, bar. 588. Then a few steps down, and up again till we come to a point, bar. 586.6, where we have variegteed beds overlaid by a sandstone containing ***Lingulipora*** which in turn is overlaid by variegated beds. The series forms an anticline with igneous rock covering it unconformably.

8 minutes later we arrive at point *B* where I took some bearings. There the sandstone strikes 70°, dipping SE. Coming down from *B* we come to the bottom of a ravine, bar. 591.7, where we find horizontal beds not unlike the ***Redlichia*** beds of Sapushan. Thence to Luchuan via Machiachuang[1] the same sandstone is exposed with dip to NW.

At Luchuan, barometer 599, temperature 26°.4, at 4.30 p.m.

May 6, 1914

Luchuan to Kuahsingshan and back to Luchuan

At Luchuan, barometer 603.7, temperature 16°, at 7 a. m.

Started about 7 in the NE direction. At 7.44 red and yellow sandstone not unlike that of Sapushan is exposed above Chiucheng[2]. Going up the ravine the sandstone is seen to have a N-S strike and dip 35° west.

At 8.45 arrived at Chihshuiching[3]. Just beyond, green scaly sandstone strikes 25°, dipping 35° NW at bar. 584.1. This alternates with coarse soft micaceous sandstone.

Soon went over the watershed down to Wayaotsun[4], the road being covered by thick reddish soil. Near Wayaotsun yellow sandstone strikes 15°-20°, dipping NW.

At bar. 597.5 a hard white limestone is seen striking 20°, dipping NW. This is overlaid by greenish soft sandstone and shale which in turn is overlaid by compact sandstone followed by thin-bedded sandstone and compact sandstone. At 10.25 coarse sandstone is exposed striking 350°, dipping 28° ENE. Thence on to Chaochu[5] there is nothing but red and green sandstone.

---

1 馬家莊 2 舊城 3 吃水箐 4 瓦窑村 5 招珠

The limestone containing Middle Devonian fossils occurs just NE of Chao-chu. The details are as shown in the section (Fig. 5). The fossiliferous band disappears N-S.

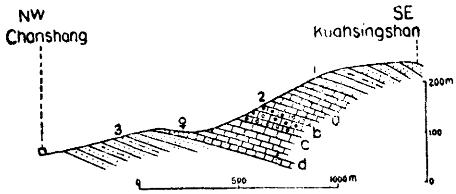

Fig. 5. Section from Chanshang to Kuahsing-shan. 1. Upper sandstone. 2. Lime-stone. a. Blue organic limestone. b. Yellow oolitic limestone. c. Blue coralline limestone. d. Organic lime-stone with fossils. 3. Lower sandstone.

At Chaochu, Barometer 587, Temperature 15°.2, at 2.50 p. m.

Left for Luchuan via Kuangchuang[1] to Luko[2] over a ridge which consists of soft sandstone alternating with hard bands. Just before reaching Luko we see the series striking NNE, dipping ESE. The main river at Malichai[3] seems to occupy the axis of an anticline, for the sandstone on the west side of the river seems to dip westward. From Luko on the path turned westward and at bar. 599.2 diabase is exposed with a N-S strike.

At the river, bar. 602. The diabase seems to extend to the first bridge when it became too dark to make any observation. It rained also. Got back to Luchuan at 8. Dined with Kao and a Mr. Yang.[4]

Much forest on the way except the part near the city.

The fossils collected at Kuahsingshan are determined by Dr. Grabau:

Brachiopoda

Athyris vittata Hall

A. vittata antecedens Grabau

A. vittata intermedia Grabau

Emanuella takwanensis (Kayser)...... common

E. takwanensis mut. *pentagona* Grabau

Atrypa cf. *desquamata* Sowerby

Stringocephalus burtini Defrance

Meristelloid

Bryozoa

Rhobopora sp.

---

1 廣莊 2 魯格 3 麻栗寨 4 楊建勳

Pelecypoda

Modiomorpha sp.

Nucula sp.

Panenka interrupta Grabau[1] ....common

This fauna is of Middle Devonian age.

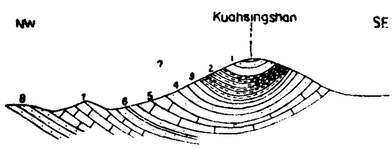

Fig. 6. Section of Kuahsingshan. 1. Sandstone. 2. Variegated red and green beds. 3. Slates. 4. Sandstone. 5. Limestone (?). 6. Sandstone and green beds. 7. Limestone (fossiliferous). 8. Sandstone.

To sum up, the succession of Kuahsingshan (Fig. 6) is as follows:

1. Sandstone
2. Multicoloured red and green sandy shale
3. Shale
4. Sandstone
5. Limestone (?)
6. Sandstone plus green beds
7. Fossiliferous limestone
8. Sandstone

May 7, 1914

Luchuan to Wuting

Came back by way of Erlungshan[2]. At Wukueitang[3], 600 m. west of Luchuan, the series from top to bottom:

1. Compact and red sandstone, 200 m.
2. Green and red beds, 70 m.
3. Coaly shale with indistinct plant remains, 5-10 m.
4. Compact and red sandstone

All dip 15°NW.

To sum up the observations, we have:

---

1 *Nomen nudum* ? 2 二龍山 3 烏龜塘

Carboniferous:	1.	*Fumin series* consisting of sandy shale, with salt, gypsum and porphyry.
	2.	*Kutzushan limestone*
	3.	*Wuting series* consisting of sandstone, green sandy shale, coaly shale, sandstone and limestone (?)
Devonian:	4.	*Kuahsingshan series* consisting of sandstone, green shale, fossiliferous limestone and sandstone.
Cambrian	5.	*Sapushan series* of igneous rock, *Redlichia* beds, sandstone and limestone.
Pre-Cambrian(?)	6.	*Yina series* of metamorphosed schists, limestone and sandstone with copper ore.

River terraces are also distinct in Luchuan valley.

Rain in the morning and cloudy in the afternoon. Magistrate Chang came in with Hu[1]. From the former I borrowed 60 dollars.

May 8, 1914

Wuting to Huachiao

At Wuting, barometer 599, temperature 16°9, at 8 a. m.

Left Wuting at 8. Going along the river. After Tahsitsun[2], I found the dark diabase predominant looking exactly like the diabase of Sapushan, so I

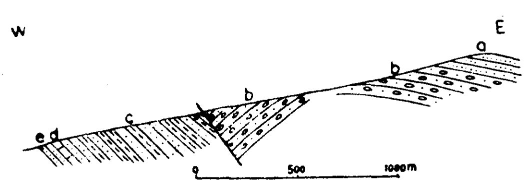

Fig. 7. Section from Wulungtung to Tangpashao. 1. Yellow slaty beds (=Trilobite of Sapushan). 2. Compact red sandstone. 3. Greenish slates (sandy) with *Redlichia*. 4. Dark greenish sandy slates. 5. Compact greenish black sandstone. 6. Grey limestone (breaking up into small squares). 7. Dark diabase. a. Limestone (greyish blue.) b. Yellow and red clay and sandy slates (*Redlichia*). c. Dark diabase. d. = 1.

climbed up the hill just behind the village of Wulungtung[3] and had a very complete series (Fig. 7) from above downwards:

---

1 胡永康 2 大西村 3 烏龍洞

1. Yellow sandy shale
2. Compact red sandstone, 70 m.
3. Greenish shale (sandy) with *Acrothele* and *Redlichia* (H_{1-13}), 40 m.

   Terrace 3

4. Dark grey shale, 40 m.
5. Compact greenish sandstone, 70 m.

   Terrace 2

6. Hard brittle grey limestone with angular breakage.

   Terrace 1

7. Dark Diabase.

Hurt my finger in collecting specimen.

In going from Wulungtung we have the above series constantly exposed especially 5 and 6, and at the pass above Yaoying[1] we have above bed 1:

a. Greyish blue limestone

b. Red and yellow sandy shale with *Acrothele* and *Redlichia* (G_{1-17}).

b'. Black shale with *Redlichia*.

c. Diabase

b + b' + c = 35 m.

d. = bed 1

Watch soon stopped. The British map accurate, but the distance between Huachiao[2] and Yaoying was too short. The real distance about 5 kilometers.

At Huachiao, barometer 572.5, temperature 16°.9, at 5 p. m.

May 9, 1914

Huachiao to Shihlata

At Huachiao, barometer 573.2, temperature 13°.2, at 8 a. m.

Fine day. Near Village of Huachiao limestone strikes 20°, dipping gently NW. It has a crushed appearance.

A little further on sandstone strikes N-S, dipping 12° W. This is a coarse hard micaceous reddish sandstone above which is the scaly yellow sandstone. At Muhsiko[3] sudden widening of the valley with more rugged landscape in front.

1 姚營 2 花橋 3 母西格

At bar. 574 soft red micaceous sandstone strikes 10°, dipping 10° W, changing into white and green to violet tints, and alternating with harder yellow bands. At bar. 575.1 it strikes 348°, dipping WSW.

At Yuchakuan[1] we cross a low pass (bar. 575) where the soft red sandstone predominates right to the top. Just west of Haitsu[2] dip changes to E. The micaceous sandstone here is quite unfossiliferous.

At Haitsu, bar. 575.5, temp. 24°, at 12. Soon the sandstone becomes horizontal, then reversed its dip gently to WNW (strike 20°).

Near Lutupai[3] sandstone strikes 330°, dipping 30° WSW. After passing the village the dip becomes even steeper. Crossing the river near Hsiaolungkai[4], it strikes 12°, dipping 50° E.

At Maanshan[5], bar. 574.7, sandstone strikes 340°, dipping 55° E.

At Motaoshih[6], bar. 750, yellow and red marl dips W, but soon changes into E (gently).

Observation interruped till bar. 562 when red sandstone becomes horizontal.

At Shihlata[7] (bar. 556.1) sandstone dips gently W.

May 10, 1914

Shihlata to Lukutsun

At Shihlata, barometer 556, temperature 14°.4, at 8 a. m.

Northwest of Shihlata red sandstone is seen to be horizontal, but soon dips gently westward. Exposure of red and yellow marl followed by red sandstone which is first horizontal, then dipping gently NW. It is thin-bedded and more clayey than the lower sandstone.

At Hsichula[8] it dips E, but soon afterwards reversed to NW. Further on it strikes 310°, dipping 60° SW, and soon becomes vertical.

At a point before Yangchiatsun[9] it strikes 310°, dipping 20° SW. At Yangchiatsun the dip is increased to 30°. Further on the dip is reversed to NE and the quartzitic sandstone becomes crushed and banded.

From the top of the pass (bar. 531.3, temp. 19°) we have a fine view of the Yangtse and the surrounding country.

---

1 油扎關 2 海子村 3 魯吐白 4 小龍街 5 馬鞍山 6 磨刀石 7 石腊他 8 西菊拉 9 楊家村

At bar. 544.5 sandstone becomes yellow and flaky, striking NE, dipping 16° SE. Then it becomes horizontal. Further on it dips WNW. The path is abominably bad.

In descending the sandstone becomes softer. At river (bar. 567.9) sandstone strikes NE, dipping 20° SE. Part of the sandstone is conglomeratic. Then a local fault.

Near Lukutsun[1] sandstone strikes 355°, dipping 40°. At Lukutsun barometer 566, temperature 23°.5, at 6 p. m. Astronomical observations.

May 11, 1914

Lukutsun to Asala

At Lukutsun, barometer 569.5, temperature 19°, at 9 a. m.

Astronomical observations.

We started with a comfortable temperature of 19°. Going along the main valley of Lukuho the miserable path is high above the valley floor, winding continuously round the head valley of the small side ravines. The red sandstone is more or less mixed with green (softer) shale. At first it strikes NNE-SSW, dipping 30° to ESE, but near the summit it strikes 32° and dips 25° NW.

The ravines are quite deep and one sees nothing but these red and green sandy sediments.

Just before we get to Sanhotsun[2] I climbed up a small hill to take some bearings. Moderately high mountains ranging N-S between the deeply cut torrential rivers which flow northward to the Yangtse.

Descending to Sanhotsun we get into a side valley. From there on we have:

1. Clayey sandstone, striking 300°, dipping 30° NNE. Fault.
2. Yellow and red bed at bar. 555.6, striking 95°, dipping N.
3. Somewhat harder green beds, striking NNW, dipping ENE.
4. Hard red sandstone, striking 330°, dipping 10° NE.
5. Red sandstone at bar. 570.0, striking 320°, dipping 20° NE.

The fault is well seen on the other side of the valley, fault line running NW-SE.

---

1 鶆谷村 2 三合村

6. Strike 340°, dip 20° NE.

Asala[1] is situated on a steep side valley to Lukuho containing some twelve *Lisu* families. I camped outside the village and had great difficulty in obtaining food for the animals although they supplied the servants of the *Tushe* who came after me.

At Asala, barometer 587.5, temperature 23°.4, at 7 p. m. Astronomical observations.

May 12, 1914

Asala to Huanchou

At Asala, barometer 591, temperature 18°.2, at 7 a. m.

Had considerable difficulty in getting coolies. Went up a difficult path. Just north of Asala the sandstone dips 80° and has the same brecciated appearance. As we went up, brecciated material less evident. The valley is very barren and wild with only dwarf trees. Geological observation rather difficult.

The sandstone is softer with more clayey bands. Near the pass bar. 544.5 it strikes NW-SE, dipping SSW. Coming down we reached Huanchou at 2. At Huanchou, barometer 556.2, temperature 22°.6. Astronomical observations.

May 13, 1914

Stayed at Huanchou, barometer 559.9, temperature 21° at 9 a. m.

The mother of *Tushe* Li came to see me with a bottle of spirit as present. She wore a simple blue dress, Chinese style, with blue turban, and spoke a little Chinese.

May 14, 1914

Stayed again at Huanchou.

In the morning went to visit the wife of *Tushe* Li who sent a messenger last night expressing the wish to see me, excusing her for not coming by saying that it would be inconvenient. After passing through several court-yards, I was received by her in her bed room together with her mother, a middle aged woman with goitre and bound feet. She is the Chinese concubine of the Tussu of Mulien[1] and is visiting her daughter.

---

1 阿洒拉 2 慕連土司

The wife of the *Tushe* has been at girls' school in Yunnanfu, but was engaged to Li from her infancy. After her father's death when she was barely 14, she was forcibly taken away from her home by the retainers of her husband and married immediately after. She has not been able to get on with her husband who is a rough fellow without any education what-so-ever, although her mother-in-law seems to be a decent woman who consoled her to some extent. The *Tushe* keeps several women outside, some of whom married and whose husband was driven away or killed by the *Tushe*. According to her he also tried to poison her and would have murdered her had not been for fear of revenge on the part of her family. Her room is dirty and disorderly, but with some European luxuries such as perfumes and cigarettes.

She dressed herself up in ceremonial costume for me to photograph, but unfortunately the plate was spoiled.

Her husband came to see me later in my lodging. A rough fellow, bare-footed and wearing a short blue cotton jacket and trousers, and is quite unable to talk.

I took also a photograph of his mother at the court.

May 15, 1914

Huanchou to Chikuanshan

At Huanchou, barometer 561, temperature 16°.8, at 8 a.m.

Left Huanchou to visit the copper mine of Chikuanshan. Going up a steep valley we see red clayey sandstone horizontal. Then there is a small fault. At point 1 on map it strikes 249°, dipping 50° SSE, then at once reverses its dip which soon becomes horizontal again. At point 3 it dips 32° NW. At point 5 a small fault.

After crossing the bridge there is another fault. At point 6 the clayey sandstone strikes 147°, dipping gently NE. Later on dip changes to 30° in the same direction.

Thenceforth sandstone dips constantly eastward varying between 25°-45°. It has a brecciated structure with imbedded quartz bands. At point 8 (bar. 552.8) yellow beds exposed.

On reaching the top of the escarpment (point 14, bar. 549) we have a fine view of the Makai[1] valley. The heat becomes increasingly trying. At 1 p..m

1 馬街

it is 30° C. Coming down the escarpment of Yangtiehpo[1] the path is very difficult and in places dangerous.

At sunset we arrived at the mine of Chikuanshan. There is a shallow shaft newly opened in the green sandstone.

At Chikuanshan, barometer 592, temperature 28°, at 7 p.m.

May 16, 1914

Chikuanshan to Chuning

At Chikuanshan, barometer 295.6, temperature 21°.2, at 8 a.m.

At a point (2 on the map) nearly half way between mine and Huangkuayuan[2], bar 640.6, temp. 32.2, at 10 a. m.

Rest at Shuichingtien[3] where bar. 641, temp. 34°.8 at 1 p. m. which increases to 35°.8 at 2.30.

On the way from Shuichingtien to Huangkuayuan we have gravel beds.

At Chuning, a big market town on the west edge of valley, I have considerable difficulty with the local *Tuantou*[4] who refused to have anything to do with me. After some negotiation I was installed in a temple.

At Chuning, barometer 649.6, temperature 31°, at 9 p.m.

May 17, 1914

Chuning to Pati

At Chuning, barometer 648.5, temperature 26°.1, at 6.30 a.m.

Went to Pati[5] to see the copper mine. Following the SW branch of the Lungchuanho[6], called the Lochaho[7], pebbles of pumice are found in the bed. Probably they came from Shihpaishan[8] in Tingyuan[9], a considerable hill some 30 li from Pati.

The rocks are intensely metamorphosed —— micaschist below which is an amphibolite schist striking WNW-ESE, dipping steeply SSE.

Arrived at Jeshuitang[10] opposite Lutun[11] at 2.30 and bathed in the dirty water which oozes out of the metamorphic rocks (sandstone). Bar. 643.6, temp. 37° at 2.30, rising to 30° at 3.30 p. m.

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1 洋鐵坡 2 黃瓜園 3 水井田 4 團頭 5 怕地 6 龍川河 7 羅岔河 8 石牌山 9 定遠 10 熱水塘 11 魯敦

Arrived at Pati at 8, bar. 641.9, temp. 33°.4. Stayed in a school which is installed in a fine temple. The teacher receives $60 per annum without food! and he is in charge of 60 boys of whom 20 are boarders.

The metamorphic series near Pati is traversed by numerous large quartz veins.

Note. Before going to Pati paid a visit to the magistrate Li[1] at Makai. The district yamen was moved there from Yuanmou[2] after the destruction of the rebellion of Tuwenhsiu[3]. The plain at Makai is 10 kilometers wide and at the edge covered with a fine sediment in which further to the SE Dr. Granger found *Stegodon* and *Equus* in the winter of 1926, thus proving it to be early Pleistocene or late Pliocene. The fault of Tungshan must be before that time.

May 18, 1914

Pati to Chuning

At Pati, barometer 644.2

Went to Palang[4] to see the copper mine. The ore is the red oxide in gneiss (?) which after picking is said to yield 40 per cent of copper. The vein is two feet wide E-W and 400 feet deep. There are two shafts: one horizontal, the other vertical, which is too difficult to get in. Height of shaft bar. 636.4.

Returned to Chuning by Locha[5], bar. 647.5.

At Luitien[6], bar. 644.

At Chuning, barometer 646.5, temperature 32°.6, at 6 p.m.

The Tungshan (Chikuanshan) is seen as an imposing N-S range. The Lungchuanho has also a well-marked terrace.

Astronomical observations.

May 19, 1914

Chuning to Hailo

At Chuning, barometer 649.8, temperature 26°.4.

Went to see the supposed coal mine at Tanglao[7].

36 minutes from Chuning arrived at the limit of the flood plain of the river. 27 minutes further at village of Tanglao. 18 minutes more at the foot of the mountain.

---

1 李阜周 2 元謀 3 杜文秀 4 帕朗 5 羅茈 6 雷店 7 當老

The mine is an abandoned shaft in the black shale striking NNW, dipping ENE. Said to have been worked before the Tuwenhsiu rebellion.

Went N to Hailo[1], Mupi[2] and Chupu[3]. Near Hailo true gneiss.

At Hailo, barometer 648.4, temperature 36°, at 6 p.m.

May 20, 1914

Hailo to Chinchiang

At Hailo, barometer 650.9, temperature 27.5, at 6 a.m.

Started for Chinchiang[4] via Napien[5], Peiniwan[6], etc. Road goes along the river cut in gneiss. The river has a valley 400-500 m. wide with ricefields. At the point where it enters the Yangtse it widens out to 600-700 m.

At 9 a. m. arrived at Chinchiang. It was so hot that we could go no further that day. Stayed in a miserable house next to its stable. The flies were so numerous that I was obliged to take refuge in my net.

At 6 p. m., temperature 37°.5. At 9 p. m., barometer 659.2, temperature 33°.8.

Went down to Chinchiang to take measurements:—

Width	200 m.
Depth	6-7 fathoms
Velocity of current	300 m. per minute

Bathed in the river towards the evening.

Astronomical observations.

VI. CHINCHIANG TO HUEILICHOU (May 21—June 15).

May 21, 1914

Chinchiang to Chiangyi[7] (Pls. 1: YMA1, 2: YMA2)

At Chinchiang, barometer 660, temperature 28°, at 6 a.m.

The sandstone strikes 85°, dipping S, but soon to change gradually in the NE direction, much crushed and folded.

The limit of the old river bed 10-15 m. above the present bed, 400 m. wide.

---

1 海螺 2 慕壁 3 朱布 4 金江 5 那邊 6 白泥灣 7 江驛

As we come up, the beds gradually become less and less disturbed and the variegated beds stop at about bar. 635, then we have red sandstone.

At Chiangyi, barometer 587.8, temperature 28°.9, at 10 p. m.

Astronomical observations.

May 22, 1914

Chiangyi to Lushuiho

At Chiangyi, barometer 584.9, temperature 21°5, at 6 a. m.

Up the west hill we observed a fine view of the country. The river makes a great semicircle. Beyond the river Tsochufangshan[1] is visible. Went to the mine SW of Alayi[2]. The surface is a very much metamorphosed sandstone. The inside is a metamorphosed limestone (?). Copper and pyrite. All the rocks are crushed and recemented. The whole range is much altered and unrecognizable. The plain of Chiangyi seems to be an old river bed.

Impure coal is hereafter seen. It occurs opposite the house a little north of the *Chiehpai*[3] which marks the provincial boundary.

Stopped at Tsao's[4] where we got eggs and sugar water. Fine house but had been robbed two years ago.

At Lushuiho[5], barometer 585.5, temperature 30°.5, at 2 p. m.

Descend into shaft N of Lushuiho and W of Sungpinkuan[6]. At outside bar. 572.4, inside bar. 574.4. Inclined sandstone with ore strikes NW, dipping 60° SW.

A belt running NW-SE, 7-8 li long, 3 li wide from mine to mine[7].

Process: They used coke coming from Mienhuati[8] on upper part of the Yangtse. It takes one day or more to get down to a place called Yucha[9] whence it takes to Yinweipa[10], 30 li from mine, 4 taels per 2000 catties. Native furnace can take up 6000 catties of ore per 2 days and 2 nights. For every 6000 catties of ore require 4000 catties of coke. Coal at bottom, then one layer of ore alternating with one layer of limestone[11] (2 catties ore to 1 catty limestone). Now 10 furnaces, each can turn out 80 *hao*[12] (1 *hao* = 140 catties) of copper. Tax on every 100 catties = 7.5 catties. Present price = 28 taels per *hao* at best. Wages = 1 *chien*[13]

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1 左佉方山 2 阿拉驛 3 界牌 4 曹家 5 綠水河 6 松坪關 7 自西北起向東南: 老廠, 新廠 (野猪窩) 及石龍廠 8 棉花地 9 魚鮓 10 円尾巴 11 俗稱代石 12 號 13 錢

per workman. Bomb for 90 days, got out 400,000 catties of ore. 100 cashes for 100 limestone.

Then returned to Lushuiho. At a point N of the village and S of Yehchuwo[1], schist strikes 315°, dipping 80° SW. Bath at the river by temperature 25°.8.

May 23, 1914

Lushuiho to Pochiao

At Lushuiho, barometer 589.1, temperature 21°.3, at 6 a.m.

At *a* bar. 591, yellow sandstone strikes 40°, dipping 20° SE, below which occurs coaly slate striking 30°-40°. I think this comes above the Chikuanshan series, but below that of Lushuiho mine. Here exposed coaly slate about 5 m. thick. It is a crushed shale rather than a slate. The upper beds are coarse, soft, and micaceous. They contain bivalves and *Calamites*, recalling those of Hsiangshuitsun, east of Wuting.

At *b*, upper sandstone, St. 347°, dip 40° E.

At *c*, above copper sandstone are yellowish brown sandstone alternating with dark grey clay, St. 40°-50°, dip SE, beginning at bar. 591.2. Soon passed through Sungpingkuan. At *e* sandstone below red marl, St. 26°, dip WNW. A few steps further, yellowship red micaceous and coarse sandstone with the same strike. At bar. 589.8, St. 16°, dip 45° ENE.

At *f*, black bed, dip E.

At *g*, crystalline sandstone, dip W. Further dip E.

From *h* (S of Chienmakai[2]) to *i* (E of that village), all red.

At *i*, bar. 588.

At *j*, grey clay begins to appear.

At *k*, green and violet beds appear.

At a point west of Panpo[3], barometer 599.5, temperature 30°, at 3 p. m.

A few hundreds of meters NW of Pochiao[4] (near Pulungho[5]), St. 45°, dip 30° SE.

At Pochiao, barometer 650.5, temperature 34°, at 6 p. m.

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1 野猪窩 2 錢馬街 3 半坡 4 坡脚 5 普隆河

May 24, 1914

Pochiao (Pulungho) to Hsinputzu[1]

At a point near Pulungho, barometer 655, temperature 27°.3, at ? a.m.

Coal coming from Pachiaoching[2] near Tunganchou[3] on its way to Sungpingkuan.

At point *b*, barometer 596, temperature 23°.4, at 9 a. m. Cloudy day.

From *e*, near Tafenshan[4], we have magnificent view of the whole region. Pulungho is to our right. The Yangtse is both to our S and W, making also a semicircle coming from Tsochu via Huanchou. Huanchou, Yuanpaoshan[5], Paiyunshan[6], etc., all to our SW. We are actually on the range running NE-SW from 21st to 29th of May.

At Tafenshan, barometer 569, temperature 22°.8, at 3 p.m. Rain falls all round except SE. Four ranges of mountain : : (i) prolongation of Tsochufangshan, (2) right bank of the Yangtse, (3) Tafenshan, (4) Paiyunshan.

The range of hills on the other side of the Yangtse seems to be made of crystalline metamorphic rocks.

Near Hsinputzu disturbance. Red clay beds again. Hsinputzu is a village of 300 families. Troubles with the *Tuantou*.

At Hsinputzu, barometer 579, temperature 22°, at about 6 p. m.

May 25, 1914

Hsinputzu to Tunganchou

At Hsinputzu, barometer 580.4, temperature 19°8, at ? a.m.

Mountain range on right consists of red bed. On the platform and in the valley, red sandstone (clayey). At Hsiaohuangtung[7] used to have copper; formerly 1000 men, now only 20-30.

The same igneous rock as that of Changchiu[8] and of Locha is here found below the red sandstone (upper limit, bar. 500). Native copper occurs in Tatunchang[9]. Over the mountain 30 li from here, used to be 400 men, now only a few 10's. Like that of Locha it is also somewhat schistose. The upper surface is conglomeratic.

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1 新舖子 2 芭蕉箐 3 通安州 4 大墳山 5 元寶山 6 白雲山 7 硝磺硐 8 掌鳩
9 大屯廠（青龍廠）

Then we got into a plain E of Hsinputzu. The soil is yellow. At bar. 586.1 just W of Yaotientzu[1] we have dark red soil above which is limestone. It is intensely altered, giving rise to calcite. It is clearly at a fault. Schistose rock exposed.

At a point NE of Yaotientzu (bar. 582.6, altitude 2069 m.), above the limestone, yellow sandstone and coaly beds exposed, striking 310°, dipping NE. A little further, red sandstone with coaly beds greatly faulted.

At Tunganchou, barometer ? temperature 27°.4, at 3 p.m.

Astronomical observations—bar. 589.6, temp. 23°.

May 26, 1914

Tunganchou to Chiangchunshih[2] and back to Tunganchou.

At Tunganchou, barometer 589.8, temperature 22°, at 7 a.m. Cloudy day.

Arrived at Chiangchunshih at about 11 a.m.

The ore occurs as calcite vein in a black stone (limestone?). The shaft is horizontal, 4 to 5.5 ft. high, 3-5 ft. wide, with side channels for water. Its direction is along the side valley NNW to N. The calcite vein is about 1 ft. thick (vertically), St. NNE to NE. At 11, temperature 28°.4, barometer 617 at Huofang[3].

At Laoshankou[4] we have the green igneous rock exposed in an unaltered condition below the yellow beds and limestone, so I think the succession is (from top to bottom):

4. Limestone
3. Coaly beds
2. Yellow sandstone
1. Igneous rock (bar. 591)

At point *C* south of Chengchiapa[5], joint in sandstone (yellow) and igneous rock. Sandstone St. 30°, igneous rock bent to 112° and vertical.

At Tunganchou, barometer 587, temperature 23°.5, at 2.30 p. m.

May 27, 1914

At Tunganchou, barometer 588.8, temperature 23°.7, at 8 a. m.

Furnace for oxidation is 17 ft. long, 3 ft. 5 in. broad, wall 2 ft. thick, 9 ft. high. One bed ore is put on wood. One layer of wood, one layer of ore (about 3

1 腰店子 2 將軍石 3 伙房 4 老山溝 5 鄭家壩

layers). One hole at the end of furnace for dropping down burning load. Here to have 15-20 days (according to amount of ore) the first-the last time take probably 6-7 days. 7-8 time altogether 1000 catties of ore require 3000 catties of wood. One tael per 1000 catties of wood coming from Suanshuiho[1]. One furnace can hold 20,000 catties of ore.

Coke from Yimen[2] $13 per ton. 100 catties of ore require 500 catties of coke. 12 hours can melt 4000 catties of ore. 3000 catties of ore give 200 to 600 catties of raw copper.

This raw copper has to be refined in Hueili[3], containing still 9-20% of slag.

Expense 60 [?] for oxidizing 20,000 catties of ore, after oxidation still 16,000 to 18,000 catties of ore left. 10 men for one smelting furnace. 12 cents per man. Price of ore: 50% ore = 7 taels per 250 catties + freight; 20% ore = 2 taels per 250 catties + freight.

Whole expense (including price of ore) 17 taels per 2500 catties of ore which on the whole gives 250 catties of raw copper. One catty of copper = 1.59 chien[4] (price for the ore = 2.5 tael per 250 catties). Tax 4.2 taels. Whole expense = 46 taels per 250 catties of copper. Sale price about 50 taels.

May 28, 1914

At Tunganchou, barometer 589, temperature 16°.3, at 9 a. m.

Mr. Kang[5] has been very kind. We went together to Chiangchunshih with Ling and Wang[6]—two men in the tax office.

May 29, 1914

Tunganchou to Luchang

At Tunganchou, barometer 590, temperature 14°.5, in the morning.

North of Tunganchou the green, violet and red sandstone looks like that of Wukueitang, west of Luchuan. Coming from Tunganchou all in the peneplane made of sandstone and clay. In approaching Yangchiaoho[7] we have red sandstone and clay alternating, at least 50 m. thick.

At point *d* between Yangchiaoho and Luitashu[8] the red clayed sandstone is flat-faced and plate-like.

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1 酸水河 2 夷門 3 會理 4 錢 5 康宗澳(淇生) 6 凌王二君 7 楊橋河 8 雷打樹

At point *e* south of Luitashu, variegated greenish marl is in fault contact with the red sandstone and clay. At Luitashu (bar. 565.2, temp. 19°, at 12) the red clayey sandstone has the same concentric banding as that of Yangchiatsun[1], north of Hsinputzu.

At bar. 587, yellow and violet beds alternating, forming coloured belts.

At Changkuanchung[2], bar 596, temp. 22°, at 2 p. m.

At point 2 north of Changkuoliangchiao[3], the sandstone, nearly vertical, is slightly metamorphosed and schistose.

In the valley of Maomaochung[4] red sandstone is coarse and micaceous.

Luchang[5] is a big village with well built houses and street. At the street it is full of slag, but I saw no furnace working. Barometer 592 at 7 p. m.

May 30, 1914

At Luchang, barometer 595, temperature 15°.2, at 8 a. m.

Section at Paitsaotung[6] (Fig. 8) 4-kilometers south of Luchang from top downward:

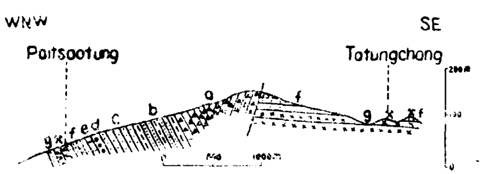

Fig. 8. Section from Paitsaotung to Tatungchang. a. Red and yellow brecciated sandstone and shale. b. Violet shale with thin bands of green sandstone. c. Red sandstone with green spots. d. Coarse yellow micaceous sandstone. e. White compact limestone. f. Coarse green and yellow sandstone. g. Andesite breccia.

a.	Red and yellow brecciated sandstone and shale striking 350° dipping 70° WNW	50 m.
b.	Violet coloured shale with thin bands of green sandstone	20 m.
c.	Red sandstone with green spots	19 m.
d.	Coarse yellow micaceous sandstone striking 5°, dipping 60°	6 m.
e.	White compact limestone[7]	4 m.
f.	Coarse green and yellow sandstone	20 m.
g.	Andesite breccia striking N-S, dipping steeply E.	3-4 m.

This andesite breccia contains in the richest samples 7% of copper, partly as carbonate, partly as sulphide. The former can be directly reduced in the blast

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1 楊家村 2 張官冲 3 張果梁橋 4 毛毛冲 5 鹿廠 6 白草洞 7 代石

furnace, but the latter has to be repeatedly oxidised by roasting. The proportion of carbonate to sulphide is about 2:5. In order to get the mat, 3 parts of limestone to 4 parts of ore have to be added as a flux. Two days and two nights are required to complete the roasting (4-6 times in succession) and 3 days and 3 nights for reduction. The charge is about 12,000 catties of ore giving rise to 350 catties of copper, using up 5-6 tons of coal.

The coking coal is obtained either from Yimen north of, or from Mingtzushan[1] south of the mine. The coal from the former costs 6.4 taels per ton including transport, that from the latter somewhat cheaper.

The Laochang[2] is an inclined shaft said to be more than 1,000 feet deep altogether including the various turnings. There is some water which is pumped with a simple wooden pump. This consists of a wooden tube made of 2 halves of hollowed wood tied together with bamboo rope. Into this tube is inserted a bamboo rod at the lower end of which is tied a leather sac open towards the upper end. At the lower extremity of the wooden tube is a leather valve allowing water to come up when the rod and sac are pulled up but preventing water to go in the opposite direction when the rod is pushed down. Thus it is a simple suction arrangement. In the beginning straw has to be put into the sac to make it effective, but when water has been sucked up the tube this is not necessary. The length of an individual pump cannot be much longer than 10 feet at the end of which is dug a small reservoir into which the water from the lower levels is pumped. This arrangement is repeated until the bottom of the shaft is reached. The shaft mouth is 6 ft. × 4 ft. and is well timbered.

The Hsinchang[3] is a little to the NW of the Laochang. It works the same lode but here it is an open cut at the outcrop. The ore is poorer in quality.

Similar ore in similar rock is said to occur in Takuanchiao[4], 15 li SE from Laochang and also at Sanchiatsun[5] (or Mulochaku[6]) 50 li south and about 20 li from Mingtzushan.

The extension along the strike seems to be considerable, but the copper content becomes increasingly poor.

About three kilometers SE from Laochang on the other side of the ridge is the mine of Tatungchang[7]. The ore is in the same rock which here dips gently eastwards, being separated from the formation to the west by a fault. The

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1 明子山 2 老廠 3 新廠 4 大關橋 5 三家村 6 慕羅渣骰 7 大銅廠

mine is a horizontal adit at the mouth of which it is only 2.5 ft. × 1.5 ft., but where the ore is rich it widens to more than 6 feet high.

Section from Taishihkou[1] eastward (Fig. 9) from top downward:

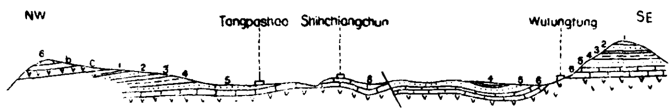

Fig. 9. Section at Taishihkou. For explanation see text.

a. Micaceous red shaly sandstone, bar. 575-577.5 dipping 10° E.

b. Coarse soft sandstone partly conglomeratic, bar. 577.5-586

c. Coarse yellow sandstone alternating with red shale bar. 586-591.2, striking 348°, dipping 40° E.

d. Fine grained white limestone, 10 m.

e. Yellow sandstone

May 31, 1914

Luchang to Fengshanying

At Luchang, barometer 602 temperature 11°.3, at 8 a. m.

At point bar. 800, yellow sandstone, St. 355°, dip 80° E.

At bar. 601, violet and green marl.

At bar. 599.5, yellow sandstone, St. 0° dip 55° E.

At bar. 592.8.

At bar. 570 yellowish sandy schistose clay, and then greyish yellow limestone.

From Paitashan[2] southwestward limestone much altered and schistose.

At bar. 565, altered black rock (igneous?).

A little south, we have the yellow schistose altered limestone, St. 90°, dip 16° N. Quartz pebbles frequent. By the side of river pebble of quartzite. Near river, limestone intensely folded. At river junction bar. 604.

At the bridge near Chiaochangpa[3] altered hard limestone, St. 75°, dip 80° N.

Arrived at Fengshanying[4] at 7 p. m., barometer 584.7.

1 代石溝 2 白塔山 3 教場壩 4 鳳山營

June 1, 1914

Fengshanying to Lungtan and return (*Pl. 2*:*YMA2*)

At Fengshanying, barometer 583.2, temperature 10°.4, at 7 a. m.

In going south-southwestward there is nothing but red clay and exposures of calcschist.

At point *b* west of Tapientan[1], schist St. 310°, dip NE. Schistose limestone St. 75°-80°.

At *c* northeast of Tachiao[2], quartzite St. 45°, dip NW (nearly vertical). To the left bank is a fault (overfolding and conglomerate). Limestone St. along the river.

At *d* north of Tachiao we have a yellowish red rock much decomposed (igneous rock?). A little further at *d'* the same igneous rock (bedded) much altered, St. 30°, dip SE. Sanchiatsun[3] and Tienpa[4] are all in the igneous rock.

In the river it is all quartzite.

Just beyond Lungtan[5] we have a dyke intruded between limestone.

Visit to mine. Two groups of old shafts, one above and one below, all in ruin and fallen down. The ore is not exposed but in the quartzite. The limestone is schistose. The village is nearly all in ruin, the fine temple[6] also. Best price for white copper is 60 taels per 100 catties.

Returned to Fengshanying, bar. 578, temp. 16°.8.

June 2, 1914

Fengshanying to Luchang (*Pl. 2*:*YMA2*)

At Fengshanying, barometer 581.4, temperature 12°.3, at 7 a. m.

North of the village we have quartzite beds to the right of the road. On the right bank of the river at Hungchuanchiao[7] we have massive limestone (altered) On the left we have the igneous rock.

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1 大扁担 2 大橋 3 三家村 4 田壩 5 龍潭 6 西嶽廟 7 鴻川橋

Coal mine at Tashihtou[1]		Hard sandstone roof
Chief seam		4-4.5 ft.
Shale		12 ft.
Second seam	8 in.	with thin seams of sandy shales between.
Third seam	2 ft.	
4th seam	2 ft.	
5th seam	2 ft.	

At point *e* east of Chingshanying[2] coal in yellow slate above igneous rock, below a hard quartzose sandstone which St. 15°-20° and dips 38° E.

At Luchang, barometer 592.2, temperature 25°, at 2 p. m.

June 3, 1914

Luchang to Hueilichou (Pl. 2: YMA2)

At Nanssu[3] (Luchang), barometer 591.2, temperature 14°, at 7 a.m.

About one li to the northeast of Hungyentzu[4], we observe the section in ascending order:

1. Schist, dip NW? (bar. 584)
2. Limestone, St. 286°, dip NNE (bar. 577.4)
3. Limestone, St. 70°, dip 3° NW (bar. 574)
4. Sandstone, St. 292°, dip 80° NNE (bar. 572.5 to 571—top)

At Wukuantun[5] south of Suchiapa[6], coaly beds seem to be exposed.

At Hueilichou, barometer 582.2, temperature 24°.4, at 3.30 p. m.

June 4-6, 1914

Stayed at Hueili.

June 7, 1914

Hueilichou to Lungchaoshan[7] (Pl. 2:YMA2), 21.7 kilometers.

Left Hueili by north gate. Barometer 589.9 (alt. 2480 m.) temperature 19°.2 early in the morning.

1 大石頭 2 青山營 3 南寺 4 紅岩子 5 五官屯 6 蘇家壩 7 龍爪山

It was raining. Passing through the village Laochiehtzu[1] we crossed a small bridge over a side stream just W of Sanyangchiao[2] when a storm breaks out. Much water, 3-5 in. high, rushes from the side valleys into the clear water of the main stream. Thence to Changlaotsun[3] via Hsintoutsun[4] the road lies in the flood plain of the river which is here divided into many branches. Near Changlao, 4 kilometers N of the northern gate of Hueili, the valley is 1,400 m. wide. The hills to the east are of red sandstone, but those to the west seems to be of limestone (?).

A little over 2 kilometers northwest of Changlaotsun we left the main road. From Changlaotsun on we find small outcrops of brecciated sandstone. Following side valley 600 m. further northwestward. we find yellowish sandstone exposed *in situ* striking 345° and dipping 12° W.

800 m. (alt. 2900 m. ±) further, we were at the foot of the mountain with red sandstone interbedded with impure limestone. 1350 m. northwestward (alt. 3000 m. ±) we have the boundary between red sandstone and basalt, the former striking 85°, dipping S. From now on, there is nothing but basalt.

700 m. up, we were at bar. 541.2 (3,100 m.) at 10 a. m.

3000 m. up, we were at bar. 518 (3,440 m.).

1650 m. up, we were at a pass, but unfortunately barometer was out of scale (height about 3500-3600 m).

The rain became very heavy and the mountain hidden in the mist, and we were reluctantly forced to give up the ascent to Lungchaoshan (3,810) m.)

We now descended into a small ravine flowing northwestward into a longitudinal N-S valley.

1600 m. from pass we reached point bar. 519.2 (alt. 3,423 m.). 300 m. to the west is the small village of Ssuchiatsun[5]. One kilometer further arrived at point *g* whence the road turned more toward north on the western slope of Lungchaoshan.

500 m. further we were at the village of Lungchaoshan bar. 527.5, temp. 15.8 (3318 m.).

Weather cleared up at night. 1575 m. (?) from point *g* good view of Salien[6] (Salientaho?), and high ranges beyond. Red colour of valley contrasts with green fields. Salien produces sugar. Panlinkou[7] north of Salien is said to be rich

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1 老街子 2 三陽橋 3 張老村 4 新頭村 5 四家村 6 撒連 7 潘林溝

June 8, 1914

Lungchaoshan to Maomaokou[1] (*Pl. 2*:*YMA2*), 11.25 kilometers.

Lungchaoshan, barometer 526.5, temperature 14°.4 at 9 a. m. 3318 m. Rain and mist. We started late.

Going N for 500 m. then turned NE, after crossing a valley 2000 m. further, we came to Hungyentzu[2] to the N of the valley crossed.

2700 m. further the road turns ESE after crossing 2 valleys on the western slope of the mountain. We here went up again. About 1000 m. further the road turned N up a steep pass. Barometer again out of range. 1400 m. further we were at a pass. Then 2150 m. zigzag down to Maomaokou from where 1700 m. further we stopped at Luchia[3]. Barometer 525.2 (3337 m.), temperature 17°.3 at 7 p. m.

Very bad day—Rain and mist all the time. Stopped early.

Both Lungchaoshan and Maomaokou are in *Lolo* country. The men are dressed like Chinese, but with turban on the head and a woolen (felt) mantle. The girls are pretty. They wear a simple band round the head (without cover at the top), but with 2 ear flaps. They wear a kind of *Makua*[4] as their upper garment and a skirt below. Married women wear an 8-corned "monk's hat"[5].

They live on mountain slopes and do not descend to valleys, cultivating maize chiefly and caring for sheep. They drink sheep milk and make cheese.

The Luchia is a rich family. They have hereditary male and female slaves. My hostess belonged to Machia[6] whose slaves went over to Wuchia[7] and came and attacked their masters killing the sister of my hostess. Machia retaliated by killing members of Wuchia. Luchia, being related to Machia, became also enemy of Wuchia. Luchia therefore built a kind of fortress and possess two rifles. My hostess who is 6 feet high watched herself and once gave false alarm in my presence. Girls marry at 17-18 and the marriage is exogamic.

She gave me some spirit made from maize, but it was undrinkable.

They say that they do not want to live in the valleys because they were afraid of mosquitoes.

Took measurements of 9 males.

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1 毛毛溝 2 紅岩子 3 祿家 4 馬褂 5 和尙帽 6 馬家 7 吳家

When cattle is sick, they tie a dog on the road side and let it die. If not cured, the priest reads *Ching*[1] and ties a pair of sandals with a young chick across the road.

June 9, 1914

Luchia to Paikuowan[2] (Pl. 2:YMA2), 15 kilometers.

At Luchia, barometer 525.9, temperature 15°2, at 8 a.m.

At point *e*, about six kilometers NNE of Luchia, sandstone and coal beds begin to be exposed, striking 60°, dipping 50° NW.

At point bar. 546 (about two kilometers SW of Iwanshui[3]), the red sandstone strikes 354°, then changes to 12°-14°, nearly vertical. In approaching Iwanshui, a white limestone, 3-4 m. thick, is exposed, striking 340°, dipping steeply to E. It is overlaid by a violet clay with thin bands of green sandstone striking 330°, dipping E.

North of Iwanshui, yellow beds with coal, striking 350°, vertical. The coal seam is said to be 20 feet in thickness.

At Paikuowan, barometer 567.8, temperature 27°, at 3 p.m.

June 10, 1914

Paikuowan northward to Taipingtzu[4] and return (Pl. 2:YMA2)

At Paikuowan, barometer 569, temperature 20°, at 6.30 a.m.

About one kilometer north of the village, sandstone St. 69°, dip 35° SSE. A little further, reddish and greenish sandstone St. 69° to 100°. At point *b*, a very coarse quartzose sandstone St. 89°, dip 27° S. At *c*, south of Wulipei[5], limestone St. and dip as before. Near the village, greenish impure limestone St. 300°, dip 27° S. The limestone extends to north of Maomaoying[6].

North of Kwanyinko[7], igneous rock below the limestone, under which is a red sandstone, much compressed, schistose and showing cataclastic structure.

Near Shuanmawan[8], metamorphic limestone dipping NNW.

At Tungkou[9] (bar. 554, alt. 2374 m.), fine ore in horizontal limestone. Descending westward to the old water level (bar. 557.2), limestone St. 10°-20°,

1 經 2 白果灣 3 一碗水 4 太平子 5 五里碑 6 毛毛營 7 觀音閣 8 拴馬灣
9 硐口

dip W, capping the basalt. Nearly vertical shaft to the NW of the old shaft made by Chang[1].

About 3.5 kilometers west of Tungkou the basalt lava begins to appear under the limestone. Then return to Paikuowan via Taipingtzu.

June 11, 1914

Paikuowan to Yimen via Wangchiaping[2] (Pl. 2:YMA2)

At Paikuowan, barometer 570.4, temperature 21°, at ? a.m.

June 12, 1914

Yimen to Tawanying[3] (Pl. 2:YMA2)

At Yimen, barometer 572.2 (alt. 2118 m.), temperature 20°.3, at 8 a.m.

Near Chihfangkou[4], greenish yellow sandstone St. 10°, dip 35° E. At Shangtsun[5], sandstone St. N-S, dip 75° E. South of Liushutang[6], St. 20°, dip 50° W. Then turning to west, we visited the coal mine of Tanchingtzu[7] where rocks strike 340°, dipping 50° E. The coal is non-coking and gives a white ash free from sulphur. 60 men or more had been employed but since the Tuwenhsiu rebellion the working has been stopped. The red beds overlie the yellow sandstone. The basalt seems to form a tongue between the coal beds and the red sandstone series.

At Yutsaiti[8], barometer 558.4, altitude 2272 m.

At Tawanying, barometer 569, temperature 24.°8, at 5 p.m.

June 13, 1914

Tawanying to Shihlouti[9] via Shihwopu[10] and return via Meitanchang[11] (Pl. 2:YMA2).

At Tawanying, barometer 571.9, temperature 18°.2, at 8 a.m.

Basalt occurs between Shihwopu and Shihloti (Fig. 10). Coal is exposed both at Meitanchang and near Shihwopu.

At Tawangying, barometer 570, temperature 20°.4, at 8 p.m.

1 張 2 王家坪 3 大灣營 4 紙房溝 5 上村 6 柳樹塘 7 炭箐子 8 油菜地 9 石樓梯 10 石窩舖 11 煤炭厰

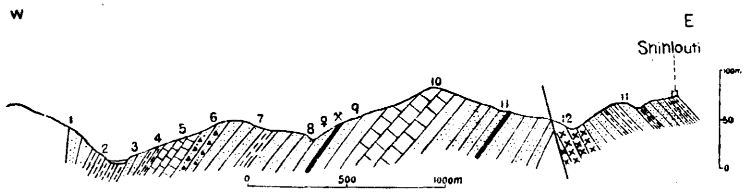

Fig. 10. Section across coal series near Shihwopu. 1. Coarse yellow sandstone. 2. Red shale. 3. Fine grained sandstone. 4. Red shale. 5. Yellow limestone. 6. Brecciated sandstone. 7. Yellow sandstone with interbedded shale. 8. Red sandstone. 9. Coal and yellow fine-grained sandstone. 10. White limestone. 11. Quartzose sandstone with coal. 12. Igneous rock.

June 14, 1914

Tawanying to Hueili via Hsiaohuangtien[1] *(Pl. 2:YMA2)*

At Tawangying, barometer 572, temperature 17°.3, at ? a.m.

Near Hsiaohuangtien, the sandstone strikes 0° to 28°, dipping 10° E. Fossils were found there but badly preserved.

At Hueili, barometer 584.5, temperature 22.8, aat 3 p. m.

June 15, 1914

Stayed at Hueilichou

VII. COPPER MINES AT TUNGANCHOU.

The copper mines of Chiangchunshih is situated 4 kilometers SE of the city of Tunganchou in the district of Hueili. The mises are situated on the very steep SW bank of the Chachehho river. The principal mineral is chalcopyrite though many other minerals of copper are also found here (see list), occurring in calcite veins in a metamorphosed black rock (probably an impure limestone) into which masses of gabbroid rock is intruded. The veins are locally known as *Shuan*[2]. The shaft I visited is just below the rock projection which gives rise to the name Chiangchunshih. It is a horizontal adit 4-5.5 ft. by 3.5 ft. widening out in places where the ore body is larger. The vein worked is about a foot thick and is nearly horizontal striking ENE-WSW, dipping NNE. A tunnel is cut at a lower level to drain off the water. Several other mines exist at a lower level, as well as to the west round the hill.

1 小荒田 2 拴

A coal mine is situated about 250 feet above and to the west of the mine. The series is the usual yellow sandstone which further westward is in contact with the igneous rock.

The ore is extremely rich, the best picked variety gives 50%. That from the mine visited averages about 10. The price varies strictly according to copper content and is always reckoned in units of 250 catties. The mine receives for the 10% ore 2.5 taels per unit while the best 50% ore may reach 7 taels per unit. Owing to the richness repeated roasting is necessary and that is done with wood arranged in three layers alternating with ore. The former comes from Suanshuiho and costs one tael per 1,000 catties or 1.7 per ton. Coke is also used for smelting. It comes from Yimen and costs 13 dollars per ton.

Thus the cost for obtaining 250 catties of copper from 10% ore is:

7500 catties of wood	7.5 taels
1250 catties of coke	7 taels
2500 catties of ore	25 taels
Wages etc.	2.5 taels
Tax	4.2 taels
Total	46.2 taels

This crude copper which contains more than 90% of slag is sold locally at 50 taels per unit of 250 catties.

The furnace used for roasting is 9 feet high, 17 feet long and 3.5 feet broad, holding a charge of ore of 20,000 catties. The roasting has to be done 7-8 times lasting altogether 15-20 days. The smelting is same as elsewhere.

Native terms for ores

Huangchinpo (黃金箔) ....cupriferous pyrites
Red Face Hsila (紅臉錫臘) ......chalcopyrite with cuprite
Tuchusha (土硃砂) ....cuprite
Talukuang (大綠鑛) .... malachite
Tatungkuang (大銅鑛) ....chalcopyrite
Heichienpihuangkuang (黑鉛皮黃鑛)chalcopyrite with chalcocite
Heikuang (黑鑛) ....chalcocite

Peihsila (白錫腊) ....bornite occurring in Shuangfengshan (雙鳳山) and Tatuntang (大屯塘)

Luyatzuhuangkuang (綠牙子黃鑛) chalcopyrite with spots of malachite

Sualan (耍藍) ....azurite

Tzuchinkuang (紫金鑛) ....chalcopyrite tarnished

Tungshakuang (銅砂鑛) .... native copper

Hoyaosu (火藥酥) ....earthy chalcocite

Shalukuang (砂綠鑛) ....impure malachite

Kopien or heitzuchin(焗片，黑紫金)impure chalcocite

VIII. NICKEL DEPOSIT OF CHINGKUANGSHAN[1], LIMAHO[2].

The deposit is situated a little more than 8 kilometers as the crow flies and 12 kilometers by the road WSW from the village of Fengshanying on the main road from Chinchiang to Hueili. The Chingkuangshan hill is on the SW side of Limaho river about 1 kilometer W of Lungtan. The mineral is a complex compound of nickeliferous pyrites scattered through the mass of an ultrabasic rock of the peridotite type. It is evidently of magmatic origin formed by segregation. The average content of nickel is about 2%. This rock is intruded into a series of metamorphic rocks of calcschist (cipolin of French authors) and quartzite. Here the peridotite is found between the calcschist (striking NW-SE, dipping NE) and the quartzite (dipping SW) which form the top of the hill, though the exact relation is difficult to make out because all the outcrops had long ago been worked out and there is left only heaps of earth with lumps of ore and 2 shaft sites. The mining village of Yuanchenlu[3] as well as the market further up the valley are in complete ruin. Heaps of ore of a poorer quality are scattered about the whole place. The industry has been dead for the last 30 years.

The metallurgy of this ore from which the famous white copper of Yunnan is derived is very complicated. As the industry has been dead for such a long time it is difficult to learn the exact process. The following details are told by a relative of Mr. Chang, the local gentry who operated the furnace and the mine and through whose kindness much of the information and comfort of my visit was due.

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1 青鑛山 2 立馬河 3 元貞爐

1. The production of *laotung*[1]

   a. *Tsowo*[2] ...... 500 catties of coke required.

The furnace is similar to that used for smelting copper. The bottom of the furnace is the *wo*, a depression 5 in. in depth and 1 foot in diameter lined with charcoal ash. 1,000 catties of ore together with 500 catties of white rock from Hsiaokuanho[3] are put into the furnace fired with coke. Slag is allowed to run off. The mat is separated into two parts: the lower part is the *haiti*[4], the upper part of the *wo* is the *tsowo*. 24 hours are required to complete the process and 210-250 catties of mat are obtained.

   b. *Touhuo*[5] .... 60 catties of charcoal required.

The *tsowo* is crushed and put into a small furnace with charcoal for 6 hours. From a charge of 120 catties a product of 70-80 catties are obtained. This is called *touhuo*.

   c. *Maohuo*[6]

The furnace used for this purpose is simply a shallow depression in front of a fire with a wind pipe directing the flame upon it. The bottom of the depression is lined with ash over which is put the *touhuo* covered up with powdered charcoal. The heating lasts 2 hours and a charge of 10 catties of *touhuo* gives a product of 6 catties of *maohuo* with a little slag. 10-15 catties of charcoal are used.

   d. *Kuohuo*[7]

The furnace is essentially the same as *maohuo* but still smaller, being only 6 in. in diameter and 3 in. deep. Charcoal is again used and a charge of 12 catties of *maohuo* gives rise to a little more than 6 catties of *kuohuo* after firing 10-15 catties of charcoal for about 45 minutes.

3.5 catties of *maohuo* + 1.5 catty of *kuohuo* + 6.5 catties of copper melted together gives rise to 6.5 catties of *laotung*.

2. The production of *Chingpan*[8]

50 catties of the nickel ore are charged with 25 catties of poor copper ore and 30 catties of limestone in a furnace similar to that for *tsowo*. The process requires from 36 to 50 hours. The product is called *chingpan*.

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1 老銅 2 坐窩 3 小關河 4 海底 5 頭火 6 毳火 7 過火 又名溜火化火 8 青板

3. The production of *chintung*[1]

The *haiti* or bottom product from *tsowo* is resmelted in a similar way as ***maohuo***. The process is repeated 5-6 times until only 1% of the original ***haiti*** is left. This is called *chintung*.

4. The formation of the alloys.

Two kinds of alloys used to be made.

a. *Chingtung*[2]

A charge consisting of	0.5	catty of	***chintung***
	3.5	,, ,,	***chingpan***
	3.5	,, ,,	copper
	0.7	,, ,,	*laotung*
	0.02	,, ,,	lead

is put into a cup made of yellow clay (from Paiyunshan) 5 in. in diameter and 5 in. deep. Inside the cup is a central core (with a small hole in the middle) round which is a deep groove. Into the latter is put the charge. The whole is covered up with charcoal. After 30 minutes the metal boils and the charcoal is knocked off with an iron rod and the boiling metal is first covered with ash and then immersed in cold water.

b. *Paitung*[3]

Exactly the same as before but without the addition of ***chintung***.

The above description is not sufficiently detailed to enable us to understand completely this remarkable process. But the following points are important:

1. The *tsowo* is for obtaining the sulphide mat whilst the ***touhuo, maohuo*** and ***kuohuo*** are merely repeated reduction.

2. The ore may contain some other metal than nickel as the separation of the heavier ***haiti*** from *tsowo* proper seems to indicate this. The final product of ***haiti*** is the only material that causes the difference between *chingtung* and *paitung*.

1 金銅 2 青銅 3 白銅

3. Copper is repeatedly used apart from the final alloying process. It acts probably in some cases at least as a flux by alloying with other undesirable metal such as iron before the nickel has been properly reduced.

The final product from 4 weighs 5 catties for *chingtung* and 3.5 for *paitung*. The cost of production averages 40 taels per 100 catties whilst the average price at Hankow used to be 70 taels. The industry was killed in about 1885.

The same man told me that nickel used to be produced at Tengchihkou[1] near Tachuan[2] two stages W of Yachou (?). The alloy is said to be three times richer in nickel than the Luchang product.

Analysis

	Sample 1	Sample 2
SiO_2	28.59	38.01
Fe_2O_3	29.14	19.67
(?)	2.05	5.76
Al_2O_3	4.75	5.48
MgO	19.66	22.50
S	11.45	4.78
Ni	2.63	1.02
Cu	0.64	0.56

IX. ZINC SMELTING NEAR PAIKUOWAN.

The furnace used for that purpose is divided transversely into two parts, each measuring about 3 ft. by 14 ft. The purpose of the division is to enable each part to be separately fired. The crushed ore mixed up with coal dust is charged into a clay crucible 22 inches long and 5 inches in diameter at the open extremity. These crucibles are put into the middle of the fuel in three rows with 16 in each row so that each half of a furnace contains 48 crucibles, holding a charge of about 300 catties of ore and 100 catties of coal dust. Each crucible is sealed up at the top with clay leaving a hole to allow the zinc vapour to come up. Into this clay receptacle which is covered up with a lid, the zinc vapour condenses. It is then poured out into brick-shaped molds, each brick weighing about 30 catties. The whole operation lasts about 14-16 hours. The clay comes from Yimen,

1 鄧池溝 2 大川

and the crucibles can be used for more than 10 times. Each crucible costs about 30 cashes. Half a ton of fuel is required.

The cost is as follows:

Ore containing 12-16% metal ...... 6 cashes per catty
Transport .... 1 cash per catty
Coal .... 1/2 cash per catty
Tax .... 7.5 % in kind
Price of zinc .... 7 to 7.9 per 100 catties
Output .... 35,000 to 20,000 catties per month
Monthly expenditure about 200 taels.

The works and the mine were reopened in the 30th year of Kuang Hsü[1] by the Industrial *Taotai*[2] who sent a man Kuo[3] with 4,000 taels to work for silver. The venture proved unsuccessful and in 1910 it was sold to the General Mining Co.[4] which is said to have a capital of 100.000 taels working also other mines. This company is said to have paid 4,800 taels to the Government in addition to 800 taels for the permit, and 100 taels for the title deed. The man Chang was put in charge but since the revolution the work has been much reduced.

The coal mines worked at the smelting plant are very primitive. Some seams are said to attain a thickness of 20 feet. Each workman carries 30 loads per day, each load weighing 60 catties. He is paid 50 cashes with food.

X. HUEILICHOU TO TUNGCHUANFU (June 16—July 19)

June 16, 1914

Hueilichou to Tankuanyi[5] *(Pl. 2: YMA2)*, 14 kilometers

At Hueilichou, barometer 589, temperature 17°.3, in the morning. Rain.

Left Hueilichou by the south gate. 600 m. south crossed the river by Tahuachiao[6]. There is considerable flood in the southflowing river. Low sandstone hills are seen east of the village of Liangyuan[7], a large village 300 m. east of road about 800 m. from Tahuachiao. 1200 m. further south passed Lungwangmiao[8] whence 500 m. south we crossed the Likungchiao[9]. Sandstone between the

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1 光緒 2 道台 3 郭 4 鑛務總公司 5 彈冠驛 6 大花橋 7 梁園 8 龍王廟 9 李公橋

two last mentioned places in the east is seen to dip W. High mountains to the west, to the east of which are low foot hills (500 m. west from the road). 1250 m. further south we came to Hsinchuangpa[1] to the ENE of which is an isolated sandstone hill.

300 m., the road left the main river valley turning SE. 500 m. at Tafengtang[2]. 400 m. southeast of Tafengtang sandstone St. N-S dip 5° W. 1000 m. Chunghotou[3] where the sandstone strikes 10°, dipping 8° W. From Tafengtang to Chunghotou we crossed a low watershed into the valley of Tanhsiho[4], the valley of which is about 300-400 m. wide. 300 m. ESE from Chunghotou we forded the Tanhsiho with difficulty, water having arisen owing to the rain. 500 m. after crossing we came to Chiensopa[5]. 500 m. SE we passed another village. 1500 m. east we came to Hsuehkuchung[6]. From Chiensopa onwards sandstone strikes E-W, dipping gently S.

550 m. from Hsuehkuchung we crossed another small stream. The sandstone forms here a gentle anticline. We are now once more near the main stream. 1100 southeastward we passed Litzuyuan[7]. 900 m. further, after crossing two streams, the red and yellow sandstone strikes 344°, dipping 47° E. The road goes up to bar. 589 (400 m. from last observation), then came down 950 m. to Tankuanyao[8] where pottery is made from a fire clay. 1700 m. east we arrived at Tankuanyi where we spent the night.

At Tankuanyi, barometer 587.2, temperature 18°.6, at 7 p. m.

The village is situated on a slope, about 30 houses. The red sandstone is coarse and micaceous, easily decomposed.

June 17, 1914

Tankuanyi to Chiangchou[9] *(Pl. 2:YMA2)*, 23 kilometers

At Tankuanyi, barometer 588, temperature 16°, at 7 a. m.

Crossed a stream immediately outside the village. The yellow sandstone strikes 114°, dipping 20° SSW. 800 m. east of Tankuangyi (point *a* on map) reddish shale and sandstone strike 7°, dipping 60° E. Soon it changed to strike 346°, dipping 30° W.

200 m. further east we crossed a large stream flowing south where the sandstone again dips 60° E, but 100 m. east it strikes 340°, dipping 35° W.

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1 新莊壩 2 大風塘 3 中河頭 4 潭溪河 5 錢鎖壩 6 雪姑冲 7 李子園 8 罈罐窰 9 江州

Immediately it is changed to strike NNW, dipping 80° W. Soon it becomes nearly horizontal.

North of Peichuang[1] 650 m. east of last stream, the road turns again to NE. The sandstone dipping about 8° E. About 2000 m. we arrived at Shan-*peiliangtzu*[2] *where the sandstone is practically horizontal, locally dipping* 6° S. 1200 m. further we are at bar. 580 point. From this pass we see a range of mountains across the valley running NE-SW.

Thence the road goes again east along a ridge. The land is poorly cultivated. 2500 m. further we began to descend. About 900 m. down we arrived at Liushutang[3], bar. 589.9, temp. 18°C, at 10 (?) a. m.

The valley of the river east of Liushutang is only 200 m. wide. Crossing it, we began to ascend in the horizontally bedded sandstone. 500 m. east we were at point bar. 587 whence we ascended 1300 m. SE to another river on the east bank of which is Chuanhsintien[4]. Searched for fossils, but without success. The sandstone is perfectly horizontal.

1200 m. case we arrived at the pass of Paitashan[5] with a pagoda. Descending eastward 1500 m. we are in another valley. Crossing the latter we went up 200 m. to point bar. 586, then descended 1000 m. ESE to Hsiaopa[6]. In the village I saw some fire clay said to have come from Tiehchiangtsun[7].

Here we crossed a large stream flowing south (barometer 591.2). Now the road goes along the valley of a winding large stream flowing east. 1600 m. from Hsiaopa we are at Chatzushu[8]. Just west of it near a bridge over a side stream red sandstone strikes 329°, dipping 50° 8, but it is quite local, as the dip is generally still gentile. About 1000 m. east red sandstone strikes 50°, dipping 20° SW. Another 1000 m. we passed Hsuchiawan[9].

400 m. SE we are at a very low pass which seems to be a former river channel from the east. Descending 250 m. we came to a stream flowing south (the same stream probably flowed formerly west through the low pass). On the west bank sandstone strikes 285°, dipping 12° S.

700 m. further east another low pass (barometer 591) which may be another former channel of the Tatunho[10]. 500 m. east red sandstone strikes N-S, dipping 85° E. Soon it changes to strike 330°, dipping 35° W 100 m. further. 500 m.

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1 北莊 2 山背梁子 3 柳樹塘 4 穿心店 5 白塔山 6 小壩 7 鐵匠村 8 渣子樹
9 許家灣 10 大屯河

east we crossed a stream flowing southward just south of Wantetsun[1] behind which are hills of horizontal sandstone. Thence eastward for 1500 m. the road goes along the northern bank of the river (from Wantetsun), then turns SSE. 500 m. further we were at Chiangchou. Barometer 591.1, temperature 19° at 4 p. m.

Stayed in a temple. It is a very large building with big courtyard and a stage for theatrical performance. It was built in the seventh year of Taokuang, but now in ruins. Formerly there must have been a lot of Kueichow people here, but now there were only two families left.

June 18, 1914

Chiangchou to Kuchu[2] *(Pl. 2:YMA2)*, 13.15 kilometers.

At Chiangchou, barometer 592.6, temperature 14°.3 at 7 a. m.

400 m. northeast from Chiangchou crossed a river flowing southeast. Another 500 m. in the same direction recrossed the same river (or a branch of it) flowing west. 700 m. further, following a side valley, sandstone strike 344°, dipping 4°-8° E. Soon the dip increases to 30°.

Going up hill for 450 m. we came to a pass (barometer 591.9) where the sandstone strikes 358°, dipping 80° E, but suddenly it changed to strike 50°, dipping 10° S.

Descending from the pass the road turned gradually northward. 1200 m. we arrived at Tachuang[3] in a river valley flowing south. 700 m. north we crossed the river. Here the sandstone strikes 94°, dipping 18° S.

The road goes up again. 1350 m. north we were at the guard station of Lukueishan[4], barometer 575.2, temperature 13°.2. The sandstone strikes 78°, dipping 8° S. 100 m. east from the guard station outcrop of white compact limestone (1 m ± thick) similar to that of Taishihkou, striking 295°, dipping 20° S.

The road now turned eastward. 700 m. further, sandstone strikes 320°, dipping 83° W, but 300 m. the dip decreased to 15°. 800 m. east, after crossing a small stream, it strikes 70°, dipping 40° S. 900 m. further we crossed the northward flowing river. 450 m. NE the river forms a waterfall Tishuiyen[5]. Here the sandstone series, which really consisted of alternatively hard sandstone and soft shale, strikes 304°, dipping 20° SW. The river traversed it at right angles to

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1 萬德村 2 苦竹 3 大莊 4 魯魁山 5 滴水岩

its strike and in the opposite direction of the dip. The comparatively easily eroded soft shale below the sandstone formed a waterfall 15 m. high. Judging by the outcrop of the hard sandstone on the banks, the fall had receded some 70 m. since its first formation. At this season the fall was quite imposing.

400 m. east of Tishuiyen the Taishihkou limestone outcropped again, striking 343°, dipping gently W.

1600 m. NE yellow sandstone and black coaly shale began to appear, striking 265°, dipping 12° S. The road now went up for 750 m. (barometer 593) then it descended 500 m. NE to Yaotientzu where the greenish sandstone strikes 183°, dipping 10° E. From there on the road followed the main river NE for 1450 m. to Kuchu, crossing the stream three times.

At Kuchu, barometer 596.9, temperature 19°.6C at 6 p.m.

June 19, 1914

Kuchu to Polotang[1] (Pl. 2:YMA2), 10 kilometers.

At Kuchu barometer 597.4, temperature 16°.2 at 9 a.m.

Started very late as the woman chief insisted upon giving me a horse which I had difficulty in refusing. She also sent some 20 rifles to be my guard of honour. This latter gave me quite a lot of trouble and I only succeeded in getting rid of them after reaching Maomaoying.

700 m. NE from Kuchu we passed the village of Lungchiatsun[2] 400 m. ENE of which was a side stream from the north. 500 m. east we crossed the main river near Maomaoying. 300 m. further red sandstone strikes 330°, dipping 15° W. From here on the wide flood plain of the river ended and we entered a much narrower valley going along its south side. At first the route was nearly towards east, but 600 m. from Maomaoying it turned north-east. After going for 2000 m., it changed again toward east. 300 m. further we turned to SE towards Changyipa[3] (450 m. from turning). Chanyipa is a E-W arranged town nearly 400 m. long. Bar. 596-598, temp. 23°.1.

Limestone was first met with just west of Changyipa (Fig. 11). but 350 m. southeastward from the northeastern end of the town, off the main road, there is a small hill (barometer 588.7) where the limestone, which was practically

1 波羅塘 2 龍家村 3 昌意壩

horizontal, overlaid unconformably the yellow and red sandstone series which was folded into a steep anticline with its axis directed 286°, dipping on each side 60°.

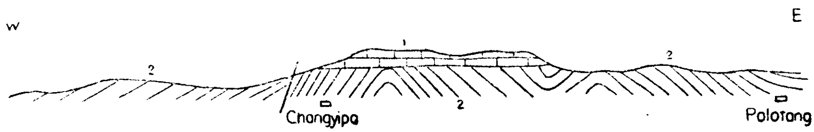

Fig. 11. Section from Changyipa to Polotang. 1. Limestone. 2. Sandstone and shale series.

From here we had a wide view of a large valley to the north. About 1.5 kilometer away, at the head of the latter was the village Wowuszu[1]. The sandstone beds were seen to dip SSW, but on the southeast side of the valley they dip ENE.

800 m. ESE from Changyipa we passed Wantzu.[2] 250 m. from the latter the road again turned east. Limestone was seen to form low hills on the south side of the road. 700 m. east it turned again to NE. Here the red sandstone strikes 300°, dipping 57° N. The river valley is here only some 300 m. wide.

Going in the same direction for 800 m. we saw in the hills north of the river another anticline formed by the sandstone series. 300 m. further the road turned again southeast thus following the arc of the river. 700 m. we were opposite Tayuantzu[3] where black coaly shale was exposed, striking 9°, dipping 40° E. 600 m. eastward we crossed the main river, 300 m. east of which was the village of Polotang. By the riverside sandstone strikes 12°, dipping 12° E.

At Polotang, barometer 598.2, temperature 24° at 2 p.m. Only about 10 houses left in the village.

June 20, 1914

Polotang to Chaho[4] (Pl2 : YMA2), 28.45 kilometers.

At Polotang, barometer 599.4, temperature 17°.9 at 7 a. m.

Section at Lunanshan[5]

9. Quartzite and red clay, bar. 552.
8. Limestone St. N-S, dip W, bar. 558.7.

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1 窩烏司 2 灣子 3 大園子 4 岔河 5 魯南山

7. Yellow argillaceous sandstone St. N-S, dip W, bar. 565.
6. Red sandstone St. 310°, dip 50° NE, some become vertical, bar. 567.
5. Slaty beds dip SW, soon reversed to NE.
4. Yellow quartzose sandstone, bar. 572.
3. Yellow sandstone (coarse and soft).
2. Variegated sands and clay, St. N-S, dip 80°E, bar 587.6.
1. Very coase red sandstone nearly horizontal, then St. 310°, dip 5° W.

At *b* (bar. 558.7), just at junction between limestone 8 and sandstone 7 the relation is not clear. The limestone is apparently below but the dip is so steep that there might be an overthrust. The limestone is yellowish, veined and brecciated (there may be a fault). Below the limestone further up, we have quartzite pebbles and red clay. Limestone appears again above it.

Near *é* quartzite 9 as a bed exposed, St. 352°, dip 8° W. Limestone is seen above it (bar. 529.5). Further up the slope is gentle, we are in terrace-like undulations (typical of limestone scenery). The decomposed quartzose sandstone 9 gives rise to good soil which is all cultivated. Remnant of opium cultivation numerous.

At *g* (bar. 517.2), we have fissile shaly beds below the massive limestone. Near *g'* quartzose sandstone exposed below shaly beds at bar. 504. Red sandstone below limestone St. 265°, dip 70° NW, rather schistose. At *h* quartzite St. 45° dip 60° SE, soon reversed to NW, intensely metamorphosed. At *k* limestone and clay. At *k'* (bar. 546.1) limestone disappears, sandstone (yellow, soft and coarse) St. NE, dip 60° SE. At *k''* violet flakes St. NW, vertical, associated with sandstone much folded (E-W), St. N-S.

At *L* (bar. 551.1) thin bedded limestone St. 330°, dip 50° NE, above which is the yellow sandstone (coarse and soft).

Complicated folding.

At *L'*, bar. 557, red.

At *L''*, bar. 565, quartzite.

At bar. 566 decomposed red sandstone.

At river bar. 575.

Chaho bar. 577.4 at 9 p. m.

June 21, 1914

Chaho to Fawo[1] (*Pl. 2 : YMA2*), 16.4 kilometers.

At Chaho barometer 578, temperature 12°.3 at 8 a. m.

We were unable to procure a guide and had to leave without one.

3000 m. east of Chaho we crossed to the right bank of the river which flows eastward to Tachiao[2]. The road now went ESE. 350 m. from river sandstone strikes 45°, dipping 80° W. 550 m. further (barometer 580), after crossing a ravine, yellow sandstone with black coaly shale strikes 92°, dipping 40° N. We went now SE for 550 m. to a village, then eastward again to cross a side ravine, leaving the main river to our left. Here yellow sandstone and slaty shale strike N-S, dipping 40°. This remained unchanged for the next 700 m. when we came to a pass (bar. 574.3).

Descending for 650 m. we came to Paichiatsun[3]. 1000 m. further down and crossing a side valley obliquely, we came down to Tselukou[4] opposite a large alluvial cone, formed by a side valley in the east. 500 m. from Paichiatsun red sandstone strikes 23°, dipping 50° WNW. The valley is about 500 m. wide.

Following the river southward for 3,300 m. and crossing it three times, we arrived at Yinchiatsun[5] where we got a guide. In the Tselukou green sandstone strikes 45°, dipping steeply NW. But the river is full of basalt pebbles. A high limestone cliff called Paishihyen[6] was seen in the SSW. Tanshankou[7] was seen west of the valley in a side ravine.

400 m. south of Yinchiatsun sandstone strikes 15°, dipping 38° W. The beds on the west side of the river are folded cross to strike. 450 m. south we crossed an important tributary on the southern bank of which is a water mill opposite Changchiatsun[8] on the west side of the Tselukou and began to ascend a ridge between it and the main valley. This ridge is formed by basalt which is in fault contact with the sandstone.

Further south at bar. 560, limestone apparently above basalt. Limestone crystalline and faulted, St. 20°, dip W.

At Fawo, barometer 546.6, temperature 26°.6 at 4 p. m.

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1 發窩 2 大橋 3 百家村 4 窄路溝 5 尹家村 6 白石岩 7 炭山溝 8 張家村

June 22, 1914

Fawo to Tiehchang[1] *(Pl. 2:YMA2)*

At Fawo, barometer 549.3, temperature 15.°4 in the morning.

Went 700 m. north from Fawo. Then turn northwest for 1200 m. to go up a cliff of limestone. 1000 m. further west then was an abandoned shaft in limestone. Another was situated 850 m. further up where the limestone St. 38°, dip 20° NW.

1200 m. southwestward we climbed up to the highest point in the region known as Paishihyen where we had a wonderful view of the country (highest point bar. 420, temp. 22° at 12). After making topographical surveying we came back to Fawo. Coming down we carefully noted the following section.

Section at Paishihyen near Wanghsiangtai[2] (Fig. 12) from top to bottom, bar. 420.

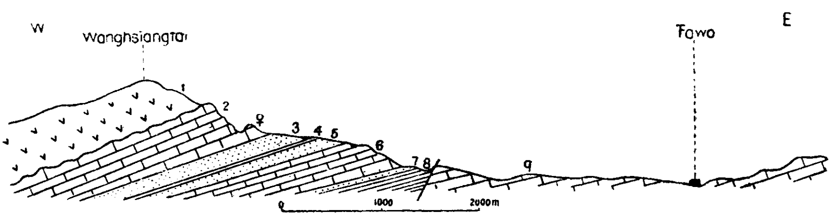

Fig. 12. Section of Wanghsiangtai near Fawo. 1. Basalt. 2. Greyish white brecciated limestone with corals. 3. Coarse compact sandstone. 4. Yellow clayey slates. 5. Compact brown sandstone. 6. Limestone with few yellow shale and cataclastics. 7. Quartzose sandstone. 8. Red clay. 9. Limestone.

1. Basalt

   Bar. 506

2. Greyish white brecciated limestone with fossils (chiefly corals).

3. Coarse compact sandstone, St. 50°, dip 12° NW.

   Bar. 520

4. Yellow clayey slates.

   Bar. 524

5. Compact brown sandstone.

6. Yellow shale soon cataclastic structure with quartz pebbles, again limestone.

   Bar. 537

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1 鐵廠 2 望鄉台

7. Quartzose sandstone.
   Bar. 538

8. Red clay with limestone pebbles.
   Bar. 541.3
   —— Fault ——

9. Limestone to river.

At bridge (bar. 544.5) immediately southeast of Fawo white limestone St. 70°, dip 10° NNW.

At *b* limestone altered green, St. 352°, dip 20° W. Much shearing and faulting.

At pass (bar. 512.4), much altered limestone.

On this side, the alteration is more intense, we have true crystalline schist St. 335°, vertical. At bar. 523, fine sandstone much altered.

Deep valley, steep slope.

At Sanchiatsun[1] still yellow sandstone.

At Tiehchang, barometer 568.2, temperature 16°.4 in the evening.

June 23, 1914

Stayed at Tiehchang

June 24, 1914

Tiehchang to north of Shuangshuiching[2] and return (Pl 2:YMA2)

Coming back from the top of the mountain northwest of Shuangshuiching we collected fossils from the limestone. At point *a* (bar. 332) metamorphosed quartzose beds. At bar. 505, yellow sandstone below schist, St. 70°, dip NNW. At *c* true schist. At *e* (bar. 520) metamorphosed limestone.

Gneiss by side of the mining office at Tiehchang, St. 350°.

At Tiehchang, barometer 567, temperature 16.7° at 9 p. m.

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1 三家村 2 雙水井

June 25, 1914

Tiehchang to Tamaiti[1] *(Pl. 2:YMA2)*

At *a* metamorphosed sandstone St. 300, dip 70° SW.

Facts concerning the mines of Tiehchang:

Pits very numerous and far apart. The ore is distributed as veins and quite irregular. Now they altogether still produce 130,000-150,000 catties of copper. Best ore=30%. Worst=7%. Mostly have to be oxidised 4-9 times. 15,000 catties of ore require 4500-6000 catties of wood (1 each per 1.5 catties). One furnace can hold 3000-4000 catties of ore. 3000 catties of ore require about 3400 catties of charcoal (20 taels per 15,000 catties). The master supplies rice and oil and pays no wage. When they get ore, the master and workman divide |it| according to agreed proportion. At present cost about $4000.

Near Kuochia[2] rock looks like altered schistose basalt.

From *e* to *h*, all sandstone and schist (no limestone).

Between the small river and the Yangtse is Hsiangpiling[3], a low ridge between high ones. On this side is the range I have been, on the other side is Tahsuehling[4]. Quartzite at *g*.

Old mine at the pass.

At Tamaiti fine view of the Yangtse.

Continuous limestone cliff. My tent is just below it. Raining all night but cleared up the next morning.

Old mine in fault fissures.

June 26, 1914

Tamaiti to Yenching[5] *(Pl. 2:YMA2)*

At Tamaiti, barometer 522.1, temperature 13°.2 at 9 a. m.

At bar. 516, quartzose sandstone St. 70°, dip (NW) NNW, strongly folded. A few steps further reversed.

At *a*, slate.

At *c*, St. 10°-20°, dip 85° NW.

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1 大麥地 2 郭家 3 象鼻嶺 4 大雪嶺 5 鹽井

In descending from Chungliangtzu[1] to Hsinkaitien[2] the basalt seems to be less and less altered, the water has a somewhat intreat task.

At *e*, conglomerate.

At Yenching, barometer 669.6, temperature 330°.4 at 4.30 p. m.

Yenching is situated on a steep slope, terraced into salt field, built of stone and made plate with sand. The salt water is filled up from well (the level of which is below the river). On the hill side are the slates now almost all underwater. This is put on the field. After two days of dry weather, the sand as a whole is scraped up and put into wooden barrels slowly filled through a side tube. This thick water is evaporated in pans.

June 27, 1914

Yenching to Topuka[3] *(Pl. 2:YMA2)*

At Yenching, barometer 676.2, temperature 26° in the morning.

Topuka lies in an enclosed basin well cultivated. We have soft sandstone and clay forming flat-topped hills.

At Topuka, barometer 573.1, temperature 27°.4 at 3 p. m.

June 28, 1914

Topuka to Niulitang[4] *and return (Pl. 2:YMA2)*

At Topuka, barometer 573, temperature 25°, at 11 a.m.

At Niulitang, barometer 575, temperature 29°.2 at 2.30 p.m.

Copper mine in much altered limestone. Veins irregular. At *b* altered sandstone. Lignite horizontal occurring in the river near Anloching[5]. At *d*, yellow clay, hardened into slate and unfossiliferous. I think all that I saw is Cambrian.

June 29, 1914

Topuka to Tashui[6] *(Pl. 2:YMA2)*

At Topuka, barometer 571, temperature 22°.3, at 8 a. m.

In ascending, yellow quartzose sandstone; above it, the much crushed clay

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1 中梁子 2 新開田 3 拖布卡 4 牛犁塘 5 安樂箐 6 大水

slates. Up to Shuangpaoyao[1], all altered clay and crushed sandstone. At *th*, bar. 543.4, alt. 2451 m.

At *b* west of Mapiaopo[2], yellow schistose clay, St. 338°, dip 40° E.

After Machiafen[3] much altered crystalline limestone, St. N-S, dip W (soon changed to E). More intensely metamorphosed beds from point *c* near Hsiaotienpa[4], St. 110°, dip vertical (S).

From Pakou[5] to the col (bar. 498.4, alt. 3084 m.) near Motzushan[6], all phyllite. At *e* between Motzushan and Tashui, red clay St. 340°, dip 50° W. At Tashui, bar. 537.2.

June 30, 1914

Stayed indoors at Tashui.

July 1, 1914

Visit to copper mines southwest of Tashui (Pl. 2 : YMA2)

At Tashui, barometer 539, temperature 16°, at 8 a.m.

Went to the open cut west of Tachiaoti[7]. Bottom of open cut bar. 493.6. Vertical quartz vein 3 to 4 feet thick. St. N-S, dip 80° or more to W.

All the old holes are situated about bar. 493.1, the lower the fewer.

At *a* bar. 494.6, crushed clayey sandstone. Pits near Chaoyangtung[8] very rich in *pantung* but very deep.

At bar. 491.9 near Laohsinshan[9], limestone St. 332°, dip 80° W.

At *b* bar. 501, limestone St. 350°, dip W.

At *b* terrible accident, 4 men died after the landslip.

At Machangtzu[10], sandstone St. 334°, dip 60° W, below which yellow clay. In the yellow clay (bar. 515.5) I found an iron ore.

July 2, 1914

Tashui to Chinglungshan[11] (Pl. 2 : YMA2)

At Tashui, barometer 536.8, temperature 17°.2 in the morning.

Dull and fog.

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1 雙寶窰 2 麻膘坡 3 馬家墳 4 小田壩 5 壩口 6 磨子山 7 大蕎地 8 朝陽洞
9 老新山 10 馬掌子 11 青龍山

At *a* reddish blue coarse sandstone, St. 280°, dip 70°S., over which is yellow limestone coming from Laohsinshan.

At *b* St. 338°, dip 60° W.

At *c,* black shaly schist St. 337°, dip W., succeeded by yellow laminated sandstone, St. and dip unchanged.

At pass, a decomposed coarse grained yellow igneous rock.

At *f,* sandstone St. 110°, dip 50° S.

Thick fog over the pass, could not see 50 m. away, then gradually cleared up from below. Corps on the way to Tienshengtang.[1]

At *f'* yellow Cambrian beds, unsuccessful search for fossils, nearly horizontal, above it is a basal fine grained breccia. At *g* (bar. 514), shaly schist nearly horizontal, St. really E-W. Above *g* the coarse igneous rock again exposed.

The phyllite (compact and limestone-like) forms cliffs above. Further down, laminated clayey beds St. E-W, dip 40° N.

At *h* (bar. 535.7) the igneous rock is again exposed, surrounded by phyllite which forms very high cliffs. I think it is a dyke.

At Tsaochihkai[2] we rested about an hour. The rain comes down pretty badly. Bar. 536.8, temp. 18°.8 at 2 p.m.

At *h'* we have the banded schist which form cliffs all round (phyllite), St. 350°, dip 60° W, gradually changed into 310°, dip W.

From *k'* we have once more igneous rock. At *k''* it disappears between the phyllite.

Near *k'''* at bar. 523, phyllite (rather less metamorphosed) St. 300°, dip 70° SW. At *k'''* and *l,* igneous rock once more exposed. At bar. 517 still igneous rock, but very soon after, slates.

At *l'* sandy slate St. 74°, dip N, soon reversed. On the other side of the valley, phyllite seen to dip S. At *l''* phyllite St. 300°, dip 60° SW. At *m* phyllite St. 106°, dip S. At Chinglungshan it strikes 300°, dipping SW.

At Chinglungshan, barometer 542.1, temperature 19°.2 at 5 p.m.

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1 天生塘 2 造紙街

July 3, 1914

Chinglungshan to Maolu[1] *(Pl. 2:YMA2)*

At Chinglungshan, barometer 544.3, temperature 17°.2, a. m.

At *a'* yellow sandstone crushed and bent to 290°.

From *b* view of the limestone cliff on the other side of the ridge. At *b'* yellow sandstone St. 314°, dip W. From *b* to *b'* plane of shearing then changed to 335°. From *b'* up yellow clayey beds much laminated.

Kuochienyen[2] has a grotto in which coal of irregular thickness (about 1 foot) was found.

At top of Maohoshan[3] (bar. 522, alt. 2728 m.) quartz veins exposed.

At *c* outcrop of limestone; further on, sandstone St. 310°, dip SW.

At bar. 546.2 a cliff of massive limestone in which copper ore is distributed along the bedding plane. Bornite and copper pyrite. It used to produce a very large quantity of ore, but now only stone house left. This limestone of unknown age, St. 330°, dip 90° W. apparently under sandstone and clay series. It is colored green and bluish and partially crystalline.

At *d* fault material. Near Ssukoshu[4], at bar. 552.5, micaceous sandy schist. At *d'*, again limestone.

At *e* just as the limestone changes its dip we have the igneous rock of yesterday exposed under it.

We continue to go along the line of fault; both limestone and igneous rock are brecciated. Soon phyllite exposed.

At *e'* igneous rock, limestone, and phyllite faulted, but at level of road, yellow schist. Along the Maolu valley proper is much cataclastic material. The cliffs seen above is of limestone.

At Maolu, barometer 644.2, temperature 27°.9, at 4 p.m.

Copper ore in schist	Chiwangtung[5]	7000-8000 catties
	Siushuikou[6]	20,000 catties
in limestone	Kanlanping[7]	20,000 catties
	Ssukoshu	20,000 catties
	Taniutung[8]	10,000 catties

1 茂麓 2 煱前岩 3 帽盒山 4 四棵樹 5 極旺洞 6 銹水溝 7 橄欖坪 8 大牛硐

Charcoal from Hsiaoho[1] and Taho[2], $50 for 12,000 catties; $17 for 12,000 catties of wood. Hydraulic sluicing.

July 4, 1914

Maolu to Changhaitzu[3] (*Pl. 2:YMA2*)

At Maolu, barometer 648.4, temperature 27° at 9 a.m.

In river just outside Maolu phyllite St. 330°, dip 80° W. High pebbly bank on both side.

At *a* begin block of phyllite St. 350°, dip W, much veined and crushed. At *b* broken phyllite St. 310°, dip W. Near *b'* phyllite St. 14°, dip 80° E. At *c* St. 5°, dip 70° W. At Yaopengtzu[4], bar. 548, temp. 22°.2 at 12. Schist St. 310°, dip 40° N.E.

At bar. 539, limestone, further up, schist again. At *d'* St. 40°, dip 40° SE. Graben faulting, breccia and conglomerate.

Before reaching *d''* (bar. 510.1) real boundary of limestone (unconformity). Near *d''* altered sandstone (phyllite) St. 347°, dip 80° W.

At Changhaitzu, barometer 487.7, temperature 15° at 7 p.m. Cloudy night. In camp.

July 5, 1914

Changhaitzu to Lohsueh[5] (*Pl. 2:YMA2*)

At Sanfengkou[6] badly preserved fossil. At level of river from Sanfengkou to Tafengkou[7], sandstone and clay exposed below limestone.

At Lohsueh, barometer 485.3, temperature 13° at 7 p.m.

July 6, 1914

At Lohsueh, barometer 487.2, temperature 15.5° in the morning.

Went north to Laoshan[8]. At top, limestone. In descending, old mine at Chutzuching[9]. Slate exposed. At Wanchintung[10] (bar. 481) the shaft is inclined, at first directed toward west (i. e. perpendicular to strike of limestone), then meeting a reddish clay, it turned to south along the strike. The ore is distributed in the limestone, occasionally it forms richer veins.

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1 小河 2 大河 3 長海子 4 腰蓬子 5 落雪 6 三風口 7 大風口 8 老山 9 竹子箐 10 萬金洞

At Sanhotsien[1], limestone St. 30°, dip NW. Rich ore (1 ft. thick) going down along St. Then returned to Lohsueh.

July 7, 1914

Lohsueh to Paihsila[2] *(Pl. 2:YMA2)*

At Lohsueh, barometer 487.1, temperature 11° at 8 a.m.

At *a* bar. 463.5 Motzushan[3], limestone on the ridge and clay and schist lower down. At *b* brecciated sandstone(?). At *c* much crushed limestone, St. 20°, dip E (?). At *d* limestone St. 40°, dip 5° E. We are in a great limestone region.

At bar. 466, junction between limestone and schist. Limestone St. 350°, dip 10° W, then changed to 20°, dip 20° W.

At *d''* limestone St. 290°, dip 10° S.

At *e'* limestone cliff St. 45°, dip 70° SE (slate below). Since *e'* limestone is much crushed and broken.

At *g* igneous rock.

July 8, 1914

Paihsila to Tangtan (Laochang)[4] *(Pl. 2:YMA2)*

At Paihsila, barometer 513.7, temperature 15.°8, at 8.30 a.m.

At *a* sandstone St. 327°, dip 60° E, soon changed to St. 60°, dip 70° N. Undulating mass with occasional conical peaks. At *b* (bar. 518.2) limestone St. 294, dip N. At *c* limestone St. 320°, dip 50° W.

July 9, 1914

At Tangtan barometer 542.2, temperature 19° in the morning.

In the town sandy schist St. 25°, dip 70° E. North of Shangtsaiyuan[5] all sandstone and schist.

Went to Yangmintung[6], about half way between Tangtan and Paihsila. Old mine made by Japanese in time of Tang. Large shaft, but veins very thin and poor, going along the bedding plane. Limestone St. 310°-350°, dip E at outside, then folded to W (very steep). At vertical shaft it st. NE-SW, dip E. Occas-

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1 三合尖 2 白錫腊 3 沫子山 4 湯丹老廠 5 上菜園 6 養民硐

sionally the vein contains quartz but mostly in limestone (calcite) as malachite (10%-) and also copper pyrites (bigger vein). A little lower down is Wanpaotung[1].

July 10, 1914

Tangtan to Chingkou[2] (*Pl. 2: YMA2*)

At Laochang (Tangtan), barometer 541.8, temperature 19° at 8.30 a.m.

At Lianfengtai[3] crushed yellow shale.

From Mafang[4] to Kuanshang[5] all sandstone and clay metamorphosed. Steep descent.

At Hsiaochiang[6] river, bar. 640, temp. 33°.8 at 11 a.m. Knee deep of water divided into many channels. Piles of wood 3-5 feet long in Shahai[7], floated down from Suntien[8].

In going up from Shahai, crushed and conglomeratic limestone mingled with sandstone and schist is exposed.

At bar. 623.4 near point *a*, limestone well exposed.

Limestone breccia St. 15°, dip E—this is the real line of movement.

Near Kanlanpo[9], yellow sandstone. Then went to Chingkou via Tachai[10].

At Chingkou, barometer 546.7, temperature 20° in the evening.

July 11, 1914

Ascent of Futsaishan[11] from Chingkou and return (Pl. 2: YMA2)

At Chingkou, barometer 546.2, temperature 16°.6 at 8 a.m.
Section of Futsaishan (bar. 429.8, alt. 4145, Fig. 13) in descending order:

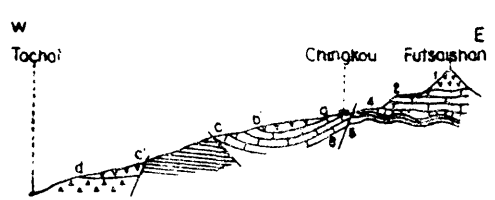

Fig. 13. Section from Tachai to Futsaishan. 1. Basalt. 2. Limestone. 4. Sandstone. 5. Black shale 6. Limestone. a-b'. Basalt. b'-c. Limestone. c-c' Cambrian. c'-d. Basalt.

1. Basalt down to bar. 480.
2. Limestone nearly horizontal at bar. 489.2
3. Basalt? not *in situ* at bar. 519.9

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1 萬寶硐 2 箐口 3 涼風台 4 馬房 5 關上 6 小江 7 沙海 8 尋甸 9 橄欖坡 10 大寨 11 佛在山

4. Sandstone with yellow clay, white inside (end of first platform), St. 312°, dip SW, soon become horizontal.
5. Black shale St. 10°, dip 10° E, soon change to W at bar. 524.4.
6. Limestone at bar. 530.

At Chingkou, barometer 541.4, temperature 17°.2 at 9 a. m.

July 12, 1914

Chingkou to Tachai (Pl. 2:YMA2)

At Chingkou, barometer 541.4, temperature 17°.2 at 9 a.m.

From Chingkou to *a*, limestone; *a* to *b'*, basalt; *b'* to *c*, limestone; *c* to *c'*, Cambrian; *c'* to *d*, basalt.

At Tachai, barometer 622.1, temperature 26°.4 at 9 p.m.

July 13, 1914

Tachai to Taheiching[1] (Pl. 2:YMA2)

At Tachai, barometer 622.1, temperature 21°.8 at 6 a m.

Fine weather since Paihsila. In the valley bottom northwest of Tachai, thick bank of clay and pebbles over limestone? 10 m. thick.

At *a* some 500 m. northeast of Kuangluchiao[2] yellow sandy clay, identical as those of yesterday. *Redlichia, Lingula* and other fossils (Fl-18) were found. At *b'* (Bar. 576) about three kilometers further, Cambrian fossil again (F19-24).

The Cambrian strata are in fault contact with the limestone. From south to north the following succession was observed: 1, Limestone. 2, Clay and sandstone. 3, Limestone. 4, Sandstone. 5, Very much crushed limestone south of Tuanchiafen[3]. 6, Whitish fissile sandstone north of Tuanchiafen. 7, Further on all limestone much brecciated. 8, From *e* to Taheiching, schist.

At Taheiching, barometer 527.6, temperature ? at 4 p. m.

July 14, 1914

Taheiching to Erhtaoping[4] (Pl. 2:YMA2)

At Taheiching, barometer 533.4, temperature 15°.5 at 8 a. m.

Rain at night, fine in the morning.

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1 大黑箐 2 光路脚 3 段家墳 4 二道坪

At bar. 512.1, some 600 m. south of point *a,* blue black limestone appears, St. 346°, dip 70° W.

Higher up St. N-S, dip 15° W. Limestone much brecciated and faulted. About 800 m. north of *a,* a fault striking NE-SW.

At *b* altered Cambrian beds are exposed, much folded and broken; the axis of folding is NE.

At Chuchiaching[1] greenish schist St. 40°, dip SE. From Chuchiaching up, we have a series of yellow sandstone with black coarse bands between; this is Lower Carboniferous.

Section between Chuchiaching and Hsuchiayuantzu[2] in ascending order:

1. Yellow clayey sandstone.
2. Coarse brown sandstone.
3. Black brittle shale.
4. Thin laminated black slate, some sheared and broken.
5. Yellow clay sandstone.
6. Black sandy slate.
7. Coarse greenish sandstone, somewhat quartzose, yellow when decomposed.
8. Yellowish lamellated sandstone.
9. Pink sandstone, white outside.
10. Clay.
11. Black limestone becoming more and more normally white with badly preserved corals.

The limestone is covered by basalt which forms a thick brown soil, and high cliff.

At Erhtaoping, barometer 493, temperature 19°.2 at 6 p. m.

July 15, 1914

Erhtaoping to Tungchuanfu[3] (Pl. 2: YMA2)

At Erhtaoping, barometer 494.2, temperature 11°.9 at 8 a. m.

Fossils were collected in the limestone at a point two kilometers north of Erhtaoping. Coming near to Soloyi[4] the limestone strikes 54°, dipping 30° SE.

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1 朱家箐 2 徐家園子 3 東川府 4 樓羅驛

1250 m. north of Soloyi is the watershed between Hsiaochiang and Yiliho[1] rivers. Descending 1100 m. northward, basalt begins to appear. At Anakou[2], limestone again. South of Wulungmu[3], basalt.

At Tungchuanfu, barometer 551.4, temperature 24° at 5 p.m.

July 16, 1914

Tungchuanfu to Jehshuitang[4] *(Pl. 2 : YMA2)*

At Tungchuanfu, barometer 554.2, temperature 18°, at 6 a.m.

At Jehshuitang, barometer 561.1, temperature 22.8° at 6 p. m.

July 17, 1914

From Jehshuitang returned to Tungchuanfu.

July 18, 1914

Stayed in Tungchuanfu

July 19, 1914

Concerning the company :

8 purifiers—4 ventilated by steam and 4 by hand. They are smaller than that I saw at Hueilichou. Process : first warmed the *wotang*[5] for 12 hours. Then put on charcoal fire copper which is ore (above covered with coal?). When all the copper has melted, then change charcoal and put in coke above the copper. Over this is mainly charcoal. It takes about 10-12 hours to complete the process. When the copper boils, the front wall is broken into a hole just below the liquid level. The molten metal runs and is held up by iron pans and put into the brickformed mould (30 catties) made of copper (taking out when red hot). As the level of metal is gradually lowered, the hole is lowered accordingly. It requires about 900 catties of charcoal and 400 catties of coke to smelt 1300 catties of crude copper (+200 catties slag). The slag is immediately resmelted. They get about 85% of copper from the crude product. The prize of coal and charcoal is the same, *i. e.*, $1.20 per 100 catties or $19.2 per ton. The workmen are paid according to the amount of copper refined. T1.8 for the machine worked furnace, T2.7 for the other per 1000 catties of copper. They have 8 furnaces, but only 4 are used at one time.

---

1 伊里河 2 阿那溝 3 烏龍畝 4 熱水塘 5 窩塘

Mint.

Three furnaces; one furnace produces 40 pots a day, each pot countains 30 catties. Furnace about 2.5 feet wide, 8 feet long, 4 feet deep. The composition of the alloy = 100 catties of copper, 135 catties of zinc, 15 catties of lead. After 2 or 3 hours, the pot is taken out and poured into said mould (made of coal ash), then it is polished and dried. 40 holes in one mould and 120 in one hole (double row). Profit about T10 per day per 200 catties.

XI. TUNGCHUANFU TO KUANGSHANCHANG (July 20—August 1).

July 20, 1914

Tungchuanfu to Santaokou[1] (*Pls. 2:YMA2, 3:YMA3, 4:YMA4*)

At Tungchuanfu, barometer 556, temperature 18° at 10 a.m.

The hills east and southeast of the city are formed by limestone. South of Tashihchiao[2], basalt appears. At Fanchiawan[3] (bar. 553.2) the following section was observed:

1. Sandstone, bar. 552.9
2. Limestone, St. 25° dip 70° ESE, bar. 548.2.
3. Yellowish red sandstone at *b'*
4. Yellow alternating with more clayey sandstone, St. 10°, dip 60° E.

At Santaokou, barometer 569.8, temperature 18°, at 7 p.m.

July 21, 1914

Santaokou to Chehai[1] (*Pl. 3:YMA3*)

At Santaokou, barometer 571.7, temperature 16°, at 6 a. m. Cloudy day.

Near Santaokou, greenish red sandstone. 700 m. northeast of the village, after crossing the river, basalt conglomerate. Further on the basalt extends to Chehai although often covered along the road by recent deposits.

At Chehai, barometer 565.2, temperature 23°.8 at 2 p. m., barometer 564.6, ttmperature 20° at 8 p. m.

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1 三道溝 2 大石橋 3 范家灣 4 者海

July 22, 1914

Chehai to Yilu[1] *(Pls. 3 : YMA3, 4 : YMA4)*

At Chehai, barometer 566.2, temperature 16°.2 at 7 a. m. Fine weather.

From Chienchang[2] made a side trip of 800 m. east of the village to Laotanshan[3]. In the old mine nothing can be seen except a little coal dust in the limestone, St. 60°, dip 70° SE. Outside the line the general strike seems to be 20°. Fault on west side of the mine.

The work started during the reign of Chienlung till that of Taokuang when it was stopped. They restarted in the 15th year of Kuanghsu with 30 furnaces, and stopped last year.

From Laitzutung[4] onward road is river (dry) with high altered bands. Two lake basins: one of Hsiaoputzu[5] the other of Sanchiatsun[6].

At Yilu, barometer 558.7, temperature 18°.2 at 6 p. m. Sulphur mine of Yilu.

It is pyrite interbedded between limestone which St. 35°, dip 70° NW. Then all under water, very narrow and low shaft 1 × 2 feet.

Price: $3 per 100 catties (1 catty = 18 liang). Formerly the match making Co. gave $4. Company sales at place at $4 to other. The freight is paid by buyer, in Yunnan for $8. Without capital.

Workmen in mine 14 for water, 6 for mining, 10 + for carrying. Ore pitch up and divide equally away. There $ 3-4 per month pay the workman.

Treatment of slag: The unburnt ores redistilled, loss of weight 70%. Furnace 2.5 ft. as wide as long, 1.5 ft. deep. One tube with 5 openings over which is the clay parts each containing 20 catties of ore, that is, 100 catties in all. In 12 hours with 150 catties of coal (72.5 S per 150 catties, coming from over hill on the other side of the pyrite mine) and 9-10 catties of sulphur. The ore is crushed and then put into pot over and surrounding which is coal fire. When red, it is taken out with a spoon. There are all together 20 furnaces. Yearly output of ore = 2000 barrels = 2000 × 300 catties. Sulphur production = 70,000 to 100,000 catties.

July 23, 1914

Yilu to Paopaochai[7] *(Pl. 4 : YMA4)*

At Yilu, barometer 559.9, temperature 14°.4 at 7 a. m.

About 700 m. southeast of Yilu the following section was made (from bottom to top):

---

1 以麓 2 鉛廠 3 老炭山 4 癩子洞 5 小舖子 6 三家村 7 包包寨

1. Limestone breccia, bar. 556.
2. Coal seam (5-6 feet thick), bar. 548.
3. Yellow sandstone St. 27°, vertical, bar. 547.5.
4. Limestone with fossils, St. 64°, dip 10° SE, bar. 545.3.

Limestone exposed near river south of Kaochiao[1], on which is the thick mass of basalt.

Coal mine of Paopaochai:

There are apparently three seams, the middle seam is most required (2-10 ft. thick). The upper one is now worked here between limestone with a sandstone above the limestone. St. E-W, dip gently N. Thickness very variable from 2 ft. to 8. The lowest is the most irregular. About a dozen of workmen here—receiving 0.8 tael, if no coal, 0.6 per 14 barrels (1 barrels = 120 catties, 14 barrels = 1 ton) (24 barrels per 24 hours). Sale price to company = 0.37 tael per barrel without freight (which from here to Muchang[2] = 2.53 taels per barrel). There are another mine near by but I have not visited it. All together produce 2000 barrels per day in winter.

July 24, 1914

Paopaochai to Huanglishu[3] (*Pls. 3:YMA3, 4:YMA4*)

At Paopaochai, barometer 582.2, temperature 19°.2 at 8 a. m.

By the river side, limestone St. 6°, dip gently E. Basalt begins to appear near Tanchiatsun[4]. East and northeast of Tsowochiang[5], all basalt, but west of the village are limestone hills. Near Hsikakuo[6] and southwest of Wayaokou[7] red sandstone exposed.

At Huanglishu, barometer 594.5, temperature 27°.6 at 6 p. m.

July 25, 1914

Huanglishu to Erhtaoching[8] *and return* (*Pls. 3:YMA3, 4:YMA4*)

At Huanglishu, barometer 597.2, temperature 20° at 8 a. m.

Just outside village coarse red sandstone, St. 350°, dip 10° W, and below it basalt.

Apparently above the basalt we have the yellow clayey sandstone which is said to be above the coal, in which I found some plants. Above it is a red sand-

1 高橋 2 木廠 3 黃栗樹 4 譚家村 5 坐窩江 6 西戛果 7 瓦窰溝 8 二道箐

stone, St. 55°, dip 10° W but mainly horizontal. At bar. 560.6 we have the junction near coal mine. Coal seam at Erhtaoching about 1-1.5 ft. thick, St. NE, dip NW. Its roof is a greenish sandstone with beautiful ferns and palm leaves, the bottom is fire clay[1]. It forms fine big lumps but they do not know how to give a good coke out of it, though it is supplied to the Kuangshanchang mines[2] in this form. The coal mine is monopolised by a company[3].

Now this mine turns out only 400-600 catties per day. Coke-making is done on a flat piece of ground.

At Lungtankou[4], northeast of Shenkou[5], the same seam is worked. Thickness a little over 1 ft., but coal of excellent quality. Price of coke T4.5 per 15,000 catties, but unburnt coal is sold at 0.13 tael per 150 catties to Tungchuan. They produce daily 5,000 catties with 12 workmen. West of Shenkou the river approximately marks the contact of basalt with coaly beds.

At *d* white sandstone St. 345°, dip 15°W. Red soil, cobalt ore at Shenchiatsun[6].

At Huanglishu, barometer 594.9, temperature 22°.2 at 9 p. m.

July 26, 1914

Huanglishu north-northeast to Wukuliangtzu[7], return to Huanglishu, thence to Muchang (Pl. 3 : YMA3)

At Huanglishu, barometer 593.6, temperature 21°.7 in the morning.

Section of Hungyen[8] between Huanglishu and Wukuliangtzu:

Bar. 593.6

1. Coarse red sandstone, St. 0°, dip 15° W.
   Bar. 563.8
2. Fine grained greenish sandstone, St. 290°, dip W.
   Bar. 566.2
3. Very coarse red beds, St. 55° dip gently NW.
   Bar. 545.8
4. Coarse grained limestone, curiously banded, St. 20° dip 20° W.

---

1 土名水白岬 2 鑛山廠 3 鑛業公司 4 龍潭溝 5 深溝 6 沈家村 7 五股梁子
8 紅岩

In the red sandstone spotted character is noticed.

At bar. 564.7 red sandstone St. 25°, dip 10° W, with very curious coral-like structure.

Contact at bar. 583.5, red sandstone rests directly on roof of coal.

Returned to Huanglishu, barometer 591.8 at 3 p. m., thence to Muchang via Pochiao[1].

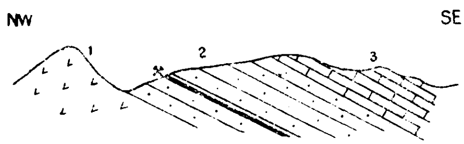

Fig. 14. Section near Muchang. 1. Basalt. 2. Red sandstone with coal seam. 3. Limestone.

Section at Pochiao (Fig. 14) from bottom to top:

1 Basalt

2 Red sandstone with coal seam

3 Limestone

At Muchang, barometer 594.5, temperature 22° at 7 p. m.

July 27, 1914

Muchang to Kuangshanchang (Pl. 3:YMA3)

At Muchang, barometer 596.2, temperature 23° at 8 a. m.

The mines at Chechiaping[2] must have been quite recently abandoned.

In these coal mines unsuccessful search for fossils; the limestone above contains the same fossils (*Chaetetes subradians*) as those found near Yilu. The limestone is much veined and crushed.

The coal exposed south of Kuangshan is between sandstone which is somewhat quartzose.

July 31, 1914

Lungwangmiao (Kuangshanchang) to Chilinchang[3] and return (Pl. 3:YMA3)

At Lungwangmiao, barometer 524.4, temperature 17°.2 at 10 a. m. Rain.

1 坡脚 2 車家坪 3 麒麟廠

At Chaoyangtung where Chilinchang is situated, bar. 541.2. Bottom of mine bar. 552.3. Strike of beds 50°, dip 80° SE. Carbonate with sulphur. Fissure with stalagtites.

Returned to Lungwangmiao at 6 p. m. Barometer 523, temperature 17°.8.

August 1, 1914

Visit to mines in proximity of Lungwangmiao

At Lungwangmiao, barometer 525.2, temperature 17°.5 at 9 a. m. Barometer 524.2, temperature 18°.2 at 12.

XII. ZINC-LEAD DEPOSIT OF KUANGSHANCHANG.

The Zinc furnace

The furnace is much like that of Yiwanshui, north of Hueilichou. The clay pots contain three catties of ore and two of the easily burnt dust coal of Hsichikou[1], Sayiho[2]. The pots were made in Laochang[3] and Hsiaoching[4], above Chungmenkou[5]. Time required is about 10-14 hours. One pot plus cover costs 40 cashes. These pots are put in a row 3 × 18—three pots are called a *chiao*[6]. Each pot yields one catty of zinc when things go well. The furnace itself is a long trough 2.5 m. high and 5.5 m. long and divided into compartments. The pots are placed on the partitions. For each smelting the cost is as follows:

1,200 catties of coal (from Paopaochai) .... 0.72 tael

(0.023 tael for transport, 0.037 per 100 catties for mine)

Labour: 18 *chiao* requiring 3 workmen, 0.12 tael each
2 unskilled men 0.06 each

Total .... 0.18 tael

Ore 0.05-0.06 per 100 catties (per *chiao*)

Transport: 0.08-0.09 per 100 catties

Total for 18 *chiao* .... 2.52 taels

Total .... 3.42 taels

Maximum yield .... 54 catties

Chilinchang: Here about four *luhu*[7] with 40 furnaces, but at the time of my visit only 14 working.

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1 西直溝 2 洒以河 3 老廠 4 小箐 5 冲門口 6 礄 7 爐戶

According to Liu, owner of the Chilingchang mine, he has one boat of coal (3,000-4,000 catties) whilst the Company has two. Cost of coal: mining cost 0.055 tael per 150 catties.

Water transport to here 0.01 tael per 150 catties
Land ,, 0.055 ,, ,, ,, ,,

From here to Kuangshan 130-140 cashes per 100 catties equal to 0.1 tael per 150 catties.

There is a loss of dust coal of about 0.08 tael per 100 catties. So the total cost is T17 per 10,000 catties.

When coal is good 40 catties of zinc per furnace will pay the cost otherwise 45-48 will be required.

The following places have furnaces:

Lungwangmiao[1] on Niulanchiang[2] below Santaokuai[3]
Hsinchiao[4] further down
Heitsochiang[5] ,, ,,
Paishati[6] ,, ,,
Yenchiangshui[7] ,, ,,
Chungmenkou ,, ,,
Tuchiakou[8] ,, ,,
Huangnikou[9] and Shuangshihtou[10] on main road to Chehai.

Zinc:

13th Kuanghsu	*30th*	*After 30th*	*Republican era*
Output 1.5 mil	1 million	1 million	1 million
Price of metal— T20.7 per 1,000 catties	T26	T34	T38.3
Price of ore— 0.03T 0.05T Transp.	same	0.05T	slightly higher
Price of coal 0.05T per 120 catties		0.06	
Labour etc. 0.07 per *chiao*		0.12	

1 龍王廟 2 牛欄江 3 三道拐 4 新橋 5 黑坐江 6 白沙地 7 岩江水 8 屠家溝 9 黃泥溝 10 雙石頭

Lead:

	13th Kuanghsu	*Before 30th*	*Time of Wang*	*Sec. year Republic*
Output	2 million			
Price lead	T220 per 10,000 catties	T240	400-500T (still worse)	
Price ore	T0.1 per *hsiao-tung* (best ore)	T0.08 (worse)	T12-13	T17.5
Coal	T8-9 per 1,000 catties	T12-13		

The extraction of silver

The *shatiao*[1] is made of fireclay one on each side. The *lungku*[2] is made when required and is at first supported with charcoal which is placed over the lead. When the furnace is half built, a charcoal fire is lit over the *shatiao* and then with coke. The space between lead and *lungku* becomes more or less empty with only an occasional addition of burning charcoal. The whole process lasts about 30 hours. Ore from Chilinchang contains 16 to 20 taels of silver per 800 catties of lead. The waste of lead amounts to 350 catties, charcoal used 80 catties, coke 300 catties, the expense for *Chaotzu*[3] is 3 taels. Price of *tatan*[4] (coke?) T4.5 per 1,000 catties, charcoal 6 taels per 1,000 catties, *hsiaotan*[5] T7.5 per 10,000 catties, but some loss in transport.

Lead smelting

The *peng*[6] is continually formed and is taken away from behind. The ore gives 220 catties of lead, the mixture of sulphur (2 parts) and carbonate (5 parts) gives 300 catties. The sulphur ore cannot be smelted alone but is smelted in the *chaotzu*.

First the *wotang* is made with clay and ash as usual. This is warmed for sometime. The first square brick is put on and a charcoal fire is put in over which is coke. This continues till all the three bricks are in place. After five hours when the fire goes all right, the ore is put on the top. The part just above the wind pipe has a *tsueitzu*[7] formed by the silicified slag which prevents the ore from going down, but allows the liquid to get through. The first load requires 36 hours, but 12 hours will be enough for the subsequent smelting. In 12 hours use 60 barrels (20 × 60 catties) with 50 catties of coke and 100 catties of charcoal.

1 沙條 2 龍骨 3 罩子 4 大炭 5 小炭 6 蓬 7 嘴子

XIII. KUANGSHANCHANG TO WEINING AND BACK TO TANGTANG (August 2—August 24).

August 2, 1914

Kuangshan to Santaokuai (Pl. 3 : YMA3)

At Lungwangmiao, barometer 527.1, temperature 14° at 9 a. m.

Basalt just behind the temple. Went southeast and repeated a part of the itinerary of the day before yesterday. Turned southward where coal beds are exposed. Fault west of Tashuiching[1], another one west of Santaokuai.

At Santaokuai, barometer 597, temperature 21°.3 at 9 p. m.

August 3, 1914

Santaokuai to Chuchiaping[2] (Pl. 3 : YMA3)

At Santaokuai, barometer 597.2, temperature 21°.4 at 8 a. m.

Limestone near Santaokuai, dip SE. Further on basalt in fault contact (?) with another limestone to the east. At Hokou[3], limestone apparently lies above basalt. The black banded limestone is partly crystalline, in which crinoid remains were found.

At Chuchiaping, barometer 584.2, temperature 25°.1 at 1 p. m. Coal was discovered near Lutsaiping[4] (10 men) and at Hsiangchiaoching[5]. Production about 10,000 catties per day.

August 4, 1914

Chuchiaping to Tsienshanpo[6] (Pls. 3 : YMA3, 4 : YMA4)

At Chuchiaping, barometer 590.2, temperature 20°.6 in the morning.

Outside the village, red sandstone St. 340°, dip W, soon changed to E. Below this are yellow beds which in turn are underlaid by basalt. After a fault north of Tahaitzu[7], this succession repeats once more. About 800 m. south of Tahaitzu, contact of basalt and coal. Rain. Coal mine to the northwest of Lutsaiping. Fossils found near mine. Hsiaohaitzu[8] on yellow beds, coal occurs nearby. Basalt west of Sanchiatsun[9]. Limestone appears near Tsienshanpo. At the village, barometer 555, temperature 18° at 6 p. m.

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1 大水井 2 褚家坪 3 河口 4 綠菜坪 5 香脚箐 6 尖山坡 7 大海子 8 小海子 9 三家村

August 5, 1914

Tsienshanpo to Chake[1] *(Pl. 4: YMA4)*

At Tsienshanpo, barometer 556.7, temperature 17° at 8 a. m.

Just before Tsienshanpo we have limestone above sandstone. It is quite crystalline with numerous red veins.* I was told that eighty years ago cinnabar was mined here. Below the limestone is a yellow quartzite sandstone.

The road at first goes ENE in the limestone. 1300 m. from Tsienshanpo a badly preserved crinoid and simple coral are found in the limestone. 800 m.

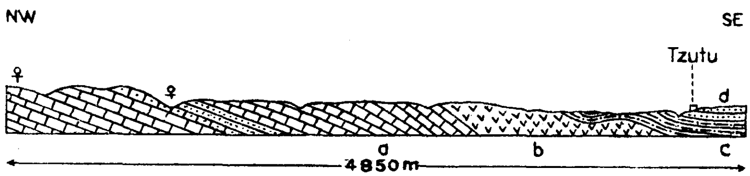

Fig. 15. Section E of Tsienshanpo. a. White limestone, partly silicified. b. Basalt. c. *Gigantopteris* coal series. d. Red sandstone.

further east coal occurs between limestone above and silicified limestone and sandstone below (Fig. 15). In the light green silicified limestone we find *Lonsdaleia* and *Schwagerina,* so its age is Lower Permian. Iron in Permian coal.

From *c* going south basalt pebbles are seen on the reddish white limestone which dips 30° SSE.

The basalt of Kuochang[2] has an outcrop of 900 m. wide, and 300 m. southeast of Tzutu[3] it dips under the *Gigantopteris* coal series, which, 800 m. further southeastward, just northwest of Tzutu, dips in turn under the red sandstone series. The latter becomes horizontal and has a wide outcrop, but 5.5 kilometers southeast of Tzutu, the road passes again into the underlying coal series just northeast Tienna[4]. In part the outcrop depends on topography—the red sandstone forming hills to the east, while the coal series occupying the valley from Tienna to Chake a distance of 7 kilometers.

At Chake, barometer 561.2, temperature 25°.8 at 3 p. m. Fine day, but rain in the evening.

---

1 渣格 2 煱廠 3 自都 4 典那

August 6, 1914

Chake to Fangmaping[1] (*Pl. 4:YMA4*)

At Chake, barometer 563.1, temperature 17°.8 at 8 a. m.

Going up a valley (NW-SE), the road passes Luchiachung[2] 3 kilometers SE of Chake, all in coal series, which is practically horizontal, and 2 kilometers SE from Luchiachung near the pass (bar. 554), it is covered by the red sandstone (Fig. 16).

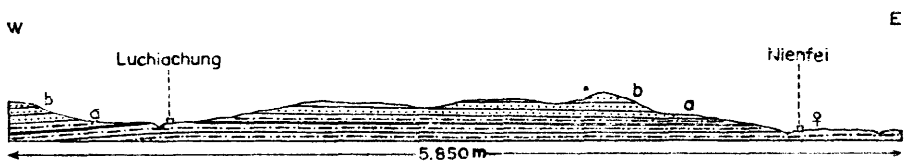

Fig. 16. Section at Nienfei. a. *Gigantopteris* coal series. b. Red sandstone.

Crossing the ridge (bar. 550.2) we soon find ourselves again in the coal series (contact bar. 558.2) where the roads to Hsuanwei[3] and Tangtang[4] branch off, the latter now goes NE. 1200 m. NE from bar. 558.2, to the river bed (pt. 568.8) W of Nienfei[5], we found a fragment of *Sigillaria*.

Then we followed river down to Hsiangchiaoching (valley level bar. 572.5) nearly 3 kilometers N of Nienfei. Then turns eastward following a side valley up to Fangmaping (10 kilometers E), passing the villages Tzuhai[6], Taichiatsun[7], Hsiaochuching[8], for the last of which the road goes up hill to Fangmaping.

All the time the road is in coal series, but close to the road to the N, is the overlying red series containing copper at Hsiangchiaoching and to the south (varying from 300 m. to 2.5 kilometers) is the basalt.

The dip is everywhere gentle, 10°-20°, the strike being NE-SW west of Taichiatsun and N-S east of it. Arrived at Fangmaping at 4 p. m., barometer 553.8, temperature 22°.8. Stayed in tent. Cloudy day. Suffered for diarrhea.

August 7, 1914

Fangmaping to Tangtang (*Pls. 3:YMA3, 4:YMA4*)

At Fangmaping, barometer 555, temperature 16°.7 at 8 a. m.

One and half kilometers N of Fangmaping are three shafts working the uppermost seam This is 0.7 m. — 1 7 m. thick and is of good quality—less firm

1 放馬坪 2 陸家冲 3 宣威 4 倘塘 5 念非 6 自海 7 戴家村 8 小竹箐

than the coal from Huanglishu, but it gives a better coke, though the latter is light and porous. Several other seams known as *tutan*[1] are not worked because they are only 0.3—0.6 meter thick. The same condition prevails at Hsiaochuching, Erhchung[2].

Two analyses of the samples give the following:—

	Moisture	Volatile matter	(H.V.)	Coke	Ash	Color of ash	Sulphur
1)	0.76	21.49	(6160)	77.85	21.96	Yellowish	0.249
2)	0.79	18.95	(7700)	80.26	15.87	Yellowish	0.222

The three shafts are located along the strike. The coal dips 10° N. During production four tons a day. Height of mouth of shaft contact with the red sandstone is bar. 551.2, but the coal seam bar. 552.5—so it is only 17 m. below the red sandstone and is roofed by a white sandstone. No fossil was found. Two kilometers east of the mine, after passing the village of Pichiatsun[3], the coal series dips 50° W and is underlaid by basalt, which has an outcrop width of one kilometer to the village of Tolo[4] where the coal series overlies it again (Fig. 17). 550 m.

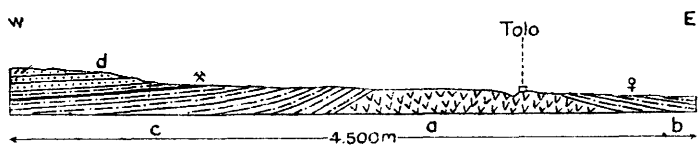

Fig. 17. Section along Chienchiakou. a. Basalt. b. & c. *Gigantopteris* coal series d. Red sandstone.

from the basalt, the sandstone called by the natives *tsotzu*[5], i. e., floor of the coal seam, contains *Aunulariea, Pecopteris* and *Taeniopteris* (?) at point bar. 572. This is the Chienchiakou[6] locality in Halle's paper.

Five kilometers northeast, following the river Chienchiakou down to the western foot of Hsianglushan[7] formed by the red series, the coal series comes to an end. The series is practically horizontal and at Mutsung[8] it is mined for coal. At Huanglungchang[9] a mine is on fire. Then for 2300 m. we are in red sandstone which, west of Fasha[10], dips 20° E, but the dip is reversed to the east of that village. Thus it forms an anticline. The overlying red series contains copper, but it is quite thin at the river near Fasha where coal is actually mined by vertical shafts.

1 土炭 2 而冲 3 畢家村 4 拖羅 5 座子 6 錢家溝 7 香爐山 8 慕宗 9 黃龍廠
10 發沙

Soon after the village of Matikou[1] it is underlaid by coal series which has only a narrow outcrop of 250 m. and is replaced by basalt. The Chienchiakou river practically forms here the boundary with the road to Tangtang following it northeastward.

The basalt contains spherical bodies of copper sulphide known as *likuang*[2] formerly much mined, for its rich quality—30% of sulphide. The poorer ore is *tuhuang*[3] which is more irregular. Taichia[4] near Matikou used to be a rich mine. Now his children have sold everything.

Cloudy day. Rain in the afternoon. Storm near Tangtang.

At Tangtang, barometer 581.2, temperature 17°.9 at 6 p. m.

August 8, 1914

Tangtang to Chintoupu[5] *(Pl. 3 : YMA3).*

No field notes and sketches were made.

August 9, 1914

Chintoupu to Tungchangho[6] *(Pl. 3 : YMA3)*

No notes and sketches.

August 10, 1914

Tungchangho to Weining[7] *(Pl. 3 : YMA3)*

Left Tungchangho at 9 a. m., barometer 544.8, temperature 15°.4C. Going north for the coal field of Waitaoshan[8] (Fig. 18). At first the road lies in basalt, but at point 542.1 we have grey limestone striking ESE-WNW, dipping 20°S.

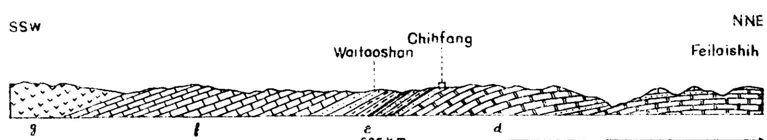

Fig. 18. Section across Waitaoshan coalfield. d. White limestone. e. Waitaoshan coal series. f. Tapingtzu limestone. g. Tungchangho basalt.

After passing the small village of Huahungshu[9], we come to the coal series at point 542.2. The strike of the latter varies, but on the whole nearly EW, dipping about 10°-20° S.

---

1 蔴地溝 2 栗礦 3 土礦 4 戴家 5 金斗舖 6 銅廠河 7 威寧 8 外套山 9 花紅樹

Just beyond Chihchang[1] we come to a white fine-grained limestone with fossils at point bar. 546.2.

From there to telegraph post 1861 continued sketch, but no further sketches were made that day. Fossils are found at Feilaishih[2]. All the way to Weining is well forested with oak and other trees.

Arrived at Weining at 7 p. m. Barometer 551, temperature ?

August 11, 1914

Weining to Hunshuitang[3] (*Pl. 3* : *YMA3*)

Left Weining at 7 a. m. Barometer 551.2, temperature 15°.2.

Going north towards Hunshuitang without making any sketches except a section at Yaochan[4]. I made the following observation en route.

At Mashihshang[5] just outside east gate we have brachiopod limestone (K_4) striking 310°, dipping 10° NE (bar. 548.9). 400 m. further north it changes into striking 65°, dipping 10° NNW—this is more general.

At Toutang[6] bar. 538.2, the same limestone is exposed. Beyond Toutang lower yellow sandstone exposed occasionally.

At Hsiawuliping[7] (5 li from Toutang) white limestone yielded a few fossils (B2).

At Shuishihtsao[8] bar. 544.2, just beyond at 545.8 a rich collection of fossils (Y_1).

Further north in coal beds.

At Erhpu[9] bar. 553 with coal (?) to right.

The coal field of Yaochan is said to extend to Liangtzupa[10] (65 li) but on the other side is limited by limestone.

According to the miners, there is only one principal (2 altogether) seam about 8 feet thick, of good quality, but rather sulphurous. The hill side is full of old pits. The coal used to go to Kuangshan. The coke is excellent.

Limestone at bar. 547, containing brachiopods and coral, apparently above coal.

At Hunshuitang, barometer 567.2, temperature 19° at 7 p. m.

---

1 紙廠 2 飛來石 3 混水塘 4 腰站 5 麻石上 6 頭塘 7 下五里坪 8 水石槽 9 二舖 10 梁子巴

August 12, 1914

Hunshuitang to Hsiaochiho[1] *and return* (*Pl. 3* : *YMA3*)

At Hunshuitang barometer 569.8, temperature 15°.9 at 8 a. m.

Left Hunshuitang to see the coal mine in the Hsiaochiho valley (Fig. 19). The coal field of Hsiaochiho consists of two workable seams the first of which (pit at 581.8, striking 55°-60°, dipping 10° N) is five feet thick, and the second

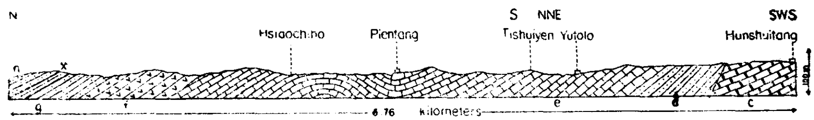

Fig. 19. Section from Hsiaochiho coal mine to Hunshuitang. c. White limestone. d. Waitaoshan coal series. e. Tapingtzu limestone. f. Tungchangho basalt. g. *Gigantopteris* coal series.

(pit at 579.4, St. E-W, dip 10° N) is four and half feet thick. There are two other seams, but not workable. Both the workable seams are semi-anthracitic, the second seam being better, giving firmer lumps, but having three thin shale bands in the seam, whilst the first being chiefly dust.

At the time of my visit there were five shafts. Output about 4,000 catties. The price is about 15-30 cashes per 100 catties according to quality. The coal goes to Chenghsiung[2]. At the mine, bar. 580, temp. 24° at 9 a. m.

The roof of the first seam is a coarse yellow sandstone and the floor light grey sandy shale. There are some old slag near the mine—copper ore comes from Fatu[3] down the valley Tsisingkuan[4].

The limestone below basalt seems to be crushed. Not far from the contact with basalt fossils are found in the dark grey limestone (T_1).

The dip changes frequently and at Tishuiyen[5] near Yutolo[6] a number of fossils were found.

Between Yutolo and Hunshuitang there is a band of sandstone striking NW-SE, dipping 35° NE being underlaid by a limestone.

Back at Hunshuitang at 1 p. m., bar. 568.6, temp. 26°.8.

Stayed at Yang's, a miserable house though the best obtainable. Both man and wife smoke opium. The child is ill with fever.

---

1 小雞河 2 鎮雄 3 發都 4 七星關 5 滴水岩 6 于多羅

August 13, 1914

Hunshuitang to Shangpanfang[1] *via Maku*[2] *(Pl. 3 :YMA3)*

At Hunshuitang, barometer 570.2, temperature 11°.8 at 7 a.m.

Going from Hunshuitang southeastward, the road lies in a sandstone with narrow strike and dip. It no doubt underlies the limestone to the east, but its relation with the limestone to the west is not quite clear. Stratigraphically this should be the Waitaoshan series, but no coal seems to exist. There may be a fault between this sandstone and the limestone to the west as the latter seems at times to dip steeply westward. About a kilometer from Maku, the upper limestone striking NE-SW, dipping 70° E, is overlaid by basalt which in turn is overlaid by the *Gigantopteris* series ending just west of Maku.

All the way from Hunshuitang there is no surface drainage until the basalt is reached. Then we are soon in the Makuho[3] valley.

At 12 arrived at Maku, bar. 568.7, temp. 24°.2. After Maku no sketch was made that day.

Niaomutun[4] about 40 li west of Maku produces gypsum.

Fossils found above Loshu[5] (U_1).

After seeing hurriedly the iron deposit at Tiehkuangshan[6] arrived at Shangpanfang after dark. Bar. 547.9.

August 14, 1914

Shangpanfang to Maku (Pl. 3 :YMA3)

At Shangpanfang, barometer 548.9.

Return to Tiehkuangshan to see the iron deposit which occurs between two layers of limestone; the lower is sandy. It is not exposed on the surface, but is worked by two shallow shafts about six feet from surface. The horizontal extent is unknown. The thickness is at least six feet high as the lower limit of the ore body is not seen. There is also evident magnetic disturbance though the ore is a haematite.

---

1 上板房 2 麻姑 3 麻姑河 4 鳥木屯 5 羅書 6 鐵鑛山

An analysis gives the following:

	a	*b*
Fe	61.70	63.60
SiO_2	2.72	1.71
S	0.025	0.028
P	0.140	0.016

It is possible that there is a fault between the ore and the limestone to the west.

The production was 10,000 catties per day, sold at \$0.40 per 3,000 catties (?) The ore is smelted at Maku. It has the best reputation for quality in a wide region.

Going from Tiehkuangshan westward, the limestone dips at first gently (20°) westward, then nearly vertical, but soon dips gently eastward. At a point near 550.2 basalt is met with, then again limestone which is also faulted against basalt as it apparently overlies it. Then we come to Loshu with conical peaks and some trees. This scenery ends at near point 545 where the limestone dips under basalt.

Then basalt, *Gigantopteris* series, and red sandstone form a regular syncline with Maku and Hsinkai[1] at the middle.

At Maku, barometer 567.2, temperature 19°.8, at 7 p. m.

August 15, 1914

Maku to Hunshuitang via Maluchiao[2] and Erhmachung[3] (Pl. 3 : YMA3)

At Maku, barometer 570, temperature 18°.2 at 9 a. m.

At a point (bar. 559.3) two kilometers west of Maluchiao is the contact between basalt and limestone. At 563.5 near Shuihaitzu[4] band of sandstone striking nearly N-S, dipping 35° E. Then it is followed by the white limestone in which the two lead-zinc mines Chatzuchang[5] and Maomaochang[6] are situated. Mining is no longer carried on, but there are several furnaces smelting slag which contains 2-6% of metal. One furnace smelts 1200 catties of slag getting about 30-80 catties of lead by rising 300 catties of coal. The cost of resmelting is about \$1. Price of coal = \$1.6 per 1200 catties. Yearly production 50,000-100,000 catties of lead.

---

1 新街 2 馬路脚 3 二馬冲 4 水海子 5 渣子廠 6 毛毛廠

I descended into one of the shafts. Ore occurs in limestone fissures, St. E-W, dip S. No mining being carried on since the eighth year of Hsienfeng[1]. Story about Japanese engineers.

Near Maomaochang fossils occur in white limestone (C_2 (1)): *Productus (Striatifera) striatus* Fischer.

Going up from Maomaochang northward we come to the highest point (bar. 526.6, temp. 17°2 at 1 p. m.); limestone strikes 50°, dips 30°S.

Just N. at 537 we have laminated black limestone, above it is thin bedded yellow limestone with fossils (D_2). A little way down is a small body of dolerite intruded into the limestone. Going down the Erhmachung the black limestone strikes WNW and dips 20° NNE. Down to the point 548 numerous fossils are found:

Productus (Striatifera) giganteus Martin
Productus (Striatifera) edelburgensis Phillips
Dielasma sp.
Lithostrotion (Siphonodendron) sp. nov.
Koninckophyllum? sp. nov.
Cyathophyllum fraternum Reed
Syringopora intermixta Reed
Syringopora sp.

The whole is undoubtedly Dinantian.

Between Erhmachung and Hunshuitang we find. in a white limestone (O_4), *Productus (Striatifera) striatus* Fischer and Fusulinoids and at C_4 near Shenwang (?) *Lonsdaleia* sp.

The boundary between the black and the white limestone is at the point 553.2 where it dips 10° NNE and the boundary between limestone and sandstone is about 750 m. north.

Got to Hunshuitang by 6 p. m., barometer 568.7, temperature 19°.5.

August 16, 1914

Hunshuitang to Yaochan (Pl. 3 : YMA3)

At Hunshuitang, barometer 570.8, temperature 16°.8 at 9 a. m.

---

1 咸豐

Passing by Fulaichang[1] the Lower limestone (White?) seems to be horizontal. Just before Wulipai[2] (bar. 562.2) it seems to dip gently to SW. Near Kanyentang[3] fossils are found in black limestone (G_2):

Productus (*Striatifera*) *striatus* Fischer
Koninckophyllum? sp. nov. (same as D_2)
Lithostrotion (*Siphonodendron*) sp. nov. (same as D_2)
Lonsdaleia sp.

So it is the black limestone horizon.

At Chuchingchang[4], an old zinc and lead mine.

A little beyond at 542.2 shaly limestone strikes 320°, dipping 20° WSW. At Szepu[5] bar. 541.8, temp. 17°2 at 3 p. m. At 542 black shale dipping 55° ESE, changing into N-S, dipping 20° E. At point *c* (about 542.8), striking E-W, dipping 20° S. Then it seems to be horizontal. Before Painiching[6] striking WSW-ENE, dipping SSE. Just beyond Painiching fossils in black limestone (M_3):

Productus (*Striatifera*) *striatus* Fischer
Reticularia sp.
Fusulinoid

Then silicified? limestone.

All the way to Yaochan sandstone to right and limestone to left (Fig. 20).

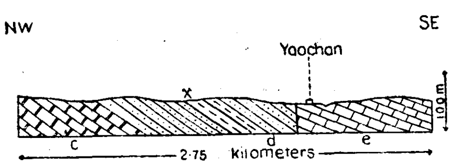

Fig. 20. Section at Yaochan. c. White limestone. d. Waitaoshan coal series. e. Tapingtzu limestone.

At Yaochan, barometer 549.6 temperature 20° at 6 p. m.

August 17, 1914

Yaochan to Weining (Pl. 3: YMA3)

At Yaochan, barometer 551.6 temperature 16°.2 at 9 a. m.

At 549.3 limestone striking 80°, dipping 20° S. At 550.7, dip 5° S. To the left of road (just S of *a*), coal mine. At point *b*, limestone St. 20°, dip 20° E.

1 福來廠 2 五里牌 3 乾壩塘 4 竹箐廠 5 司舖 6 白泥井

At Erhpu, bar. 554.6, temp. 18°.5 at 11 a. m. Several coal mines are working to the northwest of Erhpu. The section at Kungshanyentung[1] is as follows (from above downward):

Roof black sandy shale (*Lepidodendron*)	
Coal	0.3-0.5 m.
Yellow coarse sandstone[2]	5 m.
Black shale[3]	2 m.
Yellow sandstone[4]	4 m.
Black shale	3 m.
Grey shale and clay	3 m.
Spotted shale[5]	2.3 m.
Coal[6]	1-1.7 m.
Black shale	4.5 m.
Coal[7]	0.5-0.7 m.
Yellow sandstone	

At the time of visit two shafts were working, putting at 10,000 catties per day. They are only worked in Nov.-Feb. Price 80 cashes per 100 catties. In the city 160 cashes per 100 catties. Going from the mine southward we find south of Heiniti[8] sandstone striking NE-SW, vertical. Probably the boundary of a fault.

At point 546.6, limestone striking nearly E-W, dipping 10° S.

At *d*, silicified limestone striking WNW-ESE, dipping 10° NNE.

At Hsinkuanting[9] numerous fossils (H_2 = silicified limestone): *Euomphalus* sp. and *Productus* sp.

At Yangkuanshan[10] bar. 536.1, temp. 18°.1 at 3 p. m. Fossils in white limestone (D_4): *Endophyllum changiensis.*

At point *f* (near 548.2), outcrops of silicified limestone.

At Weining, barometer 551.8, temperature 15°.7 at 9 p. m.

August 18, 1914

Stayed at Weining

---

1 空山岩洞 2 草皮硤 3 黑硫 4 腰硤 5 毛巾硫 6 頭層炭 7 二層炭 8 黑泥地
9 新官廳 10 楊官山

August 19, 1914

Weining to Tapingtzu[1] *(Pl. 3:YMA3)*

At Weining, barometer 550.2, temperature 18° at 8 a. m.

About 500 m. south of the city, at 551.2, black limestone strikes NE-SW, dipping 50° N. At pt. 552.5 yellowish sandstone strikes ENE-WSW, dipping 60° N.

At point *a*, numerous fossils in black shale (J_2): *Cleiothyridina, Oxydiscus, Sinocladia, Polypora* and *Phillipsia.*

Just before Pochiwan[2] (bar. 550.8) impure limestone striking ENE-WSW, dipping 70° S.

Further on lamellated limestone and shale strikes NNW-ESE, dipping 10° SSW. Fossils (Q_3): *Pinnatophyllum* and *Athyris*? Overlaid by yellowish sandstone at 549.1, north of Shuikouwan[3].

After passing Shihlipu[4] where we find at two localities N_4 and I_2 numerous fossils in the black limestone:

N_4, *Productus* (*Striatifera*) *giganteus* Martin
I_4, *P.* (*S.*) *giganteus* Martin
Derbyia sp.
Polypora sp.
Pinnatophyllum sp.

At point *c*, bar. 549, junction between black limestone and silicified limestone, the latter strikes 30°, dipping 20° ESE.

Then we come to the white limestone of Feilaishih. From Feilaishih to Yaochan the Coal Series seems to crop out again. Stop making sketches at Yaochan (bar. 557.9).

At Tapingtzu, barometer 554.5, temperature 17° at 9 p. m.

August 20, 1914

Tapingtzu to Kotu[5] *(Pl. 3:YMA3)*

At first the road lies in Permian limestone dipping 20° SE. Near Huoshaopu[6] we come to the boundary between the limestone and the overlying basalt.

---

1 大坪子 2 簸箕灣 3 水溝灣 4 十里舖 5 可渡 6 火燒舖

(Pl. 10:YSB, Fig. 3). A little beyond, the road reaches a low pass going down to Hungshihyen[1] where is a small outlier of limestone in basalt, forming a small anticline with dips different for the overlying basalt. The southern boundary is near the point 573.5. Descending to Chintoupu (572.9), the *Gigantopteris* coal series occurs just outside the village, dipping 40° ESE. Going up we come to Tangshang[2], 500 m. to the north of which the red sandstone overlies the coal series and dips SE, but on each side it bends to strike NE-SW and ENE-WSW respectively.

Going up further, the red sandstone is covered by the limestone series. The section is as follows:

567.4

Limestone with *Pecten* sp.

564.0

Yellowish shaly sandstone

543.2 (?)

Limestone

555.3

Yellow sandy shale

Then an alternation of three layers of limestone and two layers of sandy shale.

At Yangchiaowan[3] (550.4) the limestone is overlaid by the upper red and green sandstone series, dipping 70° SE. This latter consists of a series of red, green and white sandstone (soft and hard layers alternating). Descending for Yangchiaowan we come to Chanpo[4] at 566.2. Then less than one kilometer south, a temple marks the boundary between Weining and Hsuanwei districts. Then Chiucheng[5] (591), a large village. River of Kotu 600.7. Stayed at Kotu. Storm broke out before reaching Chanpo, but clear again at night.

At Kotu, barometer 599.9, temperature 19°.6 at 10 p. m.

August 21, 1914

Kotu to Hsintienpu[6] (*Pl. 3:YMA*3)

From Kotu (bar. 600 at 8 a. m.) we went back north of the river to restudy the section near Yangchiaowan.

---

1 紅石岩 2 塘上 3 楊檔灣 4 站坡 5 舊城 6 新田舖

550.4 of yesterday (northeast of the village)

Yellow sandy shale

551 (point *d*, southwest of the village)

Soft red shaly sandstone

551.6

Hard coarse green sandstone

554.4

Coarse white micaceous sandstone

557.1

Soft green shaly sandstone near Shashihpo[1] (556.3). The same continues to point *e* at 559.6.

Going south of Kotuho the red sandstone dips 10° S at river bank, but soon reversed to dip 10° N.

At 591.7 red sandstone

587

Soft yellow and red sandstone and shale

572

White coarse micaceous sandstone

569

Soft shaly sandstone

Then limestone series (with *Pecten*) dipping 70° N (at 591.2?). Soon it is covered by the lower red sandstone with the same dip. A kilometer further, *Gigantopteris* coal series. At Shuitangpu[2] (bar. 579) coal series.

Leaving the main road, I climbed up a high point to the south. At 566, basalt underlying the coal series in the latter there were numerous ruined pits. Mukuashao[3] at point 552.9, with Erhchuanshuliangtzu[4] on the east. Further up, the highest point reached is 549.5. Coming down we meet the coal series at a point one kilometer north of Hsintienpu, dipping 15° SW.

At Hsintienpu, barometer 536.1 temperature 16°.7 at 10 p. m. Cloudy in the morning, shower in the afternoon and night.

---

1 沙石坡 2 水塘舖 3 木瓜哨 4 二串樹梁子

August 22, 1914

Hsintienpu to Tangtang (Pl. 3 : YMA3)

At Hsintienpu, barometer 556.4, temperature 18° at 8 a. m.

From Hsintienpu southward over a low ridge in coal series until we come to a point one kilometer north of Tangtang where basalt is again met with.

To the west of the road the red sandstone is seen. To the east the coal series has a wider extension. The ridges crossed are point 554 and point 560.3 (Laoyalin[1]).

The coal series dips at first 30° N, then becomes horizontal with occasional gentle dip towards N. The country is forested. A kilometer SSW of Laoyalin, fine view. Over this point the coal series dips 20° or less to the south. At 568.5, basalt. Thence to Tangtang all the way in basalt.

At Tangtang, barometer 583.1, temperature 18°.6 at 10 p. m.

August 23, 1914

Tangtang to Laotsienshan[2] and return

At Tangtang, barometer 582.2, temperature 9°.2 at 6 a. m.

Went up to Laotsienshan to make sketches and take sights (Fig. 21). Going up the different formations are

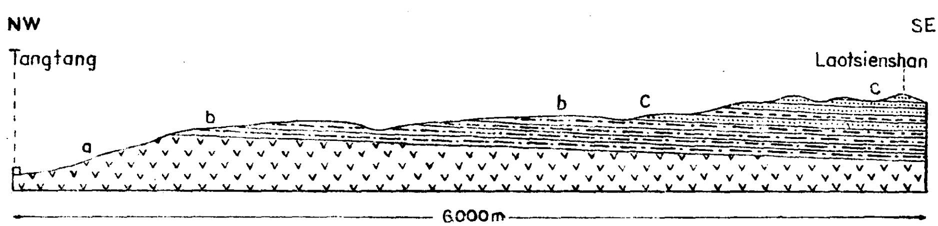

Fig. 21. Section at Laotsienshan. a. Basalt. b. *Gigantopteris* coal series. c. Red sandstone and shale.

Basalt

Bar. 750

Coal series, with pits at point 560.5

Bar. 552.6

Red sandstone

Top of Laotsienshan, bar. 540.8, alt.2446.

1 老鴉林 2 老尖山

Higher up to Tungshan[1] are red sandstone. Bar. 520.8, temp. 10°.2 at 3.30 p. m. From Tungshan numerous sights and views were taken. It is seen that Chekoliangtzu[2] beyond Mitehho[3] is of basalt, beyond which is limestone. Tutouliangtzu[4] is basalt, but limestone beyond. Mupaoching[5] is red sandstone at top. Kuatu[6] is red sandstone. Mapaitashan[7] is limestone.

In coming down the 3 formations are again noted. In the red sandstone are numerous copper mine pits long abandoned. In addition the following are said to have existed:

1. 興隆廠 in 大壩溝，嘉慶 21-22 年，carbonate. 2. 龍寶山，道光初年， 3. 大屯，道光初年， 4. 擺凹，道光初年 5. 得寶箐(彌德河)，咸豐初年， 6. 上目 (near 左溪) 道光末年， 7. 沙帽營 right bank of Kotuho near 天生橋 8. 大岔河 right bank of Kotuho near 誇部 (15 li), both this and 7, 咸豐初年， 9. 香爐山，光緒初年，10. 後山廠 between 香爐山 and 擺凹，同治初年， 11. 白草地 SE of 小南山，同治初年，12. 老皮草廠(大屯河口頭)，同治初年，13. 老牛凹 near 小屯，同治初年 14. 小屯廠，光緒十八年， all is 柴土垅。

In limestone（塘鑛）

1. 魯車 2. 小冲 3. 次營，道光二十餘年。

In basalt（立鑛）

1. 何家冲 2. 母鷄溝 below 木包箐梁子。

Each of the places has yielded 1 million catties of copper. From the beginning of Kanghsi reign, it used to be controlled from Chutsing. Tax per furnace 15 catties of copper per month, which became $2.35 later. Price of copper $7.3 to $9.3 per 100 catties. From 同治初年 to 光緒十四年 Price $10.3 per 100 catties.

光緒 14-18 年 Price $11.7
光緒 18-25 年 Price $13.3
光緒 26 年 Price $20.00

Thence it stopped altogether. The mines were collectively termed 次營.

Each firing takes 84 hours, smelting 8000 catties of ore, using 8000 catties of coal ($5-6 only). Total expense = $30. This gives rise to 100-500 catties of copper. 10 firings per month.

August 24, 1914

The river was so swollen with flood that it could not be crossed. Stayed at Tangtang. Trouble with police who squeezed my maps.

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1 東山 2 扯格梁子 3 彌德河 4 禿頭梁子 5 木箐包 6 誇都 7 馬擺大山

XIV. GEOLOGY BETWEEN TANGTANG AND TIEHKUANGSHAN.

Hearing that several copper and lead deposits occurring in the district of Weining, Kueichou that have been extensively worked in the past, I decided to make a trip to that region. The deposits proved to be of little interest, but the geological observations made on the trip turned out to be of considerable importance.

The syncline of Kotuho

From Tangtang the road to Weining lies to the north. At first it is in the Permian basalt, but at a point about a kilometer from Tangtang the overlying *Gigantopteris* coal series crops out. This continues until beyond the village of Hsintienpu when the underlying lava is again met with. The coal series has various dips and strikes, but on the whole the dip is very gentle, average less than 20°. The basalt outcrop extends northward from Hsintienpu about four kilometers just to the south of Shuitangpu where the coal series is again seen. To the west side of the road between Hsintienpu and Shuitangpu which lies in basalt, the coal series is seen to occur. In fact here the relative position of basalt and coal series is a matter of topography, the former occupying the higher grounds.

The coal series which strikes WSW-ENE gradually steepens in dip and is soon covered by the red sandstone, which gradually becomes more argillaceous and calcareous until a series of impure limestone replaces it entirely. This latter consists of a white limestone, somewhat thin-bedded, with conchoidal fracture alternating with yellowish sandy shale. It dips 70° NNW, and is covered by a thick series of multicoloured sandstone and sandy shale, the predominant colours being red and green. As we descend into the Kotuho river the upper series of sandstone becomes nearly horizontal. The village of Kotuho lies on the southern bank of the river but Chiucheng or Old Village is on the opposite side. From Tangtang to the bottom of the river we have descended some 200 m.

The same formation is found on the other side of the river, but the dip is soon reversed to southward, and as we go north, it becomes increasingly steep until we come to Yangchiaowan where the limestone series is in contact with the upper sandstone; it dips 70°. Thence to Chintoupu the lower red sandstone, the coal series and finally the basaltic lava all crop out, forming the northern limb of the Kotuho syncline. The valley of the river however occupies not the centre of the syncline, but nearer to the southern limb, hence the upper sandstone has a more extensive outcrop on the northern bank. Being harder than the underlying series it forms steeper slopes, making the ascent from Kotuho northwards much steeper. From the river bed to the village of Yangchiaowan we have ascended some 500 m.

The basalt lava, the *Gigantopteris* coal series and the overlying sandstone are identical with those seen west of Tangtang, but the limestone series and the upper red and green sandstone are here met with for the first time. I have therefore named it the *Kotuho formation*. As later on in Hsuanwei district *Myophoria* has been found in the same limestone, the whole is of Middle Trias. The relative thickness of the different series described above are as follows:

Red and green sandstone alternating with soft shale	580 m.
Impure thin-bedded white limestone alternating with sandy shale	280 m.
Median grained red sandstone	300 m.
Gigantopteris coal series (yellow psammitic sandstone)	350 m.
Basaltic lava	400 m.

The boundary between the basalt and the coal series occurs just south of the village Chintoupu. I have termed the Permian lava "basalt", but here it is more acid in character with tuff interbedded, showing often rhyolitic structure. To the north (0.5 km.) of Chintoupu a small outlier of limestone occurs, bearing the name of Hungshihyen. It forms a small gentle anticline in contrast to the nearly horizontal lava overlying above. Thus there must be an unconformity between the two.

Hearing that coal of a different character occurs at Waitaoshan and that copper exists at Tungchangho near by, I made a side trip from Chintoupu. Leaving the main road at the latter, the road leads at first west, then northwest following the Tungchangho valley which all the way lies in lava. The village of Tungchangho is some seven kilometers from Chintoupu and used to be a mining village, but at the time of my visit all mining activities have long ceased. All the small pits are in ruin. These are situated in the basalt in which the ore is found in small veins. Now only a man Li from Weining buys a small quantity of ore from the villagers who repick the waste. This ore is said to contain only 2.5% of copper.

The bornite and copper pyrite are difficult to smelt. At first 4500 catties of ore are put into the reduction furnace with 4500 catties of coal and 1,400 catties of flux material, employing 9 men at work. The process is completed after 60 hours, costing about 44 dollars and producing about 220 catties of "mat". 4400 catties of the latter representing the result of 20 firings are oxidised in the oxidising furnace 7 times over costing about 17 dollars. Lastly the crude copper is resmelted costing another 44 dollars. The net result of these is a little over a ton of impure copper. The total cost amount to nearly 1000 dollars. The oxidising furnace is the same as that of Laochang in Hucili but smaller. Oxidation is carried out with coke. At the time of Tangchiung[1] the mine comes under the administration of Yunnan. Mining completely stopped in 1904.

The Coal Field of Waitaoshan

The Waitaoshan coalfield is situated 4.5 kilometers north of Tungchangho. Going over a low watershed we soon come to the boundary between basalt and limestone which dips 20°. This is a grey to blue limestone similar to that of Hungshihyen noted above. I have called it the *Tapingtzu limestone.* A little over two kilometers further north we come to the Waitaoshan coalfield which forms a E-W belt about 700 m. wide with the same dip as the limestone. There were two small shafts which, being summer, were not working. The series consists of the following:

From above down

1. Brittle white sandstone .... 30 m.
2. Black sandy shale .... 10 m.
3. Coal .... 0.5 m.
4. Black shale .... 10 m.
5. Coal .... 1-2 m.
6. Hard white sandstone .... 1 m.
7. Black sandy shale .... 5 m.
8. Coal .... 1 m.
9. Shaly sandstone

The second seem (5) is best in quality, but all three (3, 5 and 8) give a good coke. An analysis made from sample taken from the second seam gives the following results:

moisture	volatile matter	Ash	fixed carbon	sulphur	heating value
0.95	15.28	17.42	83.77	1.15	7.920

It is from this seam that the coke used for smelting copper at Tungchangho is obtained.

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From the upper white sandstone badly preserved plant remains are found among which is a fragment of *Sphenophyllum involutum* which Dr. Halle attributes to Devonian, but as will be seen, the coal series is underlaid by the limestone containing *Spirifer mosquensis*, it can not be older than Moscovian.

The E-W extent of the coalfield was not determined. To the WNW it extends a considerable distance as coal of the same character is reported to be mined at Tanshan[1], 11.5 kilometers WNW from Waitaoshan. Eastward it passes between the village of Yaochan and Feilaishih turning to strike NE-SW.

The Weining Anticline.

The Waitaoshan coal series and its overlying limestone and basalt form in fact the southern limb of a gentle anticline with its axis at the east end of the Weining basin. For going northward from the coalfield we come to a white limestone dipping 20° south. This limestone is very fossiliferous. From a point N of Chihchang, I made the following collection:

Lonsdaleia voltzi Yabe and Hayasaka
Dielasma sp.
Marginifera? sp.
Chonetes sp.

and a number of Foraminifera.

About one kilometer east near Feilaishih where the road from the coalfield joins the main road to Weining, fossils are found in the same limestone along the strike but probably in a slightly lower horizon:

Cyathophyllum sp. nov.
Geinitzella sp. nov.
Productus (Striatifera) striatus Fischer
Dielasma sp.
Cleiothyridina?
Reticularia sp.
and a number of Foraminifera.

From Feilaishih northward the same limestone extends a considerable distance, dipping 10° or less to the south. This I have called the *Weining lime-*

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stone. About three kilometers north from Feilaishih we come upon a silicified limestone, underlaid by a dark blue to black limestone containing organic matter and often interbedded with black shale. This limestone yields, near the village of Shihlipu in two localities, the following fossils:

Locality 1.

Productus (Striatifera) giganteus Martin

Locality 2.

Productus (Striatifera) giganteus Martin

Derbyia sp.

Polypora sp.

Pinnatophyllum sp.

So this is undoubtedly Dinantian. This fact enforce the Moscovian character of the limestone overlying it.

This Dinantian limestone has the same strike and dip as the overlying beds, namely 10° SSW, but a kilometer further north near the village Shuikouwan, we come to a series of black shale, soft yellow sandstone, sandy shale, and a few bands of impure shaly limestone with its deep steepening to 70° S. In the black shale near Shuikouwan I found *Pinnatophyllum* and *Athyris*, and a kilometer further north near the village of Pochiwan, the black shale contains abundant bryozoans:

Cleiothyridina sp.

Polypora sp.

Oxydiscus sp.

Sinocladia sp.

Fenestella sp.

Phillipsia sp.

Then the dip abruptly changed into 60° N and continues so until the city of Weining is reached, outside the east gate of which the black limestone reappears, dipping in the same direction. Here then is the axis of the Weining anticline. Further north of the city the white limestone reappears, but the dip is much gentler. It is also underlaid by a silicified limestone. At a point four kilometers northeast of Weining the white limestone changes its strike and the anticline of Weining comes to an end.

The succession and thickness of the various formations[1] described above are as follows:

1.	Tapingtzu limestone	640 m.
2.	Waitaoshan coal series	240 m.
3.	Weining limestone	720 m.
4.	Silicified limestone	160 m.
5.	Shihlıpu limestone	480 m.
6.	Pochiwan shale	600 m.

These thicknesses are approximate only as the outcrops are not quite continuous and the exact boundaries of the different formations are difficult to determine, but they are believed to be of the right order of magnitude.

The Coalfield of Yaochan and Erhpu

As already noted above, in going from Weining northward we first meet the black limestone then the silicified limestone. Overlying the latter is the Weining limestone with characteristic fossils. About five kilometers north of Weining, near the village of Hsiawuliping, I found foraminifera in the white limestone. A little further NNE near the village of Shuishihtsao a collection was made, containing

Chaetetes subradians Mansuy
Dibunophyllum weiningense Chi
Spirifer (Choristites) mosquensis Fischer
Productus (Striatifera) undatus Defrance
Productus (Linoproductus) simensis Tschernyschew
Productus (Striatifera) edelburgensis Phillips
Dielasma sp. and Foraminifera

This determines the age of the Weining limestone to be Moscovian beyond any doubt.

The limestone here strikes NE-SW, forming the south-western end of a shallow syncline, as it dips on the west side of the road 30° SE whilst on the east side the dip is in the opposite direction. It is underlaid here (Shuishihtsao) by the silicified limestone which at the place called Hsinkuanting yielded the following fossils:

1. Beds 3 to 6 constitutes the *Weining Series.*

Euomphalus sp.,

Productus sp.

I have called this horizon the *Hsinkuanting limestone*.

Two kilometers further we come to the village of Erhpu on both the east and the west side of which coal series occurs, but that on the west side is separated from the eastern coal field by a limestone which underlies the coal series to the east but is in fault contact with the coal series to the west. The latter may be termed the Yaochan coalfield as it continues northeastward passing through the village of that name and is the more important of the two. The Yaochan coalfield consists of the following succession:

1.	Black sandy shale with *Lepidodendron*	10 m.
2.	Coal	0.3-0.5 m.
2.	Black shale	2 m.
4.	Yellow sandstone	4 m.
5.	Black shale	3 m.
6.	Grey shale and clay	3 m.
7.	Spotted shale	2.5 m.
8.	Coal	1-1.7 m.
9.	Black shale	4.5 m.
10.	Coal	0.5-0.7 m.
11.	Yellow quartzitic sandstone	

At time of visit only two shafts were working putting out some 8 tons per day. The price at pit mouth is about $1.5 per ton, but at the city of Weining it is nearly doubled. Going from Erhpu to Yaochan 2.5 kilometers further north, old pits are seen all the way. Only the last coal seam is worked. It gives an excellent coke which used to be sent to Kuangshan in Tungchuan.

The coal series to the east of Erhpu is not worked and was not carefully examined by me, but judging from the dips of the limestone to the south, it probably forms a small shallow syncline surrounded by the Weining limestone.

Area between Yaochan and Hunshuitang.

From Yaochan northeastwards to Hunshuitang, a distance of about 16 kilometers, the country has a karstic scenery, being formed by gently dipping or horizontal limestone which forms conical peaks with shallow enclosed basins between without any surface drainage. At first the Weining limestone dominates. At a point near Painiching it contains the following fossils:

Productus (Striatifera) striatus Fischer
Reticularia sp.
Foraminifera

Just beyond, the silicified limestone outcrops followed by the black limestone, which near Kaoyentang gives the following fossils:

Productus (Striatifera) striatus Fischer
Koninckophyllum sp. nov.
Lithostrotion (Siphonodendron) sp. nov.
Lonsdaleia sp.

After Kanyentang the Weining limestone again appears, forming a band running NW-SE. It is in this that the zinc and lead mines known as Chatzuchang and Maomaochang are situated. None of them was working, but the local people were resmelting the slag which contains 2.5 to 6 % of lead. One furnace smelts 3/4 ton of slag getting on the average 50 catties of lead. As the resmelting costs only about $1 per firing, it is a paying business. The yearly production of lead amounts to 200 tons.

At Maomaochang an attempt was being made to open one of the old shafts. They were following a narrow vein in limestone fissure only a few centimeters thick. Judging by the amount of slag the mine has been of considerable importance in the past and may be worthwhile to prospect in the future.

There are two other mines in this locality: the Fulaichang, nearly two kilometers northeast of Kanyentang, and the Chuchingchang four kilometers west of the same village. Since they have long been abandoned, they were not visited. They are certainly similar in nature to Maomaochang as they are found in the same formation.

In going from Maomaochang northward towards Hunshuitang, an interesting section is seen. Near Maomaochang the limestone is typically white with *Productus (Striatifera) striatus*. A little more than a kilometer from there the lower black limestone is exposed. A small body of dolerite intrudes through this and round this intrusive mass; the limestone dips gently away from it. Near the contact and further down to the village of Erhmachung, the following fossils occur:

Productus (Striatifera) giganteus Martin
Productus (Striatifera) edelburgensis Phillips
Lithostrotion (Siphonodendron) sp. nov.
Koninckophyllum? sp. nov.
Cyathophyllum fraternum Reed
Syringopora intermixta Reed
Dielasma sp.

This determines definitely the age of the black limestone as Dinantian. From Erhmachung to Hunshuitang the white limestone reappears with *Productus (Striatifera) striatus*.

The Makuho syncline and the iron mine at Tiehkuangshan.

From Maomaochang eastward we come to the syncline of Makuho. Maomaochang is situated on a high plateau without drainage, but with conical peaks. Eastward for 1.5 kilometers we come to a narrow band of sandstone dipping steeply towards ENE overlaid by a blue limestone similar to that of Hungshihyen. The width of this limestone is about 800 m. and is overlaid by the Tungchangho basalt. Descending eastward the basalt soon disappears under the coal series which is equivalent to the *Gigantopteris* horizon. The latter stretches beyond the village of Maluchiao and then dips under the typical red sandstone which, from east of Maku to the east side of Hsinkai, forms the middle of a syncline. From Hsinkai which is situated on the banks of the Makuho and is some 300 m. below Maomaochang, I went southeastwards to pay a visit to the famous mine of Tiehkuangshan, some 13 kilometers east of Hsinkai. The road ascends again and the coal series, basalt and limestone repeat themselves, only with less steep dip therefore wider outcrops. The coal in the Makuho valley is extensively mined, but it is poorer in quality than usual and metallurgical coke has to be transported from Yaochan and Erhpu.

Once in the limestone we are again on a plateau 130 m. above the level of the Makuho valley, without any surface drainage, but with conical peaks enclosing small basins. For a distance of 4.5 kilometers we are continuous in the horizontally bedded limestone. Near the village of Loshu I found in the limestone *Euomphalus* and Foraminifera. It is to be noted that between the limestone that immediately underlies the basalt and the Weining limestone no coal series occurs, but only the thin band of sandstone of Shuihaitzu. As the dip of the sandstone is steeper than that of the Weining limestone, a fault probably occurs between.

Two kilometers east of Loshu an unexpected occurrence of basalt it met with. It forms a narrow valley 800 m. wide between limestone cliffs on both sides. Since these do not dip under it but away from it, the basalt is probably a graben. It is characteristic of this region that as soon as we are in the basalt, surface drainage reappears, for a small stream flows through it from NNW towards SSE.

As soon as the basalt valley is left behind, we are again in limestone country with its karstic scenery. About 4.5 kilometers from the basalt valley we come to Tiehkuangshan iron deposit. No outcrop is seen on the surface, but two small shafts close together descend five feet underground and we are at once in the ore which forms a bed at least two meters thick, this being the thickness mined, striking NW-SE, dipping 20 SW, following the bedding plane of the limestone that is found both below and above. It is evidently a replacement of the limestone itself. Its prolongation along the strike is not determined as the actual mining extends only about ten meters long and no outcrop is visible on the surface. The ore is a compact high grade haematite, a sample of which gives the following analysis:

Fe	61.70	63.60
SiO_2	2.72	1.71
S	0.025	0.028
P	0.140	0.016

No doubt it is owing to the exceptionally low silica and sulphur that the iron smelted from this deposit becomes famous throughout a wide region. Whilst it is impossible to estimate the value of the deposit, it is interesting to note that it is found that the compass needle was sensibly affected round the deposit for an area about 300 m. in radius. This certainly indicates the existence of magnetite bodies underground.

At the time of visit the production amounted to some seven tons per day and is sold to the smelters at Maku at about $3 per ton.

The section from Hunshuitang to Hsiaochiho Coalfield.

Returning from Tiehkuangshan to Hunshuitang via Maku, the road leads from Maku northwestward through the northwestern limb of the Makuho syncline which is probably a real basin as it can be seen that the south-western end is completely closed. About 1.6 kilometers from Maku we come to the contact between basalt and limestone which forms another karstic plateau 100 m. above Makuho. The road practically lies near the boundary between the limestone immediately underlying the basalt and the white limestone with *Productus striatus*. There is again a band of sandstone between which in many places dips 70°-80° against the white limestone on its west. The width of the outcrop seems to increase also as we approach Hunshuitang. The impression that it represents part of the Waitaoshan coal series and is faulted against the Moscovian limestone is thus strengthened.

Arriving at Hunshuitang, I heard that there is a coalfield in the valley of Hsiaochiho six kilometers north. Hoping that it may furnish some data on the Moscovian coal series, I paid it a special visit. North of Hunshuitang the same band of sandstone persists between the white limestone of Weining and the upper limestone which dips at first 45 degrees NE, but three kilometers and half from Hunshuitang just beyond the valley of Pientang[1] the dip is reversed to be again reversed half a kilometer further to dip under the basalt. In two places fossils are found. At Tishuiyen just north of Yutolo the following fossils occur:

Productus (*Striatifera*) *undatus* Defrance
Productus (Linoproductus) simensis Tschernyschew
Enteletes sp.
Chonetes sp.

The above is found in a white limestone. In a limestone of grey colour it is found:

Streptorhynchus tingi Grabau
Verbeekina verbeeki Geinitz

In the second locality 750 m. south of the contact with basalt we find in the dark blue limestone crinoid stems and *Bellerophon* sp. It is probable this limestone is Upper Carboniferous to Permian in age.

The basalt outcrop is about 700 m. wide, overlying which is the *Gigantopteris* coal series. There are four seams altogether, but only two of them are workable. The first of these is 1.8 meters thick and the second 1.6 meters. Both strike E-W, dipping 10° N. The whole series is covered by the red sandstone.

There were five shafts working, the total production per day being only three tons. The coal supplies the city of Chenghsiung.

The journey to Weining was undertaken to examine the noted lead and coal deposits, which proved to be disappointing, but the geology was so interesting

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that it helped greatly to establish a correct classification of the Carboniferous of southwestern China. Owing however to the lack of time, I had to leave this interesting region with only the few observations noted above. Nor did I attempt to explore the Weining lake basin which forms an important sheet of water covering 32 square kilometers in area without counting its northwestern extension. The lake is interesting in that it has no outlet, but the water sinks into a *loshuitung* or sink-hole ten kilometers northwest of the city. According to local tradition no water existed before 1856 when the sink-hole is said to be partially blocked up causing an accumulation of water. The lake is undoubtedly in the process of drying up, the water surface covering only about one half of the total basin. I return to Tangtang by the same route which enables me to collect a few more fossils mentioned above than a flying trip would otherwise have permitted.

XV. TANGTANG TO CHUTSING (August 25—September 19).

August 25, 1914

Tangtang to Laipinpu[1] *(Pls. 3 : YMA3, 4 : YMA4, 6 : YMA6)*

At Tangtang, barometer 585.4, temperature 19°.2, at 8 a. m.

Going directly south the road lies in basalt until four kilometers from Tangtang where coal series striking WNW-ESE, dipping 10°S. (Pl. 10 : YSB, Fig. 4). After going one kilometer beyond Maanshan[2] (bar. 578.4) come to contact of red sandstone and coal (567.7) which crops out again 500 m. north of Chiuputzu[3] (576.2) Coal mine occurs at point 575.2, one kilometer from Chiuputzu half way between Toushanpo[4] (572.8) and Chiuputzu.

After Toushanpo basalt again which forms a NE-SW band 1.2 kilometer wide with distinct bedding plane. The village Tungnanpu[5] is situated in the middle of the band.

Then 650 m. south we come upon limestone. 500 m. further (561.1) sandstone with poor coal mined for pot making. The latter dips 80° + S, but reversed near southern boundary with limestone (width of outcrop 400 m.). Then a thin band of limestone 400 m. wide (dip uncertain) covered by basalt near Shihyakou[6] (560).

1 來賓舖 2 馬鞍山 3 舊舖子 4 陡山坡 5 通南舖 6 石埡口

Just north to Shuiching[1] one kilometer south, basalt is covered by red sandstone dipping 80° S, which after Shuiching becomes at first 50° then 20° and 15°.

This continues beyond Makuanchung[2] (564.4) to Laipinpu six kilometers SSE of Shuiching where the *Gigantopteris* coal series outcrops. Fine rice field near Shuiching.

Cloudy all day without rain. At Laipinpu (100 families), barometer 566.2, temperature 21°2, at 3.30 p. m.

August 26, 1914

Laipinpu to Hsuanwei (Pls. 4 :YMA4, 6 :YMA6)

At Laipinpu, barometer 568.9, temperature 17°.2, at 8 a. m.

From Laipinpu to Kuanyintang[3], a distance of 2.5 kilometers, we are in the *Gigantopteris* coal series striking NE-SW, dipping 10°-16° W. About 1200 m. southwest from Kuanyintang we come once more on the red sandstone which has a width of three kilometers southwestward passing Chiangsichiao[4] (bar. 571.1). The ridges on each side have 570.9 and 569.5 as heights respectively. Just west of bridge, red sandstone dips 8° SW.

Then the road follows the boundary between coal series to the west and red sandstone to the east. The two formations strike NNE-SSW, dipping 10°-15° ESE. At Shihlipu[5] we crossed into coal series which becomes practically horizontal. 4.5 kilometers SSW we come to Hsuanwei city on the edge of a broad valley.

Houses loaded with cotton yarns for Chaotung which gets cotton piece goods from the south, but some from west through Yunnan. Empty oil barrels returned from Kochiu. Very poor soil made to grow maize by careful manuring. Red sandstone used to neutralize the basalt soil. Pine needles are saved up for making manure. Oxen carts are seen everywhere.

August 27, 1914

From Hsuanwei east to Tungshan[6] and return

At Hsuanwei, barometer 571.6, temperature 16°.1, at 7 a. m. Cloudy and dull.

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1 水箐 2 馬官冲 3 觀音塘 4 江西橋 5 十里舖 6 東山

Went to Tungshan northeast of Tungshan Temple.

In coming down a careful section is taken (Fig. 22):

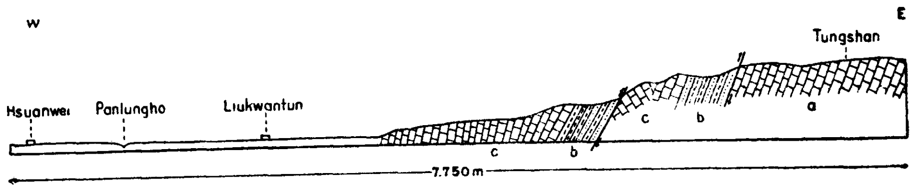

Fig. 22. Section at Tungshan of Hsuanwei. a. Light grey to white massive limestone. b. Yellowish quartzitic sandstone and black shale. c. Dark grey to black limestone.

White limestone with *Campophyllum* sp. nov. (J_4), from top (520.8) to Huangkouwa[1], St. 10°, dip 70° W.

Sandstone with black shale (533)

Dark limestone (538.6) containing *Syringopora ramulosa* (U_3)

Fault material, limestone at 545.7

Sandstone and black shale

Limestone (551) dipping 20° W, lower down becomes vertical. Fossils (Y_3) collected but lost.

Point 562.8 near end of the mountain. Section a little over four kilometers long. Then come back by way of Liukuantun[2]. At river, bar. 569.2. At Hsuanwei, barometer 568.2, temperature 18°, at 7 p. m.

August 28, 1914

Rest at Hsuanwei and solar observations.

August 29, 1914

Hsuanwei to Changchung[3] (*Pls. 4:YMA4, 6:YMA6*)

Left Hsuanwei for a round tour.

Going south towards Panghaitsun[4] the road lies at first in the plain, but a little over a kilometer from city it cuts the spur of the hill composed of the *Gigantopteris* series, the dip of which is quite gentle at first 20° ESE, then reversed. Just beyond Panghaitsun it dips 10° NNE. 800 m. south of Panghaitsun (13.20 km. from Hsuanwei), at 572.4 the spur is of basalt which continues until the village

1 黃狗凹 2 劉官屯 3 長冲 4 螃蟹村

of Hsiaokengtun[1] is reached where the coal series is again seen. This continues to Hungchiaopu[2] where a side valley widens and I left the main road to make eastward for Shangmafang[3] by way of Komukua[4] where the Panlungho[5] is crossed. At Shangmafang a narrow limestone ridge containing black shale in the southern part comes from Loshe[6] joining the Tungshan which forms an imposing fault cliff some half kilometer from the river.

The river coming from the south breaks through this low ridge at a point called Haikou[7], indicating that the upper basin was formerly a lake.

Going from Shangmafang southward we are in the lake basin covered by red clay which must be a lake deposit. After crossing three side-streams we come to a group of villages known as Lungchingkou[8] (570). One kilometer east of the last bridge we come to the limestone mountain.

The limestone dips at first 10° E (?). A spring comes of the limestone. Further southeast we come to a long valley ending into an enclosed basin near point 563. The limestone has variable strikes showing signs of movement. Then black shale is met with underlaid by black limestone (Dinantian) which continues to Changchung.

At Changchung, barometer 561.2, temperature 21°.4 at 3 p. m.

August 30, 1914

Changchung to Houkaitzu[9] *(Pls. 4:YMA4, 6:YMA6)*

Cloudy and dull.

At Changchung, barometer 562.2, temperature 11°.2 at 7 a. m.

From Changchung I went first westward to study more exactly the section. Two kilometers west of the village at 563.2, black limestone practically vertical (80° + west), then narrow band of black shale striking 10° – 20°, dipping at first 80° + E, then W, immediately overlaid by limestone which 300 m. further west, at 567.9, is overlaid by shale and sandstone dipping 70° W.

Just beyond Yatzutang[10] the Triassic red sandstone is faulted against this sandstone and shale which may be probably Lower Carboniferous in age.

Returning to Changchung I went then east. Three kilometers SSE from Changchung we come to a band of sandstone dipping 35°E. Boundary at 562.8.

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1 小耿屯 2 洪橋舖 3 上馬房 4 格母誇 5 盤龍河 6 羅舍 7 海口 8 龍井溝 9 猴街子 10 鴨子塘

Then it seems to be greatly disturbed with consequent change of strike and dip, but at 559.4, near boundary of upper limestone, it dips 30° E. The upper limestone is white (probably Moscovian).

Here the country is karstic. One kilometer and half southeastward we come to the small village Kotsaoyen[1]. (Pl. 10 : YSB, Fig. 5).

Another kilometer east we come to basalt. Going over a small ridge (height 555.4) we descend to Santaoshui[2] (556.8) where a stream goes northeast to end in a sink-hole. The road then leads over the head waters of this (556.7, 553.2 and 553.4), we come to limestone again at 551.2 which forms an outlier in basalt. 1.3 kilometers east at 555.2 the limestone seems to dip S under. A little more than 1.5 kilometers further southeast just one kilometer north of Upper Houkaitzu another small outlier of limestone dipping NNW. Upper Houkaitzu lies in basalt. Wet through. Barometer 575.9, temperature 16°.3, at 9 p. m.

August 31, 1914

Houkaitzu to Tuchang[3] *(Pls. 4 : YMA4, 6 : YMA6)*

At Houkaitzu, barometer 576, temperature 16°.4, at 8 a. m.

Paid a visit to the north of Houkaitzu in order to see the reputed iron ore. At 573.2, about 2.3 kilometer northeast from the village basalt occurs. A little more than a kilometer further north *Gigantopteris* coal series outcrops at 575.1. Here it forms the closed end of a syncline with its axis NNE-SSE (Fig. 23).

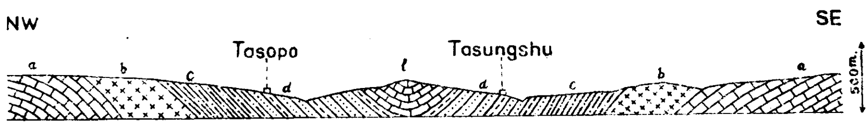

Fig. 23. Section at Tasopo near Hopeichung. a. Light grey limestone. b. Basalt. c. *Gigantopteris* coal series. d. Red and green sandstone and shale. e. Impure limestone.

The dip at the contact observed is 60° NW. There are five seams altogether, but only three are worked. The upper two are only one foot thick, but the third is about five feet and is of good quality giving a good firm coke.

The width of the outcrop is only 450 m. and then it is covered by the red series (578) which forms the valley of the Haitaichung[4] (100 li NE to Ssulicho[5]

1 蛇蚤岩 2 三道水 3 兎場 4 海岱冲 5 四里箐

to join main river). The latter is here formed by two branches: one from Tasopo[1] in NW, the other from NW joining just west of the village of Tasungshu[2]. Triassic limestone seems to occur in the middle of syncline. The coal series goes northeastward by way of Hopaichung[3].

Iron ore occurs at Tsaohuachung[4] NE of Houkaitzu. There are two main kinds of ore: (1) yellow ore, a true bog ore occurring near and below the coal beds: (2) white ore is formed by round or irregular-shaped pebble-like masses in the basalt. They are called white because the inner kern is of white limestone, the outer surface of which is altered into oxide. The ore occasionally encloses water, and bears the name Shuipaikuang[5]. They form masses from two feet to ten inches in diameter. The small ores are better in quality. These seem to be the erosion product in the time between the formation of the basalt and the *Gigantopteris* coal series or during the formation of basalt. Price $2 per 2,500 to 3,000 catties, giving rise to 1700 to 700 catties of iron. Hence percentage 60% to 30%. It requires 3,000 catties of charcoal, costing only $0.50 (!), to smelt 100 catties of iron which is sold at 1.2 per 100 catties for pig and $2 for wrought. Coal at Tasungshu is bad in quality, but better ores come from Tasopo.

Returning to a point east of Houkaitzu we went further south. In crossing the river at Lower Houkaitzu (577.6) we come to a fault, white coarse sandstone strikes 290°, dipping 10° N. Over the other side small outcrop of fire clay is exposed, then limestone. Little over a kilometer from the above named village, a tongue of basalt coming from the NW toward SE and seen ends. Arriving at Changponao[6] 2.3 kilometers from Lower Houkaitzu took some measurements. The boundary between basalt and limestone (562.2) north of Changponao.

Going from Changponao to Tienshengchiao[7] the road lies all in limestone. At Tienshengchiao a river comes out from underground to go N, then NE, joining up first with the river from Houkaitzu.

From Tienshengchiao eastward all in limestone with red residual clay or soil and some dwarf pine forest. Just beyond Hsiaohaitzu[8] red Triassic sandstone is thrown into contact with Middle Carboniferous limestone, forming the narrow end of a thrusted mass (Fig. 24). For about 800 m. wide, it is occupied by the sandstone which is again in contact with limestone which, further on, is mixed up with sandstone with various strike and dip. Then as we approach Tuchang

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打鎖坡 2 大松樹 3 河背冲 4 草花冲 5 水白鑛 6 敞坡瑙 7 天生橋 8 小海子

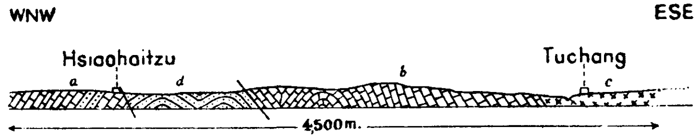

Fig. 24. Section at Hsiaohaitzu. a. White limestone with sandstone. b. Light grey limestone. c. Basalt. d. Red and green sandstone.

the limestone appeared to be crushed and sheared. On the other side of Tuchang, again outcrop of basalt.

At Tuchang, barometer 595.2, temperature 18°.2 at 7 p. m.

September 1, 1914

Tuchang to Wenko[1] *(Pls. 4:YMA4, 6:YMA6)*

At Tuchang, barometer 576.5, temperature 18°.2, at 8 a. m.

In order to study from Hsiaohaitzu N. E., we returned to that place and began to go for Tayakou[2] and Wenko.

The thrust fault is seen with great clearness. The boundary south of Hsiaohaitzu is at point 556.5, the limestone dips S, whilst the red sandstone dips also S. On the northeastern side of Hsiaohaitzu the limestone strikes 65° dipping 60°-80° N. This continues to Hsihsingtai[3] just southwest of which the rivers meet in a low basin and disappear. At point 575.1, northeast of Hsihsingtai limestone with sandstone bands dips 80° SE, but at 563.8, it is reversed. Then we went northward.

Near Hsihsingtai the white limestone yields the following fossils (W_3):

Productus (Buxtonia) scabriculus Martin
Enteletes cf. *lamarcki* Fischer

So the white limestone is Moscovian.

After that we come into the same limestone. Going over a pass (564.8), we came down to Shuipingtzu[4] (565.2). Going along the strike near the boundary (563.3) of limestone and the sandstone under it, we came to point 562.2 where sandstone forms the axis of an anticline (Fig. 25), dipping 80° on each side (NW and SE). Two kilometers and half further we are at Tayakou beyond which place limestone dips 70° N under basalt. At point *C'* (888.4), 1.8 kilometers northeast

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1 文閣 2 大𡶶口 3 西星歹 4 水坪子

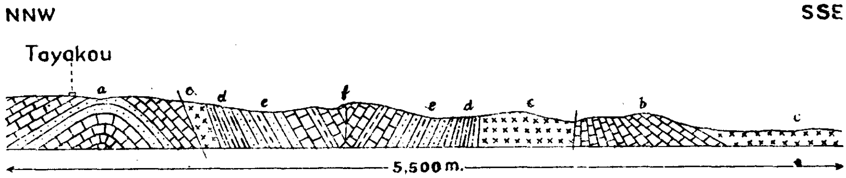

Fig. 25. Section S of Tayakou. a. White limestone with sandstone. b. Light grey limestone. c. Basalt. d. *Gigantopteris* coal series. e. Red and green sandstone. f. Impure limestone.

of Tayakou, fine view and measurements. The width of basalt is exactly one kilometer. Then we come to point 569.5 where *Gigantopteris* coal series dips 50° S under basalt: 550 m. further north red sandstone dips 85° W over coal series. At point 570, some 600 m. further north limestone series (the *Kotuho formation*) dips 70°-90° S: In the limestone we find a small ammonite (*Monophyllites*). The limestone series is two kilometers in width and at a point one kilometer south of Wenko red sandstone is seen; the dip is still S. So the whole is an iso-syncline. Descending into a deep valley to Wenko (bar. 591).

September 2, 1914

Wenko to Waluwa[1] *via Erhtaoyen*[2] *(Pls. 4:YMA4, 6:YMA6)*

At Wenko, barometer 592.2, temperature 15°.2 in the morning.

Going from Wenko NNW, we follow the deep river valley. Near Wenko a series of red and green sandstone replaces the limestone being no doubt the uppermost part of the *Kotuho formation* (Fig. 26). The dip is 60° SSE. The limestone is again interbedded with red and green shale and soft sandstone.

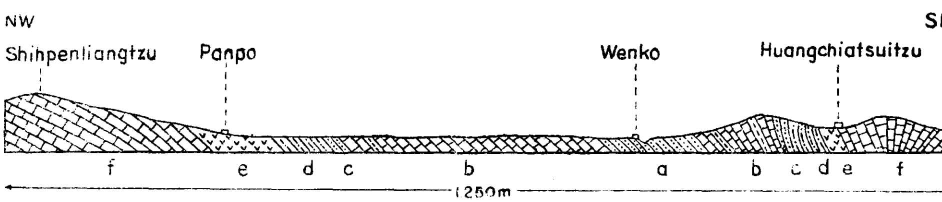

Fig. 26. Section at Wenko. a. Reddish sandstone. b. Impure limestone with shale. c. Red and green sandstone. d. *Gigantopteris* coal series. e. Basalt. f. Light grey limestone.

About 1.5 kilometer from point *a*, a deep cave in the limestone. (It is said to be 45 li long?). The limestone here becomes quite massive. There is a small

1 瓦路凹 2 二道岩

fault, then coarse red sandstone is interbedded with impure limestone. At 595.3 the lower red series is met with—thus the Triassic limestone outcrop here is some four kilometers wide! The red sandstone is succeeded by the *Gigantopteris* coal series, each having an outcrop of 400 m. wide dipping constantly SSE. The lower red sandstone contains copper. The basalt outcrops at the junction between the main river and the Chihnaho[1],—height 590. 1300 m. further northeast, after passing Panpo[2] contact between limestone and basalt is met with at 566.8—with the same strike and dip (70°). Just beyond is Machiahsiaoying[3], bar. 563.4, temp. 19°.9, at 11 a. m. Just west of point *a'* (544.7), coaly shale exposed *(Dinantian)*, striking NNE-SSW, dipping 30° SE.

Near pt. 556.3 fault, then basalt. 1200 m. further northeast, coal series outcrops, striking 10°, dipping E—the strike and dip varies greatly owing to fault condition. One kilometer further, basalt again, dipping under coal series. From Erhtaoyen descend in basalt vertical cliff to 596.4 near river. This is the Suonaho[4] valley going NNE to join main river. A kilometer north is the famous Spring[5] from which water comes out to empty itself into main river. The underground passage is certainly connected with the sink-hole[6] north of Santaoshui[7] near the boundary between basalt and the *Gigantopteris* coal series.

At Waluwa barometer 595.2, temperature 21.7 in the afternoon.

September 3, 1914

Waluwa to Wenko via Hsiamachang[8] *(Pls. 4 : YMA4, 6 : YMA6)*

At Waluwa, barometer 597.1, temperature 10° (!) at 5 a. m.

Going south we have coal series dipping 30° SSE. then covered by red sandstone of the same dip. About 2300 m from Waluwa, Triassic limestone with same strike and dip as the underlying sediments. Going southwest from Hsiamachang we see that the Triassic limestone turns to dip 40° E with all the underlying sediments (Fig. 27).

Eastwards however, we soon come to basalt just beyond the spring of Lungtan[9] (585.2) in abnormal contact with the Triassic limestone. 300 m. further east, Carboniferous limestone is sheared, striking NW-SE, dipping vertically.

1 池那河 2 半坡 3 馬家小營 4 梭那河 5 噴水洞 6 落水洞 7 三道水 8 下馬場
9 龍潭

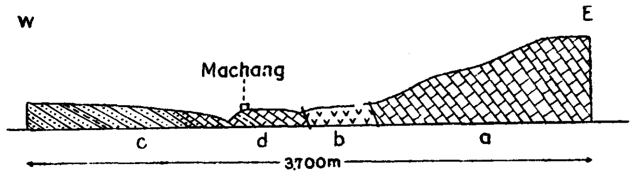

Fig. 27. Section at Machang. a. Light grey limestone. b. Basalt. c. Red and green sandstone and shale. d. Impure limestone. (Triassic).

This limestone continues to point 570.8 near Chihnaho, 4800 m. from Hsiamachang then it is covered by basalt. Following the river down to the temple, about five kilometers ENE from Chihnaho, we come to the *Gigantopteris* coal series meeting the river from Wenko which we traversed the previous day on the way to Waluwa. At Wenko, bar. 590.3.

September 4, 1914

Wenko to Tzuying[1] *(Pls. 4:YMA4, 6:YMA6)*

At Wenko, barometer 595, temperature 12°.2, at 8 a. m.

At first going northeast as far as Liuchiatsun[2] on the northern bank of the river, then I crossed the river to go southward. It is in the uppermost sandstone which strikes ENE, dipping 60° S. 600 m. south of the river the contact between the upper red sandstone and the Triassic limestone occurs just south of Shaka[3] where the dip is vertical. A little further the limestone dips 85° N. About a kilometer south following the river valley, the *Gigantopteris* coal series has an outcrop width of 350 m. dipping steeply SE apparently under basalt just north of Hotoushang[4]. 450 m. further, basalt in contact with the limestone just south of Yuehliangtien[5] (579.4).

Thus this is the eastern part of the isosyncline seen between Tayakou and Wenko.

Sketch was made from Tayakou southward, bar. 593.7, temp. 21°.2, at 2 p. m.

150 m. south of Tayakou sandstone exposed with various dip. 400 m. further, limestone at 558.9, striking 40°-50°, dipping 40° SE.

500 m. south of 559.8 thin strip of basalt. The *Gigantopteris* coal series, particularly thin, is seen below the red sandstone which is followed by the Triassic

1 紫營 2 劉家村 3 沙卡 4 河頭上 5 月亮田

limeseone—so this is the eastern extension of the broken syncline with overthrust line seen east of Hsiaohaitzu.

The limestone interbedded with yellow shale and soft red sandstone strikes 70°, dipping SSE, with a width of outcrop of 900 meters. Near the southern limit, it dips 70° N, followed by red sandstone, (566.9) coal series and basalt (566.3) all dipping 80°—NW.

At point *C'* limestone strikes 55°, dipping nearly 90° N. Here is another thrust plane.

The limestone outcrop is nearly a kilometer wide. At 574.7 it dips 30° SE, followed then by basalt which forms a band 1100 m. wide and is much altered. On the southwestern side it is again bound by limestone.

About six kilometers south of Tayakou we reached the main river, whence 3.5 kilometers southwestward we arrived at Tzuyingtatsun[1], bar. 576.4, temp. 19°.2, at 6 p. m. Tzuying used to be a well known mining centre for copper. The mines consisted of three localities: Hsiaochung[2], Houho[3], Paohochang[4] and Tzuying all in basalt near fault cliff of limestone. Only one shaft now exists—it was reopened in the time of C. Tang[5] by a man named Tung. The ore is either carbonate or sulphide. The shaft is deeply inclined going down towards the river side. It was full of water, therefore only 30 feet was accessable. The ore is of high persentage (50%) associated with calcite (?) veins. Native copper in small quantity also occurs near the limestone cliff of Kuanniuyen[6]. The mines were closed at the time of the Mohammedan revolution. Tung's effort to reopen the mine failed for want of circulation. He reached the tenth vein and there were eighteen veins.

The sinkhole at the time of my visis was partly blocked up, causing flood in the Chingshuitang[7] region. The once rich ricefield of Suonaho is converted into a waste. At Hsiaochenhsiung[8] in Fatsoho[9] a man Wu together with Li tried to work copper, but the quality of the ore was too low (1.5-2%). Hsiaofatso[10] and Lina[11] both give rise to good coal.

Rain every day since left Changchung to Wenko. The last 3 days have been fine.

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1 茨營大村 2 小冲 3 後河 4 寶和廠 5 唐炯 6 關牛岩 7 清水塘 8 小鎮雄 9 法座河 10 小法座 11 里那

September 5, 1914

Tzuying to Kuanniuyen and return (Pls. 4:YMA4, 6:YMA6)

Rain during the day.

At Tzuying, barometer 579.6, temperature 8°.2 in the morning.

Went to Changchingliangtzu[1] above Kuanniuyen to take measurements.

The section is roughly as shown (Fig. 28).

Fig. 28. Section near Kuanniuyen. a. Silicified limestone. b. Basalt.

The highest point is 535.6, in limestone.

Coming down, a second height, 1300 m. southwest from the first, is 545.8 and also in limestone; the silicified layer seemed to be below and to the west.

At Kuanniuyen (bar. 552), 1300 m. from 545.8, fault contact between basalt and limestone (Fig. 29). The fault is NW-SE, but further southeastward seems to turn N-S.

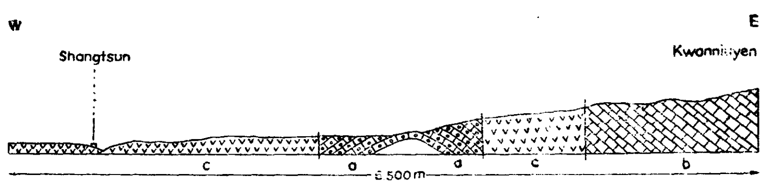

Fig. 29. Section at Kuanniuyen. a. Silicified limestone. b. Light grey limestone. c. Basalt.

At 562.2, 1200 m. west of Kuanniuyen silicified limestone in contact with basalt. The former has an outcrop width of 1400 m., then we are in basalt again (strike 70°). Whether the contact is a fault or due merely to unconformity, it is difficult to determine. Coming down westward we reached Hsiatsun[2] where we rested, but the people Tung was unfriendly, refusing to give us maize. One woman and two girls were frightened. Bar. 576.4, temp. 17°.4, at 3 p. m.

Went from Hsiatsun westward to Shangtsun[3], west of which were fault material (saw silicified limestone showing thinness of basalt). Several abandoned copper mines west of Shangtsun. Then northward to Chiuying[4], fragment of *Gigantopteris* coal series is preserved just north between tthe village and the river

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1 長箐梁子 2 下村 3 上村 4 舊營

and seems to continue east (?) of Tatsun[1] The other side of stream is dotted with numerous villages. Two copper mines are noted west of Tatsun. At Tatsun, barometer 574.7, temperature 15°.4, at 9 p. m.

September 6, 1914

Tzuying to Paochiatsun[2] (Pls. 4:YMA4, 6:YMA6)

Rain in the forenoon.

At Tzuying, barometer 580, temperature 14° in the morning.

Sketch started from Shihpankou[3], going westward, we see at once that the basalt instead of extending further west suddenly disappeared and we are at once in limestone.

1100 m. from Shihpankou, the river disappears under the limestone at 679.5. A kilometer east we have the small hole of Kantung[4] where, on the inaccessible cliff at least 30 m. high, pockets of nitrate material have been worked by wooden scaffold. 800 m. northeast of Kantung the river comes out again. This is the Tienshengchiao[5].

Following the river down for nearly two kilometers north basalt is met with, the silicified limestone dips 60° NW and there are some fault material far above the river.

The basalt forms a narrow band between the limestone and the river. Going along the left bank of the river, we come soon onto coal series in which the river flows. 2.5 kilometers down we crossed the river opposite Pailicho[6] (587.2) just where it turns northward. Height of bridge 590. West of Pailicho, coal series strikes 60°, dipping 70° NW.

Going up the side valley from northeast, we are in coal series which lies between basalt and red sandstone striking regularly NE-SW, dipping steeply 60°-90° NW for 3.5 kilometers, passing the villages of Tachai[7] and Hsiaochai[8]. After Hsiaochai it turns to strike W-E and is intensely compressed, with zigzag changes of strike, and to the north it is thrusted against Carboniferous limestone. The contact is just south of Ashuching[9] with very clear evidence of thrust and fault material. The limestone strikes NW-SE, dipping 50° N. E.

After passing over the cols 558.5 and 561 we begin to descend to the Tsichia[10] valley (Fig. 30). The limestone at first dips more gently (20-30° SW, then NE), then the strike varies greatly, and dip became vertical. It is again probably a

---

1 大村 2 包家村 3 石板溝 4 乾洞 5 天生橋 6 拍果箐 7 大寨 8 小寨 9 阿樹箐 10 七甲槽子

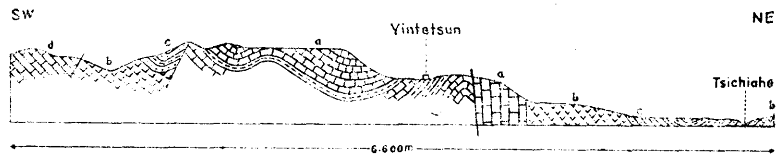

Fig. 30. Section across Tsichiaho. a. Black limestone interbedded with shale. b. Basalt. c. *Gigantopteris* coal series. d. Light grey limestone.

fault cliff. The road is rather difficult until we come to basalt at 592, about 1300 m. east of Yintetsun[1]. Descending further at 603, coal series which occupies the bottom of the valley (607).

Turning SSE, 800 m. further we come to Paochiatsun. Barometer 606.6, temperature 20°.9 at 6 p. m.

September 7, 1914

Paochiatsun to Laochangliangtzu[2] and return

At Paochiatsun (Chichia), barometer 608.7, temperature 13°.4 in the morning.

From Paochiatsun going southeast following the river down, the road lies in the coal series which strikes NW-SE, dipping 50° SW (Fig 31). Two kilometers from Paochiatsun we come to Chunako[3] at which place the coal series strikes ENE, dipping 70° SSE. North of Chunako is the N-S mountain called Matsichia-

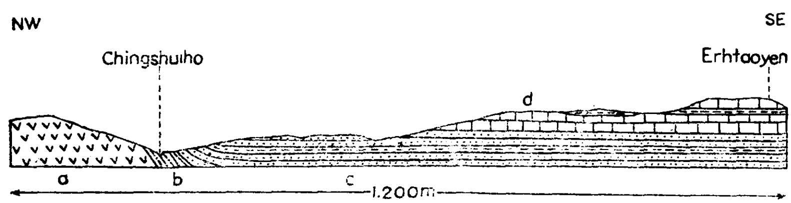

Fig. 31. Section across Chingshuiho. a. Basalt. b. *Gigantopteris* coal series. c. Red and green sandstone and shale. d. Limestone with green shale.

liangtzu[4] consisting entirely of basalt. The coal series forms a bend round its southern end. 900 m. southeast of Chunaho after passing Toka[5] where the coal series strikes NNE-SSW, dipping 70° E under the red sandstone, we come to the crossing of the main river (612). Beyond we begin to ascend the red sandstone hill. At first it dips 70° NNE, but soon the dip became gentle (10°). Going up a E-W ridge between two tributaries of the main river Chingshuiho[6] and Tochang-chiang[7] 3.8 kilometer from the bridge, we come to the village of Yikoying[8] (a few

1 尹德村 2 老廠梁子 3 矬那格 4 馬七甲梁子 5 多戛 6 清水河 7 拖長江 8 以可營

houses) bar. 574.4, temp. 20° at 12. 2.5 kilometers further east, wt arrive at a high point, Laochangliangtzu (555.0) from which measurements were taken.

It is seen that from Laochangliangtzu south and northwest all consists of Triassic limestone. From Laochangliangtzu north for 1.6 kilometer is the pass Lopanyako[1] (570.2).

Copper as usual is found in the red sandstone.

Back to Paochiatsun. My host is W. N. Pao[2], son of Y. C. Pao[3], a general of the Mahammedan war. His fifth brother is said to have just murdered the fiancé of a girl.

September 8, 1914

Paochiatsun to Peiyintien[4] (*Pls. 4:YMA4, 6:YMA6*)

At Paochiatsun, barometer 608.2, temperature 14°.2 in the morning.

Went up the hill between Tsichia valley and Chingshuiho to Tsichialiangtzu[5]. The road lies all the way in basalt. At the highest point (bar. 566.2) northeast of Paochiatsun a series of measurements was taken.

Going northwest from Tsichialiangtzu for three kilometers, at 586.4, a narrow band of *Gigantopteris* coal series is exposed in the middle of basalt. It strikes nearly N-S dipping 70° W. This is the northern end of the coal series outcrop from Paochiatsun. Then we soon pass from basalt into Carboniferous limestone at about 576.2. The sandy silicified? layers of the latter dips 30° near Mamuko[6] (572.3).

Then the black limestone is exposed south of Chiaoshuitsun[7] dipping 30° NE. changing to 80° WNW.

From point 549.3, some 450 m. west of Chiaoshuitsun a few measurements were taken. 700 m. north, the black limestone strikes 55°, dipping 85° SE. 300 m. furthtr the sandy limestone over it reverses the dip to NW. 1200 m. northwestward basalt is seen. At 566.6, about 1.5 kilometer north, *Gigantopteris* coal series. This continues all the way from through kengtiying[8] to Peiyintien—4 km. along the strike which is NE-SW, dipping NW.

At Peiyintien, bar. 578.1. Stayed at Sun's[9] house. The old man was very kind and persuaded me to stay one day in his house which I did on the 9th of September.

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1 羅板埡口 2 包惟年 3 包友菊 4 背陰田 5 七甲梁子或鐵麥梁子 6 馬木柯 7 交水村 8 耿地營 9 孫志魁

September 10, 1914

Peiyintien to Paoshan[1] *(Pls. 4:YMA4, 6:YMA6)*

At Paoshan, barometer 589.2, temperature 15°.5 in the morning.

From Peiyintien northward through Wutien[2] to Lungtaitsun[3] (580.1), the road for four kilometers lies in the coal series which forms a tongue in the basalt ending just north of Lungtaitsun. North of Peiyintien it strikes NE-SW, dipping 10° NW. At Wutien it dips 40° SSE. North of Lungtaitsun near the contact with basalt, it strikes N-S, dipping a few degrees towards basalt (Fig. 32).

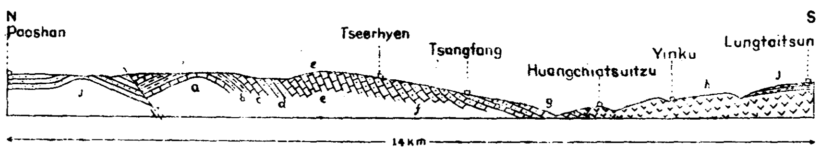

Fig. 32. Section across Kohsiangho near Ssulicho. a. Black limestone. b. Black shale. c. Black limestone. d. White quartzitic sandstone. e. Dark grey limestone. f. Silicified limestone. g. Reddish limestone. h. Basalt. i. *Gigantopteris* coal series.

Basalt extends northward for four kilometers through Pingti[4], Haitaoni[5], Yinku[6] to north of Huangchiatzuitzu[7] where the limestone is seen occupying the deep valley of the river Kohsiangho[8]. Short Storm. Then we crossed the river east of Ssulicho (616). The width of river is only 8 m. Reddish limestone hill. The limestone is silicified, underlaid by black limestone.

Arriving at Tsangfang[9] (591.7), 1.5 from river,—news item—a man, Lung[10], killing seven Cantonese. A pretty girl selling cakes by road side. Near Tseerhyen[11], limestone vertical. 1.2 kilometers north, Tseerhyen (565), 565 silicified limestone ends and limestone dips 70° SSE, soon became vertical. This contains nautiloid-like fossils—unable to extract it. This is followed by a sandy band, then lower black limestone with yellow shale interbedded. At first, all dip S., tht black limestone about 70°, but 4.5 kilometers from Tseerhyen, it strikes WSW-ENE, dipping 30° NNW and is immediately (564.7) followed by the *Gigantopteris* coal series (!), dipping 40° S.

One kilometer and half east is the dry lake of Hsiahaitzu[12], 800 m. north of contact, coal series dips 30° N.

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1 寶山 2 吳店 3 龍歹村 4 平地 5 海鳥泥 6 蔭姑 7 黃家嘴子 8 革香河 9 倉房 10 隴國梁 11 側耳岩 12 下海子

A kilometer further north we arrived at Paoshan still in the same coal series. Bar. 571.4, temp. 19°.3 at 6 p. m.

September 11, 1914

Paoshan to Lungchang[1] *(Pls. 4 : YMA4, 6 : YMA6)*

Going westward via Tematien[2] to Fangmaping[3]. Nearly four kilometers from Paoshan the coal series extends to 700 m. east of Fangmaping at 567. At first it dips 10° ESE, then horizontal but south of Tematien the dip is changed to 50° SSW, then horizontal. At the contact with basalt, it is 50° E. It is in this that a stream flows eastward to Hsiahaitzu. It is ruined. The basalt under the coal series is scarcely 400 m. wide, underlaid in turn by limestone largely covered by a red deposit (lake deposit?).

Fangmaping (572.5) on the edge of the basalt ridge. Then we come to a large basin of limestone with rich holes. The limestone dips first 10° E. Nearly three kilometers west of Fangmaping we come to Loshuitung[4] (sink-hole) a basin in which it is full of red soil; the limestone underneath dips 70° NW. 800 m. west, on the other side of the basin Kotihaitzu[5] (575.8), limestone dips 80° (?) NE with fault material. This extends via Kankou[6] (574.7), to Palo[7] (565.8) where the lake basin is ended.

1400 m. southwest from Palo the highest point is 562.8, where the sandy limestone dips 50° NNW. Then we descend an elongated basin and up again (slightly) with limestone dipping 10° WNW. 700 m. further west, we come to basalt. Valleys are again excavated in this basalt two kilometers west of the contact. A kilometer southeast of Tsuichiapo[8] small patch of coal series in basalt striking ENE-WSW, dipping NNW. At Tsuichiapo bar. 570.2. A kilometer further west limestone again till Lungchang (572.8).

In this region numerous conifers and wide oak (for silkworm). Rested at Palo. Kankou and Kotihaitzu are dry but may be flooded. Tahaitzu contains blue sheet of water going to Loshuitung via Kankou. At Lungchang stayed at Hsu's.

Coal sample from Tematien gives the following analysis:

H_2O	V.M.	Coke	Ash	S	H.V.
0.91	15.76	83.52	24.62	2.618	6270

1 龍場 2 得馬田 3 放馬坪 4 落水洞 5 革的海子 6 乾溝 7 扒樂 8 崔家坡

September 12, 1914

Lungchang to Hsuanwei (*Pls. 4:YMA4, 6:YMA6*)

At Lungchang, barometer 576.9, temperature 11°.2, at 8 a. m.

Limestone extending from Lungchang far to the northeast and southwest. One kilometer and half south of Huatsiaochung[1] contact between limestone and basalt. Huatsiaochung lies on a rather narrow band of coal series. Before and after Tatun[2], red sandstone series. Then entered again into the coal series. Section NE of Chenchiawan[3] is shown below (Fig. 33). At Hsuanwei, heard of Japanese occupation of Tsingtao.

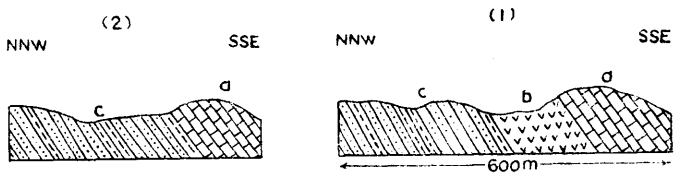

Fig. 33. Section NE of Chenchiawan. a. Carboniferous limestone. b. Basalt. c. *Gigantopteris* coal series.

September 13, 1914

Hsuanwei to Yunganpu[4] (*Pls. 4:YMA4, 6:YMA6*)

At Hsuanwei, barometer 577.2, temperature 12°.8 in the morning.

Started to make sketches from Hsiaokengtun which is in basalt continuing to Hungchiaopu where the road passes the mouth of a valley nearly two kilometers wide. On the other side we find limestone. The soil is yellow clay, but on approaching Kankou[5] 5.5 kilometers from Hungchiaopu, it turns red. At Kankou we come up on a low ridge of limestone which is continuous with the one seen north of Lungchingkou. Four kilometers further we are at Panchiao[6] (573.7) which forms also the boundary between limestone and basalt, but the former seems to dip away from the latter (Fig. 34). The basalt here forms only a very narrow band, 300 m. in width, and is soon seen to be apparently underlaid by the

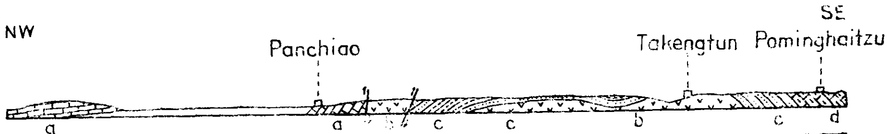

Fig. 34. Section at Panchiao. a. Limestone. b. Basalt. c. *Gigantopteris* coal series. d. Red sandstone (Triassic).

1 花椒冲 2 陳家灣 3 大屯 4 永安舖 5 乾溝 6 板橋

Gigantopteris coal series which at Hsiniutang[1] (569.3), 2.5 kilometers from Panchiao, is replaced by basalt again. It is then an isosyncline. In the basalt south of Hsiniutang, cobalt has been mined. This continues on to Yunganpu, nine kilometers south of Hsiniutang.

On the way to Yunganpu (3.5 kilometers north of it), a good view is obtained of the surrounding country near Yikuhaitzu[2] at Yunganpu, bar. 564.9?.

September 14, 1914

Yunganpu to Sungchakuan[3] *(Pls. 4 : YMA4, 6 : YMA6)*

Left Yunganpu, barometer 564.9, temperature 8°.2 in the morning.

From Yunganpu south some 7.5 kilometers [at] Yenfang[4], we are in a river valley leading to Yikuhaitzu. On the east is limestone dipping 10° E; on the west, sandstone. The valley itself is covered with a red soil—lake deposit (?).

At Yenfang (bar. 565.8) end of the lake basin. From Yenfang southwest at first we find black shale in silicified limestone underlaid by limestone which in turn is again underlaid by yellow quartzitic sandstone. Here again the country has "basin drainage"—One basin at Tangerhwan[5], three kilometers southwest of Yenfang and another northeast of Laiyuanpu[6] seven kilometers from Yenfang. At Laiyuanpu, bar. 567.4, temp. 23°.2.

After passing a low divide (561.2), a kilometer south of Laiyuanpu, we come to another NE-SW basin four kilometers long and a kilometer wide. Then the road passes again in a red sandstone with *Aviculopecten, Macrodon* and *Lima* (M_2).

Two kilometers further south we are at Sungchakuan where limestone overlies the fossiliferous sandstone. Bar. 565.8, temp. 23.2 at 8 p. m.

Numerous coolies returning from Kochiu in miserable condition, their trade being temporarily dislocated by the European War. A boy of 15 had a particularly pathetic story. Robbers at Mile[7] near Chuyuan[8] and Paishapo[9]. Crops damaged by drought and cold nights.

September 15, 1914

Sungchakuan to Sunglin[10] *(Pl. 4 : YMA4)*

Left Sungchakuan, barometer 566.3, temperature 10°.8, at 7 a. m.

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1 犀牛塘 2 以谷海子 3 松札關 4 烟房 5 唐兒灣 6 來遠舖 7 彌勒 8 竹園 9 白沙坡 10 松林

South of the village the limestone continues till to Kanhaitzu[1] whence it is replaced by basalt. Further southward, siliceous limestone. Near Sunglin, conglomerate and alluvial deposits. At Sunglin, bar. 575.1, temp. 17°.

September 16, 1914

Sunglin to Chutsing (Pls. 4:YMA4, 5:YMA5)

Left Sunglin, barometer 575, temperature 14°.3, at 9 a. m.

At Chutsing extreme kindness from many. According to local archives, Miaokaoshan[2] produces the *yen*[3], a kind of Chinese inkstand. I was told by Mr. Li[4] that there was discovered near Chukai[5] a tool  shaped, weighing 22 taels, six inches long by two to three inches wide and half an inch thick, with inscriptions[6] on its surface.

Fine weather all the time except last night. Arrive here on the birthday of the President.

XVI. CHUTSING—LOPING—PINGYI—CHANYI

(September 20—November 9).

September 20, 1914

Chutsing to Tsientsaopa[7] wih side trip to Miaokaoshan (Pl. 5:YMA5).

Left Chutsing, barometer 581.2, temperature 15°.5, at 7 a. m.

Section of Miaokaoshan from above downward:

- r_1 Alternation of yellow coarse sandstone and clay 100m
- r_2 Black slate with reddish concretionary limestone[8] containing fossils, chiefly gastropods.
- r_3 Yellow clay.

Cloudy all the day and rain in the morning. At Tsientsaopa, bar. 579, temp. 20°.3 at 6 p. m. Stayed in a school, kind reception.

September 21, 1914

Tsientsaopa to Hungtutsiang with side trip to east of Wenpishan[9] (Pl. 5:YMA5)

Left Tsientsaopa, barometer 582.8, temperature 16°.3 in the morning. Cloudy and dull.

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1 乾海子 2 妙高山 3 硯 4 李希賢 5 猪街 6 嘉熙元年馬銀 7 剪草壩 8 硯瓦石
9 文筆山

Nearly a kilometer southeast of the village, the limestone strikes 295°, dipping 30° NNE. It contains brachiopods and corals. Just east of Wenpishan, fossils same as those from Paopaochai are found. Limestone with red clay extends far in the east (Pl. 12 : YSD, Fig. 4).

In ascending from Hsiaokaitze[1] we have a red sandstone containing some fossils of gastropod and bivalves (as pebbles), at 579.9 yellow iron ore (clay) above which is a bed of blue clay, full of *Helix* (used as manure), above which is ore again.

Near Lungtanho[2] there is a series of kaolin above (?) which are seven seams of coal, the thickest being seven feet thick, the thinnest three feet, the former is uppermost. The coal is free from sulphur (specimen). Now they are worked only from February to April. Price about two cashes per catty (here $1 = 2000 cashes). On this side of Lungtanho it stops about four li further down, but on the other side it continues to Maomaoshih[3] where the kaolin is worked. Good coal near Haishangwa[4].

The Tertiary coal and variegated clay (red, blue, white and yellow) form an extensive undulating plain with low hills, so is the decalcified limestone with red soil. But as we approach Hungtutsiang[5] a limestone range came into view. Hungtutsiang with 30 families; Tertiary deposit and red soil very poor, without trees. Rain since Wenpishan. Tertiary clay very sticky and slippery. Rain stopped at Lungtanho. At Hungtutsiang, bar. 568.2, temp. 15°.4, at 9 p. m.

September 22, 1914

Hungtutsiang to Tumu[6] (Pl. 5 : YMA5)

Left Hungtutsiang, barometer 569.9, temperature 15°.6 in the morning. Cloudy and threatening. From Hungtutsiang to Chingkou[7] the limestone forms numerous outliers in the basalt. The map is greatly generalized. Arrived at Tumu early at 2 o'clock before my baggage, a rare occurrence. Bar. 572.2, temp. 19°.4 at 2 p. m.

September 23, 1914

Tumu to Sawutzu[8] (Pl. 5 : YMA5)

Left Tumu, barometer 575, temperature 14°.8 in the morning.

Hsintsun[9] is a center of iron pot industry. The ore is a true bog iron ore, about 30 per cent of iron. They work it from November to March with charcoal.

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1 小街子 2 龍潭河 3 毛毛市 4 海上窪 5 紅土墻 6 獨木 7 箐口 8 洒五子 9 新村

Good coking coal occurs here but I have been told that it cannot be used for metallurgy. Why? It is not clear. Wrought iron is also worked but pig iron is the chief product. $1 per 40 catties. Annual production, 20,000 catties. Three seams of coal, the lowest somewhat more than six feet, the other two, from two to three feet. Tumu belongs to Luliang[1], Hsintsun to Chanyi[2], and Sawutzu to Loping[3].

Arrived at Sawutzu, barometer 564.9, temperature 15°.8 at 1 p. m.

September 24, 1914

Sawutzu to Hsiamakai[4] *(Pl. 5 : YMA5)*

Left Sawutzu, bar. 565, temp. 14°.2 in the morning. Cloudy all day with occasional rain. Arrived at Hsiamakai, bar. 583.2, temp. 19° at 4 p. m.

September 25, 1914

Hsiamakai to Yangkaitzu[5] *(Pl. 5 : YMA5)*

Left Hsiamakai, bar. 586.2, temp. 16°.2 in the morning. Fog.

Tiehchang[6] is the center of wrought iron working (nail and horse-shoes). There are 20 furnaces and one furnace produces 2,000 catties per year; total products =40,000 catties per year. Tax $1 per furnace.

Taoyuan[7] is a center of pig iron product. Annual production about 840,000 catties, 40 furnaces 600 tan per year. 1 tan=35 catties 100 working days. Price of wrought iron=$0.05 per catty, annual value=$2,000.

Arrived at Yangkaitzu, bar. 576, temp. 15°.2, at 6 p. m.

September 26, 1914

Yangkaitzu to Loping (Pl. 5 : YMA5)

Left Yangkaitzu, bar. 576.3, temp. 14°.2 in the morning. Moist and rain.

Southeast of the village the limestone alternates with red and yellow clay and sandstone. The limestone is full of worm castings. South of Huangnikou[8] the limestone is much purer and of whitish color. Further southward near Tawatzu[9] yellow clay and red sandstone. From Kanhotang[10] on, massive limestone.

Arrived Niukaitzu[11], bar. 608.1, temp. 19°.2, at 2 p. m.

1 陸良 2 霑益 3 羅平 4 下馬街 5 羊街子 6 鐵廠 7 桃園 8 黃泥溝 9 大凹子
10 乾河塘 11 牛街子

September 27-28, 1914

Stayed at Loping

September 29, 1914

Loping to Ayeh[1] *(Pl. 5 : YMA5)*

At Loping, barometer 614.9, temperature 14°.2 at 8 a. m.

Went up Pailashan[2] pass (578.8), very steep and difficult in Triassic limestone. Fine rice field in the valley of Hsichiuho[3] river. Rain and fog. Climate of Loping and Tsaopaihaitzu[4] better than the adjoining region owing to high mountain. Peculiar to whole region is that in winter and autumn, north wind generally wet, south wind dry; the state of affairs is reversed in spring and summer.

Arrived at Ayeh, bar. 611.4, temp. 16°.2 at 9 p. m.

September 30, 1914

Ayeh to Shuchi[5] *(Pl. 5 : YMA5)*

At Ayeh, barometer 611.8, temperature 14°.2, at 8 a. m.

A hard day and difficult road. Passed Tsipailou[6]. At Shuchi, bar. 586.2, temp. 14°.8, at 7 p. m. Stayed in the ancestral temple of the family Tou[7].

October 1, 1914

Shuchi to Maluchiao[8] *and back to Shuchi via Yila*[9].

At Shuchi, barometer 586.2, temperature 13° at 7 a. m. Dull without rain.

About 2.5 kilometers south of Shuchi, at Heitutang[10], ammonites are found in the black impure limestone, which is overlaid by yellow and grey shales to the left side of the road from Heitutang to Shanlung[11]. The fossiliferous limestone strikes 50°, dipping 80° SE, changing to 70° SE further south. From a point some 800 meters south of the fossil locality another limestone formation appears. This is extensively covered either by alluvium or by lacustrine deposits. Just south of Hsiatsun[12], red, yellow and green sandstone with variegated clay crop out from under (?) the limestone; it dips 40° ESE. North of Hsiatsun the limestone dips invariably to the northeast more or less steeply. River at Yila, bar. 585.2.

Back at Shuchi, bar. 583.2, temp. 15°, at 6 p. m.

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1 阿耶 2 白臘山 3 喜舊河 4 草白海子 5 淑基 6 七牌樓 7 竇家祠堂 8 馬路橋 9 以拉 10 黑土塘 11 山龍 12 下村

October 2, 1914

Shuchi to Paikan[1] *and back to Shuchi* (*Pl. 5:YMA5*)

At Shuchi, barometer 584.4, temperature 13°.2 in the morning. Slightly cloudy.

Near Shuchi, yellow and red sandstone alternating with impure bands of limestone. A little further, limestone less pure with worm burrow. From Shuchi to Chungmen[2], the formation consists of six members of impure limestone (1_1-1_6) alternating with shales and sandstones. They have general strike ENE-WSW and dip to S. Normal succession from Chungmen to beyond Paikan. Below the sixth limestone layer southeast of Chungmen there are in descending order (1) red and yellow sandstone, dip SSE or SE, (2) finely banded limestone (1_7), dip 20° SSE, (3) red and dull green sandstone, dip SE changing to SSW, (4) limestone (1_8) with corals, crinoids and bivalves, (5) sandstone, (6) limestone (1_9), (7) yellow and red sandstone, (8) coal series on which is situated Paikan, (9) basalt (Tashe[3] on the basalt), (10) limestone of the Tsaopaihaitzu, great extension.

Cheapest coal—two cashes per 100 catties. Difficult to get workmen. Wage, five cashes per day with food. Three coal seams, the best is the middle, free from sulphur. The iron ore is in the Tsaopaihaitzu which is a definite element limited by Hengshan[4] (of Chutsing) and Lunghaishan[5] (of Luliang) mountain ranges and by the basalt mountain behind Tashe. The northwestern side is bound by mountains behind Maomaoshih[6] and Tachai. It is found below the soil on the surface or in the space of limestone. It is either a contact deposit or altered limestone pebbles, the latter is probable as was found always in spherical masses from less than an inch to half a foot in diameter. The lake deposit is loose and difficult to use mining timber. Depth to limestone more than 30 meters (?). Cobalt occurs in the basalt (specimen).

Back to Shuchi, bar. 582.6, temp. 18° at 6 p. m.

October 3, 1914

Shuchi to Talungtien[7] (*Pl. 5:YMA5*)

Left Shuchi, barometer 585.3, temperature 16°.2 in the morning. Cloudy.

Along the road from Shuchi to point *a*, east of Chuchi[8], limestone and alluvial deposits, with *a'* sandstone member 200-300 meters to the north of the

1 拍干 2 冲門 3 大舍 4 橫山 5 龍海山 6 毛毛石 7 大龍甸 8 竹基

road. At point *a* this member is encountered, striking 297°, dipping 70° N, soon changing to 50° NE. In ascending the stratigraphical succession further eastward, we have

Limestone, striking NW-SE, vertical
Narrow band of sandstone, same strike
Limestone, dipping 80° NE
Sandstone, dipping NNE. The village of Yichuang[1] is situated on its uppermost layers in contact of the overlying limestone.
Narrow band of limestone, east of Yichuang, dipping 60° WSW
Narrow band of sandstone
,, ,, ,, limestone, dipping 60° WSW.
,, ,, ,, sandstone
,, ,, ,, limestone, striking NNW, vertical.
,, ,, ,, sandstone
,, ,, ,, limestone
Sandstone, on which Hengchao[2] (40 families) is situated.

Near Pailashan, a kilometer and half east-northeast of Hengchao, nickel ore occurs as small crystals in the green coarse sandstone. Forty years ago many were mined owing to the belief that it was silver. Women had their fingers cut off when passing, white clothed, had their clothing off. Black dog was killed and blood spread. No result.

Coal occurs at Tatatzu[3] 25 li from Paichiatsun[4] (N?).

Near Hsiangshui[5] is a fine fall, with a drop of over 25 meters. The water is divided into several channels. Sianjentung[6] four li from here.

Arrived at Talungtien, bar. 596.2, temp. 19°.5 at 7 p. m.

October 4, 1914

Talungtien to Suka[7] (*Pl.* 5 : *YMA*5)

Left Talungtien, barometer 598.2, temperature 17°.2, at 8 a. m. Cloudy.

Talungtien on impure limestone, St. 345°, dip 10° W. East of the village, red and yellow sandstone nearly vertical, soon changing to dip 30° E. Then limestone with many worm burrows, St. 330°, dip NE. Further eastward, sandstone St. 7°, dip 60° E, changing to 40° SE. In approaching Yuehtaoshan[8], limestone dips SSE. Beyond the village, red sandstone dips 45° SSE, and two kilo-

1 以莊 2 亨召 3 大塔子 4 百家村 5 響水 6 仙人洞 7 素戛 8 月桃山

meters further it dips 40 SE. Then impure limestone dips 30° SE, and after this, red and yellow sandstone (Lushih[1] is situated on its prolongation) overlaid by another limestone dipping 70° SSE.

Arrived at Suka, bar. 592.1, temp. 15°.2 at 9 p. m.

October 5, 1914

Suka to Loping (Pl. 5:YMA5)

Left Suka, barometer 591.2, temperature 15°.1 at 8 a. m.

Near Suka, limestone St. 73, dip 80 S. Going eastward the following folded strata were observed:

1. Sandstone, dipping 60° NW
2. Limestone, dipping 70° NW, and conglomeratic limestone first dipping 60° NW, then more gently
3. Coarse light brown sandstone, covering the area east of Tawantzu[2] dipping 40° NW near that village, then vertical, and turning to SE beyond Yilung[3]
4. Limestone of Talopuka[4], dipping 70° and 40° NW (? =2)
5. Sandstone, dip NW
6. Limestone full of worm castings first St. 5°, dip 10° W, then St. 350°, dip 20° E.
7. Sandstone (? =5)
8. Limestone (? =4)

Arrived at Loping (Wumiao[5]), bar. 613.8, temp. 19° at 2 p. m.

October 6, 1914

Loping to Yite[6] (Pl. 5:YMA5)

At first, went to the river south of the city. At the bridge, barometer 613, temperature 16°.2. Outside of the city, limestone. From Liangmashan[7] a little over two kilometers northeast of the west gate, to Hsintsun[8], alternation of sandstone and limestone, forming an anticline. Then went northeast along the river, sandstone to the left and limestone at the right hand.

At Yite, bar. 613.5, temp. 17°.6, at 8 p. m.

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1 魯司 2 大灣子 3 以龍 4 大羅布卡 5 武廟 6 以得 7 凉馬山 8 新村

October 7, 1914

Yite to Yikung[1] *(Pl. 5:YMA5)*

Left Yite, barometer 614.2, temperature 14°.3. Terrible rain.

Northeast of Yite, the limestone dips SE. Near Lutuan[2] sandstone. Further north, limestone extending to Yikung. Arrived at Yikung, bar. 630.6, temp. 16°.8, at 2 p. m. Stopped at Wan's[3] fine house badly burnt last March, now only three newly built drawing rooms with marlstone.

October 8, 1914

Yikung to Kukangtai[4] *(Pl. 5:YMA5)*

Left Yikung, barometer 636.7, temperature 15°.2, at 8 a. m.

North of Yikung, brownish sandstone dips 30° NW. Half way between Yiwa[5] and Mutoching[6], northern boundary of sandstone. The underlying limestone strikes 75°, dipping 70° S. Beyond Mutoching, the limestone dips NW, upon which lies a yellow clay of the same dip. Then

A narrow band of limestone, dipping 65° NW

Clay, dipping 80° SE

Limestone, dipping ESE

Clay

Limestone, dipping 70° SE

Yellow sandy clay with *Myophoria radiata*

Limestone with worm castings

At Kukangtai, bar. 599.6, temp. 14°.2.

October 9, 1914

Kukangtai to Maokai[7] *(Laochang*[8]*)*

At Kukangtai, barometer 600.9, temperature 11°.6 at 7 a. m. Limestone with worm castings, St. 18, dip 34°E. Outside the village, yellow reddish and rarely violet sandstone. Then

---

1 以孔 2 魯團 3 萬獻延 4 苦岡歹 5 以凹 6 多木箐 7 猫街 8 老廠

Limestone, dipping 80° NW (overfold?)
Yellow clay with worm castings
Limestone
Limestone
Red and yellow sandstone, dipping SE
Sandstone with coal seam, vertical near Maokai.

There seems to be one seam. Three to four feet thick, in the brownish sandstone with black shining clay shale near the coal. Fossils are all badly preserved. The sandstone is greenish yellow when fresh but it is altered into brown by iron.

In the rubbish heap impure limestone is also seen.

At Laochang (Maokai), bar. 586, temp. 13°.9 at p. m.

October 10, 1914

Laochang (Maokai) to Lichiaying[1] (Ahung[2]) (Pl. 5:YMA5)

At Laochang, barometer 587.2, temperature 12° at 8 a. m.

At Laochang impure and fissile limestone with bivalves like spots. It dips 23° SE. Below is yellow clay. Then a narrow band of limestone full of worm castings, lying upon a red sandstone. Further north a band of very impure limestone, with a general dip to SE. From near Tashuitang[3] north the following section was observed:

1. Impure and black limestone with bivalves? 569.9.
2. Yellow and brown sandy clay, 571.5 (572.6).
3. Impure and black limestone 574.2.
4. Violet and yellow clayey sandstone, 578.8, 584.8.
5. Limestone, 591.6.
6. Red sandstone.

At Lichiaying, barometer 605.6, temperature 19° at 6 p. m.

October 11, 1914

Lichiaying (Ahung) to Pichechang[4] (Pl. 5:YMA5)

Left Lichiaying, barometer 606.6, temperature 18°.2 at 8 a. m.

200 meters north of the village, limestone conglomerate. A little further a coal mine has fallen down, with debris similar to those of Maokai. Grey clay

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1 李家營 2 阿紅 3 大水塘 4 畢浙廠

with *Myophoria* at point *A*. Going northward more or less along a fault line, coal series with clays of various colours and a few sandstone on road side. Limestone at right hand and to the east of the fault. The coal series has a general strike NNW-SSE to NW-SE, with local disturbance. Near Chichang[1], bivalves were found in the limestone dipping NW.

October 12, 1914

Went to Laochuntai[2] and back to Pichechang. Copper mines at Tishuiyen[3] and Laochuntai.

October 13-20, 1914

Stayed at Pichechang.

Metallurgy of zinc blende:

Oxidation three times in circular furnace, four feet and six inches in diameter; (1) 300 catties of coal, (2) 100 catties of coal at bottom is enough; (3) 1000 catties of coal all round the furnace and another layer in the middle between ore—because most of the sulphur has been burnt away.

Receiver made of ash. The coal used is terribly sulphurous.

1500 catties of ore[4] yields, after oxidation, 600 catties of roasted ore[5], 12 hours finish up. Required 2700 catties of coal and 400 to 500 catties of *black earth*[6].

The big lumps are ready directly for the pots; lead ore undifferentiated but found afterwards at the bottom of pots. Small bits are worked in a pond with a bamboo receiver, the heavier one quick to bottom, lighter ones are thrown away by hand. The washed ore is mixed with hand to oxidise.

October 21, 1914

Went to Hsinchang[7] and back to Pichechang. Left Pichechang, barometer 591.1, temperature 8.2° at 9 a. m. At first, coal series; then basalt. Along the main river is limestone. Some 300 meters east of the bridge the limestone is replaced by basalt. At point 594, about a kilometer southwest of Hsinchang, limestone reappears, but soon gives way to sandstone which strikes 300°, dipping 40° NE.

Went back to Pichechang, and restarted for Chikuanshan[8] where a fault, striking N by E-S by W is observed.

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1 鷄場 2 老君台 3 滴水岩 4 生鑛 5 熟鑛 6 黑土 7 新廠 8 鷄冠山

October 22, 1914

Stayed at Pichechang.

October 23, 1914

Pichechang to Mingchiatsun[1] *(Pl. 5:YMA5)*

At Pichechang, barometar 588.5, temperature 13°.2, at 8 a. m.

Near Yuanpaoshan[2] sandstone St. 45°, dip SE, above which is basalt. North-east of Toniu[3], limestone dipping 8° NE. Copper slags north of Toniu. Basalt occupies wide area south of Hsiashechai[4]. Beyond the latter village, perfectly horizontal limestone as inlier (?) in the basalt. Near the bridge, bedded basalt cliff. Some 500 m. north of the second bridge, the coal series begins to appear, St. 70°, dip 10° N. Pink and red sandstone south of Taika[5]. At Mingchiatsun, bar. 591.2, temp. 15°, at 9 p. m.

October 24, 1914

Mingchiatsun to Tukaitzu[6] *(Pl. 5:YMA5)*

Left Mingchiatsun, barometer 592.2, temperature 16°.2 at 9 a. m.

700 m. northward, red sandstone dipping 40° WSW. At point *a* and further north coal occurs. Then red sandstone, calcareous sandstone, orange and yellow clay (at Kaitzu[7]) very impure limestone (north of Kaitzu), coarse red sandstone with clay and purer limestone dip NNW at the southern bank of the river. North of Huasungshan[8], yellow clay dips 10° N. Near Tukaitzu limestone dips 20° NE.

West of the road the Tanaoshan[9] range is constituted by Carboniferous (?) limestone and between the range and here is the coal series.

At Tukaitzu, bar. 588.2, temp. 22°.8 in the afternoon.

October 25, 1914

Tukaitzu to Paimashan[10] *(Pls. 4:YMA4, 5:YMA5)*

At Tukaitzu, barometer 591, temperature 11°.6 at 8 a. m.

From Tukaitzu to Shangputzu[11], the following succession was observed:

1. Limestone with bivalves.
2. Yellow clay, dip 40° ESE.

---

1 明家村 2 元寶山 3 拖牛 4 下舍寨 5 歹戛 6 兎街子 7 街子 8 花松山 9 大腦山 10 白馬山 11 上舖子

3. Violet sandy clay, same dip.
4. Yellow clay and violet limy clay, same dip as bed 2.
5. Reddish limy clay, St. 345, dip 50 W. Western limb of the anticline.
6. Yellow clay, same dip as bed 5.
7. Red sandstone, same dip as bed 5, then St. 345°, dip 70° WSW.
8. Limestone begins from south of Changmingpu[1], dip 70° W near the village, reversed to dip ESE north of it.
9. At Hsinkaitzü[2], yellow clay, St. 320°, dip 30° SW.
10. Chocolate clay, St. 10°, dip 10° W and coarse red sandstone approximately same dip.
11. Limestone, St. 20°, dip 35° W.
12. Yellow sandy clay and coarse red sandstone, dip 60° E.
13. Coal series, St. 38°, dip 40° SE.
14. Basalt on which is situated Paimashan.

At Paimashan, bar. 551.8, temp. 13°.6, at 6.30 p. m.

October 26, 1914

Paimashan to Pingyi (Pl. 4:YMA4)

Left Paimashan, barometer 552.2, temperature 10°.8 at 8 a. m.

Went north, at first, basalt, then the following beds were observed: (1) limestone (2) basalt (3) limestone (of Lantienchuang[3]) of Carboniferous age. Arrived at Pingyi, bar. 583.2, temp. 19°.2 at 6 p. m.

October 27, 1914

Went to Chilinchang-houshan[4] and back to Pingyi.

From October 28 to November 1 and from the 3rd to the 5th of November we fail to find any written data except in the list of itinerary[5] where the daily stations are indicated under the corresponding dates. It is from this list and from the very incomplete geological map and some sections constructed after his return to Peking that these missing route sketches can be very inadequately traced.

October 28, 1914

Pingyi to Yaochan[6] via Yangweishao[7] (Pl. 4:YMA4). See Pl. 11:YSC, Fig. 3 and Fig. 4.

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1 張明舖 2 新街子 3 藍田莊 4 麒麟廠後山 5 This list contains numerous obvious errors not corrected by Dr. Ting. 6 腰站 7 楊威哨

October 29, 1914

Yaochan to Paishui[1] (Pl. 4:YMA4). See also Pl. 11:YSC, Fig. 3. Southwest of Tamaanshan[2] no data.

October 30, 1914

Paishui to Chanyi via Hsinpu[3] (Pl. 4:YMA4). See Pl. 12:YSD, Fig. 5.

October 31, 1914

Stayed at Chanyi

November 1, 1914

Chanyi to Haitzupu[4] (Pl. 4:YMA4)

The section from Hsintun[5] to Haitzupu (Pl. 12:YSD, Fig. 3) was surveyed under this date.

November 2, 1914

Haitzupu to Panchuang[6] via Hsiapo[7] (Pls. 4:YMA4, 5:YMA5)

Section west of Hsiapo from west to east (Pl. 11:YSC, Fig. 2):

1.	Yellowish red coarse sandstone	20 m.
2.	Black shale	2 m.
3.	Limestone with gastropods and brachiopods	10 m.
4.	Dark grey soft sandstone	?
5.	Yellow coarse sandstone	20 m.
6.	Black shale	2 m.
7.	White, hard, coarsely crystalline sandstone	30 m.
8.	Impure limestone with corals etc. (R_3)	2 m.
9.	Dark grey sandy shale (M_1)	5-8 m.
10.	Yellow, soft, micaceous sandstone	2 m.
11.	White hard sandstone	10 m.
12.	Yellow sandstone	10 m.

November 3, 1914

Panchuang to Ayi[8] (Pl. 5:YMA5)

November 4, 1914

Ayi to Kolangho[9] via Hamachai[10] (Pl. 5:YMA5)

1 白水 2 大馬鞍山 3 新舖 4 海子舖 5 新屯 6 半莊 7 下坡 8 阿以 9 格郎河 10 哈馬寨

November 5, 1914

Kolangho to Chukaitzu[1] *via Sanchia*[2] *and Tachingkou*[3] *(Pl. 5:YMA5).*

Section northwest of Sanchia in descending order (see Pl. 11:YSC, Fig. 1):
Limestone with nautiloids (Y_2)

1. Yellow quartzose sandstone, dip 60° E.
2. Dark grey sandstone, St. 15°, dip 40° E. .... 1 m.
3. Very impure coal .... 1 m.
4. Median grained quartzose sandstone .... 1 m.
5. Black to grey sandy limestone with fossils (R_2) .... 3 m.
6. Coal .... 2 m.
7. Black limestone .... 0.5 m.
8. Coal .... 1.5 m.
9. Median grained red sandstone St. 18°, dip. 25° E with Polyzoa (I_1) .... 6 m.
10. Coal with 2.375 meters partitions
11. Yellow shale
12. Limestone (section not clear, probably below) with fossils (Q_2) St. 40°-60°, dip 40° SE?
13. White, fine grained quartzose sandstone, dip 40° E
14. (Black shale) .... 4 m.
15. White quartzose sandstone .... 1 m.
16. Coal with thin clay partitions .... 0.5 m.
17. White quartzose sandstone .... 1 m.
18. Yellow soft sandstone
19. Purer?
20. White quartzose sandstone .... 6 m.
21. Dark grey, compact, median grained sandstone, St. 55°, dip 10° SE?
22. Limestone with gastropods (N_{12}) not well exposed

Top of anticline not well exposed.

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1 猪街子 2 三甲 3 大箐口

November 6, 1914

Chukaitzu to Chanyi (Pls. 4:YMA4, 5:YMA5)

Went at first to complete yesterday's section.

1. Quartzose sandstone, not well exposed (see yesterday)
2. Impure black sandy limestone with brachiopods (N_{13-15}) ...... 2 m.
3. Yellow clayey limestone with brachiopods (N_{16}) .... 3 m.
4. Brown clay shale .... 1 m.
5. Black scaly shale with thin limestone bands (N_{17}) .... 3 m.
6. Yellow, soft, coarse sandstone .... 0.5 m.
7. Blue hard limestone with corals, polyzoans and brachiopods (N_{18-30})
8. Yellow shaale .... 0.5 m.
9. Yellowish blue limestone with brachiopods (N_{31-35})
10. Coaly beds .... 5-9 m.

Masked

11. Same fossils as in 9, but, more clayey .... 3 m.

Path covered

12. Yellow and grey shale similar to 5 } (N_{36-38})
13. Blue limestone with interbedded shale }

(Repetition of upper series)

Repetition of beds 7-9

14. Blue limestone less fossiliferous
15. Purer blue limestone, *in situ*?
16. Impure black limestone similar to 7 with brain corals and gastropods (N_{39-44})
17. Shale with limestone nodules .... 1 m.
18. Same as above but more limy (N_{45-47})
19. Purer blue-black limestone with brain corals (N_{48-49}), *Favosites* horizon.
20. Shale alternating with thin bedded limestone to bottom.

November 7, 1914

Chanyi to east of Shihhuaying[1] and back to Chanyi

At Chanyi, barometer 582.1, temperature 10° at 8 a. m.
" " 581.3, " 11°.2 at 12.

Section at Shihhuaying from bottom up:

1. Grey to yellow shale
2. Yellow shale with thin limestone bands, horizontal, containing gastropods and *Orthoceras* ($C_3$1)
3. Grey to yellow limestone with brachiopods and gastropods ($C_3$6), St. 20°, dip 15° W.
4. Yellowish fine grained sandy limestone full of gastropods ($C_3$20 and $C_3$22), with alternating clayey bands.
5. Purer white limestone full of small brachiopods (f_3 4-5)
6. Yellow limestone with corals (f_3 1-3)

N. B. Beds 2-4 are equivalent of bed 13 in the next section.

Section at South Hill[2] from above down:

570.4

1. Limestone

570.9

2. Violet shale with bands of greenish limestone

571.2

3. Reddish yellow coarse sandstone

570.5?

4. Pinkish impure limestone

571

5. Multicoloured shale
6. Reddish limestone

571.3

7. Reddish, soft, coarse sandstone
8. Yellow shale

---

1 助花營 2 Situated to the ESE of a temple near Shihhuaying.

571.5

9. Yellow, soft, coarse sandstone

572.2

10. Dull red shale (2 m), limestone (0.2 m.), shale, limestone (0.2 m.) and sandy shale.

572.5

11. Limestone followed by two bands of shale and two of limestone (W_2 1-3, C_3 7-14)

573

12. Purer white limestone ($C_3$16-18), St. 95°, dip N

574.2

13. Yellow shale with two thin bands of limestone, St. 55°, dip 40° NW

578.6

14. Compact grey shale, yellow when decomposed, white when dry containing C_3 15 and C_3 19.

580.9 Base not seen.

On the North Hill (or Temple Hill) near Shihhuaying we have an anticline, so the bedded limestone is exposed below. Fossils (?) probably came there.

Back to Chanyi, bar. 580.4, temp. 11°.8 at 7 p. m.

November 8, 1914

Chanyi to Chiulungshan[1] *and back to Chanyi with a side trip to point Th, northeast of Lochiaotang*[2] *(Pl. 4 : YMA4)*

At Chanyi, barometer 581.4, temperature 11° at 8 a. m. Section from Chanyi to Hunshuitang[3], see Pl. 12 : YSD, Fig. 2. Section at Chiulungshan, see Fig. 35.

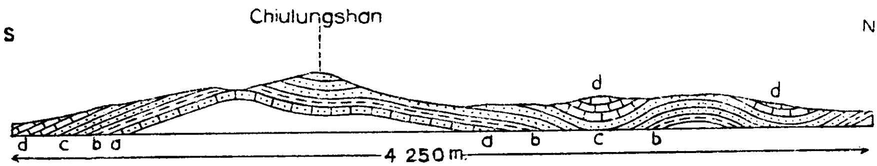

Fig. 35. Section at Chiulungshan. **a.** Silicified limestone. **b.** Black shale. c. White to red quartzitic sandstone. d. White limestone.

---

1 九龍山 2 落脚塘 3 混水塘

Section at the hill northeast of Lochiaotang (Pl. 12: YSD, Fig. 1) from above downward:

1. Limestone with Foraminifera, *Heliophyllum* and brachiopods (S_2)
2. White quartzose sandstone with *Lepidodendron*
3. Thin bands of fossiliferous limestone (X_2)
4. Coay shale

Back to Chanyi, bar. 579.6, temp. 14°.2 at 6 p. m.

November 9, 1914

Went west to Lunghuashan[1] and back to Chanyi.

Detailed section at Lunghuashan (St. 40°, dip 30° NW):

576.3

1. White, soft, coarse grained quartzose sandstone with *Lepidodendron* .... 12 m.

578.1

2. Yellow, green and red shale .... 4 m.
3. Greenish shaly limestone .... 0.3 m.
4. Shale .... 3 m.
5. Reddish limy sandstone .... 8 m.
6. Yellow coarse sandstone .... 3 m.
7. White pure limestone .... 1 m.

579.3

8. Yellowish shaly limestone passing into reddish sandstone, St. 60°, dip 35° NNW .... 5 m.
9. Greenish well-bedded sandstone .... 4 m.

579.9

580.2

10. Green and red shale .... 5 m.

580.9

1 龍華山

11. Green, fine-grained and thin bedded sandstone with *Arthrostigma* .... 3-4 m.

Ravine here goes 215 (?), 1.2 kilometer

12. Green and red shale .... 1 m.
13. Sandstone, bedding 3 mm. thick .... 0.2 m.
14. Shale .... 2 m.
15. Sandstone .... 0.3 m.
16. Shale .... 2 m.
17. Greenish sandstone with *Arthrostigma* .... 2 m.
18. Clayey sandstone .... 5 m.
19. Sandstone .... 0.5 m.
20. Shale .... 2 m.
21. Compact detritic sandstone, St. 40°-45°, dip 45° NW .... 0.3 m.

The whole series is about 60 meters thick.

XVII. CHANYI TO YUNNANFU (November 10—November 18).

November 10, 1914

Chanyi to Sancha[1] via Tienshengpa[2] and Hsinchiao[3] (Pls. 4:YMA4, 5:YMA5)

At Chanyi, barometer 580.1, temperature 11°.8 in the morning.

Section at Tienshengpa from NW to SE (Fig. 36):

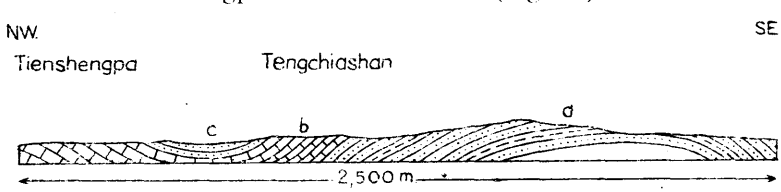

Fig. 36. Section at Tienshengpa. a. White and yellow quartzitic sandstone with grey sandy shale. b. Reddish white limestone. c. Yellowish sandstone.

580.2

1. White to green sandstone St. 40°, dip SE

---

1 三岔 2 天生壩 3 新橋

578.2

2. Sandstone (with coal?) containing badly preserved plants
   Second coal series?

579

3. Quartzose sandstone .... 3 m.
4. Gray sandy shale .... 2 m.
5. White quartzose sandstone with *Lepidodendron*

At Hsinchiao, bar. 579.6, temp. 18°.3, at 1 p. m.

November 11, 1914

Sancha to Yulungssu[1] via Tsuifengshan[2] (Pl. 5 : YMA5)

At Sancha, barometer 580.8, temperature 13° at 9 a. m.

Section at Tsuifengshan:

575.7

1. Reddish and greenish soft sandstone

575

2. Loose detritic sandstone with bands of limestone
3. Red and green sandstone to top of Tsuifengshan

Going down from the top the following detailed section (Pl. 11, YSC, Fig. 5) was made:

549.6

1. Greenish coarse sandstone with plants

550.2

2. Brown, very soft incoherent sandstone .... 5 m.
3. Green coarse sandstone .... 3 m.

550.8

This sandstone alternates with red loose sandstone, more or less micaceous, with *Arthrostigma*. Strike 40°, dip 35° NW.

554.9

4. Finer grained reddish sandstone
5. Yellow sandstone, coarse and soft

1 玉龍寺 2 翠峯山

555.2

6. Red fine-grained sandstone, more compact and somewhat limy

556.6

7. Greenish coarse sandstone, 3 m.
8. Loose, soft, reddish yellow sandstone

557.2

9. Very coarse green sandstone
10. Fine-grained red sandstone similar to bed 6

557.8

11. Reddish yellow coarse sandstone .... 1.5 m.
12. Fine-grained shaly sandstone
13. Bright yellow ferruginous shale (horizon of lake basin) ...... 1 m.

558.8

14. Brick red fine-grained sandstone, St. 75°, dip N

559.6

15. Yellow coarse sandstone .... 1 m.
16. Greenish hard crystalline sandstone

560

17. Dirty red, soft, fine-grained sandstone alternating with bands of red shale, becoming more and more calcareous downwards from 564.6, colour predominatingly red. Full of cystoids and brachiopods. Also fish remains.

566.6

568.5

18. Brown coarse sandstone .... 1 m.
19. Same as from 564.6 to 566.5 (at first dip NW, then dip SE)

571

20. Green and red calcareous shale with *Nucula* and *Modiomorpha* (dip. SE)

Arrived at Yulungssu, bar. 568.2, temp. 11° at 8 p. m.

November 12, 1914

Compass sketch from Yulungssu southwestward to hill *a*, then to point *b*, west of the temple. From *b* back to Yulungssu

Section at hill *a*:

560

1. Yellow green sandstone with *Lingula, Modiomorpha* and *Grammysia* (f_1-$_8$) .... 25 m.

557

2. Black clay shale containing minute bivalves and plants? .... 38 m.

559.2

3. Blue limestone bands interbedded with greyish green shale containing gastropods .... 80 m.

562

4. Grey shale, end of ravine. .... 65 m.

566.2

5. Yellow very fine-grained sandstone with *Palaeoneilo, Ptychopteria* and *Orthoceras* (C_1-$_7$ and g_3-$_5$) .... 10 m.
6. Black shale with limestone containing fossils .... 30 m.

November 13, 1914

At Yulungssu, barometer 569.7, temperature 6°.2 at 7 a. m.

From Yulungssu, to point 571.6, some 500 meters southwest of the temple, then to *a* (not *a* of 12th). From *a* to *b*, to *c* (Fig. 37), then to *d*[1], whence back to Yulungssu.

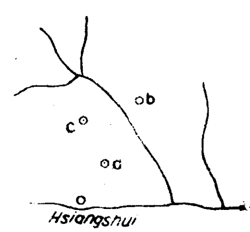

Fig. 37. Position of *a*, *b* and *c* near Hsiangshui

Section in connection with *b*: Variegated beds of Tsuifengshan 570.2

(A) 1. Green, very fine-grained sandstone .... 6 m.

570

2. Shaly limestone with brachiopods, etc. (M_9 and M_{10}), ... 1 m.

569.9

3. Green, yellow, and violet fine-grained sandstone decomposing into scales (M_{11}-$_{24}$) .... 47 m.

1. Point *d* is about 700 m. to the NNW of *a*.

571.7

(B) 1. Reddish yellow soft median-grained sandstone with harder bands alternating, with *Lungula, Nucula, Modiomorpha* and fish remains (M_{1-8} and j_4), St. 80° dip 30° NNW. .... 83 m.

574.8

2. Greenish sandstone alternating with black shale, each sandstone band about 0.2 m. thick. .... 22 m.

Section from *C'* to *d*

555.8

1. Sandstone ....19.5 m.

557.3

2. Black shale .... 64 m.

561.8

3. Thin bands of limestone with greyish green shale (i_{10} and i_{11}) .... 5 m.

562.2

4a. Limestone bands in grey shale and green sandstone with Polyzoa (i_{1-9})

4b. Green sandstone with calcareous lenticules with corals (j_{2-3}) .... a — b = 65 m.

567.2

5. Shaly limestone .... 10 m.

568

6. Red soft sandstone .... 8 m.

568.6

7. Limestone lenticules .... 13 m.

569.6

8. Thin beds of limestone alternating with shale containing gastropods (k_{1-33}) .... 11.7 m.

570.5

9. Red and green shale .... 2.6 m.

570.7

10. Limestone lenticules

11. Greenish shale

571

12. Limestone

571.5

13. Shale

571.8

14. Limestone

572 at point *d*

Back at Yulungssu, bar. 567.3, temp. 10°.2 at 7 p. m.

November 14, 1914

Yulungssu to Malungchou[1] via Heiniushan[2] (Pl. 5 : YMA5)

Section from Heiniushan to Malung, see Ting and Wang, 1937, p 8.

November 15, 1914

Malung to Yilung[3] (Pl. 5 : YMA5)

November 16, 1914

At Yilung

November 17, 1914

Yilung to Yanglin[4] (Pl. 5 : YMA5)

At Yilung, barometer 566.2, temperature 9°.2 in the morning.

Five li from Hsinkai[5] we found in a yellow sandy shale (bar. 575.2) *Obolus chinensis* Walc. and *Palaeolenus douvillei*? Mansuy (D_{1-19}). Two li further on we found in a greenish micaceous sandstone (bar. 577.8) specimens of *Redlichia* (A_{1-7}).

Much decomposed basalt from Tsaitzuyuan[6]. Small hill before Tashanshao[7] composed of basalt. Top of basalt hill, bar. 568, and near the bottom of the hill on the other side (bar. 568.9) limestone with Nautiloid? and *Schwagerina*. Relation with basalt not clear.

At Yanglin, bar. 574, temp. 13°.2, at 8 p. m.

---

1 馬龍州 2 黑牛山 3 易隆 4 楊林 5 新街 6 菜子園 7 大山哨

November 18, 1914

Yanglin to Yunnanfu

At Yanglin, barometer 574.9, temperature 8°.5 at 5 a. m.

Rocks exposed chiefly reddish sandstone much decomposed. Below is a rather impure limestone exposed here and there in small bits, but after Hunshuitang[1] it is clearly seen. About 16 li from Panchiao[2] we have a pure limestone exposed above the sandstone series. Two li west of Panchiao at 570 we have a range of hills composed of soft micaceous sandstone striking N-S, dipping 30° E. Here we found *Lingulella* possibly of Lower Ordovician age.

1 混水塘 2 板橋

XVIII. THE CHUTSING VALLEY AND ITS ADJACENT PLATEAU

By

V. K. Ting and Y. L. Wang

The area dealt with in the present paper falls into six natural region: 1. The Lake Basin of Yanglin, 2. The Yaolinshan Range, 3. The Malung Plateau, 4. The Chutsing Valley, 5. The Sunglin Plain and the Plateau beyond, 6. The Tungshan Plateau.

The Basin of Yanglin

The Basin of Yanglin is a nearly N-S depression 10-13 kilometers broad and 30 kilometers long the southern limit of which is just outside the map. In common with similar basins in Yunnan it was a lake formed in the Pliocene since which time the water surface has greatly shrunken. The present lake, Chialitse, is situated at the extreme SSE end, and occupies an area of about 10 kilometers—only about 1/200th part of the original lake. The floor of the basin is on the average 2,000 m. above the sea, and is covered with a red clay of lacustrine origin which forms a rich soil especially where irrigation is practised, hence the basin is well cultivated and thickly dotted with villages.

The Yaolinshan Range

This is a range 8 kilometers in width with its axis directed NNE-SSW, forming the eastern limit of the Yanglin basin. Its average height is about 2,400 m.—400 m. above the plain to the west. It is broken through by the head-waters of the Niulanchiang which drains the Chialitse lake into the Upper Yangtse. To the north of this transversal valley is the highest peak of the range, the Yaolinshan, which is 2650 m. above the sea level. Owing to the steep slope and nature of the rocks which consist largely of limestone and basalt, the soil is thin and poor, the whole belt is very sparsely inhabitated.

The Malung Plateau

East of the Yaolinshan Range is an area 55 kilometers from west to east forming a low plateau some 2,200 m. in height. Thus it is somewhat lower than the Yaolinshan Range from which it is separated by the valley of the Upper Niulanchiang which turns northward after it emerges from the transversal valley. Eastward several valleys running from the south towards the north except the Peishihchiang which flows eastward from the village of Mientien into the Chutsing valley. The watershed between the latter, which is the longest headwaters of the Chuchiang or Pearl River, and the Niulanchiang lies west of Malung district and is only some 150 m. above the valley floor on each side. All these streams have gentle slopes and shallow valleys cut in Cambrian, Silurian and lower Devonian strata which are largely of soft sandstone giving rise to a very poor soil and scattered cultivation. The city of Malung, the largest town in this region, contains only a few hundred houses.

The Chutsing Valley

The Chutsing valley is a N-S basin, averaging 6 kilometers in width and nearly 50 kilometers long of which only 41 kilometers lie within the map. From its extreme southern end (outside the map) it turns towards SSW extending beyond the city of Luliang. The total length of the whole basin is about 77 kilometers forming one of the important geographical features of eastern Yunnan. In the Chutsing region proper its maximum width reaches 8 kilometers and just north of Chutsing city it has a broad extension westward, 8 kilometers long and 3 kilometers wide, forming the lower reaches of the Peishihchiang. Twelve kilometers south of Chutsing it narrows down to about one kilometer for a distance of three kilometers. Then it broadens out again. Northeast of Yuehchow it has a N-S extension 14 kilometers long. Where it joins the main basin it is nearly 8 kilometers wide, but narrows gradually towards NNE. This is drained by two valleys, that of Kolangho and Haishangwa, and may be named the Kolangho-Haishangwa extension.

The main basin as well as the two side extensions are true rift valleys forming originally a large lake which is now on its way to extinction; deposit dating from the Pliocene must have covered the whole basin, but erosion has removed most of it in the main valley the floor of which is formed by recent alluvium, but in the two side extensions most of the original deposit remains. The whole basin is cultivated with extensive works of irrigation. A great number of villages cover the whole area which is one of the richest agricultural districts of the province.

The Sunglin Plain and the Plateau beyond

The Chutsing valley comes to an end just north of the city of Chanyi. Further north for a distance of 5 kilometers the Nanpanchiang, the headwater of the Chuchiang, which drains the Chutsing valley, has cut a small gorge on the narrow ridge of hills 150-200 above the plain. To the north of this ridge is the Sunglin Plain about 16 kilometers in area through which the Nanpanchiang flows towards the south. Beyond this plain is a plateau largely of limestone which serves to separate the Chutsing valley from that of Hsuanwei.

The Tungshan Plateau.

The Chutsing Basin is bordered on the east by a N-S range. As far as shown on the map it is 28 kilometers broad. Its northern end joins the plateau northeast of Sunglin, and in the south it containues to form the eastern border of the Chutsing valley as far as Luliang. This is locally known as the Tungshan which may be divided into two sections separated by a zone of N-S fracture. The west section situated between two sets of faults forms a true range the higher peaks of which are 2,550 m. above the sea level and 500 m. above the plain. On both sides the slope is deep. To the north it gradually merges into the plateau east of Sunglin, but its southern end is cut off by the Kolangho-Haishangwa extension of the Chutsing valley. The average width is about 10 kilometers but between the village Tachingkou and Sanchia it forms a waist-like construction about 6 kilometers wide which serves also as the easiest route across the range. Far the greater part of the range is formed by limestone. This combined with the steep slope makes it the least inhabitable section of the country.

The east section is some 18 kilometers broad and the higher points also reach 2,550 m., but the slope facing the fracture zone is less steep than that of the west section. The greater part consists of limestone giving rise to typical karstic scenery. Here and there where basalt or sandstone outcrops, surface drainage appears, giving rise to local variations of topography.

The fracture zone between the two sections described above begins with the Kolangho-Haishangwa extension. Northward the basin becomes narrower and narrower and finally disappears. Instead, three small separate longitudinal basins, that of Peishihai, Sanchia and Panchuang, form a discontinuous chain of low ground more or less orientated in N-S direction. North of Panchuang no fracture line is visible, but a valley runs from Hsiapo NE towards Peishui whence it turns eastward to Yaochan, forming an eaasy route connecting the district of Pingyi (beyond the map) with the cities to the west of the Tungshan. Both this zone of fracture and the east plateau are more inhabitated than the west section, although villages are generally confined to local basins and valleys.

XIX. LIST OF FOSSIL LOCALITIES.

1. Cambrian.

Label	*Locality*	*District*	*Horizon*	*Date*
E 1-35	Sapushan	Wuting	Lower Cambrian	May 4
H 1-13	Wulungtung	,,	,,	May 8
G 1-17	Yaoying	,,	,,	,,
F 1-18	Above Kuangluchiao	Tungchuan	,,	July 13
F 19-24	Further north near Hsiaoyakou	,,	,,	,,
C 1-4	Tsanglangpu	Malung	,,	Nov. 15
B 1-6	Near Yilung	,,	,,	Nov. 16
D 1-19	1.7 mile NE of Hsinkai	Sungming	,,	Nov. 17
A 1-7	One mile from Hsinkai	,,	,,	,,

2. Silurian and Devonian.

Label	*Locality*	*District*	*Date*
a 1-9	Miaokaoshan	Chutsing	Sept. 20
a 10	,,	,,	,,
R_3 1-3	At Point d E slope of Tungshan	,,	Nov. 2
M_4 1-2	,,	,,	,,
S_3 1-	Kuanniutung	,,	,,
S_3 2-3	,,	,,	,,
Q_2 1-6	Tungshan	,,	,,
R_2 1-5	,,	,,	,,
I_4 1	,,	,,	,,
N 1-8	,,		
N 9	,,	,,	,,
N 10	,,	,,	,,
N 11	,,	,,	,,
N 12	,,	,,	,,
N 13-15	,,	,,	Nov. 6

Label		*Locality*	*District*	*Date*
N	16	Tungshan	Chutsing	Nov. 6
N	17	,,	,,	,,
N	18-30	,,	,,	,,
N	31-35	,,	,,	,,
N	36-38	,,	,,	,,
N	39-44	,,	,,	,,
N	45-47	,,	,,	,,
N	48-49	,,	,,	,,
C_3,	1	Shihhuaying	Chanyi	Nov. 7
C_3,	16-18	,,	,,	,,
C_3,	15-19	,,	,,	,,
C_3,	6	,,	,,	,,
C_3,	7-14	,,	,,	,,
C_3,	20-23	,,	,,	,,
O	1- 3	Tsuifungshan	Chutsing	Nov. 11
O	4- 6	,,	,,	,,
b	1- 6	Between Hsiangshui and Mientien	,,	,,
b	7- 9	,,	,,	Nov. 12
b	10-19	,,	,,	,,
b	21-22	,,	,,	,,
C	1- 7	Hill "a" behind Yilungssu	,,	,,
g	3- 5	,,	,,	,,
d	1- 3	,,	,,	,,
g	1- 2	,,	,,	,,
f	1- 8	,,	,,	,,
e	1-13	Just above temple Yilungssu	,,	,,
j	4	Hill "c" near Yilungssu	Chutsing	Nov. 13

Label		*Locality*	*District*	*Date*
m	1- 8	Hill "c" near Yilungssu	Chutsing	Nov. 13
m	9-10	,,	,,	,,
m	11-24	,,	,,	,,
h	1- 9	Hill "c" near Yilungssu	,,	,,
i	1- 9	,,	,,	,,
i	10-11	,,	,,	,,
j	2- 3	,,	,,	,,
k	1-33	,,	,,	,,
l	1- 2	Point b' between Mientien & Hsiangshui	,,	Nov. 14
l	3	Point c' E of Hsiangshui	,,	,,
l	4-16	Point c'' W of Hsiangshui	,,	,,
l	17	Point e' W of Heiniushan	Malung	,,
l	18-21	Point d' W of Tahaishao	,,	,,
l	23-25	Point e E of Heiniushan	,,	,,

3. *Carboniferous and Permian.*

Label		*Locality*	*District*	*Date*
A1,	1-17	Kutsushan, N of Fuminhsien	Fumin	April 28
S1,	1- 5	Wanghsiangtai	Hueili	June 20
H1,	1-10	Taiyinchang	Tungchuan	June 24
M1,	1- 6	Kuniuchai	,,	July 11
N1,	1- 3	Laishihwo	,,	July 12
O1,	1- 3	,,	,,	,,
K1,	1- 6	Hsichiayuan	,,	July 14
J1,	1-10	Soloyi	,,	July 15
E1,	1- 7	Below Chienchang	,,	July 22
G1,	1-12	Yilulaoshan	,,	July 23
Q1,	1	Peichiatsun	,,	July 25
I1,	1- 3	Point C near Kungshan	,,	July 27
Z1,	1- 4	Tsienshanpo	Suanwei	Aug. 5

Label		*Locality*	*District*	*Date*
A2,	1- 4	Kuochang	Suanwei	Aug. 5
W1,	1-17	Feilaishih	Weining	Aug. 10
X1,	1- 8	Waitaoshan	,,	,,
Y1,	1-17	Shuishihtsao	,,	Aug. 11
B2,	1- 3	Hsiawuliping	,,	,,
T1,	1- 2	Hsiaonengho	,,	Aug. 12
V1,	1-11	Tishuiai	,,	,,
U1,	1- 3	Above Loku	,,	Aug. 13
C2,	1	Below Maomaochang	,,	Aug. 15
D2,	1-2, 4, 14-6	Erhmachung	,,	,,
D2,	3	Head water of Erhmachung near contact of diabase	,,	,,
D2,	6- 7	Near Shangerhmachung	,,	,,
D2,	8-13	Below Shangerhmachung	,,	,,
C4,	1- 2	Near Shenwang	,,	,,
C4,	1- 2	Between Erhmachung and Hunshuitang	,,	,,
G2,	1- 7	Kanyentang	,,	Aug. 16
M3,	1- 4	Beyond Tsekutsing	,,	,,
H2,	1-10	Hsinkuanting	,,	Aug. 17
D4,	1	Yangkuanshan	,,	,,
I2,	1- 7	Shihlipu	,,	Aug. 19
N4,	1			
J2,	1-10	Lutungchiao	,,	,,
Q3,	1- 5	Shuikouwan	,,	,,
U3,	1- 3	Above Tungshanssu	Hsuanwei	Aug. 27
J4,	1	Top of Tungshan Hill	,,	,,
Y3,	1- 2	Below Tungshan	,,	,,
W3,	1- 4	Sihsingte	,,	Aug. 31
F4,	1	Mushihkou	,,	Sept. 9
M2,	1- 8	Above Sungchakuan	,,	Sept. 14

Label		*Locality*	*District*	*Date*
K2,	1- 9	Wenpishan	Chutsing	Sept. 21
O2,	1- 6	Below Wenpishan	,,	,,
Z3,	1- 2	Point d near Pingyi	Pingyi	Sept. 25
B4,	1- 4	Near Yaochan	,,	Oct. 30
E2,	1- 7	Hsinpushan	Chanyi	Oct. 31
N2,	1- 6	Near Hsinpu	,,	,,
I3	1- 2	Between Hsinpu & Haichiashao	,,	,,
F2,	1- 4	Haichiashao	,,	,,
E4,	1- 4	Shaofang	,,	,,
I3,	1- 7	Hill near Sintun	,,	Nov. 1
P3,	1- 5			
V3,	1- 3	Above Lungwangmiao	,,	,,
B3,	1- 6	Near Haitsupu	,,	Nov. 2
H3,	1- 2	Above Hsiapo	Chutsing	,,
X3.	1- 3	Near Hsiapo	,,	,,
O3,		Shenhsientang	,,	,,
A4,	1- 2	,,	,,	,,
R3,	1- 3	At point d E slope of Tungshan	,, ,,	,, ,,
M4,	1- 2	,,	,,	,,
S3,	1	Kuanniutung	,,	,,
S3,	2- 3	,,	,,	,,
G4,	1- 2	Point f S of Peitsun	,,	Aug. 5
T3,	1- 3	Kuangshantou	,,	Nov. 3
Q2,	1- 6	Tungshan	,,	Nov. 5
R2,	1- 5	,,	,,	,,
Y2,	1- 4	,,	,,	,,
I4,	1	,,	,,	,,
L4,	1	Hungshihai	,,	,,
A3,	1- 3	Shihhuaying	Chanyi	Nov. 7
Q4,	1	,,	,,	,,

Label		*Locality*	*District*	*Date*
F4,	1- 3	Shihhuaying (Miaoshan)	Chanyi	Nov. 7
F4,	4- 5	,,	,,	,,
W2,	1- 3	,, (S. hill)	,,	,,
C3,	1	Shihhuaying	,,	,,
C3,	16-18	,,	,,	,,
C3,	2- 5	,,	,,	,,
C3,	15-19	,, (S. hill)	,,	,,
C3,	6	,,	,,	,,
C3,	7-14	,,	,,	,,
C3,	20-23	,,	,,	,,
C3,	3- 4	,, (N. hill)	,,	,,
U2,	1- 5	Kiulungshan	,,	Nov. 8
Z2,	1-15	,,	,,	,,
K3,	1- 2	Point c NE of Hunshuitang	,,	,,
S2,	1- 8	Hill NE of Lochotang	,,	Nov. 9
X2,	1-10	Above Lochotang	,,	,,
E3,	1- 3	Tailungtang behind Peshan	,,	,,
G3,	1- 2	Lunghuashan	,,	,,
T2,	1- 3	Tengchiashan	,,	Nov. 10
V2,	1- 6	Tienshengpa	,,	,,
J3,	1	Miaopo	,,	,,
D3,	1- 3	Heniushan	Malung	Nov. 14
L2,	1-11	Yilung	,,	Nov. 16
N3,	1-10	,,	,,	,,
P2,	1- 5	Near Taishanshao	Sunming	Nov. 17
H4,	1	1.3 mile E of Hsiapo	Kunming	Nov. 18
220		Hsinpu	,,	,,
220		,,	,,	,,

4. *Triassic.*

Number	*Locality*	*District*	*Date*
X, 1-6	Hsihchung near Tienhsin	Kochiu	March 1-2
XI, 1-2	Near Laokochiuchung	,,	March 5-13
XII, 1-3	Near Kochiu	,,	,,
XIII, 1-6	Near Niaoke	Ami	April 12
III, 1-2	Wukuliangtzu	Tungchuan	July 24-25
VI, 1-2	Yangchiaowan	Weining	Aug. 8
VIII, 1	Above Chintoupu	,,	,,
VII, 1	Above Wenko	Hsuanwei	Sept. 1
IV, 1-2	Huangnikong	Loping	Sept. 24-25
V, 1-16	Hetutang	,,	Oct. 1
IX, 1	Chutsingkou	,,	Oct. 2
I, 1-9	Near Kokongte	,,	Oct. 8
II, 1-8	Near Lichiaying	,,	Oct. 10

5. *Fossil-Plants.*

a. Devonian

Number	*Locality*	*District*	*Province*	*Date*
M 101-103	Hsintun	Chanyi	Yunnan	Nov. 1
N 104-106	Chiulungshan	,,	,,	Nov. 8
O 107-110	S_2A	,,	,,	,,
P 111-112	Lunghuashan	,,	,,	Nov. 9

b. Permo-Carboniferous

Number	*Locality*	*District*	*Province*	*Date*
C 13-36	Erhtaoching	Hsuanwei	Yunnan	July 25
D 37-47	,,	,,	,,	,,
E 48-50	Lungtankou	,,	,,	,,
F 51-65	Lutsaiping	,,	,,	Aug. 3
B 12	Nienfei	,,	,,	Aug. 6
A 1-11	Chienchiakou	,,	,,	Aug. 7
G 66	Tolo	,,	,,	,,
Q 113	Waitaoshan	Weining	Kueichou	Aug. 10

c. Rhaetic

Number	*Locality*	*District*	*Province*	*Date*
H 67-68	Tashihtou	Hueili	Sikang	June 2
I_1 69-75	Paikuowan	,,	,,	June 10
I_2 76-81	Tsengchiatung	,,	,,	,,
I_3 82-84	Low Pass near Paikuowan	,,	,,	June 11
K 88-93	Liushutang	,,	,,	June 12
J 85-87	Shihwopu	,,	,,	June 13

XX. LIST OF FOSSILS

(Arranged in the same order as the preceding list of fossil localities)

1. Cambrian[1]

E_{1-35}	*Obolus* sp. indet.
	Acrothele cf. *matthewi eryx* Walcott
	Acrothele orbicularis Mansuy
	Redlichia walcotti Mansuy
	Redlichia chinensis Walcott
	Palaeolenus douvillei Mansuy
H_{1-13}	*Acrotreta* sp. indet.
	Redlichia chinensis Walcott
G_{1-17}	*Acrothele matthewi eryx* Walcott
	Redlichia chinensis Walcott
F_{1-18}, $_{19-24}$	Plate of cystoid
	Lingulella (*Lingulepia*) *detritus* Mansuy
	Aluta sp.
	Bradoria douvillei Mansuy
	Redlichia chinensis Walcott
	Palaeolenus douvillei Mansuy
C_{1-4}, B_{1-6}	*Redlichia chinensis* Walcott
D_{1-19}	*Obolus* cf. *chinensis* Walcott
	Palaeolenus douvillei? Mansuy
A_{1-7}	Ostracoda?
	Redlichia chinensis Walcott

1. Probably identified by C. W. Walcott.

2. *Silurian and Devonian*

	Kirk's list	Grabau's list
a 1-9	*Chonetes* sp.	*Praecardium distans* Gr.
	Loxonema sp.	*Hormotoma kutsingensis* Gr.
	Leioptera sp.	*Dawsonoceras*? sp.
	Orthoceras sp.	*Ceratiocaris*? sp.
e 10	*Leperditia* sp.	
	Fish remains	Fish remains
R_3 1-3	*Cyathophyllum cf. quadrigeminum* Goldf.	
M_4 1-2	*Pleurotomaria* sp.	
	Paracyclas	
I_4 1	*Fenestella* cf. *compressa*	
	Rhombopora sp.	
R_2 1-5	*Composita* cf. *sulcatta*	*Composita subtilita*
	Productus cf. *lineatus*	*Composita subtilita sinensis*
	Rhipidomella sp.	*Composita globularis*
	Septopora cf. *subquadrans*	*Linoproductus tenuitriatus*
	Rhombopora sp.	*Schellwienella* sp.
		Schizophoria striatula (Schlotheim) var. *quadrangularis* Gr.
n 1-8	*Stringocephalus burtini* Defr.	*Stringocephalus obesus* Gr.
	Schizophoria macfarlani (Meek)	*Schizophoria excellens* Gr.
	Schizophoria striatula (Schlotheim)	*Crania obsoleta* Goldf.
a 9	*Cyathophyllum douvillei* Frech	
n 10	*Meristella* sp.	*Meristella kutsingensis* Gr.
		Meristella tumidioides Gr.
n 11	*Meristella* sp.	*Emanuella? plicata* Gr.
	Reticularia cf. *undifera* var. *takwanensis* Kayser	*Meristella kutsingensis* Gr.
		M. flayellii Mansuy
		M. tumidioides Gr.

	Kirk's list	Grabau's list
n 12	*Meristella* sp.	*Meristella kutsingensis* Gr.
	Reticularia cf. *undifera* var. *takwanensis* Kayser	*M. tungshanensis* Gr.
		M. tumidioides Gr.
	Atrypa reticularis (Linné)	*Plectospirifer takwanensis* (Kayser)
		Atrypa desquamata var. *auriculata* Hayasaka
		Rhipidomella kutsingensis Gr.
n 13-15	*Schizophoria striatula* (Schloth.)	*Schizophoria macfarlani* var. *kansuensis* Gr.
	Spirorbis sp.	
n 16	*Schizophoria striatula* (Schloth.)	*S. striatula* var. *quadrangularis* Gr.
n 17	*Aulopora* cf. *subcampanulata* Reed	
n 18-30	Sponge genus?	*Schizophoria excellens*
	Heterotrypa? sp.	*Schizophoria striatula* (Schlotheim) mut. *gamma* Gr.
	Pachypora sp.	*Atrypa aspera*
	Cyathophyllum caespitosum Goldf.	*Plectospirifer takwanensis* (Kayser)
	Cystiphyllum sp.	
	Heterophyllum sp.	
	Favosites sp.	
	Schizophoria striatula (Schlotheim)	
	Schizophoria macfarlani (Meek)	
	Atrypa reticularis (Linné)	
	Reticularia undifera var. *takwanensis* Kayser	
	Spirorbis sp.	
n 31-35	*Meristella* sp.	*Meristella tumidioides* Gr.
	Spirifer sp.	*Meristella flayellii* Mansuy

	Kirk's list	Grabau's list
	Atrypa reticularis (Linné)	*Meristella kutsingensis* Gr.
	Schizophoria striatula (Schloth.)	*Atrypa desquamata* var. *auriculata* Gr.
		Schizophoria macfarlani (Meek)
		Schizophoria excellens Gr.
n 36-38	*Meristella* sp.	*Meristella tumidioides* Gr.
	Schizophoria striatula (Schloth.)	*Meristella kutsingensis* Gr.
		Schizophoria striatula (Schlotheim) mut. *gamma* Gr.
n 39-44	*Cyathophyllum* sp.	*Meristella tungshanensis* Gr.
	G. caespitosum Goldf.	*Schizophoria macfarlani* (Meek) var. *kansuensis* Gr.
	Cystiphyllum sp.	*Sch. excellens* Gr.
	Schizophoria macfarlani (Meek)	
	Spirifer sp.	
n 45-47	*Cyathophyllum* sp.	
	C. caespitosum Goldf.	
	Favosites sp.	
	Schizophoria striatula (Schloth.)	
n 48-49	*Hederella?* sp.	*Schizophoria striatula* (Schlotheim) mut. *gamma*. Gr.
	Schizophoria striatula (Schloth.)	
C_3 1	*Leperditia* sp.	*Leperditia tingi* Gr.
C_3 16-18	*Leperditia sp.*	*Leperditia tingi* Gr.
C_3 15-19	*Leperditia* sp.	*Leperditia tingi* Gr.
		L. miaokaoensis Gr.
		L. subscalaris Gr.
		L. chanyiensis Gr.
C_3 6	Gastropod	

	Kirk's list	Grabau's list
C_3 7-14	*Cystina?* sp.	*Spirifer tingi* Gr.
	Leptodesma sp.	*Modiolopsis*?
	Modiomorpha sp.	*Poleumita chanyiensis* Gr.
	Polytropis sp.	*Hormotoma* sp.
	Loxonema sp.	
C_3 20-23	*Leptodesma* sp.	*Pterinea mientienensis* Gr.
	Leperditia sp.	
O 1-3	Fish remains	
O 4-6	*Modiomorpha* sp.	*Dalmanella?* sp.
	Mucula? sp.	*Mucula? kutsingensis* Gr.
b 1-6	*Spirifer* sp.	*Spirifer tingi* Gr.
	Ptychopteria sp.	*Actinopteria mansuyi* Gr.
	Avicula sp.	
b 7-9	*Spirifer* sp.	*Spirifer tingi* Gr.
	Ptychopteria sp.	*Actinopteria mansuyi* Gr.
b 10-19	*Spirifer* sp.	*Spirifer tingi* Gr.
	Rhynchonella cf. *yunnanensis* (de Kon.)	*Pterinea mientienensis* Gr.
	Actinopteria sp.	*Actinopteria mansuyi* Gr.
	Modiomorpha sp.	*Modiolopsis miaokaoensis* Gr.
	Praecardium sp.	*Praecardium distans* Gr.
	Glyptocardia? sp.	*Leperditia* sp.
b 21-22	*Schizophoria striatula* (Schloth.)	
	Spirifer sp.	
	Martinia inflatus var. *takwanensis* (Kayser)	
	Orthoceras sp.	
C 1-7 & g 3-5		
	Palaeoneila sp.	*Glimatichnites* sp.
	Ptychopteria sp.	*Cytherella mientienensis* Gr.
	Orthoceras sp.	*Edmondis? mientienensis* Gr.
		Cytherella? mientienensis Gr.

	Kirk's list	Grabau's list
d 1-3 & g 1-2	Indeterminable gastropods	*Ambonychia* (?) *kutsingensis* Gr.
		Holopea sp. 1
f 1-8	*Lingula* sp.	*Lingula cuneatiformis* Gr.
	Modiomorpha sp.	*Modiolopsis crypta* Gr.
	Crammysia sp.	
e 1-13	*Lingula* sp.	*Lingula* cf. *lounanensis* Mansuy
	Modiomorpha sp.	*Modiolopsis crypta* Gr.
	Palaeoneilo sp.	*M. mientienensis* Gr.
	Fish remains	*Cystograptus* sp.
	(same as a 10)	*Arthrophycus*? sp.
j 4 & m 1-8	*Lingula* sp.	*Climatichnites*? (j 4)
	Modiomorpha sp.	(m 1-8 not seen)
	Nucula sp.	
	Facoid	
	Fish remains	
m 9-10	*Leperditia* sp.	*Dalmanella* cf. *basalis* (Dalm.)
	Poorly preserved brachiopod.	
m 11-24	*Macrodon* sp.	
	Grammysia sp.	
	Modiomorpha sp.	
	Nucula sp.	
	Leperditia sp.	
h 1-9	*Reticularia undifera* var. *takwanensis* Kayser	*Spirifer bourgeoisi* Mansuy
		Spirifer sp.
	Martinia inflatus var. *takwanensis* (Kayser)	*Greenfieldia*? *yunnanensis* Gr.
	Spirifer cf. *aculeatus*	
i 1-9	*Favosites* 2 species	
	Orthoceras sp.	
	Worm trails	

	Kirk's list	Grabau's list
i 10-11	Crustacean	*Leperditia*?
		Ceratiocaris sp.
j 2-3	*Orthoceras*	
	Gastropod	
k 1-33	*Spirifer* sp.	*Spirifer tingi* Gr.
	Martinia inflatus var. *takwanensis* (Kayser)	*Cladopora kutsingensis* Gr.
	Loxonema sp.	*Actinopteria mansuyi* Gr.
	Praecardium sp.	*Leda yilungensis* Gr.
	Ptychopteria	*Praecardium distans* Gr. ...
		Hormotoma kutsingensis Gr.
		Holopea yilungensis Gr.
		Leperditia sp.
		Entomis (?) *corduroides* Gr.
l 1-2	*Martinia inflatus* var. *takwanensis* Kayser	
	Spirifer sp.	*Spirifer tingi* Gr.
l 3	*Spirifer* sp.	*Spirifer tingi* Gr.
	Reticularia cf. *curvata*	
	Martinia inflatus var. *takwanensis* Kayser	
	Rhynchonella cf. *yunnanensis* (de Kon.)	*Athyrisina plicata* Mansuy
	Schizophoria striatula (Schloth.)	
	Meristella sp.	
	Orthotetes sp.	
	Nucula	
l 4-16	*Martinia inflatus* var. *takwanensis* Kayser	*Camarotoechia* cf. *tonkinensis* (Mansuy)
	Rhynchonella cf. *yunnanensis* (de Kon.)	*Hormotoma kutsingensis* var. *major.* Gr.

	Kirk's list	Grabau's list
	Loxonema sp.	*Modiolopsis* sp.
	Nucula sp.	*Praecardium distans* Gr.
	Ptychopteria (2 spp.)	*Leperditia* cf. *tingi* Gr.
		L. sp.
1 17	*Martinia inflatus* var. *takwanensis* Kayser	*Spirifer tingi* Gr.
	Spirifer sp.	
1 18-21	*Lingula* sp.	*Orbiculoides sinensis* Mansuy
	Nucula sp.	
1 23-25	*Lingula* sp.	

3. *Permo-Carboniferous*[1]

A1, 1-17 Kutzushan—Chert limestone ———— Permian or Upper Carboniferous

Productus (*Striatifera*) cf. *compressus* Waagen
Productus sp.
Marginifera? sp.
Pseudophillipsia cf. *accuminata* Mansuy
Polypora cf. *koninckiana* Waag. & Wentzel

S1, 1-5 Wanghsiangtai—Sandy limestone ———— Middle Permian

Lyttonia sp.
Euomphalus sp.
Zaphrentis? sp.
Geinitzella crassa Lonsdale
Fragments of brachiopods
Schellwienia crassa Deprat
Sch. douvillei Colani

H1, 1-10 Taiyinchang—Dark limestone ———— Lower Permian

Martinia sp.
Zaphrentis? sp.
Geinitzella crassa Lonsdale

1. Foraminiferas identified by J. S. Lee, Syringoporas by Y. S. Chi and the remaining fossils by A. W. Grabau and Y. T. Chao.

Neofusulinella bocki Moller

M1, 1-6 Kuniuchai—Dark compact limestone ———Lower Permian
Bellerophon sp.
Fenestella sp.
Schellwienia granum-anenae Roem.

N1, 1-3 Laishihwo—Dark dense limestone ———Lower Permian
Fenestella sp.
Verbeekina douvillei Deprat

O1, 1-3 Laishihwo—White silicified limestone ——— ?
Euomphalus sp.

J1, 1-10 Soloyi
Fusulina sp.

E1, 1-7 Below Chienchang—Dark limestone ——— Permian
Geinitzella crassa Lonsdale
Fragment of coral

G1, 1-12 Yilulaoshan—Purple sandstone with *Schizodus* sp.
Dark limestone ——— Upper Carboniferous
Tetrapora elegantula Yabe & Hayasaka
Euomphalus sp.
Neoschwagerina globosa Yabe

G1, 1 Peichiatsun ——— Lower or Middle Permian
Doliolina lepida Schwager

I1 1-3 Point c near Kungshan—Grey limestone———Probably Moscovian
Lophophyllum sp.
Chaetetes subradians Mansuy

Z1, 1-4 Tsienshanpo—Reddish limestone ——— ?
Fragment of simple coral.

A2, 1-4 Kuochang—Light grey silicified limestone ——— Lower Permian
Lonsdaleia sp. nov.
Fusulinella (Neofusulinella) biconica Hayasaka

W1, 1-17 Feilaishih—White limestone —————— Probably Moscovian

Cyathophyllum sp. nov.
Geinitzella sp. nov.
Productus (*Striatifera*) *striatus* Fischer
Productus mytiloides Waagen
Dielasma sp.
Reticularia sp.
Athyris? sp.
Cleiothyridina? a
Cleiothyris cf. *indica*
Carnegia bassleri?
Bradyina nautiliformis Moller

X1, 1-8 Waitaoshan—White limestone —————— Moscovian

Dielasma sp.
Marginifera? sp.
Chonetes sp.
Productus scabriculus? Martin
Lonsdaleia voltzi Yabe and Hayasaka

Y1, 1-17 Shuishihtsao—White limestone —————— Moscovian

Spirifer mosquensis Fischer de Waldheim
Productus (*Striatifera*) *undatus* Defrance
Productus (*Linoproductus*) *simensis* Tschernyschew
Dielasma sp.
Spirifer bisulcatus var. *weiningensis* Grabau
Productus giganteus Martin
Productus cf. *undatus* Defrance
Productus lineatus Waagen
Chaetetes subradians Mansuy
Dibunophyllum weiningense Chi
Productus (*Striatifera*) *edelburgensis* Phillips
Bradyina nautiliformis Moller

B2,	1-3	Hsiawuliping—White limestone ——————	Moscovian
		Bradyina nautiliformis Moller	
T1,	1-2	Hsiaonengho—Dark limestone ——————	?
		Bellerophon sp.	
		Crinoidal stems	
V1,	1-11, 15	Tishuiai—White limestone ——————	Moscovian—Permian
		Productus (*Striatifera*) *undatus* Defrance	
		Productus (*Linoproductus*) *simensis* Tschernyschew	
		Productus sp.	
		Chonetes sp.	
		Enteletes sp.	
		Streptorhynchus? *tingi* Grabau	
		Verbeekina verbeeki (Geinitz)	
U1,	1-3	Above Loku—Dark limestone ————	Upper Carboniferous or Permian
		Euomphalus cf. *crotalostomus*	
		Euomphalus sp.	
C2,	1	Below Maomaochang—White limestone ———	Probably Moscovian
		Productus (*Striatifera*) *striatus* Fischer	
D2,	1-4, 6-16	Erhmachung—Dark limestone ——————	Dinantian
		Productus (*Striatifera*) *giganteus* Martin	
		Productus (*Striatifera*) *edelburgensis* Phillips	
		Dielasma sp.	
		Lithostrotion (*Siphonodendron*) sp. nov.	
		Koninckophyllum? sp. nov.	
		Cyathophyllum fraternum Reed	
		Syringopora weiningensis Chi	
		Syringopora geniculata Phillips	
		Diphyphyllum platiforme Yü	
C4,	1-2	Near Shenwang ——————	Lower Carboniferous
		Lonsdaleia sp.	

C4, 1-7 Between Erhmachung and Hunshuitang —White limestone — Moscovian
Productus (*Striatifera*)? *striatus* Fischer
Productus cf. *mytiloides* Waagen.

G2, 1-7 Kanyentang—Dark limestone — Dinantian
Productus (*Striatifera*) *striatus* Fischer
Koninckophyllum? sp. nov.
Lithostrotion (*Siphonodendron*) sp. nov.
Cyathophyllum sp.
Lonsdaleia sp.

M3, 1-4 Beyond Tsekutsing—White limestone — Moscovian
Productus (*Striatifera*) *striatus* Fischer
Productus cf. *mytiloides* Waagen
Reticularia cf. *indica*

H2, 1-10 Hsinkuanting— White silicified limestone — Probably Permian
Euomphalus sp.
Productus sp.
Meekella sp.

D4, 1 Yangwanshan—White limestone — Moscovian
Endophyllum? *chanyiensis*

I2, 1-7 Shihlipu—Dark limestone — Dinantian
Productus (*Striatifera*) *giganteus* Martin
Derbyia cf. *grandis* Waagen
Polypora sp.
Pinnatophyllum sp.

N4, 1 Shihlipu—Dark limestone — Dinantian
Productus (*Striatifera*) *giganteus* Martin

J2, 1-10 Lutungchiao—Dark shale — Permian
Cleiothyridina sp.
Griffithides obtusicaudata?
Phillipsia sp.

Oxydiscus sp.
Sinocladia sp.
Polypora sp.
Fenestella sp.

Q3, 1-5 Shuikouwan—Dark shale ——————————— ?
Pinnatophyllum sp.
Athyris? sp.

U3, 1-3 Above Tungshan—Dark limestone ———— Probably Dinantian
Syringopora reticulata Goldfuss
Syringopora geniculata Phillips

J4, 1 Top of Tungshan—White limestone ————— Moscovian
Campophyllum sp. nov.

W3, 1-4 Hsihsingte—White limestone ——————— Moscovian
Productus (Buxtonia) scabriculus Martin
Enteletes cf. *lamarcki* Fischer

M2, 1-8 Above Sungchakuan—Red sandstone —————?
Aviculopecten sp.
Macrodon sp.
Lima sp.

K2, 1-9 Wenpishan—White limestone ——————— Moscovian
Productus (Striatifera) striatus Fischer
Martinia planoconvexa Shumard

O2, 1-6 Below Wenpishan—Thin-bedded limestone ——— Permian
Marginifera cf. *ornata* Waagen
Productus (Linoproductus) lineatus Waagen
Polypora cf. *koninckiana* W. & W.
Polypora cf. *megastoma* W. & W.
Fenestella sp.

B4, 1-4. Near Yaotsan ———————————— Permian
Meristella sp.
Fusulinella sphaerica Abich

Fusulinella inflata? Colani

E2, 1-7 Hsinpushan—White limestone —————— Moscovian

Koninckophyllum trisectum Chi

Productus (Striatifera) striatus Fischer

Cleiothyridina trigonalis Gr.

C. giradiformis

Martiniopsis laokanchaiensis Grabau

Dielasma sp.

N2, 1-4 Haichiashao—White limestone —————— Permian

Cleiothyridina trigonalis Gr.

Cleiothyridina giradiformis

Lithostrotion irregulare var. *asiatica* Yabe & Hayasaka

F2, 1-4 Haichiashao—White limestone —————— Permian

Lonsdaleia sp.

Chaetetes subradians Mansuy

Bellerophon sp.

Fusulinella sp.

Sumatrina (annae?)

Doliolina lepida Schwager

Verbeekina verbeeki Geinitz

E4, 1-4 Shaofang—White limestone —————— Moscovian

Lonsdaleia obscura

Foraminiferan sands.

L3, 1-7 Hill near Hsintun—White limestone — Not lower than Moscovian

Martinia? sp.

Aviculopecten sp.

P3, 1-5 Hill near Hsintun—White limestone —— Probably Moscovian

Septopora cf. *subquadrans* Ulrich

Polypora sp.

Rhombopora sp.

Fenestella cf. *tenax* Ulrich

Strophalosia? sp.
Schuchertella sp.

B3, 1-6 Haitzupu—Thin-bedded earthy limestone ——— Permian
Marginifera sp.
Composita cf. *subtilita* Hall
Schellwienella? sp.
Polypora cf. *koninckiana* W. & W.
Septopora sp.
Fenestella sp.

H3, 1-2 Above Hsiapo ——— ?
Lophospira? sp.
Kloedinia sp.
Leperditia sp.
Beyrichia sp.

X3, 1-3 Near Hsiapo—White limestone ——— Moscovian-Permian
Lonsdaleia sp.
Streptorhynchus? *tingi* Grabau

O3, Shenhsientang ——— Moscovian
Dielasma sp.

R3, 1-3 At point d E slope of Tungshan—White limestone — Moscovian
Spirifer? *mosquensis* Fischer
Bellerophon sp.

M4, 1-2 At point d E slope of Tungshan ——— ?
Pleurotomaria sp.
Paracyclas

S3, 1-3 Kuanniutung—Reddish limestone ——— Probably Moscovian
Productus (*Striatifera*)? *striatus* Fischer

G4, 1-2 Point f S of Peitsun ——— Upper Carboniferous
Schellwienia cf. *centrelis*

Q2, 1-6 Tungshan—White limestone ——— Moscovian or lower
Syringopora intermixa Reed
Pinnatophyllum sp.

R2, 1-5 Tungshan—Dark shale ———Probably Dinantian
Rhipidomella? *michelini* (L'Evillé)

Composita cf. *subtilita* Hall
Productus (*Linoproductus*) *tenuistriatus* Verneuil
Schellwienella sp.

Y2, 1-4 Tungshan—White limestone ———————— Middle Permian
Corwenia chutsingensis Chi
Murchisonia sp.
Fusulinella inflata Colani

I4, 1 Tungshan—Thin-bedded limestone ———————— Permian
Septopora cf. *biserialis* Swallow
Rhombopora sp.
Fenestella sp.
Polypora sp.
Schellwienella? sp.
Crinoid stems.

14, 1 Hungshihai ———————————— Upper Carboniferous
Schellwienia solida Colani
Schellwienia cf. *japonica* Gumbel
Schellwienia valida var. *exigua* Lee

U2, 1-5 Kiulungshan ———————————— Upper Carboniferous
Schellwienia longissima Moller

Z2, 1-15 Kiulungshan ———————————————— Dinantian
Productus (Striatifera) giganteus Martin
Productus (Striatifera) groberi Krenkel
Productus sp.
Chonetes papilionaceus Phillips
Athyris royssii L'Evillé
Derbyia sp.
Coloceras? sp.
Cyathophyllum fraternum Reed
Dibunophyllum yunnanense Chi

K3, 1-2 Point c NE of Hunshuitang ———————— ?
Cyathophyllum sp.

S2, 1-8 Hill NE of Lochotang—White limestone —— Moscovian or higher
Pinnatophyllum sp.
Endophyllum sp. nov.

Stylidophyllum sp.
Schellwienia solida Colani
Schellwienia alpina Schel.
Schellwienia pseudo-prisca Colani
Boultonia sp.

X2, 1-10 Above Lochotang—Dark shale ——— Probably lower Permian or lower

Athyris royssii L'Evillé
Cladodus (Fish tooth)
Meristella? sp.
Schellwienella? sp.
Marginifera sp.
Fusulinella inflata Colani

T2, 1-7 Tengchiashan—Reddish limestone ——— Moscovian

Campophyllum cf. *vigilans* Reed
Lonsdaleia? *indica* W. & W.
Bellerophon sp.

V2, 1-6 Tienshengpa—White limestone ——— Moscovian

Chaetetes subradians Mansuy
Dibunophyllum yunnanense Chi
Lonsdaleia huangi Chi

220 Hsinpu—White limestone ——— Moscovian or lower

Cyathophyllum cf. *solitarium* Reed

4. *Triassic*[1].

X, 1-6 Hsihchung near Tienhsin, Kochiu district

Pelecypods.

XI, 1-2 Near Laokochiuchung, Kochiu district.

No determinable fossils.

XII, 1-3 Near Kochiu, Kochiu district.

Halobia? sp.

XIII, 1-16 Near Niaoke, Ami district.

Placunopsis? sp.
Myophoria sp. cf. *M. tennei* Dames.

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1. Identified by T. W. Stanton.

III,	1-2	Wukuliangtzu, Tungchuan district. *Pecten*? sp. c Crinoid stems.
VI,	1-2	Yangchiaowan, Weining district. *Pecten* sp.
VIII,	1	Above Chintoupu, Weining district. *Pecten*? sp.
VII,	1	Above Wenko, Hsuanwei district. *Monophyllites*? sp.
IV,	1-2	Huangnikong, Loping district. *Myophoria*? sp. cf. *M. radiata* Loczy *Anodontophora*? sp.
V,	1-16	Hetutang, Loping district. *Traumatocrinus* sp. *Trachyceras* sp.
IX,	1	Chütsingkou, Loping district. *Myophoria*? sp.
I.	1-9	Near Kukongte, Loping district. *Pecten* sp. a *Pecten* sp. b *Avicula*? sp. *Modiola*? sp. Ammonoid
II,	1-8	Near Lichiaying, Loping district. *Myophoria*? sp. cf. *M. radiata* Loczy *Anodontophora*? sp.

5. *Fossil-plants*[1]

a. Devonian

M	101-103	Hsintun	*Lepidodendron* sp. (*Bergeria*-stage)
N	104-106	Chiulungshan	*Lepidodendron* sp.
O	107-110	S_2A, Chanyi	*Lepidodendron* sp. cf. *L. veltheimi* sternb. or *L. roberti* Nath.
P	111-112	Lunghuashan	*Drepanophycus spinaeformis* Goepp.

1 Identified by T. G. Halle.

b. Permo-Carboniferous

C	13-36	Erhtaoching	*Taeniopteris abnormis* Gutbier.
			Taeniopteris sp.
			Pecopteris cf. *polymorpha* Brgn.
			Gigantopteris nicotianaefolia Schenk
D	37-47	Erhtaoching	*Ptychocarpus tingi* Halle
			Dictyophyllum sp.
E	48-50	Lungtankou	*Taeniopteris* sp.
F	51-65	Lutsaiping	*Annularia maxima* Schenk
			Pecopteris cf. *cyathea* (Schloth.) Brgn.
			Gigantopteris nicotianaefolia Schenk
B	12	Nienfei	*Sigillaria acutangula* Halle
A	1-11	Chienchiakou	*Annularia* sp.
G	66	Tolo	*Taeniopteris* sp.
Q	113	Waitaoshan	*Sphenophyllum* cf. *involutum* Ed. Bureau.

c. Rhaetic

H	67-68	Tashihtou	*Podozamites lanceolatus* (Lindl. & Hutt.)
			Cladophlebis sp.
I_1	69-75	Paikuowan	*Taeniopteris leclerei* Zeill.
			Ctenopteris sp.
I_1	76-81	Tsengchiatung	*Clathropteris meniscoides* Brgn.
			Cladophlebis cf. *nebensis* (Brgn.) Nath.
			Taeniopteris sp.
I_3	82-84	Low pass near Paikuowan	*Pterophyllum multilineatum* Shirley
K	88-93	Liushutung	*Samaropsis* sp.
J	85-87	Shihwopu	*Ctenopteris* cf. *serrani* Zeill.

XXI. MICROSCOPIC STUDY OF THE COPPER, LEAD, ZINC AND TIN ORES FROM YUNNAN AND SZECHUAN[1]

By

H. T. Lee

(With 4 Figures).

PART I. TECHNIQUE OF POLISHING AND EXAMINING THE SPECIMEN.

1. *Preparation of the specimen.*

No general rule can be formulated for the preparation of specimen, such as grinding and polishing. People who are interested in such kind of study may refer to the books, "Microscopic determination of the opaque minerals" by Murdoch, published by John Wiley & Sons, Jac., New York, U. S. A., and "Microscopic examination of ore minerals" by Davy-Farnham, published by Mc-Graw Hill Book Company, Inc., New York, U. S. A. As the methods described in these books may not be adequate for us, it is necessary to modify certain points which can not be carried out under different conditions. The following is a procedure used in the Mineralogical Laboratory of the Survey.

Choose a portion of specimen which can represent the important features and cut with a corundum saw. The size about $\frac{3}{4} \times \frac{3}{4} \times \frac{1}{2}$ in. is usually sufficient. The specimen is at first ground on iron plate with the coarse corundum sand, until all the irregularities are taken off. After a thorough washing of the hands and specimen the grinding is continued on glass plate with the fine corundum sand to have the coarse scratches removed, and at the same time the edges and corners are bevelled. Then the specimen is transfered to the canvas which is stretched on wooden wheel and the same kind of corundum sand is used. This grinding is taken about 15 minutes. The next grinding, after the washing of the specimen, is made on the fine linen which is also stretched on a wooden wheel. Rouge mixed with water is added to it. This grinding should be continued until the surface is smooth and shining, and all the visible scratches and pits are unseen by the naked eye. The time used in any stage of grinding must not be longer than it is necessary. One specimen may contain different kinds of minerals of different hardness. The soft mineral is removed much quicker than the hard ore, and an uneven surface is thus produced.

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1 The ores were collected by Dr. V. K. Ting in the Year 1914.

The specimen is much improved by a final polish on a metallurgical machine, run by a small motor. Magnesium oxide mixed with water is frequently added to it by a compressed air bottle. By this operation a surface free from scratches and troublesome relief is obtained, and can be satisfactorily studied under the microscope.

Time required for the whole process of making one specimen is about 1-2 hours. But it can be much shortened to 10-15 minutes, if every stage of grinding is made on machine.

2. *Examination of the specimen.*

The examination of the specimen is carried out in the dark room. The microscope used in this Laboratory is the ordinary Leitz microscope with a vertical illuminator attached. An arc lamp is taken as source of light. The light before entering the microscope is passed through a ground glass, placed closely to the microscope, in order to get diffused light which gives a better illumination. A Silverman Illuminator is frequently used to give a complementary result of the vertical one.

Several methods can be used in mounting of the specimen. It is either mounted by pressing horizontally into a lamp of modelling clay on a glass slide, or put into a copper tub, cemented together by sealing wax and plaster parts; or placed in a cylindrical cup, made of copper or hard paper and filled nearly to the top with coarse sand. Here the last method is employed, as it is the simplest one of the three. But this method does not answer very well for testing hardness. The cup is about 1 in. high and 1-2 in. in diameter. The specimen with the face upward is pressed down into the sand by glass slide, until the side of the cup comes in contact with the slide.

Two glass rods 3 in. long are prepared; the ore with platinum wire which is curled up at the end is used for chemical test, and the other with a steel needle is served for testing hardnes and streak. The following six reagents are prepared:

HNO_3	....	1:1
HCl	....	1:1
KCN	....	20% solution in water
$FeCl_3$	....	,, ,, ,, ,,
$HgCl_3$	....	Saturated solution in water
KOH	....	,, ,, ,, ,,

When examining the minerals under the microscope there are several things to be noted: (1) colour, varied with intensity of light and mineral association; (2) relative relief, some minerals, such as pyrite, show high relief; (3) shape and crystallized form; (4) pite, cleavage, and cracks; (5) toughness; (6) order of re-placement; (7) inclusions; (8) textures.

PART II. DESCRIPTION OF THE SPECIMENS.

No. 1 Hsinshan[1], Tungchuan[2], Yunnan (Fig. 38). Chalcopyrite, bornite, malachite, covellite & limonite.

Fig. 38. Copper ore of Hsinshan, Tungchuan, Yunnan. ×62. Chalcopyrite contains irregular masses of bornite and covellite which replaces bornite along the fracture. G. Gangue. C. Covellite. B. Bornite. Ch. Chalcopyrite.

Macro. It contains from the border to the center malachite, bornite and chalcopyrite. Small veins of bornite and malachite are both found in chalcopyrite. But the bornite also contains malachite veins. It is evidently the chalcopyrite which is first formed, then bornite, and then malachite which is last formed.

Micro. Under the microscope besides the above three minerals—chalcopyrite, yellow; bornite, pink; malachite, green—there are other two minerals—covellite, blue and limonite grey.

In chalcopyrite there are some veins and irregular masses of bornite. It is obviously the former that is replaced by the latter. But bornite is in turn replaced by covellite which is also found in chalcopyrite. In some place the chalcopyrite is totally replaced by bornite and in other place only residual chalcopyrite is left. When bornite and malachite occur in one place, the covellite is always toward the

1 新山 2 東川

former and the limonite toward the latter. As limonite and malachite are the last products of copper minerals, their position is always on the surface layer.

No. 2. Chenshuikou[1] near Maolu[2], Tungchuan, Yunnan.
Cuprite and malachite.

Macro: The malachite forms a border layer of cuprite with a thickness of 3-4 mm. But the thickness is not uniform in some parts it stretches into cuprite and, moreover, the inner part of cuprite is also traversed by small veins or particles of malachite.

Micro. Cuprite is greyish white with small particles of native copper. Malachite is greenish with banded structure. The native copper is derived from cuprite which by carbonation is changed to malachite.

No. 3. Wanchintung[3], Tungchuan, Yunnan.
Dolomite and chalcocite.

Macro. Ferruginous dolomite with irregular veins of chalcocite.

Micro. The chalcocite is bluish white and dolomite is grey. The chalcocite has the appearance of rhombic form replacing the dolomite along the fractures.

No. 4. Laohsinshan[4], Tashui[5], Tungchuan, Yunnan.
Bornite and malachite.

Macro. Bornite with malachite.

Micro. In the bornite there are numerous veinlets of covellite which is derived from the former. This specimen also contains some small particles of other minerals which are too small for identification.

No. 5. Wanchintung, Tungchuan, Yunnan.
Hematite and malachite.

Macro. The hematite forms pea-like grains distributed in the malachite. The whole mass is earthy and porous. It is evidently formed in the oxidized zone.

Micro. Malachite is green and hematite is greyish white. Their relation under the microscope is not distinct, and the iron ore may be derived from the alteration of some copper minerals which already disappeared.

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1 鎭水溝 2 茂麓 3 萬金洞 4 老新山 5 大水

No. 6. Kanlanping[1], Tungchuan, Yunnan.

Limonite and malachite in limestone.

Macro. It consists of layers of limonite and malachite, alternating with limestone.

Micro. Limonite is greyish white and contains minute inclusions of chalcopyrite.

No. 7. Houshan[2], Tungchuan, Yunnan.

Bornite and malachite.

Macro. The bornite is traversed by malachite veins.

Micro. The bornite not only contains the veins of malachite but also that of chalcocite. The remnants of chalcopyrite are seen in the bornite.

From the microscopic study this specimen seems to be at first in the intermediate zone (below the water level) to have secondary enrichment as it is indicated by the presence of chalcocite veins. But the ore was raised to the oxidized zone by the lowering of water level. New chemical changes such as carbonation had taken place to change a part of the original ore to malachite.

No. 8. Tangtan[3], Tungchuan, Yunnan.

Chalcopyrite, chalcocite and malachite in limestone.

Micro. The copper minerals, in limestone, form irregular masses. The chalcopyrite contains numerous veins of bornite which is in turn bordered by chalcocite. Pyrite inclusions are found in bornite. Limonite, which is gray is in the form of grains with high relief.

No. 9. Yilu[4], Tungchuan, Yunnan.

Pyrite and calcite.

Micro. Pyrite is yellowish white with rough surface and high relief. Calcite is dark grey.

No. 10. Yilu, Tungchuan, Yunnan.

Same as No. 9.

No. 11. Hsinshan, Tungchuan, Yunnan.

Chalcopyrite and limonite.

Macro. The outside appearance is like an iron ore with malachite and

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quartz. When cut the inner part is entirely chalcopyrite, and the iron is only found in the fractures, and malachite is unseen.

Micro. Besides the chalcopyrite there are numerous small grains of pyrite. The whole mass is more or less porous.

No. 12. Kanlanping, Tungchuan, Yunnan.

Chalcopyrite and limonite in limestone.

Macro. The Chalcopyrite is distributed between the grains of the crystallized limestone which has a porous structure.

Micro. Chalcopyrite is bordered by a layer of limonite which is derived from the oxidation of the former. During oxidation $CuSO_4$ and $FeSO_4$ are formed, the latter is easily transformed to limonite. By the presence of limonite and the porous structure this ore specimen is evidently formed in the oxidation zone.

No. 13. Tungchuan, Yunnan.

Chalcopyrite, limonite and malachite.

Micro. Under the microscope the chalcopyrite contains numerous veins of limonite.

No. 14. Tungchuan, Yunnan.

Same as No. 13.

No. 15. Tungchuan, Yunnan. (Fig. 39).

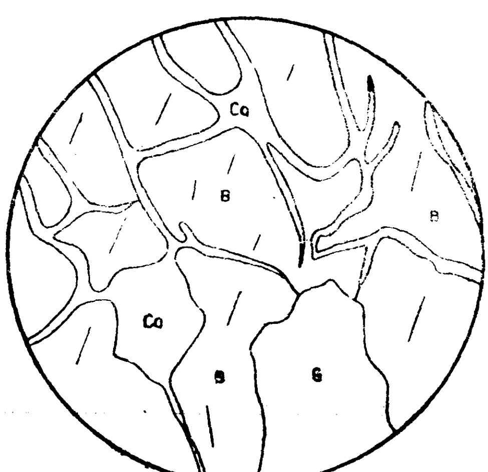

Fig. 39. Copper ore of Tungchuan, Yunnan. × 62. Bornite is replaced by chalcocite. G. Gangue. B. Bornite. Ca. Chalcocite.

Bornite, malachite and Chalcocite.

Macro. Bornite with malachite and earthy material (kaolin) on the surface.

Micro. The bornite is secondarily enriched by the presence of chalcocite along the fractures. Malachite is later formed by the carbonation of bornite.

No. 16. Lohsueh[1], Tungchuan, Yunnan.

Chalcocite with calcite.

Micro. The chalcocite includes the remnant of bornite and in some parts the specimen shows the texture of graphic intergrowth which is a common feature of secondary replacement ores.

No. 17. Tungchuan, Yunnan.

Chalcopyrite and pyrite.

No. 18. Malungchang[2], Hsiuna[3], Yunnan.

Chalcocite and dolomite.

Macro. Chalcocite veins in dolomite with small crystals of malachite.

Micro. The chalcocite shows its rhombic form and contains particles of bornite. It is similar to that found in No. 3.

No. 19. Tungchuan, Yunnan.

Native copper.

Macro. The native copper, in some places, is coated with tenorite which is in turn with malachite. This is a good specimen to illustrate the reaction of copper under the atmospheric influence. At first the native copper is oxidized to tenorite which by carbonation to malachite.

Micro. Native copper is pink. Eff. with HNo_3. Becomes brown with KCN. Darkened and dissolved by $FeCl_3$.

No. 20. Chiushantsing[4], Wuting[5], Yunnan.

Chalcopyrite.

Macro: The Chalcopyrite is sparingly distributed in the black metamorphosed shale.

Micro: The chalcopyrite is bordered by limonite and in some places the former completely disappeared. The specimen is porous.

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No. 21. Chiushantsing, Wuting, Yunnan.

Chalcopyrite and pyrite.

The general appearance is similar to that of No. 20. This specimen is slightly greenish due to the presence of malachite. Pyrite is also found in the interior part.

No. 22. Tatun[1], Hsuanwei[2], Yunnan.

Chalcocite, cuprite and malachite.

Chalcocite forms the central mass bordered by cuprite and malachite. The latter two minerals are only in the form of surface coating.

This specimen evidently has changed its position from the secondary enrichment zone to the oxidized one from which the cuprite and malachite are formed.

No. 23. Hsingpaochang[3], Fumin[4], Yunnan.

Malachite and limonite.

Under the microscope the limonite is intimately associated with chalcocite which is bluish white while limonite is grey. Malachite is found in the outer position of the specimen.

No. 24. Chiangchunshih[5], Tungan[6], Hucili[7], Szechuan (Fig. 40)

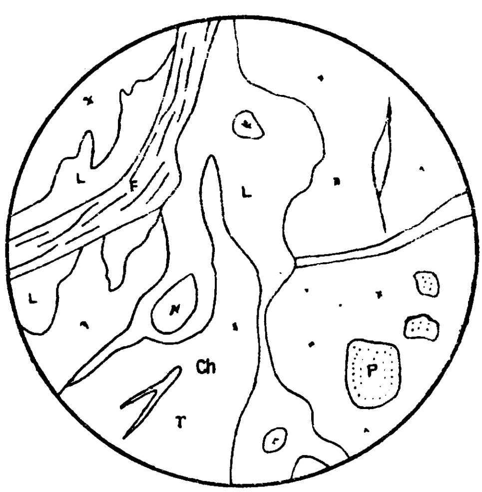

Fig. 40. Copper ore of Chiangchunshih, Tunganchou, Szechuan. × 62. Limonite is formed along the fracture of chalcopyrite; pyrite as inclusions. F. Fracture. P. Pyrite. L. Limonite. Ch. Chalcopyrite.

1 大屯 2 宣威 3 興寶廠 4 富民 5 將軍石 6 通安 7 會理

Chalcopyrite, malachite and limonite.

Macro. It looks like an iron ore with chalcopyrite and malachite, when cut the iron (limonite) only forms a coating on the chalcopyrite, and it is evidently a secondary product.

Micro: The whole mass is chalcopyrite with some inclusions of pyrite which is yellowish white and has high relief. The limonite is found on the surface and also along the fracture of chalcopyrite.

No. 25. Chiangchunshih, near Tungan, Hueili, Szechuan.

Chalcopyrite and quartz.

The chalcopyrite contains pyrite and limonite which is more abundant along the fractures.

No. 26. Chiangchunshih near Tungan, Hueili, Szechuan.

Chalcopyrite, pyrite, limonite and calcite.

The limonite forms small particles distributed in the interstitial spaces of calcite, pyrite and chalcopyrite. Pyrite, which is yellowish white, is often found in the chalcopyrite.

No. 27. Chiangchunshih near Tungan, Hueili, Szechuan.

Chalcopyrite, covellite, and limonite.

It is chiefly chalcopyrite with numerous veinlets of covellite. Inclusions of pyrite and limonite are also found.

No. 28. Chiangchunshih near Tungan, Hueili, Szechuan.

Chalcopyrite, pyrite, limonite, and calcite.

Same as No. 26.

No. 29. Tungan, Hueili, Szechuan.

Chalcopyrite and limonite.

Macro: It essentially contains limonite and chalcopyrite. The limonite is about 60% of the whole mass with reticulated structure.

Micro: Limonite stretches into the chalcopyrite and replaces it along the fractures. Pyrite inclusions are always found in chalcopyrite and not in limonite. By the presence of limonite and reticulated structure the specimen is evidently in the oxidized zone.

No. 30. Hsingpaoshan[1], Hueili, Szechuan.

Pyrite and calcite.

It is essentially pyrite with calcite crystals. Chalcopyrite in some parts is also found.

Nos. 31 and 32. Yiwanshui[2], Hueili, Szechuan.

Chalcopyrite and luzonite (?)

Luzonite is a rare mineral and resembles chalcocite. Brittle. Hardness medium. Colour black. In closed tube decrepitates.

Micro: Under the microscope it is pinkish white, HNO_3 tarnishes slowly. Rubs clean. Forms irregular masses in chalcopyrite.

No. 33. Tungan, Hueili, Szechuan (Fig. 41)

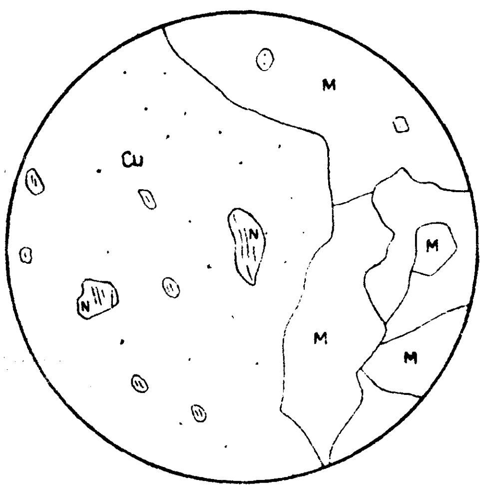

Fig. 41. Copper ore of Yiwanshui, Hueili-chou, Szechuan. × 62. Cuprite contains particles of native copper. M. Malachite. N. Native copper. Cu. Cuprite.

Malachite, cuprite, native copper & quartz.

Micro: In the cuprite there are numerous specks of native copper. Malachite is often found in the marginal portion of cuprite. Quartz, forming the gangue, occupies 40% of the whole mass, and it is grey under the microscope. The texture is porous.

No. 34. Lushuiho[3], Hueili, Szechuan.

Cuprite and malachite.

The cuprite and malachite are both found in the fractures of shale pebbles

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which occupy about 30% of the whole mass. Numerous malachite veins are contained in the cuprite. The texture is porous.

No. 35. Lushuiho, Hueili, Szechuan.

Malachite coating on the ferruginous shaly sandstone.

No. 36. Laochang[1], Hueili, Szechuan.

Chalcocite.

A little chalcocite is found in the conglomerate which composes of the grains of feldspar, quartz and amphibole, and some pebbles of sedimentary rocks.

Nos. 37 & 38. Fulochang[2], Loping[3], Yunnan.

Sphalerite & Calcite.

Under the microscope the sphalerite is greyish white. HNO_3 tarnishes faintly brown, rubs clear. Besides the sphalerite, pyrite and galena are also found in small quantity. Pyrite is both found in calcite and sphalerite, in the latter it sometimes forms small veins. Galena usually forms irregular masses. According to the position in Schurmann's series galena should be deposited on sphalerite and pyrite.

No. 39. Chilinchang[4], Tungchuan, Yunnan.

Galena.

It is white with characteristic triangular pits.

Nos. 40, 41 & 42, Kuangshanchang[5], Tungchuan, Yunnan.

Cerusite.

The Nos. 40, 41, & 42 are similar to one another. The colour is light yellow with sandy texture. They are evidently formed in the oxidized zone and have been subjected to atmospheric influence.

Nos. 43, 44, 45, 46, Kuangshanchang, Tungchuan, Yunnan.

The lead ores from this place are usually oxidized lead minerals, such as cerusite ($PbCO_3$), masscot (PbO), etc. They are also in the oxidized zone.

No. 47 Yunnan.

Limonite with cassiterite grains in calcite.

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No. 48. Kuangchushan[1], Kochiu[2], Yunnan.

Limonite with clay.

Micro: Limonite is grey. Negative with all reagents. Under oblique illumination it shows yellow and transparent on thin edges.

No. 49. Wantzutung[3], Kochiu, Yunnan.

Cassiterite.

Macro: The cassiterite forms small crystals mixed with red iron clay.

Micro: Cassiterite is dull grey colour with pitted surface. Negative for all reagents. Under oblique illumination it becomes yellow and transparent on the thin edges and brownish grey in the inner part.

No. 50. Yuntung[4], Kochiu, Yunnan.

Same as No. 49.

No. 51. Chiashihlung[5], Kochiu, Yunnan.

Same as Nos. 49, & 50.

No. 52. Lungtantou[6], Kochiu, Yunnan.

Cassiterite grains embedded in calcareous cement. Under the microscope a few grains of magnetite are also found.

Summary.

The copper ores from Yunnan and Szechuan collected by Dr. V. K. Ting in the year 1914 contain different kinds of copper minerals and some of them are good examples to illustrate the reactions involved in the oxidized or hypogene, secondary or supergene, and primary zones.

1. The copper ores from Tungchuan, Yunnan, have all types of the three zones. Nos. 1, 47, 15, etc. represent the ores in the supergene zone. Nos. 2, 5, 11, 13 are the ores in the hypogene zone. Nos. 9, 17, etc. may be the ores in the primary zone. However, no definite line can be drawn in distinction of ores. One specimen may have undergone a whole series of changes and the dominant phenomena are only considered. From the standpoint of economic value the ores from this district are more important than those from other places.

1 鑛主山 2 箇舊 3 灣子洞 4 雲洞 5 賈石龍 6 龍潭頭

2. The ores from Tungan, Hueili, Szechuan, are mostly chalcopyrite with limonite coating. The texture in general is porous. Occasionally a few ores show secondary enrichment and most of them are in the oxidized zone. The economic value is less important.

3. Two specimens are only obtained from Lushuiho, Hueili, Szechuan. The ore, No. 34, shows cuprite and malachite with porous structure, and it is evidently in the oxidized zone. The other, No. 35, contains malachite coating on the ferruginous shaly sandstone. The economic value can not be determined as the number of specimens is too limited.

4. The specimen from Laochang, Hueili, Szechuan, is a conglomerate containing a little chalcocite. It has no economic value.

XXII. LIST OF ROCKS.

No.	*Name of specimen*	*Locality*	*Date*	*Remarks*
256.	Extremely weathered Igneous rock.	Hsuchiaping, Kochiu.	Feb. 23	The colour is yellow. Feldspar altered to kaolin and the whole has a greasy feeling. It becomes very light.
257.	Weathered granite.	Machehshui, Kochiu.	Feb. 24	It is also extremely weathered. No minerals can be recognized except feldspar and mica.
258.	Decomposed & distintegrated granite.	Niushihpo, Kochiu	"	
259A.	Metamorphosed arkose.	"	"	The feldspar is altered to epidote along the cleavages. Thus it gives a gneissic texture under the microscope.
259.	Limestone	Nanshehtung, Kochiu	Feb. 26	Light grey, containing irregular black patches of limestone.
260.	Limestone	"	"	Black and stratified.
261.	Country rock	Hsiaochengmentung, Kochiu	Feb. 27	Reddish limestone
262.	Gangue material (tourmaline).	"	"	
263.	Black limestone with calcite (fossil).	Huangnitang near Mengzumiao, Kochiu	"	

264.	Dolomite	„	„	
265.	Black limestone	Huachakou, Kochiu	„	With calcite crystals.
266.	Grey limestone	„	„	With calcite crystals.
267.	Grey limestone	Fengtzutung, Kochiu	Feb. 28	
268.	Limestone (grey)	Lungshuchiao, Kochiu	Feb. 29	With stylolitic texture.
269.	Limestone (black)	Shihchung near Tienhsin, Kochiu.	„	
270.	Granite (weathered)	Paishapo, Kochiu	„	
271.	Marble (white)	„	Feb. 30	
272.	Decomposed granite.	Paishachung, Kochiu	March 11	
273.	Black limestone (fossil).	Laoyinshan, Kochiu	„	
274.	Reddish spotted clay rushed with fossil.	Laoyangshan, Kochiu	„	Trias.
275.	Sandstone with worm structure.	Shaochiwa, Kochiu	March 14	The pebbles are argillaceous fine grained sandstone, embedded in a siliceous matrix. The surface of the pebble is rough and penetrated by the quartz crystals of the matrix. It has the same appearance as the "Wurmkalk".

276.	Slate.	In the ravine near Kochiuchung, Kochiu.	„	It has slaty texture with spots in which quartz is more abundant than in the rest of the rock. The outside layer, 5 cm. thick, has lighter colour than that of the inner portion.
277.	Limestone (grey) with calcite vein.	Near Kafang, Kochiu.	March 15	
278.	Granite.	Huangshaho, Kochiu.	March 19	
280.	Granite.	„	„	
279.	Metamorphosed arkose & slate.	Below Chiaotingshan, Kochiu.	March 21	
281.	Syenite	Kuchihpai, Kochiu.	„	
282.	Brecciated limestone (fracture filled with calcite).	E. of Hsuchiachung, near fault between limestone & shale, Kochiu.	March 23	
283.	Greenish marble.	Kochiu	March ?	
286.	Andesite	?	April 21	The phenocrysts are mostly plagioclase which is altered at the central part along the lines of zonal structure. A few crystals of biotite and hornblende are also found. The groundmass is made of feldspar with a little magnetite.
1.	Yellow sandstone	Litzuping, Fumin	April 24	Carboniferous (Middle?) below limestone. Fine grained yellow sandstone mixed with very minute particles of chloritic substance.

2.	Yellow calcareous sandstone.	"	"	Carboniferous (Middle?) below limestone. Yellow calcareous sandstone. Fine grained. It is also mixed with minute particles of chloritic substance. Crystals of calcite can be recognised by their shining surface.
3.	Limestone	Between Shaoku & Tunke, Fumin.	April 25	Uralian. It is dark grey (nearly to black) massive limestone and contains a few crystals of calcite.
4.	Hematite & calcite.	Near Shalang, Fumin.	"	The outside layer of the specimen is red, like an impure hematite ore. When cut it likes a brecciated limestone with calcite crystals cemented together by iron solution.
5.	Red sandstone (medium grained and micaceous).	Laopienshan, near Muke, Fumin.	"	Lower Carboniferous. The colour is reddish purple; medium grained; speckles of mica (muscovite) are distributed through the whole rock.
6.	White crystalline limestone.	Muke, Fumin	"	Carboniferous; above red sandstone. White crystalline limestone. Big crystal of calcite is found. The fracture is flinty.
7.	Impure limestone	Point 557.0 near Shalang, Fumin	April 25	Carboniferous; above sandstone. Impure grey limestone; non-crystalline.
8.	Dark blue limestone (foraminifera?)	Yunganchuang, Fumin.	April 26	Carboniferous-Permian.
9.	White marble (dolomitic).	Sunglin, Fumin	April 26	Carboniferous-Permian. It is white & crystalline marble with small red veins. By chemical test it contains Mg.

284.	Camptonite.	Feilaissu, Fumin	,,	It contains plagioclase, altered to kaolin: colorless augite, in some crystals it alters to chlorite with separation of magnetite, and a few crystals of enstatite are also found.
285.	Porphyry.	,,	,,	Extremely weathered. Old layer below.
10.	Marble (impure).	Shehtzu, Fumin	,,	Carboniferous-Permian. White marble, intercalated with black limestone, and coated by iron solution on the fracture surface.
11.	Felspathic limestone	Near Chingshuiho, Fumin	April 27	Carboniferous-Permian; contact with the dyke.
12.	Arkose sandstone.	,,	,,	Carboniferous-Permian. It is greenish grey. Feldspar (weathered) and mica are easily recognisable.
13.	Gypsiferous shale (black).	Machiaying, Fumin	,,	Permian?
14.	Medium grained sandstone.	Nanying, Fumin	,,	Permian. It is reddish purple; medium grained and micaceous.
15.	Red sandstone with calcite crystals.	Nanying, Fumin	April 27	Permian. It is reddish, fine grained, calcareous sandstone. White crystals of calcite 5-1 cm. in length are sparingly distributed in the rock.
16.	Volcanic conglomerate	Near Chingshuiho, Fumin.	,,	Permian?

17.	Yellow crystalline limestone.	Machiaying, Fumin	„	Permian?
18.	Fossiliferous? limestone.	Between Chepei and Kutzushan, Fumin	April 28	Permian. Grey white, crystallized, impure.
19.	Breccia (volcanic).	Above Lengtsun, Wuting	„	Lower Carboniferous. The fragments are mostly feldspar which in some parts is altered to kaolin, embedded in a red cement.
20.	Cherty limestone.	In sandstone near Kanho, Wuting	May 2	Cambrian? It is black, hard limestone, slowly eff. with HCl.
21.	Limestone with calcite veins, dark blue with angular fracture.	Kanho, Wuting	May 3	Cambrian? Dark blue with numerous calcite veins.
22.	Phyllite.	Chiushantsing, Wuting	„	Cambrian? Yellowish grey, showing distinct slaty cleavage.
23.	Mica schist (weathered)	Fenshuiling, Wuting	May 3	Cambrian?
24.	Sandstone (*Redlichia* H).	Sapushan, Wuting	May 4	Cambrian. Reddish yellow sandstone. The bedding planes (both upper & lower) are covered by greenish chloritic substance.
25.	Hematite	Near Pt. A, Wuting	May 5	Devonian-Carbon. Hematite with quartz grain and oolite.

26.	White sandstone with distinct plant remains.	Wufeng, Wuting	,,	Carboniferous. It is white and more or less baked.
27.	Hard grey sandstone.	Matoukou near Machia-chuang, Luchuan	,,	Carboniferous. With iron particles distributed in horizontal layers.
28.	Calcareous shale	At the foot of Tatsien-shan, Luchuan	May 6	Devonian. Calcareous yellowish shale with a layer of conglomeratic sandstone.
29.	Yellow limestone.	Chaochu, Luchuan	,,	Devonian; above *Stringocephalus* 584.9 With calcite crystals and white spots which under the microscope, are also made of crystalline $CaCO_3$.
30.	Oolitic limestone.	Point 583.8 at Chaochu, Luchuan	,,	Devonian; above *Stringocephalus*. Yellowish white with few oolites.
31.	Calcareous shale (greenish).	At the foot of Tatsienshan, Luchuan	,,	Devonian.
32.	Rhyolite tuff.	Opposite bank of Yuliangtzu, Luchuan	May 6	Devonian. It essentially contains quartz and feldspar (weathered) with ash texture. The vesicles are filled by the same residual magma.
33.	Yellow sandstone	Tsehkuanting, Wuting	May 7	Carboniferous. With mica; medium grained.
34.	Quartzose sandstone	Wukueitang, Luchuan	May 7	Carboniferous, 9th horizon. It is greenish white. Cambrian.

35.	White limestone (2)	Wulungtung, Wuting	May 8	Mixed with thin layers of darker coloured limestone; dolomitic.
36.	Limestone (black)	Yaoying, Wuting	„	Cambrian. It is black limestone with very small reddish veins.
37.	Greenish sandstone (3)	Wulungtung, Wuting	„	Cambrian. This colour is green, micaceous, medium grained.
38.	Yellow sandy shale	Muhsike, Wuting	May 9	Cambrian. Yellow sandy shale with sandstone concretions.
39.	Black shale	Painipo, Wuting	May 9	Cambrian; with doubtful fossil.
40.	Red calcareous sandstone.	„	„	Fine grained, with minute crystals of calcite.
41.	Red sandstone.	Between Haitzutsun and Tulupai, Wuting.	„	Devonian. Red micaceous sandstone, medium grained with clay speckles.
42.	Speckled red sandstone (arkose).	Jukutsun, Wuting	May 10	Devonian. Same as No. 41, except the colour is reddish black.
43.	Conglomerate	„	„	Devonian-Carb.
44.	Pinkish & greenish shaly limestone.	Above Yangchiatsun, Wuting	„	Carbon. Greenish shaly limestone with flow stain of iron solution.
45.	Pinkish marl.	Huanchou, Wuting	May 15	Carbon.

46.	Quartz band in soft sandstone.	Near Huanchou, Wuting	„	Carbon.
47.	Grity sandstone.	Wulupaitsing, Yuanmo.	„	Carbon. It is reddish black coarse grained. In some parts it is conglomeratic.
48.	Red quartzitic sandstone with mica.	Yangteihpo, Yuanmo	May 15	Carbon. With mica aggregated in spherical form.
49.	Greenish sandy shale	Hsinglungtung, Chikuan-shan, Yuanmo.		Carbon. With distinct fissile structure.
50.	Conglomerate	Yangteihpo, Yuanmo	„	Carbon.
51.	Black limestone.	Near Chikuanshan, Yuanmo	„	Carbon. Bluish black, massive limestone with calcite crystals.
52.	Light green sandstone.	Hsinglungtung, Chikuan-shan, Yuanmo.	„	Carbon. Coarse grained with plant remains.
53.	Calcite vein with pyrite.	„	„	Carbon.
54.	Gneiss	Yangteihpo, Yuanmo	„	It contains pinkish feldspar, quartz, mica & hornblende; medium grained.
55.	Hematite & limonite	Palang, Yuanmo	May 18	In some parts the hematite is altered to limonite.
56.	Hornblende schist.	Lutun, Yuanmo	May 19	Archean? The colour is green. Hornblende forms needle-like crystals arranged in parallel lines.

57.	Gneiss	Hailo, Yuanmo	May 19	Archean. It is coarse grained and white colour. Feldspar and quartz are very abundant. Mica concentrated at portions to have the lenticular form. Hornblende is not abundant.
58.	Amphibolite	Near Chupu, Yuanmo.	,,	Archean. It is coarse grained with a great deal of hornblende.
66.	Calcite vein.	Yuanpaoshan near Chiangyi, Hueili	May 22	
67.	Sandstone	Yangchiatsun, Hueili		Devon? It is greenish. The bedding plane is coated with chloritic substance.
59.	Schist (metamorphosed sandstone).	Lushuiho, Hueili	,,	It is a metamorphosed sandstone with the texture of schist. Mica is abundant. Calcite veins are also found.
60.	Fractured ferruginous sandstone.	,,	,,	With calcite vein and mica.
61.	Gneiss	,,	,,	It contains a great deal of feldspar with mica and quartz. Malachite, specularite and early hematite are found in this rock.
62.	Hematite	,,	,,	With malachite crystals.
63.	Slag	Lushuiho, Hueili	May 22	
64.	Sandstone greenish	Shihlungho, Hueili	May 23	It is greenish, impure sandstone; fine grained.

65.	Black shale (*Lingulopora*)	„	„	
71.	Metamorphosed ferruginous sandstone with quartz inclusions.	Paishihyen near Tungan, Hueili	May 25	
70.	Impure quartzite	Laoshankou, Hueili	May 26	It is yellow and ferruginous.
72.	Black schist.	Tungan, Hueili	„	It essentially contains quartz, mica, and argillaceous matter. The schistosity is well marked under the microscope. This rock may be derived from shale.
73.	Black schist	„	„	Same as above.
74.	Amphibolite.	Below limestone of Laoshankou near Tungan, Hueili	„	It essentially contains green hornblende and feldspar. Secondary epidote is also found.
			„	
75.	Altered & brecciated quartzose sandstone	Chiangchunshih near Tungan, Hueili	„	With calcite and chlorite.
76.	Chalcopyrite	Tungan, Hueili	May 27	(For polished section)
77.	Chalcopyrite, pyrite and limonite.	Chiangchunshih near Tungan, Hueili.	„	„ „ „
78.	Chalcopyrite, malachite and limonite.	„	„	„ „ „
79.	Chalcopyrite, pyrite and limonite.	„	„	„ „ „
80.	Chalcopyrite	„	„	„ „ „

81.	Chalcopyrite, covellite and limonite.	„	„	„ „ „
82.	Mat.	Tungan, Hueili	„	„ „ „
83.	Caude copper.	„	„	„ „ „
84.	Slag.	„	„	„ „ „
68.	Coal.	Mingtzushan near Tungan, Hueili.	May 28	
69.	Coal.	„	„	
85.	Purple impure limestone.	Taishihkou near Luchang, Hueili	May 29	
86.	Amphibolite.	Near Luchang, Hueili	„	It contains green hornblende and weathered feldspar.
86A	Slag	Luchang, Hueili.	May 29	
87.	Volcanic conglomerate.	Paitsaotung near Luchang, Hueili	„	
88.	Yellow limestone.	Yuehlushan, Hueili	May 30	
89.	Sandstone	„	„	Yellow, micaceous, medium grained.
90.	Slag	Limaho, Hueili.	June 1	
91.	Shale with bitumen	Near Tachiao, Hueili.	„	Between quartzite.

90A.	Limestone.	Near Fengshanying, Hueili.	,,	Dark grey, massive limestone with amphibole minerals on the surface.
92.	Impure kaolin.	Wanchang, Hueili	June 2	Associated with coal. It is white and soft rock with slaty cleavage. Probably it is a bleached and weathered slate.
93.	Chloritic schist with quartz crystals.	Hungchuanchiao, Hueili.	June 6	
94.	Nepheline syenite	Between Paikuowan and Lungchaoshan, Hueili.	June 9	It contains orthoclase, nepheline, and green hornblende as essential minerals. The hornblende is arranged in parallel lines to have a gneissic texture. The accessory minerals are needles of apatite and small crystals of titanite.
95.	White limestone.	Yiwanshui, Hueili.	June 9.	With black limestone fragments.
96.	Limestone with galena.	Tienpaoshan mine, Hueili.	June 10	Black limestone. The galena is found in the vein.
97.	Slightly metamorphosed sandstone (black & micaceous).	Wuliping, Hueili	,,	
98.	White schistose sandstone	Near Paikuowan, Hueili.	,,	With hematite veins.
99.	Smithsonite.	Tienpaoshan mine, Hueili	June 11	
100.	Smithsonite.	,,	,,	

101.	Coal.	Chengchiaping, Hueili	,,	
102.	Coal.	,,	,,	
103.	Galena.	Yiwanshui, Hueili	,,	
104.	Diorite	Shihwopu near Yimen, Hueili	,,	It is dark colour, medium grained and contains oligoclase, hornblende, augite and biotite.
105.	Ferruginous sandstone.	,,	June 13	Junction between limestone & sandstone.
106.	Quartzite (white)	Lunanshan, Hueili	June 13	
107.	Calcareous shale (grey)	Lunanshan, Hueili.	June 13	
108.	Hard black limestone	,,	,,	
109.	Limestone with siderite.	,,	,,	Yellowish with siderite veins.
110.	Limestone with fossil.	Tayinchang, Chiaochia	June 14	Permian.
110A	Crude copper	Tiehchang, Tungchuan,	June 22	
111.	Quartzite	Tameiti, Tungchuan	June 25	It is white with hematite veins and fractured.
113.	Black shale	Above Hsinkaitien, Tungchuan	June 26	

112.	Lignite.	Anlotsing near Topuka, Tungchuan	June 28	Tertiary
114.	Metamorphic rock (schist).	,,	June 29	Above Cambrian. It is a black and dense rock. The minerals in the rock are feldspar which is completely altered to kaolin and quartz. In some places it has the structure of schist.
115.	Copper ore.	Houshan, Tungchuan	July 1	For polished section.
116.	Reddish shale.	Below Machangtzu, Tungchuan	,,	Below sandstone
117.	White & black banded limestone.	Kanchung near Tsinglungshan, Tungchuan	July 2	Limestone with alternate white and black bands.
118.	Altered diabase (green)	Ssukuoshu, Tungchuan	July 3	Under limestone
119.	White limestone	Sanfengkou, Tungchuan.	July 5	
120.	White limestone.	Yaotaishao, Tungchuan.	July 7	
121.	Gabbro.	Lanniping, Tungchuan.	,,	It contains labradorite and pinkish augite (diallage). In some places the border of augite is replaced by hornblende. Long needles of apatite and cubic magnetite are also found.
122.	Silicified limestone.	Taniutung, Tungchuan	July 8	Gray with calcite veins.
123.	Copper ore.	Tangtan, Tungchuan	July 10	For polished section.

124.	Vesicular basalt.	Kuniuchaiyakou, Tungchuan	July 11	Permian. Black with green amygdales. Microscopically it contains small-needles-like crystals of plagioclase with minute grains of magnetite.The vesicles are filled by quartz.
123A	Basalt.	Futsaishan, Tungchuan.	July 12	It is a dense and black rock, contains small crystals of plagioclase and augite.
125.	Phyllitic slate.	Near Nipotzu, Tungchuan.	July 13	
126	Limestone breccia.	Kuangluchiao, Tungchuan.	,,	
127.	Shale (calcareous) greenish.	Near Nipotzu, Tungchuan.		Below limestone
128.	Limestone breccia.	Kuangluchiao, Tungchuan.	,,	
129.	Greenish white limestone (crystalline with fossils)	Tahetsing, Tungchuan.	July 14	
130.	Limestone gray.	Hsuchiayuantzu, Tungchuan.	,,	
131.	Hard greenish sandstone	,,	,,	Medium grained.
132.	Basalt and clay with siliceous oolitic. [?]	Jeshuitang, Tungchuan.	July 16	In conglomerate. It consists of small crystals of plagioclase and granules of augite. Megascopically it is black compact rock with high specific gravity. *Basalt.* It is yellowish and soft clay with green spherical bodies. Under the microscope the spherical bodies are made of quartz and clay.

133.	Yellowish grey sandstone.	Tsouchiaka near Taokou, Tungchuan.	July 20	With indistinct plant remains. Medium grained.
134.	Basalt	Chashang near Taokou, Tungchuan.	„	Permian.
135.	Reddish limestone.	Fanchiawan, Tungchuan.	„	Black limestone mixed with impure reddish clay.
136.	Dark limestone with calcite crystals.	Beyond Fanchiawan, Tungchuan.	July 20	Second band.
137.	Limestone.	Below Chienchang, Tungchuan.	July 22	Permian; below basalt.
138.	Galena.	Yilu, Tungchuan	„	For polished section.
139.	Pyrite ore.	„	„	Permian for polished section.
140.	Coal.	„	July 23	
141.	Foraminifera limestone.	Laoshan near Yilu, Tungchuan.	„	Horizon A
142.	Limestone.	„	„	Permian; horizon b.
143.	Limestone.	„	„	Permian: horizon l.
144.	Limestone (fossil)	Laoshan near Yilu, Tungchuan.	July 23	Permian; horizon g.

145.	Feldspar porphyry.	Shenkou, Tungchuan	July 25	Permian. It is greenish compact rock. Under the microscope the feldspar is completely altered to secondary quartz and carbonate. In some places the form of feldspar is still retained. The groundmass is greenish yellow with a few grains of quartz.
146.	Grey shale (whitish)	SW of Shenchiatsun, Tungchuan	,,	
147.	Ferruginous hornstone.	Shenchiatsun, Tungchuan	,,	
148.	Coal.	Erhtaotsing, Hsuanwei.	,,	Permian.
149.	Coal.	,,	,,	Permian.
150.	Coal.	Lungtankou, Hsuanwei.	,,	Permian.
151.	Fossil limestone.	Erhtaotsing, Hsuanwei.	,,	Above coal.
152.	Red sandstone.	Wukuliangtzu near Huanglishu, Tungchuan.	July 26	Trias. With sand concretions, coarse grained.
153.	Limestone, black with calcite veins.	,,	,,	Trias.
154.	Coal.	Sayiho, Hsuanwei	July 27	

155.	Limestone (grey, with calcite veins.)	Antanho, Hsuanwei	August 3	Triassic
156.	Basalt.	Lutsaiping, Hsuanwei.	August 4	Permian. It contains needle-like crystals of plagioclase and microspherulite in black groundmass.
157.	Coarse sandstone (black).	,,	,,	Permian. With plant fossil.
158.	Cinnabar limestone.	Tsienshanpo, Hsuanwei.	August 5	Permian.
159.	Calcareous green arkose sandstone.	Hsiaohetsing, Hsuanwei.	,,	Permian. Grains of feldspar are altered to kaolin; biotite and other Fe-Mg minerals are completely changed to chlorite; quartz grains are not abundant. The cement is calcite.
160.	Coke	Fangmaping, Hsuanwei.	August 7	Permian.
161.	Coal.	,,	,,	Permian.
162.	Sandstone (green)	Shachiying, Hsuanwei.	,,	Pebble in river. Medium grained.
163.	Black limestone with pyrite.	Chintoupu, Hsuanwei.	August 8	Triassic
164.	Black shale.	Waitaoshan, Weining.	August 10	Carboniferous. With iron sulphate minerals in white fibrous form. It is derived from the decomposition of pyrite and probably is a variety of copiapite.

165.	Limonite concretion.	,,	,,	Carboniferous.
166.	Limestone (whitish)	,,	,,	Carboniferous.
167.	Limestone	Hsiaokuangchiao above Tichuiyen near Hsiaochiho, Weining.	August 12	Carboniferous.
168.	Sandstone (gray)	Hsutsing, Weining.	August 14	Interbedded in yellow sandstone.
169.	Coal.	Hsinkatzu, Weining.	,,	
170.	Limestone	Maomaochang, Weining	August 15	Carboniferous.
171.	Limestone	Erhmachung, Weining	,,	Permian.
172.	Coal.	Yaochan, Weining	August 16	Carboniferous.
173.	Coal.	,,	,,	Carboniferous.
174.	(Sandstone) Black shale	Erhpu, Weining	August 17	Carboniferous, 1st seam.
175.	(Sandstone) Black shale	,,	,,	Carboniferous.
176.	Silicified limestone (white)	Hsinkuanting, Weining	August 17	Carboniferous.
177.	Blue limestone.	Shihlipu, Weining	August 19	

179.	Claystone concretion	"	"	
180.	Silicified milestone	A small bridge; E. of the Weining city.	"	Black, with pyrite.
181.	Dark blue sandstone	Shuikouwan, Weining	"	
182.	Limestone.	Between Yangchiaowan and Shuitangshang, Hsuanwei.	August 20	
183.	Limestone (grey)	"	"	
184.	Red sandy shale.	Chintoupu, Hsuanwei.	"	Triassic.
185.	Yellow clay	Yangchiaowan, Hsuanwei.	"	
186.	Coal.	Chiuputzu, Hsuanwei.	August 25	•
187.	Iron ore (hematite)	Tsaohuachung near Houkaitzu, Hsuanwei	August 31	
188.	Basalt	Hsuanchiatzueitzu, Hsuanwei.	Sept. 9	Permian. It contains small crystals of plagioclase, augite, & small grains of magnetite with flow structure.
189.	Coal.	Palo, Hsuanwei.	Sept. 11	
190.	Reddish sandstone with fossil.	Above Sungchakuan, Chanyi.	Sept. 14	

191.	Yellow sandstone.	Miaokaoshan, Chutsing.	Sept. 20	Silurian. With claystone concretions.
192.	Lignite.	Lungtanho, Chutsing.	Sept. 21.	
193.	Lignite.	„	„	
193A.	Lignite.	Hungtuchiang, Chutsing.	„	Tertiary.
194.	White limestone (impure)	Near the city of Loping.	Sept. 26	Below limestone ( ) used as manure.
		Chutsingkou, Loping	Oct. 2	Limestone yellowish grey.
195.	Limestone	Lachungshan, Loping	„	Permian.
196.	Greywacke			This rock shows clastic structure. Fe-Mg minerals are completely altered to chlorite. Quartz is found in the interstices. Plagioclase is not abundant and in the form of angular fragments. Calcite forms the cementing material as shown in some places.
197.	Basalt.	Tasheh, Loping	„	Permian. The mineralogical composition is same as before, *i. e.*, plagioclase and augite.
198.	Asbolite.	„	„	
199.	Limestone (impure, grey)	Tasheh, Loping	Oct. 2	
200.	Coralline limestone (grey)	„	„	
201.	Limestone.	„	„	Lower Limestone. Crystallized limestone with some big crystals of calcite.

202.	Zinc blend.	Tsaopaihaitzu, Loping	,,	
203.	Coal.	Paikan, Loping.	,,	
204.	Coal.	,,	,,	
205.	Black shale.	,,	,,	With plant remains. With white fibrous iron sulphate minerals.
206.	Greywacke.	Pailashan, Loping	Oct. 3	Same as No. 196.
207.	"Wurmkalk"	Chingshihkai, Loping.	Oct. 5	
208.	Sandstone (Yellowish grey).	Yilung, Loping	,,	With plant remains.
209.	(Nodular) limestone	Kukangte, Loping.	Oct. 8	Trias.
210.	Yellowish clay	SW of Maokai, Loping.	Oct. 9	
211.	(Nodular) limestone.	Near Maokai, Loping.	Oct. 10	Trias. Black. This rock does not possess a uniform hardness. When the surface is eroded the hard parts stand out in spherical form.
212.	Coal.	Maokai, Loping	,,	
213.	Coal.	,,	,,	
214.	Nodular limestone.	Near Maokai, Loping.	Oct. 11	Trias.; C horizon. Yellowish grey. This rock contains numerous concretions which are oval in shape about 1 cm. in length. They are harder than the enclosing rock and can be taken away from the latter with a little manipulation.

215.	Arkose with plant	Point 588 near Lichiaying, Loping.	„	Permian. Feldspar is altered to carbonate.
216.	Basalt.	Tuchengpo, Loping	Oct. 22	Permian. Containing small crystals of plagioclase which is more or less altered to kaolin. The small granules of augite are also altered to chlorite. Magnetite grains are abundant.
217.	Coal.	Near Minchiatsun, Loping	Oct. 23	
218.	Nodular limestone	Tatilung near Tukaitzu, Pingyi.	Oct. 24	Trias. Limestone with crystals of calcite; on the bedding plane there are something projecting out in more or less conical shape. These may be formed by the same reason as the formation of stalactite.
219.	Coal.	At the foot of Paimashan 8 li from the river, S of Pingyi.	„	Permian.
220.	White limestone.	Hsinpu, Chanyi.	Oct. 31	With fossil.
221.	Dark grey limestone (fossil?)	Above Lungwangmiao, Chanyi.	Nov. 1	
222.	Coal.	Erhlungkou, Chanyi.	Nov. 4	
223.	Coal.	„	„	
225.	Coal.	„	„	

224.	Impure hematite.	Near Hamachai, Chanyi.	„	
226.	Greenish impure limestone (soft clay)	Shihhuayuan, Chanyi.	Nov. 7	
227.	Limestone.	Hunshuitang, Chanyi	Nov. 8	White colour; with calcite crystals.
228.	Limonitic sandstone (stalaemites)	Near Sunglin, Chanyi.	Nov. 10	
229.	Fossil (not in situ)	Miaopo, Chutsing	„	b 1
230.	White sandstone	Chutsing	„	Above oolitic Carbon., with plant remains.
231.	Calcareous sandstone (greenish).	Tsuifengshan, Chutsing.	Nov. 11	Devon., Horizon 17. Medium grained.
232.	Calcareous sandstone concretions.	Near point C, Chutsing	„	
233.	Black limestone.	Chutsing	„	With a reddish layer of limestone conglomerate.
234.	Impure shaly limestone (grey).	Near Tsaotien, Chutsing.	„	Horizon 2.
235.	Limestone.	„	„	Horizon 1. This specimen consists of two different layers of limestone, the one is black and the other yellowish brown. On the bedding plane of the yellowish limestone there are something projecting out in nail-like form. These nails may be formed by depositing on a rough surface.

236.	Impure limestone (greenish grey)	Near Tsaotien, Chutsing	Nov. 12	Horizon 3.
237.	Limestone (grey)	,,	Nov. 13	Horizon 4.
238.	Shaly limestone (grey).	,,	,,	Horizon 4. With plant remains.
239.	Impure limestone with concretion (grey).	,,	,,	Horizon 4 b.
240.	Impure crystallized limestone.	,,	,,	Horizon 6. The chloritic substance is usually found in the spaces between the calcite crystals.
241.	Black slate.	,,	,,	
242.	Black limestone.	Point E, Malung	Nov. 14	
243.	Greenish micaceous slaty shale	Point C, Malung	,,	
244.	Greenish conglomeratic sandstone.	2 li E of Tsao-hsienpanchiao, Malung.	Nov. 15	Braachiopod cast.
245.	Clay (yellow)	Point E, Malung	,,	with chloritic substance.
246.	Greenish micaceous sandstone.	Point G, Malung	,,	
247.	Green micaceous sandstone.	Point G near Yilung, Malung.	Nov. 15	Impure, interbedded with thin layers of chloritic substance.

247A.	Yellow sandy shale.	Yilung, Malung.	Nov. 16	With small water current ripple marks. One specimen shows raindrop impressions.
248.	Reddish sandy clay.	"	"	
249.	Greenish concretionary sandsone.	"	"	
250.	Dark blue limestone.	"	"	
251.	Greenish conglomeratic sandstone.	Wulungtsing, Malung.	"	
252.	Basalt.	Hill before Tashanshao, Kunming.	Nov. 17	It contains small crystals of plagioclase and olivine. The latter is weathered with the separation of iron.
253.	Micaceous sandy shale.	3 li from Hsinkai, Kunming.	"	
254.	Basalt.	Takuanti near Tangfang, Kunming.	"	It has the same mineralogical composition as those previously described.
255.	Green nodular sandstone.	Point F_1, and between F & F_1, Kunming.	Nov. 19	With (*Redlichia* near) Medium grained; micaceous on the bedding plane there are some relief impressions of mud cracks.

XXIII. 上農商總長書

爲詳陳雲南礦務情形及改良鑛政管見事，竊見政事堂交片稱國務卿面奉大總統諭，據参政蔡鍔摺，呈請開發滇省鑛產以保利權而紓財力等語，滇省地界法邊，鑛務關係國家利權，亟應及時籌劃著交財政農商兩部，會商雲南巡按使，按照所陳各節，妥速核議辦法，切實具復，原摺抄給閱看，等因，按蔡参政原摺所言，約可分爲三項：曰擴充箇舊錫鑛，整頓東川銅務，興辦已廢老廠。而著手擴充整頓興辦之法，則謂仿照前清設置雲南礦務大臣成例，特派大員督辦該省鑛務，並由國家配撥基金。

玆請就文江所知者逐一爲我總長一詳言之

箇舊爲中國全國最大之廠，產額極豐，所採之鑛大都來自地面，（滇語謂爲草皮），鑛工掘地面之土，（滇語謂爲𡎚），洗之以水至再至三，始可得鑛，就鑛之性質言，頗於吾國土法相宜，所可惜者鑛山地勢絕高，常苦缺水，故冬春所掘之𡎚，必至夏秋雨水大至始可洗鑛，故不特每年出鑛多寡不得不視雨水之多寡爲定，且春冬所投資本必經八九月之久，始可收回，其弊一也。土法鍊錫，純用木炭，鑛之佳者一晝夜始能出錫一千五百斤，所需木炭約在三千斤以上，故每年所耗木炭至二千三百七十餘萬斤之多，森林日缺，來路逾遠，近日每炭百斤價至二兩七錢之多，每鍊錫一噸，製鍊費需二百元，故成本過重，其弊二也。土法所鍊之錫中，含雜質甚多，運至香港復須淨鍊，且每片成色不齊，往往一爐所鎔，優劣互見，故不能直接銷之洋商，其弊三也。滿清末季滇中大吏鑒於以上各弊，於是有箇舊錫務公司之設，購置鍊錫洗沙機器，安設架空鐵索，移礦山之𡎚以洗於箇舊，改用煤氣以輕成本，意至善也。乃是宣統元年，迄今六載，成効毫無，虧折累累，計實收商官股共合一百七十六萬元有奇，先後借款一百三十餘萬元（純係官款），實業司撥款二十萬元，共計三百三十餘萬元，除一百六十餘萬元爲固定金外，歷年虧折在一百萬元以上，至民國三年春間，恃有流通資本者，不過六十萬元，聞其後因歐洲開戰，錫價驟落，即此區區亦所存無幾而且有向東方匯理銀行借款十萬元之說，若再不通盤籌算大爲改良，應停則停，應辦則辦，則機器將因不用而朽爛，借款亦因利息而增加，以有限之金，塡無底之壑，增土人頑固之心與商可籍之口，其後患正不堪設想矣。查該公司借款，股本三百四十萬元，官款約二百五十萬元，財政部前主張清理官產，各省已分別實行，該公司實亦滇省官產之一項，當然應在清理之中，擬請會同財政部然後酌定辦法，或接續進行，或招商承買，庶幾官欵有著，發達可期也。錫業公司用移鑛就水法，以救缺水之患，法固至善，然此只可施之於一山，而不能普及各廠，欲統籌全局，則非移水就鑛改良交通不足以濟其窮，

前曾有建議，吸紅河之水貯之山頂，以水管分佈於槽硐者，其議之可行與否，雖不可知，然未始無研究之價值，謂宜與滇巡按使會商派工程專門人才富於經驗者，前往實地計算，然後進行，此移水就鑛之說也。箇舊除錫以外，他無所出，幾百日用，皆自外來，滇越鐵路旣通，多由壁色寨車站用馬駝運至箇，計每重一噸之貨，運路七十里，運費十五元，故廠上百物騰貴，工價不貲。自滿清末年，卽有建築箇壁鐵路之據，據云每日自壁至箇，約有馬千頭，故每年所運貨物，平均爲三萬餘噸，而自個至壁之錫，尙不在此例，若鐵路旣成，假定每噸運費五元，則每年所省運費二十餘萬元之多，原議由滇人自辦，資本則出之於錫砂，每砂六担抽路股五十元，由鐵路局塡發股票，計歷年所抽路股及滇蜀鐵路公司借給之款，共計已在三百萬元以上，以之修造七十餘里之鐵路，蓋已有餘，而公司事權不一築室道謀，遷延至今，仍未著手，謂宜由滇中大吏，嚴速催公司進行，並限以時日，決定路線工程辦法，庶鐵路早成一日，箇舊卽可早收一日之効，故曰宜改良交通也。以上所言各端，雖皆迫不可緩，然其收効，則皆非旦夕可期，欲提倡箇舊鑛業，其最易行易見効者莫如改良稅則。按箇舊錫稅可分爲兩種。一爲正稅，一爲路股。正稅則每錫二千五百斤，課稅一百二十二元（箇舊通稱以二千五百斤爲一張，因納課一百二十二元，領稅票一張，故各見蔡參政原議）錫價有漲落，錫色有優劣，稅額則無變更也。路股分爲兩種。曰滇蜀鐵路路股，每錫一張抽銀五十兩；曰箇壁鐵路路股，每砂大石抽洋五十元。按每砂大石，恰可出錫二千五百斤，是每錫一張共抽路股一百二十元左右。路股雖發給股票，然鐵路未成，不能分息，且爲完全強迫性質，故實與課稅無異。路股正稅兩項，合計共二百四十餘元，以歐洲戰事以前錫價計算，約爲値百抽十，若以民國三年秋間錫價計算，則爲百分之十八，擔負之過重，不言可知。竊以爲現行鑛法，所定稅額過輕，或不易實行，然箇舊稅則有不可不改良者數端：一曰分別市價，錫之銷摺，全恃外商，價之高低，權不自我，茲錫稅不問市價何若，皆按斤收納洋元，故錫價愈低，則担負愈重，如去年歐戰以後，錫價驟落一倍，故正稅路股總數幾達百分之十八，而錫商之破產流離者，十乃五六，不特此也，箇舊舊爲鉛廠，產錫之鑛，大半亦皆產鉛鉛鑛與錫鑛比重相等不特用土法淨洗無從分別，卽用機器亦未必有効，鉛之鎔點較錫爲高，似可以淨錫爐淨之，然提鍊以後，鉛之一部，與融錫合而成一種合金，其鎔點且更低於錫，故仍不能與錫分，然含鉛之錫，亦爲有用之金品，故德國且有專煉鉛錫之廠，現若無法分析，則不妨卽鉛錫售之，惟鉛錫之價，遠不及純錫之高，現行稅則，不論鉛錫純錫，每二千五百斤，槪須納課稅路股二百五十元之多，故幾有鉛之錫鑛，皆因之而停歇，玆若稍爲區別，按照市價分別抽收，則不特錫價低時，錫商無停歇之患，且鉛錫成本大輕，未始不可爲出產之大宗也。二曰取銷路股：箇廠所出之錫，除正課一百二十二元以外，每張另須抽滇蜀箇壁路股，上已詳言之，夫滇蜀鐵路需資本過

多，滇省萬無自造之能力，今日之提議取銷滇蜀鐵路公司者，頗不乏人，江以爲此項路股，當然停收，蓋該公司測量則已竣事，修造則無能力，每年所收之款，皆轉放之於他機關，以取利息，夫已放者，尙須另籌其用途，未收者自當藏富於廠戶。箇舊鐵路即經過蒙自，長亦不過八九十里，若因陋就簡，費款亦不過三百萬元，在存資僅足用，接續收款，徒以困商，若同時停止，則出錫成本，至少可減輕百分之五，產額必可增加。三曰遷移稅地：舊日箇舊錫稅，本皆納於蒙自，設廳以來……………………………………………………

……爲全國產金千分之五，雖曰地方荒僻，交通不便，故多荒棄，或亦天產有限，無利可圖，有以致之歟？方今財政部方設採金局，整理全國金政，即此區區自亦不可置之不問，謂宜擇其出產稍豐者，着手整頓，按四廠中，以中甸爲最著，然交通亦最不便，騰越舊日產數甚微，距省亦遠，他即開化交通較便，着手不難，然據英法人士之調查，則初亦無大價値，惟永北之鑛，概爲金沙，成分雖微，鑛量甚富，他日或可供新法開採之用乎。

次請言銀，原摺舉雲龍麗江開化楚雄南安魯甸昭通爲例，以文江所聞，雲南產銀之地蓋以十數，不僅以上所言各地也。有明一代，重銀輕銅，故滇省銀與銅並稱，而銀則有駐廠之太監，其時中國出銀之省，雲南以外尙有浙江等八省，然其計不及滇省之半，（宋應星天工開物說）。前清初銀廠猶盛，其註冊納課者爲永昌之茂隆，南安之石羊馬龍土革喇，魯甸之樂馬，永善之金沙三道溝，東川之金牛角麟棉花地，順寧之湧金悉宜，新平之太和，雲龍之白羊，麗江之廻龍，中甸之古學，鎭雄之銅廠坡，楚雄之永盛，建水之摸黑，開化之白得牛，廣通之象山，共計二十一廠。乾隆中最盛時，課銀所得每年不下十萬兩，課額以値百抽十五爲標準，是當日每年出銀不少，亦七十萬兩，而廠戶之偷漏，廠員之侵蝕不計焉。各廠之中，以茂隆樂馬爲最著，故有西茂隆東樂馬之諺，經營茂隆者爲吳尙賢，富可敵國，大爲邊夷所畏服，後爲大吏勒索下獄瘐死，而廠遂衰，至嘉慶初，即不納課。樂馬自乾隆末年，亦漸衰歇，然至咸豐初，每年出銀亦且五六萬兩，與棉花地廻龍馬龍三廠，同爲最盛最久之廠，嘗搜集道咸中課稅解額列以爲表，計算其出產之數，知咸豐初年回亂未發生以前，歲產至少十六萬兩，若合計其偷漏侵蝕之數，至少亦在二十萬兩以上，蓋各廠積弊之深，莫如銀鑛，當日內外以銅政爲惟一之務，不復兼顧銀廠，或旺則地方官視爲利藪，魚肉敲詐，無所不爲，稍不如意，則籍口聚衆滋事封禁其廠，以制其死命，如永昌之茂隆，順寧之湧金，其尤著者也，迨至大理倡亂，全省沸騰，凡十餘年，各廠皆無人跡，滇省產銀至是乃絕。溯自同治十三年，滇事大定，公私籌措，恢復廠務，凡五十年，若金若銅若鐵若鎳若鉛，雖未能盡復觀舊，然皆已分別興辦，若錫若銻，舊日之廢置不問者，玆且飛騰日上爲一省出產之冠，惟銀則寂無聞焉，惟求其故，不外乎銀價之過低，鉛價之

漸漲，稅額之過重，乾嘉中，世界產銀之數不多，銀價昂貴，當日在滇省每銀一兩換制錢二千五百文，外省最高者至四千文，故雖鑛質成色稍低，亦能開採，同治以後，墨西哥南美等處銀鑛發現日多，銀價驟落，光緒初每銀一兩換制錢一千三百文，較之未亂以前相差甚遠，其原因一也；同時鉛價漸漲，禁亦漸弛，向之兼持煉銀者，今則專持煉鉛（如東川之鑛山廠），蓋滇銀多出自鉛中，提煉時費鉛極多，就今日情形言，每鉛百斤入爐提銀，所耗之鉛不下三四十斤，故至少須得銀一兩七八錢，方可獲利，否則不如逕售其鉛，未遭回亂以前，鉛價極賤，且為軍火用品，禁止販賣，故卽含銀稍低，亦須提煉，其原因二也；亂後戶口凋落，工價驟增，出銀成本實倍於前，而稅課仍以值百抽十五為準，所得利益，不足完課，其原因三也；凡此三因，有其一卽足以阻銀鑛之復開，玆兼而有之，其不能發達也固宜。居今日而言恢復，而銀價如故，鉛價亦如故，其所異者，惟稅則耳，苟非集全力以從事，恐收效正不如坐言之易也。

次請言鉛按滇語有黑鉛白鉛之別，黑鉛為鉛，亦作鍊，讀如本音，白鉛為鋅，作鉛，讀如元，或作倭鉛。原摺舉羅平平彝健水昭通為例，蓋兼指鍊鉛而言，羅平平彝產鋅之地，名卑浙廠，居兩縣之間，地屬羅平鑛稅舊歸平彝收取，姑原摺並舉之，實則平彝無鋅鑛也。建水卽臨安，廠名摸黑，舊為鍊廠，故兼產銀，前言銀廠時已言及之。昭通產鉛，為文江所未聞，魯甸之樂馬廠，出銀兼出鍊，舊為昭通府管，原摺或指此，按產銀之廠，無不產鍊，自銀廠衰歇，亦大半發棄，惟魯甸之樂馬，鍊銀之外，復產銅鑛，近日由昭通紳士，集股領照，購機器用新法開採，現正在籌劃中，東川之鑛山廠，歷年由官經營，成効頗著，年產精鍊一百萬餘斤，鍊鑛之上，卽為鋅鑛，每年出鋅亦且一百萬餘斤，是為滇省惟一之鍊廠，民國二年滇政府移交於東川鑛業公司者也。前上書言東川事已略言之，玆不復贅。羅平之卑浙廠，（反正後改名為富羅廠），只產鉛而不產鍊，文江前曾親至其地，其鑛床之厚，鑛質之佳，為滇省各鑛所未有，舊日因鋅價過低，銷路過滯，至停歇，現已有外省商人領照開採，苟辦理得宜，其發達正未可限量。按滇省簡舊以外，私人營鑛業者僅有卑浙與樂馬兩廠，政府之責，在與以法律上之保獲，知識上之補助，似不必另為干涉也。

次請言鐵，原摺舉石屏鎮南威遠鎮雄為例，舊日納課之廠，石屏之廠名龍朋里，鎮南為鵝赶，威遠為猛烈鄉，其外尚有師宗羅平宣威皆以產鐵名，然以上各地，除石屏外，距鐵路皆以數百里計，百物轉運，僅恃驢馬，其交通之困難，有非內地之所能想見，卽其鑛量極豐，鑛質極佳，亦無可以開採之價值，而以江所見之師宗羅平宣威（皆為前交通部擬造之欽渝鐵路所必經之地）三處，其鑛量鑛質皆不甚佳，卽鐵道大通，未必能與本國南北諸鐵路鑛相競爭，況如鎮雄威遠鎮南等處，二三十年內絕無有通鐵道之希望乎。石屏距滇

越鐵路較近，然據法人之調查，亦無重要之價值，是則雲南之鐵鑛，在今日實無希望之可言也。

雲南重要之鑛，有原摺所未言及者，厥爲銻。銻之爲用，不若其他金屬之廣，故不詳於舊日之記載。自隆興公司要求在滇開鑛始，稍稍有過問者，未幾有寶華煉銻公司之設，以官商股數十萬元，購置機器，設煉廠於芷川，（距蒙自甚近），其鑛質大半來自阿迷附近，文江調查滇東鑛產事畢，本擬前往，後因資本缺乏，部電疊催回京，未得如願，彼時聞因資本不充，出銻過少，不能獲利，然自開戰以來，銻價飛騰已逾數倍，湘省各鑛，因之獲利甚豐，謂宜咨滇巡按使，以該公司最近情形報部，通盤籌算於戰事未了之前增加資本，力圖擴張，庶不致坐失此不可多得之時機也。

至於着手整頓之方，原摺謂宜仿前清舊例，特派鑛務大臣，則文江竊以爲今日尚非其時，按前清自光緒十三年，任命唐炯爲督辦，先後在滇幾二十年，收效極少，積弊極深，前言東川鑛沿革時，已略陳其梗概，原摺所云與事實稍異，且吾國行政，事無大小，全賴地方長官，在前清內外聲氣相通，功令具在，故中央特簡之官，即無黜涉州縣之權，亦尚能收指臂之效，反正以來，秩序雖復，號令未週，邊遠諸省 尤多隔膜 官吏皆隸籍本省，相與排擠， 外人軍隊無嚴重長官時或干預行政，苟大吏以國家爲前提，則興利除弊，責無可辭，義不容緩， 中央定其政策，外省當然奉行，積弊掃除，易如反手否則另簡大員，徒增疑忌，遇事掣肘，呼應不靈，事未克舉，縻費已多，愈事更張，愈難收效，似非計之得也。夫國家苟欲開利源，必先除積弊，欲興新業，必先復舊觀，茲苟盡革箇舊之惡政，收回東川之利權，就已辦之事業而整頓之，經營之，款不必另籌，事不必創舉，二三年間未有不大著成効者。蓋以文江所見，吾國鑛業之不振，雖由於資本之不充，知識之幼稚，而其最大之障礙，實由於行政之不良，故往往五金小鑛，土法開採未始不宜，而所在不能發達者，誠以一著成効，人爭趨之，爭之勝負，視爭者之勢力爲轉移，故全國利源非劣紳所壟斷，即爲貪吏所把持，不然則重征疊稅，務使其力盡自斃而始止。文江以爲此等弊政一日不除，鑛業一日無發達之希望雖有千萬之基金，十百之鑛務大臣，亦無益也。文江前奉部令，赴滇調查滇東地質鑛務，在滇幾一年，於東川箇舊曲靖羅平師宗平彝霑益宣威威寧各縣皆已繪有略圖，惜爲時過迫，於西南諸處之著名銅銀各廠，未能親歷，謂宜一面以全力經營東川箇舊，一面酌派一二人前往專門從事勘鑛，先從舊日著名之廠著手研究，實地測量，雖旅費往返不無消耗，而他日所得正十倍於所失也。又前英法合資之隆興公司，於滇省獲有鑛權，雖經前清政府於宣統三年七月將第一期之二十五萬兩付訖，反正後經費支絀未能如期清付，至今尚欠一百萬元左右，去年侪聞法使已向外交部抗議，要求東川昭通

兩府鑛權以爲賠償，後因歐戰發生，暫時擱議，頃文江徼聞公司中人有於歐戰後，藉口付款延期，切實交涉要求鑛權之議，謂亟宜與財政部會商，乘歐戰未終，英法不暇兼顧之時將應付之款，趕速結算清付，以塞其口，否則歐戰以後，其結果正不堪設想也。以上各節或見之於舊日之記載，或得之於實地之調查，雖思慮或多有未周，而事實自信爲可據，用敢續陳，以備參考，伏乞鈞鑒此詳　農商總次長

附件

技正　丁文江

雲南銀鑛興衰表

廠名	屬地	稅額 道光九年	稅額 咸豐五年	產額 道光九年	產額 咸豐五年
石羊	南安	5.546兩	5.546兩	36.973兩	36.973兩
箇舊	箇舊	2306.142	同上	15374.280	同上
永盛	楚雄	217.332	同上	1448.880	同上
土革喇	南安	20.462	同上	138.413	同上
馬龍	南安	516.130	同上	3440.876	同上
古學	中甸	1262.310	2522.000	8815.400	16813.333
樂馬	魯甸	4673.851	6353.524	31159.007	42356.827
金沙	永善	686.973	1199.632	4579.820	7997.547
金牛	東川	289.814	同上	1932.073	同上
湧金	順寧	298.198	506.863	1987.987	3379.087
迴龍	雲龍	3401.229	3894.859	22674.863	25965.727
銅廠坡	鎮雄	1119.398	同上	7795.987	同上
棉花地	東川	5106.359	同上	34042.393	同上
三道溝	永善	4.879	同上	32.527	同上
摸黑	臨安	51.113	同上	340.753	同上
角麟	東川	121.108		807.387	
太和	新平	24.924	594.419	286.160	3962.793
白羊	雲龍	382.430		2549.533	
悉宜	順寧	800.000	433.334	5333.333	2888.893
總額		21306.198	25141.806	142376.636	167946.953

XXIV. 改良東川銅政意見書

東川銅政之沿革，前已論之詳已。以其變遷頗繁，故又列以爲表，以表中所列產額相較，則乾嘉時爲東川銅廠最盛時代。同治以降，經營恢復，迄今四十餘年，未著成效，每年所出，不過乾嘉中產額十分之一，是此四十年中，東川銅廠最衰之時代也。聞全國造幣廠用銅，每年在一千萬斤以上，大都來自日本，於是有改用滇銅之議。然滇銅歲產纔一百餘萬斤，不過用額十分之一，欲以供全國之用非力圖擴張不可而今日專利病民之公司，正未可置之不問也。玆請舉歷年銅政之利弊，分別言之如下：

東川銅廠盛衰之原因

嘗考一廠之盛衰，其原因不外乎五端：曰鑛脈之衰旺，鑛質之優劣，成本之輕重，銷路之暢塞，資本之多寡而已。言東川銅政者，嘗謂乾嘉時開採未久，森林未伐，鑛脈旺，鑛質優，成本輕，故其事易舉。今則洞老山空，薪炭昂貴，故日就衰廢。是說也，似是而實非。蓋東川產銅之區，寬長數百方里，即地面之鑛，亦未盡開，嘗見落雪郭某，於前年得鑛，其平均成分，在二十分以上，故以十六兩四錢之價，其獲利已及萬金，是今日之廠硐雖老而山未空也。湯丹落雪所用薪炭，多來自尋甸，爲小江之支源；茂麓大水，則恃祿勸，居金江之上流；或燒炭而運之於茂麓，或伐木而放之於湯丹，路雖以百里計，然固皆有水道，可以利用，是薪炭與人工相較，故未必較乾嘉時爲貴也。夫開鑛原理，不外乎以人力利用天產。鑛質薪炭，皆天產也，天產旣不可咎，其可咎者，其在人力乎？以言人力，則不外資本與銅價。考乾隆中部，發資本歲一百萬兩，至光緒初，則不過二十餘萬，乾隆初銀價極貴，以光緒初銀價計算，則一百萬即二百萬，是光緒初所發之資本，不過乾隆中十分之一也。乾隆中官價五兩餘，市價十兩餘，光緒中官價十餘兩，市價二十餘兩，驟觀之似乾隆時官價，與光緒時初無大異，以五兩與十兩，皆不過市價之半，皆不敷爐戶成本也，然乾隆中官價名雖爲五兩有奇，而爐戶所得，蓋幾倍之。考當日官發資本，銅本以外，又有所謂底本者，銅本爲短期之借款，繳銅時即須扣還底本爲開採之資清還之期，或爲一年，開採獲鑛則出銅多而底本有著，開採失敗則無產可破，或逃或亡，於是乎有所謂廠欠者。積之旣久，領底本者，即開採獲鑛亦有廠欠，蓋官價過低，不敷成本，爐戶非獲堂鑛，鑛脈最寬之地爲堂鑛，猶言升堂也。無不虧累，虧累無已，則恃拖欠底本爲救急計，故當日應欠者欠，不應欠者亦欠，而廠欠遂爲銅政之大弊。然是時功令嚴，京運有額不足額則當事者獲譴，故上下兢兢，日以不足額爲懼，銅足額，則又冀私售其餘銅以獲重利，故爐戶雖間欠底本，若有銅可繳，則不遑與之計舊欠也。欠久無著，則上至督撫，下

至廠員，皆須按股分攤，不勝賠累，故上下以廠欠以爲諱。廠員經理，惟恃浮支濫報以欺其上，不足則分其私銅餘利以助補，又不足則以廠衰鑛薄，爐戶逃亡，具結稟省，以圖調劑，故當日各廠有諺云：換廠員則過節，換知府則過年，蓋官吏更替，舊欠亦因之而消滅，否則接任者懼累，不敢接收也。於是銅價不足，爐商以廠欠補之，廠員以舞弊救之，底本不發，則無敢試開新硐，新硐不開，銅額卽因之而漸減，故欠者自欠，發者自發，而銅廠乃因之大旺。乾隆中立法過嚴，廠員賠補，均恃本省調劑，及嘉慶十年，開豁免之例，其後乃重見迭出，不以爲怪矣。然則乾嘉中銅廠之旺者，由於之價之昂，資本之充也。

同治以後，其事實則適相反。開辦之初，格於部議，資本既不過數十萬，銅價又不足十一兩，承辦之人，無論官紳，均皆賠累，唐炯任事之初，雖銳意恢復，然資本無出，用人失宜，其所計劃，完全失敗，夫京運既無定額，出銅多寡，辦事者實無責任之可言。且據當日情形，出銅愈多，則辦鑛者虧累愈甚，故辦事者初未嘗希望出銅之多，惟日以剋扣爐戶爲事，銅政之利害，非所計也。況同治以後，官所發款，銅價外更無長期之底本，爐戶惟恃於老硐中拾前人之遺利，以圖衣食，更無餘力以開新硐，而廠務遂一蹶不振矣。

東川鑛業公司之害

前淸銅政之弊，在於國家專利，行之善則廠員與爐戶聯合以欺國家，行之不善則爐戶之汗血，國家之庫藏，皆供廠員之中飽，今日之東川鑛業公司，其政策固無異於昔之廠員也。所異者昔之中飽於一二人者，今則分佈之於股東，昔之朦混舞弊，不敢告人者，今則明目張膽，而不以爲怪，其敗廠病民，今與昔較，蓋殆有甚焉。何以言之，吏雖舞文，猶懼或羅法網，商祇貪利，將恃法爲護符，請試詳言其害：東川產銅鉛之區，異常遼闊，東川鑛業公司，以三十萬元之資本，據有全廠，照公司章程，無論何人，苟欲於東川開鑛，必經該公司允許，所出之銅，亦必經公司定價收買，是故該公司之外，東川有爐戶而無鑛商，苟非生長於斯土，無計他謀者，又孰肯專爲該公司牟利，貨棄於地，商阻於途，其害一也。公司以十六兩四錢之價，發之於爐戶，以三十二兩之價，售之於商人，一轉手間，其利倍蓰，是公司只爲收銅售銅之機關，獲利厚而無經濟之危險，故凡爲股東者，意盈志滿，不願再事改良，前實業司所購鍊銅機器，皆不承認，東川銅業，將永無進行之期，其害二也。官辦時代，爐戶懾於官威，故不敢有怨言，今見公司以私人資格，而專國家固有之利，既妒且怒，積不能平，奸民乘之，轉相謠惑，去歲之亂，可爲殷鑒，其害三也。計公司收買毛銅，脚價提煉局薪等費，每百斤成本不過二十兩有奇，而以專利之故，重價居奇，故滇銅成色不過百分之九十五，在東川出售，價以在三十二兩以上，若照現價運銷各省，則當在三十七八兩左右，反較日本銅價爲昂，各省造幣廠採用，損失不貲，其害四也。況公司之成立，其不正當又有數端；反正以後，實業司承辦一年，獲淨利二十餘萬，合之原

有資本，幾不下五十萬元，初無藉商股之必要，乃一二劣紳，心存覬覦，遽膝混遷就，退還官股，以分其利，其不正當一也。鉛銅各鑛之槽洞，皆歷年國家之資本，爐戶之汗血所經營，若鑛山之鉛，官所自採，槽洞所費，不下十萬元，（如興寶裕國等洞，所用欀木，至三萬餘架之多。）玆東川公司，以一萬八千餘兩之代價，而據爲已有公家每年之所損，不下十六萬元，其不正當二也。廠欠二十餘萬兩中，舊欠十三萬餘，新欠七萬餘，舊欠爲時過久，或多不易收回，新欠則皆民國元年所放，不特爐戶現在，有冊可稽，且一半悉係墊本，與公司收銅，有密切之關係，乃既不列爲公股，又不實踐合同，僅以每年收四千兩塞責，其不正當三也。銅鑛本爲官產，玆無端而授之商人，已不可解，乃本省文武長官，列名於發起人中，分紅沾利，恬不爲怪，其不正當四也。鑛政爲農商部所專司，商人辦鑛，且須領照立案，以備稽查，安有以國有之鑛，付之商人，而不一問之於部者，按東川鑛業公司章程第七十六條，本有經股東會議決，呈請行政公署（指滇省言）批准，並呈報工商部核奪等語，乃商人既未請求，省吏亦未報告，故部中至今無案可稽，其不正當五也。夫公司成立之不正當也如此，其現狀之有害也又如彼，則部中之不能置之不聞不問也，彰彰明矣。

改良銅政辦法

如上所言，則東川鑛業公司之當然取消，固不待言。公司股本，共計三十萬元，商股二十萬中，實欵放之爐戶者，不足十萬，故取消手續，只須限該公司收銅之期，退還商股，即無他交涉，以公司於廠上初未有所建設也。取消之後，計劃何若，一視政府之政策爲定，今試舉其有研究價値者詳論之如下：

(一)政府自辦

政府自辦法之有三：

(甲)放本於爐戶，以賤價收銅。

(乙)用土法自辦。

(丙)用西法自辦。

按(甲)與(乙)皆不可行。甲法完全仿滿清之制，未必有利於國，而實有害於民，其弊於前章已詳言之，玆不復贅。乙法則其弊更多，因用土法開採，必多設槽硐，始可希望見效，槽洞愈多，管理愈難，冗濫偷漏，無從稽核，無論專利不專利，皆有窒碍也。東川銅脈雄厚，出鑛地面甚寬，似於西法開採，亦頗適宜，惟江非習鑛工者，不能詳細計劃。據前滇實業司所派日本工程師山口所言，則謂以五十萬元之資本金，即足以敷開採運輸製鍊

之設備，此外每日營業費，約須五千餘元，淨銅銷路甚旺，資本流轉極易，預計約有流通金三十萬元，即可敷用，是全數資本，不過八十萬元，而公家股本尚有十萬元，存於東川鑛業公司，餘欵飭各省造幣廠分籌湊足，似尚不甚難，所難者官辦事業，開支易流於濫，營業易流惰，任事者不能久於其事，用人者不易監督其人，一有虧累，往往移他項公欵爲之補助，補助愈多，虧累愈久，故其失敗也亦較私人失敗之受損爲多，如箇舊錫務公司，即可爲前車之鑒也。

(二)招商承辦

招商承辦，於吾國今日情形，最爲合宜。且東川各廠，獲利之厚，久爲滇人所深知，即就本省招股，當亦之乏應者，若將其沿革現狀，宣布之於外省商埠，則利之所在，人必爭趨，數十萬元，似尚不難募集。惟東川公司，久爲國有，茲開放之於商人，其情形自與尋常鑛權逈異，竊以爲政府所應要求於商人者，約有數端：(一)公司資本，至少在八十萬元以上。(二)其開採製錬計劃，須經政府認可。(三)尋常鑛稅之外，應加納特別鑛捐若干。(四)所出之銅，應先儘各省造幣廠購買。夫如是則政府可以分享營業利益，而不負營業責任，公司即或失敗，正不妨另招他人，以承其業，不致如官營事業，以有限之資，塡無底之壑也。

然無論官辦商辦，政府有不可不注意者如下：

(一)永遠破除專利　東川自前清初年，改爲官辦，國家專買銅之利，二百餘年，國未見其利，而民已受其害，試以表中所列洋銅市價，部發總數，爐戶領價，錬銅成本四項相較，即可知矣。東川廠地遼濶，鑛苗甚豐，决非一二公司數十萬資本所能盡辦。苟俾人以專利之權，適足以啓壟斷之害，蓋官專利則無比較，商專利則無爭競，即曰發達，損失已多，故無論官辦商辦，只可與承辦者以優先採鑛之權，限以時日，責其按法劃區，復量其資本之厚薄，定其鑛區之大小，所未劃之區，不妨聽舊日爐戶，領照自辦，以昭公久而速競爭。

(二)分別清理廠欠　廠欠分爲新舊兩項，前已略言之，咸同以降，官發銅價過低，爐戶苟非得有異常佳鑛，則成本往往不敷，故其大多數衣食僅足自給，毫無盈利之可言，甚或有虧折不堪者，離流轉死者，明知所獲利益，不歸於國家，而歸於官吏之中飽，又不能不仰給於官府放本，以謀其生，一經領到官本，欣然就業，然以得價過賤，故所出之銅，恒不足扣還所領之本，此廠欠之所由來也。乾隆時功令極嚴，廠欠全恃彌補，嘉慶以後，豁免之例始開，如嘉慶十一年十五年咸豐三年光緒十七年，其尤著者也。茲擬援此成例，凡前清時舊欠，概予豁免，以紓廠戶之困，凡民國元年實業司所

放之本，爲時未久，按冊可稽，宜視欠款者之停辦與否，分別追繳，停辦者封其舊有槽洞爲官有，未停辦者其所出之銅，應於正課以外，另納數成以補其欠，庶逐次分收，不患無著也。

(三)保護爐戶灌利　東川各廠，除鑛山之鉛廠外，其餘槽洞，皆爲爐戶所私有，蓋開採之資，雖皆出之於官，官以賤價收銅，縱有虧欠，得利已多，似不得再指爐戶之槽洞爲官有。惟銅廠舊爲官辦，則國家或國家指定之承辦人，當然有優先之權，玆若用新法開採，所劃區中，必有舊日已開之鑛洞，爲洞主者當然有要求相當酬報之權，其酬報之厚薄，可視其近日出銅之多寡爲轉移，或作爲股本，或立與現銀，悉聽洞主之便，此區以外，不妨與舊日爐戶，以優先之權，聽其領照劃區，自行開採，其營業過小，無力領照者，或另爲規定，俾勿失業。

(四)設立鑛業銀行　東川各廠，决旣非一二公司所能盡辦，前已屢言之，故欲求發達，不如變舊日之爐戶爲鑛商，蓋舊日因銅價過低，不敷成本，故所得之鑛，每百斤至少含銅八斤，方可開採。玆旣取消專利，聽其自辦自售，則銅價驟漲，獲利必豐，爲爐戶者，不必另自開採，僅收拾其昔日所棄成分較低之鑛，卽可不憂貧，一反手間，產額將驟增數倍。惟爐戶數百家，殷富者不過一二，誠恐改革之初，富者難與更始，貧者家無立錐，當新舊交替之時，將有不可終日之勢，宜一面取銷東川鑛業公司，一面卽以其中公款，設立鑛業銀行。凡舊日之可靠爐戶，有財產作抵者，仍接續借以底本，俾得營業，惟所借之款，加以利息，出銅以後，立卽淸還，所出之銅，聽其自行交易。按光緒二十九年，箇舊錫廠，爲土匪周雲祥所亂，滇中大吏，有官商公司之設，集官商股本三十萬元，放債於鑛商，按年取息，以濟其困，行之五年，獲利甚厚。東川出銅，遠不及箇舊出錫之多，苟得十萬元，卽可供全廠之用，而鑛業公司官股，已有此數，正不必另籌他款也。

中華民國四年六月十日

技正　丁文江

XXV. EXPLANATION OF PLATES*

Plate X

Fig. 1. Section across Makuho to Tiehkuangshan.
a. Dolerite. b. Weining series. c. White limestone. d. Waitaoshan coal series. e. Tapingtzu limestone. f. Tungchangho basalt. g. *Gigantopteris* coal series. h. Huanglishu series.

Fig. 2. Section across Weining basin.
a. Pochiwan shale. b. Shihlipu black limestone. c. Silicified limestone. d. White limestone.

Fig. 3. Section across Kotuho.
e. Tapingtzu limestone. f. Tungchangho basalt. g. *Gigantopteris* coal series. h-i. Huanglishu series. j. Kotuho series.

Fig. 4. Section from Tangtang to the valley of Hsuanwei.
a. Limestone with quartzitic sandstone. b. Basalt. c. *Gigantopteris* coal series. d. Red sandstone.

Fig. 5. Section S of Changchung.
a. Black to dark grey limestone. b. Silicified limestone. c. Light grey to white limestone. d. Basalt. e. Black shale. f. Red sandstone.

Plate XII

Fig. 1. Section across Tungshan SE of Chutsing.
a. Black shale and yellow and grey shale with discontinued limestone bands. b. Fairly pure dark blue limestone. c. Yellowish quartzitic sandstone with thin bed of impure black limestone. d. Impure black shaly limestone interbedded with black and brown shale. e. A series of reddish to yellowish quartzitic sandstone, black shale, black shaly limestone, reddish pure limestone. f. White limestone. g. Very pure dark grey limestone.

Fig. 2. Section from Hsiapo to S of Haitzupu.
a. Hard quartzitic sandstone, black shale, dark grey soft sandstone and light grey limestone. b. Quartzose sandstone and black shale and impure black limestone. c. White limestone. d. Quartzose sandstone with occasional band of black shale. e. Dark grey to blue limestone.

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* Explanation for other plates are unnecessary or given in the plates.

Fig. 3. Section from Chehchiawan to Tamaanshan.
a. Quartzitic sandstone, black shale, thin bedded black limestone. b. Pure grey to blue limestone. c. Basalt.

Fig. 4. Section from Pingyi to E of Chehchiawan.
a. White to light grey limestone. b. Quartzitic sandstone, black shale. c. Pure grey to blue limestone. d. Basalt. e. *Gigantopteris* coal series.

Fig. 5. Section at Tsueifengshan.
a. Brown sandstone. b. Fine-grained sandstone alternating with shale and impure shaly limestone bands. c. Red and green soft micaceous sandstone, fine-grained sandy shale.

Plate XIII

Fig. 1. Section above Lochotang.
a. Yellowish quartzitic sandstone. b. Thin band of black limestone (impure). c. Yellowish quartzitic sandstone. d. White limestone.

Fig. 2. Section from Hunshuitang to Chanyi.
a. Yellow quartzitic sandstone. b. Reddish crystalline limestone. c. Red quartzitic sandstone. d. Black shale. e. Limestone.

Fig. 3. Section from Hsintun to Haitzupu.
a. Reddish slaty limestone, red and green fine grained sandstone and shale. b. Yellowish quartzitic sandstone, black shale and thin band of black limestone. c. White compact limestone. d. Yellow quartzitic sandstone.

Fig. 4. Section at Wenpishan.
a. Massive white limestone. b. Quartzitic sandstone, black shale and thin limestone. c. Massive grey limestone.

Fig. 5. Section at Hsinpu.
a. Soft fine-grained sandstone. b. White compact limestone with black bands between. c. Reddish quartzitic sandstone and black shale. d. White to grey limestone. e. Soft yellowish sandstone. f. Grey limestone. g. Soft reddish sandstone and black shale. h. Dark blue limestone. i. Basalt.

調查正太鐵路附近地質鑛務報告書*

（圖版SMA, B, C）

文江，梭爾格，錫賓，奉命調查正太路線附近地質鑛務。梭爾格，錫賓，於十一月十號自獲鹿縣起程，經頭泉微水，步行至井陘縣所屬之岡頭村；文江因病稽遲至十一月十二日，始得由京乘火車至岡頭，於十一月十五日與梭爾格在微水會齊。自十一月十五日至二十六日，文江等在直隸[現河北省]界內正太路左近調查，商定梭爾格，錫賓擔任井陘縣北部，文江擔任井陘縣南部，至十一月二十五日事竣。錫賓先乘火車往陽泉保晉公司調查鑛井，文江與梭爾格步行前往，至陽泉會齊，至二十七日行抵娘子關，忽遇大雪，遂改計乘火車至太原，調查西山煤鑛硫礦；旋因時日過迫，於十二月一日乘火車至陽泉保晉公司與錫賓會。計山西境內正太路附近，除平定太原以外，惟壽陽榆次尚有烟煤，乃定議梭爾格調查平定州鐵路以北及盂縣，文江調查鐵路以南及樂平，錫賓分赴壽陽榆次。錫賓抵壽陽因病未克竣事，乃改計，梭爾格由壽陽澆道赴盂縣，錫賓赴太原調查正豐公司詳情，由太原再赴榆次，均於十二月二十三日後回陽泉，二十六日抵京。茲將各處所見詳繪總圖分圖，謹呈　　鈞覽，並將晉直兩省情形，分別詳述如左。

甲　直隸境內之地質鑛務

（一）地層次第　　直隸省內正太路線所經之地層可分爲五系。其最下者爲纍岩 Gneiss 及片岩 Schist 所成，獲鹿縣南井陘縣北皆有之，據德人李西德氏，美人威列士氏言，五台山卽爲其所成，故二氏名爲五台系，今沿用之。五台系之上半爲灰岩 Limestone, 間有紅板岩Red slate; 灰岩中多砂粒 Siliceous grain, 故不可用以燒灰；獲鹿縣南井陘縣北皆有之，德人李西德氏始見之於山東，爲中國南北所共有，故李氏名爲Sinisch, 譯爲支那，今因其名不雅馴，擬就李氏所首見之地名之爲兗州系（兗州等于威列士之滹沱）。此系之上爲純粹之青灰岩，爲此次調查區域中最普通之岩石，美人威列士名之爲冀州系，今沿用之（冀州當作𨺗州）冀州系之上爲砂岩 Sandstone 板岩Slate, 中含煤層，間有灰石，是爲吾國北部普通之石炭系，井陘縣煤田卽爲其所成。此系以上在調查區域內，祇有黃土，黃土之上間有古火山流出之石歐，名爲 Basalt, 日人譯爲玄武岩；玄武臆爲日本地名，不適於吾國之用，今擬改譯爲雪花岩，蓋文江始見之於井陘縣城西南之雪花山故名。以上所言五系於總圖之右，視其次第厚薄，列爲直面圖，以便與平面圖相參考［圖 SMC］此五系之次第以文江等所

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*此報告已見民國三年出版之「農商公報」，惟無附圖。今爲便讀便利計，特予重印。

見聞言之，皆確定不移，從無混雜，故若能知一地之岩石爲冀州系以下之地層，則可知其下必無煤炭，此爲地質與鑛務關係最密之點，故不厭煩瑣詳述如上。

（一）地層構造　地層之次第如上所言固已，然地層成就以後所經變遷不一而足，向之坦平者今則傾斜，向之連續者今則隔斷。太行山脈在調查區域內大都由東北延向西南，沿山地層無不捲疊傾斜，或斷或續，故石炭地層間｜?｜之漏地皆是者，今僅於斷澗殘溝中見其踪跡，山脊嶺畔，惟餘冀州系之青灰岩，其上之石炭系，久爲風蝕水沖，掃地淨盡。蓋以兩系相較，石炭系遠不及冀州系之堅硬，故不及其經久。若衆山之中因地層斷裂而成平谷，則石炭系若得一蔽風雨之所，雖其下仍有冀州系地層，而其所處地點則反較其四圍之冀州系地層爲低，如井陘縣煤田即其例也。

（一）井陘縣之煤田　井陘縣煤田平均計算長約三十餘里，寬約八里，周圍皆山，棉河從娘子關來，橫貫縣城之南，河之北爲鳳凰嶺，分煤田爲兩部，嶺北爲岡頭村煤田，井陘鑛務局在焉，嶺南爲井陘縣城，城西南二里許爲黃村，正豐公司在焉；岡頭之南橫澗之西，尙有井昌公司，亦用機器掘井，惟因水過多，至今尙未出煤。據梭爾格所見，該公司煤井適在煤層斷線之中，將來恐不易發達。茲將井陘鑛務局及正豐公司情形畧述如下。

井陘鑛務局地上所占面積，除至南河頭之鐵道外，約五百畝，原爲岡頭村，在井陘縣城之北二十餘里。自地面下二十五米突，皆係黃土，煤共五層，最下一層距地面約一百八十米突，厚在九米突左右，第三層最薄，厚不過半米突，其他三層則在一米突二米突之間。煤質則各層稍有區別，平均每百分煤有灰十分有奇，飛質二十餘分(其最佳者灰只百分之六)。可用以燒礁炭，惟灰質成分則更較多(約百分之十二)。出煤共祇兩井，南井較淺，北井較深，昇降轉運皆用機器，開採則用人力。出煤多時，日可得九百噸，用工人約二千。現因銷路遲滯，日出煤不過五百餘噸。工人下井者不足八百人，而局中堆積之煤爲數尙多，聞石家莊售煤處亦極遲滯，自六月以來各戶所欠煤價爲數甚鉅，公司因之支絀，至今井上八月工資尙未發給，其他可知。公司營業本部實在天津，石家莊爲其轉運之中心，岡頭村則專爲出煤地點，故每月開支不過一萬三千元，而組織精密，百事具舉；以辦事人言，局中主政者不過十人，監工以外，井以下有煤鑛師一人，井以上現無總工程師，一切事務均由化驗師兼管。中國人除助手外，有駐局委員一人，專管局中內外治安，官醫一人，專治工人損傷疾病。計工人上下千人，而所用巡警不過二十餘人，內尙有工人受傷殘廢不能工作，由局委充門丁者在焉。井下工作分爲數區，每區總以工頭一人包辦一切，工資以出煤多寡計算，計每煤一車重可半噸，視地底運路之遠近難易以定工價（自一角五分至二角一車）。其他工人皆爲工頭所招，然須受局中節制。村中生活程度甚低，井中工人每日所入不過銅元十八枚，皆由工頭發給與局無

涉，惟受傷身斃則由局給洋四十元爲安家之資。據官醫李君言，工人受傷者雖多，身死者極少，特十分之一皆係幼孩，工作極苦，工資極賤，往往受傷未愈即復下井，是可憐耳。局中開支雖省，而設備則頗完備，井以下無論已，井上蒸汽機以外，復有鎔鐵處，模型處，製造處，舉凡普通之大小機器皆可在此自造，無須外求。井底之水，用機器吸上，中多煤末，初不可食用，現造水池多座，連以長管，水由高處下流，先與空氣相和合，再逐次入池，由動至靜，沙灰下沉，逐漸清潔，至能見池底，乃可供尋常日用。又有磚窰能造火磚，礁池能燒礁炭，俱雜用土法。礁池即在地中，每四池有十字形洞一，以通於外，所燒之礁，灰雖略多，質甚沉重，惜銷路不旺，行將停辦矣，局中所辦之事，可足爲吾人取法者，厥爲種植；鑛井所用材料，以木爲最貴，北部既無森林，取材往往不易，現公司就局之周圍掘溝築堤，堤內廣植槐楊，及今不過四載，大者徑已四寸，十年以後計可蔚然成林，而局外諸山雖遍有黃土，皆童禿荒凉，無一草一木良可歎也。

正豐公司煤井，即在正太路井陘縣車站附近［圖 SMC］，運路較岡頭爲便，然岡頭煤共五層，該處只餘其一。以文江所見該處煤層即岡頭之第五層，此下即爲青石，再無他層。且煤層斜向東南，一里之外恐有斷裂。煤井之西北爲雪花山，山水沿煤層而來，井中常受水患，故其天然位置，實不如岡頭。以人事言，則公司中無工程師，無鑛井圖，舉凡一切事務，惟無高等教育之工頭是賴。辦事者對於該井將來著手之方法次第，毫無確定把握。文江非習鑛者，對於工程本不敢置喙，惟就普通知識言，掘煤宜在煤層最低處，然後次第上向，井中縱有水患皆在已掘地面，不致因此停工；今該公司則反是，且其地底工程皆極草率，地底以鐵路言，煤車來往因軌道傾側往往停滯，苟不延有鑛工知識者主持其事，恐非求公司發達之道也。惟煤層厚幾二丈，煤質亦係烟煤，可燒礁炭，若辦理得宜，銷路推廣，未始不可與他公司競爭。現該井深約十三丈，每日出煤二百噸，因銷路遲滯，運費過重，堆積頗多；計該公司運煤一噸，每一法里需運費洋一分，故煤價在黃村每噸不過一元有餘，至保定即須六元。正太鐵路車輛過小(每車不過二十噸)，運費過貴，因軌道過狹，至石家莊必須換車，實晉直兩省鑛業發達之大障碍也。

(一)井陘縣之五金　岡頭村之北，橫溝河之西，有五台系地層，以梭爾格前在京北，文江前在山西天嶺所見，中國北部之金銀鑛質，皆在此系之中。該縣小作村之北，曾有金鑛，惟成數過微，不敷成本，久未開採。按中國普通閱歷，石炭系煤田之下，冀州系灰石之上，類有鐵鑛，井陘煤田當非例外。惟文江，梭爾格從未見有可用鎔鐵之鑛質，蓋鐵在煤與灰石之間者，既爲煤所掩，煤層之上，復有黃土，故發見不易。詢之土人云，舊亦有掘鐵者，後因煤價過貴，成本過重，不能與平定競爭，故久廢棄。按平定煤爲硬煤，鍊鐵不如烟煤之能

燒礁炭者，如井陘鐵質果佳，則甚宜於西法，惟用西法鍊鐵，需鑛質極多，井陘煤田本不甚廣，鐵鑛必不敷用，且鐵非煤比，不易發見，即開採之絕大障碍。故該處除煤田外，他無可採之鑛可斷言也。

乙　山西境內之地質鑛務

(一)太原府之西山　　太原東西皆山，中爲平原，山之附近有烟煤，亦有硬煤。西山復產硫磺。文江，梭爾格曾同往西山之石槽溝，地距城約三十里，山根爲冀州系地層，其上爲石炭系，中只有煤一層，厚約一丈，上有有化石之灰石，因知此亦爲石炭系中最下之煤層，再下不復有煤矣。山側有煤井，然煤質頗劣，井下即硫磺鑛，鑛質爲鐵硫，厚約三尺許，在冀州系與石炭系之間。鍊硫之法，先掘三穴于地，每穴置一空缸，缸口上向，高與地平，缸之四周地面之上，用舊罐築爐，再用三罐滿盛碎鑛，倒置爐中。地上各缸之口，與地下各缸之口相對，罐口用大塊鑛石堵塞，不使小塊墜出，罐缸相合之處，以泥封固不使透氣。罐之四周密佈碎煤，火即生于其中，地上之罐爲火所圍，熱度甚高，其中鑛質因空氣不多不能養化，故硫磺變成氣體，下入地中之缸，熱度漸低，復凝結于缸底，乃以長杓取置大口泥盆內，冷透即成圓形硫餅，厚約四寸，徑約七寸。自生火至出硫計須兩日，據云每鑛質一百十四斤，可得硫磺十五斤，是不足百分之十一。據前山西大學化學教習鈕君（瑞典人）［似即 Nyström］化驗云，西山鐵硫每百分可得四十餘分，與此不符。以文江等所見，用土法鍊硫，法甚單簡，而得硫頗多，成分之低，因所用鑛質雜有灰泥，非鍊渣中有餘硫也。文江，梭爾格所見之鑛，爲王封公司所有，因爲時過迫，未得至該公司詳詢一切。錫賓至太原後，乃復往王封山調查，該山之白道村礬水溝，有煤窰四座，均開平井，高約四尺，長約二三十丈，煤層厚不過三尺，上層爲硬煤，下層爲烟煤，用小車運煤出井，每井每日約出煤千斤，所出之煤以牛馬運至太原省城銷售。煤質佳者可得二文一斤，普通之價不過一文。此外王封山西二十里之王封鎮，亦產煤鐵，礬水溝附近之塔岩地方復有石膏，厚約半寸至二寸不等，現尙無人開採。王封公司專採鐵硫以製硫磺，所有之鑛除石槽溝外，尙有礬水溝，大片洞，台圪洞三處，每處約用工人四十名，每日四處共出鑛一千五百斤。所製硫餅運至太原省城，每斤脚力二文三毫，售價每斤七十文，運銷之地區域頗廣，皆由直隸奉天山東商人自運，與公司無涉。

(一)平定州　　光復以前，平定爲直隸州，壽陽盂縣樂平屬焉，壽陽盂縣爲縣，樂平爲鄉，光復以後俱改爲縣，文江等所調查區域，適與舊直隸州治地相合，是爲正太路附近鑛產最富之地，文江等調查時日亦以此爲最久。今將該處地層之構造，煤鐵之分佈，并現在開採之景狀，將來發達之希望，詳述如左。

地層之構造　自平定四出，北至盂縣，南至樂平，西至壽陽，東至井陘，無地無山。就山之種類，可分爲三區：東區在晉直兩省之間，爲純粹之冀州系所成，其中奇峯迭起，峭壁相接，平均高度約在二千尺以上，是爲太行山；平定以西之山，高不過千尺，無出突之峯，捕天之嶺，蜿蜒相續，宛如邊牆，是爲高原；太行高原之中，衆山起伏，纍纍如墳，高不過三百尺，上有黃土，中有深谷，是爲煤田。此就地形言也，考其地質，則三區之中可分爲五層：太行爲冀州屬，無煤無鐵，煤田太行之間爲產鐵之區，自北至南成一狹帶，文江等首見之于陽泉站東之五渡村，因名之爲五渡層。煤田中有煤多層，其最要者則祗有三，此三層中以最下一層爲最厚(一丈半至二丈)，其上有有化石之石灰岩，土人名之爲閻石，爲開採最要之標識。閻石以下非遇大水或舊窰，未有無煤者也。此層之中心爲平潭村，因名之爲平潭層。平潭層以上之煤二層，厚皆在一丈以內(一約七尺一約四尺)，是爲賽魚層，蓋賽魚爲古受州城址，又爲鐵路車站，適居此層之中故名。過此即爲高原，中多砂石，不復有煤，是爲坡頭層（坡頭亦車站名)。凡此五層，以坡頭爲最上，賽魚次之，平潭又次之，五渡冀州爲最下。特地層自東西傾，故最下之層其現於地面亦最東［圖SMA］，自東西行，凡灰石凡鐵凡煤皆逐次斜入地中，不復可見，然其次第厚薄要皆確定不移，無復疑問。故如高原之中，現雖無開採煤鐵者，而煤鐵各層實在其下無可疑也。至於各層之廣狹曲折，按所附呈之圖可知，惟圖中所繪僅爲現於地面之地層，如平定州西高原之下雖有鐵層，而發現於地面者則爲坡頭層，故圖中即以坡頭層繪之，非謂平定之煤至高原即斷也。煤礦煤層與地形之關係，既已如上所言，然同一煤層，或爲硬煤，或爲烟煤，或不易開採，或灰質過多，又皆因地而異。現時開採之煤井，或在平潭，或在賽魚地層之中，要皆無過三十丈以上者，過此則單用土法開採不易。然調查區域內平潭層中最厚之煤層，距地面無過一千尺者（平均約七百尺），將來用新法開採正復不難。惟平定樂平境內，只有硬煤，煙煤則惟壽陽縣北之榮家溝及盂縣之華山有之。榮家溝之烟煤在賽魚層中，華山則平潭層中亦有烟煤。榮家溝有保晉公司煤窰，其煤火力甚大，可供正太鐵路之用，惜皆係碎煤，恐不宜燒焦炭，華山之煤亦然。平定以南，聞遼州尚有烟煤，外此則皆係硬煤矣。

保晉公司　自晉人以二百七十五萬金向福公司贖回鑛權，保晉公司即因以成立，其股本二百餘萬，大半爲山西政府移償福公司之用。原定以晉省每年畝捐收入逐次清還，光復以後畝捐移爲軍餉，保晉公司遂因以大窘，秩序恢復以後，鑛井乃復開工，合計各井每日可出煤三百噸，運銷於上海者每年約二萬噸，餘則銷於京津保定。現時在陽泉開採之井，共有八處，錫賓皆親往調查：(一)鐵爐溝，在陽泉車站之東六里，即在鐵道之側有直井一，深約十四丈，井口圓形，對徑十四尺，井內週圍均以石砌之，煤層約厚二丈許，井上設有高車一具，

升降機兩座，大號六十馬力，小號三十馬力，無盛煤車。升煤時將大塊煤縛於一處，以鐵鉤鈎之，井之附近設有鍋爐兩座，爲升降機及吸水機之用，吸水機水管有三，一大號管徑三寸，二小號管徑二寸，每日出煤約百四十噸。(二)燕子溝，在鐵爐溝之西三里，亦在鐵路左近，開有二直井，大者對徑十四尺，深約十五丈，小者對徑八尺，深約十四丈，均未見煤；井上有高車一具，井旁有機器風扇及升降機，外復有壓氣機一，平形大鍋爐二座，直形大鍋爐一座，機器房一所，鐵工房一所，惜開井時曾遇火數次(爲炭輕四所致)，宣統三年六月間即已停工。(三)賈地溝，在平定西北，係用土法開採，有直井二，一深約二十七丈，對徑八尺，一深二十四丈，對徑八尺，純用土法開採，每數日始用木桶取水一次，每日出煤四十噸。(四)段家碑，在平定西北，純用土法，僅有一井，水較賈地溝爲多，日出煤十餘噸。(五)後山溝，即在段家碑山後，亦係土法，井深十六丈，每日出煤二十餘噸。(六)老先聖溝，距縣城二十七里，係用土法開採，有直井二，均深十九丈，每日約出煤三十五噸。(七)莊花溝，係用西法開採，有直井一，井口對徑八尺，深約十七丈，以石砌之，井上有高車一具，三十馬力之升降機一座，直形鍋爐一座，吸水管有三，大者徑三寸餘，二管約二寸，每日出煤約六十噸。(八)漢河溝，兼用西法開採，有直井二，一用人力絞煤，深約十七丈，一用高車，深二十丈，井口皆八尺，有三十馬力升降機一座，直形鍋爐一座，惟吸水則用木桶，無吸水機。以上八處除鐵爐溝燕子溝外，皆在鐵路之北，煤用驢運至陽泉該公司。此外尚有榮家溝之煙煤井，在壽陽縣北四十餘里，僅一斜井，深約在三十四丈，由井口向下均以石砌梯，煤層厚約九尺。運煤出井之法，由工人以布袋裝煤，負之而出，每日出煤約六十噸(夏間只出煤二十噸)，井旁設有鍋爐二座，一四十馬力，一三十馬力，爲吸水機之用，吸水機管徑三寸，煤用牛車或驢馬駱駝運至車站。

平定州煤礦之前途　煤田之廣，開採之易，煤層之厚，如平定州者，不特吾國所罕有，亦歐美所僅見也。陽泉車站之北，交通較便，尤易發達。蓋煤上爲固石，用木極少，水亦不多，雖間有斷裂，皆無大障礙；且煤質堅硬，開採轉運皆極便利，故自古平定爲產煤地，其煤價亦極廉。據平定樂平二縣行政官所調查，兩處共有煤窰四百五十餘座（樂平縣只七十餘座，俱在平定境內)，每年約共產煤一百八十萬噸(平定縣約出十之八，樂平縣十之二)，其外銷者統二十萬噸，餘俱供本地住戶爐戶之用，約尤以爐戶爲大宗。蓋土法煉鐵不特用硬煤生火，且用煤末與礦質和，以去礦質之養氣，故用煤若是之多也。是平定之煤，實與鐵相表裏，茲欲推廣該處之煤礦，不患礦產之不豐，開採之不易，而患銷路之不暢。欲推廣煤質之銷路不外三端：(一)推廣本地之鐵爐；現時平定樂平二縣，約共有鐵爐一千座，每年共煉鐵八萬餘噸，若能增加產鐵之額，則產煤之額亦必因之而增加；然此僅就增加用土法煉鐵之爐而言，若用

西法煉鐵，則需用焦炭，硬煤全不合用，故若今日使平定區域所有各爐全數改用西法，則不特無益于煤鑛而且有損矣。(二)籌畫硬煤之出口；硬煤以英美爲最著名之產地，英之西南所產硬煤，均恃出口爲銷路，若平定之無烟煤能轉運至海，或可與英美所產者競爭；然據瑞典人鈕氏所化分平定之硬煤，灰分較英產者爲多，此卽爲一大障礙，且距海過遠，運費過重，就目前之事勢言之尙無籌畫之可言。(三)推廣內地之銷路；硬煤無烟宜于家用，且火持久，不若灰煤之易滅，故吾國人尤樂用之，如直隸臨城井陘等處，本地雖有煙煤，而轉運平定樂平之硬煤者踵仍相接，若能使該處之煤轉售于黃河及揚子江之下流，則向之專恃柴火者，且將改用煤爐，旣可爲硬煤籌銷路，又可爲童山保森林，實一舉兩得者也。所可惜者，正太鐵路軌道太狹，運車過小，運費奇昂，保晉公司所出煤，在本地出售每煤一車(二十噸)價四十七元，運至石家莊，路不過二百四十中里，即須加運費八十餘元，自石家莊至天津路約一千里，所加運費計不過六十餘元，則正太路價之貴不言可知，若能與交通部轉商設法，使正太路減收運費，則卽今日開達平定硬煤鑛救急之一法也。

鐵鑛

鑛質之由來　凡平定樂平盂縣鐵鑛，皆在五渡地層中，前已畧言之。五渡地層爲石炭系最下之層，在冀州系之上，中有古代之火山石，日久蝕爛成灰白色。此石之下，冀州系石灰岩之上卽有鐵鑛，而尤以石灰岩破裂之縫中爲最多。考其原來，蓋火山石中鐵質甚多，成岩以後，上覆煤層，當煤層成就之先，森林繁殖，土性必肥，其中多含酸質，此酸下流，經火山石中，鎔化其鐵，成今日鐵之溶液，再下流遇石灰岩乃起化學作用而成今日之鐵礦，故鑛質爲二鐵二養三三水與鐵炭養三相合而成，分佈頗廣，惟其最豐富者則在石灰岩縫中，故無一定規則，此就平定盂縣樂平鐵鑛之大部分而言。至于樂平與和順交界之鐵鑛，則與此稍別，文江于南野頭村南之爐溝口，見有鐵礦夾于煤層之間，是與上所言略異，然亦在五渡地層之中。聞自鐵爐溝至和順，沿途多有鐵爐，其鑛質是否與爐溝口相同，頗有研究之價值，惜爲時過迫未得南行耳。

鐵鑛之分佈　鐵鑛雖皆在五渡層中，然五渡層不必盡有鐵鑛，蓋地層成就以後，所經變遷不一而足，故斷紋破裂所在皆是，又有發現于地面之地，適爲河流之所經，則早爲河水之所掃盡，今日鐵鑛最豐之地，實在平定州之東北，平定東南已不若東北之豐，及至樂平縣城之北，鐵卽中斷，至樂平縣城南四十里柴嶺之南，始復發見，然其性質已較北部稍異。礦之所在不必有爐，然有鐵爐之地，距鐵必不甚遠，故觀鐵爐之分佈，卽可知鑛質分佈之大概。據平定樂平二縣行政官所調查，平定州境內鐵路以北共有爐九百七十二座，以蔭營爲中心，鐵路以南共有爐一百二十七座，以東溝爲中心，至于樂平則南北共六十八座，遠不及平定之盛

矣。

鍊鐵之方法　土法鍊鐵，頗甚簡單，先用陶土製長筒數十（約長二尺），然後鎚鑛成末，與煤屑和置其中，各筒盛滿，堆置長方式之地爐中，其上下用舊筒砌成故易透空氣，火即生于其中，筒之四周密佈煤屑，一晝夜後乃開爐，以長鐵叉取筒出擊破之卽得生鐵，是爲悶鐵爐。生鐵中含雜質甚多，且易破碎，用之之法或再鍊成熟鐵，或卽鎔鑄成器。鍊熟鐵之爐名炒鐵爐，亦係地爐，惟須用柴火或烟煤，蓋必須有火焰，始可合用，故不能用硬煤，火焰之上堆置生鐵，上蓋煤末，勿使養化，俟鐵已燒紅，卽開爐用長鐵棍攪之，故曰炒鐵，蓋爐中熱度不足以鎔鐵，而可以鎔鐵中所含之渣，炒之使鐵與渣離也。爐壁有孔通于外，初時閉塞，炒鐵畢乃開孔放渣，渣鎔如水，由孔外流，鐵旣未鎔，仍留爐底，然已去渣而成熟鐵矣。鑄鐵器之爐名倒鐵爐，與悶鐵爐相似，惟以生鐵代鑛質，且祇于筒上略置煤末勿使養化，不若悶鐵爐用煤之多，生鐵鎔化乃倒置砂製之模型中，卽成鍋罐等器。

生熟鐵之消長　生熟鐵產額之比較頗有研究之價值，以熟鐵與生鐵較，熟鐵用廣而價高，似其銷路宜較生鐵爲廣，產額宜較生鐵爲多，考之事實則適相反。以平定縣境內計算，每年所產生鐵至少較多于熟鐵一倍，推求其故或有數因：(一)各處鑛質或爲不同，如含燐質太多，則宜于生鐵而不宜于熟鐵，(據福公司調查員報告，平定生鐵每百分含燐〇．九六，是燐質成分太高，惟是否各處相同尚不可知）。梭爾格在盂縣時，聞壽水以北之鑛，宜于熟鐵，且鍊生熟鐵各有區域，毫不相混，如鐵路以北蔭營，河底，山底，中佐村專鍊生鐵，楊家莊，侯家溝，楊家溝(屬盂縣)專鍊熟鐵，鐵路以南則東溝爲生鐵之中心，梁林頭鎖簧專鍊熟鐵，樂平縣則所有鐵爐幾無不鍊熟鐵者。文江等此次皆攜有各地標本，俟化驗事畢後卽可確定。(二)熟鐵須用烟煤或木柴，材料過貴不能多製，然樂平與平定情形相同，而樂平皆製熟鐵似此非其眞因。(三)煉熟鐵須用炒鐵工人，不若生鐵之易，炒鐵之法或惟少數能之，例如樂平雖有陶土，樂平土人只知燒缸不能燒壺，燒壺惟平定土人能之，故樂平境內砂壺皆出平定工人之手，文江在陽泉時聞保晉公司中人卽以此答，然以常理度之似不甚確。(四)近年來熟鐵器具(如兵器針釘等物)由外國輸入者日多，故本地熟鐵銷路漸滯，例如蔭營舊亦鍊熟鐵，今不復作是也。

鐵業之前途　據平定樂平縣行政官調查，每年兩縣共產鐵八萬餘噸，以兩縣面積計亦不可謂多，故欲求鐵業之發達，非改用西法不可，然欲知西法之適宜與否，必先知(一)鑛產之多寡，(二)鑛質之優劣，(三)開採之難易，(四)材料之完缺。茲請分別略言之如下。鑛產之多寡爲最難解決之問題。考平定盂縣樂平之鐵鑛約可分爲兩區，一發現於地面者，一深藏於地下者；第一區之鑛皆在地質圖中所繪五渡地層之內，自古至今經人掘發，蓋不知其幾千百年，現

所餘者已成弩末，欲恃此散布不全之鑛，供一絕大鐵廠之求，恐決不足用；且若用西法開採則現在各處之零星小鑛，勢必受其直接影嚮，利未及見而害已先成非計之得也。然五渡地層深藏于地下，從未經人開採者，其豐富正不可限量，若其中鐵鑛果與發現于地面者相等，則必有絕大之價值，蓋平定產鐵自古已然，其開採時期以千五百年計，每年出鐵八萬噸（即現在產額），則已掘之鐵已在一萬萬噸以上，此皆出於發現于地面之五渡層中者也。故今日欲用西法鍊鐵，必求之於較深之地層，僅就文江等地面所見，尚不能確定其多寡，似應於鐵路附近煤層之上，掘深井數處，以驗其有無，例如鐵路以北之桃林溝即甚適宜之地點也(該處煤層之下如果有鐵，深必不過百丈，以平定現時工價計，不過數百金即可竣事。鑛質之良否則不難決定。文江等攜有各處所採之標本，化驗事畢當可確定。據福公司報告則燐質過多，然該公司所化驗標本，是否可代表全區尚不可知。開採之難易亦應俟深井掘畢後方有把握。以發現于地面者言，則不甚適宜于西法開採，蓋鑛質之分佈約一定規則，且文江梭爾格所見最厚之鑛無過二尺者，然若鐵在煤層之下，同時可開採煤鑛，則仍可獲利亦未可知。鎔鐵材料除烟煤外，本地俱極完備，烟煤則壽陽之榮家溝，盂縣之華山皆可供用，要之平定樂平盂縣之鐵，較之吾國最著名之大冶則固瞠乎其後，然其分佈之廣，鎔鍊之易，材料之備實亦不可多得。若用深井試驗地下之層，果與地面之層不甚相遠，則將來定有實業之價值，不可以其零星瑣碎而棄置不顧也。且土法鍊鐵不甚合宜，所棄之渣恐多餘鐵(俟標本化驗後即可斷定)，中央即不能大舉，似亦應於該處設置小廠以爲模範，俾土人知逐漸改良，參用西法，則平定不但可出鐵，且可製鋼亦未始非發達鑛業之急務也。此外平定樂平復產陶土，亦在五渡層之中，土人用以製缸罐砂壺等器，土質甚佳似可改良。

(一)楡次縣　楡次縣居太原府平原之東南，縣北之山東連壽陽，西接陽曲，是爲北山，由縣城行二十里，至蟲店鎭純係平原，自此北行二十里，地勢漸高，半爲黃土所掩，至大峪口乃達北山。錫賓所見之岩石非砂石即岡石，蓋即文江梭爾格在平定所見之賽魚平潭地層，賽魚層中之煤厚不過四尺，或爲烟煤或爲硬煤，視地而異，平潭地層中之煤厚約丈許，則全係硬煤。玆將錫賓所見各鑛畧述如下。

楡次鑛務局　該局爲本地紳商所辦，股本一萬七千餘兩，祇在縣呈請立案，并未領有部照，亦無公司名目。設局於楡次之大峪口，共開窰五處，曰乾泰，曰季麻，曰後龍岡，曰半溝，曰豐泰，皆在大峪口及沙溝之間，距縣城約四五十里，各窰相距不過八里，開採純用土法，每窰開一斜井，深約二百五十丈至三百丈，高六尺許，寬五尺許，井上井側均以砂石砌成頗甚堅固。煤共三層，第一層不足三尺，是爲烟煤，惜質不堅，易成煤末，第二三層則爲硬煤，第三層最厚約可丈許(在平潭層中)。每窰用工人不過十名，每日出煤一噸至三噸不等，

夏間猶不過此數之半。該局自前清光緒三十年開辦以來，由承辦人王念忱、孫榮晉經理，資本稍有虧損，現正開股東會議，商定停續。計五處煤窰，每年共出煤二千噸，只售洋千六百二十元，是每煤一噸售洋不過八角，運費則三十里以內每斤錢半文，五十里以內每斤錢一文，運銷于榆次太谷等處。

北山以西之煤窰　北山以西之崇窰，五掌，龍岡，東窰，西窰，及西北之東庫，皆有土窰。崇窰在大峪口西十五里，再西十四里即為五掌，其他三處皆距五掌極近，東庫在大峪西北十二里。崇窰五掌東庫之煤，厚皆不過四尺，龍岡東窰西窰係同一煤層厚約丈許（平潭層），皆係硬煤，各窰皆用斜井，深約百餘丈，至三百丈不等，每日每窰出煤自半噸至兩噸不等，運費銷路與榆次礦務局同。又北山小峪口鎮，設有煤釐總局，專收北山煤釐。總局以外各處尚有分局，計每煤一驢（約二百斤）抽釐十五文，每年平均共收釐金四千數百串文。

以上各節為文江等調查正太鐵路附近地質礦務之大畧情形。此行也迫于時日，困于風雪，訛誤漏落，知所不免，惟凡所見聞，皆有畧圖可供研究。竊以為文江等所繪之圖，以為科學上最後之報告則不足，以為行政官辦事之參考則有餘，擬即定為格式，為將來調查地質之標準。

其他此次調查區域內之科學問題有研究之價值者所在皆是，如太行之構造，火山之新舊，河流之變遷，黃土之分佈，或有益于水利，或有關于地形，容當俟地質調查所經費稍充，機關稍備，然後化驗其標本，檢定其化石，推算其經緯，改正其方向，重繪新圖以備出版，非今日倉卒之所能詳述者也。

中　華　民　國　三　年　一　月　　　日

丁文江
梭爾格
王錫賓

Route Descriptions along the Chengtai Railway

From Tsingchinghsien[1] *to Kaochiapo*[2] 18.11.13*

After making some theodolite measurements on the Hsuehhuashan[3] I left for the south. At the level of the railway a few steps E. of Nankuan, *Kohlenkalk* was exposed with conglomerate beds showing probably faulting, but the strike was not clear as it was in greater part covered with loess which is about 7-10 meters thick. Going along a loess ravine we soon came to the village of Kaochianao[4] which is situated on a low hill covered with loess, but in descending to the southern side we have *Kohlenkalk* exposed,—they were almost horizontal with slight dip to the W. On both sides we have ravines cut partly out of loess partly out of the limestone, which is seen to be folded in the N-S direction. In the limestone I found a single fossil (brachiopod?). Going gradually up we came to Wuchiayen[5] which is also situated on the top of a loess-covered hill, but here and there we have thin beds which are oolite—these must be the upper Sinian beds which pass gradually into the bituminous *Kohlenkalk*. From Wuchiayen on, we descended again, then ascended to a loess-covered prominence, but soon descended by a steep path to Kaochiapo[6]. Under the loess on the way one saw the oolite beds until we came to Kaochiapo. On the loess hill one has already the higher mountains in front. Unfortunately, it was practically dark and observation was a little difficult.

At Kaochiapo it was a little difficult to find a *tien*[7] but I succeeded in obtaining a *Kang*[8] in the kitchen,—there was by the way practically nothing to eat.

From Kaochiapo to Nanchangcheng[9] 19.11.13

From Kaochiapo we descended into a very narrow ravine. On the N. side we have the typical *Kohlenkalk* exposed. Going E. a little the beds strike about 70°, dipping rather steeply 70° towards SSE. About 200 meters further (at point b), the dip is reversed and there is a fault running from WNW to ESE. The beds are of 3 layers: one coralline limestone above a more crystalline limestone in the middle and underlaying it comes the reddish blue beds (typical *Kohlenkalk*). Now the path becomes steeper leading directly to the S. The beds are the typical lime-

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* November 18, 1913.

1 井陘縣 2 高家坡 3 雪花山 4 高家坳 5 吳家岩 6 高家坡 7 店 8 坑 9 南障城

stone but with a lighter grey limestone above it—between them come thin beds of argillaceous limestone. The strike is about 80°, dipping all to the north. At height 739 comes a fault line, running almost E-W, and the beds now on dipping to the N. A few minutes later we came to the pass of Shihtsaochien[1] which lies directly on a great fault line—the beds are thrusted against each other and with much characteristic fault material. Climbing up a hill E. to the pass we have a fine view of the mountains all round; it is seen clearly that to the south we have ridges more or less along a E-W line. On the E. side the mountains run along the right bank of the Shoushui[2] and finally between the Shoushui and Mienho[3] there are low loess-covered hills. A curious looking block perched at the top, showing very clearly the fault line—N to that line the beds dip [?] but on the S. side they dip S. Descending by a winding path the typical *Kohlenkalk* is well exposed and we saw that they are badly folded and overthrusted. A fault line running NE-SW seems to meet the line we have at the top of Shoushui. The strike gradually changed into a NE-SW direction with corresponding folding. The limestone is cavernous. It is dark grey when weathered, light grey when fresh, and reddish when leached with water. In it we find also thin bedded layers of clayey limestone. Descending into the valley of Shoushui the strike is NNE-SSW, then it is covered with loess (to about 30 meters above the plane).

From Kangtou[4] *to Tsingchinghsien*, 17.11.13

In leaving Kangtou I had no intension of doing any topography as we have to pass the whole way in going to Pingtingchou[5] and it was already 10 o'clock when we started. But after passing through the village of Hengtsun[6] the ground rises gradually until we reached Fenghuangling[7] which is a pass in the low hills that separate the basin of Kangtou from that of Tsingching city. The whole was thickly covered with loess, but at the top of the pass *Kohlenkalk* is exposed though it was rather difficult to make at the dip. In coming down we have a fine view of the plane and the Tanho (or rather Mienho so-called because it receives the water of Mienshan[8] where Chiaitzutui[9] starved) that flows through it. About one km. from the N. gate we came to a fine section just by the left side of the river. The beds are as follows:

	Thin beds of shale
Strike 209°	coarse-grained sandstone (4-6 meters thick)
dip 20°	Thin bed of shale (about .7 meter thick)
	Blue limestone (=*Kohlenkalk*?)

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1 石槽澗 2 壽水 3 棉河 4 岡頭 5 平定州 6 横村 7 鳳凰嶺 8 棉山 9 介子推

In the shale I found many plant fossils——fern leaves, etc. If my identification of the *Kohlenkalk* is correct, then we have here for the first time some beds that directly overlie the *Kohlenkalk*. Near the bridge over Mienho S. E. of the city wall on the right bank of the river, limestone is again exposed, and a few steps further a conglomerate which might be found by faulting though I saw no direct evidence of it. The strike of beds here is 40° and dip 32°, so the dip is practically reversed. The river makes a bend towards west and the road follows it, and soon we come to the Chengfeng[1] mine after passing through the railway station. Leaving my things at the mine I walked up the Hsuehhuashan from the eastern side. At first we have white coarse sandstone striking 205°, dipping 125° SE. At about the height 744 (press.) (2/3 of the way up) we have the basalt *in situ*. On the way up I found a broken piece of limestone (black) which is very like that which I found afterwards in the *Kohlenkalk* in the south, but I could not find it *in situ*. Thence to the top we have nothing but basalt.

From the people at the mine I got the following information:—
The shaft is about 4 meters deep, getting through the white sandstone. The coal seam is about 7 meters thick with occasionally very thin beds of shale between. Below the coal we have bituminous shale. I went down to measure the beds and found that they strike NE-SW dipping with an angle of 30° towards S. E. I found some badly preserved fossils in the shale.

According to the people there the coal is found underneath the river and also in Tsingching city where one met with it in boring wells. But further south only one single exists--it is situated at Shihpanpien[2] about 5 li S. W. of the Chengfeng mine thus along the strike. The coal is said to be of good quality but there is too much water. There has never been any mine on the E. side of the river, nor there is any in the S. E. direction. This is the universal opinion as I had already gathered from the people on my way to the mine. It is said that there is coal also under the Hsuehhuashan—in fact there was one old mine but it was closed owing to the occurrence of fire damp.

Putting all observations together, then, the old basin of Tsingching city is quite limited. It forms perhaps a narrow belt running NE-SW about 5 km. long and not quite 1 km. wide. It seems to be probable that the seam worked there corresponds to the 5th seam in the Kangtou coal field and in all probability it is not far above the *Kohlenkalk*, as the pebbles of limestone found in Hsuehhuashan seem to point to the part.

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1 正豐公司 2 石版片

From Tsingchinghsien to S. W. 24.11.13

From Tsingchinghsien I went to the S. W. head of the Hsuehhuashan mass in order to obtain from there a view of the Shihpanpien village. I saw at first on the S. E. side slates striking about 40° dipping somewhat steeply to the S. E. Climbing up I found first weathered tuff (?) Then about 2/3 way up we have the olivine (?) basalt. The height of the hill is 749. Coming down from the S. S. W. side we have the slates exposed at the height of 751—the strike is about 70°, but a few steps down the strike is again 40° dipping S. E. (on the way to the hill and S. E. to it I saw 2 old mines) Instead of going to Shihpanpien directly I went over to the S, over a loess hill to the village of Haochiatsun[1] to the S. E. of which we have the village of Panchiao[2]; both places have abandoned mines—the one at Haochiatsun has been even recently worked. The last coal mine to the S. W. of Tsingchinghsien is the pass of Changshenkou[3] which I saw only from a distance on a loess hill about 1 km. from it. I got also information that W. of Panchiao, on the other side of the loess hill, 5 li S. of Nankuan[4] at 5 li E. from Wuchianao[5] is the only coal mine that has ever been worked. Again it was confirmed that E. of the Mienho there never existed any mine, nor was there any between Tsingchinghsien and Fenghuangling. Now turning to the W. we came to the head of the valley that runs S. W. of the Hsuehhuashan and at the height of 746.7. The typical *Kohlenkalk* is exposed, strike 40° dipping S. E. But opposite this exposure on the E. side of the valley there existed several old mines; the height is 749. Coming gradually down to Shihpanpien I found the *Kohlenkalk* again exposed at 756. The strike is 20°-70°. At the well the slates seem to lie conformably on it but that which is between is covered by about one meter of loess. Going north round the W. side of Hsuehhuashan the slates are seen to strike 30° (at 754) overlaying the limestone (which is somewhat crystalline). Further south at 753, limestone is exposed striking constantly 40° and dipping SE. On it I found thin beds of iron ore. Going up again basalt occurs at 749. Between it and the limestone are the red slates, much decomposed, giving the soil a red colour. Thus from this point draw a line in the S. W. direction we get the limit of the coal basin. It seems strange that the basalt is surrounded on all sides by sedimentary beds which do not seem to have been much disturbed tectonically, though of course altered somewhat by contact. (The limestone at Shihpanpien is similar to that of Wuchiayen).

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1 郝家村 2 板橋 3 長生口 4 南關 5 吳家坳

From all these observations I draw the following conclusion:—

(1) Locally at least *Kohlenkalk* seems to lie conformably under the Carboniferous beds.

(2) The iron ores are sedimentary beds occurring between the uppermost *Kohlenkalk* and the coal formation.

(3) The coal worked by Chengfeng Co. and the other mines in the district is very likely the last seam of coal.

(4) As the thickness of seam here corresponds to the 5th seam in Kangtou it is probable that they have also no other seams there.

(5) The anthracite of Pingtingchou must thus be younger than the bituminous coal—additional proof is that the roofing *Überkohlensandstein* is nowhere seen here.

(6) Lastly my former conclusion of the Tsingching coal field is in the main quite correct.

By height of station Tsingching = 762.5

From Tsingchinghsien to Talungwo[1] 25.11.13

At 9 o'clock I left Tsingching to go to Changshenkou where the southernmost mine is said to be situated. As it was rather more than 14 li from the city and I wanted to work a little topographically I rode to the place and walked back. Just about 1 li outside Nankuan (S. W. to it) I found that limestone is exposed dipping to ESE, on which comes the coal formation with the characteristic clay iron stone in it. Further on near Chuchiatsun[2] the limestone is again seen with practically the same St. and dip—its height was 752.5—, the level of the river is 757. At Chuchiatsun (height 751.3) typical *Kohlenkalk* exposed St. about N-S. After Chuchiatsun came the large village of Panchiao which is now far less prosperous as the railway has taken away all the traffic. 5 li further we came already to Changshenkou where is a tower with a tablet indicating Kukuantao[3]. I climbed up the tower in order to make observations with the fluid compass. Then we came to the village of Changshenkou where I saw many empty hotels. [This] is an indication that the place had seen better days. The old mine is situated about 300 meters SSW from the tower and forms the S. limit of the Tsingching coal field. The coal as usual underlies the white sandstone which is exposed at the

1 大龍窩 2 朱家村 3 固關道

mine dipping to the N. As the limestone is not sufficiently exposed I went further on until I came to Talungwo where I was delighted to find a great amount of breccia with the bed much disturbed. To the N. of the village is the hill Lungwangmiao[1] up which I climbed and found that the whole hill is a mass of breccia. On the N. side of the valley the limestone was seen to dip WSW. At the village the beds dip steeply (80°) to the SW but just before Changshenkou it is reversed. Going back to Tsingchinghsien I went along the E. side of the valley and to my surprise I found the limestone is exposed dipping ESE. This goes on right to Chuchiatsun forming a lower ridge of hill. Between Wuchianao and Chuchiatsun we have an old mine—thus the coal field of Tsingchinghsien must be really divided into two fields between which we have a ridge of limestone which must have been faulted up (see map).

From Tsingchinghsien to Niangtzukuan[2] 26.11.13

We had snow on the night, so in the morning when we woke up we found the hills sprinkled with white lines which shows the bedding planes very well indeed. After taking a photograph of the Hsuehhuashan we went round the N. side of the hill and there not only saw the contact between coal formation and *Kohlenkalk*, but also the contact between sandstone and basalt. The sandstone was burnt and in it we found often mixed with basalt so the basalt eruption must have taken place after the sandstone was weathered. Not only that; the loess which was found occasionally along the contact zone was also burnt through. It contains still remains of *Helix*—thus proving that the basalt is a very young eruption indeed. Again everywhere comes before the high mountains a sort of terrace which Dr. Solger thinks to be the old basal level of erosion. He had also somewhat unorthodox ideas of landforms—for example, he thinks that the upper sharply cut ridges of the mountains are the work of water alone, but lower down the more rounded forehills are also due to wind erosion—at the higher level the wind had not sand enough to work.

Going along the river we found the *Kohlenkalk* faulted due to which cause is seen a layer in the *Kohlenkalk* which is soft and powderly along which lien forms [?] the Mienho a subsequent valley. After going over the Faluling[3] where the railway makes a turn, we found the fault line again on the left bank of the river, the strike about 60°. The upper beds are seen to be unaffected so it was probably an overthrust—the upper part being thrusted over—Solger thinks that

1 龍王廟 2 娘子關 3 乏驢嶺

the S. part be thrusted E. and then over to the N. We then dined at Peihsi[1] and got on our donkeys to ridge. Just before Niangtzukuan we have a great deal of calcareous sinter by the river side and the terrace form of the forehill was very well seen indeed. Above the similar [?] we were surprised to find a siliceous *Kalk* which might be Sinian but we could not find any oolite.

27.11.13

It snowed badly and we decided to go to Taiyuanfu[2] at once where we arrived at 5.30.

1 北谿 2 太原府

調查棗莊中興公司鑛區地質報告*

煤田之地形

中興公司採煤於嶧縣城北之棗莊，故煤田以棗莊稱，然其全部長數十里，不特不限於棗莊附近，且不全於在嶧縣境內也。棗莊之北有山如平台，是爲棹山，高約百五十米突。其東爲峩山，東南爲方山，方山之東南爲雙山，爲龍山，入沂州境與嶧縣城東北之壇山，古龍山，土山，東山，相連接。棹山之西爲釣魚台，古山，墓山，墓山以西蜿蜒十餘里入滕縣境，至青山頭而止縣城之西，爲鍋臍山，大小福山，杏子峪山，西北亦入滕縣境至匡山而止。匡山與青山頭相對峙，泥河之水自東而西，出兩山之間，而與西倉河會於黃甸，南流而達於臨城之西焉。泥河之上流爲城河，源出于墓山古山之間，至鄒塢乃折而西，張家嶺，羅家嶺，嚴家嶺，以西之水皆歸之。嶺之東水皆南流，其沙河之大者爲齊村河，童樓河，郭里集河，安城河，皆合于嶧縣之北，是爲煤田中河流兩系，臨棗鐵路沿前者以至鄒塢，台棗鐵路沿後者以達棗莊，蓋二者爲南北山脈之斷點也。煤田可分爲兩部，一在郭里集之東，其面積不過數方里，茲姑不具論。其在郭里集之西者，介于南北兩山之間，而不盡以山爲界，其南界距山遠者十餘里，近者亦六七里，其東北界則二三里至五六里，惟西北則直至山麓，西則自石溝村之東斜折而西北，經潘家樓之東至北山之麓而止，其全部面積約爲三百四十方里，其包于中興公司鑛界之內者，爲三百〇六方里。蓋墓山以南之一部(約三十方里)，煤層較深，露頭較少，故劃區者置之于區外也。

地層之次序

鑛物生岩石中，其露于地面者至微且細，茲欲從此至微且細者而知其不可見不可量之部分，其道何由？昔人有言，上有丹砂，下有黃金，驗之事實雖可憑，而以在上之可見者，測在下之不可見者，其法與地質學所用者無異。故研究一區之地質，若先知區內之岩石，共有若干種，每種厚若干尺，何種在上在前，何種在下在後，則其事易舉。然以此施之于煤田，頗不易言。蓋煤層大都生于平原，十分之八九掩于浮土，故研究煤田地層之次第，往往以打鑽或開井所得之剖面爲根據。中興公司自開採以來，並未打鑽，開井之時又未記載其岩石之層次，故着手頗難。幸地層之一部露于齊村以北之溝中，茲就溝中所見者言之，全剖面長約八百米突，走向東西，傾斜向南，陡者約四十度，平者亦二十五六度。剖面之北端爲藍色之石灰石，質極純粹，沿溝北向直至北山之麓，故此層絕厚。圖中用 L_4 爲符號，以便對照。L_4 之上部有青色之粘土一層，中含赤鐵，以露於郭里集以北之部分觀之，似爲極古之火成

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*此報告原附有圖件若干，存地質調查所圖書館，今乃遍覓不得，只得將報告單獨付印。

岩所變，是爲圖中之 I 。其上爲粗粒之砂岩，其色暗粽，厚約九米突，是爲 S_3，乃含煤岩石之底部其上有煤一層，厚一米突有奇，是爲圖中之 C_5，卽土名所謂渣子窰者。再上爲陶土，是爲 F_2，齊村中人于溝測小阜採之爲燒陶器之用。陶土之上有煤一層，厚亦一米突有奇，是爲 C_4，土人謂爲鷄子石窰。其上有石灰岩兩層（L_3 與 L_2），中夾板岩。L_3 厚約三米突，L_2 厚約七米突，中皆多化石，且皆含硅質甚多。自 L_2 南行，岩石爲土所掩，約六十米突，又有石灰岩一層，其質較純，厚約七米突，是爲 L_1。其上亦爲土所掩。又四十餘米突爲粗粒粽色之砂岩(S_2)，其下有煤一層，厚約七米突，是爲 C_2，卽土人之所謂大窰也。S_2 見之于剖面者，厚約一百米突，然中有斷層，故其確實厚薄不可得知。S_2 之上爲土所覆，南行一百四十餘米突，復有陶土 (F_1)，其上部含有鐵質，土名謂爲疊石，以其大部爲土所掩，故其厚薄不易知。F_1 之上爲脆質之砂岩，其色微黑，再上爲粗粒白色之砂岩 (S_1)，是爲磨石，齊村附近之小山皆爲其所成。再南卽爲齊村，岩石傾斜變而北向，剖面不復可見矣。

據上所言，共有煤三層，曰大窰，鷄子石窰，渣子窰。然土人所知及中興公司大井中所見者，固不止此。按棗莊以南，窰神廟附近，舊窰頗多，皆開採 L_1 與 L_2 之間之煤層，土人謂爲泥窰，據云厚約二米突。此在大窰之下者。大窰之上 S_2 與疊石之間，尙有煤一層，厚約一米突，以其不能煉焦，故謂之爲柴炭。又就大井北石門所見，大窰之下尙有薄煤一層，厚不過〇·二米突，是爲薄炭，其上有石灰岩一層，厚約半米突，中含化石甚多。故合上所言者，共有煤六層，除薄炭 (C_1) 過薄，不可開採外，其曾經開採者，共有五層焉。此僅就棗莊與齊村溝北兩處所見者而言也。全部地層固不止此。安陽村之東有磨石，傾斜向西約十六度至二十度，村之西有小溝，自北來，溝之中有紅砂岩，質脆粒粗，中含不規則之石灰岩薄帶，間有石子其大如卵，散布於沙岩中，傾斜二十餘度向西，故其位置應在 S_1 之上，因之爲 S。自此西向二百餘米突，有土阜爲礫岩所成，中含石子，大者如拳，小者如猫眼，傾斜甚微，蓋卽 S 之上部。以此計算其厚約一百二十米突，是爲煤田中之最上層。過此卽爲黄土淤泥矣。

S_3 之下爲 L_4，已如上所言。煤田附近地層之應在其下者，尙有墓山所見之魚子石灰岩，其層厚薄相間，中有青色之板岩。惟其與 L_4 相接之點，頗不易明。又其下當爲棹山所見之地層，蓋中興公司大井之北，L_4 與雲母片岩相接觸，再北爲棹山。雲母片岩之上有粗粒之砂岩，又上爲灰色石灰岩，其層次頗厚，與 L_4 及墓山之魚子石灰岩逈異，蓋皆在其下者也。

煤田中岩石之性質次序，既畧如上所言，請再言其統系與時期。雲母片岩與其上之石岩爲斷續層，故自爲一系，襄山口村適在此系之中心，因名之爲襄山層。其上之砂岩與石灰岩又爲一系，是爲棹山層。墓山之魚子石灰岩與 L_4 實爲兩系，以其實地之界限不易區別，

暫合爲一系曰慕山層，L_4 上之含鐵層附焉。再上自 S_3 至 F_1 爲含煤層，統名之爲棗莊層。L_1 以上爲上棗莊層，L_1 以下爲下棗莊層。S_1 與 S 或應爲一系，茲以其岩石性質易於區別，暫分爲兩系，S_1 爲磨石嶺層，S 爲安陽層。蓋兩者之露頭以磨石嶺(在大甘林村之北)與安陽兩處爲最顯故名。其黃土河淤，其層極薄，姑置不論焉。

地層之時期應决於其中之化石，而上所言各層，除棗莊層外，化石頗鮮。大窰 (C_2) 接近之砂岩中，有植物化石數種曰 *Annularia, Sigillaria, Calamites,* 皆屬於古生期者。L 中多珊瑚類化石，其可別識者爲 *Cyathophyllum*,亦古生期者。L_1 L_2 L_3 中皆有化石，L_2 中含多孔虫名 *Fusulina,* 屬于石炭紀者。故上棗莊層爲二疊紀或上石炭紀，下棗莊層爲石炭紀。L_4 中未尋得化石，然以其地位及岩石性質言之，當與泰安南部之石筍石灰岩相同，則應爲奧多維西亞紀。慕山之魚子石中有三葉虫，是爲寒武利亞紀。棹山層之時期不可知，以地位言當爲太古上紀之上部，雲母片岩爲太古上紀之下部，蓋即美人威立士所謂滹沱層及五台層也。棗莊層以上之地層，以無化石，故其時期至不易知，若與山東他處地層相比較，應即布列克威爾特氏所謂新台地層，布氏假定之爲二疊紀，然以余所知，直隸山西兩省古生期煤層之上，尚有侏羅紀煤層，再其上始有紅砂岩，其時期最早爲中生期之上部。棗莊層中 L_1 之上部微含鐵質，頗有風雨侵蝕之跡，似與磨石層爲絕續層者，果然則當與山西直隸之紅砂岩同一時期，故暫定之爲中生期之上部。以上所言地層之性質，次序，厚薄，時期，頗甚複雜，不易比較。茲以齊村北溝所見爲根據，補以棗莊棹山慕山所見，爲直剖面以供參考。

地層之分佈

峩山層之露於地面者，悉在煤田之東北，其東界不可知。自方山古屯以北，直至峩山，皆爲片岩所成。自此西北行經棹山之南坡至葛村而止，成一西北東南之帶，長約二十里，西北狹而東南寬，寬者約八里，狹者不過里許。帶之南北爲煤田北部諸山，山之下部亦悉爲峩山層所成，棹山層在北部諸山之上部，其分佈與峩山層相似，亦至葛村而止，其堅度較峩山層爲高，故覆於衆山之頂，上平如台，如棹山如釣魚台皆以得此名。慕山層可分爲上下兩部，其下部煤田西北諸山，自古山起至青山頭止，其上部則分佈較廣，蓋直接與煤田相接，故其露頭幾環繞煤田爲一週。以南部言則自餘粮店起，西行經岳家樓龍頭之北，邵家莊官店之南，越沙河經秦家戸折而南向，於黃家村之南，復折而西北至曾家店，復西南行經黑石嶺而西，經張范之北，東西夾埠之南而至姜家店，乃轉向西北，經潘家樓而北，與慕山層之下部相接。以北部言，則西起於北城河東之張公嶺，西北與慕山層相接，西南抵劉家村之南，東南經喬家店之南，齊村之北，曲折而達於谷口村，再東經殷村王村，斷續相間不絕如縷，至方山而

復寬。方山餘粮店之間，地層爲砂土所掩，其確狀不可得而知，然以理推之，郭里集之附近當亦爲石灰岩。自是以東，除棗莊下層於安城之西成一狹帶外，亦皆係石灰岩，故煤田本部與郭里集以東之煤層相連接也。

以上所言皆煤層以下之地層，故若其露頭現於地面，則其下卽無煤層。煤層以上之地層大部分包於墓山層之間，故墓山層之內界卽煤田之外界也。

下棗莊層在煤層之南部，成一半圓之長帶，帶之南界自山之西起至青山頭止，與墓山層上部之北界相接。帶之北界自侯宅子南行至貴子之右，始折而東，經窰神廟，孔家莊，石牌莊，以至沙河，復西北至後川，西南至張范，經夾埠之北而至韓家店。自此而西露頭絕少，頗不易定其界限，大約西北經山家林之南至劉家樓而止。此線以南舊窰林立，皆泥窰鷄子石，或渣子窰也。此外下棗莊層之露頭尙有三處，一在張公嶺之西，成南北之狹帶，至劉家莊而止；一在齊村之北，曲折與孫家莊之露頭相續；一在郭集里之東，西抵沙河，東抵安城，北抵鐵嶺，南抵官村，卽中興公司五方里之礦區也。郭集里之東，中興公司尙有礦區一處，在鐵嶺之北。據伊立生云，該處並無露頭，故圖中暫假定爲墓山層，苟中有煤層如舊圖所列，則亦當爲下棗莊層。下棗莊層之北，墓山層之南，大部分爲上棗莊層所佔，中興公司之棗莊煤井，及山家林陶莊分廠皆在此層露頭之中，惟其一部分傾斜於磨石嶺層之下，該處之露頭共有三處；一在中興公司大井之東北，雷家村與北嶺之間，其面積較小，中爲沙河所斷；一在大小甘林之北，是爲磨石嶺，西起於鄒塢之東，蜿蜒而東，經尖山子卽石溝至齊村之東北而止；一在鄒塢袁山之北，其與上棗莊相接之線，西北起於黃貝莊，經武學袁山，布湖，蕭家村，嚴家埠，至安陽而止，成一完全無缺之半圓，是爲磨石嶺層露頭之最大者。半圓之北部常村與紀家村之間，爲紅砂岩礬岩所掩蓋，卽安陽層也。又羅家嶺尖山子之北，磨石嶺之上亦爲安陽層所覆，但半爲土掩，其露頭不若前者之明顯耳。

地層之構造

煤田各地層之構造可分爲兩期，曰成於古者，曰成於今者；前者與今日地形之關係爲間接，後者則今日之山谷河流無不受其直接之影響，玆分言之。

各層之最下層爲襄山層，其岩石大都爲砂岩所覆，其地層悉壁立，間復捲疊斷裂不可窮詰，然覆於其上之棹山層則皆平坦，變態亦鮮。是則襄山層之捲疊，其時期當在棹山層成就以前，兩層之間旣絕復續，其理自明。此外墓山層與下莊棗層爲絕續層，上棗莊層與磨石嶺層亦爲一絕續層，然自墓山層起至安陽層止，各層層層相因，其傾斜走向無一不同，故除襄山層之摺疊外，此時期中雖海岸線屢有更變，其構造初無大異也。

構造之成於今者有二，曰煤田之成長盆，曰長盆之斷裂。大約前者之成在後者之先，故

凡煤田中各層，在南者其傾斜向北，漸東則傾斜而西，漸西則傾斜而東，北部則爲斷層所切。然其小部分在齊村之北者，其傾斜向南，故若假定全田爲長盆形，盆之北邊破裂，盆底與他層相接觸，則畧得煤田之眞相。惟盆邊之傾斜北向者，平均不過十五度，東向或西向者約二十五度，是故盆之南部較淺，東西較深，再東則地層漸平，過郭里集地層復傾斜向北，至鐵嶺之南亦爲斷層所切，安成之東亦不復有煤，故又自成一破盆形，但盆之面積極小，盆底復淺耳。

盆之破裂由於斷層，土人謂爲石壓，其影響於煤田者絕大。茲就其性質可分爲兩系：第一系自南至北，第二系自東至西。第一系斷層之大者，其數有六。其一起於古山之南，經墓山之南而西，直抵青山頭，斷層之北爲墓山層之下部，其南則在東西兩端，爲墓山層之上部，兩端之間則自下棗莊層起，至安陽層止，皆逐一與之相接。以各層厚薄計算，大約斷層之南部較北下部墜八百米突以上，其大可知。其二在煤田之東北，起於北安城之北，西北行，經方山，王村，殷村，谷口以達葛村，與第一斷層相接連。斷層之北爲襄山層，其南一部爲墓山層之上部，一部爲上棗莊層。大約南部之下墜至少一千米突，而其南之墓山層與上棗莊層之間，復往往有小斷層，可視爲大斷層之一部。其三起於孫家店之北，墓山層與下棗莊層相接，西南至土井子，則斷層之南亦變爲安陽層，再西南經羅家嶺之北，洪家村之南。斷層之北爲上下棗莊層，其南爲安陽層，再西其踪跡不可復見。南部下墜最深之處，大約爲四百米突。其四東起於齊村，經朱子埠之南，後川之北，至甘林之東而止；上棗莊層上部之疊石與 C 相接，斷層之北下墜，故 C_2 不復露於地面，其下墜之深約爲一百五十米突。其五爲中興大井以北之斷層，起於德四德五兩窰，東北行經金四金五以達北石門之北，斷層之北部上推而覆於南部之上，故大窰之煤上下視若兩層，其斷層平面之移動約爲三十米突，上下之變遷在東爲七十米突，在西約四十餘米突。其六在郭里集之東鐵嶺之南，下棗莊層傾斜北向，鐵嶺之墓山層亦傾斜北向，故其接觸處爲斷層，南部下降約數十米突。以上六斷層，除第四斷層外，皆北部上昇，南部下降，除第五斷層其性質皆爲直下斷層。除第一第二斷層外，各斷層大抵東部昇降較大，西部逐次漸低，此皆可注意者也。

第二系斷層遠不若第一系之重要，且僅限於煤田之東部，其有關全部之構造者，不過有三。其一起於古山之西，南行經孫家莊之東，齊村王家溝之西，折而西南，經小屯棗子之西，以達墓山層。詳研究其性質，大約各層之移動，非上下而前後，斷層以東之地層移而向南，其西之地層移而向北，故古山移於墓山之南，齊村北溝之下棗莊層，移於孫家店下棗莊層之南，小屯棗子之煤層不與後川以東之煤層相接，而黃家村西南之墓山層折而向南也。其二起於湯莊之西，經童樓南行，沿河以達官村之西，斷層之西部下墜，故湯莊以東之舊井深

百餘米突，而湯莊以西之窰深且在一百五十米突以上。斷層之在沙河河下者不可見，然 L_1 之露於南石牌者，不與齊村王家溝之 L_1 相連，亦爲斷層之証據，而官村以東之慕山層，因上昇而在黃家莊以南，慕山層之東北焉。其三在侯宅子村之東，成南北線，而北微偏於西，南微偏於東，使上棗莊層之 C_2 與下棗莊層之 L_2 相接，所謂泥窰者不可復見，蓋斷層之東上昇，其西下降，故致此也。

除上所言者外，第二系之斷層最少尚有四處。一在南石牌，二在東廟之東，即大井之所謂東石壓是也，三在金十一金十二窰之東，四在于金家場棗莊村之東，其性質情狀當于論大井附近之地質時詳言之。

地層構造與鑛業之關係，觀于舊日土窰之分佈，即可知其梗概。土窰之多莫過于棗莊附近，蓋大窰露頭之寬以此爲最，故土窰易於開採，且兩系之斷層使煤層逐級上昇，不使過深亦爲土窰易於工作之原因。自齊村以西，土窰之開採大窰者無不失敗，以斷層 F_4 使大窰下降也。鄒塢以西露頭復顯，土窰亦漸多，然究不若棗莊附近之盛者，煤層一律傾向西北，入地漸深，反不若棗莊附近之有斷層使之上昇也。

以上所言各斷層頗甚複雜，茲復列表如下。

系	數	方向	地點	移動	符號
1	1	東西	古山至青山頭	北昇南降約八百米突	F_1
1	2	東偏南西偏北	北安城至葛村	北昇南降約一千米突	F_2
1	3	東偏北西偏南	孫家莊至洪家村	北昇南降約四百米突	F_3
1	4	東偏北西偏南	齊村北至甘村西	北降南昇約一百五十米突	F_4
1	5	東偏北西偏南	中興大井之北石壓	北覆於南之上上下七十米突前後三十米突	F_5
1	6	東西	鐵嶺之南	北昇南降四五十米突	F_6
2	1	南北	古山至簍子南	東移向南西移向北	F'_1
2	2	南北	湯莊至官村	東昇西降約五十米突	F'_2
2	3	北偏西南偏東	侯宅子東	東昇西降約三十米突	F'_3
2	4	東北西南	南石牌	東昇西降	F'_4
2	5	南北	大井東石壓	東昇西降	F'_5
2	6	南北	金十一十二之東	東降西昇五六十米突	F'_6
2	7	南	棗莊西	東昇西降	F'_7

以上所言皆地質構造之成於今者。雖然今與古者指地質之時期言也，其年數不可以千百計，欲知其確期頗不易言。全部最上之地層爲安陽層，亦爲斷層捲疊所影響，故若安陽層爲中世紀之上期，則構造之成最早當在近世紀與中世紀之間。地層以外可以供研究者，厥爲地文。夫現在構造未成以前，調查區域內之山川形勢何若無從而知。以現有之地形言，則北山爲斷

層之面，南山爲斜坡之背，河流則西部之水西流，東部之水北向，頗有研究之價值。夫煤田本爲長盆，東西長於南北，如北部之斷層盆形已成之後，則盆形初成時，水必游於盆底成長形之湖，若北部之斷層發生於一時，則水應蓄積於斷層，於盆底之間亦無出路可尋。然調查區域內並無古湖地之淤跡，似當日盆形成功費時甚久，故在昔已有之河流，能不爲其所變。果如是則自南向北之沙河，應爲斷層盆形未成以前之河道，其沖蝕之力能與南部逐漸增高之速度相抗，故未爲其所阻。且第一系斷層大抵北部上昇，南部下降，故尤足以增加河道沖蝕之能力，而第二系之斷層又皆自南至北斷線所經岩石破裂易於沖蝕，故東部各河平行者多南向，而會於縣城自東西流之泥河，大約係受斷層影響所成。蓋第一系之斷層如 F_3 及 F_4 其上昇之一部，皆東高於西，故有使水西向之勢。斷層 F_1 又破長盆西端之壁，使水易流，同時長盆西端背部之水，其坡既陡，速度亦高，不久即可破盆之西邊而奪盆內之水使之西流也。

由是觀之則山川之形勢，與構造之關係固彰彰可考。構造之成功，必非甚古，然兩山之間其谷甚寬，堅如石灰岩，其在山之前谷之側者，其平如削，當日斷層所造之昇降，在煤田之內者大都不可復見，故構造之成亦決非最近，以意度之當在近世紀之始期乎。

大井附近之詳情

中興公司所開大井，乃昔日土法開採之興五窰所修改，在大窰露頭之北約五百餘米突，自地面下掘五百八十五尺，始與大窰煤層相遇。大井之南一百三十米突，爲土窰元三與元五，其深皆約爲三百四十尺，以此計算，大井井口煤層傾斜應爲二十五度向北，據朱鑛師言，全鑛斜度平均爲十八度，西稍平而東稍陡，近大井井口之岩石已掩覆不可復見，然以大窰之深淺及傾斜計算，大約非 S_1 之下部，即 F 之上部，故柴炭之露頭亦在大井井口之南。至於井底工程則爲斷層所限，前所謂第二系第五斷層(F'_5)者，即大井之東石壓，西與北皆爲第一系第五斷層(F_5)所阻，是爲大井附近最重要之斷層，分現時開採之小井爲二部，如九窰，十窰，元三，元五，祿窰，祿一，祿五，祿六，金一，金二，德一，德二，皆在斷層之東南，如金九，金十，金三，金六，金四，金五，德三，德四，德五，皆在斷層之西北，其中之金三，金四，金六，德四，諸窰乃現在出煤最旺者。此外則德八，德九，復爲東北西南之小斷層所隔，不與以上所言各井相通。金十一金十二在東石壓之東，亦自爲一區，故全鑛可分五部：一大井，二 F_2 以南之小井，三 F_5 以北之小井，四小斷層以北之小井，五東石壓以東之小井。四與五開採未久，二則開採將罄，故小井之出煤均在 F_5 斷層以北也。爲採鑛計，其必須解決之問題有三：一東石壓 F'_5 以東有無斷層，二北石壓 F_5 以北之地質何若，三泥窰距大窰究若干尺，可否用大井開採。茲逐次詳論之如左。

東石壓之斷層東降西昇，故大窰煤層移向東西。據土人言斷層南行，掩於東棗行村之下，北則似沿東廟西北沙石嶺之西邊，金十一十二兩窰，在此石壓之東。，然兩窰之東不數步，即有斷層F'_6來自金莊之東，經東廟而北，可見之於雷村以西之沙河中。故沙石嶺之磨石，(S_1)，與陶土(F)相接觸，其關係似頗複雜，然大約東昇西降。自雷家村西行，復有S_1傾斜西向，則雷村與S_1之間必復有斷層，其南部可於金家場之北棗莊之西南見之，是即F_7'大約東降西昇。凡此斷層皆與將來開採東部之煤有關，然金十一金十二兩井已穿斷層而東，則S_1自應無阻礙。而就金家場以北所見言之，F_7之昇降甚微，似亦不難通過。故東石壓以東，雖有斷層，然以地面所見言之，當不能阻開採之進行也。

北石壓以北露頭絕少，舊井未開，故其地質確狀頗不易知。露頭之可測量者，僅有三處：一處爲東廟以北之砂石嶺(S_1)二爲北嶺(S_1)，三爲田家村西之北砂石(S_2)。大井北石壓之北，煤層傾斜變而南向，斜度約二十二度至四十度不等。然北嶺磨石之北部，傾斜向北約十度，牛村附近之疊石其南部亦傾斜向南，其北部仍傾斜向北，以此觀之，北石壓以北之煤層，似仍應轉而向北。東廟以北之砂石(S_2)走向，南部爲東北，西南漸變而爲南北，爲西北東南，傾斜亦向東，是則北嶺以北之地層似逐漸變其走向。田家村之S_2與砂石嶺之S_1之間，應爲F_1其下固應有煤，其在田家村附近者，深應在一千尺以內。惟自此以東露頭太少，不易決定其深淺，爲開採便利起見，應於田家村雷家村之間打鑽探之。蓋大井西南限於小井東部，以多舊坑，且有石壓，將來最易開採之煤應在北部。按東至雷家村，西至田家村，南至北嶺，北至小王村，未經開採之煤，其面積約爲八十萬方米突。若平均煤厚六米突半，則其煤量應爲七百萬噸，除其間或有未經發現之斷層，及應留之支柱外，可採之煤至少亦四百五十萬噸，以之另開新井，雖不足以之補救大井，則固有餘也。

照齊村北溝所見，泥窰距大窰不過五十米突，泥窰至雞子石亦不過五十米突，是則現開之舊大井，未始不可用以開採大窰以下之煤。蓋大井附近地層，其平均斜度爲二十度，則自井底至泥窰，應不過六十餘米突，其工程固甚易易。質之朱鑛師，則云自大窰露頭（三合莊西）一直南行至泥窰露頭(窰神廟西)，長約一千米突，L_1露於鐵路附近者，傾斜向北，約十五度，則大窰泥窰直下之距離，應爲二百米突，故恐太深，其說誠是。然自大井南行地層極平，如薛家莊左近所謂薄炭者，幾於全無傾斜，故大窰泥窰相距雖遠，其間之平均斜度無從測知，以他處所見者相較，最多亦應在一百米突以內。將來大井北部打鑽時，若一直通煤層而過，則此種問題亦即可確實解決矣。

煤之性質

據土人言，可採之煤共有五層，即柴炭，大窰，泥窰，雞子石，渣子窰是也。此五層

中僅大窰有確實化驗，煤質極佳，其餘各層均無煤樣可取。閘泥窰炭亦頗佳，惟礦質微多。鷄子石窰則極與大窰相似。柴炭不能煉焦，渣子窰灰分過重，均遠不及其他三層。茲將大窰煤分析結果詳列如下。

(a)煤之分析

名稱	塊煤	末煤	統煤	大窰中部	大窰下部	普通平均	同上
水氣	0.08	0.22	0.20	1.20	0.5	0.5	0.1
分灰	7.34	10.32	9.80	17.50	9.92	15.82	9.82
揮發分	29.48	26.60	26.80	31.50	35.00	31.34	26.80
淨炭	62.18	26.96	63.28	46.79	54.58	52.34	63.28
硫黃	0.40	0.5	0.5	0.93	0.64	0.70	0.50
燐	1.15	0.08	0.07	0.007	0.005	0.008	0.007

(b)焦之分析

名稱	一號焦炭	二號焦炭	備考
水分	0.21	0.29	水分攝氏百度烘一時間
灰分	12.03	14.38	
瀝青	0.73	0.47	
炭素	87.03	84.86	

(c)附記　嶧縣煤與各處煤之性質比較

(甲)火車試燒之比較(據李士鑑黃世泰陳惟士報造)

名稱	單位時間所需煤量	備考
嶧縣中興公司煤	20磅	
開平煤	23磅	
賈汪煤	31磅	

(乙)發熱量之比較(據唐山步爾洛尼氏之調查)

名稱	塊煤	末煤	名稱	塊煤	末煤
嶧縣	7720	7475	西北井塊煤	7840	——
唐山第五層煤	8040	7400	同第五層煤	——	7460
唐山機車煤	7885	——	同東洋煤	——	7240
唐山第一號煤	——	6835	林西一號	7085	——
同第二號煤	——	6290	同二號	6825	——

(丙)灰之成分比較(同上)

名稱	塊煤	末煤	名稱	塊煤	末煤
嶧縣近六處之煤	11.11	13.45	西北井塊煤	9.10	——
同上部煤(斷層上部)	12.82	10.95	同第五井末煤	——	14.04
同下部煤(斷層下部)	7.85	9.90	同東洋末煤	——	15.34
唐山機車塊煤	9.84	10.32	林西第一號末煤	15.96	19.86
同五層塊煤	6.66	——	同二號煤	19.02	25.00
同一號末煤	——	20.67	趙家莊第十二層煤	12.00	17.00
同二號末煤	——	6.56	馬家口一號	17.50	18.30
同五層末煤	——	14.24	同第二號煤	25.40	30.55

新井探鑛之地點

全煤田面積約爲一百一十二兆方米突，茲若只以大窰泥窰鷄子石三層計算，而假定其平均厚度共爲十米突，則除郭里集以東之小煤田不計外，共應有煤一千五百餘兆噸，煤量之豐罕與比匹。所可惜者，露頭所在舊井如林，廢棄多年，積水蓄氣，已採者既悶老山空，未採者亦傾覆淹沒，施以近世工程不無危險。此種半經開鑿之煤田，應如何施工續採，自當決之於工程師，爲中興公司擴張起見，則另開新井應擇全鑛中未經開採之部分從事探鑛，庶幾事半功倍。就此次研究所得，全鑛中完全未經開採之區域共有兩處，一爲長盆最深之地，北限於墓山之斷層(F_1)，東北界線自常莊起，南經安營之東至洪家村，折而西向，經大席店鄒塢小武學折而北向，至黃貝而止。除近於斷層岩石破碎之區域不計外，其面積共爲二十五兆方米突有奇，若僅以大窰計算，假定其煤層平均爲五米突，應得煤一百六十餘兆噸。即若尙有斷層支柱各種關係，不能全得此數，可採之煤至少亦有一萬萬噸。每月出煤六千噸，足供五十年之用。所不可知者爲煤層之深淺，蓋可測之露頭僅限於四圍之磨石，及常村安陽附近之紅砂岩及礬岩，而東西兩端岩石之傾斜，皆在二十度以上，僅就此計算，則中部之煤層且深不可採。然南部之地層則又極平，陡者亦不過十二度，是煤層最深處應在六七百米突之間，欲知其究竟，非打鑽莫由。打鑽之目的有三，一以知煤層最淺處若干尺，二以知煤層最深處若干尺，三以知無露頭處之情狀。故至少須打鑽三處，茲擬置一鑽於嚴家埠之東，是爲鑽之最淺者，大約二三百米突之間即可見大窰，故應於發見大窰後，接續下鑽至渣子窰而止，庶可知各煤層之確實關係。置一鑽於劉家溝之南，是爲鑽之最深者，大約五六百米突可達大窰，一達大窰即可停工。再置一鑽於布湖黃貝之間，以周圍無露頭，故其深淺不能知，姑妄言之，則煤亦當在三四百米突之間。若第三鑽見煤較第一鑽反淺，則應於此接續下鑽，而第一鑽見大窰即止，庶可以最省之費收最大之效焉。

僅為證明地質，有此三鑽已足達其目的，然布湖之東北露頭過少，即第三鑽極滿希望，恐尚須另鑽他處，方可確有把握，但其地點應視前三鑽之結果與施工程之計畫而定，故當俟第一次打鑽事畢後決之於工程師方為有益也。

以上所言為全鑛中希望最大之區域其次則尚有朱子埠至鄒塢之煤田，亦完全未經開採者東西長約十四里，南北廣一里有半，介於兩斷層（F_3，F_4）之間，其面積為十兆方米突，僅算大窰以五米突為其平均厚度，應有煤五千餘萬噸，是不過前所言者三分之一。但大窰距地面較淺，其最深處當不過五百米突，苟有兩鑽，一置於土井子羅家嶺之間，一置於尖山子之西北，則全部之地質不難由此而知焉。

結論

中興公司鑛區以內之地質其詳已如上所言。惟其間或根據於學理，或注意於事實，頭緒複雜，不易得其要領，玆特將報告中論點有關於實用者，簡摘之如左。

(一)郭里集以東之煤田，面積甚小，且上棗莊層已為風雨侵蝕而無遺跡，故僅有泥窰以下煤層。

(二)郭里集以西之煤田，狀略如長盆，北部破裂太甚，東西斷層以外復有南北斷層，故構造複雜，沿盆之四周煤層露於地面舊井極多。

(三)大井以東尚有斷層，但於開採當無大妨碍。北部煤層較深，舊井較少，希望較佳，但露頭太微不易知其構造，以其可見者測之，田家村，雷家村，小王村之間，當有煤七百萬噸，傾斜漸轉向東北。

(四)鑛區內未經開採之煤田，最有希望者，莫如鄒塢以北；其界線自常村起，經洪家莊，大席莊，鄒塢，小武學，至黃貝而止，面積二十五兆方米突，大窰煤量應為一百六十餘兆噸。惟深淺不能知，大約深者六百米突，淺者三百米突。其次為朱子埠與鄒塢之間，其面積十兆方米突大窰煤量為五千餘萬噸，深者約在五百米突以內。

以上乃關於事實者。至於公司應著手之事件，約有數端：

(一)郭里集以東之兩鑛區，似無兼領之必要，應廢棄以省鑛稅。

(二)大井以北田家村雷家村之間，打一深鑽，直達渣子窰。

(三)鄒塢以北，應先打鑽三處(嚴家埠之南，劉家溝之東，冶常子之西)，三者如不能同時興工，應先於嚴家埠冶常子著手。

(四)如打鑽結果與希望相符，應擴充鑛區，將自常村至黃貝之狹帶，包入鑛界之內。

(五)如有餘資，或鄒塢以北打鑽結果與希望相反，則應於第二區內打鑽。其一在羅家嶺與土井子之間，其二在郎石溝之東南。

打鑽時所應注意者有二：

(一)打鑽深者六七百米突，淺者亦二三百米突，其確數不能預知，故應以見煤爲止。先言明每尺價若干，後按鑽洞尺數計算。

(二)打鑽費應分期交付，責成打鑽者將所得之岩石，照其上下次序送公司備考。

夫營鑛業者不患資本之不足，而患鑛量之不豐，不憂工程之困難，而憂交通之不利。良以人力經營其道無窮，地勢寶藏一成不變也。茲中興公司據津浦之下游，專煤田之大利，開採則百餘年無缺乏，銷路則千里內無競爭，有鑛如此而不能獲利，則天下將無可以獲利之鑛矣。雖曰斷層水患，損失踵至，而及時補救，棄舊維新，亦反手間事耳。抑又聞之，地利不如人和，然則公司之有今日也，地之咎乎，人之咎歟。旣往不諫，亡羊補牢，鄙人不敏，於公司執事諸君子有厚望焉。

附此報告之後者尚有調查中興公司鑛業報告一篇由梁津丁文江二人署名。因材料太陳舊且與地質無關故未予以排印。——編者。

Geological Reconnaissance in Kuangsi

I. ROUTE DESCRIPTIONS.

20 July, 1928: From Nanning[1] to Pumiao[2].

Went to Pumiao in a motor launch with Mo "Fukuan"[3]. Left at 6:30 arriving about 9. White crystalline crinoidal limestone with brittle angular fracture occurs immediately S. of village. Found some brachiopods and corals. Plenty of bryozoa. It is practically horizontal with occasional dip to S (5°-8°).

Below Pumiao the limestone forms occasional isolated and rugged peaks suggesting upper limestone seen near Wuming[4].

About half way between Pumiao and Tsientaohsu[5] small outcrops on right bank of river—a pink flaky limestone rather impure, barren of fossils.

Near the landing of Pumiao fossils found in pavement stone—it is a dark blue limestone with conchoidal fracture. Origin unknown.

The hills of Musingling.[6] Tsingshanta[7] and Shanniuling[8] are of coarse sandstone with reddish soft bands—Mr. Chu's[9] Devonian. It contains also a conglomerate. Below the Pumiao limestone, there seems to be a limestone breccia.

Got back about 2:15. Very hot day—no wind, slight rain, and strong wind at night.

Information from a report by Mr. Ho-Chih-chien[10] employer of the Liuchou Shih-yeh-yuen[11]:—

Analyses of Coal

Locality	Moisture	Vol. M.	Carbon	Ash	S
Shatang, Liucheng	1.75	10.55	48.08	39.62	
Hsingshu, Maping	5.08	11.16	68.10	15.66	
Locheng sold at Liuchou	1.21	3.01	90.08	5.70	

1 南寧 2 蒲廟 3 莫副官 4 武鳴 5 剪刀墟 6 木星嶺 7 青山塔 8 山牛嶺 9 T. O. Chu (朱庭祜) of the Geological Survey of Kwangtung and Kwangsi. 10 何致虔 11 柳州實業院

Hoshan, Chienchiang	0.72	10.25	79.20	9.83	9.20 (?)
Wulichiao, Chienchiang	5.95	12.94	52.32	28.79	
Szutsutechiao, Yishan	2.37	10.28	56.94	30.41	
Tungtsukulung-kang, Tienho	4.54	2.29	89.79	3.38	
Yunchiang, Lo-yunghsien	1.15	9.57	54.05	35.23	
Siwan, Chung-shan	0.55	33.59	61.43	4.43	
Taipingtsun, Locheng	3.52	2.44	89.62	4.42	1.21
Szumen, Locheng	5.04	1.37	86.58	7.01	3.04
Erhtang, Yungning	13.60	40.95	32.65	7.80	

Information from friends:—

Coal occurs at Wulichiao[1], Chienchiang[2] (81 li from Chienchiang and 5 li from Hungshuiho[3]) in black shale and sandstone in low undulating ground; out-crop below 3 ft. of clay; thickness 4 ft., strike N-S dipping 10° E.

Northwest of Holi[4], Hoshan[5], coal worked before 1918. Stopped since; now belongs to Limin Co[6]. Coal said to contain 6 seams; the thickest is 6 ft., thinnest 3 ft.

At Holi, according to Tochner, several seams in red sandstone, thickness more than 8 ft., steep dip.

In Locheng[7] district, coal worked at Szumen[8], Huangchin[9], Siaochangan[10], Lungan[11], Lengtsun[12], Taipingyintsun[13]. Coal of Taiping[14] is best, Szumen next. that from other localities is very poor in quality.

1 五里橋 2 遷江 3 紅水河 4 河里 5 合山 6 利民公司 7 羅城 8 寺門 9 黃金
10 小長安 11 龍岸 12 冷村 13 太平銀村 14 太平

Coal at Szumen :

Outcrop at Kuanyinshan[1] 5 li S. E. of Szumen. Going S. to 30 li N. of Huangchinho[2] also coal, but not worked. Used to be worked before Republic by Tai-Hung-Tzu[3], Hung Feng Co[4]. Numerous pits said to go down the incline for 2 li. After the Republic An Yung Co[5]. is working. Coal used by electric works at Liuchou[6].

Stratigraphy :	Descending	
	Pure thick-bedded limestone	400 ft.
	Shale	80 ft.
	Black Shihpanshih[7]	
	Coal and fire clay	2 ft. 8 in.
	Shale & K. [?] sandstone	200 ft.
	Limestone with fossils.	

On hill 7-800 ft. high, strike N 30° E dipping 20° S E. Details of coal seams :

Coal	2 in.
Shale	5 in.
Coal	2 ft. 8 in.
Shale	6 ft.
Coal	5 in.

Largely worked at Shuiweitsun[8] 15 li from Szumen. Sulphur [pyrite] occurs near roof and floor.

Coal at Taiping : 20° NW of Locheng, situated on low hills. 5 seams, the uppermost 2 ft., good quality. 15 ft. below another seam, 3 ft., but full of sulphur [pyrite]. The rest are few in.

Field from Yintsun to Tienhohsien, sulphur mine [mining pyrite for S manufacture?] 30 ft. below coal is a bed of pyritiferous shale 4 ft. thick. Used to be worked. No company organised.

Coal at Yintsun : 6 seams 8 in. to 2 ft. Distance between seams few in. to 6 ft., pyritiferous.

Coal at Huangchinhsu[9] : Yuantoutsun[10] 5 li S. E. of village Huangchin, S. W. thereof, at Lengtung[11], also coal. Poor quality and small thickness.

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1 觀音山 2 黃金河 3 戴鴻慈 4 鴻豐公司 5 安榮公司 6 柳州 7 石板石 8 水尾村 9 黃金墟 10 圓頭村 11 冷洞

Coal at Lungan: From Lungan S. W. to Huangchin all coal of poor quality ("dust coal").

Coal at Siaochangan: main seam may have an extension of 2,000 ft.

It appears from the information given above that we are dealing with 3 coal fields:

(1) Szumen via Shuiwei continuing S. W.

(2) Lungan, Huangchin to Chiaotou[1]

(3) Yintsun, Taiping, Shantui[2] to Tienhohuangchang[3]

Above Liutang[4] (S. of vil.), yellowish somewhat hard sandstone with plants strikes 30° E of N, dipping 16° NW and some ferruginous bands occur on top. Bedding about 40 cm thick. This probably represents the upper part of Tertiary.

Just beyond Liutang by roadside, hard coarse brown sandstone (bedding 1 ft.) and brown and grey sandy shale, striking E-W dipping 10° S.

Beyond Tsitang[5] reddish sandstone and conglomerate and breccia dipping nearly horizontal to S.

Then S. of Shanhsin[6] hard pinkish and yellowish sandstone (median-grained and micaceous) and grey shale, St. WNW-ESE, dipping 3° SW——the conglomerate is seen overlying it unconformably.

Just S. of Nanning[7] brown and yellow hard sandstone,——with thin beds of black shale and red and green strata, strike E-W, dipping 75° N.

South of Patang[8] red sandstone with dark veins [?]. At Patang much weathered granite, metamorphism not seen. Contact of granite with sandstone and shale opposite Kangyaotsun[9] south of Tinghsu[10].

After passing Pinyang[11] to its E. going N. on the small hill cutting through by the road, red and yellow soft sandstone and yellow shale strike N-S, dipping 45° W.

At Changping[12], limestone conglomerate underlying sandstone, St. NW-SE, dip 20° NE. Conglomerate is intraformational as well seen at bridge near Chouhsu[13]. Then we are in massive limestone, St. NNW dip ENE 40°-30°.

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1 橋頭 2 山堆 3 天河礦廠 4 六塘 5 七塘 6 山心 7 南寧 8 八塘 9 岡窰村
10 丁墟 11 賓陽 12 長平 13 鄒墟

After Yingyai[1] we come to some grey sandstone? and shale, overlying limestone to W. [coal series?]. At bridge, good section, black limestone opposite river, St. NNE dip 25°-30° ESE. Local guides waited at Kuanyuan[2]. By horses and chair went to mine. 1 li or so S.W. of Wulichiao[3], nothing to be seen except silicified limestone dipping 20° E. At about 2 li NW of Wulichiao same [coal series as] at Meitanshan[4]. The series consists of silicified limestone with fossils and ferruginous sandstone and black shale.

25 July, 1928: From Chienchiang to Liuchou.

After Peissu[5], we have blue thin-bedded limestone and soft greenish shale very like [that of] Trias. Practically horizontal, strike NW-SE dipping at pass 10° SW.

Red sandstone seems to be below shaly sandstone 2 li S. of Chiama[6], strike ESE, dipping 10° SSW.

[Section seen in coal mine.]

Overburden	2' – 10"	(foraminifera sand?)
1. White limestone	1" – 33"	(foraminifera sand?)
2. Coal	2'	
3. Silicified limestone	1'	
4. Thin layer of black shale		
5. ,, ,, ,, white shale		
6. ,, ,, ,, black shale	5"	
7. Black flint	1' – 5"	
8. Black limestone with cherty nodules		

The whole formation strikes N 30° W dipping 17°. It is found that (1) contains gastropods and foraminifera, (3) foraminifera, (7) gastropods and (8) brachiopods. The whole overlaid by thick white limestone.

But ½ li from pass, going down, silicified limestone with shale, St. NNW-SSE dip—65°—90° WSW. Limestone just to N. seen to be nearly horizontal St.

1 營隘[?] 2 觀元 3 五里橋 4 煤炭山 5 北泗 6 架馬

NE-SW, dip 20° NW. Possible unconformity as seen from pass coming down. At Shihtieh[1] black limestone full of calcite veins. St. N-S, dip 60° W. It seems therefore that the limestone is not really horizontal over the coal series——no unconformity! (Fault to the left, coal overlaid by gently dipping limestone.)

At Tatang[2] blue limestone St. 20° W of N dip 47° W, soon reversed.

At Paitzuyai[3] pass white limestone nearly horizontal, brachiopods, bryozoa, crinoids and corals.

27 July 1928: left Liuchou for Tapu[4].

Left at 12:20. On left bank [of river] opposite Liuchou black limestone exposed. Stop at Liucheng for night.

Went up from Tapu beyond Nantsun[5]. Just below rapid, cherty limestone exposed along the left bank, but not on right. Behind it is the lower red sandstone forming high hills. Strike & dip not clear, contact not seen; but as coal series forming low yet isolated [?] hills on SSE bank, it is probable [that] limestone strikes along river. Dip may be reversed.

Coal strikes nearly N-S dipping 18° W to the N side of shaft 20 ft. deep, 4 ft. of coal, but in the same slightly winding hole it becomes 3 ft. The roof is a sandstone which cannot be very thick as it is soon covered by a greyish limestone. The floor is a hard yellowish limestone. The first shaft was made W of Chungwei[6] said to be 2 ft. [?] deep with 4 ft. of coal dipping steeply N (?). Bituminous coal said to occur at Kulu[7]. The map[8] is quite incorrect. The distance between Toutang[9] and Tapu is far too long and that between Liucheng and Toutang too short.

Cherty limestone[10] strike 75° WSW dip 52° NNW. 100m. S., contact with red sandstone St. 25° N of E. Crushed & sheared. It consists of coarse grained reddish sandstone interbedded with reddish shale. Further down the river 2 km. from Tapu hard sandstone St. ENE dip 70° S. 20 m further down, same sandstone St. E-W, dip 35° N——almost immediately reversed to S. about 35°.

Just before getting to Toutang on right bank of river, [folds in black silicified limestone and red shale, with coral reefs]. Then horizontal conglomerate all

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1 石碟 2 大塘 3 百子隘 4 大埔 5 南村 6 中韋 7 古蘆 8 Refers to military map of the province of Kwangsi. 9. 頭塘 10. The observer was perhaps at Tapu.

the way along river; the pebbles are big (2½ cm). At a big band [?, bend of river] silicious limestone St. NE-SW, dip 15° N, overlaid by massive blue limestone.

31 July 1928: from Liuchou[1] to Chuanshan[2]

According to the records of the Industrial Bureau[3] the temperature and pressure (For 1928) are as follows:

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec, (1927)
55.7F	51F	60F	62F	76F	76F	84.6F	84F	—	—	—	59.7F

Average pressure: 29".5.

The third and the highest pass from Ssufangtang[4] (to the north of) is a yellowish brown sandstone at first dipping 72° W, but a few steps further iron and manganese occurring in it and the strike turning to NE-SW dipping SE. Immediately after, the iron bed strikes WNW-ESE, dipping 35° NNE. Further on it strikes NNW-SSE, dipping 40° WSW, gradually changing into NNE-SSW dipping 50° WNW. Then it dips to SW, changed again to NE. Limestone is seen on the top of the hill. Limestone cliff first met wih N. of the sandstone hill, striking NS dipping 15°-20° E.

According to one of the engineers the coal mine at Shatang[5] is 10 li NE of village. The seam is 4 feet thick, dipping 30° NNE. At Hsingshu[6] the seam is only 1' 8".

1 August 1928: Liuchou to Kueilin

At Liuchou, barometer 293 (140 m). At River 294 (110 m). Limestone here strikes 10°N of W, dipping 15° E. All limestone from Liuchou to Sanmenchiang[7] dips gently to NE. River at Sanmenchiang flowing SSW, barometer 294.5 (100m). At right bank of river greenish brown hard sandstone, striking 25° N of W dipping 17° E. On the cliff, barometer 293.9 (113 m). Black shale and brown sandstone overlain by thin-bedded dark limestone and harder gray sandstone. It took us two hours to cross the river. Near Tungma[8], soft yellow sandstone and gray shale St. NNW-SSE, dipping 60° W. Thin limestone in yellow shale at Chioahua[9] is rich in fossils. It is Middle Devonian. It strikes E-W, dipping 32° S. The car broke down and we (Dr. Ma, Mr. Huang, and myself) had to walk from Chiaohua to Liuchiang[10]——a distance of 15 li. Spent the night at Liuchiang.

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1 柳州 2 穿山 3 實業院 4 四方塘 5 沙塘 6 新墟 7 三門江 8 洞馬 9 敎化
10 榴江

2 August 1928: Liuchiang to Kueilin

At Liuchiang, barometer 292 (168 m). Departed in company of Mr. Fang-kan[1]. The new road is W of the old road as indicated on the map. Fossils are common in the impure limestone along the road near Liuchiang, but did not stop to collect. At Tangkou[2], 18 li S of Liuchiang, (N of the village by the name and at the bridge) good fossils found in a bluish shaly limestone. Thickness of the fossiliferous bed about 10 feet, dipping 15° W.

Rested at Sanpei[3]. Barometer 292 (168 m).

From Hsinchiao[4] on, conglomerate and red clay predominate, forming low hills.

At Shihjenchung[5] old road joins the new (The "Shihjen" is formed by quartzite.). Yellow shale and black limestone containing pelecypods, striking NNE-SSW, fault at river. At Chalu[6], the road enters high mountain, and fine-grained greenish sandstone and greenish yellow shale interbedded with black shaly limestone and hard brown sandstone [crop out by road side], striking 10° W of N dipping 24° W.

At Sanchianghsu, barometer 288 (282 m). Several Yao girls[7].

From Palichiao[8] to mouth of mountain all hard brown sandstone. At first it seems to dip 15-20° N, but at mouth it strikes ENE-WSW, dipping 80° S.

In the plain of Hsiujen[9], gravel beds are more extensive than the red clay with which it is always associated. Half way between Hsiujen and Lipu[10], cross river by ferry. Outcrop of coal (?) series. River going SE, barometer 290 (224 m). At Hsintsun[11] limestone on right prolongs backwards and forwards, and on the left soft shale and sandstone. Limestone on right prolongs to Shuangshouting[12] and beyond, 10 li from Lipu. Soft shale and sandstone on left. Plain between. At Lipu, barometer 290.5 (210 m).

Below first hill N of Lipu, coal series observed striking E-W dipping 75° N——it is complicatedly contorted. At Chiehpai[13], soft sandstone and shale with thin-bedded limestone, striking E-W dipping 10° N with the N end near the spring. At the S. end near tablet, complicated folds followed by black shale. Soon soft sandstone and shale form flat-topped mountain on the right (anticline), the N end finished at Kaotien[14]. After that, limestone, perfectly horizontal, continues to Yangshuo[15] forming wonderful cones.

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1 方剛 2 當口 3 三碑 4 新橋 5 石人冲 6 岔路 7 猺女 8 八里橋 9 修仁 10 荔浦 11 新村 12 雙壽亭 13 界牌 14 高田 15 陽朔

First pass N of Yangshuo outcrops of black limestone striking EW dipping 40°-60° N. White limestone on the top seems to be horizontal. Soon less eroded limestone on right. S. of Peisha[1] it is replaced by soft sandstone. Then limestone cones again.

6 August 1928: Kueilin to Tahsu by boat.

At Hsiangpishan[2], height 1650+ft. [?], pinkish white limestone with black bands, fracture subflinty. Strike NNE dipping 5° WNW, changing into E-W dipping 15° N. Went to the top with great difficulty. From the top it is seen that on the left bank one limestone hill to the N striking ENE-WSW dipping 15° S. *To the S Chuanshan*[3], striking 20° N of E, dipping 15° E. This measurement is confirmed when I went to Chuanshan.

Anticline just N of Touchishan[4], axis NE-SW. R. Touchishan, pinkish white limestone with crystalline spots dipping 10° SE.

Below Weichiatu[5], section by river bank consisting of fine, half consolidated sands passing below into coarse sandstone. Total 4.7 m; gravel 1 m.

S. of Chamuhsu[6] grotto. Gray semicrystalline limestone striking N-S dipping 20° E.

Half way between Lungmen[7] and Tahsu[8], limestone seems horizontal, coming across the river on left bank dipping N. A little further, mountain right down to right [river?] bank, striking NE-SW dipping 30° SE. Further south high tabular limestone underlaid by a black shaly limestone (cherty). At a point opposite Shihchiatu from the lower limestone a number of Lower Carboniferous corals were obtained——the fossils weathered out in cherty bands. Strike here NE-SW, dip 25° SE. It is overlaid by yellowish red clay and gravel consisting of quartzite pebbles.

10 August 1928: Visit to Fuposhan[9]

Limestone strikes ENE-WSW, dip 10° SSE. Here the water is very deep. At Peimen[10], at the S end, limestone strikes E-W, dipping 20° N, then horizontal to N. Approaching main road from N, sandstone strikes 10° S of W, dipping 50° N.

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1 白沙 2 象鼻山 3 穿山 4 門鷄山 5 衛家渡 6 柘木圩 7 龍門 8 大圩 9 伏波山 10 北門

12 August 1928: *to Chuanchou* in company of Huang and Ma.

At Kantangtu[1] black cherty limestone striking NNE dipping 60°-90° ESE. All the way to Lingchuan[2] in Lower Carboniferous low hills of black shale and shaly limestone covered by Hungtu and gravel. After Liangfengchiao[3] the road goes up and it is probably in Devonian, thence to Hsiaoyungkiang[4] mostly in soft sandstone and shale. At Hsiaoyungkiang soft reddish shale striking N-S dipping 36° E. Barometer here 258 m. High mountains on the left. In the Hsiaoyungkiang river thin-bedded limestone (?) and schistose shale strike NNW-SSE dipping 60° WSW.

From Hsiaoyungkiang to Tayungkiang[5] big valley. Tayungkiang Bar. 255 m. Shallow river *with granite pebbles.* 10 li from river small outcrop of gravel and sandy clay. Otherwise E-W plain. Further N (a few li) eroded low clay hill.

Soon after Peichufu (5 li) limestone on right side of road with soft sandstone, thin-bedded shaly black limestone dipping 25°-30° S. Limestone disappears at Tangpuyi[6]. Road in yellow shale and thin-bedded limestone. Red and yellow shale before coming to limestone again.

From Lupanpu[7] to Paisha[8] Devonian (?). Paisha to Hsienshui[9] gravel and Hungtu form low hills. After Panshan[10] violet sandstone and shale. Chuanchou[11] 213 m.

13 August 1928: *from Chuanchou back to Kueilin*

Special trip to Chiaotu[12] via Feiluanchiao[13]. At the latter limestone mountain highly folded (Fig. 46). At Chiaotu which is about 15 li plus from Chuanchou, a moderately high limestone hill known as Yupingshan[14] to the N (right) of the village shows blue limestone, striking NNE-SSW dipping 40° ESE. About 200 m E dip is reversed and pinkish impure limestone interbedded with greenish red shale dipping 50° W. Then reversed again and dip becomes more gentle. It is to the east covered by pure limestone. The shaly layers contain a rich fauna of *Yunnanella.*

8:45[15] Chiaotu. 8:54 Lungyingan[16], limestone gently dipping E. 8:57 Hokouling[17], sandstone above (?) limestone. 9:00 thin limestone on left. River

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1 甘棠渡 2 靈川 3 涼風橋 4 小溶江 5 大溶江 6 唐甫驛 7 路板舖 8 白沙 9 咸水 10 板山 11 全州 12 橋渡 13 飛鸞橋 14 玉屏山 15 Figures from now on indicate time read from the watch of the author who made the trip in an automobile.
16 龍隱菴 17 河口嶺

to the right; left side, sandstone hill wooded, but limestone beyond to left also. A beautiful section seen across the river to the S. 9:09 Kangtitu[1] opposite LV in section. 9:19 Fenglitung[2], sandstone to left disappears and limestone two kilometers away. 9:26 Fumoshan[3] 9:35 Chaichiao[4]. 9:39 low limestone hill on left strikes NE-SW, dips 20° SE, overlaid by yellow clay, sandstone (?) and thin limestone on left all the way to Feiluanchiao. 9:42 opposite F. H. on other side of river in section.

Coal pits at Chiehshou[5] road. Strike of sandstone NNE-SSW dipping 30° NW.

*17 August 1928: from Kueilin to Yaoshan**

Went by way of Pengchialing[6]. At quarry typical pinkish gray limestone with subconchoidal fracture striking 10° N of E dipping 20° S. From Tienshenshan[7] to Maoan[8] 12° N of E distance 2 km plus. Limestone at Tienshenshan seems to be horizontal. 8:45 Bar. 220 m. Chushenssu[9] (Maoan) to Tientzetien[10] E. 8:54? 9:30 Peiyunkuan[11]. From Tienshenshan to temple 10° N of E, distance 2500 m plus. From Chushenssu up 1 km plus. Going up from Maoan, at first red hard sandstone striking N-S dipping 40° plus E. It is *overlaid* by a greenish white limestone, so pure that it is used for burning lime and quarried on the N valley. On the S valley it is seen to be consisting of 4 layers dipping in the same direction. Then 100 m W of Tientzetien the hard sandstone forms a steep anticline dipping W-E more than 70 degrees. On the way to the pass, reddish sandstone striking NE-SW dipping 30° SE. Pass 620 m, red sandstone dips 35° NW. From Tienshenshan it is E. From Pengchialing 18° N of E. Going down from valley 10° N of E road to Tunghsian[12]. Sandstone strikes N-S dipping 60° E. This measurement is more reliable. On right, *it dips W*. Further S the strike is 10° W of N dipping 60° E. Turned S E pass ?. From Tienshenan 8° S of E. Turn S again. *Highest point 3650* feet (820 m ?) *and 7° S of E from Tienshenan*. Turning E again, going down to pass, leading to Huayuanli[13]. Reddish brown sandstone strikes NNW dipping 50° E. Then it changed to strike E-W and dip 50°-60° N. *Limestone below dips 50° plus N. See sketch section* (Fig. 41). At Liangting[14] 1900 feet (274 m?). At Putoshan 1920 feet (280 m?). Limestone at

*Only a rough route traverse without accompanying description is shown in Dr. Ting's field book for August 14-16.

1 岡底渡 2 風裡洞 3 伏魔山 4 再橋 5 界首 6 彭家岑 7 天聖山 8 茅菴 9 祝聖寺 10 天賜田 11 白雲觀 12 東西菴 13 花園裡 14 涼亭

Kuatzeshan[1] (Ed). Evidence of faulting NE of Lunghantang[2]. Conglomerate after Kuatzeshan.

18 August: *went to Liangkiang* and surveyed the hill between Tanchiao[3] and Chungkou[4]. See map.

21 August: *went to Pankuling*[5] via Tingkiang[6].

Barometer at 6 a.m. at Putoshan[7] 293.1. From Tingkianghsu the road lies between Maochia and Sannantsun. Limestone forms small hills between the latter and Maochia where there are low hills of sandstone?. The latter occurred also W of Maochia and at Tingkiang, which lies between two hills. There coal is said to have been mined long ago. Arriving at Lingti[8], left the pony and started to climb. Barometer at Lingti 2926. Shaly limestone very impure strikes 15° E of N dipping 34° WNW, interbedded with sandstone and silicified limestone. At 2916 limestone disappears. 2906 cherty black shaly limestone and red and gray shale strike NE-SW dipping *35° SE*. A little further up strike turns ENE dipping *vertically* with signs of faulting, veins of calcite.

2898 reddish shaly limestone strikes E-W dipping 20° N. Then strike changes into 20° N of E, dip 50° N, interbedded with shale. 2888 limestone disappears. 2863 limestone and red sandstone strike E-W dipping 20° N. 2856 limestone strikes NE-SW dipping 20° NW. 2848 quartzitic sandstone blocks begin to appear. 2838 *white and pure* limstone (40 m). *At temple of Pankuling.* 2828 quartzitic sandstone brown outside and white inside with iron veins; strikes 20° E of N dipping 39° W.

Going down

Very cherty limestone	27 m.
2844 sandy limestone and sandy gray shale strike 20° N of E dip 35° N	117 m.
2845 black thin bedded less cherty shaly limestone	
2846 greenish gray shale bands	
2848 reddish black cherty limestone, *vertical,* ENE-WSW, dip on each side more gentle. Calcite veins	28 m.
2849 vertical again. Then 80° W followed by greenish sandy shale and sandstone. Signs of faulting. Thin limestone to N horizontal	

1 掛子山 2 龍汗塘 3 丹橋 4 沖口 5 盤古岺 6 丁江 7 普陀山 8 靈地

2852 poor outcrop		
2853 to 2861 one band of thin bedded limestone in shale and sandstone strike 23° N of E dipping 39° W.	}	70 m.
2872 more limy very cherty sediments down to 2872, strike E-W dip 20° N.		
2876 sandy shale and sandstone all brown in color	}	45 m.
2879 white veined black limestone few meters thick		3 m.
2880 brown sandstone with darker gray bands		40 m.
2884 very cherty black limestone strikes 10° N of E dip 25° N.		36 m.
2889 shale and sandstone covered by bush		70 m.
2899 cherty limestone again		80 m.
2908 sandstone and shale with fossil (?)		60 m.
2912 massive light gray limestone with less chert		100 m.

2918 temple. To all appearance pure limestone is below.

From temple on, flat ground in sandstone and silicified limestone*. 2970 Hochiapu, magistrate Chengmeiwen[1] waiting. Just S of Hochiapu (250 m) black limestone and calcareous shale striking 35° N of dip 40° S. It contains crinoids and other fossils. Outcrop N of Wushihkai strikes (the same limestone) WNW-ESE dip 70° N, underlaid by silicified limestone containing Mn.

2927 Mulungtung.

Section from top downwards:—

1.	Quartzitic sandstone	100 m. +
2.	Light gray pure limestone	40 m.
3.	Gray very cherty shaly limestone	27 m.
4.	Greenish gray shale with thin beds of shaly and cherty limestone	15 m.
5.	Reddish to dark gray cherty limestone	28 m.
	Fault	
6.	Reddish yellow shale	46 m.
7.	Reddish and greenish soft sandstone and shale with thin bedded limestone	70 m.

* Meaning of phrase not clear. 1 陳美文

8.	Soft brown sandstone and shale interbedded with bands of silicified limestone	45 m.
9.	Black shaly limestone full of calcite veins	3 m.
10.	Soft brown and gray shaly sandstone	40 m.
11.	Dark gray limestone full of chert	36 m.
12.	Brown sandstone and shale	70 m.
13.	Very cherty dark gray limestone	80 m.
14.	Soft brown sandstone and shale	60 m.
		560 m.

*25 August: started for Chuanchou**[1]*

First outcrop of Lower Carboniferous occurs just N of Wushihkai[2] after which no outcrop is seen until S. of Hochiapu[3], the low ridges being formed by red clay and gravel.

From the latter numerous fossils were obtained in the black shaly limestone inter-bedded with greenish yellow sandstone. To the N. of the village another outcrop of the same striking 28° W of N dipping 55° NE, but on the next hill which is continuous with the low range to the NE, it strikes 10° W of N dipping 60° SW. Descend into the river at Kantangtu[4] where the shaly limestone and shale have various strikes and dips—on the W. of the road they dip 60° WNW, but on the east they dip 60° ENE, and near the river bank they strike 22° N of E dipping 30° S. They contain poorly preserved fossils.

Beyond the river the low ridges are formed by gravel and red clay except the ones NE and SW of Wulungpu[5]. In the ridge SW of Wulungpu the strike is SSW-NNE and steeply folded, the dip is 60° E or W; NE of village the shaly limestone has the general strike 10° N of W, and is contorted (see sketch section).

From the last right to Linchuan[6] no outcrop at all except the red clay and gravel forming ridges across the road.

From the high ground in the Magistrate's (Chenmeiwen) Yamen where I lunched, it is seen that the limestone mt. to the east of Linchuan seems to strike 25° W of N dipping E on the NE part—forming an anticline (?).

* No records for August 19-24.

1 全州 2 烏石街 3 禾家舖 4 甘棠渡 5 烏龍舖 6 靈川

From Linchuan on NE., a hill of red clay lies between Kanshehpu[1] and 15 mile point, then alluvium to Liangfengchiao[2] where on the left is sandstone, but on the right still red clay. Soon we enter into the mountains where on the right lower hills consist of yellowish soft shale and sandstone without clear outcrop, but on the right [left] we have hard brown micaceous sandstone underlaid by yellowish red shale which acquires schistose structure. It strikes 20° W of N dipping 50° ENE, but on the west end it is faulted and sheared with visible metamorphism. Going to Hsiaoyungkiang by way of Erhnanliu[3], the yellowish sandstone on right SW of Erhnanliu dips SW, but W. of Hsiaoyungkiang village it strikes NE-SW dipping 20° SE. Between the village and the river, it strikes NE-SW dipping 30° NW—the lower shale layers seem to be schistose. In the river is strikes 20° E of N dipping 70° NW.

From Hsiaoyungkiang to Tayungkiang, on outcrop near the road but high Mts. are seen on both sides, formed by hard sandstone dipping both *towards* the road.

Passing Tayungkiang, Taihopu[4], Tsilitang[5], Shihmaping[6], and Peichupu[7] no outcrop except red clay which continues to the E. of the village. Soon we are in the hills. On the right side of the road halfway between Peichupu and Tangpaoying[8] is a cliff composed of limestone 100 m high the lower part of which consists of black shaly impure limestone, but the upper part is purer and is mined for burning lime. The cliff face strikes N-S dipping E (?), much cross-folded and faulted. Lower down the slope it strikes E-W dipping 15° S (see sketch). On the left side of the road we have shaly limestone, yellowish red shale, and brown sandstone forming fairly high mountain striking E-W dipping 20° S.

The road then goes along the S. slope of the Mt. and goes over a low pass and down to Tangpaoying (Fig. 52). At the pass the shaly limestone and yellow shale strike NE-SW dipping 20° SE under *pure limestone* cliff.

Beyond Tangpaoying—beyond 30 mile point—, we have outcrop of impure thin-bedded shaly black limestone containing *Cystiphyllum*-like corals and Devonian brachiopods. It strikes 20° N of E dips 25° S and seems to be overlaid by violet sandstone, yellowish red shale and thin bands of shaly limestone striking 10° E of N dipping 35° E. Then down to Tahungchiao[9] in plain.

Soon we are in limestone moutains again. This limestone is of exceptional purity and is white in colour—very like Maping limestone. Near Yenkuan[10] it

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1 甘奢舖 2 凉風橋 3 二南流 4 太和舖 5 七里塘 6 石馬平 7 白竹舖 8 唐堡營 9 大紅橋 10 巖關

strikes NE-SW, dipping gently SE (?). High Mts. are seen to the south consisting of hard sandstone with a few conical limestone peaks sticking out from its N. slope. At Sutzupu[1] pure white limestone strikes 35° N of W, dips 25° N (measured). At 35 mile point pure limestone strikes E-W (slightly ENE-WSW), dipping 10° N, but to the right side of the road in the second row of hills before we came out of the Mt., it dips S. (Strike and dip estimated but not measured). Soon in red clay. W of point 'a' on map limestone dip 20°--15° NW. After a black shaly limestone striking 20° N of W dipping 20° SSW. Then red clay to Hsinan[2]. From Hsinan to a place on the Siang River, the road is all in red clay, but on left side of road is white limestone seeming to be horizontal and here and there it is seen to be underlaid by black shaly limestone which crops out just beyond at point b dipping gently eastwards. It seems to contain coal seams.

Then no outcrop till NE of 45 mile point. Between the latter and Tatungtien[3] is a small pass, consisting of black shale, greenish hard sandstone and shaly black limestone full of *Dibunophyllum*-like corals. On left side of road it strikes 30° N of E and dips 20° S (?), on right side of road it dips 10°-20° SW. At top of the pass it is nearly horizontal, but lower down it dips SE. The beds are:—

1.	Black shale	2 m
2.	Greenish sandstone	3 m
3.	Black shale	1 m
4.	Black limestone	2.5 m+

From the pass we saw on the other side of the river conical limestone hills in front of sandstone mountain.

No outcrop except red clay and gavel till a point halfway between Tsiliping[4] and Panshan[5] where a small outcrop of soft yellowish sandstone is seen, striking N-S dipping 30°-40° E on left. On right it dips W. Very high range is seen to the N of Panshan.

From Panshan to Hsienshui[6] no outcrop except red clay. A little beyond Hsienshui small outcrop of pure white limestone with flinty structure. Then covered by red clay which extends all the way to Chihmienpu[7]. At the latter small outcrop of black shale and shaly limestone strike NW-SE dipping 40° NE, then+.

1 蘇子舖 2 興安 3 大洞田 4 七里坪 5 板山 6 鹹水 7 赤面舖

S. of Peisha[1] and also S. W. of Hsiawulipai[2] is (in each place) a small isolated hill of black limestone dipping 20° S. Beyond Wulipai is a low pass in a range of low hill across the road called Lanhualing[3] at the foot of which silicified limestone, black shale, soft sandstone and black limestone striking 27° W of N dipping 40° E. This has furnished me with numerous Lower Carboniferous fossils.

The road now enters Chiaoshan[4] and Kueishan[5] consisting of reddish brown sandstone and shale first dipping S then 65° W. Near Shatzuwa[6] limestone dipping NW, covered by red clay. At Chutang[7] yellow shale dip W. Limestone Mt. on right, no outcrop on left except isolated limestone (3). Contact between limestone and the shaly series about 70 M. point. Between Chutang and Taizupu[8] red clay and limestone. At 70 M. point it is seen that the massive limestone dips 50° NW therefore below the Chutang shaly limestone.

26 August 1928: Chuanchou—Huangshaho—Hsingan

Chuanchou barometer 293.4 at 6 a. m.

The new road goes out from the N. gate in the direction NNW. At first it is in red clay. At Wuliting[9] a small hill to the east of the road consists of limestone. Then in red clay again until just S. of Tsilichiao[10] where is another limestone outcrop to the W. of the road. All the time the Siangshanssu[11] massive limestone is seen forming a mountain of considerable height to the west of the road. After Tsilichiao (after 79 M. point) the road turns westward to cross the mountain in question. Here the limestone strikes NE-SW dipping 50° SE. From the top down we have 1, thin-bedded limestone, 2, very cherty massive blue black limestone, 3, shale 5 m, 4, black blue limestone.

Coming down the pass via Tapingpu[12] we go along the western side of the limestone ridge until we reach Tengchiawan[13]. Thence to Shatzuwan[14] road all the time in red clay, but after Shatzuwan it strikes near the eastern slope of a limestone hill which dips 40° SE. This continues to Jungsuipu[15] when several small limestone outcrops are seen on the east side of the road until about half way between Jungsuipu and Jiyuehchiao[16] where the western limestone ridge becomes near to road again. After going over several low ridges of red clay we descend into Shuangchiao[17] and wide plain is seen to the left.

1 白沙 2 下五里牌 3 蘭花嶺 4 角山 5 桂山 6 沙子凹 7 朱塘 8 代子舖 9 五里亭 10 七里橋 11 湘山寺 12 太平舖 13 鄧家灣 14 沙子灣 15 永歲舖 16 日月橋 17 雙橋

At Yachapu[1] however small limestone hill is seen on the W. of the road. Then to Sanchiaossu[2] no outcrops of any kind except red clay which is here unusually thick and passing into soft sandstone. Also a point beyond 90 m. at the mouth of the low hill is a small outcrop of yellowish green shaly limestone striking 8° N of E dipping 20° S under the red clay.

From that point to Huangshaho[3] (Sauchiaossu) the road is in alluvium. There is a pontoon bridge of 33 boats on the Siang River. Impure limestone outcrops at right bank. Back to Chuanchou. According to Lushankao[4] at Taiyangchiao, Shashihling[5] 5 li E of Mengshan[6] there are Devonian fossils. Went to Siangshanssu[7]—a very big temple built in the sixth year of Chihteh[8] of the Tang dynasty by Wuliangchujen[9]. Only the Puchinlou[10] and a pagoda called Miaomingta[11] are in good repair. Entrance into suburb Siangshanssu, limestone strikes 28° N of W dipping 55° NNE. Carefully sketched the complicated folded mountain of Devonian limestone—see section.

At Taitzupu weathered silicified limestone. First hill S. of Chutang soft reddish sandstone and silicified limestone (weathered into fragments) strikes N-S, dips 60° W—fossils. 291.8 Chiaoshan and Kueishan. High hill on right of violet shale. 291.8 above Kueishan violet shale and gray sandstone strike N-S dipping 70°-80° W (turning to dip E at small bend 2 m long). After that the strike turns into 10° W of N dipping still W.

Just before Sanlichiao[12] violet shale is seen to be steeply folded. From 47 M. point went east to visit Chiaishou. Opposite the market on the other side of Siang River massive impure black limestone strikes 40° N of E dip 23° NW. S. of ferry it becomes 18° N dipping 8°-20° N. Limestone is very cherty and is full of Lower Carboniferous fossils. Raining.

Spent the night at Hsingan.

27 August: Hsingan to Linchuan

Went to see the canal junction. ½ km from city between canal and river gray shaly limestone strike 15° N of E dip 20° N—it is rather free from chert. Made a survey on way back.

At Fenshuitang[13] there is a tablet bearing the following characters.

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1 枒槎舖 2 三角司 3 黃沙河 4 陸山高（似爲人名） 5 太陽橋沙石嶺 6 蒙山 7 湘山寺 8 唐至德六年 9 無量主人 10 布金樓 11 妙明塔 12 三里橋 13 分水塘

Arriving at Hsiaoyungkiang lunched about 11 o'clock. After lunch went on horse-back to Chungkou, whence went westward on foot—the road is out in the quartzitic sandstone very narrow and slippery on the N of the Hsiaoyungkiang river.

12:10 M.[1] at mouth the quartzite strikes 20° E of N dipping 60°-80° E. An overfold is seen on the otherside—strike changing into N-S, dip apparently more gentle (due to overfold).

12:38 Strike 15° W of N dip 40° E.

12:47 Softer bands (Sunglin)[2].

12:53 Nearly horizontal (5° E).

1:00 25°-30° E then 10°-20°.

1:05 More fold.

1:10 Steep, then 10° & less.
River bends at Tawuchu[3]

1:17 Strike 20° E of N dip 20°+.

1:20 Dip 35° then 25°-20°.

1:25 Dip 10° W.

1:44 Near hsiaowuchu[4] strike 30° N of E dip NNW.

1:46 Again dip 10° E.

1:49 Dip 10° N.

1:52 Strike E-W dip 25° N.

Turned back from that point and went to Linchuan for the night.

28 August 1928: Linchuan to Kueilin Barometer 294.0 at 6 a. m.

N. of village Tungsui[5] blue limestone full of *Amphipora,* dips 15° (15° E of S). See section. ENE of Tungtang lower limestone, strike 20° W of N dip 20° W—This change is local, for soon it strikes E-W, dipping gently S. One kilometer E it dips SSW 23°. Near gap white limestone strikes 25° W of S dip 20° E. Direction of gap 20° S of E. Left side of gap limestone strike N-S dip E. Hsienyinyen[6] on left side (E) of valley within the gap.

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1 M. signifies minutes as read from Dr. Ting's watch. 2 松林 3 大五竹 4 小五竹 5 東遂 6 仙隱岩

Back to Kueilin.

3 Sept. 1928

Left Kueilin for Pinglo[1] by boat, arriving at Tahsu[2] by sunset where I spent the night in the boat.

4 Sept. 1928: Tahsu, 3:30 barometer 2951.

Went ashore and made a trip to Shihtzuyen[3] by Lian[4].

At Shihtzuyen massive limestone, fairly pure, St. 20° E of N dip 30° W, increasing in steepness westward to 40° but bending horizontally to E. Bedding plane rather thin and the lower part contains small recemented pebbles of the same material; the cement is very ferrugenous—looking not unlike "Wurmkalk". Fracture is subflinty. The upper part seems to be siliceous. A few steps east it dips 10°-14° E.

500 m east from Shihtzuyen there is a quarry in white limestone with dark red vein inter-bedded with gray limestone with red vein, striking 40° E of N dipping 30° E. *Height 292.6.*

S. of Shangfuli[5] the beds consist of soft sandstone forming low reddish hills. From Kutung[6] the road goes between pure limestone (Devonian) and soft shale and silicified limestone (Lower Carb.). Dip not clear. At Yenkou[7] the pure limestone seems to dip 20° E. First pass near Kutung, barometer 293.0. Highest pass south of Yenliu is 291.2, 370 ft. above Tsaoping[8]. Here road in silicified limestone?—More limestone on both sides.

At Tsaoping barometer 295.0, where the boat is waiting. Started at 11:30 a.m. 12:00 limestone cliff dipping slightly ENE. At Tangyuan[9] *Amphipora* limestone striking 78° E of N dipping 30° W. Soon after Shuangchuan[10] dip becomes gentle (about 10°). On right waterfall. 1:50 Yangpi[11], limestone nearly horizontal. 2:34 Langshih[12]. 3:07 Chihlungshan[13] lower black limestone.

20 minutes later valley opens out, and the limestone is underlaid by soft reddish sandstone and shale. On the left bank typical quartzite, strike E-W dip 15° N. 10 minutes later dip turns S. The soft shale and sandstone is not thick—a few meters. 3:37 sandstone horizontal, then 10° S again. 3:50 sandstone dips 15° N. 3:53 dips 15° S. Section at right bank. 4:02 in limestone cones.

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1 平樂 2 大墟 3 獅子岩 4 李安 5 上福利 6 古洞 7 岩口 8 草坪 9 糖園 10 雙泉 11 羊皮 12 浪石 13 鷄籠山

4:10 Taishang[1] (Fig. 58) halfway between Pinglo and Kueilin village on right, 500 m from Huashan[2], with 9 houses. Rest 14 minutes. 4:35 Huashan hill on left, village by that name on right. Few houses on left also called Wutaitungtang[3]. After Huashan massive pure limestone forms long cliffs with cones on top, not reaching the level of river—they are *perfectly* horizontal. 5:10 Huangpu[4]. 5:40 Chiaohuayen[5] on left. 6:10 Hsingping[6], barometer 294.0. Cliff on left just below Hsingping, limestone is closely folded—axis of folding NNE-SSW but on right bank a little below that point it is again horizontal.

6:15—6:30 Continuous massive cliff which finishes at 6:35. Limestone horizontal. Sketch of cliff at Loshihyen[7] where we stopped for the night. It faces N and is 600 m long, lying just above Yutangchou[8] which is on the left bank, the cliff being on the right. Because of a big sandy flat[9], exact relation between limestone and sandstone on right bank is only seen from distance.

5 August 1928: Loshihyen to Pinglo

Started at 5:25. 5:45 Yutangchou. *See (Fig. 57).* Left bank is much covered by bush, contact is further down the river than on the right bank. 6:05 limestone on left bank is seen to be overturned, then sandstone in contact—see sketch.

6:21 Shawan[10]. As seen from the left bank, sandstone is nearly horizontal forming cliffs on both banks. 6:30 Shaly limestone dips very slightly W. 6:35 Quartzitic sandstone outcrops dipping 15° E. It looks not unlike silicified limestone. The cliffs are at first formed by both the shaly limestone and sandstone below it, but at 7:05 the former disappears and flat-topped sandstone alone forms the cliffs which make the valley narrower.

Shaly limestone plus upper limestone about 100 feet. Sandstone forms cliffs more than 100 m high. 7:25 sandstone dips 15°-20° SE. 7:40 Thin-bedded black shaly limestone (bedding only 2.5 cm thick) outcrops, at first horizontal, then gently dipping E. Cliff at least 170 m high.

7:48 Niunitang[11] (villages always on a sandy flat or "chou"). Opposite Niunitang more massive cliffs with temple. Thin-bedded limestone strikes 25° E of S dipping 22° W. It is full of chert and overlaid by purer and more massive limestone (which is also somewhat shaly and with some chert). The valley is more open. Stop 10 minutes. Side valleys reach nearly to river.

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1 太上 2 花山 3 五代同堂 4 黃舖 5 叫花岩 6 興平 7 螺獅岩 8 魚塘洲
9 Locally called shachou. 10 沙灣 11 牛溺塘

8 : 10 Rest. 8 : 25 restart. Much bushy vegetation—few outcrops. From 8 : 25 going slowly over a rapid, "Tiengnotiaoching[1]. 8 : 46 thin-bedded limestone showing small undulating folds. 8 : 47 Massive cliff—limestone dipping 20° E. (strike unchanged). 8 : 52 undulating gentle folds again. 8 : 55 limestone dips 10° E. Low country on left. Softer beds forming brownish soil. 9 : 10 dip 20° ENE. No outcrop on 200 feet hill on right.

9 : 30 Laochai[2] on left bank. See sketch (Fig. 56). Just before Laochai on right bank, lower limestone (shaly) dips 15° SSW (?). At point a in the sketch, massive limestone with indistinct bedding plane looking rather impure dipping E (?). From Laochai river goes NW meeting a N-S range (height on right bank 200 m) the lower part of which consists of typical quartzite striking 25° E of N dipping 22° E. Stop 5 minutes. 9 : 45 river turns into narrow gap in the range, sandstone forming cliffs. Laochai is said to be 10 li from Yangso[3]. 9 : 55 river turns WSS, then S. Sandstone dips 30° W.

10 : 00 dip is 10°E on left bank. 10 : 07 on right bank, sandstone dips 25° E. 10 : 13 sandstone in middle of river dipping 15° W. 10 : 26 Shuangtan[4] river E-W, sandstone forming an anticline and a syncline. See (Fig. 55.)

At Yangso, river ESE then turns east. 11 : 55 rest. Barometer 295.1. Just beyond, limestone seems to strike NW-SE dipping 15° SW. 12 : 10 restart, going E. 12 : 18 going ENE. 12 : 26 NE. 12 : 35 Mushan[5]. Just beyond Mushan small earthy hill, typical quartzitic sandstone striking N-S dipping 10° E under the earthy hill. 12 : 44 sandstone dips W in river forming a rapid and an anticline with Mushan sandstone. River makes here a bend. Limestone on left bank seems to form a same anticline, but folding more steep—strike N-S, dip 25° E. 12 : 50 river turns E. Then massive limestone with indistinct bedding on left bank. Sandstone ends on the right bank in a Shachou. 12 : 53 river goes SE. Calcareous stalactites form a screen over cliff face. 1 : 00 Kuanchiatingtzu[6] on left, white limestone cliff on right horizontal. 1 : 11—1 : 26, bad shallow rapid just above Fuli[7]. 1 : 48 Fuli rapid caused by hard limestone. Long white cliff with cones on top on right bank. Wasted 7 minutes. Valley becomes wider and wider, hills fewer and farther between. Big limestone cliff N-S, horizontal. 2 : 56 rest. 3 : 10 restart, 3.35—4 : 26, soft brown sandstone forms brownish soil—no outcrop of thin-bedded limestone. 4 : 30 rain storm.

5 : 09 restart. 5 : 16 red quartzite outcrop striking NNE-SSW dipping 20° NNW—the level of the river is probably the level of hard sandstone. 6 : 00 dip

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1 天鵞吊頸 2 老寨 3 陽朔 4 雙灘 5 木山 6 管家亭子 7 伏荔

changes to SE—at first 10°, but at 6:07 just before Hsiaowan[1] it increases to 40—it is seen to be intercalated with soft shale. 6:10 Hsiaowan on right bank, Kueiyutang[2] is opposite. 6:20 sandstone St. NE-SW, forming a steep anticline (35° +). 6:28 dip 8° NW, then 50° E 40° W within 20 minutes. Too dark to observe. 9:10 Pinglo barometer 296.

6 September 1928: at Pinglo

In the hill just N of station, quartzite strikes 20° N of E dip 80° S. River 2960. At Linkungmiao[3] sandstone strikes E-W dips 15°-20° N. Rock in the middle of the river, Kungchenghokou[4], striking WNW-ESE dips 15° N. False bedding is shown. It is about 10 ft high 20 ft in diameter. By the temple Peitimiao[5] opposite Lipu[6] river, quartzitic sandstone strikes E-W dips 45° N— conglomerate inter-bedded (?). 52 steps down, sandstone strikes 35° E of N and vertical. 100 steps further we crossed a side valley.

At 1938 steps, softer sandstone striking NE-SW dipping 30° NW. Between this outcrop and the temple mostly soft sandstone with N (?) dip—at 1000 steps it is dipping steeply S. but soon changed to dip N which is the prevalent dip.

100 steps from 1380, sandstone dip 5°+ENE. 50 steps further, rock in river strikes NNE-SSW dip 30° SE.

7 September 1928

Barometer at Pinglo at 6.50=295.6. Just outside station, white pure limestone outcrops. At Chiaochangti[7] (Fig. 59) pass entirely crystalline limestone strikes NW-SE and is *vertical*. A few steps further it strikes NNW-SSE dipping 45° E. Dark red shale is thrusted against it. (See section at a time 7:10). Limestone to the right seems to be vertical. 500 m up at 7:12 (pt b) limestone forms anticline on the right. The road follows the boundary. After b white limestone becomes horizontal.

7:15 Matiching[8]. 7:19 river. Low hill consisting of violet shale dipping 15° E. 7.22 Maanshan[9] dark gray limestone with flinty fracture dipping gently (15°) NNW. 7:30 Tahsu[10] From Erhtsao[11] on to Fuyang[12] low red hill. At Liangting[13] before Fuyang limestone dips 25°-20° NE on right hand of the road. Limestone continued from Pinglo to this point.

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1 小灣 2 桂魚塘 3 令公廟 4 恭城河口 5 北帝廟 6 荔浦 7 教場地 8 馬蹄井
9 馬鞍山 10 大墟 11 二槽 12 伏羊 13 涼亭

7:30 Fuyang. 7:47 Shuichantsao[1] limestone on right strikes NNW-SSE dipping 70° ENE. Sandstone and shale forming low hill on left. Stop 3 minutes. Limestone is seen beyond sandstone hill, and dips W. 7:55 Yungchin[2], ferry. 8:00 village Kaokouwan[3] (?)—small bridge. From river to this bridge, slightly folded violet shale and soft sandstone interbedded with thin beds of limestone. Just beyond the bridge, limestone ("a" on map) *overlies* this series. Below this limestone grayish brown sandstone at first dips E, then W all gently, but at 8:06 it strikes N-S dipping 25°-30° E. Interbedded with the sandstone are thin bands of black and brown shale. Further east in limestone again in narrow gap.

8:13 restart. 8:14 Laomuchih[4], limestone dips east. 8:16 Huashanchieh[5], black bituminous limestone strikes 25° W of N dipping 56° W, but at once the dip becomes 25° (many calcite veins). Then folded slightly and finally change to dip steeply eastward. Restart 8:20, limestone on the left dips regularly 20° NE. On the right smooth topped hills (limestone?). 8:27 Thin-bedded black limestone dips 35° NE. 8:30 Tatungchieh[6]. 8:34 Tungan[7] school. On left high mountain of quartzitic sandstone. Fault? 8:35 on the left limestone dips 40° NE. On the right fairly high hill consisting of violet shale and sandstone. 8:37 bridge S. of Shihkuei[8] limestone cones continue in form of low hills. 8:40 low hill of gravel. 8:44 Shanshan[9] still in limestone. Long range of sandstone to the right—road in limestone. 8:51 Enter region of limestone cones. Sandstone range on right far away. 8:52 Chihhouting[10] limestone strikes NW-SE dipping 45° NE. 8:55 in low ground. 9:00 Chehting[11] ferry Shuitang[12]. 9:07 Tingpengshan[13] last cone in low ground. Cones on the left quite near, but further on the right. Limestone dips 25°-30° E.

9:10 Choutungchiao[14] cross range of cones. 9:13 Shuiyuantou[15] wide plain—road turns to left, limestone cones on left, *horizontal*. 9:15 bridge, enter cones again. Strike NNW-SSE, dipping 25°-20° ENE. 9:23 village. Limestone on left, but sandstone (?) ridge to right. 9:25 Mulinyai[16] in limestone, gentle dip to N & S on each side of the road. Further east limestone to the N dips 30° + to S, but to the S it seems to dip steeply to N. Stopped 3 minutes.

9:33 Paohsu[17] limestone dips S on the right, road going N. 9:35 Going east, limestone dips N. 9:36 Bridge, quartzitic sandstone outliers on left, lime-Stone on right dips 30° + S. 9:40 Tingtzu[18], then *village* on right. 9:45 end of

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1 水沾槽 2 榕津 3 高藕灣 4 老穆趐 5 花山街 6 大同街 7 同安 8 石龜 9 贍山 10 啓後亭 11 車亭 12 水塘 13 亭蓬山 14 洲東橋 15 水源頭 16 木林隘 17 寶墟 18 亭子

sandstone on left. Limestone on beyond village dips 40° S. Yinchia[1] not far to the right (S. of Yentang[2]). 9:48 Paishaching[3] wide plain in limestone hills. 9:49, 2 bridges. 9:51 in limestone hills. It dips 15° S to SSW. Fairly wide plain. 9:55 large bridge Shiherhcheh[4], stop 1 minute. Limestone horizontal, forming cones on right (?).

10:00 Chihhsiangtsun[5]. Limestone on left dips SE 15°-20°, wide plain with isolated cones. 10:04 village on left. Wider plain with cones further away. 10:07 Bridge. 10:08 Maanshan[6] hill on right, village on left. Tachiao[7] can be seen on the right. 10:10 Distant limestone hills dipping 25° E. 10:12 Near limestone hills. 10:13 Koupeiling[8] on left opposite which are all earthy hills under limestone. Stop for sketching.

The limestone ridges on right strike 20° W of N, dipping 25°-40° W. On the left limestone much folded, seems to dip under (?) sandstone to N—it in fact turns to dip W. Line of turning near village of Tuyangkou[9]. 10:24 Restart. Stopped 10 minutes. 10:25 Tuyangkou. 10:26 enter sandstone mountain. Dark gray pure limestone on left, strikes NW-SE dips 45° SW. On right it dips ENE 20°-40° but shortly turned to dip 40° SW above sandstone. Sandstone dips W. Restart 10:36 going up, pass in sandstone. 10:40 stop, village on left near bottom of sandstone slope. On right it forms high mountains dipping SW (?). 10:54 hill of gravel W. of Chungshan[10]. Ferry 10:55 limestone forming rugged hills on other side of river NE of Chungshan. Crossing 30° N of E. Two limestone hills on left of road 1000 m away dipping 15° SW. But far away on right, several kilometers, it dips 30°-35° NE. Looking from the river, limestone far away to left of road all dip to SW. 11:06 over ferry. Isolated limestone hill on left and further on also on right.

11:09 Bridge, limestone dips NE on right. 11:13 Bridge. 11:14 Big bridge. 11:21 Bridge. All in red clay. 11:29 Tin working on left. On the right, flat topped hill of reddish sand (=Shatzuyai[11]). Deep pits are made in this. The colour is more red than usual—deeper down it is yellowish.

11:30 Wangkao[12]. Barometer 294.1. 12:25 Left Wangkao. Just outside Wangkao on left, small hill looking like granite beneath limestone. On right Shatzuyai hills. 12:32 Bridge going up. Village on left. Pass in limestone forming anticline. East limb on right side dipping E. Looking east from pass granite

1 英家 2 燕塘 3 白沙井 4 十二車 5 吉祥村 6 馬鞍山 7 大橋 8 狗北岑 9 土羊口 10 鍾山 11 沙子隘 12 望高

on high mountain slope. 12:34 Sand again. Limestone (?) ridge parallel to road on right dipping W. 12:38 Litou[1]. 12:40 bridge. High mountain on left. Sandstone crops out in red sand. 12:47 Bridge, village on left. 12:49 Branch road to Shuiyenpa[2]. 12:56 Workmen's quarters. Seems to be granite on mountain. 12:59 Washing plant[3], open work in alluvium. 1:10 left. 1:14 branch road. Still in red sand and low hill. 1:17 Low hill on right. Limestone half kilometer away on left. 1:20 Limestone on left dips slightly to SW.

1:24 Hsiwan[4]. 1:26 minging office. Barometer 293.4.

8 September 1928.

Hsiwan at a.m. barometer 295.0. Went to the top of the hill W. of the office, then descended into the native pit 100 m SSE of the old big shaft about 10 m vertically higher. In this incline there are 3 seams. The detail section is as follows: (from above down):

(1) Tatan, good coal 1.3 m widening to 2 m lower down

(2) Gray clay shale 1 m

(3) Black shale with coal veins 1.3 m

(4) Still black shale 1.3 m

(5) Very ashy coal 0.10 m

(6) Pitan, good coal 1.2 m widening to 1.7 m

(7) Still black shale 0.5 m

(8) Potan, fairly good coal 0.3 m widening to 0.75 m.

The wole seems to dip 45° E at highest level, but becoming vertical at the lowest.

According to the foreman who showed me round and who used to work for the old mining company, there was sunk a square shaft 12 feet across lined with timber. The shaft was 300 feet deep all in a gray limestone. At 150 feet a cross-cut to the N was made. The first 30 feet are in limestone. Then in the lowest coal seam, Potan. The section is the same as the one given above. Beyond the first coal seam, the Tatan, all yellwish sandstone and shale. This cross-cut was 200 feet long. All the beds are vertical. At 300 feet another cross-cut was made, but was abandoned before it reached coal. Levels were driven along the strike in

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1 渠頭 2 水岩壩 3 洗沙處 4 西灣

the coal seam 100 feet N and 700 S, where faults were met with and coal seams disappeared. They had some 24 boilers, but only 2 could be seen. Limestone fragments are to be seen round the abandoned shaft which has been filled up. It is light gray and quite free from chert. No fossil. A small outcrop is also seen to the N. of the shaft.

Went from the shaft westwards. About 400 m NNW from the shaft on the slope of the hill, light gray limestone outcrops striking NNE-SSW dipping 30° + E. Near pass overlooking Huangshihchai[1] NW from shaft, yellowish soft sandstone striking NNE-SSW dipping 80° E, followed by gray and violet shale. By the river side opposite Huangshihchai violet shale strikes NNE-SSW dipping 40° W. The dip however becomes more gentle up the River. 200 m up from Huangshihchai greenish micaceous sandstone strikes NNE-SSW dipping 25° E.

At Chaochiangmiao[2] 800 m below Chinchu[3] typical quartzitic sandstone striking 35° N of E dipping 45° SE on the left bank. 100 m above the temple dark blue massive pure limestone (veined) strikes NNE- dipping 5°-10° ESE on the S bank. Then going up all limestone exposed on left bank. Coming down the river, 60 m below Chaochiangmiao quartzitic sandstone dips 15°-20° ESE, then nearly horizontal. Low hill on right bank—sandstone. In the second island or "chou" below Huangshihchai greenstone outcrops beneath the first observation in the violet shale—about 30 m long (2/3 of the length of the island). Then red shale again dips W.

60 m from end of islet greenish micaceous [sandstone] strikes N-S dipping 30° W (Specimen). Outcrop extends 100 m down river across mouth of small stream on left bank. It extends to right band forming steep bluff underlaid by a soft yellowish red shale. Quartzitic rock, point marked on map. White coarse gritty sandstone (very hard) striking N-S dipping 35° W, 100 m above Shangsungchai (Chiangchiatsun)[4]. On left bank same sandstone dips 51° W, then cover and village of Shangsungchai. At Shangsungchai typical pinkish gray limestone with angular spots inside (with conchoidal fracture). At first it strikes 20° E of N dipping 56° W. At Lungtaoshui[5] on left bank highly cherty limestone partly completely silicified strikes NNE-SSW dipping 30° E (?). On the northern side of the river completely silicified and brecciated limestone strikes N-S dipping 40° E. West of that it seems to be a fault. Small pockets of coal was mined below this limestone some 40 years ago. Rock in the river is seen to dip W (at fault). A few

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1 黃石寨 2 朝江廟 3 金竹 4 上宋寨(蔣家村) 5 龍道水

steps further less silicified limestone with chert dip gently 20° E. Further on limestone seems to strike E-W dipping 20° S.

At Tingtzu[1] above Hsiwan purer limestone seems to be horizontal. At Hsiwan pinkish crystalline limestone as Lungtaoshui strikes (Fig. 62) NE-SW dipping 15° E but on right bank it dips 5° W, then horizontal. Round east slope of Tatientang[2] and Hsiaotientang[3] discontinuous outcrop of the silicified limestone seeming to be nearly horizontal. At upper Hsiaotientang pass blocks of the same is seen on the slope[4]. Red soil with Mn and Fe.

At Changwotung[5] ferruginous sandstone strikes NNW-SEE dipping 30° W. 10 m WNW from the last is an abandoned test shaft (100 feet deep). A few steps further N. yellowish sandstone dips W.

9 September 1928.

At 6:00 Hsiwan. Barometer 295.2. Went to top of Laoshan[6] (Fig. 66). Here all silicified limestone. At the S. slope it seems to dip steeply E, but at the top the dip is seen to be quite gentle. At the west slope it strikes 20° E of N dipping 35° W. According to foreman Ho 2 testing shafts were sunk between Taling[7] and Laoshan; coal was found to dip 30° W, but full of faults and only 8 in. thick.

At Laoshan it is the same. Testing pits were put down N of Laoshan on the earthy hill, but nothing at all was found. The mountain near Shihti[8] seems to strike NNW-SSE dipping 20° W. Limestone on the other side of the valley strikes E-W dipping 30° S. Yellow sandstone is seen just N of top of Laoshan. Silicified limestone exposed on W. slope of Laoshan dipping W. From Laoshan to Hsiamaling[9] at first small hill on left with bits of silicified limestone, 400 m further red shale. Further on both silicified limestone and shale occur. At river side as indicated on the map, the hill top consists of siliceous limestone. By road side typical floor [?][10] limestone, but at the river 15 feet below soil, coal is found first dipping 25° W, but lower down turned to dip steeply E. To N & S it turns round and disappear. Top of the mountain to the west consists of quartzitic sandstone, continuous to the N with Shihti mountain. Coal 3 feet thick and is of bad quality.

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1 亭子 2 大天堂 3 小天堂 4 Meaning of sentence not clear. 5 長窩洞 6 老山 7 大嶺 8 石梯 9 下馬嶺 10 Meaning not clear.

Silicified limestone outcrops just S of Lientangtzu[1] right by river side. Just N tin is mined from red clay. About 500 m S of Hsiamaling on both sides of river quartzitic sandstone, but just near Hsiamaling at river bend silicified limestone exposed on right bank. NWW of Hsiamaling coal series strikes 20° N of E dipping 60° N. Further N on first hill silicified limestone, but second hill consists of white limestone dipping W near boundary of quartzitic sandstone. From point NW of Hsiamaling sight on Kuposhan[2] 15° E of N. Hill directly N of Hsiamaling all in yellow sandstone striking NW-SE dipping 40° NE. Road to Wukungshui[3] in red clay—many "Chuangtou" (farm houses). Returned to office in time for lunch and then left for Papu[4] by motor car.

Just pass beyond village Liyupu[5], typical thin-bedded silicified limestone striking NW-SE, folded and sheared. The hill immediately to the east of the village is also of the same rock. Further on it strikes across the road dipping 20° + SE. Near old road, crossing red clay—limestones continue to Papu.

Papu, barometer 295.5 at 2:40. Left Papu, for Hsintsunping[6]. At first road goes ENE. At 3:00 it turns to N, leaving gap in limestone to the left. Village Liangtingchiao[7] on left. A section in the limestone is sketched. It strikes 10° E of N and folded. See (Fig. 61). 3:10 point 'a'. 3:25 Shuyingli[8] temple. 3:26 Chushuchiao[9], stop. 3:34 restart. Huangtien[10] only 600 m away. 3:44 Hsinchai[11]. From Huangtien up, cones continue on left. 3:58 limestone on right striking NNW folded into anticline and syncline—last dip to SW. 4:09 it dips 15° SW.

4:16 stop near Tapanchiao[12] where *limestone ends*, Tapanchiao to stopping place 600 m. Here black limestone full of calcite veins striking N-S dipping 36° E. 4:34 restart for Tapanchiao, barometer 250. Silicified limestone here dips SE forming low hill at Tapanchiao bridge—much sheared. 4:40 over low pass in yellow soil—weathered limestone on right. 4:46 Fengweiling[13], end of sandstone series. 4:52 N Hsintsunping barometer 295.2. Heavy rain in the night.

10 September 1928

Hsintsunping barometer 296.1 at 5:00. 5:43 going NE, then along the river to N. 6:41 Tuchuantou[14] big bridge over river whose bed is sandy with very small pebbles. Houses on both banks. Kouerhshan[15] on right with limestone cones. 5:55

1 蓮塘仔 2 姑婆山 3 五孔水 4 八步 5 鯉魚舖 6 新村坪 7 凉亭脚 8 樹陰裡
9 竹樹脚 10 黃田 11 新寨 12 大板橋 13 鳳尾嶺 14 渡船頭 15 狗耳山

low hill. 6:05 crossing a small stream flowing west. Niuchai[1] on right. 6:07 foot of limestone. On the left 100 m away smooth-topped hill—granite. Marble dipping 15° SE. Walking up. 6:15 End of limestone, reddish granite outcrops. Road going 30° E of N with granite on left and limestone on right. 6:20 Shihwa[2] 294.0. The road now goes N, gently down a valley. 6:28 going NE in granite. Tawan[3] on other side of valley (100 m W). 6:30 going E up valley. 6:34 horizontal limestone on right surrounded by granite. 6:40 going 15° E of N, crossing valley in granite. 6:43 Chair broken. 6:45 in a valley head. 6:49 along water going 30° E of N. Limestone reappear on the right, but granite on left. Limestone seems to dip SE at 6:52. Road full of pebbles of hematite, and the narrow ravine has tin clay. 6:55 begin to descend. 7:07 road going 29° W of N. 7:10, 20° W of N—hut. Limestone on right, and granite on left. 7:20 stop, took a specimen of granite. 7:24 going 22° W of N. 7:42 Panlu[4] barometer 295.3. Just east of Wangchiachai[5] on the S. slope of Talungshan[6] weathered limestone (no outcrop except E of Wangchiachai) and weathered granite (?) are worked. The method is very simple; the clay is pushed into a winding ditch and water is let in. When sufficient ore has been collected it is pushed by a rake along the floor until enough is got together and taken up. Coming back by way of Paimienshan[7]. The limestone here strikes N-S dipping 40° W, but near to the top small outcrop of quartzitic sandstone. Coming down the limestone dips 35° E. It is less metamorphosed. Two farm houses east of Paimienshan again in weathered granite (?). Water is brought over from Kouerhshan by bamboo pipe lines over the pass. 11:06 Paimienshan. 11:10 black crystalline limestone dips 80° W, then granite. 11:13 Small limestone outcrop. Otherwise all granite. On the other side of valley (outside map), limestone hill with granite beneath, but at 11:14 it is all granite again. Going 10° S of W. 11:16 top of pass. 11:20 village behind which flat topped hill. Quartzite pebbles in gravel. 11:25 steep descent. 11:35 in plain, crossing over valley, going 10° S of W. Stopped 3 minutes. 11:40 joined old road traversed this morning. Remeasured first pass N of Hsintsun. Limestone Strikes N-S dipping 25° E.

High mountain opposite Hsintsunping is of sandstone.

At Panlu borings with 4 in. bore-hole were made W of Wangchiachai. Out of 110 holes made in an area of about one km, 58 holes were without tin. The following are taken at random:

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1 牛寨 2 石凹 3 大灣 4 半路 5 王家寨 6 大龍山 7 白面山

No. 2	Gray clay 12 ft.
3.8 Liang	Yellow clay 6 ft.
	,, ,, 12 ft. with tin
	,, ,, 6 ft.

No. 33	Soil 6 ft.
5.5 Liang	Black clay 18 ft. with tin
	River sand 12 ft.
	Rock

No. 61	Soil 6 ft.
1.3 Liang	...........Red clay 6 ft. with tin

No. 78	Yellow clay 6 ft.
3.8 Liang	,, ,, 6 ft. with tin
	Black clay 12 ft. ,, ,,
	,, ,, 6 ft.

No. 99	Soil 6 ft.
0.9 Liang	Yellow clay 6 ft.
	,, ,, 6 ft. with tin
	Sand 6 ft. with tin

Left Hsintsunping 1:40 going W. 1:44 end of village 40° N of W. 1:52 Paitu[1] on right. 1:56 village on left Paitu (?). 2:00 Tuyangpa[2] bridge, river flows to right. Direction 45°. 2:05, 20° N of W. 2:10 Laikangtou[3]. 2:14 bridge. 2:17 Yangniuchung[4] mouth, limestone on left, granite on right. 2:19 30° N of W. 2:32 Yangniuchung village 8° N of W. 2:36 crossing the valley. 2:38 house 50° W of N to 2:42. 2:45 to Yenkou[5] barometer 294.5. At 180 steps, marble strikes 20° N of W dipping 80° S; contact of granite at the head of valley. 400 steps 292.2, 30° W of S. 250 steps W. At "a" 480 steps 291.8 NW limestone striking NW-SE dipping 35° SW ("a"=head of valley going NNW & W). 380 steps, 30° W of N steep descent. 370 steps, 18° W of N, turning to side pass. 280 steps, 293.0 head of pass, 13° W of N 120 m from here granite. 200 steps, 10° N of W, 293.5, 120 steps, 5° N of W.

1 白士 2 屠羊壩 3 賴岡頭 4 羊牛冲 5 崖口

3:34 going down valley on left side, limestone. 3:39 W, limestone on both sides, valley width 200-300 m. 3:41, 20° S of W. 3:42 Chuangtoumaopeng[1]. 3:52 restart, 15° S of W. 3:56, 20° S of W, small pass between limestone, valley still on right, limestone dips W? 3:58, 25° S of W. 4:03 Hut. 4:09, 35° W of N, crossing valley. 4:14 narrow ravine, limestone dips 8° W (?) 4:15, 30° N of W. 4:21 limestone hill on right but to N and S granite—further south limestone cones. 4:23 NW to Shuiyenpa[2]. 4:26 end of limestone hill—open valley—granite to N (rather high hills) and S (lower). Limestone continues on right, forming irregular fringe on granite mountain. 4:35 Wenhsuitun[3] limestone fringe disappears. 4:38 mining office, water flowing 25° N of W. To works, W & 400 m.

11 September 1928: Hsiwan to Litou and Wangkao.

Below Tungluling[4] weathered silicified limestone striking 45° N of W dipping 80° SW. On N side of small river it seems to dip NE. Opposite Yenkou[5] silicified limestone striking NNE-SSW dipping 30° ESE. First limestone hill met on N. side of valley striking WNW dipping 10° S. Granite seems fairly far away. Litouyuan[6] to quartzitic mountain 18° W of S. To *contact with limestone* 18° S of W.

Went to Chushuipi[7] at Wangkao. Mouth of Chushuipi 292.0. Ssutang[8] 292.0. Top of shaft 287.0. Shaft to Chinchuyen[9] 5° N of E. To Soshihshan[10] 43° E of S. To Shihtzuyen[11] 25° N of E. 25° N of E is also the strike of Shihtzyuen limestone which dips S. To Pingtoushan 40° N of E.

12 September 1928: from Hsiwan to Lipu

Left Hsiwan at 2:06. Beyond Aokou[12] limestone dips 50° W, then horizontal. Small hill on left. To the right, a little way west, limestone is vertical. After Miaotou extensive limestone outcrop on the left. Car broke down on way from Pinglo to Lipu. Limestone steeply folded dipping 80° W near road. Sandstone is in contact. Near Hsinchiao[13] it strikes NNW-SSE dipping vertically, but further SW it seems to strike ENE-WSW dipping most of the time SSE. After Limu[14] wider valley and occasional coal series, which crops out near river SSE from Lipu. At first it consists of soft yellow and greenish sandstone, black shale and reddish yellow hard sandstone, but at the top of the pass (Barometer 2943) it strikes E-W dipping 45° S. Then turning to strike WNW-ESE dipping 45° N.

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1 莊頭茅蓬 2 水岩壩 3 文水屯 4 銅爐嶺 5 岩口 6 栗頭源 7 出水壁 8 四塘 9 金竹岩 10 鎖匙山 11 獅子岩 12 坳口 13 新橋 14 栗木

Immediately after, to strike N-S, (10° E of N) dipping 40° E right to the bottom of the hill where it is covered by gravel. A few steps further it turns to dip west, then horizontal and E again. In the second hill largely covered by red clay and gravel, it dips first W and finally E. See section.

The above description was made the next morning.

13 September 1928: Lipu to Liuchou

6:30 at Lipu barometer 296.0. First hill red clay, second hill gravel, but on the right is coal series (?). After bridge limestone cones appear on the left, first 1,000 m then 500 m away. Coal series on the right disappears. 6:41 gravel hill. 6:50 near Lichiangping[1]. Crossing the river took 10 minutes. Small outcrop of coal series after crossing, striking N-S first dip W then E and then W again. Soon covered by gravel. On the left coal series seems to continue, and limestone is seen beyond it. After Wulipai[2] quartzitic sandstone on right, only 600 m away. Up to Palitang[3] pass. After crossing river quartzitic sandstone seems to dip W (?). At 7:17 white quartzitic sandstone with beds of reddish shale strikes NE-SW dipping 60° SE—much crushed and sheared. (This observation is made W of the one measured on 2 Aug.). A little further it is E-W and vertical (slightly to N). Average strike is 10° N of E. 7:27 restart. 7:38 Pingpu[4]. After second bridge on the left of the road, yellow greenish quartzitic sandstone much crushed and sheared strikes E-W dipping 80° S. Typical brown quartzite seems to be *horizontal, forming cliffs on both side of the valley* (*Unconformity?*).

7:55 Sanchiang[5]. Just after, brown quartzite strikes ENE-WSW dipping 20° S. On the right most of the time yellow and green sandstone (softer) is seen to be overlaid by brown quartzite, but at 8:02 last bridge near Hsingtsun solid brown quartzite. On left side going up pass by a side valley, yellow and red sandstone striking NW-SE dipping 50° SW. On the other side of the valley typical hard quartzite quite horizontal forming limestone-like cliffs (sandy towards top). Specimen of lower series rock. Further up on the left side the yellow and red series is overlaid by brown quartzite striking NNW-SSE dipping 50° WSW. Restart 8:20, 8:25 dark blue calcareous sandstone, thinbedded limestone with interbedded shale striking N-S dipping 27° W. (This is just above Chalu where I got my fossils on 2 Aug.). Big pelecypods.

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1 荔江坪 2 五里牌 3 八里塘 4 平步 5 三江

Restarted at 10:00. Going down we have a complicated section. It is certainly overtopped by nearly horizontal quartzite 200 m before bridge, covered by gravel forming low hills below near Toupai[1]. On the right sandstone etc. still dipping W, but on the left only low hills of red clay and gravel.

Before Miaotsun[2] in the plain. Approaching Ssupai[3] wide river plain beyond which is gravel and clay. From Toupai[4] to Hsintsun road is in gravel and clay, covering sandstone series. Between Hsintsun and Shihjenchung[5] it makes several folds. Shihjen is quartzite on the other side of the river. Axis of folding E-W. Before Shihjenchung, marble (?) dips 20° S, but after Shihjenchung fault, it dips 30° N. Soon road is in gravel. Small outcrop (?) of shale is seen to dip N in the second hill. 10:48 Toutang[6]. (Fig. 26). 10:50 bridge, fossil locality, Just before reaching Tangpu 10:52, limestone (?) *dips 30° N*. Then alluvium and gravel on right. 10:58 village on right. Yellow shale dips 20° S continuing to village on right. 11:00 Wuyentsun[7].

After Wuyentsun low hill of gravel and clay with outcrop at road cutting of yellow shale which forms a double anticline the last limb of which dips still SE. 11:04 reddish yellow sandy shale very like that of Takaofeng[8], strike 35° W of N dipping 45° W. 2 minutes' stop. 11:08 bridge at Shangwayao[9], barometer 296.5. River here flowing WNW then W. Restart 11:45 in gravel. 11:50 yellow shale. 11:51 Liuchiang[10] (river) (Fig. 39) 11:53 end of city. *Stop 2 minutes.* Road now goes NW. Small outcrop of gray thin-bedded sandstone dips 45° SE then 10° NW. All moderately high hills. 11:58 village on left bridge Poching[11]. Gray thin-bedded sandstone, dip first E then 55° E. The road then enters mountain, and green and yellow shale dipping 40° E. 12:02 Shihpai[12]. Impure limestone (?) dips W then E. 12:04 Mangpa[13] on left, yellow shale dips W and is underlaid by red shale striking NE-SW dipping 45° SW. 2 minutes' stop. Going up, red shale dips 30° E. 12:11 yellow shale dips 10° W. Then horizontal limestone.

12:14 Chiaohua[14]. (Fig. 39). River plain. 12:17 Lungchiang[15] bridge. All the time in limestone dipping W. Soon after, silicified limestone (thin-bedded) and yellow shale striking E-W dipping 35°-40° N. Road here goes N. Stopped 2 minutes. Yellow and red shale makes two folds, then dips again N. Then folded three times. 12:24 vertical, going up dry valley. 12:25 gray silicified

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1 頭排 2 廟村 3 四排 4 頭排 5 石人冲 6 頭塘 7 烏燕村 8 大高峰 9 上瓦窰
10 榴江 11 波井 12 石排 13 茫覇 14 教化 15 龍江

limestone dips 20° S. 12:26 down, whitish sandstone dipping 25° S. 12:27 yellow shale dips N. 12:28 stop, *see section*. 12:35 restart. 12:36 dip SW, then east again. 12:37 small bridge, Tungchiang[1] on the right. 12:38 silicified limestone folded then dips 30° W., then whitish sandstone dips E, then W again (strike NE-SW dip 40° NW). 12:40 Ssuli[2] down to plain. Stop. 12:45 restart. 12:47 horizontal quartzitic sandstone seen in high mountain ahead, on left. 12:49 stop. Grayish yellow sandstone strikes ENE-WSW dipping 45°S. Road goes SW. 12:53 restart. 12:55 about 400 m from Changtang[3] grayish yellow and red sandstone and thin-bedded silicified limestone—*see section*. 1:01 restart. 1:02 Changtang. Just beyond, pure gray limestone dips SW together with black shale. Then yellowish quartzitic sandstone dips 25° W. 1:07 bridge over Tang (?). 1:08 in plain. 1:10 red clay, Tahu[4] on left. High quartzite forming mountain on left. 1:14 car trouble, stop. We are in the basin of Luchai[5] with low undulating hills of red clay and occasional outcrops of Mn and iron beds. *It dips 15°-20° S under the quartzite mountain on the left*. 1:48 restart, road to Luchai going W. 1:51 blocks of pure limestone on the right covered by red clay. 2:00 Luchai. 2:04 village on right. First pure limestone hill across the road. Wide plain. 2:10 Mouth of gap (Kukou[6]). Pure limestone on the right on the other side of the river striking NNE-SSW dipping few degrees N, then S. 2:14 Chiaopanchou[7]. Pure limestone down river is seen to strike N-S dipping 15° E. Barometer 297.1. 2:48 restart. All in red clay and gravel. 2:56 village on right. Opposite high limestone hill, small outcrop of pure limestone. 2:58 limestone forms syncline, axis perpendicular to road. Last limb dipping NE. 3:02 large village on both sides of the road. Pure limestone looking like mammalae sticking out above smooth-topped hills. 3:06 Loyung[8] River, barometer 297.2. Clay and gravel form a bank of 12 to 15 m high. The former is overlaid by unstratified brown clay. 3:19 restart. 3:29 bridge, outcrop of shaly limetone in plain. 3:30 village on left. 3:35 red clay and gravel.

3:38 stop and *studied the section* before the River at Sanmenchiang (section 38). 3:49 restart. 3:59 Sanmenchiang. By the river side very hard micaceous reddish quartzite dipping gently NNE under the beds in the section sketched above. But across the river high flat-topped hill and down the river typical conical limestone. On the west bank near water thin-bedded shaly limestone dipping 5° NNE. Opposite the ferry point on the east bank is pure lime-

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1 東江 2 思力 3 長塘 4 大湖 5 雒容 6 谷口 7 脚扳洲 8 雒容

stone cliff seeming to dip NNE (Fig. 38). Here is probably an unconformity as the pure black limestone in the lower part seems to be horizontal. Road on west bank in red clay and gravel. Loose fragment of silicified limestone and grayish yellow sandstone also found in the clay. 5:06 restarted. Sandstone and silicified limestone in second hill on the west bank slightly folded and finally dipping NNE. Pure limstone on the right horizontal. 5:11 road in red clay and gravel, but between pure limestone cones which dips 5°-10° NNE. Low hills in red clay and wide plateau until Liuchou—no cultivation. 5:24 Hsiakou[1].

5:26 Liuchou. Barometer 296.8.

20 September 1928: Liuchou to Chingyuan

Barometer 2982 at 6:54. Left for Chingyuan[2].—11.7 km—7:20 entering limestone mountain soon after Lapu—2.7 km—7:26 Lungtuan[3]—0.9 km—7:28 Liutao[4]—2.7 km—7:34 Pawang.[5]—4.5 km—7:40 Santuhsu[6]; 7:44 Santutsun. 7:59 Aokou[7]. 8:03 Paitseao[8], fossils. Restarted 10:50—2.7 km—10:56 Likao[9] (Liuchou to Likao 33.7 km).—1.8 km—11:00 pass to north.—1.35 km—11:03 double bridge to river flowing to left.—0.9 km—11:05 stop.

Pass between Kufang[10] in the east and Huangtung[11] in the west blue cherty limestone with conchoidal fracture, strike N-S dip 37° E. (Fig. 22). At point b conglomerate on lower limestone (unconformity?). 11:36 restart from b, but stop again at c 11:37. Here black shale and thin-bedded silicified limestone strike NNE-SSW dip 35° ENE. *Restart* 11:51 ½ after Huantung limestone dips 25°-30° W while the lower formation seems to dip at 45°. 11:53 stop (from pass up to here 1.87 km). *12:04 ½ restart.* 12:08 at Tatang Br. 289.0 (From Liuchou to Tatang 41.4 km; the same distance is measured at 47.0 km on the map.)—1.6 km—

12:52 pass limestone dips gentler.—0.9 km—12:54 it is horizontal. Road following boundary between lower and upper limestone. Then it dips 5°-10° W.—1.35 km—12:57 Lulan[12] on the left.—1.35 km—1:00 pass going down all in upper limestone. From Tatang road in narrow valley with limestone cones.—4.05 km—1:09 upper limestone horizontal—0.45 km—1:10 (?) Mulo[13] Br. 289 on left.—1.8 km—1:14 stop. Black limestone strike 5° E of N dipping 25° W—0.67 km—1:28 restart. Here small pass down. 1:20½ Tientung[14] on both sides.—

1 峽口 2 慶遠 3 龍團 4 六道 5 把王 6 三都圩 7 隘(坳)口 8 百子隘(坳)
9 里高 10 古房 11 黃洞 12 路闌 13 木羅 14 田峝

3.15 km—1:35 on left upper limestone dipping 40° W, but on the right it is horizontal.—4.95 km—1:47 Aotung[1] on left. Lower limestone dips 20° W. Up to 289.5 then gently down.—0.45 km—1:48 village Peiliao[2] on left—on right lower limestone, but on left upper limestone horizontally overlying it. From Peiliao two small hills where the thin bedded silicified limestone is complicatedly folded —1.35 km—1:05 stop. Shaly limestone (chert and silicified limestone above) strike NE-SW dip 15° NW. 1:54 restart in lower limestone on both sides—folded, then dip NW.—0.9 km—1:56 in upper limestone again dipping 28° NW. —1.8 km—2:00 Fungantsun[3] on right.—0.45 km—2:01 Lawu (?)[4]—3.6 km—2:09 small village on right Chushan[5]. Stop 3 minutes.—0.67 km—2.13½ before bridge small outcrop of lower limestone dip 30° + SE.—0.67 km—2:15 Limiao on left, upper limestone horizontal.—2.25 km—2:20 descend into a valley with patches of rice fields.—0.9 km—2:22 houses on right. 2:23 road turns to right (N) Yaowang[6] on left.—0.9 km—2:25 Chingtan[7] on right. Barometer 292; bridge, then Pangsheh[8] on left—4.5 km—2:35 Pass, stop. Black limestone then silicified limestone (Fig. 24 between Lala & Panfang[9]). Barometer 291.6. Restart 2:45 shaly limeston continues to 2:48 Panfang on right. 2:40 valley on left. 2:51 barometer 293, Hsiawei[10], limestone dip 45° N, soon in plain with low hills of red clay. 2:56½ bridge over river flowing east with horizontal (?) limestone exposed, covered by conglomerate and red clay—the former is quite thick. To the right limestone hill 1 km away. 3:00 stop (Fig. 23). First thin-bedded silicified limestone dip 45° N, then thin-bedded blue limestone sheared and folded (horizontal movement changing strike into N-S), then again dip 50° N. After that covered by red clay. 3:10 restart. 3:13 Liupo[11] (Fig. 25) bridge, on right upper limestone again. Last hill but one before Liupo coal sandstone dip ? 3:15 village on left then bridge. Section with following notations: (1) dark blue oölitic limestone (2) thin silicified limestone, (3) blue to brown shale, strike 5° N of E, dip 53° N, (4) greenish shaly sandstone (thin bedded). Restart 3:25½. 3:26½ last low pass before 2 bridges, view of city. 3:29 last low hill before city, silicified limestone dip 30° N. 3:32 station—city of Chingyuan 300 m east of station. Barometer 295.2 (distance from Tatang to Chingyuan 50.9 km).

21 September, 1928. Chingyuan (Yishan) to Hochih.

Chingyuan barometer 296.0. 6:30 start. 6:55 stop opposite Tushan[12]. Blue limestone strikes 30° E of N dip 55° W—outcrop 20 m long covered by

1 襖閙 2 北料 3 鳳安村 4 拉烏? 5 竹山 6 堯望 7 清潭 8 龐舍 9 板房 10 下惟 11 六坡 12 獨山

yellow clay—the east end seems to strike N-W—shearing plane. From Chingyuan road is in yellow clay on the S. bank of river—undulating low hills with occasional outcrop of white limestone. On N. bank limestone (dip 25° N) forms fairly high range. Further south low fore-hill before limestone mountain,—the low hills of shaly beds seen yesterday. Near Tushan the latter seems to disappear and the limestone on left closes in. The valley is a lake basin—clay particularly thick. So far to-day no conglomerate is seen. 7:07 left, a few steps further silicified limestone dips 40° W (small outcrop also). Road goes now between limestone mountain and the river with low hill on left before limestone mountain. At (a) on map silicified limestone strikes NE-SW dips 50° SW, becomes gentler below, but change of strike (shearing plane?). Limestone on left forms cliff, strike and dip not clear. 7:12-7:19 stop. 7:23 second hill on map after Tushan, stop. Shaly black limestone, strike NW-SE dip vertical, on left side of road. On right side of road a limestone cliff lies between river and road with low hill between. Restart 7:29. Limestone on left horizontal—right near road. 7:34 Tatungtang[1]. 7:42 step, hill before Tuihochieh[2] dark blue veined limestone (thick-bedded) strike NW-SE dip 20° NE. 7:45 restart, immediately at Tuiho[3], barometer 296.0 7:48 river. Road cut deeply in sandy loam underlaid by massive blue limestone with calcite veins cropping out at river, strike NW-SE. At river, 296.9. Immediately beyond the ferry black limestone faulted (NW-SE) to NE. It dips at first 50°—then gentler. Bituminous matter. Overlaid by light gray limestone strike NW-SE dip 25° NE. On top of bank silicified limestone and shale are seen underlying black limestone dip 50°+ NE. Walked to *small house*. Just E of it thin-bedded silicified limestone and shaly limestone strike 10° N of W dip first 60° N then S, then vertical, folded several times, and at last again vertical. Outcrop 30 m long. All covered by yellow loam. *Restart 8:25* immediately in silicified limestone dipping 15°-20° S—cover. 8:30 Tantsun[4]. Upper limestone fairly high hill to NE—road in valley alluvium between two ranges of limestone hills. High limestone mountain two kilometers away to left. After Kuanpa[5] road is in lower limestone striking along road dip 40° N. 8:46 Lientang[6]. High hill on right, lower limestone dip 30°+ N. 8:50 stop, shaly limestone strike NNW-SSE dip 35° E. 8:56 restart. 8:57 Taiping[7]. 8:59 bridge. 9:04 Hsiehpiaoling[8], stop. Entrance to hill pass. Black limestone strike N-S dip 40° W (thin-bedded) over-laid by shale (brown) and thin silicified limestone, barometer 295. 9:12 restart to go up. Top 294.1, silicified limestone striking across road,

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1 大洞塘 2 對河街 3 對河 4 潭村 5 官壩 6 蓮塘 7 太平 8 寫表嶺

dip vertical. 9:21 Hsintsun[1], upper limesone striking 35° N of W dip NE then 45° SW (anticline). Much crushed. 9:27 upper limestone hill prolongs on left side of road. 9:40 village on left. 9:41 low hill of red clay. 9:49 Lanpu[2] on left 10 li W of Tehshen[3] (stop 1 minute). 9:56 Tangkuohsu[4] on left and right (1 m. stop). 10:30 Tuchieh[5]. Just beyond, yellow sandstone striking 30° N of W dip 40° N—black shale underneath. Near last bridge (4th from Tuchieh) it turns E-W and vertical (silicified limestone occurs also). At 5th bridge, sandstone silicified limestone and black shale strike NW-SE dip 65° SW. Remount 10:22. Then thin-bedded limestone folded and vertical, sandstone dip NE. 7th bridge, thin-bedded limestone above sandstone seems to be horizontal. 8th and 9th bridge quartzitic sandstone strikes 25° E of N dip 60° N, 300 ft. between 9th and 10th bridge (See Fig. 9). At pass, brown sandstone on right strikes 15° N of E dip 65° N, on left dip 75° S. 2 bridges further shaly limestone on right dip 10° + N. At C (?) brown quartzitic sandstone stikes WNW-ESE dip 65° SSW. Then dip N. Next bridge, then Lungwan bridge. 10:55 Lungwan[6]. At d sandstone and black shale strike 15°N of W dip 65° N. 11:04½ bridge Wanlitsun[7], on left all in limestone 5 li from Tungchiang[8]. 11:10 bridge. 11:11 Tungchiang river. Road from d on in yellow clay surrounded by limestone mountains. At Tungchiang white limestone strikes E-W dips 40° S. Rest. Barometer *294.0*. Restart 12:30. 12:40 Chiatao[9].

12:45 stop. Here fossils in white limestone striking E-W dip 35°-40° S, where the road goes S. to enter into mountain. 1:46 left, massive limestone mountain. 1:50 Peiwang[10] on right. 1:58 Liuyo (?) (stop 2 m) on right. 2:2½ Weilao[11]. 2:12 bridge, black shaly limestone strikes E-W dip-25° S. Stop 3 m. 2:17 Panlitsun[12] on left. Point e near Liuhsü[13]. 2:24 Liangchai[14]. 2:27 stop before bridge (see Fig. 16,18), before Liutang (?)[15]. 2:34 left. 2:38 stop, black shaly limestone strike NNE-SSW dip WNW. Restart 2:44. 2:49 Liutang on right and left. Bituminous limestone strike E-W dip N & S (road axis), Going up Liangshuiao[16] (Fig. 15) yellow shale and black limestone dip west, folded complicatedly. Axis of folding NNE-SSW (silicified limestone). Barometer 288. W. of Liangshuiao black limestone striking 20° N of E dip 70° N, then 20° N of W dip vertical, with fossils. The E-W striking and vertically dipping limestone is overlain by horizontal upper limestone. 4:47 restart. 4:54 Hungshahsu[17] bridge. 5:07.2 bridges. Limestone on both side of the valley. 5:14 Hochih[18], barometer 291.

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1 新村 2 闌埔 3 德勝 4 唐郭圩 5 都街 6 龍灣 7 萬里村 8 東江 9 加道 10 北望 11 畏鬧 12 半里村 13 六圩 14 梁寨 15 六塘 16 涼水坳 17 紅沙墟 18 河池

22 September 1928

Left Hochih at 6:39 Br. 291.8 = 391 m. At 7:04 on S. bank of creek, isolated hill of cherty, black shaly limestone striking N-S dipping 32° W, but on the east side the dip turns steeper. This hill is SE from Paan[1] known as Jungshan[2]. The distance from Paan is 800 m. Restart at 7:26. At 7:36 stop, hill by the right side of the road, same limestone with crinoid stems practically horizontal—this is NW of Jungshan. 7:52 restart. 7:58 village of Lakan[3]. 8:11 went up a ravine opposite the village of Yangtsun[4] on the otherside of the river. Here a massive bluish green limestone with chert bands, bedding 6 in. and flinty fracture, overlies quartzite and reddish shale and sandstone the strike and dip of which is not seen, but the limestone strikes NW-SE dip 10° NE. No fossils. 8:57 restart Br. 291.9. 9:12 Br. 290.4 quartzite. 9:15 rest. At tea-house Tashantangchiao[5] limestone NNW-SSE dipping 40° ENE. 9:28 restart. 9:55 river coming down from N entering a cave to the NE. 10:06 stop, Br. 287.2, black shaly limestone striking NW-SE dipping 60° NE. Limestone above *seems horizontal.* 10:12 walking up. 10:27 remount—in quartzite. 10:34 Latsun[6]. 10:44 Tashantang[7]. Pass Br. 281.6 (900 ft above Hochih). Quartzite striking along the road dipping to ENE. 11:42 left, walking. 11:51 yellowish silicified limestone striking NNW-SSE, dipping 45° ENE. 11:58 slaty shale striking NW-SE, dipping 63° NE underlaid by black shaly limestone and overlaid by pure limestone *seeming to be horizontal.* 12:00 remount. Br. 283.8. 12:12 quartzite striking NW-SE dipping 80° SW overlaid by *horizontal limestone.* Br. 284.0. 12:18 restart. 12:25 shaly limestone striking NE-SW dipping 56° SE. 12:31 restart. 12:47 Lumatien[8] village Br. 284.9. 1:15 Fengmutien[9] Br. 285. From Lumatien to Fengmutien, road is in limestone strike and dip as before (NW-SE and NE?). Limestone forming steep cliff to right and left behind earthy hill. 2:24 left Fengmutien. 2:50 small village named Weipa[10] on right side of a broad valley opening towards N. All shale, sandstone and shaly limestone striking NW-SE, dipping 30°? NE. 3:00 stop, 3:16 restart. 3:23 stop. Black cherty limestone striking E-W dipping 40° S. Br. 286.6. 3:30 restart. High limestone cliff on both side of valley. 3:42 village of Nama[11] on right side of valley. Typical *Liangsuiao limestone with fossil,* striking 30° N of W dipping steeply S. 3:55 restart. 3:58 road here branches to W from the leading north to Papu[12]. 4:10 stop. Small hill Br. 285.4, 15° E of [?] to Papu. On the NE side of Papu, limestone cliff seems to come right down to valley floor. Then a deep wide valley (at least

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1 巴岸 2 容山 3 拉坎 4 羊村 5 大山塘脚 6 拉村 7 大山塘 8 路馬店 9 楓木店 10 葦壩 11 那馬 12 八步

2 km wide) on the west side of which limestone cliff occurs high above valley floor. The hill on which observation is made is at the N end of the cliff. From there we can see a wide, slightly dissected plateau which is surrounded by high limestone mountains. 4:26 restart going west. 4:30 stop. 3:36 restart. 4:42 small village on right side of the road which follows limestone cliff. 4:51 crossing Yecheho[1] (Fig. 13) river, Br. 288.0 (498 m). This river going S contains some tin in its sands. 5:00 restart. 5:11 Br. 282.9, another river going S. The road hitherto is very rough in bamboo forest. Here black limestone similar to Liangshuiao strike NW-SE dipping 36° SW.

5:16 restart, going west. From here to 5:21, road in gray shale and yellowish brown sandstone striking NW-SE closely folded into a syncline.

5:25 Br. 287.5 (513 m). *River* flowing N. Restart 5:27. 5:41 village of Heimu[2], (Fig. 1) Br. 287.6. Stopped at Shan Mo's house.

23 September 1928.

6:15 left Heimu Br. 288.2 (528. m). At 6:30 quartzite strikes 15° W of N dipping 30° ENE. 6:36 restart. 6:40 small stream flowing N, Br. 289.4 (482 m). 6:43 foot of his pass, dismount, ascending on foot, very steep path. Stopped 5 minutes. 6:50 pinkish shaly limestone strikes NW-SE dipping 70° SW & NE. 6:55 stop. Black crinoidal limestone. 7:05 restart. Further up similar shaly limestone striking NW-SE dipping 53° SW. The black limestone becomes thinner-bedded comparatively free from chert, but with reddish bands of clay shale. 7:10 stop. 7:20 restart. 7:30 Bluish green limestone similar to that near Yangtsun seen yesterday, underlying sandstone, but overlying blue crinoidal limestone. 7:40 restart. 7:45 nearly to the top. Br. 282.4? = 685 m limestone striking NNE-SSW, vertical. Begin descent. 8:10 stop. 8:17 restart on horse back. Going more or less in SSW in soft yellowish shaly limestone, leaving the valley to the right (WNW side). 8:30 top of another pass, Br. 283.0 (669 m). Limestone cliff below it strikes WNW-ESE dipping 45° SSW. To *Yulung*[3] *village 30° S of W*. 8:36 outcrop of silicified limestone striking NNE-SSW dipping 45° ENE. 8:46 impure shaly limestone strikes NW-SE dipping 70° NE. Limestone blocks are seen to be impure grayish in colour with reddish shale. 8:51 stop. 8:53 restart. 9:00 stop. Fine view of Yulung valley. To highest limestone mountain (Pamienshan)[4] 30° W of N. (See Fig. 2, 3, 4) Br. 283.0 (669 m). 9:22 restart. 9:25 turning S to descend, walking. Gray and black slaty shale similar to yesterday seen at Heimu.

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1 野車河 2 黑木 3 玉隆 4 八面山

St 20° E of N dipping 65° E & W. Mountain on otherside across the river strikes NE-SW dipping steeply SE. 9:39 same shaly limestone seems to dip S. 9:50 Br. 289.1, Yulung river just N. of Yulung village. 10:00 remount going up in quartzite, striking 14° E of N dipping 20° ENE. 10:17 black semicrystalline limestone with very impure spotted pinkish bands, striking N-S dipping 25° E. Unsuccessful search for fossils in burnt cliff. 10:41 remount.

10:51 pass, Br. 286.0 quartzitic sandstone (silicified limestone?) with limestone just N and S of the pass. The road now turns N to go along the large valley of Machiaho[1], impure shaly limestone bands occurring in quartzite (silicified limestone?).

11:00 village of Lanao[2]. Br. 286.3 (573 m). *From Lanao to Makuaitsun*[3] (*Fig. 5*) *W to Chihpei*[4] *29° W of N.* 12:08 left Lanao. 12:13 stream, Br. 288.4. Slaty shale, striking N-S dipping 40°W. 12:20 Makuaitsun. River 288.8 (526 m). Quartzite (?). 12:32 going up pass. Hard bluish shaly crystalline limestone striking NE-SW dipping 20° NW. Walking. 12:36 remount. All in blue limestone. 12:45 limestone more shaly. 283.5 nearly horizontal. 12:54 shale. On the right (east) side of pass, solid limestone cliff striking N-S dipping 10° E. 1:00 Br. 281.5 (723 m) *in gray shale.* 1:06 Br. 280.2 (761 m) Chihpeitsun[5] 1:10 Br. 279.0. Blue limestone with chert striking NNW-SSE dipping 56° E. Here is a Liangting[6]. Rest. It is about 480 m above plain, 2880 feet above sea level. *Road up pass 25° W of N.* 1:59 left, going gently up, Br. 276, in gray shale. 2:02 top of pass, Br. 274.8, in solid blue limestone. 2:09 Br. 274.3, black coaly shale dirting fingers, along the road, horizontal (?). Stop 5 minutes. 2:15 walk. 2:21 village of Kaofengchieh[7] (Fig. 4). Br. 273.9. 2:26 end of village. Turning to right and going very slowly, we see Tachang[8] at 2:40. 2:45 at Tachang (by upper road) Br. 274.9 (920 m).

24 September 1928.

At Tachang Br. 275.5 (920 m). Took the upper route to Changpo[9], (See detailed map and Fig. 10). After the road branches off to Nantan[10], at the head of a valley is granite outcrop on the south, but to the north there is thin-bedded impure limestone striking E-W dipping 18° N. Going down the valley all granite on left, but just as we turn N to Changpo, limestone outcrops on the right striking NNW-SSE, dipping 70° ENE. Soon we are on the top of the pass overlooking

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1 馬家河 2 拉𨻶 3 馬拐村 4 紙背 5 紙背村 6 涼亭 7 高峰街 8 大廠 9 長坡
10 南丹

Changpo. Going round the hill to the right we came to a stream flowing from NE towards the village. Here dark blue shaly limestone striking SSE-NNW dipping 70° WSW, but on the SE bank of the stream is granite. At the village of Changpo reddish shale and grayish shaly limestone striking SSE-NNW dipping 40° E.

Going north from the village we came to a creek with a small waterfall. Thin-bedded impure black shaly limestone striking 15° N of W dipping 65° S. Further up, we soon came to the tunnel. Here impure bluish limestone striking E-W dipping 70° S. A survey is made of the tunnel; about 100 m from its mouth the limestone seems to dip towards N. Small vertical veins of calcite 1-3 in. thick containing pyrite, cutting the strike at right angles. At an old working to the right impure black limestone strike WNW-ESE dipping SSW. Coming out from the tunnel we descended again to the office. Rock on otherside (?) dipping N.

Opposite office gray shale striking NW-SE dipping 50° SW. After lunch descended into a mine of Li Motsai. On the way from office on the direction NNW blue shaly limestone striking 25° N of W dipping 65° W. At Li's mine Br. 274.8. Limestone dips 15° E of N. At end of shaft (see map) Br. 275.3, limestone dipping gently N. We have here two veins, one 5 in. the other 8 in., coming down vertically to join (specimen?). Went N to the mine of Taihukou. Br. 274.2. In the mine impure limestone dipping generally 23° NE. At the end of long tunnel, black shaly limestone striking 35° N of W dipping 26° NE. There is a vertical vein, the broadest part is about 3 feet, but broken up into irregular veinlets Br. 275.

Went NW to the top of the cliff. At the top Br. 271.5. From it we see that on the other side of the mountain is an E-W valley opening to east with pure limestone overlying the shaly sediments forming cliffs on the N side of the valley. This limestone seems to form a gentle anticline dipping 20° NE at the east end of the anticline.

To the NE of the cliff the mining bureau opened a new adit. Level 272.7. It is in the shaly limestone striking E-W and dipping 23° N. It is weathered into a reddish clay with small amount of cassiterite. Came back to the southern side of the cliff by going round the eastern part. From office to pass 30° E of N. East of this line practically no mine.

Came to the mine of Hsu Pao-ting. Br. 274.3. The limestone seems to dip generally 25° N. The Tachingshan[1] is famous and is situated to the W of the

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1 大金山

mine communicating with it. Just below the mine calcareous shale striking 25° N of W dipping vertical.

25 September 1928.

At Tachang Br. 276.8.

Left for Kaofengchieh via the upper route (see map). At the NE corner of village limestone contains *Productus gigantus,* occurs in a small outcrop and is practically horizontal. From a point 31° W of S a temple on limestone hill, the road lies in soil containing iron ore, but on both sides there are limestones. At a point directly N of Kaofengchieh gray calcareous shale on the N slope of mountain striking N-S dipping 30° E. Going east and then north, we came to the hill of Wuchihshan[1]. At horizon 274.2 we have black coaly shale, gray shale and sandstone and silicified limestone. Further up, we have thin-bedded limestone striking NW-SE dipping 15° NE, but going up it is nodular (not unlike Würmkalk), becoming purer at the top where it is massive. No fossil. From Wuchihshan to Pamienshan 70° E of S.

After coming down and going S from Kaofengchieh, we climbed up the ridge west of the village. Near the pass we have black shale, then sandstone with iron, and silicified limestone dipping zone [?] at the place of ascent. Along the whole ridge the silicified limestone containing antimony seems to dip gently to ENE, but in reality the dip is very steep, a little to east. Went the whole length of the ridge and then descended to Mashihpeng[2]. Just N of Mashihpeng, pure limestone not unlike that of Wuchihshan underlying the silicified limestone dipping steeply N. There is supposed to granite at Mashihpeng, but no outcrop could be seen. Granite however is seen between the limestone with *P. giganteus* forming hill by the river side and the silicified limestone ridge. The former dips 60° N with fault breccia (?).

Coming down by the temple in the limestone referred to, we rested at one of the furnace houses at the mouth of the Kaofengchieh valley. After that, went up SW to the mines in the residual clay. Blocks of granite are seen above the mine. Below is a limestone containing numerous corals and brachiopods (*P. giganteus* horizon). It strikes generally NW-SE dipping 30° NE.

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1 五指山 2 麻石硼

26 September 1928.

Spent the day in collecting fossils from the limestone below the village of Tachang. Numerous *P. giganteus.*

Went to Kaofengchieh by lower route to complete topographical sketches.

Just at the junction of the Tachang and Kaofengchieh valleys there is a small tunnel in P. limestone working residual clay in the cavities of the limestone on the right side of the road.

27 September 1928, Tachang Br. 276.6.

Went to Palai[1] (Fig. 7) by the upper route. Climbing up south westward from the office we are in silicified limestone. But 250 m southward we are in limestone with *Productus giganteus.* Less than 100 in westward, in granite. The hill to the N is entirely of granite. Further west we have silicified limestone with big quartz vein. This continues to Palai. But at 276.2 near Palai, black shale and limestone outcrops. From a point just above the village we went NE to mine. All the way lies in silicified limestone with shaly limestone above in which is the mine. There the main rock is soft yellow and gray shale. Br. 274.5. This is the south mine. Another mine is north to it. Between the two lies a small outcrop of granite. The second mine is in gray shale which is apparently horizontal, but a little to the west it is vertical. From the last to village of Palai (following the Palai valley, is a good section (Fig. 7). Just below the mine black sandy and shaly limestone striking 35° E of N dipping 80° E. Lower down greenish sandstone overlying shaly limestone striking 15° E of N dipping 70° E. Right down to the small hill beyond Palai all in yellowish shaly limestone (more shaly than calcareous).

The road branches off from that to Wonglo to Changpo over the hills. At the foot of the path slope, we have massive limestone striking NW-SE dipping 70° SW, underlaid by black shale.

Further up quartzite is seen, but no outcrop that could be measured. Going down we soon arrived at Changpo. After resting we came back by following first the Changpo valley till we came to the road to Wonglo. The quartzitic sandstone overlying gray shale strikes WNW-ESE dipping steeply SW under a massive limestone bluish in colour with plenty of chert. Fragments of gastropod. It is certainly *the same as that of Yangtsun.*

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1 巴來

Going by the bridge over the Changpo river toward Palai, we went over a low slope in the same limestone, and then down on the Palai road, to Tungchehchiang. The valley is strewn with broken pieces of silicified limestone washed down from the head-valley of the Palai stream. Entering the hills north of Tungchehchiang we crossed a stream flowing west. Then crossing a low pass we found the rocks (sandstone ?) striking NW-SE dipping vertical. Just east of Tungchehchiang dark blue shaly sandstone strikes 30° W of N dipping 30° SW. This is folded (see section) and becomes vertical at contact with *P. giganteus* limestone, which at first strikes N-S dipping 65° E, Br. 276.1. Small outcrop of granite on N (?) side of bridge.

Information obtained from the miners.

Two sections are obtained from two different native miners. The second of these is more reliable:

Section I (from top down)

			Remarks
1.	Paipeng (白盆)	40 ft	
2.	Tawuhuang (大烏磺)	4	with three *pingho*
3.	Hsuikohuang (碎殼磺)	5—6	
4.	Paipeng (白盆)	2—4	
5.	Huangshali (黃砂粒)	1	
6.	Heipeng (黑盆)	2—3	
7.	Huangtsunghuang (黃種磺)	10	thin-bedded silic. limestone
8.	Hsiaochingshali (小青砂粒)	0.5	
9.	Hsiaowuhuang (小烏磺)	0.5	small *pingho*
10.	Sashali (殺砂粒)	1	
11.	Chingshali (青砂粒)	1	with *paopao*
12.	Tawuhuang (大烏磺)	2	with *pingho* & *paopao*
13.	Wushali (烏砂粒)	1	
14.	Cheko (揭殼)	6	
15.	Chijouhuang (雞肉磺)	12	
16.	Maomao (貓毛)	1	

17. Tashali (大砂粒) .... 1.5 with *paopao*
18. Chientzeko (錢紙殼) 3
19. Hsiaowuhuang (小烏硫) .... 0.7 with small *pingho*
20. Hsiaoshali (小砂粒) .... 0.7 with small *paopao*
21. Niuchohuang (牛角硫) 15
22. Kouchiahuang (狗夾硫) .... ?
23. Huoshihuang (火石硫) .... 1 with *pingho*
24. Tzeko (紙殼) 0.5
25. Kuaitzelung (拐子龍) 15
26. Tawuhuang (大烏硫) .... 1 with *pingho*
27. Chilinghuang (麒麟硫) 25

Section II (total 111.2 ft.)

		Thickness	*Ore content*	*Rock character*
1.	烏雞肉硫	10 ft		Compact black shale
2.	烏砂粒筒	1.5	big flat vein above	2 layers of black cal. shale with thin shale between
3.	錢紙殼	0.4		
4.	白盆	2		White compact clay shale
5.	砂粒筒	10	scattered vein	Yellow compact sandstone alternating with shale each less than 1 foot
6.	黃種硫	0.7		Yellow porous sandstone
7.	牛角筒	10	*suiya*, no *paopao*	Compact gray limestone (?)
8.	烏砂粒	2	vein 4" by 10'	2 black shaly limestone with black shale
9.	小烏硫平湖	0.4	vein (flat)	
10.	牛角筒雜貓毛	1.5		Black sandy shale with thin limestone (?)

11.	大斷筒礦	0.5	*suiya* no *paopao*	Compact black limestone (?)
12.	揭殼礦	0.5	small flat vein	Black shale with pyrite
13.	貓毛礦	2	*suiya* only	Black sandy shale
14.	雞肉礦	0.5	*suiya* only	Gray calcareous shale
15.	大青砂粒	2	big *paopao*	Coarse crystalline limestone
16.	大筒礦	6	*suiya* only	Hard compact semi-crystalline blue limestone, fracture concoidal
17.	烏錢紙礦	2	Flat vein above, 2" thick	Thin-bedded black shale
18.	牛眼礦	2	*suiya, paopao* 3" thick	Gray compact siliceous limestone with concentric structure
19.	狗夾	3	*suiya, paopao*	Impure dark gray limestone
20.	牛角礦	6	*suiya, paopao*	Compact gray limestone, flinty fracture
21.	白礦	1.5	*suiya, paopao* 1/2-2"	White clay limestone
22.	馬拐筒	1.5	*suiya*, flat vein 3" 8"-1'.4	Pyrite and calcite
23.	火石礦	2.0	*paopao*, flat vein	Black silicified limestone
24.	紙殼礦	0.4	*suiya* only 4"	Black shale
25.	板錢紙礦	0.4	*suiya* only 1"	Grayish sandstone
26.	拐子龍	12	*suiya* with *paopao* 1.5" 2.5"	Pure light gray limestone with nodules
27.	紙殼礦	0.4	*suiya* 1.5", flat vein 3"	Black shale

28.	大鳥硫	20	*suiya* 3"	Black limestone with calcite and shale streak, subconchoidal fracture
29.	麒麟硫	10	*suiya*, upper 3" lower 4"	Hard compact gray limestone with black shale streaks & thin calcite.
30.	雞腰倚礦	?	flat vein, 3' by 2'.5	

Economic Information.

According to all the miners I have asked, the lowest workable vein in the area round Changpo must contain *10% of cassiterite.* It is usually necessary to mine 500 catties of rock in order to obtain 100 catties of crude vein material. *So the lowest percentage workable is really 0.2%*[1].

In Lungtaochang the average payable clay contains 0.2% ore. Two roastings are required at least.

In the alluvium that occurs from Sanhotsun down to Lapun where the Fengho comes between Pingtsun and Panchiatsun meeting the river from Yülung, the payable percentage *is 0.1%*. This alluvium is from 2-3 feet thick occurring from 2-10 feet bellow the surface soil. The width is variable, but never very large. It is however more free from sulphides. It is largely worked between Sanhotsun and Tanglung, because below the latter village the valley is narrow. (Compare with Fu-Ho-Chung district where the lowest workable alluvium and residual clay contains only 0.025% and needs only 2 washings as the ore contains no sulphide or magnetite).

The ore at Changpo is full of pyrite, chalcopyrite, magnetite, and a zinc iron sulphide known as "Fengtze", therefore it must be roasted with grass 3 times;

Note on native terms. Suiya 水牙 is a vertical vein, usually calcite. 白線 is thinner than 水牙. *Paopao* 包包 is a swelling in a small vertical vein. *Pingho* or Pinghu 平湖 is a flat vein between bedding planes of country rock, generally forming a part of a *suiya*. *Lanshanchi* 攔山寄 is a steep-dipping strike vein usually along a fault line. Of these there are three: Good ore occurs between Tahu and Wenchulung. Below the latter is a Lanshanchi extending to Tahu one foot and more thick. About 30 feet SW another occurs but is small and cannot be worked. East of Suitung is another but also unworkable.

1. Perhaps 20% was meant by Dr. Ting.

each roasting is followed by grinding and washing before refining. The concentrate contains only 60% tin while that in the Fu-Ho-Chung district contains at least 70. Each roasting lasts 15 days because it must be allowed to cool down before washing can take place. Each firing roasts only 3-4,000 catties of ore.

Price of the ore that has been crushed and washed only once is 4 cents per each 10% of cassiterite. Price of crude tin is $1.00 per catty (all in Cantonese currency). This crude tin is refined at the Government Bureau. This process of refining gets rid of 0.2-0.3% of slag and the tin is cast into blocks of 35 catties each. These latter are carried by men to Huaiyuan whence to Liuchou by boat. The cost of the whole is as follows:

Price paid to smelters	$100 per 100 catties,
Transport to Huaiyuan	$ 7
Transport to Liuchou	$ 0.80
Transport to Hongkong including taxes	$ 22
Total	$129.80 (Cantonese currency)

The cost to the smelters is said to be at least 15 dollars per 100 ca. The alluvial ore (concentrate) from Tanglung is sold at $60 per 100 catties and it contains 80% tin (?).

I calculated that the area at Changpo is 2,000 msq. If it is worked down to 50 m depth below the present lowest workings, there are probably 2,000,000 tons of rock, containing 0.1-0.2% cassiterite.

29 September 1928

Left Tachang, Br. 276.9 (920 m). Went NNE up the valley. At a temple water comes out from a spring, where black shale crops out, followed 90 m later by silicified limestone and *Wuchihshan limestone* striking NW-SE dipping 40° NE. Then it is overlaid by black calcareous shale forming an anticline (dip 40° NE & SW). Soon it is underlaid by Wuchihshan limestone dipping 40° SW (see section). At point 274, 360 m from temple, yellowish sandstone striking NW-SE dipping 40° NE. From Tutiao[1], which is the pass between the Tachang river and that of Yülung branch, the road goes down a little, then up again. To the

1 土地坳

west the hills seem to be of granite. From here ENE no clear outcrop, but the beds are formed by thin-bedded shaly limestone partly silicified, weathering into yellow clay with lumps of Mn.

At Hsiaotengtsaoping[1] fossils found in similar shaly limestone partly silicified (height 274.2). The most characteristic fossil is a crinoid which is the same as shown to me by engineer King collected in the *Wuhsuan*[2] manganese field. Other brachiopods show the age to be Devonian. A fault intervenes between the fossil locality and the rock to the south? The rock strikes 30° W of N dipping 23° NE before reaching the fault. At Hsiaotengtsaoping it seems to strike 20° E of N (?) dipping 70° E. After going round the head of a side valley another fault is observed, near point 274.2. Then followed by black shale (coaly) dipping 20° ENE.

At point "a" on map black shale and hard sandstone striking E-W dipping 13° N. Fine view from here. From "a" the road follows a watershed up to Yangchiaochien[3]. To the left beyond the deep valley, massive limestone is seen to strike 30° W of N dipping gently to ENE (about two kilometers away). At Yangchiaochien (N of peak), the conditions are complicated. At point "b" 272.9 (1040 m) the silicified limestone strikes 80° E of N dipping on the left hand of the road 45° N, but on the right it is thrown into fold (see section). The small hill to the left is formed by a pure limestone seeming to dip gently east. The Yangchiaochien is probably of the same limestone, but it is not certain.

At point 273.9 (1010 m) coarse gritty sandstone strikes N-S dipping west. To the southeast a cliff is seen, formed by nearly horizontal brown quartzite (dipping 10° NE). The road now goes NE to descend very steeply into a valley. From top to 275.8 all quartzite, but at 275.8 and down to 278.3, black crystalline limestone with crinoids. From 278.3 to 279, black limestone less crystalline with flint. From 279 to 282.3, white clay shale interbedded with blue limestone (not unlike sandstone in appearance, nearly horizontal). From 282.3 to 282.9, and a little beyond, typical quartzite with some black shale, striking N-S dipping 30° E.

Beyond Layang[1] (Fig. 6) at 284, pure limestone like that of Wuchihshan striking NNE-SSW dipping 20° west forms cliff on the left side of the road. This continues to 284.9 at the bottom of side valley, where it seems to become vertical on the left side of the road. Then descent into the main valley with water flowing south to Yülung. *Br. 285.2.* On the east bank the cliff consists of massive silici-

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1 小燈草坪 2 武宣 3 羊角尖 4 拉羊

fied limestone striking NE-SW dipping in the north to 20° NW, but reversed to 15° SE.

From here observation becomes less careful. The road crosses two divides and then round the head valley of a branch of Yechiho[1]. There at 286.1 brown sandstone and shale striking ENE-WSW dipping 45° SSE. The road now ascends again. Just before the top of the pass (300 m) quartzite (?) overlaid by thin-bedded shaly limestone.

At pass 283.2 partly silicified shaly limestone strikes NW-SE dipping 20° NE. Lower down just before Yechiho village, shaly limestone dips 60° NE. At Yechiho 287.6, rest. Black shaly limestone strikes 10° E of N. dipping 45° ENE.

Going from Yechiho to Huilo[2] the road lies all the time until we arrive at the latter on the west bank of the river, in the direction NNW. At first we are in massive silicified limestone looking like quartzite, then followed by a series of black shaly limestone and yellowish sandstone and shale, followed again by silicified massive limestone, all dipping constantly about 40° NE. Just before the village of Huilo, granite blocks are seen in contact with massive silicified limestone (quartzite-like) dipping 70° NE. At the village typical white gray shale dipping 70° NE.

West of the village at the river bend, washing of residual clay and alluvium in white shale dipping constantly 70° ENE. *Br. at Huilo 287* (635 m).

30 September 1928 Huilo

There are three main areas where mining has been carried on:

1. *Lannga*[3] about 1.25 kilometer NNW from village. Two peaks much cut up by mining. At the western peak Br. 285.8, quartz veins 1.5" to 3.5" thick, cutting across the strike of black limestone which is only 1 m thick between 2 layers of black shale striking 37° W of N dipping 57° NE. The quartz vein thins out in depth.

2. *Paowangmiaopei*[4] about 800 m S of village, Br. 283. Quartz vein 2" to 6" thick, with specular iron (zinc and iron) along bedding plane of a pyritiferous sandstone (silicified limestone?), (see Fig. 11, 14), forming a N-S anticline with dip of 60°-70°. The veins are irregularly joined together. The silicified limestone contains also antimony. Up the side valley (E-W) granite is said to occur.

1 野鷄河 2 灰羅 3 濫× 4 寶王廟背

3. *Maopingtsung*, not visited. But seen from a distance; the high steep cliff NE from Paowangmiaopei is formed by reddish yellow residual clay with old working on the slope. It is no doubt formed by softer shale, which seems to strike NW-SE dipping vert. Beyond this behind the valley of Maopingtsung is ***white limestone cliff***.

Went by same route back to Yechiho. Br. 290 (615 m). Granite is said to occur 2 km SSE from the village. After crossing the river of Yechiho the road ascends up a low divide consisting of reddish, yellow soft sandstone and black shale. Then it descends into another stream, flowing SE. Going up to 289 we crossed two valley heads and up a pass 286 (730 m), where residual clay in the same rock is worked (see section). The red and yellow shaly limestone strikes 38° E of N dipping in various directions.

Fine veiw of the valley (N-S) beyond village of Lutung[1]. The east ridge is formed by massive pure limestone at the top underlaid unconformably (?) by older sediments.

Descent to the village of Lutung, Br. 289. Reascended the valley west of village. On the northern side there is a number of shafts and adits. In one of these, limonite vein 1"-3" thick, cutting vertically across the strike of the brown black and gray calcareous shale which strikes 10°-30° E of N dipping 30°-40° ESE. From thence went up the low pass between Lutung and Kangma[2] which is about 800 m SSW from the former. The pass is 287.2 (693 m) where the rock strikes 28° W of N dipping 45° or more in all directions (see Fig. 12). A little lower down fossils in the partially silicified shaly yellow limestone. Fossils are the same as those of Hsiaotengtsaoping. Just below the fossil locality near village of Kangma, brown black slaty shale strikes 30° W of N dipping 33° NE. At Kangma Br. 290.

1 October 1928

Left Kangma, Br. 291.2 at 7:00. Main pass between Yechiho river and Papu valley 291.0. Going from Kangma to Papu we are all the time in shaly limestone and reddish and yellowish shale. At first these strike NW-SE dipping 40° and more NE, but after leaving the Yechiho river to SE the strike changes to NNE-SSW dipping ESE. About 2/3 of the way from pass 291 to Papu, it becomes vertical with NW-SE limestone cliff to the east. (This latter is nearer to the road than is indicated on the map.) The limestone seems to be horizontal, coming right down

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1 鹿洞 2 抗馬

to the valley, whilst the shaly series forms low hills between our road and the Yechiho. The road from Tachang to Papu can be seen from the pass 291.

At Papu at 8:35, Br. 293.1. On approaching Papu the dip of the shaly series is still to the east, but it becomes more gentle (20°). Left Papu at 9:26. 9:40 (1100 m from Papu) we are at the junction of the Tachang road. Limestone cliff on right seems to be horizontal, but cross-folded in many places. It comes near bottom of valley, but divided by shale layers into two. At branch road to Tachang limestone seems to dip 30° W. Stopped here 6 minutes. 10:00 road in yellow sandstone, but soon in impure (?) limestone again. 10:05 limestone cliff disappears. Br. 291.9. Road in soft rock. 10:17 Br. 290, soft limestone on left dipping 35° E. 10:20 limestone cliff seen on right through gap, otherwise all earthy hills.

At 11:00 Lumatien, Br. 290. From Fengmutien to Lumatien we are constantly on the left bank of a stream flowing northward. (There is no river, as indicated by the map, between Papu and Fengmutien.) The road is in fragmentary silicified limestone, and on the left fairly high hills with thin-bedded limestone dipping steeply NE. On the right over the other bank of the stream the hills are brownish earthy beyond which are high limestone cliffs. *Quartzite pebbles begin to appear.*

Going from Lumatien we are constantly in Wuchihshan limestone with bands of softer rock dipping steeply eastward on the left, but at Tashantang[1] 11:55, we are suddenly in typical quartzite.

At Tashantang, Br. 285.2. Left Tashantang 12:45, slowly walking. 1:20 quartzite disappears and limestone on left dips E, that on right W. 1:35 river disappears underground. Quartzite (?) hill by river bed. Limestone hill on left ahead is seen to dip 50° ENE, Br. 291. 1:49 limestone on left seems to be horizontal (?). It is full of chert same as that of Yangtsun. 1:56 limestone ahead referred to above is seen as by section.

Restart 2:13. Valley now widens. Quartzite on left and on right—more on right over which is limestone dipping W. 2:20 Tea-shop in limestone, but soon again in quartzite. 2:25 limestone on the left, but quartzite forming low hills on the right, under limestone cliff.

After isolated hill at Yungshan, between Hsintsun and Hochih there is a fairly high hill on the left formed by yellow sandstone and clay overlaid by lime-

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1 大山塘

stone cliff, but the road is in silicified limestone looking very like the fossiliferous beds of Kangma. Yungshan limestone seems to continue to SE on right dipping under (?) quartzite. 3:25 at Hochih, Br. 294.0.

According to an official in the yamen, there is a famous antimony mine at Fuyungshan[1] (Fuyungai ?) in the Tumingli[2], SE from city on the Liaotsun[3] road. Now the mine is being worked by the Wanhsin Co. which is trying to set up a smelting plant at Wuchou[4].

According to the district record compiled in 1919: the Chingtungho[5] (i.e., Yenchiho) comes out at Chuanmatsun[6] south of Nantan in a waterfall. The river Hsiushui[7] has a waterfall "200" ft high at Wushan[8] 5 li from the city (SW). It gives also the following figures of population including Nantan:

Hochih (pre-Kanhsi time[9])	1,463
Kanhsi 20-50, increase of	1,706
Yungchen[10] 9th year, increase of	80
Chienlung[11] 36th year, increase of	1,016
Taokuang[12] 6th year increase of	61,715
In the 8th of Republic (1919) houses	23,594
people	188,636

According to the local people, before 1925 families numbered 23,000, but after the trouble in 25-26 the number is reduced to 7,000.

2 October 1928 Hochih

Went to Malushan[13] where a shaly cherty limestone strikes E-W dipping 29° N. It is only 60 m S. from the eastern end of Hochih city. To Yungshan (?) 75° W of N where the same limestone dips S. From Malushan we rode to Liaokoshan[14] which is ESE (?) from Hochih just N of Liangting. There the upper pinkish white *Schwagerina* limestone overlies a hard blue limestone free from chert, but with sandy layers between, and subconchoidal fracture. In the latter there were a few fossils including a *Productus*. There was a series of recent gravel between Liaokoshan and the road.

Left Liangting at 9:43 by car. 9:45 Bridge. 9:46, 2 more bridges cutting in the gravel and sand. 9:47 slight turn, going faster. 9:48 bridge, 9:49 bridge

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1 芙蓉山 2 都銘里 3 廖村 4 梧州 5 金峝河 6 轉馬村 7 秀水 8 吳山 9 康熙以前 10 雍正 11 乾隆 12 道光 13 馬鹿山 14 了哥山

with river flowing south. Left side is limestone mountain with violet coloured earthy hills in the fore-ground. On the right side all limestone. 9:51½ bridge. 9:25 bridge. 9:53 limestone on left disappears behind earthy hills. 9:54 Hungnitsun[1] on right. One minute's stop. 9:56 stop. Small outcrop of black shaly limestone striking ENE-WSW dipping 82° S on left. Restart 9:59½. Road close to low reddish hill. 10:01 stop. Black shaly limestone as before striking 5° S of W, dipping 80° N. Restart 10:23. 10:24 hut on right and bridge. 10:25 stop. Black limestone with bituminous matter, semi-crystalline, conchoidal fracture, full of calcite veins. Strike E-W dipping 35° S. Restart 10:30. 10:31 bridge. On the right pure limestone appears horizontal. 10:33 stop. Village of Hungsha[2] on left. Same black limestone striking E-W dipping 27° S. Restart 10:35. 10:36 bridge. 10:37 bridge, river. Hungsha on left. 10:38.5 stop. Black limestone striking 18° N of E dipping 65° S. 10:41 restart. 10:43 Kenpu[3]. One minute's stop. 10:46 Liangshuiao, stop (see Fig. 17).

12:56 left Liangshuiao. 1:01 bridge. 1:15 village on right, upper limestone to left dipping steeply in the same direction. 1:04 village Liutang on right and left. Massive limestone striking ENE-WSW dipping 40° N. On the right the dip seems to be south. *Stopped 3 minutes.* Br. 272,9. ½ minute later stopped again. Liangshuiao limestone striking E-W dipping 80° S, overlaid by upper limestone dipping more gently in the same direction. *1:10 restart.* Same limestone striking E-W, vertical all the way. 1:13 bridge, road turning to right. *1:16 stop,* bridge. Draw a section. Devonian limestone, strike 35° N of E dipping 40° NW. *1:22 restart. 1:25 stop, draw a section* on right. *1:34 restart,* road turning to right, 1:36½, village Yangshan[4] on left. *1:38½ restart,* 1:40 bridge. Devonian limestone dipping 40° E. 1:41 bridge, river flowing S, then plain becomes wider. 1:42 bridge, river. On both sides Devonian limestone overlaid by purer limestone. 1:46 *stop,* Pali[5] on right near Liuhsu[6]. *1:47½ restart.* 1:49 bridge, view of Liuhsu—road in yellow shale. 1:52 bridge, last outcrop of Devonian limestone (where the road turns to right). 1:54 bridge. 1:56½, light gray limestone with chert same as Liangshuiao. 2:07 just before Weilao[7], low hill of brownish shale (Devonian ?).

3:30 start from Tungchiang, Br. 296. 3:35 limestone end on left. 3:37½ after crossing several bridges the road is in yellow shale (see Fig. 19). This is point "d" on map, 4 li from Lungtan[8]. The yellow, red and gray shale with bands of iron and manganese (1" thick) is complicatedly folded. It crops out ENE-WSW

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1 紅泥村 2 紅沙 3 耿埠 4 羊山 5 巴里 6 六圩 7 畏闊 8 龍潭

right near river. *3:47 restart.* 3:48 brown quartzite sandstone (2' bedding) interbedded with yellow and gray shale striking E-W dipping 39° S. 3:51½ restart, 3:53 it is folded dipping N, then vertical, going to right of road overlaid by pure limestone in places. 3:55 crossing 2 bridges, left side in white limestone. Sandstone series continues on right. 3:58 bridge, Lungwan on right, 2 minutes' stop. Limestone disappears on left. 4:01 bridge. 4:03 after pass it dips N, then S, then N again. 4:51½ bridge, up. 4:06 bridge, up again. 4:07 Br. 2937, overfold (see sketch). 4:09½ restart, soon last bridge. 4:12 sandstone vertical. 4:14 limestone on left, earthy hill on right, *outside Lungkou.* 4:15 Tuchieh. Earthy hill on right capped by limestone. 4:18 earthy hill, violet coloured. 4:19 village on right. 4:21 Pitsun[1]. 4:24 stop, low violet hill on right, away from road. 4:31 restart. 4:41 Tehshen[2] at mouth of entrance into limestone mountain 400 m from road on right. 4:45 stop. 4:50 restart. 5:04 point "I" on map, yellow quartzitic sandstone with dark gray shale vertically folded (see sketch). This is just N of Hsiehpiaoling[3]. 5:10 restart, Br. 295. Hsiehpiaoling sandstone dips NNW. 5:12 foot of Hsiehpiaoling. Black shaly crinoidal limestone with interbedded yellow shale, striking 12° E of N dipping 45° NW. 5:21 restart. 5:26 Taiping[4] on right. 5:40 shaly limestone and shale dipping 20° NW. From Kuantang[5] on to Huaiyuan right in sandstone series forming mountains. Limestone mountain on left 2 km away. 5:53 Huaiyuan. By station gray limestone with chert bands striking NNW-SSE dipping 47° E. It is interbedded with yellow thin-bedded shale and shaly limestone.

4 October 1928

Left Huaiyuan at 10:00, arriving at Chingyuan 10:45. Left at 12:00. At 1:00 above Aotung large area of sandstone and silicified limestone (?) folded and unconformably overlaid by the pure limestone. At Tatang at 2:00.

1 避村 2 德勝 3 寫表嶺 4 太平 5 官塘

II. LIST OF LOCALITY NUMBERS FOR FOSSILS COLLECTED IN KUANGSI

Loc. No.	*Locality*	*Date of Collecting*	*Fossils Identified By*
1600	Santang, Nanning[1]		N. H. Odhner
1601	S. of Tapu[2] near beach, Liucheng[3]		C. C. Yu
1602	Toutang[4], Liucheng		,,
1603	Chushanting[5]	20/8/1928	
1604	Intercalated in sandy shale, Wushihchieh[6]		
1604a	Last layer of black shale, Wushihchieh		
1605	Kantangtu[7]	25/8/1928	
1606	North Gate, Kueilin city[8]	,,	
1607	Lower limestone, Shuang-pating, near Taipingpu[9]	26/8/1928	
1608	Pankuling, Linchuan[10]	21/8/1928	
1609	Hsiangpishan[11], Kueilin	6/8/1928	
1609a	,, ,,	,,	
1610	Fengtungshan[12], Kueilin	,,	
1611	E. of Weishui[13], Kueilin	26/8/1928	
1612	NE of Laochuntung[14], Kueilin		
1613	Black limestone ENE of Laochuntung below Kungmintai[15]	20/8/1928	
1614	Black limestone, Kungmintai	29/8/1928	

1 南寧三塘 2 大埔 3 柳城 4 頭塘 5 楚善亭 6 烏石街 7 甘棠渡 8 桂林北門 9 太平舖雙把亭 10 靈川盤古嶺 11 象鼻山 12 風渡山 13 威水 14 老君洞 15 孔明台

1615	White limestone, Lukou[1], Kueilin	30/8/1928	
1616	White limestone, Touchishan[2]	6/8/1928	
1617	Black limestone, W. of Tatungtien[3]	25/8/1928	C. C. Yu
1618	At river side, Chiehshou[4]	26/8/1928	Y. T. Chao, A. W. Grabau
1619	Chihopien[5]	,,	C. C. Yu
1620	First hill after Chutang[6]	,,	Y. T. Chao
1621	Near Wuliping, Chuanchou[7]	,,	C. C. Yu, Y. T. Chao
1621a	Nanhualing[8]	,,	C. C. Yu
1621a'	,,	,,	
1622	Crinoidal limestone, Hochiapu[9], Linchuan	,,	Y. T. Chao
1623	Between Tungtang and Hsienyinyen[10], Liuchuan	,,	A. W. Grabau
1624	Tunghsien quarry	27/8/1928	
1625	Chiaotu[11], Chuanchou	13/8/1928	A. W. Grabau
1626	30 m NE of Tangpuying[12]	25/8/1928	C. C. Yu, A. W. Grabau
1627	N. of Shihjenchung, Tangkou[13]	2/8/1928	A. W. Grabau
1627a	Shihjenchung, Tangkou	,,	
1628	Cross road beween Ssupai and Sanchiang[14]	3/8/1928	
1629	Chiaohua[15] (Devonian)	1/8/1928	
1630	Black limestone, Shihchiatu, Tahsu[16]	6/8/1928	Y. C. Sun
1631	Hsiaotengtsaoping[17]	29/8/1928	A. W. Grabau
1632	Pavement of Huaiyuan	4/10/1928	,,

1 路口 2 門雞山 3 大洞田 4 界首 5 陟河邊 6 朱塘 7 全州五里坪 8 南華嶺 9 禾家舖 10 東嶽及仙隱岩 11 橋渡 12 唐堡營 13 當口行人冲 14 四排及三江 15 敎化 16 大墟石家渡 17 小蹬草坪

1633	Toutang, Liucheng	29/7/1928	C. C. Yu, A. W. Grabau
1634	Lungchiangchang, Nantan[1]	24/9/1928	Y. T. Chao, A. W. Grabau
1635	Tachanghsia[2]	,,	A. W. Grabau
1636	Liangshuiao[3]	21/9/1928	,,
1637	Near Shihtieh[4]	25/7/1928	Y. T. Chao
1638	,, ,,	,,	,,
1639	Between Wulichiao and Meitanshan[5]	23/7/1928	,,
1640	Limestone above coal, Meitanshan (Hoshan)	24/7/1928	,,
1641	3 km E. of Meitanshan	,,	,,
1642	Holi[6]	24/7/1928	
1643	Limestone [near] old shaft NE of Holi	,,	
1644	Same as 1637		
1645	Pavement [of] Tapu	29/7/1928	
1646	Near Shihtieh (same as 1637)	25/7/1928	J. S. Lee
1647	Kengma[7]	30/9/1928	A. W. Grabau
1648	3 li of Huaiyuanhoshang[8]	3/10/1928	,,
1649	Lower bed, Liaokoshan[9]	2/10/1928	
1650	Upper bed, Liaokoshan, 2½ km E. of Hochih[10]	,,	J. S. Lee
1651	E. of Hunglitsun[11], Hochih	,,	
1652	White limestone, W. of Pumiao, Nanning[12]	20/7/1928	Y. T. Chao
1653	Pavement at Pumiao	,,	

1 南丹龍江廠 2 大廠下 3 涼水坳 4 石疊 5 五里橋及煤炭山 6 河里 7 坑馬
8 懷遠河上 9 了哥山 10 河池 11 紅利村 12 南寧蒲廟

1654	Grey to blue limestone N. of Mihuaping[1] near Nanning	18/7/1928	
1655	W. of Chiatao[2]	21/9/1928	A. W. Grabau
1656	Tungchiang, Yishan[3]	,,	,,
1657	Petzuai, Maping[4]	20/9/1928	,,
1658	Cave near Liuchow[5]		C. C. Young & ?
1659	Above 1602, Toutang, Liucheng		
1660	Devonian brachiopods, Liangshuiao[6]	Coll. Y. Y. Huang	
1661	Pavement near Liangshuiao	Coll. Wu Ting-shen	
1662	Sanlihsu, Wuhsuan[7] (same as Hsiaotengtsaoping)	Coll. Y. Y. Huang	
1663	Tachanghsia	,,	
1664	Chalukou, Hsiujen[8]	13/9/1928	

III. LIST OF FOSSILS COLLECTED IN KUANGSI

Loc. 1600

Hyriopsis arcidens Odhner

Rhombunio ellipticus Odhner

R. ventricosus Odhner

R. Spinifer Odhner

Psilunio tuberosus Odhner

Tulotoma gigas Odhner

Stenothyra rissoides Odhner

S. rissoids var. *minor* Odhner

S. brevis Odhner

S. ovata Odhner

1 米花坪 2 加道 3 宜山東江 4 馬平百子隘 5 柳州 6 涼水坳 7 武宣三里墟 8 修仁叉路口

S. gibbula Odhner

S. percarinata Odhner

S. costellata Odhner

S. marginata Odhner

S. scala Odhner

S. fasciolata Odhner

S. supracarinata Odhner

Purgula sinensis Odhner

Oncomelania sp.

Valvata sp.

Loc. 1601

Lophophyllum irregulare Yu

Siphonodendron cf. *junceum* Fleming

S. kuangsiense Yu

Dibunophyllum leei Yu

D. lamellum Yu

D. huangi Yu

Clisiophyllum yengtzeense Yoh var. *multiseptatum* Yu

Loc. 1602

Lophophyllum longiplatum Yu

Siphonodendron kuangsiense Yu

Cyathophyllum fraternum Reed

Corwenia tingi Yu

Loc. 1603 No fossils

Loc. 1604 No fossils

Loc. 1605 No fossils

Loc. 1606 Fragment of brachiopod?

Loc. 1607 No fossils

Loc. 1608 No fossils

Loc. 1609 No fossils

Loc. 1610 Fragment of gastropod?

Loc. 1611 Siliceous limestone without fossils

Loc. 1612

Pterophyllum sp. nov. (*Alveolites*?)

Loc. 1613

Amphipora asiatica Reed

Loc. 1614

Amphipora asiatica Reed

Loc. 1615 No fossils

Loc. 1616 No fossils

Loc. 1617

Siphonodendron vesicutabulatum Yu

Loc. 1618

Spirifer bisulcatus Sowerby

S. semicriculavis Phillips

Productus premanchuricus Grabau

Athyris ingens de Kon.

Loc. 1619

Pseudouralinia gigantea Yu

Loc. 1620

Syringopora sp. (same as 1621)

Siphonodendron (same as 1621?)

Loc. 1621 & 1621a

Siphonodendron plataxisoides Yu

S. rossicum Stuckenberg

Lithostrotion mccoyanum Edw. & Hei.

Syringopora sp.

Kansuella cf. *edelburgensis* Phillips

Loc. 1622

Spirifer subduplicosta Grabau

Chonetes tuberculata
Parallelodon sp. nov.
Astartella sp. nov.
Rhipidomella michelini
Linoproductus cf. *tenuistriatus* Verneuil
Productus sp.
Zaphrentoid coral

Loc. 1623

Productella cf. *subaculeata* de Koninck
Schizophoria macfarlani var. *kansuensis* Grabau
Atrypa desquamata var. *kansuensis* Grabau
A. desquamata var. *kansuensis* mut. *alpha* Grabau
A. desquamata var. *kansuensis* mut. *beta* Grabau
A. desquamata var. *auriculata* Hayasaka
A. aspera var. *kwangsiensis* Grabau
Reticularia lensiformis Grabau

Loc. 1624

Amphipora asiatica Reed

Loc. 1625

Productella subaculeata (Murch.) mut. *alpha* Grabau
Stropheodonta (Douvillina) cf. *interstrialis* (Phill.)
Yunnanella synplicata Grabau
Y. synplicata mut. *alpha* Grabau
Y. mesoplicata Grabau
Y. criesoni Grabau
Y. grandis Grabau
Orthothetes sp.
Sinospirifer sinensis mut. *alpha*? Grabau
S. gortani (Pellizzari)

S. vilis Grabau
Cyrtiopsis graciosa Grabau
Rhipidomella sp.

Loc. 1626

Productella subaculeata
Chonetes sp.
Cystiphyllum sp.

Loc. 1627 & 1627a

Spirifer tonkinensis Mansuy
Spiriferina (Eospiriferina) lachrymosa Grabau
Tangkouella rostrata Grabau
Craniella sp.
Athyris sp.
Aviculopecten sp. nov.
Grammysia sp. nov.
Goniophora sp. nov.
Orthonota sp. nov.
Goniatites sp.

Loc. 1628 [No fossils]

Loc. 1629 [No fossils]

Loc. 1630 *Syringopora intermixta* Reed
Cyathophyllum (Fischerina?) insolitum Reed
Zaphrentis sp. nov.
Dielasma cf. *tenerum* de Koninck
Athyris sp.

Loc. 1631

Chonetes sp.
Pagodicrinus sp.

Loc. 1632

Spirifer subduplicosta Grabau

Leptaena rhomboidalis var. *kwangsiensis* Grabau

Loc. 1633

Productus inflatiformis? Grabau & Tien

Productus sp.

Siphonodendron kwangsiense Yu

S. kwangsiense var. *concaveum* Yu

Loc. 1634

Davidsonia kwangsiensis Grabau & Tien

Siphonodendron cf. *irregulare* var. *asiatica* Yabe & Hayasaka

Other large corals

Loc. 1635

Productus giganteus mut. *alpha* Grabau & Tien

Loc. 1636 and 1660

Productella productoides var. sinensis Grabau

Schizophoria striatula Schloth.

Camerophoria bitingi Grabau

C. tritingi Grabau

C. quadritingi Grabau

C. pentatingi Grabau

Hypothyridina procuboides var. *hochihensis* Grabau

H. parallelopipeda Kays.

Atrypa desquamata var. *kansuensis* Grabau

A. desquamata var. *kansuensis* mut. *alpha* Grabau

A. desquamata var. *kansuensis* mut. *beta* Grabau

Reyicularia pachyrhynchoides Grabau

R. pachyrhynchoides mut. *alpha* Grabau

R. pachyrhynchoides mut. *beta* Grabau

R. maureri Holzapfel

R. lensiformis Grabau

Meristella flayellii Mansuy
M. sp.
Stringocephalus burtini mut. *alpha* Grabau
S. obesus Grabau
S. obesus var. *grandis* Grabau
Bactrites indifferens Grabau
Goniatites sp.

Loc. 1637

Bellerophon sp.
Naticopsis sp.
Macrocheilus sp.
Fusulinids

Loc. 1638 (same as 1637)

Lyttonia sp.
Productus kiangsiensis Kayser
Squamularia nodosa? Chao

Loc. 1639

2 species of *Tainoceras*

Loc. 1640

Spirigerella sp.
Fusulina?

Loc. 1641

Gastrioceras liu Grabau

Loc. 1642 No fossils
Loc. 1643 No fossils
Loc. 1644 (same as 1637)
Loc. 1645
Loc. 1646 (same as 1637)

Fusulinella inflata Colani

Fusulinella sphaerica Abich

2 other new species of *Fusulinella*

Loc. 1647

Schizophoria sp.

Atrypa spinosa (Schloth.)?

Atrypa desquamata Sow.

Atrypa reticularis Linn.

Atrypa sp.

Spirifer cf. *officinalis* Kayser

Reticularia pachyrhynchoides Grabau

Reticularia maureri Holzapfel

Cyrtiopsis sp.?

Spiriferina octoplicatoides Grabau

Columnnicrinus pentalotuba Grabau

Loc. 1648

Camarophoria huoliformis Grabau

C. latiplicata Grabau

Stringocephalus burtini mut. *alpha* Grabau

Loc. 1649

Productus cf. *lineatus* Waagen

Spirifer sp.

Derbyia? sp.

Loc. 1650

Fusulinella? *inflata* Colani

Schellwienia japonica Gümbel

Doliolina aliciae Deprat

Boultonia sp. nov.

Schubertella?

Glandulina sp. nov.

Dentalina sp. nov.

Bigenerina sp.

Textularia sp.

Tetrataxis sp.

Loc. 1651

Fragment of brachiopod

Loc. 1652

Derbyia? sp.

Striatifera cf. *compressa* Waagen

Loc. 1653

Fragment of coral (Lower Carb.?)

Loc. 1654 No fossils

Loc. 1655

Diphyphyllum ultimum Grabau

Productus (*Linoproductus*) *lineatus* var. *crassus* Grabau & Yoh

Productus (*Striatifera*) *striatus* var. *suppressus* Grabau & Yoh

Orthothetes sphenaeformis Grabau

Orthotychia magnifica Grabau

Orthotychia elongata Grabau

Camerophoria uniplicata Grabau

Pugnax cf. *connivens* Eichwald

Terebratuloidea triplicata Kut.

Terebratuloidea? senex Grabau

Athyris expansa var. *kwangsiensis* Grabau

Athyris acutirostris Grabau

Athyris girardi Diener

Dielasma mapingensis Grabau

Dielasma? rudis Grabau

Palaeostrea sinensis Grabau
Pseudomonotis daonelliformis Grabau
Aviculopecten janus Gemmellaro
Pterinopecten sp.
Streblopteria deprati Mansuy
Septifer? curvirostris Grabau
Bellerophon sp.
Eumphalus cf. *khmerianus* Mansuy
Holopella latispira Grabau

Loc. 1656

Rugothocalia mapingensis Grabau
Productus porrectus Kutorga
Productus grunewaldti Krotow
Productus cf. *mammatus* Keyserling
P. (*Marginifera*) cf. *lopingensis* Kayser
Martinia semiplana var. *lata* Grabau
Martinia semiplana var. *asinosa* Grabau
Martiniopsis cathaysiensis Grabau
Squamularia nucleolus Grabau
Squamularia nucleolus var. *sinosus* Grabau
Aviculopecten mapingensis Grabau
Aviculopecten laosensis Mansuy

Loc. 1657

Multithecopora grandis Grabau
Diphyphyllum ultimum Grabau
Orthotychia magnifica Grabau
Spirifer panduriformis Kutorga
Spirifer mignon Grabau

Martiniopsis subaviformis Grabau
Athyris acutivostris var. *pygopeoides* Grabau
Dielasma mapingensis Grabau
Bakewellia sp.
Euconospira permiana Grabau
Naticopsis sp.
Capulus? sp.
Anomphalus minutus Grabau
Neoproetus sinensis Grabau

Loc. 1658

Nodularia triformis Heude
Lamprotula cornuum-lunae Heude
Vivipara quadrata Benson
Melania swinhoei H. Adams
Eulota kiangsinensis (Martins)
Rhizomys cf. *troglodytes*

Loc. 1659 Corals.

Loc. 1660

Loc. 1661

Loc. 1662

Pagodicrinus

Loc. 1663

Loc. 1664

IV. LIST SHOWING THE RELATIVE ABUNDANCE OF FOSSILS OCCURRING IN SOME OF THE MOST IMPORTANT LOCALITIES.

cc—*very common;* c—*common;* rc—*not rare;* r—*rare;* rr—*very rare*

Loc. 1625. *Yunnanella* Bed

Productella subaculeata	c.
Stropheodonta (*Douvillina*) cf. *interstrialis*	rr.
Orthothetes sp.	rr.
Rhipidomella sp.	rr.
Yunnanella synplicata Grabau	c.
Y. synplicata mut. *alpha* Grabau	cc.
Y. mesoplicata Grabau	c.
Y. ericksoni Grabau	rr.
Y. grandis Grabau	rc.
Spirifer sinensis mut. *alpha*?	rr.
S. gortani Pellizzari	rc.
S. vilis Grabau	c.
Cyrtiopsis graciosus Grabau	r.

Loc. 1623

Productella cf. *subaculeata* de Koninck	rc.
Schizophoria macfarlani var. *kansuensis* Grabau	rc.
Atrypa desquamata var. *kansuensis* Grabau	cc.
A. desquamata var. *kansuensis* mut. *alpha* Grabau	rr.
A. desquamata var. *kansuensis* mut. *beta* Grabau	r.
Atrypa aspera var. *kwangsiensis* Grabau	r.
Reticularia lensiformis Grabau	r.

Loc. 1626

Productella subaculeata	c.
Chonetes sp. b	

Loc. 1631.

Chonetes sp. a	rc.
Rhipidomella? sp.	rr.
Reticularia sp.	rr.
Pagodicrinus striatus (stem)	cc.

Loc. 1636.

Productella productoides var. *sinensis* Grabau	cc.
Schizophoria striatula	rr.
Camerophoria bitingi Grabau	rr.
Camerophoria bitingi Grabau	c.
C. tritingi Grabau	cc.
C. quadritingi Grabau	rc.
C. pentatingi Grabau	r.
Hypothyridina procuboides var. *hochihensis* Grabau	rr.
H. parallelopipeda	c.
Atrypa desquamata var. *kansuensis*	cc.
A. desquamata var. *kansuensis* mut. *alpha*	rr.
A. desquamata var. *kansuensis* mut. *beta*	r.
Reticularia pachyrhynchoides Grabau	rc.
R. pachyrhynchoides mut. *alpha*	r.
R. pachyrhynchoides mut. *beta*	rr.
Reticularia maureri Holzapfel	cc.
Reticularia lensiformis Grabau	rr.
Meristella flayellii Mans.	r.
Meristella sp.	rr.
Stringocephalus burtini mut. *alpha*	c.
Stringocephalus obesus Grabau	r.
Stringocephalus onesus var. *grandis*	r.
Bactrites indifferens Grabau	c.
Goniatites sp.	rc.

Loc. 1647.

Schizophoria sp.	r.
Atrypa spinosa?	r.
A. desquamata	rc.
A. reticularia	r.
A. sp.	r.
Spirifer cf. *officinalis* Kayser	rr.
Reticularia pachyrhynchoides Grabau	cc.
Reticularia maureri Holzapfel	c.
Cyrtiopsis sp. ?	rr.
Spiriferina octoplicatoides Grabau	rr.
Columnicrinus pentalotuba (stem only)	c.

Loc. 1648.

Camarophoria huoliformis Grabau	r.
Camarophoria latiplicata Grabau	rc.
Stringocephalus burtini mut. *alpha*	rc.

Loc. 1660.*

(Collected by Huang Yun-yi)

Productella productoides var. *sinensis* Grabau	r.
Hypothyridina parallelopipeda Kays.	r.
Atrypa desquamata	c.
Atrypa desquamata var. *kansuensis*	r.
Reticularia maureri Holzapfel	rr.
Stringocephalus obesus var. *grandis*	r.

Loc. 1661.

Stringocephalus burtini

Loc. 1662.

Euomphalus kwangsiensis Grabau	rr.
Pagodicrinus striatus Grabau (stem only)	c.

*It is to be noted that the fossils listed for this and the following localities are not given in the "list of fossils" (see above).

× present
\+ identification not wholly certain

		1625	1623	1626	1631	1632	1636	1647	1648	1660	1661	1662
1.	*Productella subaculeata*	×	+	×	—	—	—	—	—	—	—	—
2.	*Productella productoides* var. *sinensis*	—	—	—	—	×	×	—	—	×	—	—
3.	*Chonetes* sp. a	—	—	—	×	—	—	—	—	—	—	—
4.	*Chonetes* sp. b	—	—	×	—	—	—	—	—	—	—	—
5.	*Stropheodonta (Douvillina)* cf. *inter-strialis*	×	—	—	—	—	—	—	—	—	—	—
6.	*Orthothetes* sp.	×	—	—	—	—	—	—	—	—	—	—
7.	*Leptaena rhomboidalis* var. *kwangsiensis*	—	—	—	—	×	—	—	—	—	—	—
8.	*Rhipidomella* sp.	×	—	—	×	—	—	—	—	—	—	—
9.	*Schizophoria macfarlani* var. *kansuensis*	—	×	—	—	—	—	—	—	—	—	—
10.	*Schizophoria striatula*	—	—	—	—	—	×	—	—	—	—	—
11.	*Schizophoria* sp.	—	—	—	—	—	—	×	—	—	—	—
12.	*Camarophoria bitingi*	—	—	—	—	—	×	—	—	—	—	—
13.	*Camarophoria tritingi*	—	—	—	—	—	×	—	—	—	—	—
14.	*Camarophoria quadritingi*	—	—	—	—	—	×	—	—	—	—	—
15.	*Camarophoria pentatingi*	—	—	—	—	—	×	—	—	—	—	—
16.	*Camarophoria huoliformis*	—	—	—	—	—	—	—	×	—	—	—
17.	*Camarophoria latiplicata*	—	—	—	—	—	—	—	×	—	—	—
18.	*Hypothyridina procuboides* var. *hochih-ensis*	—	—	—	—	—	×	—	—	—	—	—
19.	*Hypothyridina parallelopipeda*	—	—	—	—	—	×	—	—	×	—	—
20.	*Leiorhynchus kwangsiensis*	—	—	—	—	×	—	—	—	—	—	—
21.	*Yunnanella synplicata*	×	—	—	—	—	—	—	—	—	—	—
22.	*Yunnanella synplicata* mut. *alpha*	×	—	—	—	—	—	—	—	—	—	—
23.	*Yunnanella grandis*	×	—	—	—	—	—	—	—	—	—	—
24.	*Yunnanella ericksoni*	×	—	—	—	—	—	—	—	—	—	—
25.	*Yunnanella mesoplicata*	×	—	—	—	—	—	—	—	—	—	—
26.	*Atrypa desquamata*	—	—	—	—	—	—	×	—	×	—	—
27.	*Atrypa desquamata* var. *kansuensis*	—	×	—	—	—	×	—	—	×	—	—
28.	*Atrypa desq.* var. *kansuensis* mut. *alpha*	—	×	—	—	—	×	—	—	—	—	—
29.	*Atrypa desq.* var *kansuensis* mut. *beta*	—	×	—	—	—	×	—	—	—	—	—

× present
+ identification not wholly certain

		1625	1623	1626	1631	1632	1636	1647	1648	1660	1661	1662
30.	*Atrypa reticularis*	—	—	—	—	—	—	+	—	—	—	—
31.	*Atrypa spinosa*	—	—	—	—	—	—	+	—	—	—	—
32.	*Atrypa* sp.	—	—	—	—	—	—	×	—	—	—	—
33.	*Atrypa aspera* var. *kwangsiensis*	—	×	—	—	—	—	—	—	—	—	—
34.	*Spirifer sinensis* mut. *alpha*	×	—	—	—	—	—	—	—	—	—	—
35.	*Spirifer gortani*	×	—	—	—	—	—	—	—	—	—	—
36.	*Spirifer vilis*	×	—	—	—	—	—	—	—	—	—	—
37.	*Spirifer* cf. *officinalis*	—	—	—	—	—	—	×	—	—	—	—
38.	*Reticularia pachyrhynchoides*	—	—	—	—	—	×	×	—	—	—	—
39.	*Ret. pachyrhynchoides* mut. *alpha*	—	—	—	—	—	×	—	—	—	—	—
40.	*Ret. pachyrhynchoides* mut. *beta*	—	—	—	—	—	×	—	—	—	—	—
41.	*Ret. maureri*	—	—	—	—	—	×	×	—	×	—	—
42.	*Ret. lensiformis*	—	×	—	—	—	×	—	—	—	—	—
43.	*Reticularia* sp.	—	—	—	×	—	—	—	—	—	—	—
44.	*Cyrtiopsis gratiosus*	×	—	—	—	—	—	—	—	—	—	—
45.	*Cyrtiopsis* sp.	—	—	—	—	—	—	×	—	—	—	—
46.	*Spiriferina octoplicatoides*	—	—	—	—	—	—	×	—	—	—	—
47.	*Meristella flayellii*	—	—	—	—	—	×	—	—	—	—	—
48.	*Meristella* sp.	—	—	—	—	—	×	—	—	—	—	—
49.	*Stringocephalus burtini*	—	—	—	—	—	—	—	—	—	×	—
50.	*Stringocephalus burtini* mut. *alpha*	—	—	—	—	—	×	—	×	—	—	—
51.	*Stringocephalus obesus*	—	—	—	—	—	×	—	—	—	—	—
52.	*Stringocephalus obesus* var. *grandis*	—	—	—	—	—	×	—	—	×	—	—
53.	Gen. et sp. indet.	—	—	—	—	—	—	×	—	—	—	—
54.	Gen. et sp. indet.	—	—	—	—	—	×	—	—	—	—	—
55.	Gen. et sp. indet.	—	—	—	—	—	×	—	—	—	—	—
56.	*Euomphalus kwangsiensis*	—	—	—	—	—	—	—	—	—	—	×
57.	*Bactrites indifferens*	—	—	—	—	—	×	—	—	—	—	—
58.	*Goniatites* sp.	—	—	—	—	—	×	—	—	—	—	—
59.	*Columnicrinus pentalotuba*	—	—	—	—	—	—	×	—	—	—	—
60.	*Pagodicrinus striatus*	—	—	—	×	—	—	—	—	—	—	×

V. CORRESPONDENCE

Letters from J. S. Lee.

Shanghai, July 26th, 1929.

Dear Ting,

Here is a preliminary list of the Foraminifera so far found in the rock-specimens of Kwangsi. I am rather disappointed to find that only two small lots of material are contained in the packet brought here by Wong on his way to Java. I myself collected some fine material in Kwangsi last year. Only the shame is that I was not at all sure of its stratigraphical position. Is there any way to connect it up with your stratigraphical work?

Foraminifera from Liaokoshan, No. 1650.

Fusulinella ?inflata Colani	very rare
Schellwienia japonica Gümbel	frequent
Doliolina aliciae Deprat	rare
Boultonia n. sp.	frequent
Schubertella?	rare
Glandulina n. sp.	rather rare
Dentalina n. sp.	frequent
Bigenerina sp. ind.	
Textularia sp. ind.	
Tetrataxis sp. ind.	

The presence of *Doliolina aliciae* favours an early Permian age, the rest being of little stratigraphical value.

Foraminifera from Kiamah, No. 1646.

Fusulinella inflata Colani	abundant
Fusulinella sphaerica Abich	common
Two other new species of *Fusulinella*	

These are usually found in the Chihsia Formation. I would, on account of evidence found recently, place the Chihsia in the lowest position of the Permian.

I shall probably come to Peking on the 15th Aug.

Yours,

Shanghai, August 7, 1929.

My dear Ting,

I am glad you have raised the question about the age of your Liaokoshan. I meant to inform you an important fact in my last letter. Apparently I had forgotten all about it when I wrote. Under the microscope, especially through polarized light, the Liaokoshan limestone exhibits innumerable grains which are mostly of foraminiferal tests and occasionally fragments of shells that had gone through a process of attrition before setting in a limy matrix. I cannot be sure what the process was, but I am sure that the foraminifera found therein were not entombed in situ.

Doliolina aliciae has been found in Indo-China and Yunnan. Its exact stratigraphical position however has not been established in those cases because of the poor stratigraphical work of the collectors. My belief in its Lower Permian age is based on two independent lines of thought: Firstly, either *Doliolina aliciae* itself or its intimately related forms such as *Doliolina claudiae, D. ovalis* etc. actually occur in the Chihsiashan; and secondly, these are all primitive type of *Doliolina* apparently forerunners of *Doliolina lepida* which is of Middle Permian age. Whether these facts can afford a sound basis for my belief I leave you to judge.

Judging from a but slight degree of wear of the grains and their tumultuous arrangement, I am inclined to think that the Liaokoshan Limestone is a consolidated foraminiferal sand. Its age therefore cannot be much later than the foraminiferas that it contains. This also harmonizes with the fact that not a single fragment of the Middle Permian foraminifera has been detected in it. The latter must be plenty about in that district, and must have contributed something to the quota, had the Liaokoshan been deposited in Middle or Upper Permian time.

My foraminiferal lists for the localities which I visited have not yet been carefully worked out. I can here only give you the names of the more outstanding forms and their approximate age. I say their approximate age because the conscientious foraminiferal workers are still looking for a reliable time scale founded on other stratigraphical considerations. We must guard ourselves against the misfortune of entering into a vicious circle. The alleged zones are very much of the nature of gas.

Here are my localities and lists:

(A) Hwanglien-hsia (黃練峽), near the village of Hwanglien-hsu, several miles N. W. of Kweihsien (貴縣).

1. *Schellwienia simplex* Schell.
2. *Schellw. parvula* Schell. (em. Lee).

age :— Uralian.

(B) Chienkiang (遷江), close to the city of Chienkiang, on the point where the motor road crosses the river.

1. *Schellwienia exilis* Schwager
2. *Neoschwagerina craticulifera* Schwager
3. *Neoschw. multiseptata* Deprat
4. *Verbeekina verbeeki* Geinitz
5. *Sumatrina* sp. ind.

age :— Middle Permian.

These are the two localities that I have touched upon. I do not think I should bother you with those which have been only examined with a pocket lens.

Yours,

Letter from C. C. Young.

Dear Dr. Ting,

The bone remains from Kwangsi are mostly very fragmentary. It consists chiefly of fragments of limb-bones and some teeth which belong to the deer group. The specific name is not determinable. However, there are two fragments of lower jaws which belong, no doubt, to the genus *Rhizomys*. It is somewhat smaller than *Rh. tioglodytes* from Wan-hsien and about the same size of *Rh. sinensis* which is still living in South China. I hope, that I could make out a little detail study about it, when I come back from the trip.

With the best compliments,

Yours,

C. C. Young.

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VII. DESCRIPTION OF PLATES

Plate 22 : KsSA1

Fig. 1: Via Heimu across hill, Nantan.

4. Shaly limestone
3. Blackish cherty limestone
2. Dark gray quartzitic sandstone
1. Yellowish red shaly sandstone

Fig. 2: East of Yülung, Hochih.

All massive limestone

Fig. 3: West of Yülungho, Hochih.

4. Impure grayish shaly limestone
3. Reddish shale
2. Quartzite
1. Quartzitic sandstone

Fig. 4: West of Yülung, Hochih.

3. Shaly limestone
2. Limestone
1. Quartzitic sandstone

Fig. 5: From Makuai to Kaofengchieh, Nantan and Hochih.

7. Black bituminous shale
6. Massive blue limestone
5. Steel gray shale
4. Yellowish red calcareous shale
3. Shale and silicified limestone
2. Bluish cherty limestone
1. Quartzite

Fig. 6: From Laochang to Layang, Nantan.

3. Massive Permian limestone
2. Silicified limestone intercalated with shale and sandstone to be lower Carboniferous in age
1. Shaly limestone (party silicified) intercalated with black shale and sandstone to be Devonian in age

Fig. 7: At Palai, Tunglan.

b. Granite
a. The complex series of lower Carboniferous shale, sandstone and impure shaly limestone

Fig. 8: East of Tungchehchiang, Tunglan.

b. Semicrystalline gray limestone containing *Productus giganteus*
a. Bark brown quartzitic sandstone

Fig. 9: Near Kaofengchieh, Nantan and Lochih.

c. Granite
b. Aluvium
a. The complex series of lower Carboniferous shale, sandstone and impure party silicified limestone

Fig. 10: Along the Ch'angpoe valley, Nantan.

The complex series of lower Carboniferous shales limestone and sandstone in alteration.

Fig. 11: At Paowangmiaopei, Nantan.

b. Sandstone
a. Shaly limestone

Fig. 12: Pass between Kangma and Lutung, Nantan.

All shaly limestone and shale

Fig. 13: From Yecheho to Lutung, Nantan.

3. Black shale
2. Sandstone reddish, yellow in color
1. Shaly limestone

Fig. 14: Northeast of Paowangmiaopei, Nantan.

5. Granite
4. Massive limestone
3. Silicified limestone
2. Pyritiferous sandstone
1. Shaly limestone

Fig. 15: At western entrance of Liangshuiao, Hochih.

b. Black massive limestone

a. Black shaly semicrystalline limestone with sandy layers

Fig. 16: East of Liut'ang, Hochih.

b. Massive limestone

a. Black shaly limestone with sandy layers

Fig. 17: At Liangshuiao, Hochih.

b. Massive black limestone

a. Shaly limestone and yellow shale folded complicatedly

Fig. 18: West of Liangchai, Hochih.

b. Black shaly limestone

a. Contorted shale and limestone strata

Fig. 19: From Tuchialungk'ou to Lung Wan, Hochih.

b. White limestone

a. Sandstone, shale and silicified limestone

Fig. 20: Near Huaiyuan

b. Red clay

a. Folded impure limestone

Fig. 21: South of Liuch'eng on right bank of river, Liuch'eng. All limestone

Fig. 22: Between Kufang and Tatang, Yich'eng.

b. Pure Maping limestone

a. Dark gray limestone and shale

Fig. 23: ½ km. southeast of Liupo, Yishan

5. Red clay

4. Impure limestone
3. Shales
2. Sandstone
1. Silicified limestone

Fig. 24: At low pass between Panfang and Lala, Yishan.

4. Impure limestone
3. Shales
2. Sandstone
1. Silicified limestone

Fig. 25: North of Liupo, Yishan.

6. Red clay
5. Greenish shaly sandstone
4. Black to brown shale
3. Silicified limestone
2. Dark blue shaly limestone
1. Massive pure light gray limestone

Fig. 26: Between Nantsun and Toutang, Liuch'eng

b. Impure limestone
a. Quartzite sandstone

Fig. 27: Cave south of Liuchou.

Fig. 28: Cave wall

Fig. 29: At Ch'uanshan, Liuchou.
Pure limestone

Fig. 30: At T'iehmaoshan, Wuhsuan.

b. Pure limestone
a. Cherty limestone

Fig. 31: Small hill near Lutung, Wuhsuan.
Pure limestone

Fig. 32: South of Lama, Wuhsuan.

3. Quartzitic sandstone and shaly sandstone

2. Impure limestone and red shale
1. Pure limestone with Mn.

Fig. 33: Continuous figure of Fig. 32 Wuhsuan.
Quartzitic sandstone and shaly sandstone intercalated.

Fig. 34: Through Youlung and Ch'enta, Wuhsuan.
All Devonian quartzitic sandstone shale and sandstone.

Fig. 35: Left bank near T'aipi, Kueiping.
All quartzitic sandstone and shaly sandstone

Plate 23: KsSA2

Fig. 36: Northeast of Shawan and Tawantu, Kuieping.
All quartzitic sandstone and shaly sandstones intercalated with limy shale, Devonian in age.

Fig. 37: Near Nut'an, Kueiping.
Shale, limy shale and sandstone

Fig. 38: On east bank of river below Shanmenchiang, Liuchou.
6. Massive pure white limestone
5. Hard reddish micaceous quartzitic sandstone
4. Silicified limestone
3. Thin bedded sandstone
2. Gray shale
1. Silicified limestone, dark gray limestone and gray shale complicated folded.

Fig. 39: From Liuchiang to Ssuli, Liuchiang.
c. Yellow and red shale, and sandstone
b. Dark gray fossiliferous shales and limestone
a. Reddish soft sandstone, gray shale and silicified limestone with Mn and Fe

Fig. 40: P'ankuling west of Hochiapu, Lingchuan.
9. Pure massive gray limestone

8. Reddish shale and soft sandstone
7. Dark gray cherty shaly limestone
6. Soft reddish brown shale and shaly sandstone
5. Very cherty gray shaly limestone
4. Gray shale greenish soft sandstone with thin beds of black shaly limestone
3. Very cherty limestone with reddish shale
2. Light gray pure limestone
1. Quartzitic sandstone

Fig. 41: At Yoshan, Lingchuan.

4. Quartzitic sandstone
3. Pure limestone
2. Soft sandstone
1. Pure limestone

Fig. 42: At pass southwest of Tungan, Lingchuan.

b. Quartzitic sandstone
a. Pure limestone

Fig. 43: Between Wangfen and Lungshiht'ang, Kueilin.

b. Quartzitic sandstone
a. Pure limestone

Fig. 44: Opposite Shihchiatu, Kueilin.

c. Light gray massive pure limestone
b. Dark blue shaly limestone rather cherty
a. *Amphipora* pure limestone

Fig. 45: Shihtzuyen, Kueilin.

b. Shaly limestone
a. Pure massive limestone

Fig. 46: From Ch'iaotu to Feiluanchiao on south bank of river, Chuanhsien.

b. Soft reddish sandstone, sandy shale and thin bedded silicified limestone
a. Massive blue limestone with chert

Fig. 47: At Paoshan, Kueilin.
- c. Quartzitic sandstone
- b. Red and green sandstone and sandy shale
- a. Massive blue limestone with minute grans of Cinnabar

Fig. 48: From Chingt'ang to Liutsun, Kueilin.
All massive dark gray to white limestone

Fig. 49: North of Tungch'ien, Kueilin.
- 3. Quartzitic sandstone
- 2. Shaly limestone with *Atrypa*
- 1. Massive blue limestone with *Amphipora*

Fig. 50: From Chungko to Siaowuchu, Kueilin.
All Quartzitic sandstone

Fig. 51: At Yupingshan north of Chiaotu, Chuanhsien, Kueilin limestone

Fig. 52: South of river near Tangpaoying, lingchuan.
Impure black limestone

Fig. 53: Just below Kuanchiatu on west bank, Kueilin.
- b. Limestone and shale
- a. Kueilin limestone

Fig. 54: Between Kaoshengtse and Liukoutsun, Yanyso (?).
- b. Limestone
- a. Sandstone

Fig. 55: From Shuangtau to Yangso, Yangso.
- b. Sandstone
- a. Limestone

Fig. 56: At Laoch'ai (10 li north of Yangso).
- b. limestone
- a. Shale, sandstone and shaly limestone

Fig. 57: Between Shawan and Loshihyen, Yangso.
- b. Massive limestone
- a. Sandstone and Quartzitic sandstone

Fig. 58: Near Tai'shang, Yangso.
- b. Limestone
- a. Sandstone and shaly limestone

Fig. 59: At Chaochungti, near Pinglo.
- b. Shale and shaly limestone
- a. Limestone

Fig. 60: At Kanchi southwest of Chungshan.
- b. Limestone
- a. Quartzitic sandstone

Fig. 61: Near Liangt'ingcho north of Papu, Hohsien.
Massive limestone

Fig. 62: Between lungykaoshui and Hochiang, Hohsien (?).
- c. Silicified limestone
- b. Quartzitic sandstone
- a. Limestone

Fig. 63:*
- 3. Granite
- 2. Sandstone
- 1. Limestone

Fig. 64:*
- 4. Sandstone
- 3. Sandy shale and sandstone in alteration
- 2. Limestone
- 1. Silicified limestone, sandstone and shale

Fig. 65: At trial shaft south of Lieutangtze, Chungshan.
- 3. Sandstone
- 2. Sandstone and shale
- 1. Limestone

Fig. 66:* At Laoshan, Hohsien (?).

b. Silicified limestone

a. Shale and sandy shale and yellowish sandstone

Fig. 67: Underground map of Chushuipi mine

Fig. 68: North Takaofeng, Nanning-Wuning.

5. Pink and gray massive limestone bedding about 2-4ft. thick quite pure

4. Red clay

3. White pure limestone rather massive with flinty fracture

2. Devonian (?) reddish median grained soft sandstone with thin bands of silicified limestone

1. Cambrian (?) yellowish shaly sandstone, hard felspathic sandstone with quartz veins, greenish fine sandstone, all slightly metamorphosed

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* Including in the geological map of Fuchuanhsien-Hohsien.

廣西河池南丹縣屬長坡與龍口廠之錫礦

王　恒　升

緒言

廣西河池南丹二縣交界之錫礦凡分兩類：(一)爲原生錫礦脈．分佈於長坡北方之砂岩頁岩及不純石灰岩岩層中，東距花剛岩可〇．五華里（二)爲剩積錫砂，分佈於龍口廠花剛岩與半結晶石灰岩之接觸帶及巴來東方花剛岩與砂岩頁岩之接觸帶，爲原生礦脉受侵蝕剩積之結果，該地居民設窰開採已歷年所，近始移歸官辦，雖已散載於書籍（中國礦產誌畧一九四頁，中國礦業紀要第二號二一三頁），然其所記，大抵偏重礦業，其於附近之地質，礦脉之生成，作學理之研究者，則率因調查未遑，語焉不詳。

客歲丁公在君作桂省調查地質之遊，於該錫礦附地質之勘察，標本之採集　尤爲詳盡，歸來以其所攜標本授余．令作研究，旋被派赴閩調查京粵線沿路地質礦產而中輟，今暑賦歸．丁公將復有廣西之行．擬將上次調査報告付梓，囑速繼續錫礦之研究．遂倉猝以成是篇，火成岩悉製薄片藉顯微鏡透射光線觀察之，金屬礦物製光亮方板，藉垂直反射光線研究之。

位置與交通

長坡位南丹縣之南而略偏東．距南丹縣城可五十餘華里，東望河池縣約四十三華里．龍口廠在長坡之東南相距三華里有奇。四週多山交通不便，惟西距盤江約四十餘華里，該江東至桂平合西江經粵入海．或可藉爲運輸之用。

地質

本區地層凡分五系，而花剛岩不與焉。試簡述如左：

(一)下石炭紀半結晶石灰岩　　因斷層上升露出於龍口廠左右，西以斷層與其上之砂岩頁岩系相接觸，北爲花剛岩所衝斷。其呈半結晶狀態者，大概因受花剛岩侵入之影響也。屬下石炭紀。

(二)下石炭紀頁岩砂岩系　　在大廠之西南，整合於半結晶石灰岩之上。全系以頁岩．砂岩及不純之石灰岩所組成．大致爲灰及灰黑諸色，因花剛岩之斜侵，其分佈縱隔爲二帶：一帶分佈於花剛岩之東側，成大廠高峯街一帶之高山；一帶分佈於花剛岩之西側，成長坡同車江一帶之高山。與其下部之半結晶石灰岩無間斷之分界，且在龍口廠之東方尋得化石．似仍屬下石灰紀者。

(三)二疊紀矽質石灰岩層　　不整合於下石炭紀頁岩，砂岩系之上，分佈於長坡之西南。岩石大抵爲淺藍色，含砂質，其南掩覆於沖積層之下，無化石，但以其層位及岩石之性質

論之，或屬於二疊紀。

(四)含錫剩積上砂層　主要分佈之區凡二：一位於龍口廠之西側，一位于巴來村之東側。大致皆沿花剛岩之接觸帶，成西北東南之分佈，二者皆寬可〇.三華里，長殆四倍之。所含物質多泥土，細砂，間含礫石及錫石砂。龍口廠與巴來一帶之錫砂礦，率取給於是。乃原生礦脈，經風化侵蝕剩積所成者。

(五)冲積層　分佈於巴來，同車江之西南，覆蓋於二疊紀矽質石灰岩及下石炭紀頁岩砂岩系之上，爲冲積之泥土及細砂所成，乃地層之最新者。

(六)白雲母花剛岩　其分佈北起長坡之東北，向東南延展以抵龍口廠。大致沿斷層面而斜列，長〇.六華里有奇，寬不及其十分之一，成一狹帶狀。然兩端細而中腰寬，頗似一薄扁之岩盤，因受侵蝕而僅露出其一邊者。是以其上部之地層(大廠一帶)皆背其傾斜，其下部之地層皆向之傾斜也。龍口廠之西側及巴來之東側各有孤立花剛岩一塊。前者以下石炭紀之半結晶石灰岩，後者以剩積之土砂層與上述之主要露頭相隔斷。然自大體觀之，三者似仍相連接，在龍口廠者，或因尚隱伏於半結晶石灰岩之下，在巴來之東側者，或因被剩積層所掩覆也。岩石顏色大抵淺白，近龍口廠者呈斑狀結構，斑晶爲石英及長石，長石恆分解爲石英及方解石，顯受氣質蝕解之痕跡，其餘造岩礦物有白雲母及細粒電氣石。在長坡一帶者，斑狀結構不顯著，主要造岩礦物爲石英，長石，白雲母三者，亦含電氣石，尚視龍口廠者爲多。

地層構造

地層已受摺皺而傾斜，大致多傾向東北。惟長坡之西側反轉向西南，似有成背斜之趨勢，故二疊紀石灰岩露出於西南。傾斜角大都在三，四十度之間，成中國南部褶皺之特徵，但亦間有因局部之變遷增至七十度或減少至十餘度者。主要斷層一，斷層線北起長坡之東北，向東南延展，以迄高峯街，東北爲仰側，西南爲俯側。下石炭紀之半結晶石灰岩即受該斷層上掀而露出。斷層發生之時期，丁先生在當地之觀察，疑其後於花剛岩，但現在地形之形狀，已無顯著斷陷之遺痕，花剛岩之分佈大致沿斷層線，固似其孳生先於花剛岩，花剛岩因以得乘地層之裂罅而侵入，即錫礦脈之分佈，則亦皆限於花剛岩之西側(即緣斷層線)若與斷層相關連，凡世界著名之錫礦脈，恆與白雲母花剛岩相共生，無不有有同源之關連。今本區之火成岩，亦爲白雲母花剛岩，奚能例外，使其分佈果與斷層有關係，則該斷層之發生至遲當與花剛岩之侵入爲同時，若後之其相隔之時間亦必甚邇，約在花剛岩侵入之後，錫礦脈生成之前。

中國南部花剛岩侵入之時期，昔翁所長曾假定在侏羅紀之前，古生代之後。邇來南方調查漸多，觀察漸確，始知其應屬於白堊紀，大致與馬來半島之花剛岩，及香港花剛岩爲同時，

三者皆含錫，鎢，銅，鉛，鋅，諸金屬，成東亞主要金屬礦產沉澱期。（一九二六年太平洋科學會議四七九頁）南美鮑力文錫礦北部花剛岩之時代亦曾有相似之改正，凡昔日研究該礦者，率信其肇源於南部之侵入岩，與其北方鄰近之花剛岩無關，後者侵入在古生代。迨一九二〇年戴威氏（經濟地質十五卷四六三頁一四六九頁）詳細研究之後，始確定該花剛岩之侵入在第三紀，且與鮑力文錫礦脈爲同源。二者侵入時代之改正由老而新，如出一轍其偶然歟，若上論斷層與礦脉之關係不謬，則斷層之發生當亦屬白堊紀，大致與南嶺或喜馬拉雅地動期爲同時，而非最新者。試觀地形地層斷隔之遺痕已侵蝕殆盡，其歷時之久可徵也。

中國南部地層之主要褶皺多肇生於南嶺或喜馬拉雅地動期，凡該期所發生之褶皺其軸多作東北西南向，地層傾斜角約在三，四十度之間，本區地層褶皺之情形大致與上者相符合，或亦發生於此時歟。惟丁先生在廣西他處之觀察，謂古生代亦有二主要地動期期，一在奧陶志留之間，一在二疊石炭之間。本區地層最古者，爲下石炭紀，故前者無從考證。其下石炭紀頁岩砂岩系與二疊紀藍石灰岩層之間斷，或能爲後者之代表。然此皆與錫礦之生成無關，因言地質，僅附誌之耳。

錫鑛脉

錫礦脈多集中於長坡北方約〇·七華里之地帶，大致沿斷層線，而尤多集於斷層線之東北側或因該處地層受斷層之影響而生裂罅，挾錫質之氣或液體遂乘機而入歟。礦脈大抵沿地層傾斜之方向而横展，故多作東北西南向，成傾斜礦脈。厚自半尺至寸許，以厚二，三寸者爲最習見。近其底部多漸增厚，或成偏平體，或成礦囊，或成不規則之礦脉，恒生於砂岩與石灰岩之中，而尤多集於砂岩與石灰岩或頁岩與石灰岩之銜接帶。最罕見於頁岩之內，所含礦物，有石英，黃鐵礦，毒砂，含鐵閃鋅礦，錫石，硫銻鉛礦，及方解石等。其中以毒砂之量爲最多，次爲含鐵閃鋅礦，黃鐵礦，方解石，錫石，硫銻鉛礦，黃銅礦雖有而甚徵，石英多自成分脈，錫石與毒砂及方解石恒相伴生，含鐵閃鋅礦則與黃鐵礦相伴生，故礦脉之錫石，方解石及毒砂多者則含鐵閃鋅礦及黃礦少。反之，如黃鐵礦及鐵閃鋅礦多者則錫石及毒砂必少。凡富錫石之鑛脈，多生於砂岩內。如森泰洞之穀砂粒，青砂粒，皆成色最高之錫礦脉，穀砂粒乃淺黃色砂岩之土名，青砂粒，大青粒乃深灰石英岩之土名也。在穀砂粒之中，錫石生於石英脉內，黃鐵礦量頗寡，黃鐵礦與含鐵閃鋅礦多生於石灰岩及石灰質頁岩內，如牛骨銅，雜貓毛，雞肉硔，大銅硔，牛眼硔，牛角硔，紙殼硔，麒麟硔，雞腰銅，皆係含礦脉而錫量甚脊者。牛骨銅，雜貓毛，乃砂質頁岩與泥質灰岩之土名，貓肉硔，乃淺灰石灰岩之土名，大銅硔乃半結晶石灰岩之土名，牛眼硔，牛角硔，乃灰色石灰岩之土名，紙殼硔，乃石灰質頁岩之土名，麒麟硔，乃灰色石灰岩之土名也。由是觀之，錫石礦之生成不獨與原來脉泉有密切之關係，其

圍岩之性質似亦有相當之影響，故始能獨富於砂岩之中，昔日研究礦床學者率相信石灰岩爲其最宜沉澱之圍岩，石灰岩於沉澱鋅，銻，諸金屬也固爲最宜，其於錫質則似有非盡然者•衡之此例，其益信之。

鑛脈之分帶

凡今日習礦床學者，率相信金屬礦產在地理上之分佈，非漫無規則，而恒有一定之富集區與排列，是謂金屬礦產區域及金屬礦產之分帶，研究中國礦產區域者首爲法人特羅南氏。而記論較詳，切近事實者，則當推本所翁所長（地質彙報第二號九頁一二四頁），惟其於錫礦也多係廣漏言之，至於各礦具體之論述，則尚有所未遑。錫礦爲金屬礦產中與酸性火成岩有同源關係之最明確者，戴威氏之研究南美鮑力文錫礦脈也。綜分之爲二帶：(一)爲高溫度帶之礦脈(二)爲中間帶之礦脈。復因礦脈所在地位之不同，每帶又包括三類，(共計六類)每類因生成地位之不同，其所具礦物之組合，亦隨之而差異，故以礦物組合之差異可定其屬於若何一類。長坡之礦脈頗與鮑力文中間帶第一類第一項相似，蓋二者皆具錫石，黃鐵礦，毒砂，硫銻鉛礦，石英諸礦物也。惟亦有異點二：(一)長坡一帶除上述諸礦物之外，尚具含鐵閃鋅礦及方解石甚多，而缺黝銅礦及黃錫礦，後之二種礦物皆見於鮑力文。(二)鮑力文之礦脈與斑岩相接近，在長坡則產生於花剛岩不遠之遞積岩中，應屬高溫度帶之第二類，以礦物言屬彼，以火成岩言則屬此，此亦大費解者。惟火成岩使其侵入之岩石溫度增高也，恒隨其體積之大小而差異，一小體積之深造岩散佈於其四周之熱量不必多於一巨大之侵入岩。長坡花剛岩之體積較小，其散佈熱量當亦無多，故不能使其附近遞積岩之溫度升至特高。凡上述之礦脈皆生於遞積岩中，此其所以成中間帶之礦脈歟。

龍口廠及巴來東方之剩積錫砂原爲礦脈受侵蝕剩積之結果，其原來礦脈雖已侵蝕無餘，然以現在之位置論，最近花剛岩，似屬於高溫度帶，凡高溫度帶之礦脈，恒有鉍或鎢之硫化物及電氣石等。鎢礦雖易風化，而電氣石則頗耐侵蝕。苟能於錫砂之混雜物中，尋電氣石則上之推論信而有徵矣。

鑛物沉澱之次序

凡礦物結晶之先後，恒隨其溶液之溫度及壓力而不同。故研究礦床必先明乎其當時溶液或氣體溫度之高低，壓力之大小，而後始能論其生成之原因，欲知其溶液或氣體之溫度及壓力，則研究各礦沉澱先後之次序尚焉，本篇所述各礦物沉澱先後之序，乃將各脈含礦物最多之部分製成光亮面而得者，試先列其次序如左：

(1)黃鐵礦

(2)錫石

(3)毒砂

(4)硫銻鉛鑛

(5)含鐵閃鋅礦

(6)方解石

上述之次序，乃綜合六方光面觀察所得之結果．蓋每一光面所含之礦物恒僅三四．罕能窺其全豹也。即上列所謂先後者亦非嚴格的言前一礦物結晶完了，其次一者方始發軔，在一光面之上恒見有二鄰接之礦物互相包圍(如黃鐵礦與毒砂)其結晶先後之次序頗不易言，及另易一片觀之，則該二礦物結晶先後之次序又甚明顯，其必一則結晶較早，一則較晚，但後者未待先者結晶完了而已肇始耳，復次凡用平面觀察以言其二種礦物結晶之先後．乃就其結晶完了先後之次第言．而非就結晶起始之先後言，茲將用反射光線觀察之結果述之如左：

黃鐵礦　色鍮黃，光面多凹點及擦痕，有時顯晶面，恒與含鐵閃鋅礦相團聚而爲其所包圍亦有包圍於毒砂之中，或成長條與毒砂相間生者，爲結晶最早之礦物。

毒砂　色灰白，光面帶微凹點，擦痕少而裂紋多，晶面顯著，有成斜方體者，恒與錫礦相團聚．而包圍錫石．若與含鐵閃鋅礦共生，則多被閃鋅礦所包圍，其結晶似在黃鐵礦與錫石之後。

錫石　色棕黃．或灰黑，多透明，光面少凹點，多裂紋，晶面顯著，恒成細長方形，梢形，斜方形，及正方諸形體，多與毒砂相共生而被其包圍，若與黃鐵礦相銜接，則常包圍黃鐵礦。其結晶似在黃鐵礦之後，毒砂之前。

硫銻鉛礦　色鋼灰．光面微具凹點及擦痕，晶面不顯著．有成細針狀者．恒爲方解石及含鐵閃鋅礦所包圍，與毒砂相共生，則包圍毒砂。其結晶在毒砂之後閃鋅礦之前。

含鐵閃鋅礦　色灰黑，光面多凹點及裂紋，乏光澤，晶體不顯著，其量之增減恒與錫石成反比例。時具黃鐵礦毒砂錫石及硫銻鉛礦之包裹物，結晶較後。

方解石　色淺白透明，光面明平滑，無晶形，恒填充於上述諸礦物之間，且有時侵入閃鋅礦之裂罅．蓋礦物中結晶之最後者。

石英及黃銅礦在光面上則皆未之見。

茲試以與戴維氏研究南美鮑力文錫礦所列各礦物先後之次序較（經濟地質第十五卷四九一頁一九二〇年）．則錫石逆倒於毒砂之前，硫銻鉛礦逆倒於含鐵閃鋅礦之前．以與戴維遜研究西英格蘭之錫礦較（地質雜誌第十八卷五〇一至五一二頁．一九二一年；礦學雜誌第三十一卷一五至十七頁，一九二四年），則黃鐵礦逆倒於含砒黃鐵鑛之前(或相當毒砂)。以與舊恩氏研究馬者來較．(世界錫礦誌六二頁，一九二五年)則黃鐵礦逆倒於錫石之前．但各礦

物之生成及沉澱之先後，既隨其當時溶液或氣體之成分與溫度壓力而變異，當各礦生成之際，其溶液或氣體之溫度，壓力及其成分未必盡同，故各礦物沉澱之先後亦恒有分歧，林格倫研究……………之錫礦(經濟地質十九卷二三三至二二八頁[？]·一九二四年)，謂黃鐵礦結晶最遲，大異於戴維氏所言，此亦或因個體之差別也。

各礦物沉澱先後之次序，雖間隨各個礦床而有差別。然自其全體言之，則尚大致不謬，即其組合亦莫不然，故高溫度之礦脈不必無中間帶礦脈之礦物，中間帶之礦脈亦恒有少許高溫度帶或低溫度帶之礦物，然其各具自已之特徵礦物，則大致相同，且在高溫度礦脈中，低溫度帶之礦物恒結晶較晚(如本礦脈之含鐵閃鋅礦爲低溫度之礦物故結晶較後)，此則大可値人注意，而爲金屬礦物分帶排列之勢有必然也。長坡礦脈作者疑其屬於中間帶，據舊恩氏)世界錫礦誌五八頁·一九二五年)及杜威氏(……………之礦物帶，地質學會會長講演，一二九頁，一九二五年二月)之研究，凡中間帶之溫度約在攝氏五〇〇度，其深約二千五百英尺，後者之數又頗近於哈克爾計算花剛岩侵入之深度。(哈克爾火成岩自然史，八六頁，一九〇七年)然則長坡當時花剛岩之侵入必深在地表二千五百尺之下，迄今露出地面，則已有約如上數厚之地層被侵蝕而去矣。

鑛泒之生成

凡含錫石之礦脈恒與白雲母花剛岩相伴生，其礦脈且具含氟，硼原素之礦物，花剛岩又不時顯被蝕解之象，故研究錫礦者以其礦脈雖原與花剛岩爲同源，但其生成必略後於花剛岩，乃剩餘之岩漿富含氣體上升而成者。凡以人工法試製錫石者，多以錫之氟化物，氯化物，或其硼氧化物製成之，於是上說益可徵信，長坡錫礦脈分佈於白雲母花剛岩之西側，大致沿斷層或因花剛岩之上侵而發生斷層，凡白雲母花剛岩剩餘之岩漿，富挾氣質及錫質遂逸入其中及其四周以成礦，惟電石僅於花剛岩中見之，於礦脈內則皆未之見，舊恩氏於研究馬來錫礦(礦學雜誌四頁，一九一五年十月)之際，遇兩種礦脈一富含黃鐵礦及毒砂，一則甚微。舊恩氏以前者錫礦之來源必非如普通之爲氟化物，而爲硫化物，砒化物或硫砒化物等。長坡花剛岩雖顯蝕解之現象，而不顯著，其電氣石爲量又甚微，各礦脈中多含黃鐵礦及毒砂，似頗與舊恩氏之論相符合。

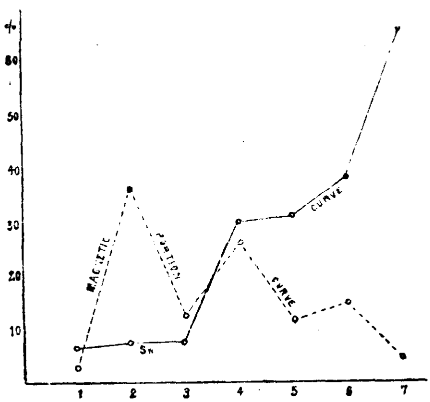
普遍言之，錫石爲高溫度之礦脈其次爲鎢，爲銅，爲鉛，爲鋅，爲銻，爲汞，爲銀，據本所分析生礦之報告，錫之成分不高，且含鉛，鋅，銻諸原質，雖含鉛，鋅，銻諸原質之礦物結晶較晚，其爲中間帶之礦脈，似頗可信，凡中間帶之礦脈恒有銀礦生成，惟距花剛岩較遠，盼事礦業者於距花剛岩較遠之處尋之。

剩積錫砂

錫石溶度，雖人言而殊，然其爲最耐侵蝕之礦物，則彰彰明甚，因其最耐侵蝕比重較大，故其礦脈一經風化，或被水冲徙恒富積於一處爲冲積之錫砂或其礦脈中之他種礦物被水溶解冲徙而去，錫石得以富積，成剩積之錫砂。龍口廠附近及巴來東方之錫砂，據丁先生之觀察謂皆屬於剩積類。旣屬剩積又密邇花剛岩，原來之礦脈或屬高溫度帶。凡高溫度帶之礦脈恒富錫石，而含砒鋅鉛銻諸原質之礦物少，故龍口廠及巴來東方有特富錫石礦脈之可能。業礦冶諸君於取砂掏礦之際亦可注意及之。

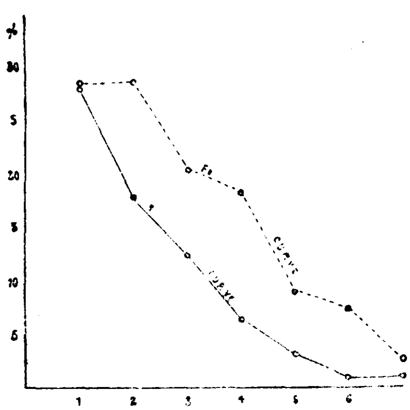
錫石之洗煉

長坡錫礦脈屬於中間帶，故富含鐵，砒，鋅，銻諸原質之硫化物，據本所金梁二君之分析，生礦其錫僅百分之六·三四(參照後表)，其生砂僅百分之五·八二，其他混雜之化合物：



第一圖　示帶磁性鑛物及錫石砂在各次烘燒中之變化。1，毛礦　2，第一次烘燒中段　3，第一次烘燒　4，第二次烘燒　5，第三次烘燒中段　6，第三次烘燒　7，第三次烘燒後之富積部份

一爲鐵硫化合物，二爲砒鐵硫化合物，三爲銻硫化合物，四爲鋅鐵硫化合物，凡硫砒諸原質皆有害於冶煉，故冶煉之先必經烘燒及淘洗以去之，但生礦因含鐵，砒，鉛，鋅，銻諸原質之

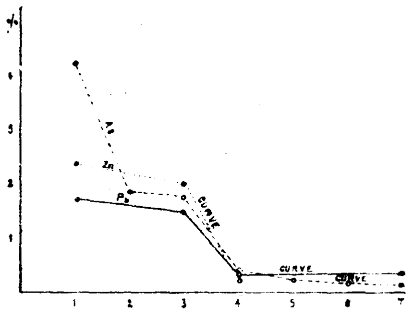


第二圖　示各次烘燒中鐵及硫質成分之變化，1，毛礦　2，第一次烘燒中段　3，第一次烘燒　4，第二次烘燒　5，第三次烘燒中段　6，第三次烘燒　7，第三次烘燒後之富積部份

硫化物過多，每經一次之烘燒及掏洗，恒不足以盡去之，故必須經二次三次之後方可供冶煉之用。烘燒之作用在使鐵，鉛，鋅，銻之硫化物變而爲氧化物，大凡金屬複雜硫化物之比重，恒大於其簡單之養化物，（如毒砂之比重爲五·九至六·三〇，而赤鐵礦之比重則僅爲四·九至五·三）且經烘燒所成之養化物恒較其硫化物爲疎鬆，而易於沖洗。故凡原來用水沖洗不能分開者，一經烘燒皆可用水沖洗而分離也。（錫石之比重爲六·一八至七故水不能沖去）作者曾用磁鐵將各次烘燒後之帶磁性部吸出，大致得其成分如左：

	生砂	生礦	第一次烘燒中段	第一次烘燒	第二次烘燒	第三次烘燒中段	第三次烘燒後之富積部份
磁性部份	7.49	2.77	35.95	12.10	25.85	2.08	4.00

凡帶磁性之部份，多爲鐵之養化物。試用第一圖表之，可知烘燒効力之最大者爲第一次之中段，其餘則成遞減之勢，且每次已經沖洗之含磁性部分，恒少於其烘燒之部分。觀此則



第三圖　示各次烘燒中砒，銻，鋅，鉛諸原質成份之變化。
1，毛礦　2，第一次烘燒中段
3，第一次烘燒　4，第二次烘燒
5，第三次烘燒中段　6，第三次烘燒　7，第三次烘燒後之富積部份

烘燒與沖洗相用之効而益明。

第二圖乃代表各次烘燒，沖洗標本所含鐵硫二原質成分之變化，第三圖乃代表各次砒，銻，鋅，鉛諸原質成分之變化，由上三圖可知砒銻最易除去，其次爲鋅。鉛與鐵最難，據金梁二君之分析淨錫所含之錫份僅估百分之九六·八五，其餘三·一五份，雖未分析，或大部爲鐵與鉛之混雜物歟。

Geological Reconnaissance in Szechuan, Kueichou and Kuangsi

I. ROUTE DESCRIPTIONS[§]

13 January 1930: From Kueiyang to Huangnishao[1]

Outside [Kueiyang] arsenal thin-bedded white Trias limestone St. N 65° W dip 33° NW [?]. Before School of Agriculture[2] St. becomes N30°W which remains constant. After school, going up pass it becomes vertical—veins and nodules and schistose. It is probably Trias. Then near bridge Permian limestone overthrusted against [the latter]. Thrust plane about N 25° W, dip 30°-40° E. [East of Tuyunkuan[3], limestone with gastropods.] After gastropod horizon outcrop becomes few. Locally it is steep but becomes more gentle. At first thin black limestone with corals, then chert in limestone and shale St. N 25° E dip 14° E.

14 Jan. 1930: From Huangnishao to [Lunglihsien]

At Niuerhkuan[4] [Lierhkuan], Bar. 657.8.*

*Gastrioceras*** [shale?] with *Fusulina* occurs below Kuchiao. Then *Gastrioceras* limestone with shale at first dipping NW then SE forming anticline—full of gastropods and big *Schwagerina*. It dips soon NW again. After Lichiachia[5] [?] *Lyttonia*-bearing beds St. N-S dip 24° W underlaid by black cherty limestone.

West of Kuanyinshan[6] black shale interbedded with shaly limestone St. N 65° E dip 23° NW. After limestone range white sandstone and soft reddish sandstone. At pass E. of Kuanyinshan white limestone with fossils—below white limestone *Productus giganteus*?

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§ This chapter is to be read with Pls. 25:KMA1—38:KMA14 and Pls. 39:KsA1—41:KsA3.

1 黃泥哨 2 農業學校 3 圖雲關 4 牛耳關=梨兒關 5 李家卡 (Ting's hand-writing here not clear) 6 觀音山

* It is surprising to note that Dr. Ting made no remarks on the geology of the Paomuchung area which is known for its oil seepages.

** What Dr. Ting calls "Gastrioceras" are really ammonoids with ceratitic suture. The horizon is probably equivalent to the Talung Series of Kuangsi.

15 Jan. 1930: From Lunglihsien[1] to Wengchengchiao[2]

The city of Lungli is situated in a sandstone series. Outside city towards east white quartzitic sandstone, black grey shale St. N 45° W dip 20° SW. Then it changes to N 78° W dip 10° S. 100 m further same sandstone St. N 62° W dip 25° S. Limestone forming high cliff further S. Opposite sandstone cliff on right, sandstone St. N 20° E dip 24° W. Limestone cliff is seen to the right on other side of the valley. Sandstone St. N 62° E dip 12° SE. Before point "a" (100 m W.) impure black sandy limestone St. N 70° W dip 40° N. At point "a" sandstone St. N 70° E dip 40° SE,—continuing to E. sandstone St. N 30° W dip 20° SW. Then Wulichiao[3], wider valley, no outcrops.

100 m. W. of 2 houses near Motzupu[4], sandstone St. N 42° W dip 16° NE. Some black shale and sandy shale to Motzupu. Limestone forming cliffs on left from Motzupu to Lungsung[5]. Dip becomes gentle to N. At Lungtouying[6], W. of bridge, sandy and shaly limestone St. N 80° E. dip 20° N. General dip is gentler. 300 m from Lungsung quartzitic sandstone St. N 75° E dip 30° N. (Coal occurs at Maolipo[7] 5 li to NE of Motzupu). Outside Lungsung on right, sandstone with *Lingula* and plants, St. N 80° E dip 14° N. Cliff on left of road (lower part at least consists of black sandy limestone full of calcite cavities. At pass ESE of Yuntingkuan[8] same limestone St. N 54° E dip 14° NW. W. of Wangshanpu[9] black shale, otherwise no outcrops. E. of Wangshanpu small outcrop of same black sandy limestone with calcite. Just E. of Wangshanpu near bridge black sandy limestone with *Lingula* (?). Then white quartzitic sandstone St. N 45° W. dip 28° NE—N 70° W being the more general strike. E. of Wangshanpu [*sensu stricto*] ostracod limestone St. N 70° W dip 20° NE. Valley on left beyond which is limestone cliff with cones over sandstone. Then steep descent to Sinchai[10], reddish limestone full of calcite dipping gently E. Outcrops poor. West of Shuiyenchung[11] white limestone with large *Schwagerina* and brachiopods. Descending steep pass from Shuiyenchung cherty limestone St. N 77° W dip 14° NNE.

Coal series 200 m W. of turn of road and 1.5 km. from Wengchengchiao, St. N20° E dip 27° E. Just E. of turn grey shale St. N 5° E dip 45° E. 200 m W. of Tsaopeng [a hut] on left *Gastrioceras* limestone St. N 20° E dip 39° E.

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1 龍里縣 2 甕城橋 3 五里橋 4 磨子舖 5 龍松 6 龍頭營 7 毛栗坡 8 雲頂關 9 望山舖 (Ting's handwriting not clear). 10 新寨 11 水淹冲

16 Jan. 1930: From Wengchengchiao to Kueiting.

At stopping place [of Wengchengchiao] thin shaly limestone with *Gastrioceras* [?]. Outside Wengchengchiao very thin dense limestone (reddish and shaly) with 12 m of bluish thick-bedded limestone between. Going NNW it turns to dip 60° E striking N 7° E. A few meters further dip about 40° E. At road turning thicker-bedded limestone with *Gastrioceras* [?] St. N 12° W dip 50° W.

17 January 1930: From Kueiting[1] to Machiatun[2]

Just outside the east gate of the city of Kueiting *Gastrioceras* shale St. N. 35°-54° E dipping 30° E. Descending 45 m, 500 m eastward we came to a stream flowing N. After crossing the latter by bridge we left the motor road to go up hill, following the old caravan road to Kutung[3]. Here the shale strikes N 54° E dipping 28° W. 100 m further, it strikes N 38° E dipping 18° W. Another 400 m eastward, we came to the top of a low hill with the small temple Tungkuanko[4] where shaly limestone strikes N 30° E dipping 17° W, the dip increasing locally to 32° W.

300 m east of Tungkuanko we came to another bridge over a river flowing N. and bluish gray thin-bedded limestone outcrops with gastropods and corals. We now follow a side stream flowing W. 120 m further where the road crosses to the southern bank we find typical *Lyttonia* (T104).

650 m further we came to a massive blue limestone underlying the coal series, forming massive cliffs. In it we found *Tetrapora*-like corals (T105). The dip becomes less than 10° W.

Going up for 950 m the road turns south-east and another 1,000 m always upwards, the road turns again east and we came to brown quartzose sandstone with a band of light pinkish gray crystalline limestone interbedded which yielded some corals (T106). Limestone peaks are seen on both sides of the road. This was near the small temple called Ert'uti[5], some 1,200 m from the contact between the sandstone and the massive *Tetrapora* limestone. 700 m further all in sandstone we came to a massive reddish siliceous limestone containing Ostracods. This forms a plateau 1,500 m in its east-west extent with conical peaks here and there on both sides of the road striking N 15° E dipping 15° W. Then we descended a little

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1 貴定 2 馬家屯 3 谷洞 4 東關閣 5 二土地

into brown quartzitic sandstone in which the village of Tungshanping[1] is situated. It strikes N 10° W dipping 12° W.

Descending from Tungshanping we find that it is underlaid by impure siliceous limestone massive enough to form cliffs. 800 m further we came to reddish brown quartzite, dipping gently under the limestone. The descent became rather steep for 500 m when we came to green shale interbedded with reddish brown sandstone striking N 75° W dipping 20° NNE.

The road became once more nearly level until 1,000 m we came to a bridge over a stream flowing south. Just beyond in the impure shaly limestone interbedded with green shale and sandstone we found (T107 & 107a) the following fossils:—

Spirifer tingi Grabau
Retzia multistriata sp. nov. Grabau
Whitefieldella? sp.
Spirifer sp. (more plications than *S. tingi*).
Retzia indenta (sp. nov.) Gr.
Streptelasma sp.
Favosites cf. *basaltiformis*
Cup coral.

This is the Upper Silurian beds of East Yunnan described by Dr. Grabau. Here it strikes N 75° E dipping 23° NNW changing to strike NNE dipping 18° NNW. 600 m east of the last mentioned we were at Machiatun.

18 Jan. 1930: From Machiatun to Kutung.

Outside village of Machiatun reddish and greenish sandstone St. NW-SE dip 20° W. After descending steep slope at point 1162 greenish sandy limestone horizontal. At point 1155 bottom of a slope brown limy and clayey sandstone St. N 70° W dip 22° N. A little further greenish shale with cystids, ostracods and *Lingula*. Before turning of road to SW is a limestone full of *Spirifer tingi*. Red massive hard sandstone. Then impure shaly limestone morly horizontal.

Valley widens with 2 houses on each bank. At point 1152, Tutimiao, greenish sandstone. Then greenish sandy shale nearly horizontal. At point here two streams meet, still sandy shale After that, harder greenish thin-bedded impure

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1 東山坪

limestone nearly horizontal. Going up side valley impure limestone St. N 80° E dip 12° N. At foot of limestone greenish sandy cliff on right where road goes S. towards gap, St. N 85° E dip 5° N. Then limestone becomes purer. At point 1162 bridge, valley widens.

Just above Loping[1] St. N 80° W dip 18° N. At Loping valley widens in nodular limestone, [which is full of gastropods at stone monument] near houses called Putzu[2], 2 li W. of Tsukuchang[3] sandy limestone and yellowish sandstone St. N-S dip 2-3° W. Opposite Tsukuchang at small side bridge limestone cliff about 100 m high showing horizontal limestone. At Chiangkang[4] same limestone St. N 85° W dip 15° N.

Pass above Tachung[5] horizontal limestone St. N 60° E dip 5° N. At Tachung same limestone. E. of Tachung limestone St. N 25° W dip 45° NE. At Kutung limestone horizontal.

19 Jan. 1930: From Kutung to Yangliuchieh.

Going S. from Kutung[6] no outcrops, road being in shaly rock. Limestone cliffs however appear here and there, especially on right. Fossils seen in greenish shaly limestone (full of pyrite) used for pavement. Also chert. Further down at point 667.5, light grey quartzite-like limestone with black chert, nearly horizontal. It breaks up in small square or angular fragments—typical Loping limestone*. Descending 300 m, near two Maopeng on right fossils in pavement. Small outcrops of light grey limestone St. N 23° W dip 4°-30° E. Soon road in clay with no pavement, but before descending to bottom pavement again. Then village Lopushih[7].

Outside village trilobites and *Orthoceras* seen on a stone tablet in front of a temple. At bridge still typical Loping limestone, St. N 22° W dip 21° NE. Descending reddish limestone with crinoids as pavement. At point 1148 opposite Maopeng on other side of valley *Orthoceras* in reddish and greenish shaly limestone St. N 55° E dip 20-32° S. Then greenish yellow shale with badly preserved fossils, Then no outcrops due to weathering of shaly rock. 100 m N. of village Chingtaokuan[8] on right quartzite begins to appear on pavement. At Chingtaokuan sandstone St. N-S dip 40° E. At bottom of pass quartzite St. N 15° E dip 19° E. Immediately above, dense dirty bluish grey limestone full of brachiopods St. N 26°

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1 羅坪 2 舖子 3 慈菇場 4 姜岡 5 大冲 6 谷洞 7 蘿蔔市 8 敬道關

* Dr. Ting probably meant by this term, the limestone seen at Loping (*vide supre*)

E dip 22° E. 50 m from top red quartzitic sandstone. Then greyish limestone again St. N 23° E dip 26° E. At point 1122 red quartzitic sandstone. At point 1068 loose blocks containing black ostracods, immediately black shale *in situ* overlaid by sandstone. Just beyond sandstone St. N 65° W dip 29° SW.

After crossing small stream pinkish massive dense limestone partly silicified and with flinty fracture. 200 m further St. N 29° E dip 24° E. This is the general strike. Crossing second stream up hill brown sandstone (above limestone?). 2 steps further white limestone with brachiopods. The little sandstone followed by dark blue to black limestone up a small pass, which contains *Schwagerina* [?] and brachiopods.

20 Jan. 1930. From Yangliuchieh to Tuyunhsien.[1]

Just where motor road turns to cross pass very cherty limestone St. N 8° E dip 25° E. The limestone contains a very rich fauna including *Lyttonia*. Going up pass high limestone mountain is seen on left, presumably *Gastrioceras* limestone. Going down zigzag along strike near bottom of slope, upper cherty bed St. N 2° W dip 25° E. Then going along strike, both strike and dip remaining constant.

After Talungching[2] up slope, contact between *Lyttonia* and *Gastrioceras* beds in green shale which is about 50 m. [The later] is superposed by limestone and shale about 10 m. Then thin-bedded limetsone (30 m) forming solid cliff. This is overlaid by greenish brown shale, their contact being 360 m from bridge.

South from Shapaopu[3] road in gravel and wide valley. High mountain on right formed of quartzite (?) dipping steeply E. Low foot-hills probably Lower Permian. On the left *Gastrioceras* limestone forming a continuous range. Opposite bamboo grove and village it dips very steeply E. about 350 m from road. Going up pass coal series outcrops on left of road. At first St. N 34° E dip 56° NW, then N 27° W dip 53° SW and then N 10° W dip vertical. [Here the coal series] is full of badly preserved plants and with a thin coal seam. Then [the country is] covered by consolidated gravel which consists of quartzite pebbles cemented with sands forming terraces 40 m above river level. Coal pit to the right in limestone which is nearly vertical. On the left *Gastrioceras* (?) limestone 350-400 m away. Near bottom of slope cherty limestone, black shale and thin coal seam of the coal series St. N 25° W dip 57° SW. [Then effect of crushing and thrusting is seen]. Going down, conglomerate disappears, coal series crops out on right. On left

1 都匀縣 2 大龍井 3 沙包舖

high limestone peak St. N-S dip 45° E. Opposite limestone quarry black limestone full of calcite veins. Outcrops on right full of crinoid stems. 100 m W. from Maopeng coal pit. 50 m N. from Maopeng sandstone and chert limestone. Maopeng is in blue limestone containing *Tetrapora* St. N 60° E dip 50° SE. This is overthrusted on to the coal series.

At Maanshan[1] proper St. N 20° E dip 60° E, outcrops continuous with limestone mountain to N. Halfway between Maanshan and Maopeng on left black shaly limestone full of brachiopods St. N 8° E dip 53° E. Then 20 m further coal outcrops steeply folded (mountain on left probably coal series limestone ?) into a syncline. Opposite Peiting[2] just beyond two Maopeng coal series chert limestone St. N 25° E dip 54° S, soon change to dip 80° W (St. N 10° W). Just before old road crossing from right to left it goes above motor road,—outcrop of thin-bedded *Gastrioceras* limestone St. N 4° W dip vertical to 80° W, overlaid by greenish shale. Last pass over the city [of Tuyunhsien] green and red shale St. N-S dip 50° E, then vertical, fault [?], then dip 45° E. Gravel at foot of pass, then plain. At small hill with shrine chert limestone of coal series St. N 23° W dip 27° E.

21 Jan. 1930: Side trip to the west of Tuyun

By river side near Changchiamiao[3] coal series limestone St. N 20° W dip 36° E. See Wang's notes.*

23 Jan. 1930: From Tuyun to Maotsaoping[4]

South of Tungshanssu[5] green *Gastrioceras* shale at first St. N 4° E dip 80° to vertical W, immediately reversed to St. N 10° E dip 67° E, reversed again to W. but at turn of road it dips 80° E. At turn thin-bedded limestone St. N 10° E dip 65° E. At pass thin-bedded limestone overlaid by yellowish green soft shale complicately folded. (See Pl. 40: KsA2, figs. 21, 24).

Left motor road, down a little then up steep pass near the top of which shaly thin-bedded limestone St. N-S dip 65° W immediately changed to E. Descending steep slope on left of stream—no outcrops till near bottom of slope where green sandy shale St. N-S dip 60° + E.

At Kaochi[6] massive dense grey thin-bedded limestone St. N 10° W dip 56° W. River on right going up. Descending light grey dense platty marble-like

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1 馬鞍山 2 碑亭 3 張家廟 4 茅草坪 5 東山寺 6 高基

* Dr. Ting refers us to the notes of Mr. Y. L. Wang, which are not available to me—T. K. Huang.

limestone St. N 16° W dip 26° W with poorly preserved brachiopods. Going up pass it is succeeded by greenish dense massive but sandy limestone, then reddish limestone with square fracture. At Maopeng on right, sandy thin black and brown shale. Then ostracod limestone St. N-S dip 52° W. Underlying it is similar impure green limestone full of brachiopods. Then quartzite. Just below pass grey limestone full of calcite 200 m from Maopeng platty yellowish grey limestone St. N-S dip 50° W. At Maopeng* lower (Loping) limestone; *Orthoceras* found on pavement.

After Niuchang[1] road follows river valley; near mountain on left all Loping limestone whose dip is seen to be quite gentle still to the W. After Panyangchai[2] and Limuchai[3] road goes right to hill on left where grey limestone with very flinty fracture St. N-S dip 13° W. This is 100 m W. from a Maopeng on right. Dip and strike unchanged up to Lungchiawan[4] where motor road joins old road, sandy shale or sandy limestone very like Cambrian outcropping between bridge and Lungchiawan—*Obolus* ? found. It is underlaid by a massive very dense flinty limestone St. N-S dip 15°-20° W. After bridge greyish cherty limestone St. N 84° E dip 55° S. Soon village Niukotang[5] outside which St. N 32° W dip 19° SW but limestone range to N. seems to dip NE. A little further at top of pass same limestone St. N 40° W dip 35° W. This is underlaid by soft sandstone. No outcrops after passing a Maopeng on the left. Horizontal limestone forming cliff on right 200-300 m away. Road then turns N. before it goes again E. Outcrops of lower siliceous limestone crushed and brecciated. Where road turns E. it strikes N 67° E dip 19° NW. Just before Mapo[6] very cherty limestone St. N 55° E dip 30° NW. Then old road branches from Mapo to Motsaoping. Going steeply down all in brown soil formed by weathered chert limestone. At bottom blue limestone with calcite veins dipping steeply E. 20 m further *Obolus* shale outcrop. 280 m further road crossed stream, same shale St. N 43° E dip 20° SE. Recrossing valley 300 m down, massive dark blue limestone St. N 47° E dip 23° E. 100 m further it is N 33° W dip 25° NW. This limestone is blue and dense but platty with sub-flinty fracture. Going up slope grey limestone with flinty fracture—The two limestones seem to be separated by brown shale. Shaly interruptions between last [............]** on shrine on right. Below temple 903 typical flinty fracture in

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1 牛場 2 斑羊寨 3 栗木寨 4 龍家灣 5 牛角塘 6 馬坡

* "Maopeng" means thatched hut. There were many Maopengs along the newly built motor roads in Kueichou and Dr. Ting took them as temporary landmarks in his field notes.

**Ting's handwriting not clear.

grey limestone which is horizontal. At shrine on right, reddish and sandy limestone appears less flinty but still horizontal. 100 m from house on left white limestone with flinty fracture St. N 45° E dip 15 SE, increasing to 20° 80 m from Maotsaoping.

24 Jan. 1930: From Maotsaoping to Pachaihsien[1]

At Maotsaoping low hill of reddish shale. 250 m from village red and white limestone with partial silicification St. N 20° W dip 12° E. Typical flinty fracture, dip increasing to 30°. Just before steep descent same limestone which forms low flat-topped mounts St. N 30° E dip 20° E. The same limestone forms steep cliff by river side St. N 20° E dip 30° E. Crossing river with green water by ferry to reach the village of Chichiaho[2]. Similar cliff on eastern bank, up which the road makes a steep climb, then on plateau again,—a good deal of reddish soil and terraces. We cross over to a side valley going up; white limestone St. N 15° E dip 32° E. Near top of small pass NW of Panpienchieh[3] same grey limestone St. N 15° W dip 28° E. Immediately after Panpienchieh on top of small pass dense light grey limestone St. N 10° E dip 24° E. Then steep descent. At bridge white marble-like limestone St. N 10° E dip 20° E seems to immediately underlie quartzite (or silicified limestone ?). Then light grey dense and massive limestone.

Going up along N. bank of stream all loose blocks of quartzite but 400 m from bridge on S. bank white and dense limestone is still exposed. 50 m further a block of grey impure limestone is seen by roadside on left. Up bend [?]* typical Loping limestone St. N-S dip 40° E. Near top of small pass thin-bedded limestone overlaid by typical Loping. Going down narrow valley black limy shale St. N-S dip 28° E.—full of nodules. Then crossing over stream to left and going up, limestone cliff forming escarpment; it is partly thin-bedded with angular weathering dipping E. Quartzite seems to crop out (?). At pass NW of Tehlutsing[4], grey limestone full of brachiopods which appear to be the same as yesterday's (E. of Kaochi). At 1169 quartzitic sandstone St. N 4° E dip 32° E. Then the village of Tehlutsing.

Outside village grey sandy limestone St. N 15° W dip 26° E. Descending into valley before ascending white marble-like limestone St. N 15° E dip 26° E. Immediately by W. side of bridge reddish quartzose sandstone St. N 10° E dip 34°

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1 八寨縣 2 姬家河 3 半邊街 4 得路箐 The direction stated might be wrong.

* This might mean river bend.

E. 69 m from point beginning to ascend, black shaly limestone with few fossils. 21 m further quartzite. 10 m vertically up, limy shale and yellow sandstone St. N 80° E dip 70° W?. Going up to Erhtengkao[1], mostly soft sandy and shaly rock St. and dip not clear but probably dip 20° E. Full of badly preserved fossils including brachiopods in greenish sandy shale overlaid by quartzite St. N 5° E dip 45° E.

At Tatengkao[2] quartzite St. N 30° W dip 20° W. Just below Tatengkao St. N-S dip 22° W increasing to 30°. 350 m from village, greenish shaly limestone.

25 Jan. 1930: From Pachai to Lungtang[3] and back

From city to Changtsingpu[4] no outcrops except hills seen far away which seem to be formed of limestone. From Changtsingpu across two streams typical Loping limestone St. N 10° E dip 10-15° W. From pass down to Lungtang by a ravine platy and shaly Cambrian limestone St. N 25°-30° E dip 20°-25° W.

26 Jan. 1930: From Pachai to Shihtzulu[5]

Going south from city no outcrops until bridge where reddish limestone seems to be faulted. Otherwise terraces in reddish soil. Escarpment of Tatengkao seems to be dipping quite gently W. After bridge red soil seems to be found by crushed silicified limestone. Then road goes between a low range on the left and an isolated hill on the right. On the left dark grey nearly completely silicified limestone St. NW-SE dip 30-40° SW.

About 3-4 li NW from Wulipu[6] where road turns east over low pass, same limestone St. N 20° E dip 30° W. A little further it strikes N 5° W dip 25° W. Near Wulipu there are numerous imperfect cones [of limestone] to the east; nearly low ground of reddish brown soil, Road soon enters mountains formed of reddish grey limestone. Below pass N. of Yangchia[7] same limestone St. N 20° W dip 38° W. Before Yangchia motor road is impassably.........* bluish limestone St. N. 20° W dip 40° W, with *Syringopora*-like fossils.

Descending from Yangchia we see a N-S range (of quartzite) on left parallel to the Tatengkao range with a deep valley between the latter and the road. 300 m from bottom of slope typical Loping limestone St. N 30° W dip 40°-E. (partly it seems to strike ENE and dip nearly vertical.) Near bottom of valley where motor

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1 二登高 2 大登高 3 龍溏 4 長青舖 5 十字路 6 五里舖 7 楊甲

* Dr. Ting's handwriting is not clear.

road makes a double bend same limestone seems to strike N-S and dip W. 12 steps further it strikes N 15° E and dips 50° E. The whole series is badly crushed and veined. Descending steadily where motor road makes a double bend, limestone on right dips 40° NW. Then high limestone range comes to meet road to S. The latter turns E. At a remarkable, high, conical, hill about 600 m from Yangyungchieh[1] St. N 60° E dip 48° SE. 200 m further, Yangyungchieh.

After Yangyung village road turns to right for Putang[2], limestone along main road is seen to strike nearly N-S dip vertical. On right of branch road dark grey [limestone] with pyrite and clear bedding planes St. N 16° E dip 64° W. After crossing stream grey limestone St. N-S dip 54° W. underlaid by yellowish shale and then dark limestone with pyrite. It is succeeded also by yellow shale and platy limestone all dipping W. About 100 m from pass (which is 400 m from Putang) typical Loping limestone dipping 30° E.

After Putang road along left bank of river, then cross over to right. Low foothills on right before high mountain (of quartzite). On left bank there are limestone hills appearing as fantastically shaped isolated irregular cones forming a range the lower part of which seems to be horizontal or gently dipping W. At pass before Chouchiatung[3], Loping limestone on right St. N-S dip 30° W. After Chouchiatung limestone on left forms a partly dissected range. On right also range of limestone but much lower. Further to right high quartzite mountain. Lower limestone on right is reddish and crystalline and full of calcite. Near Ssushihchai[4] quartzite mountain forms solid massive high cliff—Devonian? Then pagoda on left. On road red sandstone followed by greenish shale. 300 m from pagoda light grey limestone again overlying green shale. The road again is in sandstone. Outcrops of light grey sandy limestone [near] small stone bridge about 300 m north of Yehkao[5]. Near Yehkao soft red sandstone. Then small pass in limestone but the hill on right is certainly of sandstone. After village and at bridge N. of Yangneng[6] platy greyish sandy limestone St. N-S dip 70° W.

From Yehkao to Shihtzulu all platy limestone [St. nearly N-S dip steep to W].

27 Jan. 1930: From Shihtzulu to Fenghsiangshu[7]

Outside village of Shihtzulu platy limestone St. N-S dip 68° W. Over a small pass with few houses on left in valley platy limestone St. N 30° E dip 45°

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1 楊湧街 2 普堂 3 周家洞 4 四十寨 5 夜高 6 羊能 7 楓香樹

W. then changed to N 12° E dip 80° E. At Taipingchiao[1] platy limestone St. N 12° E dip vertical but to the left dip 20° E. About 100 m from Taipingchiao grey shale and yellow sandstone St. N 12° E dip 47° E. Road now all paved with quartzite; hill on both sides seems to be shale and sandstone. Descend into Lungchang[2] wide valley with rice fields. After crossing large stream flowing S. platy limestone St. N 6°. W dip vertical, but to SE to left overlaid by shale and sandstone which are thin. After Taho[3] limestone mountain seen on left dip gentle E. After crossing river going up low pass, pavement stone full of *Orthoceras* but at top [of pass] quartzite flat slabs. Then outcrops of yellow sandy shale St. N-S dip 70° W. Just as road enters another low pass a conglomerate containing quartzite pebbles overlies yellow micaceous sandy shale. After passing a large village on left by riverside, went up be left bank of stream; road pavement full of *Orthoceras* in reddish shaly limestone. Hill on left by roadside consists of brownish limy and shaly micaceous sandstone St. N 25° E dip 45° E. Reddish sandy *Orthoceras* limestone blocks rolled down hill at Tingtzu [a pavillon], apparently above sandstone. Went up low pass still in same rock which on southern slope strikes N 10° W and dips 47° W.

North of Lantu[4] reddish *Orthoceras* limestone dip 40° W but to the W. of it sandy limestone greenish in color St. N 40° E dip 40° E. Outside Lantu platy greenish limestone nearly horizontal forming a cliff (Ordovician?). A few steps further it strikes N 25° W and dips 12° SW, passing into sandstone. Then red dense and massive *Orthoceras* limestone St. N 40° E dip 30° SE changing into N 60° E dip 30° S. Cliff about 250 m long, then it is overlaid by yellow shale—interval of valley—going all the time along limestone bank of large river. 500 m from × Kungchai[5] black limestone with corals in pavement. 1000 m further entering a gorge formed by limestone, sandstone and shale. Then 200 m from steps up, it is a dirty limestone—corals probably came from here. At steps quartzose and hard sandstone dips E. The river then turns S. On left limestone cliff. Black limestone occurs between quartzite and upper limestone—on pavement numerous fossils. The follow the strike up and down to bridge (coral specimens before reaching the later). Then turned in sandstone horizon—no pavement. Opposite Pangchai[6] cliff of quartzose sandstone St. N 50° E dip 44° S. The latter is full of fossils. Descending, black limestone full of corals St. N. 30° E dip 50° E. Then shaly and limy sandstone with dip reversed (?) Then reddish limestone again, same dip—St. N 50° E dip 48° SE.

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1 太平橋 2 龍廠 3 大河 4 爛土 5 ×公寨 (Ting's handwriting not clear) 6 邦寨

28 Jan. 1930: From Fenghsiangshu to Nichai[1]

Went back from Fenghsiangshu to Panchiawan[2] [apparently for fossil collecting]. Outside Funghsiangshu light grey pure massive limestone with calcite St. NE-SW dip 45° SE. This limestone is free from chert and quite massive containing large gastropods and some corals St. N 40° E dip 50° SE. In descending toward Panchiawan [?] it strikes N 34° E dip 70° SE. Above Mochai[3] brachiopods *in situ* coral on pavement. St. N 30° E dip 50° SE. Section seen from pass between Paishuichiao[1] and Shuiyen[5] in something like that shown in Pl. 40:KsA2. Descending from pass above Shuiyen St. N 20° E dip 40° E. Outside Shuiyen same limestone on right St. N 30° E dip 36° W? At Chihlupei[6] St. N 40° E dip 20° E. Descending low pass same limestone overlaid by another limestone forming irregular peaks looking like lower Permian. Descending into Shuiyen limestone St. N 75° W dip 10° S. At Shuiyen limestone St. N 13°-20° W dip 13°-18° SW. 300 m further St. N 28° W dip 18° W. At Hsiaokanchiao[7] St. N 30° E dip 10° SE.

At Nichai St. E-W dip 12° S.

29 Jan. 1930: From Nichai to Tushanhsien[8]

Road in valley; limestone forms plateau. We follow a dry river on its left bank. Near Shiaochuang[9] limestone St. N 59° W dip 10° SW. About 1,000 m from Yangmeng[10] limestone St. N 35° E dip 35° SE (?) 300 m further it becomes horizontal—general dip as seen from the hill is about 10° to SW striking NNW-SSE. About 100 m SE of Yangmou shaly limestone and yellow shale full of brachiopods. Just opposite Yangmou corals. Limestone practically horizontal. One kilometer further it strikes N 35° E dip 12°-15° SE,—all flattopped hills—then horizontal again. Beginning to ascend slope toward Chipao[11] St. N 50° E dip 16° NW. Outside Chipao limestone St. N 50° dip 12° SW. Crossing a low pass, coming down to riverside, solid limestone full of corals St. N 10° W dip 14° W. Near junction of road from Chichang[12] [outcrops of sandstone and yellow shale]. Going into river valley after small village on left, quartzite St. N 42° W dip 20° SW. At Sungchiachiao[13] black shaly limestone dipping gently to SW furnishes badly preserved fossils. At temple quartzitic sandstone St. NE-SW dip 25° NW.

4 Feb. 1930: From Tushanhsien to Kolaoho[14]

Just outside South Gate of city at stone monument black shaly limestone St. N 45° E dip 20° NW furnishes *Stringocephalus* and gastropods. At Shihancho[15] 3

1 泥寨 2 潘家灣 3 磨寨 4 白水脚 5 水岩 6 指路碑 7 孝感橋 8 獨山縣 9 小莊 10 羊猛 11 鷄泡 12 鷄場 13 宋家橋 14 犵狫河 15 石案棹

li from city it strikes N 45° W and dips 8° SW. 200 m from Shihancho bluish grey limestone with angular fracture and with *Amphipolar*-like corals St. N 25° W dip 15° SW. This is overlaid by brown shale. 350 m from a few houses [Wengchiao[1]] on right shaly bluish limestone with brachiopods and corals (T174). Opposite said village reddish shale and shaly limestone with gastropods, corals and polyzoans (T175). Near pass on curve of motor road corals, brachiopods and polyzoans (T176). Then massive limestone, 10 m thick, overlaid by shale and shaly limestone to top of pass when the latter furnishes a rich fauna of corals and brachiopods St. N 70° E dip 20° SE (T177). Then 100 m interruption [due to soil cover] when shaly limestone reappears St. E-W dip 9° S, overlaid by violet shaly limestone with angular fracture. 100 m descend to Sanchiaochai[2]. 80 m, grey shaly limestone nearly horizontal. Just below temple and village on left dark grey limestone with corals and small brachiopods (T179) underlaid by black limestone with strange corals St. N 20° E dip 11° W. Solid massive limestone forming higher mountain on right between massive limestone and thin-bedded shaly limestone with limy bands full of sun-cracks. Up minor pass horizontal [?] black shaly limestone. Coming to limestone mountain, at contact massive limestone [with aglae-looking fossils] is dark grey full of calcite veins. A few steps further cephalopods, then black limestone containing same corals as (T179) St. N 80° W dip 12° S. Descending 200 m to S. [hamlet] Yaoso[3] on left. At bridge greenish yellow shale overlaid by purer limestone forming a cliff behind village. At halfway up pass angular light grey limestone St. N 60° E dip 3° NW which is overlaid further on [by] black or dark blue limestone with strange corals (no other fossil). Near to top of main pass limestone St. N 50° W dip 3° SW overlaid by limestone with strange corals. Road then turns SE with village on right, coming to purer limestone St. N 57° E dip 10°-15° SE.

5 Feb. 1930: *Kolaoho to Shangssu*[4]

Outside Kolaoho dark blue shaly limestone St. N 35° E dip 18° SE, full of fossils mostly corals (*Tetrapora*-like) (T181). This is overlaid by black shale or shaly limestone at bridge. 300 m further where road makes bend to enter mountain, curved cephalopods (T182) occur [in thin-bedded limestone] St. N 60° E dip 40° SE. 250 m from pass with temple, dark grey limestone with calcite veins overlaid by quartzite nearly horizontal—it is between 2 sandstones. Then steep descent St. E-W dip vertical. Before Tangpakou[5] dark blue limestone full of calcite veins and containing large corals and *Productus*. It strikes N 30° W (?)

1 甕橋 2 三角寨 3 堯梭 4 上司 5 湯耙溝

dip 12°-15° E. From Tangpakou to Aikuan[1] limestone on right red yellow shale and sandstone on left with limestone outcrops here and there. After Aikuan it is seen same limestone on left St. N 10° W dip 20° E but limestone on right seems to dip W. Further on near Tantzuyao[2] limestone on left nearly horizontal but S. of village it dips to E on right of road. Mountain on left all quartzitic sandstone. Opposite Tantzuyao black shale in quartzitic sandstone. Before descending to village on right and to go up again typical Tangpakou limestone St. N 80° E dip 10° S. 650 m from Tutsing rock full of brachiopods (T187). From here to Tutsing at least 3 faults along strike (N 60° E). Limestone on both sides. Up first pass with chert limestone over yellow shale—blue limestone full of calcite viens and corals (T189) St. N 80° W dip 10° S. Then to highest of second pass, interbedded [variegated] shale and dark blue limestone overlaid by reddish quartzite. Descending, limestone becomes purer and dense, full of chert forming high mountain with irregular and rugged tops St. N 86° E dip 19° S. It is still with big corals. Limestone then becomes nearly horizontal, dipping 3° N, At Maopeng (called Hsiakuan[3]) yellow shale and shaly limestone beyond which is [limestone] overlaid [fault?] by quartzose sandstone interbedded with thin beds of black shale St. N 75° E dip 23° S. Further, quartzite St. N 35° E dip 18° SE. Descending, all yellow and black shale. 1-2 km above Shangssu shale with thin limestone St. N 12° E dip 10° E overlaid by black shaly limestone with *Syringopora.*

6 Feb. 1930: From Shangssu to Hsiassu[4]

Outside Shangssu black shaly limestone St. N 16° E dip 20° E with *Productus.* Entering mountain massive limestone with corals St. N 30° E dip 10° E. After Sinchai[5] on pass *large corals* same as yesterday. Descending, limestone on right dips 10-15° W. This limestone is fairly pure forming cones and cliffs with brachiopods including *Productus,* large corals and other Lower Carboniferous-like forms. Not far from Kechai[6] St. N 10° E dip 10° E (300-400 m from Mapao[7] up a small pass)—there quartzose sandstone about 10 m in thickness occurs between limestone, the upper limestone being grey and red with no fossils. From there to a village Tangmeng[8] more or less along sandstone but more limestone toward lower horizon. *Productus giganteus* (?) horizon near Taipingtang[9] (pass above). From Taipingtang on, road turns to S. in sandstone which has very small dip to ESE until pass above Hsiassu where pure limestone meets sandstone seeming to dip W.

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1 岩關 2 罈子窰 3 下關 4 下司 5 新寨 6 革寨 7 馬包 8 唐猛 9 太平塘

7 February 1930: From Hsiassu to Nanchai

Going from Hsiassu south we find ourselves in an enclosed basin surrounded by limestone hills. The basin is at first nearly 100 m wide but about 1000 m S. from Hsiassu it begins to narrow. In this basin small outcrops of a dark gray semi-crystalline massive limestone are to be met with. Near the point where the basin begins to narrow, we find in the limestone, which strikes nearly E-W dipping 10°-N, 2 brachiopods (T201). 200 m further S. in a higher part of the same limestone, somewhat brecciated, we find *Fusulina* and a single small coral (T200). A little further south the limestone becomes white and marble-like striking N 10° E dipping 30° E. 200 m N. of Payu[1] in the same limestone we find gastropods and brachiopods (T202) which are difficult to extract from the solid limestone.

The road now goes up gently. About 130 m from Payu soft reddish micaceous sandstone overlies the white crystalline limestone containing masses of brachiopods (T203). Poorly preserved fossils are also present in the sandstone which strikes N 40° E dipping 40° SE and is overlaid by a grayish white limestone with chert bands and nodules, full of crinoid stems, brachiopods and large corals (T204). Then descending a little we arrive at Matao[2].

From Matao southward, this reddish gray coralline limestone is quite massive. At a first just S. of Matao it dips 35° SE yielding fossils (T204a) similar to T204. The road then goes along the strike over a pass walled in between solid limestone to Tiehkeng[3].

After the last named village the road turns SE. to cross the strike. The limestone becomes dense, grayish in colour, with conchoidal fracture, almost free from chert, forming massive cliffs, bedding plane about 30 cm thick, striking N 35° E, dipping 35° SE. A little further the same limestone striking N-S, dipping 20° SE, yields numerous fossils (T205). 600 m further dark gray limestone contains corals & brachiopods (T206).

From Shantiehkeng[4] the road goes at first SE for 2600 m, then turns S & SW. All the time the limestone becomes more and more gentle in dip which is on the average less than 15° SE and the scenery becomes more and more karstic with numerous isolated cones and I begin to realise that we are in the typical Upper Permian [Uralian] limestone which I named Maping in Kwangsi. This continues unchanged until Mawang[5].

1 巴巋 2 馬道 3 鐵坑 4 上鐵坑 5 麻網

350 m S. of the last named village we made a large collection of fossils from the white limestone in every respect the same as the Maping Limestone of Kuangsi (T207). Just beyond the bridge over a small stream is a series of black shale and thin bands of chert which are much disturbed. Between the latter and the Maping Limestone to the N. there is probably a fault. It strikes N 60° E dipping 40° S.

Going up a low pass, the shale becomes interbedded with black shaly limestone bands with poorly preserved fossils (T208) which is overlaid by the white limestone. The latter becomes gentle in dip, forming numerous cones. The road descends gently to Sutzuchai[1]. After crossing 3 streams we arrive at Tungchio[2] with a large cave above the village of that name. The white limestone which dips at first gently N changes to dip S just N of Tungchio with a small fault as sketched in Pl. 41 : KsA3, fig. 51.

It is already nearly dark, and we hurry to reach Nanchai[3] by way of Mawei where we are to stop for the night. From Tungchio on, the road is in a black shaly limestone underlying the typical white limestone.

8 February 1930 : Nanchai.

We stayed in the house of Mr. Mo Hsin Chih[4] who with his several brothers (one named Yinsan[5]) has great influence in the country. They have organised a well-armed corps of militia, said to amount to hundreds of men. The family is said to have come originally from Shantung, but its name belongs to a well-known Chuang family which used to rule in Nantan in Kuangsi. As our Kueichou escort cannot go into Kuangsi without creating misunderstandings, I ask Mr. Mo to provide me with an escort of 20 rifles to go as far as Hueilo[6] and back. He first hesitated a little, but later on promised me to do so, asking me to write to the magestrate of Nantan which I did at once, sending a special messenger. I then ordered the Kueichou soldiers to go to Sanpang[7] some 30 li E. from here to wait for my return. In order to wait for Mo to assemble his men, we stopped one day at Nanchai, and as we were not sure of the stratigraphical position of the black shale and shaly limestone, we want up a low hill east of Mawei[8] to collect fossils. There in the dark gray limestone and the shale we found a few poorly preserved small brachiopods. At the N slope of this hill facing Tungchio in contact with the gray limestone the shale strikes N 50° W dipping 28° NNE. At the foot of the W. slope S. of Tungchio the black shale limestone strikes N 10° W dipping 19° E, yielding poorly preserved *Gastrioceras*. (T209).

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1 蘇子寨 2 洞脚 3 南寨 4 莫信之 5 蔭三 6 灰羅 7 三邦 8 馬尾

200 m S. of Mawei the black shaly limestone contains brachiopods and large pelecypods, striking N 32° E dipping 10° E. But the white limestone to W. dips 30° W.

The weather is exceptionally fine though, somewhat warm.

9 February 1930: From Nanchai to Ssuting

Mr. Mo sends his youngest brother to command the Chuang escort which is a very necessary measure since very few of the escort speak Chinese.

Leaving Nanchai we go SEE. The conical hills on our right are evidently of Maping Limestone but on our left the road is in a black shale and shaly limestone which at first strikes N 5° W dipping 32° E, but 100 m SEE from the village it strikes N 50° W dipping 16° NNE under the Maping Limestone which soon becomes horizontal and extends a great distance further to the east.

About 2000 m from Nanchai we pass the village Matao on our left, and turning SSE, come to a wide flood plain surrounded by conical hills formed by the Maping Limestone, dipping a few degrees eastward. Numerous caves are seen in the cliffs.

600 m from Matao we cross a small stream flowing east, and begin to go up. 700 m further south we come to the top of a low pass some 20 m above the river we have crossed. Descending gently, we have the fairly large village of Yaolan[1] some 500 m east of the road which is level and surrounded by conical hills. The limestone at first is horizontal, but after crossing a small stream it strikes N 70° W dipping 12° NNE, to become horizontal again as we go S. towards Kuli[2] Several huts bearing the same name, but some 600 m N of that village lies on our route. Just to the north of these huts where we stopped to have a rest, the weather being rather hot, we found *Schwagerina* (T211 which is in loose blocks and T211a *in situ*).

The road now goes SSE and is level. 1800 m further we come near to the mouth of a narrow gorge where we collected some brachiopods and *Schwagerina* (T212). 400 m further we entered the gorge and collected some more *Schwagerina* which are unusually large (T212a). Turning south, after going gently up for 600 m, we came to Kunfu[3] situated half way up the pass and we had lunch. Here we collected some more brachiopods (T213) in the weathered white limestone which strikes N 60° E dipping 15° NNW.

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1 堯攔 2 古里 3 更夫

Turning SW we went up a pass 600 m from Kunfu? and 85 m higher. Here the limestone is grayish in colour full of *Schwagerina* (T214). Descending 200 m somewhat steeply we came to a cave in which we found some bones, and gastriopods (T215). 250 m further down we crossed a stream flowing SW forming a wide flood plain. The road now goes S along the eastern cliff of the plain. 600 m we came to the top of another pass 20 m above stream. Here the limestone strikes NE-SW dipping 25° NW. Descending slightly, then up again to a low pass 300 m from the limestone pass and about the same height, we find the gray limestone underlaid by soft reddish ferrugenous sandstone. In the overlying limestone we collected some *Schwagerina* and brachiopods (T216). Descending another 400 m we came to a stream which froms a wide valley with its floor in the red sandstone, but surrounded by conical limestone hills, 600 m 35 E we came to Ssuting[1] which is situated on a low hill of soft red sandstone. Here we stopped in the house of Mr. Chu[2], a relative of Mo's.

10 February 1930: From Ssuting to Mangchang[3]

The village of Ssuting is situated in red sandstone which forms a low mount, striking NW-SE, dipping 10° NE. The road goes at first SE and soon in Maping Limestone. 600 m from Ssuting we came to a low pass in limestone, the road here turning SW. Another 600 m we came to another low pass descending gently into a basin in which the village Chiawei[4] is situated. 800 m from the second pass in the direction SW, we came to a few huts used for holding a market whence the road branches off NW-ward to Liuchai[5]. The view seen from the huts is sketched below. [Dr. Ting gives a simple sketch section which is not reproduced here.].

150 m NW of the huts *Schwagerina* (T217) occurs in the cherty limestone. We are on the boundary between Kueichou and Kuangsi. 200 m further road turns to S. another 800 m we came to a ruined tower. From the huts up road is in shale and silicified limestone on which rock the tower is situated. From the blocks fallen from the wall of the tower, we collected a rich lot of fossils (T218). Here it is seen that the black shaly limestone forms the basal part of the hills all round whilst the white pure limestone overlying it forms conical peaks. It is the shaly rock that makes the basin wider.

The road goes zigzag to the S. entering into a mountain gully. The shaly limestone becomes more cherty dipping 10° N, overlaid by pure limestone typical of that of Maping.

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1 泗亭 2 朱 3 茫場 4 甲尾 5 六寨

About 1000 m from the tower the thinbedded limestone is overlaid by a reddish-gray limestone containing brachiopods and *Schwagerina* (T219).

900 m further we came to a low pass, (35 m above Kotzushih[1]) in the very cherty thin-bedded limestone, black to reddish-grayish in colour with numerous shale partings. 500 m down we came to Kotzushih.

Going in the general direction SSE, we descend for 400 m to go up again 450 m to a low pass in gray cherty limestone with *Schwagerina* (T220). From Kotzushih on, Maping Limestone forms isolated peaks perched on shaly layers forming earthy slopes. Descending 400 m, we go up 200 m to another low pass where the black shaly limestone yielded corals (T221) striking N 30° E dipping 14° S. On both sides purer limestone forms cliffs. 200 m from pass the same limestone strikes N 40° E dipping 16° N. Descending all the time for 600 m we are at Heini[2] where we stopped for lunch. A specimen of *Gastrioceras* was found on the pavement stone a little N of Heini.

Just S of Heini beyond the bridge over a stream flowing SW, black shaly limestone strikes N 80° W dipping 18° N and is underlaid by grayish limestone containing *Gastrioceras* (T222), dipping 8° S. 600 m southward, the road is in low ground formed by shale and limestone which here strikes N 40° E dipping 53° NW containing also *Gastrioceras*.

After crossing a small stream, 200 m from the last hut, we enter a narrow ravine at the mouth of which black shale strikes N 20° E dipping 44° NNW. 50 m further we are in typical *Gastrioceras* limestone which extends 300 to the top of pass where the dip is reduced to 20° N.

Descending, we crossed a small bridge to go up again. Underlying the *Gastrioceras* limestone at the last pass is a series of yellowish shales interbedded with 2 layers of impure shaly limestone. In the former both above and below the first limestone layers are trilobites and brachiopods (T223 and T224). The outcrop is 400 m wide coming near to the top of another low pass, the general strike being N 80° E dipping 40° N.

At the pass shaly limestone nearly horizontal, but 150 m down is another small bridge just beyond which the same limestone strikes N 45° W dipping 23° N.

About 200 m further south we came to a light gray massive limestone, somewhat brecciated, with calcite veins, followed by thinner-bedded very cherty

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1 壳子石 2 黑泥

limestone striking N 80° W dipping 35° N. 320 m N of a small ravine (with small bridge?) lower shaly limestone (below that of Kungchishan[1] strikes N 40° W dip 32° NE. Here to the east the remarkable limestone range of Kungchishan rich in fossils (T241) extends for considerable distance, but on the west side of the road no massive limestone is seen, In stead the hills are formed by impure limestone and shaly and sandy sediments. Possibly a fault occurs along the direction *N 40° W-S 40° E.*

From the last mentioned ravine we descend 150 m S. along the west cliff of Kungchishan, coming to a series of yellowish shale and sandstone lithologically similar to the trilobite beds, but seem to underlie the impure limestone below Kungchishan limestone striking nearly E-W dipping 30° N (?). 250 m lower down impure shaly limestone striking N 40° W dipping 15° S. The road now turns east and up slightly then down again. For 400 m in the black shale followed *chert bands* striking N 56° E dipping 15° N increasing to 22° N and then to 34° in the same direction, and we came to quartzitic sandstone striking N 32° E dipping 38°-48° NW. 400 m further at bridge over river flowing east, but on the N. side, black shale again striking N-S dipping 60° E. From bridge up for 150 m black shale underlaid by massive dense black to gray limestone which at contact strikes N 30° E dipping 79° NW. 600 m further (all in limestone) we are at Mangchang. Part of the limestones looks very like that of Wuchihshan[2].

11 February 1930: From Mangchang to Ichou.

Just S. of Mangchang brownish gray shale dips 10° N. Pavement stone with Wuchihshan limestone structure looking very like Würmkalk. The shale soon strikes N 35° E dipping 15° NW from which we collected the following fossils (T225).

Spirifer? nantanensis sp. nov. Grabau
Leptaena analoga Phill. var.
Chonetes latesinuata var. *nantanensis* Grabau
Chonetes sp.
Reticularis?
Pagodicrinus?

This fauna as well as the rock is exactly the same as that I met with N of Tachang[3] in 1928. It is most probably Lower Carboniferous. It is here underlaid

1 公鷄山 2 五指山 3 大廠

by a dark gray shaly limestone striking N 68° E dipping 18° N. This is followed by thin-bedded limestone full of chert.

400 m from Mangchang, going up gently with a ravine on the right, the same limestone strikes N 70° E dipping 17° S and is overlaid by a dark massive cherty limestone containing corals (T226). This limestone forms fantastic peaks & cliffs on both sides of the road. From here the high mountain near Tashanchang[1] could be seen to the west. 500 m further the dip is changed to 10° NNW. The road begins to descend & 400 m southward we passed 2 huts on the right. The massive limestone forms a range of cones east of the deep valley, to the east of the road. 600 m lower down we came to a few huts named Lamapo[2] situated at the foot of the limestone cliff which here diverges away from the road south-westward. From the bottom of the cliff we collected a number of corals (T227, T227a). 250 m further S the cliff ends & the road is again in shaly rock. Some more corals are obtained for the overlying limestone (T227b). Thence the outcrop became poor, but 600 m further black calcareous shale strikes N 55° W dipping 18° NEN. Another 100 m we crossed a bridge over a small stream flowing SE into the main valley. This shale is inter-bedded with shaly limestone and bands of chert. On the S. side of the bridge it strikes N 30°-40° E dipping 34° W. 100 m further the dip becomes 10° NW. 500 m further we are at Huangchiangpo[3] S. of which the shaly series strikes N-S dipping 40° E. 200 m further it becomes horizontal. Here the sandstone yields badly preserved brachiopods and crinoids and the black semi-crystalline limestone seems to contain *Fusulina* (T228). To the east of the valley flat topped hills are formed by the cherty limestone.

The road now descends into the main valley and 1,200 m from locality T228 we are at a bridge over the stream flowing S. Halfway down the stiff black shale strikes N 16° E dipping 47° E. under the high limestone cliffs on the east side of the valley. 200 m further greenish brown sandstone and shale strikes N 16° E dipping 24° EES. Then the road follows the strike along the W. bank of the stream to the bridge mentioned above.

The road goes up again for 200 m to the top of a col, and then descends 600 m to small bridge over a branch stream flowing SW into the main river. The road follows the boundary between the sandstone and shale series and the thin-bedded cherty limestone overlying it. The general dip is about 40° E. Through

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1 大山廠 2 拉馬坡 3 黃鱔坡

the gap of the branch valley massive upper limestone cliffs and cones are seen to the east.

300 m SE-wards we come to another bridge over the main stream half of which has fallen down. Then 400 m further we are at Pingchiao[1] where we had our midday meal.

For a distance of 600 m the road makes a semi-circle round the limestone hill to the west coming to another stream flowing EES. Crossing the bridge 300 m further S sandstone strikes N 26° W dipping 66° NEE. Since Pingchiao the hills consist of the lower sandstone and shale series dipping steeply east, but to the west of the road the dip seems to be gentle and the low smooth-outlined hills are here and there overtopped by the upper purer limestone. After crossing the stream mentioned above we have a massive limestone range to the east of the stream now flowing N with the road along its W. bank in the sandstone and shale series. 600 m S from the last observation a remarkable isolated monadnock of the upper limestone is seen to the W. ca. 600 m away. Then we descend gently 600 m S. to a side stream to the N. of which sandstone and shale strike NW-SE dipping 35° SW.

Going up gently for 400 m we took the branch trail for Ichou[2] some 1000 m away. The road zigzags all the time in shale which has a general dip of 20° SWS.

At Ichou stayed in the house of Mo ex-Tuantsung[3] of Nantan whom I met in 1928.

12 February 1930: From Ichou to Nantan

Going S.E. for 600 m we come to the main river flowing N. On the east side of the bridge is Hsintien[4] situated at the foot of the upper limestone cliff. 200 m S. we cross to the W. side of the stream. Then up a low hill, turning SSE for 600 m we come to the same stream. Crossing the branches about 200 m apart, we go southward and begin to enter the upper limestone up a steep pass. 250 m we are at a gateway where the grayish crystalline limestone yield numerous fossils (T229 & T229a). Limestone on the W. seems to dip steeply (40°) ENE. Descending 200 m to a small side ravine, we go up again for 400 m to another pass whence we descend 200 m to go eastward and upward to Shihpanching[5].

200 m east & descending gently, we come to quartzose sandstone (coal series?) striking N 25° W dipping 45° ENE. 400 m further east, we are in a thin-bedded

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1 平橋 2 遺州 3 團總 4 新店 5 石板井

very cherty grayish limestone interbedded with some shale striking N 4° W dipping 64° E. From the purer bands we collected some fossils (T230). The road then goes along a stream flowing east for 800 m. crossing it and up for 100 m to Kuanshang[1]. Just before crossing, the purer limestone dips 35° E. The beds between the 2 points of observation seem to be dipping gently and in places the thin-bedded cherty limestone is overlaid by purer limestone capping the summit of the hills.

150 m S. we cross a small stream flowing N. Here the thinbedded cherty limestone strikes N 40° E dipping 60° SE. The road now goes steadly up. 300 m S. the same limestone strikes N 24° E dipping 20° NWW increasing immediately to 56° NWW. 600 m further S. crossing 2 small streams, going up all the time, we turn to go east. Just before the turning *Schwagerina* (T231) occurs in the reddish limestone which seems to dip 15° SE.

Descending steeply eastward for 400 m we come to the foot of the pass where the limestone is vertical striking N 28° E. Descending gently for 200 m reddish yellow shale interbedded with thin limestone bands, typical of the *Gastrioceras* series, strikes NNE dipping 15° SEE.

The road now turns SE following a winding stream flowing in the same direction. 250 m further an isolated outcrop of the greenish shale strikes N. 60° E dipping 37° NNE, then a small bridge. 200 m lower down limestone strikes N 45° E dipping 5°-8° SE-. This seems to be the general dip. The limestone is full of *Schwagerina* (T232). Massive limestone forms cliffs to the east of the road.

The valley now opens out wider and 200 m further S. we cross the stream to recross it 350 m lower down where the greenish shale of probably the *Gastrioceras* formation strikes N 80° E dipping 30° N. Another 600 m SE the same green shale strikes N 70° W dipping 38° NNE. 200 m further S., crossing another branch stream which joins the one from Kuanshang flowing east in a gap in limestone, we are at Papa[2].

The road now goes directly W. over a low pass in gray limestone (specimen 233) situated 180 m from Papa. Descending another 180 m, we are in a wide flood plain surrounded by limestone hills with the village of Chungpinghsinchieh[3] 400 m away. Here we had our lunch.

600 m S. after crossing the stream flowing N., we come to Lala[4]. Just beyond we collected some *Schwagerina* (T234). 850 m further we come to a fairly

1 關上 2 巴壩 3 中平新街 4 拉臘

large bridge over the eastern branch of the river at the point where it joins the one from SSW. The impure shaly limestone forms a cliff right by the river and the road goes over its W. edge. It strikes N-S dipping 10° east and yields both *Lyttonia* and *Gastrioceras* (T235). Crossing over the bridge we go SW. for 800 m to the large village of Chema[1]. The impure limestone is underlaid by a series of reddish and yellowish sandstone which at the village strikes at first N 9° W dipping 17° E, changing to strike N 20° E dipping 17° W, then N 33° W dipping 38° W, and finally the strike becomes N 85° E dipping 14° N. All this happens within 100 m of distance.

800 m further SW, opposite the village of Hsiwang[2] on the W. side of the river, the sandstone strikes N 40° E dipping 60° NWW. The valley is 400 m wide and is cut in the sandstone, but on both sides are hills formed by thin-bedded limestone interbedded with shale. The road is probably along the axis of an anticline.

After crossing a small bridge on a side stream from the S., we went 800 m SW and came to a large stonebridge over the main river from Nantan, which cuts through a narrow ridge of solid massive dark gray limestone almost free from chert, but with calcite veins striking N 50° W dipping 60° NE. In it we found a few Lower Permian corals (T236).

400 m S. of the bridge yellowish gray shale strikes E-W dipping 50° N, forming low hills N. of the city. 300 m further S. we are at the N. gate of Nantan.

We stayed at the city house of Huangtecheng[3]. The magistrate promised me an escort, but the militia demanded money. After some negotiation, they agreed to send 2 men to go with us to Hueilo as guides.

13 February 1930: From Nantan to Hueilo

Crossing the bridge just S. of the city, we have a limestone hill to the east striking N 20° E. dipping 60° W. (?).

200 m further we recrossed the same river and the shaly rock underlying the limestone strikes N 20° W (?) dipping 60° W which itself is underlaid by a Würmkalk-like limestone (Wuchihshan limestone) striking N 55° E dipping 38° NW. 700 m from the second bridge we come to Erhhochiao[4] where 3 streams join. Just E. of the bridge the Wuchihshan limestone is largely silicified and 300 m from the bridge where the road turns to east, it strikes N 55° W dipping 80° NNE. Another 300 m to the east we crossed the stream again to go SE and were again in

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the upper shale horizon. The road now enters a narrow ravine with a winding stream flowing N. The silicified limestone strikes N 25° W dipping 55° east. 500 m from the last crossing we cross again to the east bank. The silicified limestone is locally complicatedly folded. Then 200 m SE. up a low watershed where the silicified limestone strikes N 38° W dipping 40° NE. This is overlaid by the unsilicified Wuchihshan limestone. Descending 300 m we came to the stream again going SE. for 400 m, we crossed it twice. The road now turns S. and the ravine becomes narrower. The Wuchihshan limestone strikes N 34° W dipping 25° E under higher peaks of Lower Permian (?) limestone which forms a NW-SE range further to E. 600 m further, after crossing the stream twice the Wuchihshan limestone strikes N 72° W dipping 35° NNE, changing to strike E-W. 950 m further we are at the top of the pass of Tahsipo[1] some 60 m above the level of Nantan. Just below and N. of the Tahsipo pass, black shale interbedded with silicified limestone strikes N 28° W dipping 48° EEN. (Later measurements indicates that the strike is E-W.).

Descending 400 m SE-wards, we find in the yellow calcareous shale the following fossils (T238):—

Pterina sp.
Camarotoechia or *Leiorhynchus*
Pelecypods 2 sp.
Styliolina
Phacops (pygidium)
Athyris
Tentaculites sp.
Reticularia (crushed).

Therefore the horizon is Middle Devonian.

800 m from locality T238, descent becomes very steep and the black shaly limestone strikes N 33° W dipping 33° NEE.

600 m lower down we are at the foot of the Tahsipo with a few huts known as Lêngchiotien[2] where black shaly limestone interbedded with purple sandy shale strikes N 40° W dipping 42° ENE. Lêngchiotien is 240 m below the pass. Here we collected a crushed pelecypod in yellow shale (T238a).

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1 打錫坡 2 冷脚店

From Lêngchiotien we go over the bridge southward. The river is seen to come from the N near the village of Chuanmatsun[1] 1,400 m N of Lêngchiotien just above which the shaly series is overlaid by thin-bedded limestone forming cliffs connecting the limestone cliffs on both sides of the valley. Near the junction of shale and limestone water comes out as a spring cutting the shale underneath and forming a waterfall some 20 m high. 600 m S. of Lêngchiotien, crossing the S-shaped bend of the river 3 times to go along the W. bank we come to gray limy shale striking E-W dipping N yielding the following fossils (T238b):—

Stringocephalus burtini

Merestella (crushed)

Lepidodendroid (?)

From now on the strike and dip become changeable. At first it strikes N 68° W dipping 31° NNE, but 50 m further it changes to strike E-W and dip 70° N, then N 20° W and 14° ENE, and finally N 72° W and 27° NEN. All these take place within 600 m. Another 800 m we cross to the east bank of the river at Nanmutsun[2]. Between this crossing and a side stream in the gray and black shale we find another *Tentaculites* (T239). 600 m SE along the east bank we came to the village of Tahsipo. All the way from Lêngchiotien to Tahsipo, we have the deep valley enclosed between mountains 250-300 m high. To the west they consists of sandstones and shales somewhat metamorphosed, but to the east the softer rocks are surmounted by massive limestone probably that of Lower Permian. The lower Carboniferous Wuchihshan series must come between the upper limestone and Middle Devonian shale and shaly limestone.

From Tahsipo, where we had out lunch, we cross the river to the W. bank. 400 m SSE, black shale strikes N 4° W dipping 40° W. 200 m further we crossed back to the east bank where the same shale strikes E-W dipping 10° N, but soon it dips again steeply toward west. 400 m further the same shale strikes N 49° W dipping 20° NE this is the general dip. 700 m we cross over to W. bank where the shale strikes N 20° W dipping 26° ENE. 1000 m further the dip increases to 40° in the same direction. Here are few huts by the river side near a branch ravine.

1600 m SSE the shaly series becomes more metamorphosed and harder, striking N 30° W dipping 26° ENE, the road turns WSW for 550 m, then S.

1 轉馬村 2 楠木村

again following the horse-shoe bend of the river. The upper limestone cliff to the east recedes away from the river (further to the east).

200 m SSE we come to a small stream coming from west. From now on for 800 m to Lannga[1] we come to the hard sandstone series much metamorphosed with tin and antimony ores. The strike and dip are extremely variable—at first it strikes N 53° E dipping N. then N 10° W and dipping 40° S, and finally N 56° W dipping 40° NE. (For Lannga see Kuangsi report).

600 m from Lannga after crossing the river 3 times we came to Hueilo[2] where we stayed in the mining company.

14 February 1930: From Hueilo to Nantan

We went back to Nantan by the same route.

At Erhhochiao we followed the side valley SSW into a narrow ravine cut in solid limestone with nearly vertical dips. The main road to Tachang branches off about 1600 m from Erhhochiao southward, whilst another road follows the canyone to the S.W. We went along the Tachang road for 600 m and saw from the low pass that to the S and SW there was nothing but solid limestone. This limestone is greenish in colour, extremely hard, rather cherty and absolutely devoid of fossils. It may be metamorphosed Lower Permian limestone. Then we turned back to follow the canyon to the SW., tried to find fossils, but without success. (Compare Wang's section).

15 February 1930: From Nantan to Tashan

We left Nantan for Tashanchang[3]. At first we took the road W. of the one we came by. Here the brownish sandstone and spotted gray shale strike N 38° W dipping 44° NE. changing to strike N 20° E dipping 68° ESE. Near to the stone bridge it strikes N 46° W dipping 44° NE. At the stone bridge the road joins the main road by which we came to Nantan.

Arriving at Pingchiao about 1, we had our lunch there. Then we started for Tashan. The road branches off the main road immediately N of Kungchiao[4] N. of Hsiahuangchiang[5]. There we ascend a steep slope in yellow brown shaly sandstone and impure black limestone dipping 15° ENE. 300 m N we are on the east side of a deep canyon cut in the sandstone. On the other side of the valley a high mountain formed by silicified limestone and hard sandstone 400 m above Kungchiao

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1400 m N and 150 m above Kungchiao ferrugenous quartzite strikes N 20° W dipping 30° NE. 400 m further N we came to a reservoir made for washing the tin ore. Here we crossed to the W. side of the stream where the quartzite strikes N 32° W dipping 40° NE. 800 m N we come to Tashanchang where the hardened shale strikes N 82° W dipping 39° N.

Stayed at the temple which was without doors.

16 February 1930: From Tashan to Mangchang

We went westward from the stream at Tashan accompanied by the manager Mr. .... up a low divide. At first the road lies in reddish shale, then in greenish sandstone. 100 m above the stream it strikes N 20° E. dipping 44° WNW. 100 m W. top of low divide. From here we have a good view of the country to the W. and NW: a deep valley coming from the N. is joined by another from the NNW. about 1500 m NNW. of the divide. In the latter branch a large village named Kungmingtai[1] is seen. Below the junction and on the W. side of the main valley is the NNW-SSE sandstone range the highest peak of which is called Kuahungchang[2] said to be a famous lead-silver mine.

60 m down from divide same sandstone strikes N 20° W dipping 32° ENE. The road now follows the deep valley at a level 200 m above the valley floor round the west slopes of Tashan which is some 320 m above Tashan village, forming a conspicuous peak.

Descending 150 west we turn SW. to go up gradually. Near the small spring 1000 m from divide, the sandstone is nearly horizontal, but 300 m further it strikes N 68° E dipping 20° NNW.

At a point 400 m further on quartzitic sandstone strikes N 80° E dipping 17° N. Descending slightly for 40 m it changes to strike N 65° E dipping 34° N. 350 m SW round the corner is an abandoned tin mine.

420 m up we are at the pass above Lanao[3]. Descending steeply and turning to SE for 200 m we come to the mines of Lanao proper. These are situated on the SE. slope of the mountain on the W. of the pass by which we came, and on the W. bank of a deep ravine flowing SW. to join a N-S valley some 1,500 m away. On the W. side of the main valley are imposing limestone cliffs.

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1 孔明台 2 掛紅廠 3 濫坳

At Lanao mine the metamorphosed sandstone strikes E-W dipping 50° S. The huts were empty. With an oil lamp found there we tried to descend into one of the numerous mines, but soon had to turn back owing to the dangerous conditions under ground, as it was unsafe to go deeper without a guide. We took some samples of the ore from the heap pyrite veins in shaly and sandy rock.

We turned back and returned to the pass above. Thence we went along the ridge NW-ward for Lanpai[1]. Here the sandstone strikes N 52° W dipping 44° S. 1000 m further we began to descend into another ravine. The sandstone now strikes N 70° E. dipping 18° SE? But the sandstone mountain to the S. forming the SE. bank of the valley seems to strike NW-SE dipping steeply SW. 500 m lower down we are at the mines of Lanpai, but as the huts were also empty we could not go down and we started to go NW. up a small divide. 20 m further we suddenly came upon an outcrop of a granite which is however too deeply weathered to go give any satisfactory specimen. It is seen only that dark minerals are rare and large quartz grains are scattered in the completely kaolinised felspars. Another 50 m we have the NW. contact between the granite and the sandstone. Going in the same direction for 200 m we are at the top of the divide. Turning to go NNE for 220 m gently upwards, we came to the mine of Taotzuwo[2]. Fortunately there are 2 mines working so we descended into the shallow pit on the steep cliff. They are working small veinlets ½ mm — 2 mm in silicified limestone 0.60 m thick inter-bedded with quartzitic sandstone. The cassiterite crystals are very minute and are free from any association with the sulphides. We returned to Lanpai mine together with the miners and had our lunch there. After that we got back to Tashan village by the same route.

The various streams we have seen from the pass W. of Tashan village to Lanao unite to form a river which goes NNW to Wangchiang[3] 50 li from Tashan, where alluvial tin is worked. The annual output of tin from the last amounts only to 600 catties whilst the total output for the whole region of Tashan is about 2 tons. Price paid to miners for worked ore is on the average $0.30 per cattie. The miners as well as merchants are Makas.

From Tashan we follow a branch stream eastward. At first the black calcareous shale strikes N-S dipping 60°-E, but 250 m from Tashan at a bridge on the right of the road shaly limestone strikes N 50° W. dipping 48° NNE. 500 m from the bridge after crossing the stream 3 times we come to yellow shale striking N 48°

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1 濫排 2 桃子窩 3 王江

W. dipping 50° east. 200 m N. the valley widens and the road turns eastward for 400 m passing the village of Tashantang[1] on the left. No clear outcrop, but the dip probably becomes gentle. We now ascend a low ridge north-northeastwards where dark shaly limestone strikes N 45° W. dipping 20° NE. The fantastic peak of upper limestone to the NE. which lies between our road to Mangchang and the one leads to Huangchiang[2] is well seen from here. 200 m further where another road branches off to Lama which could be seen from here, the black shaly limestone strikes N 20° E. dipping 54° ESE. decreasing to 30°. Going up NE. black shaly limestone is overlaid by quartzose sandstone and sandy shale. 200 m further the road turns NNE., always ascending and the sandstone series is now overlaid by thin-bedded limestone with shale which in turn is overlaid by the upper pure limestone forming the peaks of Hsienjenchang[3] mentiond above, and 450 m N we are at the top of the pass where the latter dips gently east, whilst the former which forms the low isolated hills to the W. of the road is nearly horizontal. The road is in the thin-bedded limestone, all the way to Manchang which is 800 m NNE. from the pass.

17 February 1930: From Mangchang to Mienhuatsun[4]

From Manchang we went back by the same road to beyound the ruined boundary tower 2,000 m S of Ssuting, then took the branch road to Liuchai[5]. The road lies between conical hills formed by the Upper Permian Maping Limestone, and is practically level. From the point where the Liuchai road branches off to the village of Chekengchai[6], a distance of 3,000 m, and from the last named village to Mienhuatsun, another 2,200 m in distance, all in the general direction NW., the greatest difference in height is 20 m. The Upper Permian limestone is almost horizontal all the way, and the road level is in the contact between Upper Maping Limestone which is of great purity and marble-like in colour, and the underlying shaly black thin-bedded limestone which probably still forms part of the Maping Limestone. For this reason we have several streams having their valley floor in the shaly rock, flowing in the NE. direction.

Just east of Mienhuatsun we made a large collection of beautifully preserved fossils. The white limestone is of great purity, easily breaks up and the fossils are often separated from the surrounding rock by simply hammering (T242).

We stopped at Mienhuatsun in a relative of Mo's for the night.

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1 大山塘 2 黃牆 3 仙人寨 4 棉花村 5 六寨 6 者坑寨

18 February 1930: From Mienhuatsun to Nanchai

Just outside Mienhuatsun we made another large collection of fossils (T242a) from the Maping Limestone. The road at first goes west. After 250 m it turns NW. Another 550 m it turns again west. So far the road is nearly level. Now it goes over a low pass 15 m above the valley floor, the top of which is reached 250 m W. of the last observation. Here the Upper Permian limestone strikes NNE-SSW. dipping 20° W. We then descend 600 m westward to a bridge over a small stream flowing NW. near Chean[1].

Going in the general direction WNW. for 850 m, we came to another low pass, then descend another 800 m zigzagly to a stream flowing west. The road goes up westward for 150 m in limestone which strikes N 5° W dipping 62° E and through which the stream has cut a narrow deep gorge. We then descend westward 400 m and find ourselves in shaly and sandy rock dipping steeply under the pure limestone to the east. We then go NNW-wards along the strike for 600 m coming to another small stream flowing south. This valley is situated between 2 ranges of limestone each of which has a low ridge of sandstone and yellow shale as foot hills, and the valley between represents the axis of an anticline. By the river side the shaly limestone in part looking rather like that of Wuchihshan, strikes N 16° E, dipping 30° E, changing to strike N 15° W dipping 60° 600 m further N. Here it contains *Schwagerina,* corals and brachiopods which seem to be those of lower Maping Limestone.

We go nearly N. along the axis of the anticline, 600 m further we are at top of a low divide 10 m above the valley. Descending northward for 200 m we come to another stream coming from the east and turning to flow N. The road follows on its W. bank for 400 m then crosses it where there is a water mill. The shaly limestone here strikes N. 75° E dipping 38° S. Soon however the strike is N-S again and the shaly limestone to the west seems to dip 40° W.

350 m N from the last crossing we cross another branch stream coming from the N. and the road is now in yellow shale which forms the western limb of the anticline. 800 m further we are at the large market town of Liuchai where a limestone hill with a tower stands just east of the town, overlying the shales below. At Liuchai we had our lunch at an open-air gambling house.

From Liuchai on the road turns east again. It is still in shale without any definite outcrop. The anticline seems to extend northward from Liuchai 1,200 m

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east, after entering a narrow ravine in the upper limestone which strikes NNE-SSW dipping 20° E. We begin to ascend a low pass. 450 m NE we are at the top of the pass and the limestone strikes N-S dipping 30°-east. Descending gently we soon find ourselves in a wide plain surrounded by horizontal limestone forming isolated cones. 800 m NNE we are at another low pass in limestone where the motor road from Tushan terminates. From here on northeastward we are in a wide enclosed basin the soil of which is formed by a white limy deposit partly dissected which may be a recent lacustrine deposit. 2,000 m further we are at Nanchai —Mo brothers came out 2,000 m to welcome us.

19 Feb. 1930: From Nanchai to Huanghou[1]

Follow same road to Matao whence to SE, limestone dips 15° NE. At Matao wide plain to near Nanchai. Emerging from mountain to another plain, that of Yaolan[2], branch road to Sanpang[3], village on left. Valley narrows and we are in mountain again. Limestone St. E-W dip 19° N. After about 1,500 m we cross a low rocky pass and desend into another small basin—limestone still dips 10° N. Then stone bridge over dry river just S. of hill where limestone dips S.

20 Feb. 1930: From Huanghou to Laao

Road all the way from Huanghou to Manchai[4] all in Maping Limestone—in the yellow shaly layers. About 3 li a rocky pass. Then another 3 li Minchiaao[5]. 10 li from Huanghou, Manlin[6], 13 li Manmu[7], 15 li Manchai. Higher range on left all the way, softer beds on right St. ESE dip 15° NE. Manchai is at the foot of a rocky cliff along which in the direction of SE-NW is a valley. Road crosses to left in thin yellow shaly layers forming a low foot hill (NW-SE) in front of higher limestone mountain. Road then goes round high round-topped mountain on left with horizontal limestone. Soon road in mountain turning to left but still in soft beds. Then coming to stone wall with 2 hills in dark greyish limestone full of *Schwagerina* (T244) St. N 80° W dip 20° N. Then descending along left side of ravine in limestone. Road partly in soft beds—an isolated small hill in valley. Then a small pass; mountain becomes more rugged dipping constantly 20° N. Coming out from the narrow ravine into a wider valley still walled by solid limestone cliffs but with low soft rock in foreground. View of rugged high NW-SE range in front village [Huangtsaoping[8]]. Just W. of village in silicified limestone *Schwagerina* and crinoids (T245). At foot of pass quartzose sandstone, chert

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1 黃后 2 姚欄 3 三捀 4 蠻寨 5 悶家坳 6 蠻林 7 蠻木 8 黃草坪

and partly silicified limestone all fossiliferous—corals, large schwagerines, gastropods and brachiopods (T246). Also badly preserved plants in white sandstone. Interbedded is also ferrugenous brecciated sandstone. At pass above Liulin[1] St. N 60° W dip 10° NE. We cross this long pass, descend rather steeply to the valley of Liulin.

From Luilin going along foot of cliff on left, up valley on right. Road in reddish clay. Limestone St. N 20° W dip 10° E (800m-1,000m from Liulin). 600 m further road turns NE. High horizontal limestone cliff on right of valley, on left all yellow shale. Going along dry valley. Then similar valley on left and right where limestone seems to dip SSE. About 5 li from Liulin valley narrows down, limestone St. NE-SW dip 30° SE. 50 m further view of village Laao[2]. Limestone becomes more and more intercalated with shale. Road then turns to right into a valley with stream—going down crossing it by a bridge—then in shale to Laao by large river.

21 Feb. 1930: From Laao to Pahui[3]

Ferrying across large river cut in shale, brown shale underlaid by limestone at riverside. On E. bank it strikes N 60° E dip 26° SE, interbedded with grey limestone. Road now follows a narrow ravine at the mouth of which reddish grey limestone St. N 30° E dip 65° E, with *Schwagerina* and small brachiopods (T247). Follow ravine up 350 m, turn left into branch ravine, view of Langpotang[4]. At pass, hill seen on right St. N 40° E dip 60°-80° SE, corals, schwagerines and brachiopods (T247a). On left it is nearly vertical dipping 80° W. Then we go along right slope of mountain with narrow blind valley on right St. N 33° E dip vertical. Going down, erosion surface full of corals and schwagerines—Lower Permian. Where road crosses ravine to right, limestone on left dips 30° ± but on right and in front of us [complicated structure with prevailing steep dips]. Then up small pass— stone wall, limestone on right St. N-S dip vertical. [Dr. Ting's handwriting is hardly readable for the rest of the day's traverse.].

22 Feb. 1930: From Pahui to Lipohsien[5]

Road goes along river. On this side narrow flood plain which is somewhat wider than that on the other side. At stone bridge, outcrops of green soft shale dip 38° E. Road then goes right near outcrops of *Gastrioceras* shale. 150 m from river bend St. N 30° E dip 55° E. At bend shale St. N 30° E dip 50° E. Then

1 六林 2 拉㘭 3 巴灰 4 浪波塘 5 荔波縣

bridge and water fall. Road goes away from hill until bridge of Lakao[1] where hill comes behind village, St. N-S dip 20° E. Opposite Futsun[2] St. N 36° E dip 53° SE. One house on left and Layü[3] on right on the other side of river [?]. Thence hills close in on both sides, then bridge. *Gastrioceras* limestone seen in a distance. At river head *Gastrioceras* limestone St. N 25° E dip 50° E. Few meters further greenish limy shale St. N 78° E dip 20° N. At bridge behind which all limestone, limestone in river St. N 55° E dip 45° SE. Near river bend *Gastrioceras* limestone St. N 75° dip 39°. Bridge beyond which coal series? limestone with corals and schwagerines (T258) St. N 30° E dip 45° E.

23 Feb. 1930: From Lipo to Shuiti

Going along river bank, after 2 small bridges (200 m from city), good outcrops of gravel bed consisting largely of quartzite pebbles about the size of a fist and smaller—here and there some chert and limestone, no fossils. Few steps after Liangting[4], gastropods in red soil (Recent?). Then on cliff at side soft reddish sandstone St. N 20° E dip 20° E (with doubtful pelecypods T259) lying unconformably on limestone, which is cherty and contains coal series?, coals outcroping at bridge opposite Paao[5]. St. N 25° E dip 5-7° E changing to N 5° E dip 57° E. Road turns to enter mountain, shaly limestone St. N 25° dip 50° E. After Shihhuiao[6] road goes along strike for about 1,000 m, then turn to cross strike again. Descend a little, then Shihpaipo[7]. Up first pass to go up again to the right, typical Lower Permian limestone St. N-S dip 10° W. Steeply descending from Shihpaipo, go up a low pass, then descend a little, then up again to Maopeng, limestone dipping 15° E. Then up pass again, yellow shale and shaly limestone forming low hills below. The limestone looks like silicified limestone but quite pure; it contains ostracods and in the yellow shaly part fossils (T261) are found. Then black shaly limestone also with fossils (T261a).

After Hsiashuilung[8] quartzitic sandstone and yellow shale St. N 40° E dip 15° SE overlaid by yellow shale and black shaly limestone; then massive limestone cliff. Near top of pass below cliff quartzitic sandstone St. N 25° E dip 20° E. At pass of Shangshuilung[9] sandy crystalline limestone with *Schwagerina*? and corals (T262). Then flat country ahead—low earthly range running NW-SE. Quartzitic sandstone after bridge St. N 60° E dip 10° SE. Isolated limestone mountain on left near bridge. Go up pass in quartzitic sandstone. Cross valley, up low pass in quartzitic sandstone which extends to right but on the left limestone

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1 拉高 2 富村 3 拉魚 4 涼亭 5 巴坳 6 石灰坳 7 十排坡 8 下水龍 9 上水龍

hill 1,000 m away. Here it strikes N 40° E dip 10° SE. Descending to Shuiti black shale, then brown sandstone with indistinct plants?

24 Feb. 1930: From Shuiti to Fangtsun[1]

Limestone cliff on left on village St. N 10° E dip 8° E. Crossing a bridge river flowing to right; few houses on right. Up a low pass in white crystalline limestone, same limestone as that above Shangshuilung, beds nearly horizontal. In a greyish bed corals and brachiopods (T263). Up pass Sansopo[2]. Descending steeply, at first limestone on left only but 100 m down on both sides limestone St. N 20° E dip 15° NW. Go up Lungchingpo[3], before ascent, limestone St. N 10° E dip 25° W. At pass *Schwagerina* and brachiopods (T264). At contact with sandstone and shale fossils abound (T265). After descending from an earthy low pass, bedded limestone. Then up again to go right round the mountain when it crosses the pass St. N 15° E dip 60° NW. Descending, *Gastrioceras* limestone St. N 30° W dip 35° NE, but the dip is seen to be reversed lower down? Further down St. N 30° E dip 35° E, then vertical. Then all shale to bridge. Beyond this limestone St. N 80° E dip vertical, to 70° N.

According to a miner the coal series contains one seam of noncoking bituminous coal, 4 feet thick, but all dust and no lumps.

25 Feb. 1930: From Fangtsun to Piaochai[4]

Road goes down, view of *Gastrioceras* shale forming low ridges and undulating hills St. N-S dip 40°? W. Descending to bridge where green shale St. N 20° E dip 70° W,—dip becoming 40° W 100 m away. Up on ridge, shale still St. N 20° E dip 65° W. 100 m further dip steeply E then W again below a pass. At pass dip 40° E—view of large village on left at mouth of ravine. 600 m further St. N 10° W dip 70° E. Another low pass—view of large village on right on N. slope of valley—still dipping E. 400 m, at low pass St. N 40° E dip 20° SE. Another 500-700 m St. N 37° E dip 37° E. Limestone plates begin to appear on road more and more. At low pass stone pillars. Descending 350 m thin-bedded reddish shaly limestone St. N 25° E dip 35° E, interbedded with yellow, red and green shale with purer beds of limestone—dip becoming 20° E.

Just E of Laliao[5] blocks of limestone and shale near contact of coal series with *Gastrioceras* limestone. This is underlaid by greenish shale St. N 25° E dip 39° SE. Opposite Laliao numerous *Gastrioceras* (T267), in sandy shale and partly

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1 方村 2 三所坡 3 龍井坡 4 瓢寨 5 拉料

silicified shaly limestone underlaid by cherty limestone St. N 37° E dip 19° E. which latter is full of schwagerines (T268). Then road turns WNW [by a coal] mine below which is more solid limestone. According to a miner from Chialiang[1] the coal is dust bituminous but only one seam of about 1 ft in thickness [is workable]. In purer limestone where road turns W. we found schwagerines, brachiopods and corals (T269) St. N 15° W dip 10° E. Then Chialiang village in valley.

Outside village massive limestone on right. Just before going up slope St. N 20° E dip 30° SE. On slope Lower Permian limestone with schwagerines, corals etc. (T270). The limestone is more shaly than usual—chert is present in moderate amount.

26 Feb. 1930: From Piaochai to Chihchang[2]

In the valley outcrops of reddish grey limestone breccia; associated with it are coals, and, fusulines (T272). This is a lower horizon than T271b. Dip nearly horizontal. Road then goes N in narrow valley, limestone horizontal. 5 houses on right on other side of valley—road going along E. slope of hill near Lanyenching[3] St. N 15° W dip 18° E. Good spring, then small bridge. Going up slightly opposite Tungpa[4], outcrop of sandstone on left, St. N 25° E dip 5-10° E. Road turns to left—sandstone full of badly preserved plants (T273). This is underlaid by a black shaly limestone with ostracods ? and brachiopods (T274). Then black shale. Then thin quartzose sandstone in soft yellow shale, then black limy shale St. N 7° E dip 25° W. Then black shaly limestone and black shale weathering into yellow clay and quartzose sandstone with plant fossils.

After Lanchai[5] sandstone St. N 30° W dip 10° NE. 400 m further limy sandstone St. N 19° E dip 11° NW changing to NNE dip 10° W. 400 m further village on left pavement is made of platy limestone. This limestone crops out at Sinchieh [new street] of Lanchai St. N 19° E dip 10° E—containing ostracods? Few meters further, 30 m from bridge, beautiful *Syringopora* and *Cyathophyllum* (T275) in black sandy limestone St. N 12° E dip 20° SE—quartzite between, then limestone again at bridge large simple coral underlaid by sandstone. At Laochieh beds reversed to dip 10° W. After Laochieh open low undulating country same limestone interbedded with shale dipping 12° NE. Then black to dark grey shaly limestone without fossils (= Kolaoho limestone?). Then sheet of water with village on right (Tangkuan[6])—fusulines? (T276). SSW to village on right limestone St. N 50° E dip 12° SE—full of sun-cracks. Then village Tahsih[7] on left where road

1 甲良 2 雞場 3 爛岩井 4 洞壩 5 爛寨 6 塘關 7 打錫

typical *Gastrioceras* limestone St. N 45° E dip 40° NW. Descending a little into side valley. On the way thin-bedded limestone St. N 10-15° E dip 30°-45° W. Crossing valley up slope good outcrops of *Gastrioceras* limestone St. N 20° E dip 37° W, cross-folded into small saddles. Then limestone becomes more and more shaly until reddish yellow hale predominates. 350 m to 400 m from pass on left side of valley, old pits—road full of chert but dip seems unchanged. Going right up to top of pass, all soft sandstone with silicified limestone and chert St. and dip not clear. Slight descent into dry valley—a branch valley coming from right on the other side of which is a range of limestone seeming to dip W. Road is still in soft sandstone, direction of valley SW. Limestone on the other (right) side of valley dips steeply NW. Road turns to cross strike, coal series limestone St. N 42° E dip 58° NW with fossils (T285). Then large schwagernies (T285a). Then hut on left, opposite Choushuiching[1]. Road then goes along strike, which is essentially NE-SW. [At the place where limestone St. N 45° E dip 80° NW] road turns NW across strike. Up a little to wall [?] white crystalline limestone. Up still to low pass, then descend, limestone St. (?) followed by quartzose sandstone. At pass limestone again—black and shaly and full of chert and fossils (T286) St. N 45° E dip 50° NW. Toward Tamapo[2], black limestone with yellow veins and fossils (T286b). The limestone is very dense and full of chert—fossils difficult to obtain. Immediately, pass and temple then steep descent. Sandstone and reddish shale very like *Gastrioceras* shale St. N 40° E dip 68° NW. At bottom of slope where road goes to near water on right side of ravine, shaly limestone and green shale St. N 38° E dip at first vertical then 82° E, then 5° W but soon becomes steep again towards west. When road turns to right again thin-bedded shaly limestone St. N 50° E dip 60° W. 250m from mouth of ravine dip becomes 45° NW (reddish shaly limestone with *Gastrioceras* overlaid by green shale= upper part of formation). Bridge on side stream on right, valley widens. Green shale dip 26° NW increasing to 40°. After village [Sankoshu[3]] descend to river—gravel beds. At cutting by river side 400 m SSE of city of Pingchou, shale St. N 43° E dip 33° SE.

4 March 1930: From Pingchou to Kanchai[4]

Wooden plank tied on rock forming a bridge 100 m long over river. After that low hill on right showing shale overlaid by conglomerate. 100 m further low ground again to foot of hill where *Gastrioceras* shale St. N 26° E dip 60 SE. Going up with ravine on right, about ⅔ up, St. N 10° E dip 57° E. Up first pass following the upper one of two diverging routes. Soon they join, thin-bedded limestone St. N 5° E dip 48° E. Road now goes down a ravine, then up small

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1 臭水井 2 大馬坡 3 三棵樹 4 干寨

pass view of Lissu[1] on left. Yellow sandstone St. E-W dip 40° N?—This is quite local, for it changed to nearly N-S again dipping 26° E. Go by right side of Lissu where chert limestone of coal series crops out. Then pass temple with 2 fine trees. Down a little with branch road to Tuchang[2]. Up low pass on left all cherty limestone and sandstone; then down again shale looking like *Gastrioceras* shale St. N 15° E dip 20° E.

Opposite Liangshuiching[3] on left *Gastrioceras* limestone St. at first N 50° E dip 16° W then N 20° E dip 26° E. 50 m W. of Liangshuiching before entering another ravine *Gastrioceras* limestone St. N-S dip 32° W. Up ravine on left side same limestone St. N 20° W dip 28° W. Further up St. N 40° W dip 30° SW changing immediately to N-S dipping 50° W. Road goes down again in greenish sandy shale. Fine stone bridge green shale St. N 20° W dip 45° E with plant remains and other (T287). 100 m further St. N-S dip 50° E immediately reversed to W. Then road goes round side valley. To go up slightly, Maopeng on slope to right. Yellow red sandstone and shale with platy limestone dipping still E. Near pass at side valley green shale St. N 15° E dip 42° E. Up to pass mostly greenish sandstone. Road after pass goes first to left then to right. 600 m further sandstone St. N 18° E dip 39° E. 200 m from Motaoshih[4] platy limestone, 100 m further sandstone St. N 20° E dip 36° E. After Motaoshih up slope to right, impure grey platy limestone St. N 10° E dip 30° E. Road turns W. down more shaly layers. Opposite side valley to left limestone St. N 10° E dip 26° E. Then coal series consisting of silicified limestone, shale and chert limestone St. N 10° E dip 24° E. Ravine on left. Then small bridge by which we cross to the other side, typical coal series chert limestone. Then village Liuchiawan[5] on left on the other side of valley. Cross to right side, broad plain. Maopeng on right near boundary between Lower Permian [limestone] and coal series.

5 March 1930: From Kanchai to Yachou[6]

Outside Kanchai up low pass quartzitic sandstone below black fossiliferous limestone St. N-S dip 20°. Opposite Laokanchai[7] St. N 18° E dip 28° E. Then up a steep pass breccia St. N 30° E dip 32° SE. All in solid limestone dipping 30° E. From pass a low mountain is seen [to the S.] with dose folds. Road descends, then up again, mountain on right. Made a large collection of fossils (T288). Up second pass dark grey limestone St. N-S dip 44° E. Descend to plain. Over the other side smooth-topped quartzitic sandstone. Then cross valley to go up again, quartzitic sandstone St. N 20° E dip 40° E., reduced to 25° at foot of pass. At second pass St. N 10° E dip 45° E. Descend a little, ravine with water on right.

1 李司 2 兎場 3 涼水井 4 磨刀石 5 柳家灣 6 牙舟 7 老干寨

turns to W. Then Chating on right, mountain with pine trees on left. Near Paha[1] on right same limestone St. N 20° E dip 15° SE. Fossils near Chikochai[2] (T277), St. N 8° E dip 18° E, changing into N 44° W dip 14° NE.

27 Feb. 1930: From Chichang to Tushan.

1,000 m from Chichang dense crystalline dark grey limestone breaking up into squares St. N 35° W dip 25° NE. Few steps further Tsaiyuan[3] on right. Mountain on right consists of rather massive limestone without shaly interruption dipping gently NE. Temple or Tingtzu on road. Near end of mountain on right a few houses. Road in residual clay? (reddish clay with small pebbles). Then some trees. We are in more shaly rock. Mountain on right becomes very low, of shaly rocks too. Fossils in semi-crystalline dark limestone (T278), St. NW-SE dip 14° SW. 250 m further bamboo grove; corals in pavement (T278a). Limestone black and shaly. Then village Lungchai[4]. Earthy pass on right, but limestone mountain on left on the other side of valley. 200 m again corals. Limestone also full of 2 species of gastropoda (no collection).

Near Matao[5] at Paifang (stone archway), view of limestone peak on left and two mountains ahead forming a gap. One or two houses on left—where I met Tseng. 500 m further purer limestone forming a low ridge. Few houses on right—limestone St. N 40° W dip 16° SW. Just after Tapotang[6] going up gentle slope nodular limestone St. E-W dip 16° S, changing to N 70° E dip 25° SE. Richly fossiliferous limestone (with *Stringocephalus burtini*?, T278c) St. change to N 60° E dip 10° SE. underlaid by shaly limestone. Then pass and temple. Descending, houses on both sides, limestone St. N-S dip 10° W. Soon changed to N 60° E dip 10° NW. 200 m before descending to Taho[7] St. N-S dip 40° E. At Taho bridge river flowing to E. Limestone fairly pure, nearly horizontal, St. N 60° W dip 5° SW. After ascending and descending a pass ½ li from Siaoho[8] St. N 30° W dip 15° SW. Then bridge and Siaoho. Up low slope, round to left. Quartzose sandstone, then limestone again (and soft shale!). Near a few houses on slope on left nodular limestone St. N 65° W dip 16° S. Across valley, quartzose sandstone same strike and dip; at pass increasing to 20°. Cephalopods found between Taho and Siaoho (T279).

2 March 1930: From Tashan to Paichia[9]

Outside Siaosimen[10], limestone St. N 60° W dip 20° NE. Going up left slope of mountain St. N 60° E dip 25° NW. Then descend a little to Feifeng-

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1 巴哈 2 七哥寨 3 菜園 4 龍寨 5 馬道 6 大坡塘 7 大河 8 小河 9 擺卡
10 小西門

ching[1], broad valley and village. Then side valley with peach blossoms. Then up high slope St. N 50° E dip 30° NW. Then small bridge, bluish semi-crystalline limestone with small calcite veins breaking up into small squares St. N 65° E dip 18° NW. Mulberry trees. Same limestone at place where road is level before going up again on right side of valley St. N 40° E dip 40° NW. Soon changes to dip 25°. Going up again, limestone is greyish and still impure but more platy. Up to near top, limestone becomes greyish blue St. N 40° E dip 30° NW. Top of pass still without fossils, St. N 55° E dip 20° NW. Then shaly limestone with fossils including ostracods (T280). 30 m further, begin to descend, road forming boundary between pure limestone and yellowish shale. A little further up cephalopods and brachiopods (T280a). Descending, shaly limestone interbedded with brown shale; where road makes a semicircle quartzitic sandstone overlaid by yellowish shale with poorly preserved brachiopods St. N 45° E dip 32° NW. Then quartzitic sandstone and black shaly limestone with large corals (T281). Then quartzitic sandstone again. Then massive dark reddish grey semi-crystalline limestone. Then quartzitic sandstone. Then thin-bedded limestone with *Syringopora* (T281a). Then quartzitic sandstone again. 100 m further, bridge St. N 45° E dip 20° NW. Upper part of quartzitic sandstone becomes more and more shaly with brown and light grey clay-shale. 4 groups of houses on right side of valley, road being on its left. Boundary between upper pure limestone and sandstone and shale just behind easternmost village. Near Maopeng quartzitic sandstone St. N 55° E dip 20° NW. Cross valley, up low pass to Patai[2]—pavement is a black limestone with corals (T282.) Then grey to dark blue semi-crystalline limestone St. N 50° E dip 30° NW. Then descending, dip becomes gentle, about 20°, fossils (T283). Descending into an enclosed basin St. still N 50° E dip 20° NW. Up pass, always pinkish grey limestone St. N 30° E dip 25° NW, overlaid by about 10 m of soft sandstone followed by dark blue to black limestone interbedded with shale —full of calcite veins. Descending gently by a low pass with deep valley on right, at first occur shaly layers interbedded with limestone then solid massive grey limestone in which large schwagerines are found (T284). Just about to turn to right, this is overlaid by silicified limestone, then limestone with chert. Going up slightly with valley to left, then descend, typical sandstone, chert limestone and shale of the coal series. Steep descent to Maopeng, turn to left in ravine. About 1 li from Paicha thin-bedded sandy limestone St. N 40° E dip 35° NW (in second ravine before turning).

3 March 1930: From Paicha to Pingchou[3]

Outside village of Paicha cherty limestone St. N 52° E dip 30° NW increasing to 50°. Up a valley on right sandy shale St. N 40° E dip 55° W. 150 m up

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1 飛鳳非 2 八台 3 平舟

Quartzitic sandstone and limestone range [...........]. Near road turning to left quartzitic sandstone changes strike on the other side to N 20° W but on this side it is still N 5° E dip 60° E. This is interbedded with black shale well seen at waterfall. Soon it strikes N 10° W dip 32° E. Then grey limestone with angular fracture and calcite veins.

Road then turns to right along stream with 2 houses on right (Chiala[1]). Limestone St. N 24° E dip 28° E. We are in wide plain of Chiala bounded by limestone hills. After passing Shang- and Hsiachala, turn to left, with plain narrowing a little. Near Shangchala corals found in black limestone (T289), dip still 20-25° E. After Pinghopa[2] limestone dips 20° W. After Kanmatang[3] limestone seems to be underlaid by quartzose sandstone, St. N 20° E dip 40° SE. Going up pass in quartzose sandstone St. NW-SE dip 25° NE. At pass it strikes N 35° W dip 32° NE. General strike as seen further on seems to be N-S. At second pass quartzose sandstone St. N-S dip 12° W. Crossing a ravine and up to low pass same St. N 20° W dip 20° W.

6 March 1930: From Yachou to Chiussu[4]

Outside Yachou black limestone St. N 30° E dip 12° W. Go up very steep pass, corals found (T291). At pass with temple St. nearly N-S dip 25°-30° W. Further up St. N 15° W dip 30° W. Steep descent, then over low pass, down and up again, dip becomes gentle (15° ±) St. N-S. Descend again and up low pass the descend gently going by left (with ravine on right). Round up pass again limestone St. N 40° E dip 22° W. Descend and cross to left, some sandstone on S. side of valley but no clear outcrops. It is overlaid by black platy limestone. Hut on left (Kankung[5]). Up low pass limestone with coral (T291a) St. N 10° E dip 35° W. Down again limestone St. N 20° E dip 28° W. Soon shale and quartzitic sandstone with houses on right. Then black limestone again followed by black shale and quartzitic sandstone forming a range on left side of valley.— black shale lower down in contact with black limestone on road 50-60 m from last point. 2 bands of black limestone on the slope, then other bands on [upper slope] interbedded with shale and sandstone. Further up to small temple about 3 more black bands of limestone St. N 30° W? The limestone at pass St. N 4° E dip 42° E. On steep descent 2 solid limestone ranges are seen to the west beyond which is a plateau. Road turns to right along strike—schwagerines in limestone (T292). Deep valley on left forms axis of anticline.

Outside Lintang[6] limestone St. N 20° W dip 60° SW. Then very steep descent with Lower Permian limestone St. N 12° W dip 85° W. 130 m from bridge

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1 卡拉 2 平和壩 3 看馬塘 4 舊司 5 干貢 6 令當

after Panchiao[1] platy green and brown sandstone St. N 20° E dip 30° W. 200 m further, conglomerate of limestone pebbles usually 2-3 cm up to 30 cm across. The pebbles are cemented by calcareous cement, forming a red cliff. The dip is very gentle to W? Near end of conglomerate cliff brown shale St. N 15° E dip 56° W. Just above Hungyenho[2] *Gastrioceras* limestone which is better exposed at river side St. N 15° E dip 48° W. On the western side of river typical upper coal series limestone with chert St. N 5° W dip 40° W. Up to point 840 purer limestone St. N 55° dip 20° SW. Descending mountain on right seems horizontal but on left the strike is N 25° W dip 80° W.

7 March 1930: *From Chiussu to Tatang*[3]

Outside Chiussu shaly limestone St. N 80° W dip 9° N (very like Devonian) with *Syringopora* (T296). Few huts still called Chiussu black shaly limestone St. N 80° E. dip 7° S. Mountain on right far away upper part of which is more massive limestone, on slope probably quartzitic sandstone and shale. Lower down shaly limestone. 100 m further St. 80° W dip 7° N, up gentle slope between 2 small valleys at (1,025)*, brown shale with beautifully preserved *Productus*. Near top of pass St. N-S dip 10° E. Black limestone with corals (T296a). Descend a little 2 huts on right. (1,150) quartzitic sandstone, 50 m highest point, then limestone 1,000 m further (1,180) chert and silicified limestone. Descend into a shallow valley. Up a little, sandstone St. NW-SE dip 12° NE. Road more or less along strike going round head of ravine turning to right. Silicified limestone again overlaid by black fossiliferous limestone which is [near] Jungtung[4]. High cliff of Tatang in front [trending] N 20° W. [Then] come to limestone cliff. It is purer—but still black and shaly—perfectly horizontal, same *Syringopora* (T296b). Overlaid by silicified limestone, shale and sandstone. Where I met Tseng black shaly limestone with corals (T296c) again overlaid by yellow and black shale. Silicified limestone St. N 35° W dip 5° NE. overlaid again by black limestone.

Descend slightly shale again. Up steep slope, at base shale overlaid by platy limestone which [persists] up to top of pass, St. N 35° W dip 10° NE.—very large corals (T296d). Tseng's mark immediately above quartzitic sandstone again overlaid by limestone. 80 m from last. It is also interbedded with black shale

1 板橋 2 紅岩河 3 大塘 4 冗洞

* Figures in parenthesis indicate aneroid reading in meters. It is probable that Dr. Ting and his topographer (Mr. S. Y. Tseng or his assistants) carries separate aneroids so that the readings given by him are usually different from those on the field sketch map which in the work of the topographer.

and quartzitic sandstone. At Chalu[1] limestone over sandstone (only 2 m thick), then yellow soft sandstone right to top. View of Tatang.

Whole city only [about] 100 houses, city wall 200 m in diameter with N and S gate. [Within the city] only Chenhuangmiao[2] and Yamen.

8 March 1930: From Tatang to Touti[3]

In city quartzitic sandstone St. N 40° E dip 9° SE. At (1,495) limestone St. N 80° E dip 5° NW. Descend to shallow valley where shaly black limestone horizontal. Large corals (1,480). Up slope (1,530) quartzitic sandstone. Small temple (1,570), several changes of Strike and dip. 100 m from temple quartzitic sandstone St. N 80° E dip 20° S.— then N 80° W dip 10° S. Descend a little. Then up again quartzitic sandstone horizontal. Descend very slightly on head of valley and up very little. [Flat] valley on left to the W. of which shaly limestone forming cones. Up very flat hill in gray clay shale with quartzitic sandstone block here and there. Down on low watershed with valley on each side. Then up a little again. Round [?] going all the time N. Quartzitic sandstone horizontal. Before descending to flat valley sandstone St. N-S dip 7° W. 50 m further St. N 9° W dip 20° W. Passing a shallow low ground and up a few meters quartzitic sandstone St. N 80° W dip 7° S. very flat land, view of Chiapa[4]—flat ground materially all formed by gray shale—very little sandstone.

To Shangchiapa[5] 32° W about 2,000m ±, Limy sandstone in gray shale St. N 10° W dip 6° W. Then ruined watch tower, St. N 30° W dip 4° W.

About 700 m from Shangchiapa St. N 85° E dip 15° N. 100 m further St. N 70° W dip 15° S. 100 m further St. N 6° W dip 85° SWS (local). 100 m further St. N-S dip 15° E. Near Chiapa St. N-S dip 6° W, changing to N 42° W dip 3° SW.

Rested at Shangchiapa. Entered a Miao[6] house. Lusi[7] wall, 3 *chien,* one cow on right, open hearth in middle. Rubbish and mill on left. 2 stones [?] bamboo ceiling on which they sleep. All fled on our approach.

After Chiapa cross wide flat plateau with rice fields. No outcrop. Approaching round-topped hill [?], descending to (1510) black shaly limestone outcrops nearly horizontal. Then sandstone underlying St. E-W dip 15° N. Then black shaly limestone forming cliffs interbedded with shale and sandstone St. N-S. dip 15° ± E.

Limestone black shaly with chert—corals (T297). St. N 20° E dip 12° W still interbedded with-sandy and shaly layers. Met Tseng. Descend to small temple.

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1 岔路 2 城隍廟 3 斗底 4 加把 5 上卡巴 6 苗人 7 蘆席

Descending shaly and sandy layers again below limestone St. N 15° E dip 9° W. (1,470) quartzitic sandstone. At (1,410) limestone cliff horizontal, on left. (Sandstone full of ripple marks).

9 March 1930. From Touti to Paichin[1]

.... but still platy limestone dip 10° ± W., contains some large corals and brachiopods. Did not collect large corals, but look for some brachiopods and one smaller coral (T298). St. at point where valley ends is N 65° E. dip 20° NW?

Small temple, St. N. 55° SE. dip 12° NW? Big *Productus*. At high pass St. N 15° E dip 20° W. Descending, limestone becomes purer and purer, forming massive cliffs—one coral (T298a). Crossing to right side of ravine, up low pass, St. N 20° E. dip 5° W. Pure limestone also characterised by large corals and large brachiopods. Follow the right side of another valley, limestone with more of brachiopods St. N 20° E dip 4° SE—more cherty. 4 huts in valley. Up narrow path, then descend into another valley still in the right side. Up pass, descend, Liuchai[2] |seen| on other side of valley. Sandstone with large corals and brachiopods St. N-S dip 4° E. Water mill, quartzitic sandstone blocks. Bridge. Road along river up massive flat limestone St. N 5° E dip 4° E. About 500 m from bridge quartzitic sandstone outcrops St. N 13° W, dip 12° E—ripple marks. Up slightly in limestone again. Met Tseng, quartzitic sandstone again.

Stone pillar bridge, crossing to left. Then Laipiho[3] halfway between latter and mouth of ravine quartzitic sandstone dominating. Quartzitic sandstone opposite Limuchai[4]. St. N 40° W dip 7° E. Beyond Limuchai lower shaly limestone St. N-S dip a few degrees E. At ruined bridge below Tsingshuinien[5] quartzitic sandstone St. N 45° E dip 20° NW. At Tsingshuinien limestone St. N 75° E dip 20° NW. A few steps further St. N 82° dip 18° NW. Branch valley on the right village on the left. After the former, limestone is more massive. Descending |......| bridge. Road along right side of ravine in sandstone.

10 March 1930: From Paichin to Tingfan[6]

At bridge limestone cliff seems to be horizontal; ahead 2 low hills between 2 Mts. Went by temple over very low pass. On the left low hill forming a range before limestone. Not certain but very like. There low ground is formed by soft yellow sandstone. Bridge. Then up sandstone slope, silicified limestone containing *Schwagerina* (T299). Coal series! Descending a little, turn to right, up pass. Descend again, always in sandstone. Valley to right, mine 1,000 m away in NE direction. Sandstone and yellow shale seem to be dipping very gently NNW,

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1 擺金 2 六寨 3 癩皮河 4 梨木寨 5 青水碾 6 定番

overlaid by thin-bedded limestone on hill on right. Level road in coal series, sil. limestone and sandstone and shale dip horizontal going on right side of a shallow valley. Kuchungshan[1] on left (said to be 10 li from Paichin). Road on left side valley. About 600 m further sandstone St. N 70° E dip 44° S. 500 m and further coal series (?) limestone St. N 75° E dip 27° SE—limestone remeasured = N 16° E dip 35° E. Limestone white and semicrystalline, *Schwagerina* (mellon-like) (T300). Up very slightly 100 m in limestone. Cross over to right side of new valley. 400 m further limestone massive pinkish gray St. N 18° E dip 20° ESE. 420 in further houses on both sides, Tahuoshao[2]. Limestone cliff on hills on both sides. Road run, to be in silicified limestone. Limestone free from chert. 100 m further road above [?] in limestone which is white with ½ m of conglomerate .... [?] Road then coming to silicified limestone and sandstone forming low hills just E of Lanmuchiao-Pochiao[3] on both sides are massive white limestone cliffs. Descending all the time gently to dead valley. Then Lanmuchiao-Pochiao on left on the other side of valley. Descend gently to bottom of valley, then up rocky slope to Lanmuchiao. Dip becomes less than 15° E.

Stopped at Lanmuchiao for lunch, afterwards go up low pass in solid limestone—small temple. St. N 10° E dip 23° E. Coral (T301). Level ground, then up a little, solid limestone St. N 25° E dip 20° E. Just before descending shaly thin-bedded limestone between solid limestones. Steep descent, limestone is black—corals (T302). Descending a little, large corals (T302). In sandstone, not *in situ*, gastropods and brachiopods (T302a). Then large corals and large brachiopods also occur (T302). St. N 45° E dip 14° E on left N 20° E on right. Over another pass, then descend steeply again. St. N 45° E dip 10° SE. *So far all dip to E.* Road turn left then right. Up low pass, St. N 45° E dip 10° ± SE. Large coral—fine specimen (T302b). [Toward] Chiwoshua[4] limestone more and more shaly. Road to left, St. N 60° E dip 5° S. Road at front turns a little to left, then to left again (to S) in solid limestone again. St. nearly E-W dip 10° S. Cross pass, turn to SW, then W. Descend to Chiakou[5] St. N 35° W dip 25° W coming into white limestone again.

400 m further solid white limestone St. N 12° E dip 62° W, overlaid by shaly blue limestone—thin-bedded. Then solid limestone, dip reversed to E becoming nearly horizontal, but near contact with sandstone [?] it suddenly dips steeply W. Black limestone full of calcite veins. Then sandstone and shale and

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1 古冲山 2 打火哨 3 爛木橋坡脚 4 雞窩哨 5 夾溝

limestone again. Contact between lower limestone and shale at bridge and Shaopeng[1]. More than 100 m further upper gray limestone with *Schwagerina*? (T303). Descend, turn to left, across strike which is N-S, dipping 25° ± W under sandstone. Contact again at bridge. At small temple on left, limestone in coal series. Descend to valley, up Wangchengpo[2]. At Poting[3] typical cherty coal series, limestone St. N 40° E dip 27° E! Immediatly become N 50° E dip 15° W. Descending, chert St. N 20° E. Then Yenpêng[4] in right. From here it is seen that Mt. on right consists of cones, but with steep escarpment towards, the plain.

11 March 1930: From Tingfan to Tuchiao[5]

Heavy sand storm. City is built on Pliocene gravel and red clay, which from a low ridge on left, 20-30 m high right to large stone bridge. River cut in red clay.

After Changling[6]. We cross gravel and red clay Mt. Road about level of red clay. Gravel consists mostly of quartzitic sandstone pebbles—largest one 30 cm., mostly 1-5 cm. Pavement stone, limestone conglomerate may also come from this horizon. Mt. on left only 800-1,000 away. Round-topped and flat, certainly not limestone—said to be of sandstone and shale beyond which coal is said to occur. Probably *Gastrioceras* limestone and shale. From Shaching[7] it is seen to NW but dip 45° ± E. *Gastrioceras* limestone is used for pavement here. Specimen. Chihtu[8] low hill—red clay below gravel above. Anthracite dust comes from a place about 10 li to the west. 400 m N. from Chihtu, on left, coal series, limestone with fossils (T304). St. N 30° E dip 60° E. From place marked on Tseng's map we enter low hills consisting of a very cherty limestone. After passing a large village on left and a small temple on right, cherty limestone and shale St. N 35° E dip 65° NW covered by red clay on the top. The latter dip 14° towards SE.

Top of low pass. Descending into coal series again. Limestone on right is seen to dip 25° ± NNW (steeper). Descending slightly and then up again; here on left limestone seems to dip 35° ± SE? Village of Tungkou[9] on right. Descending very gently, platy *Gastrioceras* limestone St. N 4° E dip 67°-70° E. From last point to small temple on right 480 m—platy limestone on right, typical *Gastrioceras* shale on left. Temple to first house of Tuchiao 280 m.

13 March 1930: From Tuchiao to Huakolao[10]

200 m from bridge outside Tuchiao on left at first *Gastrioceras* shale, then limestone St. N 10° E dip 67° E. Just beyond *G.* shale below limestone over-

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1 哨棚 2 望城坡 3 坡頂 4 烟棚 5 土橋 6 長嶺 7 沙井 8 赤土 9 洞口 10 花格老

turned to dip W presumably below coal series limestone. It is also cross-folded. Gradually rising ground at place where I meet Tseng. *G.* shale on left St. N 50° E dip vertical faulted and crushed—sheared. On right still *G.* limestone. At highest point (200 m from last) *G.* shale St. N 20° W dip 35° E still cross-folding. Flat ground, then rising again. 300± m further *G.* limestone on right St. E-W dip 22° N. At highest place where highway ends, impure silicified? limestone looking like Trias, St. N 10° W dip 53° E. Higher Mt. (formed by coal series? limestone) nearly on right. Descending, same limestone St. N 5° W dip 70° E.—pavement stone thick and platy. Higher Mt. on left close by road (limestone of coal series?). Bridge. Shaly rock on both side, but on right platy limestone outcrops here and there. Changtien[1] on right, in village, platy dense limestone St. N 45° W dip 72° E.—cross-folded and sheared. Up steep pass. First highest part [?] temple on right. Third pass with village on left at head of valley. Limestone in yellow shale on right St. N 25° E dip 57° E. Descending just N. of Sankuan[2] shaly limestone (*G.* limestone?) St. N 25° E dip 52° E (Just opposite Maopeng[3] on right). Just above the last, platy limestone St. N 5° E dip 67° E. Then St. N 20° E again. Highest point between Sankuan and Siaoshan[4] thin bedded gray limestone containing ammonite—badly preserved (T305), St. N 20° E dip 66° E. Immediately W is *Gastrioceras* limestone behind which is high Mt. formed by coal series limestone—W of which is Lanpa[5] coal mine. This Trias? limestone is thin-bedded and cross-folded.

Then Siaoshan over low hill, seems to be in limestone. Coal series on left, not far with low valley between road. Descending a little Trias limestone on right St. N 7° W dip 45° E, soon shanging to N 7° E—average N-S.

At bridge same limestone St. N-S dip 47° E partly yellow and sandy—dolomite? Up a little and descending we are in *Gastrioceras* limestone on left, but on right Trias limestone St. N 3° W dip 65° E. Soon in shale above, platy Trias limestone. Higher Mt. on left near road, may be of Trias limestone?

Singshao[6] view of Tsingyen[7]. Low hills on right (shaly limestone). Higher Mt. on left. Soft rock in valley between, massive limestone ahead, beyond Tsingyen. Met Tseng, Trias? limestone St. N 7° E dip 82° E.—It becomes more massive than usual although still overlaid by yellow shale. Right to Tsingyen road in the same formation, no change of strike and dip. Bridge Mt. on left on one of which is a large temple, seems to be coal series limestone? At Maopeng opposite Tsing-

1 長田 2 三關 3 茅蓬 4 小山 5 爛壩 6 新哨 7 青岩

yen (S. of), Trias limestone St. N 12° W dip 36° E. In Tsingyen well paved town with fine wall. Temple hill, platy limestone seems to St. E-W dip 25° ± N. In the city white marble [?] like limestone outcrops. Outside city wall Trias limestone St. 15° W dip 33° E. 3 bridges wide plain. Another bridge, we come to limestone hill—up steep slope. To the W. low hills behind which are seen high rugged limestone Mts. On the east high limestone, looking like lower Permian. On slope at front, Trias limestone St. N-S dip 35° E then turn to dip 57° W. Then dip 25° E. Up top of pass, highway still in Trias dipping 35° ± E. 300 ± m further road turns into Mt. On left white limestone (*Gastrioceras* limestone?) beyond which is a valley on the other side of which is N-S range of rugged limestone dipping steeply E. Massive limestone forming high Mt. on right is pinkish gray in colour breaking up into small squares with typical angular fracture. St. N 7° E dip 35° E.

Motor road ends [follow] old route up pass, then descend in rugged limestone Mt. No big slabs but cobbles. Then take half finished road; at Shanwangmiao[1] rain.

Mortor road again, low earthy hill on left, valley on right. Beyond valley limestone Mt. forming cones and steep escarpment towards W.

At Tungmuling[2], limestone Mt. on right continues. Road in red clay which forms low undulating hills—further on the left than the right. Another lit [?] of old road, ground rising—at top, motor road again—limestone blocks here and there in red clay.

Descend then over low pass below which is outcrop of Trias limestone St. N 20° W dip 27° E—lower down 400 ± m St. N-S dip 46° E. Limestone Mt. on right coming gradually nearer until we come right at foot of Mt. at top of very gentle slope. On left broad valley two large villages on the W. side behind which are two ranges—one low and the other higher of limestone. Road now up low pass between two limestone hills, where white limestone St. N 5° W dip 55° E. Descend very gently to Huakolao (1,200 m from pass).

Near Tienfang[3] white marble-like limestone St. N 4° W dip 63° E—beautiful sun-cracks.

14 March 1930: From Huakolao to Kueiyang[4]

At Tsikungchiao[5] broad river dividing into two branches. Wide plain up river. Isolated limestone hills arranged in a line. Behind that is a continuous

1 山王廟 2 桐木嶺 3 殿坊 4 貴陽 5 七孔橋

ridge to the west of which are higher peaks. At bridge, white platy limestone St. N-S dip 57° E. Large village on left. 200 m further breccia interbedded between shaly limestone St. N 10° W dip 62° E—sun-cracks again. Shallow valley on right at foot of Mt. Road close to low hill on left near water mill and few houses in bamboo. St. N-S dip 62° E. Just beyond water mill St. N 10° W dip 55° ± E. 300 further St. N 5° W dip 52° E Tungchiayen[1] on left with another village opposite St. N 10° W dip 56° E. Large flat stone bridge on right. At Tashuikou[2] (before first valley from left with water and bridge) limestone St. N 7° E dip 45° E. N of Tashuikou St. N 10° W dip 45° E. Hill in valley with ruined wall. On right large village in side valley. After that road rather far from outcrop. On left, clayey bands forming rice fields in front of a low range of hill. Soon however two cones of limestone appear behind that range. Here on right white impure limestone St. N 7° W dip 85° E. 200 m further flat road goes between two limestone hills forming a steep anticline—on left St. N 5° W dip 84° W. 300 m houses on left. Ridge with limestone peaks behind prolongs northward and turns round in a circle N to an isolated hill on the S. slope of which are a few houses (Taopaifang[3]). After one isolated house on left isolated limestone hill St. N 5° W dip 50° W. A little further E of three houses fairly high mountain St. E-W dip 55° ± S. Then Taopaifang. Coal lis said to come from Paichao[4] about 10 li W from here. Just outside Chiachang[5] house St. N 50° E dip 68° SE. N 50° W and 400 m from large village on right St. N 45° E dip vertical, on each side dip in different directions.

50 m further St. N 67° W dip 47° S on left, returning to N 45° E dip 67° SE. 400 m further opposite one large house on right in valley St. N 5° W dip 75° E to vertical. Again with valley on right. A little further St. N 35° E dip vertical. 200 m further St. N 20° E dip 85° W. Complete gap in range on right—one village on each side. Then old stone road. Up low pass St. N 4° E dip vertical. Motor road again St. N 20° E dip 50° W—near river again. Descend, one house on left by road side. A little of old road, then motor road again.—limestone N 20° E dip 60° E. In the river beautiful view of limestone bands nearly vertical, with constant swinging of strike. At brick over St. N 35° E dip 53° E. Then village on right. St. N 50° E dip 48° SE. On left a higher range (coal series?) behind two limestone ranges dipping probably to E. Road turns to left St. N 80° E dip 35° S, then road turns right again—making semi-circle. St. then N 45° E dip 35° E. At bridge over large river St. N 38° E dip 46° E. Cokes from Liangshuiching[6]. Just W from here. View of Tungshan[7]. Over bridge St. N 30° E.

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1 董家堰 2 大水溝 3 倒牌坊 4 擺綽 5 甲長 6 涼水井 7 東山

Low pass. Opposite small village St. N 30° E dip 30° E turning to strike N 22° E dip 32° E.

24 March 1930: Left Kueiyang

Below Hoshangpo[1] shaly limestone (Sungtzekan Shale) St. N 17° W dip 45° E. Up pass, Hoshangpo on right—Trias limestone St. N-S dip 40° E. Motor road pass on the E. of Yachiangchai[2] to Yunkuan[3] with a few houses on right. Yachiangchai is situated in Sungtzekan Shale, whilst the few houses are on limit of limestone. 200 m further N. limestone on right St. N 7° W dip 85° E—on left shale. Then road turns in shale. Just below Yangkuan[4] limestone on right St. N-S dip 28° W. Then road still in brown shale. The village of Yangkuan on left. Up slope again. (Lantang[5] is on left some distances from the road). Road go up hill exactly N. 150 m, large temple on left, Yuntingpo[6] on right where limestone dips 45°.

Top of pass.

N 30° W* Shuitang[7] on right, village to N 300 m, all brown shale on limestone.

N 17° W	200 m	
N 18° W	350 m	
N 24° E	400 m	all shale
N 5° E	340 m	Tachupochiao[8] on right
Sinchiao[9]	500 m	Rest.

Go up hill to low pass on the N. slope of which are a few houses. On the right impure limestone Mt. (dip gently E). Otherwise all in brown shale—no strike and dip can be measured. At the last house limestone in brown shale St. N 14° E dip 15° E. Undulating low ground on left. Road goes close to limestone Mt. on right. At isolated house St. N 5° E dip 20° E. Road goes N 20° E. Top of pass. Szufangtsing[10], still in brown shale. Road goes N 34° E.

At forest limestone on right St. N 27° E dip 49° E. Road goes N 37° E. approaching Mt., limestone (shaly, but still limestone) St. N 4° E dip 17° E. 450 m

* This and the following bearings are not measurements of strike of rocks but direction of route taken by author.

1 和尚坡 2 鴨江寨 3 雲關 4 楊關 5 濫塘 6 雲頂坡 7 水塘 8 大竹坡脚 9 新橋 10 四方井

further Mt. on right comes first. 400 m further entering Mt. on right St. N 55° E dip 24° W, but on left still dipping E? 2 houses on right 450 m away in shale—here Mt. on right dies away, and Mt. on left begins—dipping gently W.

Just above Maolipu[1] St. N 40° E dip 85° W. Just N of Maolipu limestone on left seems to be horizontal. Rice field on right beyond which is limestone Mt. Up a small pass with white house some 200 m ± away on right and 5 houses on left—road goes over undulating ground in brown shale. 2 houses on left near the road. Limestone Mt. on right comes near road dipping steeply SE. By the road-side on left limy shale dips W. but hills further away dips very gently E. 100 m further N typical shaly but platy and hard Trias limestone St. N 52° E dip 14° N. Up low pass limestone St. N-S dip 28° E—here is a turn. Up pass St. N 42° E dip 32° NW increasing to 60° and faulted. Further to left nearly horizontal, gently to S. Then E dipping 75° SE. Shale on right dipping gently NW. About 270 m S. of Shatzushao[2] impure fossiliferous limestone St. N-S dip 28° W. —Limestone on each side.

25 March 1930: From Shatzushao to Chatso[3]

Outside Shatzushao limestone hill on each side nearly horizontal, St. N 25° W dip 5°-8° E—typical Trias limestone forming fairly massive cliffs. Road goes at first N 25° W—but at last Maopeng it turns N—valley on left 800 ± m away where is shale. Going up slope. 350 m further top small road, goes N 20° E—in shaly layers between limestone. Descending limestone on left St. N 17° E dip 32° E—that on the right dips gentler. Near Maopeng St. N 35° E dip 34° E. Then bridge Panchuyuan[4] river flowing to left. We are at mouth of Mt. valley. Road goes N 14° W over coal in village, then descend gently turning N 4° W where typical dolomitic limestone, St. N 22° W dip 11° E. With one house on left and two on right we descend into a fairly broad valley at foot of Mt. seen already yesterday from afar—all limestone dipping constantly E. Brown shale seen on left here forming low hill with several villages between limestone Mt. and here. Earthy hill in middle of valley with one house by roadside. Limestone on right St. N 14° W dip 16° E—road near a stream flowing S. Then village of Chieh-ning[5], a few houses on right—one on left. Limestone on left swings to St. E-W dip 16° N (other changes also), but general St. is N 40° W dip 26° NE. Road turns N 30° E, limestone overlaid by brown shale, but still forming fairly high hill. Traces of coal. 300 ± m, side valley from right with 2 huts on each side of

1 茅栗舖 2 沙子哨 3 扎佐 4 班竹園 5 街寧

road and one up valley, limestone St. N 60° W dip 48° SW, underlaid by brown shale which forms another valley on right with huts on each side. Road now goes N 60° E up hill—dip becomes at once gentle. Up fairly steep slope on the right 2 or 3 huts. The road turns N 45° E to go between Mts.—on the left is Pienshan[1] limestone horizontal. At its foot is Lushihtun[2]. Descending road turns N 15° W in limestone, 3 huts by the road. Before huts shale; after, limestone. The latter may be under—since it dips gently S? Going up gentle slope black shaly limestone horizontal, but bending evenly to dip a few degrees E.

At Shihpanshao[3] same limestone with black soil St. N 32° W dip 22° E. On the left valley in brown shale (coal series?). Descend somewhat steeply same limestone St. N 5° dip 22° E—thin-bedded. Bottom of slope—a group of huts on right. Road up again in direction N 12° E coming to shale near top. In direction N 50° W 1,000 m coking (poor coke) coal is mined, said to be 3-4 feet± thick. At top red sandstone pebbles and blocks (angular) overlying and in red clay! On right 100±m limestone Mt. (*Gastrioceras* limestone?). Descending, road crosses coal series (no clear outcrop). Limestone on right ends beyond 2 huts on right slope. Limestone [Mt.] smooth-topped, but fairly high beyond Sanchungyen[4] to which road descends in direction N 30° E. Yellowish shale 200 m S. from Sanchungyen St. N 10° E dip 45°±E. High limestone Mt. continues to right from Sanchungyen seeming to overlie *Gastrioceras* (?) limestone (Coal sample). Right of Sanchungyen light gray platy limestone quarried for pavement, nearly horizontal. Road right at boundary between this and coal series (fault?) which extends 2-3 kilometers westward bound by smooth topped Mt.—coal series limestone? After 2 Maopeng on right road in coal series. After the second hut coal series forms a fairly high Mt. on right whilst the yellow shale looks like *Gastrioceras* shale? But 500 m N., coal is mined on right (W. slope of the high Mt. noted above). Irregular limestone patches appearing N of it interbedded with shale and sandstone. Last pass above Chatso reddish clay on each side—on right at top horizontally banded (coal series) limestone—Gravel in clay. View of Chatso. A broad valley before it. Descending, yellow shale St. N 15° E dip 35° W? After passing a large village on right, come to slightly higher ground where limestone lense [is seen] in shale, practically horizontal—shale on right dipping gently east. Chatso contains 2,000 houses with city wall.

Coal is mined at Wameichung[5] 1,500 m W. of Chatso—it is coking and has gentle dip towards east but only 1 m thick. It is said that at Chilungtsing[6] 3 li N

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1 扁山 2 盧師屯 3 石扳哨 4 三重堰 5 挖煤冲 6 鷄籠井

from Chatso on motor road coal reaches 4 ft. or more; at Hsinitang[1] 12 li NE it is 10 feet ± ?, gives good lump and is coking.

26 March 1930: From Chatso to Liyuanshao[2]

Went to seen Chaneichung mine. At Shuitang[3] by river *Gastrioceras*? limestone St. N 80° W dip 5-12° N. Few fossils is yellow shale (T306). 2 shafts, one on each side of ravine. The southern one is working a seam about 3 feet thick; but it often thins out to 2, St. nearly E-W dip 30° S. The N. one is not working owing to bad ventilation, St. E-W dip 20° N. Judging by the mouth the seam is only one foot—The thickest place is said to be 2 feet. S. shaft output about 200 boat × 50 catty = 5 tons+. 50 men working. N shaft output about 80 boat × 50 catty = 2.5 tons.

Joined motor road by cross-country at Siaochangtien[4]. Then up steep pass. Cutting exposed yellow shale St. N 30° E dip 30° S, but gently. *Gastrioceras* (T307).

Shale underlaid by *Schwagerina* limestone (T307a) St. N 70° E dip 40° S, but immediately sandy shale with 2 inches of coal dips few degrees SE. Then Tungkuangmai[5] gray and yellow shale St. N 20° E dip 10± E.

From above down:

1 = 7 in Wupeinien[6]

200 feet

2 = 1 feet + Szupeinien[7] ⎫

10 feet ⎬ Tungkuang "Copper ore"

3 = Sanchia[8] 2 feet-30 feet ⎭

4 = Tachia[9] 2 feet—3 feet

300 feet

5 = Erhchia[10] 2 feet-bituminous

300 feet

6 = Yehmai[11] 5-7 feet?

Near second pass—beautiful *Lyttonia* (T307b). St. N 25° E dip 22° E—then limestone with chert begins to appear—no more coal. 100 m to point where

1 稀泥塘 2 梨園哨 3 水塘 4 小塲店 5 銅鑛煤 6 五背年 7 四背年 8 三夾 9 大夾 10 二夾 11 野煤

road turns N 70° W, limestone disappears, yellow shale again, but occasional bands occur still. Road turns soon N 50° W to hut on right. Lower Permian limestone: grayish, fairly free from chert, subconchoidal fracture; St. N 50° E dip 45° SE—to limestone cliff on right N 50° E. 400 m, Chutoushan[1] still in limestone 100 m, limestone which still dips 10° ± SE, disappears. Earthy Mt. with red clay ahead. Descend to bridge. Red soft sandstone with limestone pebbles here and there, well consolidated; bands interbedded with gravel and standstone, St. N 45° E dip 25° NW. 500 m further well consolidated conglomerate of angular limestone pebbles 1-15 cm in diameter with sandy cement St. N 80° E dip 16° N. On right high peaks (100 m) looking very like coal series—gray and reddish brown soft sandstone? Soon conglomerate horizontal. On left higher hill with big limestone blocks, 40 cm in diameter, and limy cement.

S. of Tapo[2] by village, crushed grayish shaly limestone looking like Trias St. N 75° E dip 45° N, increasing to 62°. After Tapo on top of pass brown shale and shaly Triasic limestone St. N 80° E dip 70° S. Then yellow brown shale turning to dip steeply N. Then shaly limestone dip 50° ± S, then S. 30° ± S. Low undulating hills. Maopeng on both sides. Shaly gray nodular limestone horizontal. Up pass, descend, Lungsintien[3] on left. Road turns to right still in Triassic limestone. Very extensive view on right all low plateau. S. of Maopeng shaly Triassic Sungtzukan limestone St. E-W dip 13° N. At Lochiatien[4] limestone becoming more and more massive. Road turning to right. Sanwangmiao[5], Maopeng on right, then road to left again. S. of Sanwangmiao typical Trias. limestone St. N 20° E dip 25° E. Descending, constantly passing Maopeng on right, into a valley beyond which is a range of limestone. Just S. of Kouchang[6] typical Triassic limestone St. N 30° E dip 37° E.

N. of Kouchang grayish massive limestone with subconchoidal fracture (reddish veins) St. N 40° E dip 66° SE. [From this limestone to first shaft (first coal seam) 140 m, then another 20 m second seam. 130 m further limestone again which is] somewhat cherty (90 m) with coral and *Schwagerina* (T308). Then yellow shale sheared and overfolded, but generally dip still to E. 170 m to second Maopeng on right. Then road turns N 5° E. Third group of Maopeng—view of Lopang[7]. Large valley to left beyond which are limestone hills—Lower Perm? Few houses on right. 800 m beyond Lopang. Road turns N 20° E to enter limestone Mt. which seems to dip W. 2 huts on left. So far valley in lower shale. Where there are huts on left we come to limestone which is brecciated—below is hard, but shaly limestone

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1 猪頭山 2 大坡 3 龍心田 4 羅家田 5 三王廟 6 狗場 7 羅邦

looking like Trias. St. N 80° W dip 30° S. Then small bridge. 2-300 m up, shale with limestone lens and shaly limestone. In it trilobite and brachiopod (T309). It seems to be shale below coal series limestone. St. N 70° E dip 22° N changing to N 35° E dip 24° NW. This is more general. The shale is overlaid by pinkish gray limestone with angular fracture—rather massive. St. N 35° E dip 35° NW. Top of pass same limestone. St. N 30° E dip 19° NW. Yellow shale on descending—a hut on each side—up steep pass in limestone Mt. inter-bedded with brown shale which forms top of pass.

Descending to Liyuanshao we come to more massive limestone forming rugged Mt.—lower permian? Massive but clear bedding plane and shaly with angular fracture St. N-S dip 18° W.

27 March 1930: From Liyuanshao to Sifung[1]

Outside village, massive white crystalline limestone with angular fracture nearly horizontal—St. N 50° E dip 12° W. *Schwagerina*? (T310). Bands of it silicified. Descending steeply. At bottom where road makes sharp turn St. N 45° E dip 14° W. Huts on left on right side of valley, few hundred meters further up steep slope again—here same limestone St. N 75° E dip 26° N. On left on the other side of valley, limestone forming massive cliff. Up pass to Maopeng same limestone St. N 52° E dip 22° N. 300 m up Heitupo[2] in black limestone full of black chert—many poorly preserved fossils (T311)—coal series. Descending somewhat steeply black shaly limestone St. N 45° E dip 32° E—massive limestone on left on the other side of valley seems to dip under it. Descending constantly, shale and coal outcrop below cherty limestone—on left massive Lower Perm. limestone. Coal series St. constantly N 40° E dip 26° E. Near foot of pass coal series limestone St. N 55° E dip 26° S. Further 800 m. About 800 from Loputung[3] on left, beautiful *Productus* and round *Schwagerina* (T311a). Road now on left of valley turning to right. Then shaly and cherty layers St. N-S 16° E. 400 m further, Loputung. Outcrop of coal St. N 55° E dip 35° W.

Between second and third groups of village of Loputung, limestone becomes thin-bedded St. N 80° W dip 35° N. Then group of houses and pass. At Pass purple shale St. N 80° W dip 25° N, typical fossils (T312), even in this limestone lenses. Then hut on left. Overlaid by thin-bedded gray limestone full of nodules St. N 70° W dip 20° N.

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1 息峰 2 黑土坡 3 羅葡洞

Road turns to left, limestone swings to St. N 35° W dip 20° E.—Purple shale on left behind thin band of limestone. Descending a large house on left near boundary. A little further Hungyen[1] village on left in purple shale—road forming boundary—limestone on right St. N 15° W dip 35° E. Road turns right to cross pass in limestone, Maopeng on left. Descending we come to Sungtzukan shale? which St. N 62° W dip 42° N (limestone rather like Kueiyang limestone). Road to left, wide view, limestone and shale interbedded St. N 50° W dip 34°. High range on right—far away. Road turns to right at last we come to true Sungtzukan shale—St. N 45° W dip 35° NE. Green and gray shales with this limestone bands. Dip soon reversed to SW, but at once changed to NE again. Approaching Yanglangpa[2] brown shale St. N 55° W dip 34° NE.

At first group of huts limestone dip 16° NE. Bridge second group of houses after which limestone dips steeper. Rest at third group. Higher Mt. on right formed by Trias in front with purple shale dipping steeply SW. Coal series limestone forms higher peaks behind. Outside Yanglangpa upper Trias limestone St. N 45° E. dip 49° NW. 2 huts on road side—road turns to left, limestone on right St. N 30° E dip 51° NW. Road has been going between limestone Mt.—on right higher. Before houses on right limestone St. N 30° E dip vertical. Actually at house on right limestone St. N 18° E dip 50° E. Houses on both side, Hsiayanglang[3]. On right behind houses limestone dip 40° ± W. 3 huts scattered on right limestone St. N 5° W dip 24° W. Mt. on left dips also W.

At Panmienchieh[4] limestone St. N 5° W dip 34° W. [Then a] few scattered huts and road goes between 2 hills village Lungchaoshu[5] on right. A little further limestone on right St. N 17° W dip 40° W.

Descending, shaly layers above limestone which is like that of Kueiyang, St. N 13° W dip 42° W.

28 March 1930: From Sifung to Paishapu[6]

Outside city bridge typical Kueiyang limestone (= Sungtzukan) St. N 50° E dip 40° SE. Up slope changing to N 40° E dip 40° SE. Road makes a semicircle to go up to pass near the top of which a hut on left. Descending, St. N 45° dip 45° SE, but on left vertical, then dip 60° NW—fault. Bridge, water mill on left. On right typical Sungtzukan shale St. N 72° E dip 32° S—Road goes along right bank of a stream—more solid limestone on right St. N 55° E dip 47° SE, changing

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1 紅岩 2 陽郎壩 3 下陽郎 4 半面街 5 龍爪樹 6 排沙舗

to St. N 28° E dip 36° SE. Then hut on left and village on right Lungtanwan[1] where brown purple shale with index fossil St. N 55° E dip 17° SE. underlaid by platy limestone with brown shale intercalated—with undulating dip but generally nearly horizontal. 3 huts on right villages to left—Matantien[2]. Further up 5 scattered huts on right (Changtienpa[3]) and one on left, dark gray limestone St. N 7° W dip 18° E changing to N 17° W dip 12° E. 2 huts on left up slope, platy limestone horizontal—view of high Mt. to NE.—seeming to dip SE. Road turns left, another hut on left, descending gently into Mt., light gray thin-bedded limestone with calcite veins St. N 17° E dip 25° NW—it becomes horizontal at Loshihtien[4] village. At bridge road turns to left along right bank of stream to the W. of which shaly rock behind limestone.

Up pass St. N 60° dip 23° S, changing to N 30° E dip 47° SE. Descending, one hut on left, then up steep slope, true purple shale underlying limestone St. N 47° E dip 56° SE. At Sanhotu[5] purple shale again, at first St. N 78° W dip 15° N, changing to N 50° W dip 40° NE. Then complicated fold—at last turns to St. N 60° E dip vertical—all this within 30 m of Wafang[6] on left. Then it is underlaid by gray limestone St. N 34° E dip 34° SE. Then 5 houses on each side of road, still called Sanhotu beyond which grayish limestone St. E-W dip 32° S. Underlaid by shaly limestone and gray limy shale looking very like Sangtzukan series St. N 48° E dip 70° SE. Then descend to Panchiaying[7] in the same rock, St. N 40° E dip 34° SE.

Road goes now NE along strike. At low pass it is seen to the right—purple shale at foot of high Mt. (Nanshan[8]) which is formed by horizontal? limestone. Then Maopeng on right—descending.

Road makes SE detour so we come near purple shale again—shaly gray limestone underlying it, St. N 45° E dip 34° SE. Maopeng on right near head of loop, brown shale between limestone, going right up to former pass to S. Descending from head of loop well-built wooden house (Chouchiawan[9]) on right—purple shale just to its right. Road turns to N. again into limestone. Hut on right read turns to right up to Heishenmiao[10]. Nanshan on right purple shale forming low spurs. Road in brown shale with occasional bits of limestone. To SW high range.

At Heishenmiao gray nodular limestone St. N 45° W dip 23° SW. Road turns to left, then to right—descending, huts on both side (Wayao[11]). Bridge, yellow

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1 龍潭灣 2 馬担田 3 長田壩 4 螺絲田 5 三合土 6 瓦房 7 潘家營 8 南山 9 周家灣 10 黑神廟 11 瓦窑

limy shale St. N 45° W dip 44° SW. Beyond [?] turning to St. N 30° E dip 44° SE. On the other side of the stream it seems to dip NW. A few meters further N, it strikes N 80° E dip 25° S. Houses on both sides (Tungtzewan[1])—on left St. N 9° W dip 35° W. Road soon turns to R. 350 m further on right limestone St. N 29° W dip 27° W, then St. N 35° W dip 24° W. Before Siaochaipa[2] St. E-W dip 14° S.

Heavy rain, rest in unfinished house. Then Shihpai[3]? Coal comes from Erhtunyen[4] near top of Nanshan below solid limestone. Black shaly limestone at Shihpai St. N 70° E dip 17° S. Then Hsimayao[5], limestone still dips S. but at once it swings to strike N 20° E dip 17° E. Then 3 huts on left, descending, St. N 25° E dip 24° E—black limestone forming considerable hills. Road limestone left zigzag up hill. One hut on left, there another, limestone dip gently to E. Then Panshapu purple shale on left St. N-S dip 47° E.

29 March 1930: From Paishapu to Wuchiang[6]

Outside village, on left, dark gray to blue shaly limestone, St. N 20°-10° E dip 32° E. Just above purple shale. Zigzag 2 times up pass, descending, small shrine on left. limestone more shaly. Purple shale still visible to left 3-400 m away. Heitaochin[7] on left, descending. Hut on right. Dark gray limestone St. N 12° E dip 24° SE.

Road follows boundary between limestone and upper shale. Then it turns left. Limestone on left St. N 30° E dip 16° E. Road goes now N 38° E. Limestone on left turns to strike N 60° E dip 12° S, but soon change to strike N 40° E dip 17° E. On right shale. Shanwangpo[8] on left, limestone full of small nodules St. N 12° W dip 20° E. 400 m further 3 or 4 houses immediately purple shale with varying St. and dip, but generally St. N 50° E dip 20°-E. Then 2 houses on right—road right in shale which at houses St. N 25° E dip 18° E, but changes to N 56° E dip 18° SE at turning of road.

Up pass Tsingshankou[9], purple shale St. N 60° E dip 18° S. White limestone 10 m in form of lenses in shale. Down to bottom of slope huts on left. Lower limestone St. N 30° E dip 23° NE—limestone very nodular. Hut on left limestone St. N 30° W dip 12° E—it is nodular thin-bedded and platy.

Then few huts Yehchiakou[10], limestone nearly horizontal, road turns to right. Ravine goes in direction of left—brown shale (*Gastrioceras* shale?). Road turns to right again then to left, limestone St. N 12° W dip 16° E.

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1 桐子灣 2 小寨壩 3 石牌 4 二屯岩 5 洗馬窯 6 烏江 7 核桃箐 8 山王坡 9 青山溝 10 葉家溝

Soon Yanglungchai[1] limestone hill behind—it, but behind the latter is purple shale. Limestone here St. N 16° E dip 12° E. From Yanglungchai road to left limestone St. N 25° W dip 15° E.

3 huts, 2 on right one on left, limestone becomes very shaly forming thin lenses in shale. Several huts on right one on left, limestone overlaid by brick red shale. On left limestone St. N 75° E dip 45° N. Descending one hut on right beyond which limestone St. N 32° E dip vertical, changing to St. 50° E dip 75° SE. Then it St. N 40° E dip 60° SE.

100 m further it dips 40° ± NW on right and on left St. N 35° E dip 12° NW. Limestone inter-bedded with red sandy shale—it forms lenses, but locally massive. Up slope (50 m) it dips 65° SE, very much crushed and brecciated. Descending to Lianglungchao[2] it strikes N 52° E dip 45° SE—more regular here—limestone impure but massive. At turning of road in village, limestone St. N 45° E dip 50° E. Descending, limestone becomes nearly horizontal. 2 huts, one on each side. Then unfinished motor road. Shaly limestone St. N 45° W dip 26° NE.

Original motor road passes from Lanpanteng[3] to Hsiatzuho[4] then up river to Wuchiang in order to avoid Laochunkuan[5]. This route is no doubt easier.

30 March 1930: From Wuchiang to Sinchan[6]

Up steep bank, limestone St. nearly E-W dip 15° ± N. Further up actually measured St. N 75° W dip 15° N.

Flowing water on right, one hut on left, then several on both sides, Laochunkuan. Limestone St. N 80° E dip 24° N. Going gently up, limestone becomes horizontal. Then several huts on right Yentou[7]. Approaching huts higher up, limestone becomes shaly. Near huts St. N 40°-35° W dip 70° ± SW. At Chengmentuierh[8] begin to descend gently. Road first to left then to right. Between first and second turn limestone at first St. N 5° W dip 63° E then St. N 10° W dip 64° W. Second turn at bridge where it is vertical (to left higher up it seems to be dipping 10° ± W). Halfway beyond second turn it dips E, but bent and sheared. Then vertical. Road turns slightly to left to Linao[9]—descending gray nodular limestone St. N 15°-20° W dip 32° E. Bottom of slope, hut on left.

Up slope on right dip SE, but on left yellow shale and shaly limestone St. N 25° W dip 60° W. Road turns in semicircle round side valley to left it is in anticline

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1 養龍寨 2 兩龍槽 3 濫板隥 4 蝦子河 5 老君關 6 新站 7 堰頭 8 城門堆兒
9 靈坳

axis. After turning, going up, shaly thin-bedded limestone vertical on left—strike changes to N 58° W. Pass cut in rock, hut on left. St. N 58° W, anticlinal axis. Descending, Nikoupa[5] on right. Road turns right to go up again. Purple shale is seen on left high up above limestone dipping first steeply then gently W. Kantienchieh[2] on left ravine. Just beyond the former, limestone St. N 25° W dip 52° E. Then vertical bed E and W again [?] St. N 10-15° W Silur. Limestone becomes pure free from shaly bands. At bridge it dips 70° E. Limestone very massive, looking like coal series? 100 m from bridge thin-bedded but dense limestone, St. N 70° W dip 80° NE. Up still but before turning, to right St. N 25° W dip 30° E, 10 m further 70° E again. View of old road. Purple shale at head of pass. Limestone crushed and bent generally St. N 15° W dipping steeply east. Hut to the W of which limestone dip 40° ± W. (passed fault).

Road turns to right, Huchiaao[3] hut on left. Road in brown shale (coal series?). Descending hut on right, shaly limestone St. N 8° W dip 70° W (overfold), then vertical, fossil (T314). Then Shihkungchuang[1] on right. Road turns to left, we come to solid limestone (overlying? fossiliferous shale) still vast, but generally dip W (St. N 15° E dip 70° ± W). Soon dip becomes 44° W. 28 m, then dips 45° ± E; then 25 m, thinner bedded limestone vertical; 40 m vertical; 70 m, dark brown shale with limestone lenses vertical; 50 m, purer massive gray limestone; 27 m purple shale, St. N 30° E dip 85° E to vertical. Opposite hut on left 80 m, white to gray limestone St. N 23° E dip 60° W (Panshan[5] Limestone) 250 m, *Gastrioceras* shale vertical then dip 70° W; 30 m, typical coal series limestone vertical; 30 m, sandstone; 31 m, coal seam dip 45° ± W. 80 m, last coal seam immediately below limestone St. N 30° E dip 54° W. (This is the general dip of coal series)—bands of siliceous limestone full of *Schwagerina*. 50 m, dip 80° W. Motor road winds back. About 70 m-100 m to limestone cliff presumably Lower Permian.

Road then winding steeply upward to top of pass (huts on left), contact between coal series and Lower Permian? Then former consists of thin chert bands St. N 30° E but complicatedly thrusted. By the huts mentioned (Shihtzuyen[6]) road passes into Lower Perm. limestone full of *Schwagerina* (T315). 100 m, hut on right, road turns to left then right again. Large valley on left—Purple rock. Hut on right limestone with large bits of chert and *Schwagerina* St. N 20° E dip 69° W—still coal series, not Lower Perm. as mentioned. Another hut on right, pure limestone

1 泥溝壩 2 乾田街 3 胡家坳 4 石公莊 5 半山 6 石子埡

dip 85° ± E—no outcrop but brown soil (coal series?). One hut on right, then another house, side valley, many houses; up slightly to Taopashui[1].

Lower range of limestone seeming to dip W. between here and purple Mt. 300 m S of Taopashui on right Trias? looking limestone St. N 28° E dip vertical. End of Taopashui beyond valley on right crushed limestone Trias looking St. N 30° E dip vertical. 50 m up to the left of last observation massive limestone (Panshan) St. N 38° E dip 35° E, but on right a little further N St. N-S dip 32° W—which is general. 100 m further, just S. of hut on right in branch valley St. N 40° E dip 30° W.

Lungyen[2]-Kuanyinmiao[3] on left, limestone dip 10° ± W. Several huts on right limestone St. and dip very variable but still St. N 35° E dip W. Soon we are in more shaly beds—limestone lenses with yellow shale apparently underlying the first? Limestone but itself apparently underlaid by purple shale! Huts on right in yellow bands. Huts of Wulipa[4] in brown shale—limestone on left. Large sheet of water on right, hut on left. Road turns left, limestone St. N 50° E dip 11° W. Houses on both sides a little off the road. View of a ridge at the W. foot of which coal is said to occur.

Road turns left, limestone on right, St. N 18° E dip 20° W; then hut on left, road turns to right—purple shale only 400± m away to left. Going up slightly village on right off road, opposite last house on right, Trias limestone St. N 80° E dip 50° N. Descending Tungtzushih[5], purple shale near to left. Then fairly large village to left, up slightly temple on left. Up to Loshihyen[6]—at temple above mentioned Trias limestone St. N 14° E dip vertical. Top of pass Loshihyen, purple shale on left behind which yellow hill overlying coals. Just outside Loshihyen, Trias limestone St. N 45° E dip 29° E on right, but on left it dips W. Brown ridge on right seems to be a dip slope. Small temple on left then hut on right, up gentle slope. One hut on each side, Totzutai[7]. Several villages on left off road. Going up, few houses, Lianglukou[8] on right. Branch road to left, up gentle slope. House on left slightly off road. Limestone breccia.

Hut by road on right opposite large house off road on left. Limestone on right St. N 20° E dip 50° ±.

31 March 1930: From Sinchan to Huangnipu[9]

[The description of a side trip to a coal mine (see map) SE of Sinchan is omitted since too much emphasis was laid on route sketching.]

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1 刀把水 2 龍眼 3 觀音廟 4 五里壩 5 桐梓司 6 螺絲岩 7 駝子台 8 兩路口
9 黃泥堡

250 ± m on motor road N. of Sinchan limestone St. N 45° E dip 29° W near Wafang village on right. Purple shale 4-500 m away to left,—yellow soil in front. On right, houses, Shuiwoerh[1]—Sunglinpu[2]. Go up slightly, purple shale appears as a fore hill W. of coal series range. Maopeng on right off road. 200 ± m N, houses on left, Maopingshang[3]. Over low ground houses on right. Then Tangpaao[4]. Road turns to left. Purple shale on right not far away, but on left flat ground with limestone dipping 50° ± W. Up gentle slope road turns left more. Descend, hut on right off road. Hut on left, NW syncline opens up, E. limb far away, W. limb rather near. Low earthy hill in middle of valley. Road up slight slope. Here limestone St. N 37° W dip 20° W. Hut on right. 200 m N. on left limestone St. N 15° E dip 49° E. 2 houses on right one on left. Brown hill on right. Houpachang[5] very closed to brown hill on right.

Then village on right, Mungtzutai[6]. Limestone dipping 45° ± E. Road now 150 N from purple shale on left. Village on right on the other side of valley. Huts on both sides off road. House by road (left). House off road on left.

Changchichiao[7] on right. Just beyond, good outcrop of typical Trias St. N 29° E dip 40° SE. On right brown earthy hill (Sungtzukan ?). Large oolite (T317). Hut on left. Hut on right 150—200 m from purple shale on left. Purple shale on right 800 ± m away. Another hut on left Lanpanteng[8]. 350 m N, hut and large temple on right. 200 m N, huts on right. Fairly high limestone Mt. dipping constantly E. behind temple 500 ± m from road. House on left and right. Limestone Mt. on right only 200 m away. Hut on left, limestone Mt. on right 50 m away. 2 huts on right. Hut on left, 300 ± m further hut on right where brown and purple Mt. come together. Limestone which extends to left St. N 15° E dip 40° E—on left limestone dips probably 50° ± E. Descending, opposite hut on left off road, limestone on right St. N 15° E dip 32° E. Valley becomes wide again. Purple shale 500 + m away.

1 April 1930: From Huangnipu to Tsuni[9]

Old village about 800 N of rest place. It is situated on yellow shale which seems to be continuous with limestone Mt. of yesterday? Purple shale on left diverges away with low hills between. That on right parallel to that on left with also low hills of yellow soil. House on right then bridge monument. Beyond the former typical limestone band in yellow clay St. N 13° E dip 47° E. After

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1 水窩兒 2 松林堡 3 茅坪上 4 湯巴坳 5 後壩場 6 蒙自台 7 昌吉橋 8 藍板櫈 9 遵義

Paifang[1] road goes over yellow clay ridge. We are now nearer to right limb of syncline. About 600± m N, 2 limestone hills appear in front of purple shale on right, [which] seems to dip steeply E. This may mean two things: limestone very inconstant, turning into yellow clay along strike; or a fault is between purple shale and limestone. Large house on right. Brown shale forms higher hill on left on the otherside of valley behind which is probably a limestone range before coming to purple shale which is seen 1,500± m away.

(B) Limestone Mt. on right near hut St. N 20° E dip 38° E. But small limestone (c) hill 400-500 m N, right at foot of purple shale dip 50°± W, and higher range (d) also of limestone on left opposite the latter dips also steeply W. (with reddish and yellowish clay between). Further on looking back it is seen that limestone Mt. B has its dip reversed on E. and limestone (c) near Paifang St. N 28° E dip 67° W. Then Lungkengchang[2] close to purple shale on right. Limestone (d) to NNW. Huts on left opposite round limestone hill, then hut on right. Road in yellow clay immediately over purple shale. School on left, limestone and yellow clay St. N 22° E dip vertical, changing to N 57° E dip 42° E. Further N, limestone in reddish soil. Purple shale 400 m on right. 200 m N, limestone in clay St. 5° E dip 82° E. Hut on the left, then another on right, in yellow shale with limestone blocks. At bridge met Sun*. All yellow shale between 2 ranges of purple shale—limestone 200 m further, St. N 73° E dip 40° N. 300 m further limestone on right, shaly and much crushed, St. N 10° E dip 70° E. Purple shale on left diverging away. 400 m from Chungchuangpu[3] same impure crushed and veined limestone St. N 7° E dip 66° E—swinging to dip 70° W.

3 April 1930: From Tsuni to Huoshihpa[4]

After small bridge on left shaly limestone in dark brown shale St. N 45° E to N 70° E dip 75° NW to vertical. General St. N 50° E dip 70 W.

At low pass shaly limestone St. N 48° E dip 52° W. Descending, more massive limestone (Maotsaopu[5] Limestone). In valley yellow clay. Then up slope, shaly limestone St. N 22° E dip 55° W. At front pass with small temple on left, limestone in purple shale St. N 28° E dip 57° W. After village limestone in brown shale St. N 47° E dip vertical. At top of pass, houses on right, more dense limestone but thin-bedded St. N 8° E dip 37° W in yellow clay. House on right,

1 牌坊 2 龍坑場 3 忠莊舖 4 火石壩 5 茅草舖

* Sun Te-lin, Dr. Ting's experienced "surveying coolie".

black limestone with fossils (coal series) St. N 55° E dip 55° SE. After Huangnipao[1] joined motor road. Sandstone underlaid by limestone St. N 70° E dip 65° S. Took a few fossils (T318) from very cherty limestone. A little N St. N 70° E dip 40° S. Near hut on right, sandstone St. N 30° E dip 64° W. Overlying limestone St. N 35° E dip 60° W. At bridge limestone St. N 12° E dip 44° W. Then purple shale with limestone St. N 5° E dip 34° W (over-valley). House on right limestone St. N 20° E dip 34° E. S. of Tashan[2] limestone St. N 14° E dip 40° W. After bridge up slope Maotsaopu Limestone St. N 67° W dip 40° W. Then yellow shale at Shuianwan[3] limestone St. N 40° W dip 33° W.

At Huakung[4] limestone St. N 67° W dip 37° W. Before descending Yüchiapa[5] on right, purple shale St. E-W dip 32° S. After Tangfang[6] up limestone slope, St. N 40° E dip 30° E; up a little dip 25° E.

Beyond Shihlungpo[7] coal mine, 1½ ft. seam 160 ft. incline. There is coal series to Komayen[8]. After turning to N coming to (coal series?) limestone nearly horizontal. Below Huchiawan[9] silicified limestone (full of fossils), St. N 15° E dip 16° E. At Tienkouwan[10] 2 feet ± seam dipping 20° E.

4 April 1930: From Tsuni to Taotsoshih[11]

W. of bridge outside Laitungmu [?]. Upper Trias limestone near contact St. 65° E dip 75° N. Then fault breccia. 40 m after [river] bend St. N 33° E dip 73° E changing to N 40° E dip vertical. At temple sandstone St. N 45° E dip 84° E.

At SW corner of city black limy shale St. 73° E dip 47° N. 100 m W. of S. W. corner of city dark gray shale St. N 20° E dip 50° E. Full of pelecypods (T319). Then red shale St. N 34° E dip 40° E. 200 m further hard quartzitic sandstone St. N 30° E dip 39° E. Then near Yenkou[12] between 2 N-S valleys thin clay [?] limestone 2 m thick in red shale. Hut at head of N. valley Manaowo[13]. Then round to W side of N. valley, sandstone St. N 84° W dip 58° S. Halfway down quartzitic sandstone St. N 14° E dip 54° E.

Sinchoupa[14] to hut N 15° E. 100 m limestone St. N 58° E dip 55° S turning to St. N 48° E. dip vertical. Then near hut St. N 52° E dip 48° E.—this is contact strike as it goes a cross N valley, turning at hut to N 14° E dip 70° E. Beyond hut St. N 65° E dip 48° S. At second hut on left St. N 40° E. fault dip 64° E turning to St. N 15° E dip 72° E—true contact strike.

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1 黃泥堡 2 大山 3 水安灣 4 華孔 5 于家壩 6 糖房 7 石龍坡 8 割麻崖 9 胡家灣 10 田溝灣 11 倒座石 12 埡口 13 瑪瑙窩 14 新州壩

[Feild notes unreadable for 3 or 4 lines.]

At foot of Mt., purple shale St. N 30° E dip 72° E, turning to N 65° S, slightly up near contact with lower limestone St. N 20° E. 350 m from village on pass, lower limestone St. N 15° W dip 48° E. Near bridge St. N 5° E dip 50° E. dip soon reduced to 28°. At Hungpienchiaochalu[1] crossed bridge, up valley, crossed valley, up coal series, sandstone St. E-W dip 37° S Peiyangling[2] and house, coal series St. E-W dip vertical. 420 m further Meitungyen[3], white limestone of coal series; 220 m further contact between coal series and limestone 200 Maopeng. Then Lower Perm. limestone just beyond.

5 April 1930. From Tsuni to Tutipa[4]

Near Fenglochiao[5] on right limestone St. N 58° E dip 73° W. At quarry 50 m S, St. N 45° E dip 75° W—fossil from fence wall (T320). Limestone at second bridge (beyond Tayuantzu[6]) St. E-W dip 34° N. At Panchulin[7] limestone St. N 32° E dip 52° E. At Yenwan[8] limestone St. N 48° W dip 26° NE where we cross stream to left. 200± m further St. N 60° E dip 25° NW.

Hitherto limestone is massive, but after that it becomes very shaly with flinty [?] bands at crossing to right St. N 60° E dip 27° NW. Between here and Tutipa, shaly limestone St. N 85° W dip 42° E.

Near Tutipa St. N 82° W dip 17° N. Above Tutipa shaly limestone St. N 60° W dip 34° N.

[The rest of the field notes for the day is mainly devoted to topographic surveying and for this reason it is omitted here.]

6 April 1930: From Tsuni to Tachiao[9]

Near temple where 2 roads join limestone with fossils (T321) St. N 56° E dip 46° SE turning to St. N 40° E in the river (dip 55°±). At junction of 2 rivers solid limestone St. N 24° E dip 62° E. Near bridge Maotsaopu Limestone St. N 70° E dip 34° S (Branch road near village where road turns left away from river, Lower Trias limestone St. N 33° E dip 36° E). At river bent St. N-S dip 49° E, gastropods (T322). Back to main road at bridge. Beyond limestone St. N 75° E dip 47° SE. Near Sinpaifang[10] limestone in contact with purple shale St. N 60° E dip 48° SE. Near Tsichitan[11] purple shale St. N 72° E dip 35° S. Ordovician limestone at contact just N of house on left St. N 67° E dip 21° S.

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1 紅邊橋盈路 2 白羊嶺 3 煤洞崖 4 土地壩 5 豐樂橋 6 大院子 7 斑竹林 8 岩灣 9 大橋 10 新牌坊 11 七級灘

Second valley after Tungkungssu[1] brown and reddish shale. S of Heiniao[2] on left, small outcrop of black shaly limestone (lower Perm?) with small brachiopods (T323).

At (1) contact between Ordovician limestone and coal series St. N 22° E dip 16° E. Opposite bridge, brown shale with trilobite (T324). After road to Yinshan[3] brown sandy shale with shaly limestone.

Recollected from Feilaishih[4] (T325), and at Mungtzuechiao[5] (T325a) above (T324).

Tashihpa[6] (= Hsima[7]) just beyond, limestone St. N 20° E dip 80° E. Just beyond, sandstone St. N 27° E dip 64° E. At Kungankuan[8] sandstone St. N 60° E. dip 30° N.

7 April 1930: From Tachiao to Panchiao[9]

Fossils in Cambrian (T326, T326a & T327).

8 April 1930: From Panchiao to Tungtze[10]

Siliceous limestone all the way to Loushankuan[11] where the crystalline limestone with fossils (T328) overlies it. Just below Loushankuan siliceous limestone St. N 55° W dip 10° NE.—Quarry of fossiliferous limestone.

Ordovician? shale. N 29° W*, 50 m. Another ridge. N 30° E (another valley). Sight [?] on limestone. 200 m, Yangtienwo shale often green with fossils (T329). N 30° E, bridge, cross valley, same as before N 40° E, 150 m, impure limestone in red shale, fossils (T329a). N 20° W, 170 m. Shale, N 75° W 140 m. N 50° W 110 m. Green shale St. N 85° W dip 27° N, 40 m. N 10° E 110 m. gray and cherty Lower Perm. limestone (T330). N 5° W 90 m. N 57° E 440 m. St. N 7° E dip 7° E. N 44° E, limestone on right also sil. [?] limestone underlying coal. Pass 280 m. Sight on Tingshancheng[12] N 37° E. Large valley on right "Tashan" [big mountain] beyond. 165 m. Fossils in coal series limestone (T331) N 60° E 240 m coal series limestone St. N 50° W dip 7° N. N 32° E at 70 m, up again. N 45° E, 63 m. "Tashanlu" [mountain road]. 140 m, shale and sandstone.

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1 董公寺 2 黑泥坳 3 銀(?)山 4 飛來石 5 蒙梓橋 6 大石壩 7 洗馬 8 拱安關 [?] 9 板橋 10 桐梓 11 婁山關 12 頂山城

* Bearings designate direction of traverse.

[Section of coal series].

Tiehkumei	0.5 ft.
	20.0 ft. (limestone)
First, Kaopao	5.0 ft.
	30.0 ft.
Second, Tiehmei	2.5 ft.
	50.0 ft.
Third, Aitiehmei	1.0 ft. +
	30 ± ft.
Four, Aipaomei	2.0 ft.

Large valley opposite temple (to N), all Lower Perm. limestone. 500 m, temple. From temple road turns N. Coal series finishes, underlaid by limestone. Road turns NW. Steep descent. Cave in limestone. Hut on left. Descending constantly, road N 10° W.

N 55° E to Manaoyen[1], village on right in ravine, greenish shale below Perm. limestone St. N 20° E dip 24° E. 20 m further impure greenish limestone richly fossiliferous (T332). Beyond gully about 150 m, green shale St. N 34° E dip 28° E. Near river side with road to right red shale. At bridge, cross over, impure limestone (T333), St. N 30° E dip 54° E.

200 m, brown shale inter|bedded with| hard limestone St. N 35° E dip 28° E (T334). 110 m shaly gray limestone St. N 15° E dip 54° E. Yellow shale 140 m, near bridge (small) massive limestone St. N 40° E dip 65° W. At bridge, siliceous limestone St. N 20° E dip 24° W overlaid by semi-crystalline and brecciated limestone.

Then Hopa |alluvial plain of Tungtzu|.

11 April 1930: From Chumipu to Lohsikou

Outside Chumipu[2] going NNW, coal series St. N 78° W dip 20° S. Lungtaishan[3] on right. 50 m further house on right Chukuwan[4]. After it sandstone St. N 70° E dip 28° S. House on right, smaller one on left, 350±m further N, limestone.

1 瑪瑙岩 2 猪米舖 3 龍台山 4 竹姑灣

Up hill in solid limestone full of chert. Soon some shaly and sandy bands. Small hill of the same rock on left over creek. Up to nearly Koukou[1] then enter ravine in solid limestone St. N 78°E dip 20° S. Small temple on right. Cross stream by bridge, solid cliff on right, of Lower Permian limestone. Up slightly green and brown shale underlying limestone, Silurian? St. N 70° E dip 20° S. Then impure limestone with typical Silurian fossils (T335). Then small bridge in side ravine. 400 m further small bridge over side ravine, greenish shaly limestone forming cliffs—fossiliferous. Small stone bridge. Soon it is horizontal. T336 with *Orthoceras* and corals.

Cross small creek in same limestone, then cross main stream to right then left. Then to right again by wooden bridge. Lunch.

200± m further cross by bridge to left, another stone bridge to left. Same greenish shaly limestone St. N 50° E dip 20° S. Going up again. Cross stream to right, small temple on left. Below pass platy limestone St. N 10° E. dip 28° E.

Then descend a little, up gently. Green shale. Up a little, then descend a little. Cross stream (no bridge) to right. Then grayish sandy shale with very badly preserved graptolites (T337). Then fairly pure limestone, fossils (T338)—typical Matishih[2] [= *Orthoceras* limestone]. St. N 15° E dip 20° E. Took left road up, turning round to right, black shale over [?] limestone (T339) graptolites. Up steeply shale underlaid by Matishih limestone—beautiful *Orthoceras* (T340). St N 50° E. dip 12° S.

Turning to left off road in underlying shale, brownish and soft sandstone with typical trilobite (T341). Went round right slope of Mt. to Yangliutai[3]-Yaokou[4] above Niukuentang[5] all is shale (Yangtienwo shale).

Descending constantly. Near house in valley Matishih limestone St. N 40° E dip 25° SW. Above house mentioned black Silurian shale St. N 64° E dip 38° W. Small bridge. Another bridge. Brown and gray shale (Ordov.?) St. N 80° E dip 45° N.

12 April 1930: At Lohsikou[6]

Near village, a few steps up, fossiliferous limestone St. N 50° E dip 32° N (N 80° W dip 32° N more reliable) Hunghuayuan[7] limestone, underlaid by sandy shale with trilobite, dip 22° higher up. Further up along strike, same shale St.

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1 溝口 2 馬蹄石 3 楊柳台 4 坳口 5 牛滾塘 6 羅溪溝 7 紅花園

N 66° W dip 46° N. Further up near Pomaopeng[1] shale becomes nearly horizontal, on left limestone overlying it. Near pass black shale with graptolites (T342) St. N 84° W dip 16° N. Top of pass Matishih limestone dipping in the same direction, underlaid by shale, but laterally it is limestone.

Descending on N side of ravine, Hunghuayuan limestone full of trilobites. Rest.

In side ravine between ruined houses, green shale with typical *Orthis* (Yangtienwo shale). Cliff opposite of main valley is *Orthoceras* limestone. Round side valley 1.5 km from Pachiaotung[2] brown shale St. N 68° W dip 24° N. Road going NE—thin 1 limestone with trilobite interbedded. Then road winds round spur, then large valley head. 200 m from low pass above Pachiaotung, Matishih limestone with brown shale. Interbedded shale St. N 56° W dip 30°± S. Over the other side of ravine below pass, greenish shale dip circa 15° N. At pass trilobite sandstone St. N 70° W dip 40° N.

Descending, then round head of ravine and up pass *Orthoceras* limestone St. N 60° W dip 20° N. Pachiaotung all in limestone (*Orthoceras*) St. N 50° W dip 40° NE.

Passing houses up slope in limestone St. N 45° W dip 15° NE. Descend, bridge, up pass, brown and gray shale interbedded with limestone. Then at pass reddish shale, green sandstone and shale—Silurian? Descending light gray limestone with crystals of calcite. Descending, we are in horizontal limestone (Silurian?). Limestone soon St. N 60° W dip 12° N. Descend gently limestone St. N 40° W dip 34° N, overlaid by yellow brown Silurian shale. Descending steeply sandy limestone and shale. 600 m from Peikuopa[3] crystalline limestone with crinoids (Lower Silurian).

Road now goes S. Then brown shale. One house on left. Beyond green sandstone St. N 19° W dip 48° W.

Descending, crossing small stream to left, sandstone horizontal. Paishou[4] houses by ravine, graptolites by house in sandy black shale underlaid by Matishih limestone forming solid cliff under Silurian shale and limestone on other side of valley St. N 40° W dip 18° NE. Village above cliff. Beyond village, lower down, lower shale. Up pass steeply in lower shale. 400± m from pass it strikes N 25° E dip 26° E.

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1 破茅蓬 2 芭蕉洞 3 白果壩 4 排首

13 April 1930: From Lohsikou to Yehlangpa[1]

Outside village, descending, sandstone St. N 80° E dip 32° S, underlaid by crystalline Hunghuayuan limestone dipping in same direction. Crossing side stream dark gray limestone St. N 73° W dip 25° N—more general St. E-W dip 20° N and becomes typical Matishih (*Orthoceras* limestone).

Descend to river side in shale—limestone between *Orthoceras* and shale (graptolite). 80 m from crossing sandy Silurian limestone. At crossing Silurian limestone St. E-W dip 25° N, forming a hill immediately overlaid by brown and green shale St. N 65° E dip 35° N—impure limestone inter-bedded in between shale. Then crystalline, full of brachiopods (T343), still with shale.

75 m, platy limestone St. N 70° E dip 32° N (T343a), *Favosites*.

120 m, brown shale

21 m, small stone slab bridge

70 m, shale becoming reddish

110 m, opposite ruined hut, shale brownish gray again.

42 m, limestone conglomerate—½ ft.

20 m, dark gray massive limestone with Ostracod-like fossil and small brachiopods (T344).

210 m, solid cliff (Kuanyinyen[2]) St. E-W dip 30° ± N.

56 m, crossing river still in solid limestone.

Whole of Silurian beds = 589 m.

Then road goes close to cliff on left—limestone seems horizontal and overlaid by younger rock up to purple shale? [Beds] between cliff and lower limestone—seem to be shaly and cherty—black limestone full of *Schwagerina* (T345). St. N 70° E dip 28° N.

House on left (Shuikouyen[3]) below solid cliff. Up limestone pass, road turns left (on right road to Sanpo[4]). On left one house in coal series behind which purple shale forms high peaks. 260 m from [road bifurcation] sandstone and coal series 70 m, coal mine on left. 110 m, upper limestone (Panshan[5]) St. N 82° W dip 24°. 84 m up, brown shale followed by thin-bedded limestone St. E-W dip 44° N. Solid limestone, 340 m, purple shale, St. N 78° E dip 46° N.

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1 夜郎壩 2 觀音岩 3 水口岩 4 三波 5 半山

Coal series seems to cross river just N. of narrowest gap. Top of pass still in purple shale—then flat ground for 150 m, limestone St. N 80° E dip 40° N. Road now goes N 40° W. Where it turns to go N 20° E, purple shale again. St. N 82° E dip 40° N. About 150 m solid limestone again. Then houses on left, Tishengtsao[1]. Then cross valley to go up slope in limestone interbedded with brown shale St. N 72° E dip 38° N. Up slope to pass where limestone is more shaly. Road turns NNW round valley head. Road then goes NEE, very shaly limestone inter-bedded with green and black shale St. E-W dip 45° N—limestone bands rather siliceous overlaid by yellow brown shale. Then Tsingkangwo[2] (=Tienshuichih[3]). At village yellow sandy soil (Jurassic), then red sandstone after pass, St. E-W dip 56° N. Descending steeply into a ravine cross over to left. Bush.

Then turn to left. Then cross side ravine. Up slope. Descend into another ravine to Chinchuyen[4] (=Peiyengping[5]). Up valley to pass—watershed between Sinchan and Yehlangpa Rivers. Red sandstone St. E-W dip 50° N. Descending very steeply to house Hungshuwan[6]. Road follows steep ravine to W. In greenish sandy shale, indistinct plant fossils overlaid by shale greenish sandstone St. N 75° W dip 45° N. with fossil pelecypods (T346) overlaid by black shale.

140 m Tungshupa[7]. Road turns to right to descend very steeply for 300± m to river. Cross river to left, 200 m down coarse and reddish sandstone St. N 65° E dip 45° N. Cross to right turning to right. Cross to left. Houses on left on slope Panhoerh[8]. Cross to right 400± m further, hard sandstone St. N 82° W dip 36° N. 200 m, small bridge (one slab).

600± m, hard sandstone St. N 84° E dip 45° N. 300, one slab bridge, up a little. Descend. Cross to left. Photo No. 1. Soon one slab bridge. Small shrine, sandstone St, N 84° E dip 50° N. Recross river to right for the last 1.5 km. Red shale interbedded with hard sandstone. Valley wider. Cross to left, Tienchiakou[9] in red shale, dip is much gentle. Cross to right. Some close |?| to cliff, sandstone. St. E-W dip 40° N.

Then Sun's mark T. P. Village Lochiatun[10] on right. Wide valley, red shale. Cross to left. Road turns to left. Large village on right and left. At village red shale, St. N 50° W dip 40° N. Cross to right, sandstone dip much gentler. Then Yufung[11], coarse sandstone St. N 64° E dip 20° N. Wood bridge, sandstone St. N 67° E dip 16° N.

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1 底生槽 2 青岡窩 3 天水池 4 金竹尾 5 白楊坪 6 紅薯灣 7 通樹壩 8 半合兒 9 田家溝 10 羅家屯 11 油房

Bridge on right, main road ("Talu") on S. St. N 70° E dip 12° N. River turns to right Mungtu[1]. Tower. Red shale, more open valley. Bridge, large branch stream, sandstone St. N 40° E dip 9° N. More clayey beds—open valley. Pagoda on right. 80 m, yellow clay. Descending by steps. Impure limestone. Crossing river to Yehlangpa.

14 April 1930: From Yehlangpa to Tsichênhsi[2]

Slight Rain. Road along river. Bridge over branch stream, false bedded sandstone and red shale dipping 10° S. Road along an earthy ridge between a branch stream and main river to Chanlungyen[3], yellow shale dips 10° S. Then turns to right crossing wooden bridge. Impure limestone forming low cliff on right of bridge.

Up W. branch of main stream, soft sandstone St. N 65° W dip 22° S—remeasured further on, St. N 45° W dip 24° S, turning to strike N 20° W dip 40° W at point where road turns to enter side valley,—turning again to strike N 80° E dip 40° S. Then Mumutang[4] on left. In main river valley with stream on right sandstone St. N 60° W dip 30° SW. At side stream St. E-W dip 28° S. 100 m further St. N 40° W dip 40° S. This is confirmed at crossing to right. Huangnipan[5] in soft red shale cross river to left. Crossing to right, house on right, small bridge. Hill on other side with house on top, red shale St. N 60° W dip 20° S. Hut on right. 200± m red shale St. N 40° W dip 25° S. Temple on left by river side, red shale St. N 35° W dip 40° S. Cross to left, brick house of Huangnipan.

800 m N, 200 m S of hut on right, St. N 80° W dip 32° S. A little further hard sandstone remeasured St. E-W dip 45° S.

Temple on left, then houses Toutaohao[6]. Crossing long wooden bridge, going steeply up. Met Sun, up small ravine, hard red sandstone St. N 70° E? dip 48° S—still mostly soft red shale. Soon road becomes less steep, valley wider, with terraces up to top, sandstone and red and yellow shale St. N 65° E dip vertical? Crossing small stream, up by steps, turn to right across valley, yellow soft sandstone St. about E-W dip 28° S. Village below Meiyen[7] rest. Going up, red shale St. N 70° W dip 30° S. Higher up it strikes N 50° W dip 25° S. Pass, temple on right. Descending steeply, houses on right. Red shale St. N 30° E dip 38° W. Then Panpo[8], sandstone St. N 16° W dip 34° W. Descending further, sandstone St. N 15° W dip 30° W. Steep descent. Bridge over side

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1 蒙渡 2 七陣溪 3 斬龍崖 4 姆姆塘 5 黃泥板 6 頭道壕 7 梅崖 8 半坡

ravine, Hsiangshantai[1]. Descending still steeply, St. and dip unchanged. Houses on left and right (below and above). Temple on right. Black shale and gray impure limestone St. N 25° W dip 25° W increasing to 50°. Side ravine, hut on left and on right, red shale St. N 10° W dip 45° W. The Kuankou[2], main road.

Bridge. St. N 15° E dip 45° W. Outcrop of impure limestone near Tsichenhsi.

15 April 1930: From Tsichenhsi to Sungkan[3]

Outside village hard sandstone St. N 56° W dip 50° S? Crossing river twice—going on right shaly rock. Going along near Mt. on right, impure limestone in shale. Descending, impure limestone St. N 28° E dip 80° E, crushed and recemented with yellowish clay. 20 m light gray limestone St. N 18° E dip 74° W, interbedded with brown sandstone and shale with plant remains and pelecypods underlaid by brown shale not unlike Sungtzukan shale. Then Shihpatze[4]. 250 m from Shihtzupa much crushed and brecciated grayish limestone (St. and dip not clear) to Hsiunghuangszu[5]. Near the latter it strike N 15° E dip 65° W. This is probably upper Trias limestone. A little further on, near small temple, St. N 30° E dip 50° W at Pushanchiao[6].

N 68° W 200 m, end of solid limestone (beyond brown shale, further purple shale, then mine S. of it, vertical limestone cliff (3 crossing to Mungtu), limestone St. N 16° E dip 42° N with *Schwagerina* (T347).

N 60° W	200 m	
N 45° W	120 m	
N 12° W	50 m	houses on R.
N 25° E	90 m	river crossing
N 15° E	50 m	
N 34° E	80 m	
N 28° E	100 m	
N	250 m	
	50	
N 45° W	100	
W	90 m	

(limestone St. N 22° E dip 50° W)

1 巷山台 2 關口 3 松坎 4 石壩子 5 雄黃寺 6 普善橋

S 45° W 120 m

Last houses of Hsiunghuangszu.

From Hsiunghuangszu by main road over cliff in brecciated limestone. 200 m further St. N-S dip 25° W, increasing to 38° W.

Then descend to Wantze[1] which is nearly on boundary between Trias (?) and Jurassic yellow clay shale—limestone becomes very thin-bedded and shaly. Bridge before Wantzu.

Small bridge over spring, black shaly limestone, St. N 10° W dip 18° W, which swings to strike N 64° W dip 18° S. Then yellow clay and impure limestone St. N 10° W dip 25°-30° W. Descend into large side valley. Cross to Sanyuanpa[2]. Small bridge, up hill. Rain. Limestone St. N 10° E dip 20° ± W. Then one house right by road. On other side of river brown shale with limestone (dip slope).

After Liangfungyen[3], dark gray to blue limestone St. N-S dip 15° E. 3 houses on left. Limestone forms a low gorge in the river—rejuvenation. Then Tsingshuihsi[4]. Reddish limestone St. N 20° E dip 28° E. Large bridge over considerable river to the W. of which limestone forming narrow gorge and steep cliff. Then large houses (Yenhao[5]). After shaly limestone St. N 5° W dip 52° E, overlaid by more dense and purer limestone although thin-bedded, which forms a cliff with one house on right, St. N-S dip 34° to 40° E changing to N 15° S dip 80° + E—reddish in colour and thin-bedded. Before house on right, descending, it strikes N 30° W dip 50° NE. Then house on right (Sinchiehtze[6]). Limestone becomes platy and more shaly dip 10° ± E. Then up a little seeming to be in red sandstone which seems to extend to E side of river with underlying limestone dipping steeply W. Then stone bridge. Descending to water edge to Takoupu[7]. On the otherside of the river, purple shale? behind limestone dipping W. Bridge. Then few houses. Sandstone on the otherside of river dips 30° + W, St. about N 40° E. Then over house on left, descend. Sandstone St. N 20° E dip 45° W. Then water mill (Tungshanchiao[8]). Limestone cliff on both side seen through gap not more than 400 m from river. Limestone? seems to crop out on other side of river dipping W (beyond mouth of side stream). Before descending steep slope, sandstone St. N 40° E dip 40° W. Descending it becomes vertical? Just before Sungkan, sandstone St. N 40° E dip 70° W. Likin station. Bridge. Then Sungkan.

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1 灣子 2 三原壩 3 兩峯巖 4 清水溪 5 鹽號 6 新街子 7 打狗舖 8 同善橋

16 April 1930: From Sungkan to Taipingchiao[1]

Coarse brown sandstone between 2 cities, St. N 30° E dip 52° E.

8:06* in sandstone St. N 43° E dipping steeply E on left. 8:11 Tan [rapids], impure limestone in red and green shale, dip 17°- E.

(1)	8:13	N 60° E
(2)	8:15	N 15° E
(3)	8:21	N 41° E in red shale dipping gently E.
(4)	8:24	N 44° E red sandstone horizontal
(5)	8:26	N 24° E impure limestone and sandstone on left
	8:29	Tan
	8:32	gap on right, limestone not far away
	8:33	sandstone on left St. N 24° dip 45°-50° E
	8:35	Tan
(6)	8:37	
(7)	8:41	335 m
(8)	8:43	N 50° E Shuiniutang[2] limestone
(9)	8:45½	N 16° E vertical diff on left

Violet and brown soil with bushes, sandstone in river St. N 10° E dip 45° E

(10)	8:49	N 10° E
	8:53	Tan
(11)	8:54	N 25° E cliff dip 10° E
(12)	8:56½	N 15° E Tan. Limestone on left sandstone on right
(13)	8:59	344 m
	8:60	Tan, solid massive gray limestone St. N 25° E dip 50° E
	9:08	Tan
(14)	9:10	320 m solid limestone frequently thin-bedded
	9:15	high rapids or Toutan dip nearly vertical
(15)	9:17	330 m. Very bad "Taolatan"
	9:19	200 m

1 太平橋 2 水牛塘

* Figure indicate time by the author's watch. Apparently he was taking a boat down river.

"Heitan", just roam for one boat, St. N 25° E dip 65° ±.

(16)	9:37	N 5° E. Limestone full of chert (Permian)
(17)	9:37	N 15° E. Purple shale below

Heitan

(18)	9:46	N 20° E. Along St. of chert black limestone
(19)	9:58	Tan. 350 m
(20)	10:00	in soft rock
	10:02	stop.

Contact, Silurian green shale, St. N 20° E dip 68° E. Restart

(21)		300 m
(22)	10:17	330 m
	10:20	Silurian limestone
(23)	10:22½	N 10° E. Black shale. Muchehho[1] on right 100 m Ordovician limestone
(24)	10:27	
	10:30	Stop 2 minutes
(25)	10:35	N 10° E Chinchiatan[2]. More massive still platy bluish gray limestone dipping 20± E
	10:40	Tan. Valley narrower
	10:43	Stop 2 minutes
		Tatan[3] 250 m to next [?] right. Massive light gray limestone (Loushankuan limestone) St. N 20° E dip 56° E

Restart. (26) 10:59 289 m

Entering gorge—700 m

	11:06	
	11:07½	axis of anticline
(27)	11:16	355 m dipping 10° W
(28)	11:21	314 m Across strike.
	11:27	waterfall on limestone, overhanging cliff Youshihkou[4] 30 m wide
(29)	11:28	Tan, 265 m. Same limestone dipping 10° ± W
(30)	11:30	225 m, dipping 30° W

1 木澤河 2 金家灘 3 大灘 4 油石口

	(31)	11:34	305 m
	(32)	11:37	0 m
	(33)	11:39	25 m, dip 30° W
		11:42	Stop

Contact between solid limestone and brown shale. Panfanto[1] on left at contact. Hunghuayuan limestone St. N 30° E dip 35° W (T347).

Restart.	(34)	11:49	0 m. Yangtienwo shale
	(35)	11:55	255 m, Ordovician *Orthoceras* limestone
		11:58	end of Ordovician limestone Yentsingho, then black shale
	(36)	12:02	270 m. Then Silurian limestone dip 20° ± W
	(37)	12:07	285 m Silurian shale
	(38)	12:13	293 m Permian limestone
	(39)	12:17	282 m
		12:21	Stop up. Lungchangtze[2], Szechuan

Boundary between coal series and limestone. Landed. Coal series limestone St. N 25°-30° E dip 18° W.

Re-embark.	(40)	boundary between coal series limestone and upper shale and limestone.	
		1:03½	248 m
	(41)	1:05½	223 m
	(42)	1:08½	Siaotan. 286
		1:11	purple shale? overlaid by massive limestone on top
	(43)	1:13	329 m. On right Huangkuoshih[3]
		1:15	limestone dipping W
	(44)	1:16	N 25° E
	(45)	1:21	354 m. Brown shale between limestone, vertical cliff on left less steep on right.
	(46)	1:27	351 m
		1:30	Stop. Trias limestone St. N 15° E dip 55° W, turning to St. N 10° dip 20° W.

1 板房沱 2 龍廠子 3 黃果石

Restart.	(47)	1:37	354 m. Vertical cliff on left less steep on right. Monkey cry.
		1:40	Left dip less, but right vertical.
	(48)	1:41	327 m. Limestone dip about 30° W.
	(49)	1:44½	305 m
	(50)	1:48	330 m
		1:51	Tan.
		1:52	Chaotungpa[1] on left, contact between limestone and shale.
	(51)	1:53	265 m. Coal mine on right, impure limestone.
		1:56	Sandstone
	(52)	1:58	313 m
	(53)	2:01½	344 m. Coarse massive brown sandstone.
		2:06½	Stop. Same sandstone St. N 16° E dip 24° W. Paishihtang[2]
	(54)	2:12	313 m. Red shale inter-bedded with sandstone
		2:20	Chatan[3] or left. Gravel, coarse sandstone.
		2:26	Yentzutang[4].
	(55)	2:27½	275 m
	(56)	2:32½	310 m. Chiangkungtan[5]. Dip about 15° WNW
	(57)	2:40½	337 m. Thick-bedded red sandstone
		2:42.5	Siaotan
	(58)	2:43	318 m
	(59)	2:47	305 m
	(60)	2:48½	324 m. Thick-bedded red sandstone nearly horizontal.
	(61)	2:53½	283 m. Red sandstone dip 8°-10° W. (High water 30 feet or more above present level).
	(62)	3:06	350 m. Kanshui[6]. Sandstone.
		3:09½	305 m
		3:11	Stop, about and of Kanshui [village].
Restart.		3:13	280 m

1 趙通壩 2 白石塘 3 茶灘[?] 4 燕子灘 5 姜公灘 6 趕水

3:18	316 m.	Horizontal red sandstone.
3:26	10 m.	Over red shale.
3:30	315 m	
3:38	235 m	
3:41	279 m	
3:47½	271 m	
3:54	296 m	
3:56	Taipingchiao	

20 April 1930: From Chiehshih[1] to Chungking[2]

Opposite village on right, 400 m from Wang's* measurement, St. N 15° E dip 35° E. One kilometer from Shansientien[3] St. N 8° E dip 32° E. 200-300 m further, descend. House on right. Then river. At bridge Matantachiao[4], St. N 10° E dip 30° E. At Laoyashu[5], St. N 12° E dip 34° E.

Up slope. When at top, going along ridge, view of limestone Mt. Sandstone still St. N 10° E dip 45° to 50° E. Outside Luchochang[6] sandstone St. N 15° E dip 45°-50° E. About 800 m further, red sandstone St. N 20° E dip 40° E. Then Shuangtuti[7] on right road turns W.

At Peimiaotze[8] red shale inter-bedded with soft yellowish sandstone St. N 30° E dip 55° E underlaid by yellow shale which in turn is underlaid by red shale. Yellow shale contain indistinct plants. Descend, red shale on right but yellow Jurassic coal series on left. At watershed near house on right road goes W. to go up in Jurassic—pelecypods (T348), St. N 40° E dip 68° E. All yellow gray (unwathered shale. Then Yentanchiao[9]. After bridge, red shale with sandstone, St. N 25° E dip 57° E. Then yellow shale in red shale, house on left up slope. Then brownish sandstone. Then house on right still in brown sandstone (Sinlungping[10]), becoming quartzitic and massive before descending into deep ravine, St. N 25° E dip 55° E, forming high Mt. Then stone bridge behind which is still sandstone. Just below Chinshanya[11] sandstone St. N 30° E dip 70° E. Then Chuanshanya[12] descending, impure shaly limestone dipping steeply E. Then Heitaowan[13] typical Trias limestone St. N 18° E dip 60° E. Coal mine immediately

1 界石 2 重慶 3 神仙殿 4 馬灘大橋 5 老鴉樹 6 鹿角場 7 雙土池 8 白廟子 9 雁灘橋 10 新龍坪 11 金山崖 12 泉山崖 13 核桃灣

* Mr. Y. L. Wang.

above limestone E of Heitaowan. Then Kantienchih[1], limestone dip 30° E. South of Laochang[2], limestone St. N 15° E dip 28° E.

Laochang. Rest.

After Muchulung[3] up pass limestone St. N 35°-40° E dip 18° NW. Few steps further at Yenfangtze[4] it strikes N 30° E dip 22° W. Near Sinmiao[5] it strikes N 25° E dip 32° W. Valley on left on the other side of which is Jurassic. Descend to Huangkotun[6] limestone St. N 50° E. dip 24° W.

Then along boundary between Trias and Jurassic—motor road. Then Huangkoya[7]. Direction of anticlinal axis = N 25° E. Just below Huangkoya shaly limestone with bituminous remains. Coal mine on E. slope. From Huang-koya descend sandstone St. N 50° E dip vertical. Little Lower down it is seen on S. dipping 75° W.

[Then crossing the Yangtze, the author reached Chungking.]

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1 乾天池 2 老廠 3 母豬龍 4 烟房子 5 新廟 6 黃角墩 7 黃桷埡

II. LIST OF LOCALITY NUMBERS FOR FOSSILS COLLECTED BY

V. K. TING AND Y. L. WANG (1929-1930)*

Loc. no.	*Locality*	*Horizon*	*Date*	*Fossils identified by*
T 1**	——	——	——	
T 2	Wentang, Pahsien, Szechuan. 四川・巴縣，溫塘	Trias (shale)	——	Etienne Patte
T 3	S. of Tutai, Painikang, Chichiang, Szechuan. 四川・綦江・白泥崗・土台南	Trias (Sungtzekan shale)	——	E. Patte
T 4**	North Bank of Santaoho, Chichiang, Szechuan. 四川・綦江・三道河北岸	Trias (Maotsaopu limestone)	12/11/29	
T 5	Wantze coal mine, Chichiang, Szechuan. 四川，綦江，灣子煤礦	Permian (Wantze coal series)	12/11/29	T. K. Huang & A. W. Grabau
T 6**	Shihniulan, Chichiang, Szechuan. 四川・綦江，石牛欄	Silurian. =TW 63	13/11/29	
T 7**	Yangtienwo, Chichiang, Szechuan. 四川・綦江，仰天窩	Ordovician =TW 58	,,	
T 8**	Chiehpai, between the border of Szechuan & Kueichou. 四川貴州交界間・石牌	Ordovician (*Orthoceras*)	,,	

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* All locality numbers for fossils collected by Ting or by Ting and Wang together are designated as "T"; those for fossils collected by Wang along are designated as "TW".

** Collection either lost during transit or not yet studied by specialists.

T 9**	1 li S. of Chiutienya, Tungtze, Kueichou. 貴州，桐梓，酒店埡南一里	Silurian (Graptolite) = TW 57	14/11/29	
T 10**	1 li to S. of Hsiaokengtang, Tungtze, Kueichou. 貴州，桐梓，蕭坑塘南一里	Ordovician (Chiehpai series).	„	
T 11**	Hanchiatien, Tungtze, Kueichou. 貴州，桐梓，韓家店	Silurian (shale)	„	
T 12	Kuanyinai, Tungtze, Kueichou. 貴州，桐梓，觀音岩	Permian (Yangsin limestone)	„	A. W. Grabau
T 12a**	Immediately below coal series, Tungtze, Kueichou. 貴州，桐梓，觀音岩橋脚	Lower Permian	15/11/29	
T 12b**	Above the second bridge of Kuanyinai, Tungtze, Kueichou. 貴州，桐梓，觀音岩第二橋上	„	„	
T 12c	Above Kuanyinai bridge (1st & 2nd between). 貴州，桐梓，觀音岩橋(第一第二之間)	Permian (Yangsin limestone)	„	J. S. Lee, S. Chen & A. W. Grabau
T 12d**	Above first bridge of Kuanyinai. 貴州，桐梓，觀音岩第一橋上	Lower Permian	„	
T 12e	Above first bridge of Kuanyinai.	Permian (Yangsin limestone)	„	A. W. Grabau
T 13	East of Kuanyinai 貴州，桐梓，觀音岩東	Trias		E. Patte
T 13a	Below Kuanyinai, above coal series, below red shale. 貴州，桐梓，觀音岩下煤鑛上紅板石下	Middle Permian	„	

T 14**	Near Chichenhsi. 貴州，桐梓，近七陳溪	Trias	16/11/29	
T 15**	Above Shangpo 貴州，桐梓，上坡	Trias (upper Anwenpa limestone).	17/11/29	
T 16	Above Kochang, Tungtze. 貴州，桐梓，鍋廠上	Permian (Chihsia limestone)	,,	T. K. Huang
T 17	Above Shanpo (?) 貴州，桐梓，上坡	Trias	,,	E. Patte
T 18a**	Below Tsushihkuan, Tungtze, Kueichou. 貴州，桐梓，祖師觀	Lower Permian	18/11/29	
T 18b	Tsushihkuan.	Permian (Chihsia limestone)	,,	T. K. Huang
T 19**	Kanlungtung 3 li north of Tungtze, Kueichou. 貴州，桐梓，乾龍洞	Lower Permian	,,	
T 20a	Above the Panshan (by the side of the motor road) 桐梓，半山煤窯上(馬路邊)	Permian (Changhsing limestone)	19/11/29	T. K. Huang
T 20b	Same locality	,,	,,	,,
T 20c**	Above Panshan coal mine.	,,	,,	
T 20d**	Above Panshan coal mine just below T20e.	,,	,,	
T 20e	Above Panshanchang, Tungtze, Kueichou. 貴州，桐梓，半山廠	Trias (Santaoho shale)	,,	E. Patte
T 21**	S. of Maanshan, Tungtze, Kueichou. 桐梓，馬鞍山南	Silurian (Hanchiatien shale)	23/11/29	

T 22**	S. of Maanshan (in quarry) Tungtze, Kueichou.	Silurian (Shihniulan limestone)	23/11/29
T 23			
T 24**	S. of Shatsui, Tungtze, Kueichou. 貴州，桐梓，沙嘴南	Ordovician (Matishih limestone)	,,
T 25**	Mouth of Hunghuayuan ravine, Tungtze, Kueichou. 貴州・桐梓，紅花園溝	Ordovician (Yangtienwo shale)	,,
T 26**	S. of Hunghuayuan, Tungtze, Kueichou.	Ordovician (Hunghuayuan limestone)	,,
T 27**	Loushankuan, Tungtze, Kueichou. 貴州，桐梓，婁山關	Cambrian (Loushankuan limestone)	,,
T 28**	Below Hsiaoyakou, east of Panchiao, Tsunyi, Kueichou. 貴州，遵義，板橋小埡口	Ordovician (above siliceous limestone)	24/11/29
T 29**	Below Hsiaoyakou, (above T28) Tsunyi, Kueichou.	Ordovician (Yangtienwo shale)	,,
T 30**	Above Hsiaoyakou, near Panchiao, Tsunyi, Kueichou.	Ordovician (Matishih limestone)	,,
T 31**	Shangpa, Tsunyi, Kueichou. 貴州，遵義，上壩	Cambrian	25/11/29
T 32**	Shangpa (above sandy shale), Tsunyi, Kueichou.	,,	,,
T 33**	Taotsoshih, Tsunyi, Kueichou. 貴州，遵義，倒座石	Cambrian (siliceous limestone)	,,

T 34**	Below Taotsoshihai, Tsunyi, Kueichou. 遵義，倒座石崖下	Ordovician	28/11/29	
T 35**	Below Taotsoshihya-kou, Tsunyi, kueichou. (T34) 遵義，倒座石埡口下	Ordovician (Yangtienwo shale)	,,	
T 36**	Below Taotsoshihya-kou, (between T37 & 35) Tsunyi, Kueichou.	Ordovician (?)	,,	
T 37**	Below Taotsoshihya-kou, (above T36) Tsunyi, Kueichou.	Lower Permian (*Fusulina* limestone)	,,	
T 38	Below Taotsoshihya-kou, Tsunyi, Kueichou.	Permian (Yangsin limestone)	,,	J. S. Lee & S. Chen
T 39	S. of Shihtzepu, Tsunyi, Kueichou. 遵義，十字舖南	Permian (Maokou limestone)	1/12/29	T. K. Huang
T 40**	Shihtzepu (top of slop), Tsunyi, Kueichou. (below T39) 遵義，十字舖(坡頂)	Lower Permian	,,	
T 41	N. of Shihtzepu, Tsunyi, Kueichou.	Permian (Chihsia limestone)	,,	J. S. Lee, S. Shen & T. K. Huang
T 42**	Shihtzepu (in quarry), Tsunyi, Kueichou.	Ordovician (Matishih limestone)	,,	
T 43	Shihtzepu stone quarry (below T42), Tsunyi, Kueichou.	Ordovician (Yangtienwo shale)	,,	Y. C. Sun
T 44**	Shihtzepu quarry, (below T43), Tsunyi, Kueichou.	Ordovician (Hunghuayuan limestone)	1/12/29	

T 45a**	S. of Tungkungssu, Tsunyi, Kueichou. 遵義，董公寺南	Lower Permian (*Fusulina* limestone)	1/12/29	
T 45b**	Tungkungssu, Tsunyi, Kueichou.	,,	,,	
T 45c**	Tungkungssu (by the side of inn) 遵義，董公寺(飯舖旁)	,,	,,	
T 46**	N. of Heituao in quarry, Tsunyi, Kueichou. 遵義，黑土坳北	Ordovician (Matishih limestone)	,,	
T 47**	S. of Mengtzechiao, Tsunyi, Kueichou. 遵義，蒙自橋南	Ordovician (above oolitic limestone)	,,	
T 48	Shihtzepu (above 2nd. coal seam), Tsunyi, Kueichou.	Permian	,,	A. W. Grabau
T 49**	S. of Shihtzepu, (above T48) Chiuchitan, Tsunyi, Kueichou. 遵義，九級灘，十字舖南	Trias (oolitic limestone)	2/12/29	
T 50**	S. of Shihtzepu, Chiuchitan, Tsunyi, Kueichou.	Trias	,,	
T 51**	Chiuchitan (No. 3 in S. S. Yoh's section) Tsunyi, Kueichou.	,,	,,	
T 52**	Chiuchitan (No. 5 in S. S. Yoh's section) Tsunyi, Kueichou.	Trias	,,	
T 53	Chiuchitan (6 in S. S. Yoh's section), Tsunyi, Kueichou.	Trias (Santaoho shale)	,,	E. Patte

T 54	W. of Chiuchitan (7 in S. S. Yoh's section) Tsunyi, Kueichou.	Trias	2/12/29	E. Patte
T 55**	Maotsaopu (No. 10 in S. S. Yoh's section) Tsunyi, Kueichou. 遵義，茅草舖	,,	,,	
T 56**	Makan, Tsunyi, Kueichou. 遵義，馬坎	Middle Permian?	3/12/29	
T 57	Tashihpan, Tating, Kueichou. 貴州，大定，大石板	Permian (Chihsia limestone)	10/12/29	T. K. Huang & A. W. Grabau
T 58	Shuiaipa, Chien-hsi, Kueichou. 貴州，黔西，水岩壩	Permian (Yangsin limestone)	9/12/29	A. W. Grabau
T 59	1 li NE of Shihsan-chia, Tating. 大定，十三家東北一里	,,	11/12/29	,,
T 60**	Panshui coal mine 泮水煤窰	Middle Permian	7/12/29	
T 61	Below Chiulungshan coal mine, Tating. 大定，九龍山煤鑛下	Permian (Chihsia limestone)	10/12/29	T. K. Huang & A. W. Grabau
T 62a	Panfang, Tating 大定，板房	Permian (Yangsin limestone)	11/12/29	A. W. Grabau
T 62b	1 km W. of Panfang, Tating	,,	,,	,,
T 63	Between Panfang, and Pailachang 大定，板房白腊廠間	,,	10/12/29	J. S. Lee & S. Chen
T 64	Below coal, Shashu-ping, Tating. 大定，衫樹坪	,,	12/12/29	,,

T 65	Chengyaoai, Tating 大定，撐腰岩	Permian (Upper Lopingian)	12/12/29	T. K. Huang & A. W. Grabau
T 66	Yulungshan, Tating 大定，雲龍山	Trias (?)	,,	E. Patte
T 67	Huoyenshan, Tating. 大定，火焰山	Permian (?)	,,	,,
T 68	Below Maanshan, Tating. 大定，馬鞍山	(Upper Lopingian)	17/12/29	T. K. Huang
T 69	Below Koya coal mine, Tating. 大定，閣鴉煤礦下	Lopingian	,,	,,
T 70	Near Toutsang, Tating. 大定，頭倉	Trias (Santaoho shale)	21/12/29	E. Patte
T 71**	500 m W. of Yang-changpa, Tating. 大定，羊腸壩	Trias limestone	,,	
T 72	Tienpingshao, Chienhsi. 黔西，天平哨	Trias (above purple shale)	23/12/29	E. Patte
T 73a**	Above Yachihho, Chienhsi, at barometer reading 641.2. 黔西，鴨池河	Lower Permian?	25/12/29	
T 73b**	Just below pass below thin coal seam Yachihho, Chienhsi.	,,	,,	
T 73c**	At barometer reading 644.8 Chienhsi.	,,	,,	
T 73d	At barometer reading 650, Chienhsi	Upper Lopingian	25/12/29	T. K. Huang
T 73e	At barometer reading 658.5, Chienhsi	Lopingian	,,	A. W. Grabau

T 74	Hsintientze Chienhsi 黔西，新店子	Trias (Santaoho shale)	23/12/29	E. Patte
T 75**	Laowangchung, Chingcheng 貴州，清鎭，老王沖	Middle Permian (*Schwagerina*)	27/12/29	
T 76	Laowangchung coal mine, Tsingcheng 清鎭，老王沖煤礦	Lopingian	,,	T. K. Huang & A. W. Grabau
T 77	Kuanyinko, Tsingcheng 清鎭，觀音閣	Lopingian	,,	T. K. Huang
T 78	S. of Kuanyinko, Tsingcheng 清鎭，觀音閣南	Yangsin limestone	,,	,,
T 79**	N. of Chikang bridge, Tsingcheng 清鎭，季康橋北	Trias limestone?	28/12/29	
T 80	S. of Chikang bridge Tsingcheng 清鎭，季康橋南	Trias	,,	E. Patte
T 81	Outside east gate, Tsingcheng 清鎭，東門外	,,	,,	,,
T 82	Tatiehchieh, Tsingcheng 清鎭，打鐵街	Lopingian	,,	T. K. Huang
T 83	Sanchiao, Kueiyang. 貴陽，三橋	Trias	,,	,,
T 84a	Sanchiao, Kueiyang.	,,	,,	,,
T 84b	Sanchiao, Kueiyang.	,,	,,	,,
T 85**	Sanchiao, Kueiyang.	Jurassic? (plant? fossil)	28/12/29	
T 86	Between Touchiao and Erhchiao, Kueiyang. 貴陽，頭橋二橋間	Yangsin limestone	,,	T. K. Huang & A. W. Grabau

T 86a	Between Touchiao and Erhchiao, Kueiyang.	Yangsin limestone	28/12/29	T. K. Huang
T 87**	Touchiao, Kueiyang; Gastropod in coal series. 貴陽，頭橋	Middle Permian	,,	
T 88	W. of Tuyunkuan, Kueiyang. 貴陽，圖雲關	Yangsin limestone Mid-Carboniferous (according to Hsu)	13/1/30	K. H. Hsi, T. K. Huang & A. W. Grabau
T 89	E. of Tuyunkuan, Kueiyang.	Permian	,,	T. K. Huang
T 90	Paomuchung, Lungli, Kueichou. 貴州，龍里，泡木冲	Trias	14/1/30	C. C. Tien
T 90a**	Upper Horizon.	,, ?	,,	
T 91a	*Gastrioceras* shale W. of Kuchiao, Lungli. 龍里，谷脚西	Lopingian	,,	C. C. Tien
T 91b**	W. of Kuchiao, Lungli.	Lopingian (*Fusulina*)	,,	
T 92	W. of Kuchiao, Lungli.	Trias	,,	C. C. Tien
T 93	At Kuchiao, Lungli.	,,	,,	,,
T 94**	E. of Kuchio, Lungli.	Middle Permian	,,	
T 95	Near Kuanyinshan, Lungli. 龍里，觀音山	Yangsinian or Uralian?	,,	A. W. Grabau
T 96	Pass east of Kuanyinshan, Lungli.	Wieningian	14/1/30	Y. S. Chi & A. W. Grabau
T 96a	E. of T96, Lungli.	,,	,,	Y. S. Chi
T 97**	E. of Kuanyinshan below T96, Lungli.	,,	,,	

T 98	E. of Lungtsung, Lungli. 龍里，龍松	Fengninian	14/1/30	A. W. Grabau & C. C. Tien
T 99**	W. of Yenshanpu bridge, Lungli. 龍里，鹽山舖	Lower Carboniferous	,,	
T100**	E. of Yenshanpu bridge, Lungli.	,,	,,	
T101	Shuiyenchung, Lungli 龍里，水淹沖	Yangsin limestone	,,	J. S. Lee, S. Chen & A. W. Grabau
T102	Near Wengcheng-chiao, Kueiting. 貴定，甕城橋	Lopingian, (*gastrioceras shale*)	15/1/30	C. C. Tien
T103	Between Wengcheng-chiao and Tsung-pachieh, Kueiting. 貴定，甕城橋與粽巴街間	Lopingian	18/1/30	T. K. Huang
T103a				
T103b	Between Wencheng-chiao and Tsung-pachieh, Kueiting.	Yangsin limestone	18/1/30	T. K. Huang
T103c				
T103d	Between Wencheng-chiao and Tsung-pachieh, Kueiting.	Yangsin limestone	18/1/30	A. W. Grabau
T103e				
T103f				
T103g	Between Wencheng-chiao and Tsung-pachieh, Kueiting.	Yangsin limestone	18/1/30	J. S. Lee and S. Chen
T103h				
T103i	Between Wencheng-chiao and Tsung-pachieh, Kueiting.	Chihsia limestone	18/1/30	T. K. Huang & A. W. Grabau

T103j	Between Wencheng-chiao and Tsung-pachieh, Kueiting.	Chihsia limestone	18/1/30	T. K. Huang & A. W. Grabau
T103k	,, ,,	,,	,,	T. K. Huang
T103l	,, ,,	,,	,,	,,
T103m	,, ,,	,,	,,	,,
T103n	,, ,,	,,	,,	,,
T104	W. of Tungshan-chiao, Kueiting. 貴定，同善橋西	Lopingian	17/1/30	,,
T105	Tashanpa, Kueiting. 貴定，大三壩	Chihsia limestone	,,	,,
T106**	Between Erhtuti & Tungshanping, Kueiting. 貴定、二土地東山坪間	Lower Carboniferous	,,	
T107	W. of Machiatun, Kueiting. 貴定，馬家屯	Silurian	,,	A. W. Grabau & C. C. Tien
T107a	W. of Pachiatun Kueiting (pavement).	,,	,,	,,
T108	500 m. E. of Machia-tun, Maha. 麻哈，馬家屯東	Silurian	17/1/30	A. W. Grabau & C. C. Tien
T109	Below T108.	,,	,,	,,
T110	Below T109.	,,	,,	,,
T111**	200 m E. of Chaho, Maha. 麻哈，岔河東	Ordovician?	,,	
T112**	At Kuankou, Maha. 麻哈，關口	,, ?	,,	
T112a**	Near a bridge, N of Lohu, Maha. 麻哈，呼羅下	,,	,,	

T113**	S. of Kutung, Tutimiao, Maha. (pavement) 麻哈，谷峒南土地廟	Ordovician	19/1/30	
T113a**	5 li S. of Kutung, Hsiaochiao, Maha. (pavement) 麻哈，谷峒，南五里小橋	,,	,,	
T114**	Lopussu (not in situe), Maha. 麻哈，蘿蔔寺碑	,,	,,	
T115**	5 li S. of Lopussu, Maha. 麻哈，蘿蔔寺南五里	,,	,,	
T116**	500 m N. of a small pass S. of Tangfang, Maha. 麻哈，塘房	,,	,,	
T117	Chingtaokuanchiaotou, Maha. 麻哈，敬道關橋頭	?	,,	A. W. Grabau & C. C. Tien
T118	At foot of pass Chingtaokuan, Maha. 麻哈，敬道關	Devonian	,,	,,
T119	400 m. S. of Yangliuchieh, Maha. 麻哈，楊柳街	Lopingian	20/1/30	T. K. Huang
T119a	130 m S. of T119	,,	,,	,,
T120	500 m N. of Hsiaolungching, Tuyun. 都匀，小龍井	,,	,,	,,
T121**	100 m N. of Talungching, Tuyun. 都匀，大龍井	Middle Permian	,,	
T122**	100 m. N. of a hut E. of Maanshan, Tuyun. 都匀，馬鞍山	Lower Permian	,,	

T123	Between Maanshan and a hut to the east, Tuyun.	Chihsia limestone	20/1/30	T. K. Huang
T124	S. of Maanshan, Tuyun.	Lopingian	,,	,,
T125	W. of Changchiamiao (W. of Tuyun) 都匀・張家廟	Chihsia limestone	21/1/30	,,
T126	Below Mangshan below quartzite, Tuyun. 都匀・蟒山	Silurian?	,,	A. W. Grabau & C. C. Tien
T126a	Wall near T126	,,	,,	,,
T127**	1 li North-east of Pangshuichiao. 邦水橋・東北一里	Ordovician	,,	
T127a**	,,	,,	,,	
T128**	,,	Silurian? (not determinable)	,,	
T129	W. of Kaochi, Tuyun. 都匀・高碁	Lopingian?	23/1/30	T. H. Yin
T130**	E. of Kaochi, Tuyun.	Middle Permian	23/1/30	
T131**	3 li E. of Kaochi, Tuyun.	Lower Carboniferous	,,	
T132	4 li E. of Kaochi, Tuyun.	Upper Devonian	,,	A. W. Grabau & C. C. Tien
T133**	W. 100 m Mulaopu. 母老舖西	Ordovician	,,	
T134**	Lungchiawan. 龍家灣	Cambrian	,,	

T135	1 li S. of Teluching, Pachai. 八寨，得路箐	Devonian	24/1/30	A. W. Grabau, C. C. Tien & Y. S. Chi
T135a	½ li S. of Teluching, Pachai, (Pavement).	Middle or Upper Devonian	,,	,,
T136	1 li N. of Koutichai, Pachai. 八寨，溝底寨	Fengninian	,,	A. W. Grabau & C. C. Tien
T137	Erhtengkao, Pachai. 八寨，二登高	,,	,,	,,
T137a	above T137	Devonian	,,	,,
T138**	Lungt'ang, Pachai. 八寨，龍塘	Cambrian	25/1/30	
T139**	S. of Taho pavement Sanho. 三合，大河南	Ordovician	27/1/30	
T140**	S. of Taho (covered bridge) Sanho. 三合，大河南亭子	,,	,,	
T141	Opposite Mankung-chai, Sanho. (Pavement) 三合，蠻公寨	Middle Devonian	,,	Y. S. Chi
T142	500 m. S. of Man-kungchai, (Pavement) 三合，蠻公寨	Middle Devonian	,,	A. W. Grabau & C. C. Tien
T143	1 km. NE of Pang-chai, Sanho (pavement) 三合，邦寨	,,	,,	Y. S. Chi
T144	Opposite Pangchai, Tushan (pavement). 獨山，邦寨	,,	,,	A. W. Grabau & C. C. Tien
T145	Limestone above T144	,,	,,	Y. S. Chi
T146	Between T145 and T147 (pavement).	,,	,,	A. W. Grabau & C. C. Tien

T147	Limestone SE. of Pangchai.	Middle Devonian	27/1/30	Y. S. Chi
T148	Above Kangchai, Tushan, (Pavement). 獨山・康寨	,,	,,	,,
T149	,,	,,	,,	A. W. Grabau & C. C. Tien
T150**	Between T151 & T152, Sanho.	,,	28/1/30	
T151	S. of Panchiawan, Tushan. 獨山・潘家灣	,,	,,	Y. S. Chi
T152**	Opposite Fenghsiang-shu, Sanho. 三合・楓香樹	,,	,,	
T153	Paishuichiao, Tushan, (Pavement). 獨山・白水脚	,,	,,	Y. S. Chi
T154	S. of Paishuichiao, Tushan (pavement).	,,	,,	A. W. Grabau & C. C. Tien
T155	Near Fenghsiangshu, Tushan. 獨山,楓香樹	,,	,,	Y. S. Chi
T156	½ li S. of Shuiai, Tushan. 獨山・水岩	Middle Devonian	28/1/30	Y. S. Chi
T157	100 m. NE. of a waterfall (SW of a small bridge), Tushan.	,,	,,	,,
T157a	Near bridge NE of waterfall, Tushan.	,,	,,	,,
T158	100 m NE of waterfall, Tushan.	,,	,,	,,

T158a**	100 SW of waterfall, Tushan.	Middle Devonian	28/1/30	Y. S. Chi
T158b	500 m SW of waterfall, Tushan.	,,	,,	,,
T159	Between waterfall and Munichiao, Tushan. 獨山・牟尼橋	,,	,,	,,
T160	1 li E. of Lapo, Tushan. 獨山・拉坡	,,	,,	,,
T161**	Near Lapo, Tushan.	,,	,,	
T162	1½ km. NW. of Nungchi, Tushan. 獨山・農鷄	,,	,,	A. W. Grabau & C. C. Tien
T163	½ km. NE of Yangmeng, Tushan. (100 NW of a mill NW of a bridge). 獨山・羊猛	,,	29/1/30	Y. S. Chi
T164	SE of Chipao, Tushan. 獨山・鷄泡	,,	,,	Y. S. Chi, A. W. Grabau & C. C. Tien
T164a**	SE of Chipao, Tushan (pavement).	,,	,,	,,
T165	NW. of T164.	Middle Devonian	29/1/30	Y. S. Chi
T166	1 km NE. of Chipao, Tushan, river crossing.	,,	,,	,,
T167**	At Sungchiachiao, Tushan. 獨山・宋家橋旁	,,	,,	
T168**	The side of ChunglIehtzu, Tushan (pavement). 獨山・忠烈祠旁	,,	,,	

T169	The French church, Tushan (pavment). 獨山，天主堂	Middle Devonian	31/1/30	A. W. Grabau & C. C. Tien
T170a	On motor road outside south gate, Tushan. 獨山，南門外馬路旁	,,	2/2/30	Y. S. Chi, A. W. Grabau & C. C. Tien
T170b	,,	,,	,,	,,
T170c	,,	,,	,,	A. W. Grabau & C. C. Tien
T170d	,,	,,	,,	Y. S. Chi A. W. Grabau & C. C. Tien
T171a	Deep ravine E. of the city, Tushan. 獨山城東，深溝	,,	,,	A. W. Grabau & C. C. Tien
T171b	,,	,,	,,	Y. S. Chi, A. W. Grabau & C. C. Tien
T171c	,,	,,	,,	A. W. Grabau & C. C. Tien
T171d	,,	,,	,,	Y. S. Chi, A. W. Grabau & C. C. Tien
T171e	,,	,,	,,	A. W. Grabau & C. C. Tien
T171f				
T171g	Deep ravine E of the city, Tushan.	Middle Devonian	2/2/30	Y. S. Chi, A. W. Grabau & C. C. Tien
T171h	,,	,,	,,	,,
T171i	,,	,,	,,	A. W. Grabau & C. C. Tien
T172	N. of Shihancho, Tushan. 獨山，石案桌北	,,	4/1/30	Y. S. Chi

T173	At Shihancho, Tushan.	Middle Devonian	4/1/30	Y. S. Chi,
T174	½ li N. of Weng-chiao, Tushan. 獨山・甕傍橋	,,	,,	A. W. Grabau & C. C. Tien
T175	At Wengchiao, Tushan.	Upper Devonian	,,	Y. S. Chi, A. W. Grabau & C. C. Tien
T175a	,,	,,	,,	,,
T176	N. of Wangchengpo, Tushan. 獨山・望城坡北	,,	,,	,,
T177	At Wangchengpo, Tushan.	,,	,,	,,
T177a	,,	,,	,,	A. W. Grabau & C. C. Tien
T178	N. of Sanwangmiao, Tushan. 獨山・三王廟	Upper Devonian	4/1/30	Y. S. Chi
T179	Sanwangmiao Tushan	,,	,,	Y. S. Chi, A. W. Grabau & C. C. Tien
T180	½ li N. of Yaoso-chiao, Tushan. 獨山・堯梭橋	,,	,,	A. W. Grabau & C. C. Tien
T181	S. of Kolaoho, Tushan. 獨山・猼佬河	Fengninian	,,	C. C. Yü, Y. S. Chi, A. W. Grabau & C. C. Tien
T181a	above T181	,,	,,	A. W. Grabau & C. C. Tien
T182	1 li S. of Kolaoho bridge, Tushan.	,,	5/1/30	,,
T183	Above T182	,,	,,	Y. S. Chi, A. W. Grabau & C. C. Tien

T184	18 li S. of Kolaoho bridge, Tushan.	Fengninian	5/1/30	Y. S. Chi, C. C. Yü. A. W. Grabau & C. C. Tien
T185	At Tangpakou, Tushan. 獨山，湯耙溝	,,	,,	Y. S. Chi, A. W. Grabau & C. C. Tien
T186	1 li SE. of Liweng, Tushan. 獨山，梨甕	,,	,,	Y. S. Chi
T187	½ N. of small bridge, NE. of Chicha, Tushan. 獨山，鷄札	,,	,,	A. W. Grabau & C. C. Tien
T188	E. of Chicha, Tushan	,,	,,	C. C. Yü
T189	SE. of Chicha, Tushan.	,,	,,	Y. S. Chi
T190	At Heishihkuan, Tushan. 獨山，黑石關	,,	,,	C. C. Yü, A. W. Grabau & C. C. Tien
T191	½ li N of Shangssu, Tushan. 獨山，上司	,,	,,	Y. S. Chi
T191a	At Shangssu, (Pavement).	,,	,,	A. W. Grabau & C. C. Tien
T192	¾ km. S. of Shangssu.	,,	,,	C. C. Yü & Y. S. Chi
T193	5 li S. of Shangssu.	,,	6/1/30	C. C. Yü, A. W. Grabau & C. C. Tien
T194	1 li SE of Chachai, Tushan. 獨山，札寨	,,	,,	,,
T195**	At bridge SE. of Chachai, Tushan.	Lower Carboniferous	,,	
T196	SW of Hsinchai, Tushan. 獨山，新寨	Fengninian	,,	Y. S. Chi, C. C. Yü, A. W. Grabau & C. C. Tien

T196a	SW of Hsinchai, Tushan.	Fengninian	6/1/30	A. W. Grabau & C. C. Tien
T197	Fenghsiang, Tushan. 獨山・楓香	,,	,,	,,
T198	At turning of motor road, Mala, Tushan. 獨山・馬拉・馬路轉灣處	,,	,,	,,
T199	4 li NE of Taiping-tang, Tushan. 獨山，太平塘	Fengninian	,,	A. W. Grabau & C. C. Tien
T200**	2½ km S. of Hsiassu 下司南	Lower Permian?	7/1/30	
T201**	,,	,,	,,	
T202**	500 m N. of Payu. Tushan. 獨山・巴獪北	,,	,,	
T203	1,200 m S. of Payu, Tushan.	Uralian	,,	A. W. Grabau
T204	400 m N. of Matao, Tushan. 獨山，馬道北	Fengninian	,,	C. C. Yü & A. W. Grabau
T204a	500 m S. of Matao, Tushan.	Weiningian	,,	A. W. Grabau
T205	At Tiehkeng, Tushan. 獨山，鐵坑	Uralian (?)	,,	,,
T206**	300 m S. of Tiehkeng.		,,	
T207**	300 m S. of Mawang. 麻網南		,,	
T208**	1 km S. of Mawang.	Middle Permian	,,	
T209	At Tungchiao, Tushan. 獨山，洞脚	Uralian	,,	A. W. Grabau
T210	At Mawei, Tushan. 獨山，麻尾	,,	,,	,,

T211	1 km S. of Pachieh (Kuli), Tushan. 獨山，巴節	Uralian	9/1/30	J. S. Lee & S. Chen
T211a**	1 km S. of 211 (at Kuli).	Upper Permian	,,	
T212	3 li NW of Kengfu, Kuangsi. 廣西，更富	Uralian	,,	A. W. Grabau
T212a	2 li N of Kengfu, Kuangsi.	,,	,,	J. S. Lee & S. Chen
T213	S. of Kengfu, Kuangsi.	,,	,,	A. W. Grabau
T214**	2 li S. of Kengfu, Kuangsi.	Upper Permian	,,	
T215**	3 li S. of Kengfu, Kuangsi.	,,	,,	
T216	1 km N. of Machieh (1200 m N. of Ssuting), Kueichou. 貴州，麻街	Uralian	,,	J. S. Lee & S. Chen
T217	1 li NW of Chiawei, Kueichou. 貴州，家尾	,,	10/1/30	,,
T218	At old fort, Nantan, Kuangsi. 廣西，南丹，舊砲壘	,,	,,	J. S. Lee, S. Chen & A. W. Grabau
T219	At Militia station, Nantan. 南丹，團防分站處	,,	,,	J. S. Lee & S. Chen
T220	1 km NE of Lapien, Nantan. 南丹，拉扁	,,	,,	,,
T221**	1 km E. of Heini. 南丹，黑泥	Upper Permian	,,	
T222	At Heini, Nantan.	Lower Trias or Permian (*Gastrioceras* shale)	,,	C. C. Tien

T223	Between Kungchishan and Heini, Nantan. 南丹，公鷄山與黑泥間	Lopingian (?)	10/1/30	A. W. Grabau
T224	Between Kungchishan and Heini, Nantan.	Lopingian (?)	"	A. W. Grabau
T225	S. of Mangchang, Nantan. 南丹，芒場	Fengninian	11/1/30	A. W. Grabau & C. C. Tien
T226	2 li S. of Mangchang, Nantan.	Middle Carboniferous	"	J. S. Lee, S. Chen & T. K. Huang
T227	N. of Lamapo, Nantan. 南丹，拉馬坡北	" (?)	"	T. K. Huang
T227a**	At Lamapo, Nantan.	Lower Permian	"	
T228**	S. of bridge S. of Huangchiang, Nantan. 南丹，黃牆坡南，小橋南	"	"	
T229**	4 li N. of Shihpanching, Nantan. 南丹，石板井	"	"	
T229a	S. of T229	Moscovian	12/1/30	J. S. Lee, S. Chen & A. W. Grabau
T230	3 li W. of Kuanshang, Nantan. 南丹，關上	Lopingian	"	T. K. Huang & A. W. Grabau
T231	2 km S. of Kuanshang, Nantan.	"	"	J. S. Lee, S. Chen & K. H. Hsu
T232**	1 km SEE from T231, Nantan.	Middle Permian		
T233**	Pass above (N. of) Chungpinghsinchieh, Nantan. 南丹，中平新街	"		

T234	S. of Lala, Nantan. 南丹，拉蜡	Uralian?	12/1/30	J. S. Lee, S. Chen & A. W. Grabau
T235	N. of Tahochiao, Chematsun, Nantan. 南丹，者馬村，大河橋	Lopingian	"	T. H. Yin & C. C. Tien
T236	At Kungchiao, N of Nantan. 南丹，孔橋	?	"	J. S. Lee, S. Chen & T. K. Huang
T237**	S. of Tahsipo, Nantan. 南丹，打錫坡	Lower Carboniferous	13/11/30	
T238	Tashipo, Nantan.	Devonian	13/2/30	A. W. Grabau & C. C. Tien
T238a	Lengchiaotien, Tahsipo, Nantan. 南丹，打錫坡，冷角店	"	"	"
T238b	1 km S. of Lengchiaotien, Nantan.	Middle Devonian	"	"
T239	1 li W. of Nanmutsun, Nantan. 南丹，楠木村	Devonian	"	"
T240**	In ravine SW of Nantan city.			
T241	1 li S. of Kungchishan, Nantan. 南丹，公鷄山	Uralian	10/1/30	J. S. Lee, S. Chen, T. K. Huang, A. W. Grabau & C. C. Tien
T242	E. of Mienhuatsun, Nantan. 南丹，棉花村	"	17/2/30	A. W. Grabau
T243	Between Chiku & Huahuatsun, Nantan 南丹，鷄庫與花花村	" ?	18/2/30	J. S. Lee, S. Chen, T. K. Huang & A. W. Grabau
T244**	1 km E. below Hsiamanchai, Nantan. 南丹，下蠻寨東		20/11/30	

T245**	SE of Huangtsaoping, Nantan. 南丹，黃草坪		20/11/30	
T246	1 li E. of Huangtsaoping, Nantan.	Yangsinian	20/2/30	J. S. Lee & S. Chen
T247	At Paku opposite Lanao, Lipo. 荔波，爛坳對河八古	?	21/2/30	A. W. Grabau
T247a	1 li N. of Langpotang, Lipo. 荔波，郎坡塘	?	,,	,,
T247b	Pass NW of Langpotang, Lipo.	Chihsia limestone	,,	T. K. Huang & A. W. Grabau
T248	Slope W. of Weichai, Lipo. 荔波，韋寨西坡上	Fengninian	,,	Y. S. Chi, A. W. Grabau & C. C. Tien
T249	,,	,,	,,	C. C. Yü & Y. S. Chi
T249a	At foot of slope W of Weichai, Lipo.	,,	,,	Y. S. Chi
T250**	At foot of slope E. of Weichai, Lipo.	Lower Permian	21/11/30	
T251	Pass above Weichai, Lipo.	Yangsinian ?	21/2/30	A. W. Grabau
T252	At small pond overpass above Weichai, Lipo.	,,	,,	J. S. Lee & S. Chen
T253**	600 m E. of T252 Lipo.	Lower Permian	21/11/30	
T254	700 m E. of T252 Lipo.	Yangsinian	21/2/30	T. K. Huang
T255	Slope W. of Pahui, Lipo. 荔波，巴灰	Lopingian	21/2/29	T. K. Huang

T256	Slope W of Pahui, Lipo.	Lower Trias.	21/2/29	C. C. Tien
T257	,,	,,	,,	,,
258**	4 li W. Lipo, Lipo. 荔波，荔波西四里	Middle Permian		
T259**	At Liangting outside north gate of Lipo, Lipo.	Tertiary (Young sandstone & Gravel)	23/11/30	
T260	1 km S. of Shihhuiao, Lipo. 荔波，石灰坳	?	23/2/30	T. K. Huang
T261	1 li S. of Hsiashui-lung, Lipo. 荔波，下水龍	?	,,	A. W. Grabau
T261a	N. of T261, Lipo.	?	,,	,,
T262**	Above Shangshui-lung, Lipo. 荔波，上水龍	Lower Permian	23/11/30	
T263	½ li N. of Shuiti, Lipo. 荔波，水底	Weiningian	23/2/20	Y. S. Chi
T264	Between Sanshuifen & Fangtsun, Lipo. 荔波，三水分及方村間	Uralian ?	,,	A. W. Grabau
T265	,,	,,	,,	T. K. Huang
T266	1 li E. of Laliao, Lipo. 荔波，拉了	?	25/2/30	C. C. Tien
T267	At Laliao, Lipo.	Yangsin limestone	,,	J. S. Lee & S. Chen
T268	1 li E. of Laochia-liang, Lipo. 荔波，老甲良	,,	,,	T. K. Huang
T269	1 li W. of Laochia-liang, Lipo.	Chihsia limestone	25/2/30	J. S. Lee, S. Chen, T. K. Huang & A. W. Grabau

T270	Pass S. of Kuanyin-tung, Lipo. 荔波，觀音洞	Yangsin limestone	25/2/30	J. S. Lee & S. Chen
T271	Pass S. of Kuanyin-tung, Lipo.	Uralian	,,	J. S. Lee, S. Chen & Y. S. Chi
T271a**	At foot of pass S. of Kuanyintung, Lipo.	Lower Permian		
T271b	At foot of pass S. of Kuanyintung, Lipo.	Weiningian	25/2/30	Y. S. Chi & A. W. Grabau
T272	N. of Piaochai, Lipo. 荔波，瓢寨北	,,	26/2/30	,,
T273**	1 li N. of Tsangtou, Tushan. 獨山，倉頭	Lower Carb. plants	26/11/30	
T274	2 li N. of Tsangtou, Tushan. 獨山，倉頭	Fengninian	26/2/30	A. W. Grabau & C. C. Tien
T275	At Lanchai, Tushan. 獨山，爛寨	,,	,,	Y. S. Chi & C. C. Yü
T276**	Between Tanghuai & Lanchai, Tushan. 獨山，唐懷爛寨間	Lower Carb. plants.	26/11/30	
T277	At Paho, Tushan. 獨山，巴合	Fengninian?	26/2/30	A. W. Grabau & C. C. Tien
T278**	1 li S. Tatungho, Tushan. 獨山，大同河	Upper Devonian	26/11/30	
T278a	½ li S. of Tatungho, Tushan.	Devonian	27/2/30	Y. S. Chi
T278b	S. of Maotao, Tushan. 獨山，麻道	,,	,,	A. W. Grabau & C. C. Tien

T278c	Tapotang, Tushan. 獨山，大坡塘	Devonian	27/2/30	A. W. Grabau & C. C. Tien
T279	½ li N. of Hsiaoho, Tushan. 獨山，小河	?	,,	,,
T280	2 li W. of Maochai, Tushan. 獨山，茅寨	Fengninian	2/3/30	,,
T280a	W. of T280, Tushan.	,,	,,	C. C. Yü, A. W. Grabau & C. C. Tien
T281	Top of western slope of Maochai, Tushan.	Fengninian	,,	C. C. Yü
T281a**	W. of T281, Tushan.	Lower Carboniferous	,,	
T282	At Shangchai, Patai, Tushan. 獨山，八台，上寨	Viséan	,,	C. C. Yü, A. W. Grabau & C. C. Tien
T283	3 li W. of Patai, Tushan.	Weiningian	,,	J. S. Lee, S. Chen, Y. S. Chi, A. W. Grabau & C. C. Tien
T284	3 li E. of Pamaochung, Tushan. 獨山，八茅沖	Yangsinian	,,	J. S. Lee & S. Chen
T285	2 li E. of Chouchuiching, Tushan. 獨山，臭水井	Uralian	3/3/30	J. S. Lee, S. Chen & A. W. Grabau
T286**	Tamapo, Tushan. 獨山，大馬坡	Middle Permian	,,	
T286a	Tamapo, Tushan	Yangsinian?	3/3/30	,,
T286b	,,	,,	,,	T. K. Huang & A. W. Grabau

T287**	At Chissuchiao, Tushan. 獨山，祈嗣橋	Lower Permian	4/3/30	
T288	Between the Laokan-chai and Huanglu-chai, Tushan. 獨山，老干寨黃陸寨間	Weiningian	5/3/30	Y. S. Chi & A. W. Grabau
T289**	1 li W. of Shangkala, Tushan. 橋山，上卡拉	Lower Carboniferous	,,	
T290	NW of Liangting, Tushan. 獨山，涼亭	Fengninian	,,	Y. S. Chi
T290a	SE of Yachou, Tushan. 獨山，牙州	,,	,,	,,
T291**	1 li W. of Yachou, Tushan.	Lower Permian	6/3/30	
T291a	W. of Kankung, Tushan. 獨山，干貢	?	,,	T. K. Huang
T292**	Above Lingtang, Tingfan. 定番，陵塘	Lower Permian	,,	
T292a	2 li W. of Lingtang, Tingfan.	Viséan	,,	C. C. Yü
T293**	At foot of W. slope Hungaiho, Tingfan. 定番，紅岩河	Middle Permian	,,	
T294**	W. slope of Hungai-ho, Tingfan.	Lower Permian	,,	
T295	At foot of east slope of Chiussu, Tingfan. 定番，舊司	Fengninian	7/3/30	C. C. Yü
T296	NW of Chiussu, Tingfan.	,,	,,	Y. S. Chi, A. W. Grabau & C. C. Tien

T296a	1 li NW of Hsiang-fen, Tingfan. 定番，向坟	Fengninian	7/3/30	A. W. Grabau, C. C. Yü & C. C. Tien
T296b	1 li W. of Jungtung, Tingfan. 定番，冗洞	,,	,,	Y. S. Chi & C. C. Yü
T296c	1½ li W. of Jungtung, Tingfan.	,,	,,	A. W. Grabau & C. C. Tien
T296d	3 li W. of Jungtung, Tingfan.	,,	,,	C. C. Yü
T297	½ li of E. Tutikuan, Tingfan. 定番·土地關	,,	8/3/30	C. C. Yü, A. W. Grabau & C. C. Tien
T298	At Tutimiao east of Touti, Tingfan. 定番，斗底，土地廟	,,	9/3/30	,,
T298a	1 li SE of Tiwuchung, Tingfan. 定番，第五重	,,	,,	A. W. Grabau & C. C. Tien
T298b	2 li SE of Tiwuchung, Tingfan.	,,	,,	C. C. Yü
T299**	2 li W. Paiko, Tingfan. 定番，擺閣	Middle Permian	10/3/30	
T300**	Between the Kutsunshao & Tahuoshao, Tingfan. 定番，古村哨打火哨間	Lower Permian	,,	
T301	At Lanmuchiao, Tingfan. 定番，爛木橋	Fengninian	10/3/30	C. C. Yü
T302	1 li W. of Lanmuchiao, Tingfan.	,,	,,	A. W. Grabau & C. C. Tien
T302a**	1 li W. of Lanmuchiao, Tingfan.	Lower Permian?	,,	
T302b	3 li W. of Lanmuchiao, Tingfan.	Fengninian	,,	C. C. Yü

T303**	4 li W. Lienmenho, opposite Tingfan. 定番，蓮門河	Lower Permian	10/3/30	
T304	1 li W. of Shang-massu. 上馬司	Lopingian?	11/3/30	J. S. Lee, S. Chen, T. K. Huang & A. W. Grabau
T305**	At Huangpiaochai. 黃鏢寨	Trias	13/3/30	
T306	Wanchang, Chingai, Kueiyang. 貴陽，青岩，碗塲	Lopingian	,,	T. K. Huang & A. W. Grabau
T307	At the pass N. of Hsiaochangtien near Chatso, Hsiuwen, Kueichou. 修文，札佐小塲店	,,	26/3/30	J. S. Lee, S. Chen & T. K. Huang
T307a**	Near Erhchia, 2nd pass above Hsiaochangtien, Hsiuwen, Kueichou. 修文，小塲店二夾	,,	,,	T. K. Huang
T307b	,,	,,	,,	,,
T308	N. of Kouchang, Hsiuwen, Kueichou. 修文，狗塲	,,	,,	J. S. Lee, S. Chen & T. K. Huang
T309	At the pass above a hut, N. of Papang, Hsiuwen, Kueichou. 修文，罷邦	Yangsinian (?)	,,	A. W. Grabau
T310**	Outside Liyuanshao, Hsiuwen, Kueichou. 修文，梨園哨	L. Permian (*Schwagerina*)	27/3/30	
T311	Heitupo, Hsifeng, Kueichou. 息烽，黑土坡	Yangsin limestone	,,	A. W. Grabau
T311a	1 km S. of Loputung, Hsifeng. 息烽，蘿葡洞	,,	,,	A. W. Grabau & T. K. Huang

T312	At the pass N. of Loputung, Hsifeng.	Trias	27/3/30	E. Patte
T313**	Yanglungchai, Hsifeng, Kueichou. 息烽，養龍寨	,,	29/3/30	
T314	Between Huchiaao & Shihkungchuang, Tsunyi. 遵義，胡家坳石公莊之間	,,	30/3/30	E. Patte
T315	Shihtzeai, Tsunyi. 遵義，獅子崖	Lopingian	,,	A. W. Grabau
T316	Komaiai SSE of Hsinchan, Tsunyi. 遵義，新站，割麥崖	,,	31/3/30	T. K. Huang
T317**	Changchichiao, Tsunyi, Kueichou. 遵義，場基橋	Trias	,,	
T318	Huangnipu, Tsunyi. 遵義，黃泥堡	Lopingian	,,	T. K. Huang
T319	Between city wall and Manaopo, Tsunyi. 遵義，瑪瑙坡	Cretaceous?	3/4/30	E. Patte
T320	Panchulin, Tsunyi, Kueichou. 遵義，斑竹林	Trias	5/4/30	,,
T320a	W. of Fenglochiao, Tsunyi. 遵義，豐樂橋	,,	,,	,,
T321	Near the temple of Chiuchitan, Tsunyi. 遵義，九級灘	Trias.	6/4/30	E. Patte
T322**	Meitungya, Tsunyi, Kueichou. 遵義，煤洞崖	,,	,,	
T323	S. of Heiniao, Tsunyi. 遵義，黑泥坳	,,	,,	E. Patte
T323a**	S. of Heiniao, Tsunyi, Kueichou.	,,	,,	,,

T324**	Mengtzechiao, Tsunyi, Kueichou, immediately below trilobite shale. 遵義・蒙自橋	Ordovician	6/4/30	
T325	Feilaishih, Tsunyi. 遵義・飛來石	,,	,,	Y. C. Sun
T325a**	Mentzechiao, Tsunyi, Kueichou.	,,	,,	
T326**	Between Tachiao & Yanghuya, Tsunyi, Kueichou. 遵義・大橋羊虎崖間	Cambrian	,,	
T326a**	Below Yanghuya, Tsunyi, Kueichou.	,,	7/4/30	
T327**	Immediately below Yanghuya, above limestone.	,,	,,	
T328**	Loushankuan, Tsunyi, Kueichou. 遵義・婁山關	Ordovician (above siliceous limestone)	8/4/30	
T329**	Above Hunghuayuan, Tungtzu, Kueichou. 桐梓・紅花園	Ordovician	,,	
T329a**	Above Hunghuayuan. (Above T329)	Ordovician	8/4/30	
T330**	Near Tingshan, Tungtzu. 桐梓・鼎山	Lower Permian	,,	
T331	SW of Tingshancheng, Tungtzu. 桐梓・鼎山城	Lopingian?	,,	J. S. Lee & S. Chen,
T331a	Tingshancheng coal mine, Tungtzu.	,,	,,	A. W. Grabau
T332**	Opposite Manaoai, Tungtzu. 桐梓・瑪瑙岩	Silurian	,,	

T333	At bridge north of Manaoai.	Silurian (Below red shale)	8/4/30	C. C. Wang
T334	Chiupakou below T333, Tungtzu. 桐梓，九壩溝	Silurian	,,	,,
T335**	Liuyanghsi, Tungtzu. 桐梓，六楊溪	,,	11/4/30	
T336**	Between Laolinkou & Liuyanghsi, Tungtzu. 桐梓，老林口六楊溪間	,,	,,	
T337**	Near Laolinkou, Tungtzu.	,,	,,	
T338**	Near Laolink'ou, below T337, Tungtzu.	,,	,,	
T339**	Below Yangliutai, Tungtzu. 桐梓，楊柳台埡口	,,	,,	
T340**	Below T339, Tungtzu.	Ordovician	,,	
T341**	Below T340, Tungtzu.	Middle Ordovician	,,	
T342**	W. slope of pass above Paikuoshu, Tungtzu. 桐梓，白果樹	Silurian	12/4/30	
T343**	Near Shuikoupa pass, Tungtzu. 桐梓，水口壩埡口	,,	13/4/30	
T343a	Above T343	,,	,,	C. C. Wang
T344	Above Silurian 1 km from Shuikoupa pass.	Yangsin limestone	,,	A. W. Grabau
T345	Above T344, Tungtzu.	?	,,	,,

T346	Near Tienchiakou, Tungtzu. 桐梓，田家溝	Cretaceous	13/4/30	E. Patte
T347**	SE of Hsiunghuangs-su, Tungtzu. 桐梓・雄黄寺	Trias	15/4/30	
T347a**	Panfangto, Chikiang, Szechuan. 四川，綦江板房沱	Silurian	16/4/30	
T348**	400 m W. of Pai-miaossu, Pahsien, Szechuan. 四川，巴縣・白廟寺	Jurassic	20/4/30	
TW 1**	Taoliushui, Tsunyi, Kueichou. 遵義・倒流水	Ordovician	5/12/29	
TW 2**	Huaiyangtung, Jen-huai, Kueichou. 仁懷・懷陽洞	Cambrian? Oolitic lime-stone.	7/12/29	
TW 3**	N. of the city, Lungchin, Jenhuai, Kueichou. 仁懷，龍井	Stone implement from cave	7/12/29	
TW 4**	2 li N. of Meitze-wo Jenhuai, Kuei-chou. 仁懷，煤子垇	Ordovician	8/12/29	
TW 5**				
TW 6**				
TW 7**				
TW 8**	Meitungtze, Jen-huai, Kueichou. 仁懷，煤洞子	Silurian	10/12/29	
TW 9**	5 li S. of Meitze-wo, Jenhuai, Kuei-chou. 仁懷・梅子垇	Ordovician		

TW10	Yuanchiachiao, N. of Hsinchang, Chienhsi, Kueichou. 黔西，新塲，袁家橋	Trias	12/12/29	E. Patte
TW11	5 li NE of city, Cheinhsi, Kueichou.	,,	20/12/29	,,
TW12	N. of Lungching-kou, Chienhsi. 黔西，龍井溝	,,	21/12/29	,,
TW13**	Taishutien, Ching-chen, Kueichou. 淸鎭，代書田	Middle Permian (*Gastrioceras*)	25/12/29	
TW14				
TW15				
TW16				
TW17				
TW18				
TW19				
TW20				
TW21	Taho, Tuyun, Kueichou. 都匀，大河	Lopingian	23/1/30	T. K. Huang
TW21a**	Taho, Tuyun, Kueichou.	Permian (*Lyttonia*)	,,	
TW22	½ li N. of Panpien-chieh, Tuyun, Kueichou. 都匀、半邊街	Lopingian?	,,	A. W. Grabau
TW22a	S. of Panpienchieh, Tuyun.	,, ?	,,	,,
TW23	1 li S. of Puling, Tuyun. 都匀，普靈	Yangsin limestone	,,	J. S. Lee & C. Chen
TW24	1 li N. of Kuan-shang, Tuyun. 都匀，關上	Chihsia limestone	,,	T. K. Huang

TW25	5 li N. of Lianglukou, Tushan. 獨山・兩路口	Chihsia limestone	26/1/30	T. K. Huang
TW26**	4 li N. of Lianglukou, Tushan.	Carboniferous	,,	
TW27	Lianglukou, Tushan.	Fengninian	,,	Y. S. Chi, A. W. Grabau & C. C. Tien
TW28	Below TW27.	,,	,,	A. W. Grabau & C. C. Tien
TW29**	Shihpanchai, Tushan. 獨山，石板寨	Lower Carboniferous	,,	
TW30	1 li NE of Huangchiachiao, Tushan. 獨山・黃家橋	Devonian	27/1/30	A. W. Grabau & C. C. Tien
TW31	Huangchiachiao, Tushan.	,,	,,	A. W. Grabau, C. C. Tien & Y. S. Chi
TW32	2 li S. of Huangchiachiao, Tushan.	,,	,,	,,
TW33	N. of Shenho by the side of bridge, Tushan. 獨山・神河	,,	,,	,,
TW34				
TW35	4 li E. of city, Tushan.	Middle Devonian	29/1/30	A. W. Grabau, C. C. Tien & Y. S. Chi,
TW36	5 li E. of city, Tushan.	,,	,,	,,
TW37**	Ravine 6 li E. of city, Tushan. Kueichou.	,,	,,	
TW38**	Ravine E. of city, Tushan.	,,	,,	
TW39	Ravine E. of city, Tushan.	,,	,,	Y. S. Chi

TW40	4 li NW of city, Lipo. 荔波	Yangsinian?	23/2/30	A. W. Grabau
TW40a**	4 li NW of city, Lipo, Kueichou.	Lower Permian	,,	
TW41**	300 m N. Shuian, near bridge, Lipo, Kueichou. 荔波，水安	Carboniferous?	24/2/30	
TW42**	N. of Shuian, Lipo, Kueichou.	Carboniferous	24/2/30	
TW43	Slope N. of Layin, Lipo. 荔波，拉銀	Late Carboniferous	,,	T. K. Huang
TW44**	E. of Maotsaopa, Tingfan, Kueichou. 定番，毛草壩	Lower Permian?	10/3/30	
TW45	Pienchieh, Tingfan. 定番，邊街	Late Corboniferous	24/3/30	Y. S. Chi
TW46**	Chiachia, Tingfan, Kuenchou. 定番，甲家	Lower Carboni ferous	12/2/30	
TW47**	Pinghsihopa, Tingfan, Kueichou. 定番，平西河壩	,,	13/2/30	
TW48				
TW48a**	N. of Pingta, Shashangkuan, Tingfan, Kueichou. 定番，沙上關，平代	,,	,,	
TW48b**	Between Kiangpi & Yangchang, Tingfan, Kueichou. 定番，江比至羊場間	,,	,,	
TW48c**	Ravine S. of Liukuchiao, Tingfan, Kueichou. 定番，劉凸橋	,,	,,	

TW49**	N. of Liukuchiao, Wuchipo, Lungli, Kueichou. 龍里，烏鷄坡，劉凸橋	Lower Carboniferous (Upper limestone above quartzite sandstone).	14/3/30	
TW50**	Chingchenghsia, Lungli, Kueichou. 龍里，京城下	Lower Carboniferous	15/3/30	
TW50a**	2 li N. loshuitung, Lungli, Kueichou. 龍里，落水洞	Lower Carboniferous (ostrocod)	15/3/30	
TW51**	Hsinchang, Lungli, Kueichou. 龍里，新塲	,,	,,	
TW52	Chiaotzushih, Kueiyang. 貴陽，橋子石	Viséan	,,	C. C. Yü, A. W. Grabau & C. C. Tien
TW52a	1 li N. of Chiaotzeshih, Kueiyang.	Fengninian	,,	A. W. Grabau & C. C. Tien
TW52b	Pass 2 li S. of Tahopo, Kueiyang. 貴陽，大河坡	,,	,,	C. C. Yü
TW53	Tahopo, Kueiyang.	,,	,,	,,
TW53a	Shuichangpu, Kueiyang. 貴陽，水常舖	?	,,	A. W. Grabau
TW54	S. of Wumatsao, Kueiyang. 貴陽，五馬槽	Lopingian	,,	T. K. Huang
TW54a	Niutachang, Kueiyang. 貴陽，牛大塲	,,	,,	,,
TW55	Changtso, Kueiyang. 貴陽，常祚	,,	11/4/30	,,
TW56	Tsushihkuang, Tungtzu. 桐梓，祖師觀	,,	,,	,,

TW57	Chiutienya northward to Chuanlungwan, Tungtzu.	Chihsia limestone	14/4/30	T. K. Huang
TW58	Lokopien (below Yangkulao) Chichiang, Szechuan. 綦江・羅各邊(羊古老下)	Ordovician	15/4/30	Y. C. Sun
TW59**	Touponao, Chichiang, Szechuan. 綦江，頭坡瑙	Ordovician (below Matishih).	,,	
TW60**	S. of Chiaoken, Chichiang, Szechuan. 綦江，橋根	Ordovician (one thin bedded limestone embedded in shale below Matishih).	,,	
TW61**	Below Chiaokou, Chichiang, Szechuan. 綦江，橋溝下	Ordovician (*Orthoceras*).	,,	
TW62**	Yentui, Chichiang, Szechuan. 綦江・烟堆	Silurian (graptolite)	,,	
TW63	Shihniulan, Chichiang, Szechuan. 綦江・石牛瀾	Silurian	,,	C. C. Wang

III. LIST OF FOSSILS COLLECTED BY V. K. TING AND Y. L. WANG[§]

(Compiled by N. Chin)

T 2 *Pseudomonotis* (?) (40, p. 7)
Myophoria (?) (40, p. 7)

T 3 *Lingula* sp., *Pecten* (?), *Myophoria* sp. (40, p. 7)

T 5 *Meekella* aff. *kueichowensis* Huang (31, p. 97, 28; 29, p. 51)
Chonetes sp. (30, p. 7; 31, p. 97; 29, p. 51)
Productus (*Dictyoclostus*) *yangtzeensis* Chao (30, p. 26; 31, p. 97; 29, p. 51)
Squamularia aff. *elegantula* (Waagen) (31, p. 34, 97; 29, p. 51)
S. cf. *grandis* Chao (31, p. 36, 97; 29, 51)
Athyris (*Cleiothyridina*) cf. *globulina* Waagen (29, p. 51)
Lyttonia sp. (29, p. 51)
Spiriferina cristata (?) Schlotheim (29, p. 51)
Myalina cf. *trapezoidalis* Keys*
M. sp.
Limatulina consanginnea Gemm.*
Platyceras? sp.*
Ostracod gete sp.*

T 12 *Chonetes spinulostriatus* Gr. (12, p. 27; 13, p. 31)

T 12c *Schellwienia douvillei* (Colani) (G)
Neoschwagerina craticulifera Schwager (G)
Chonetes spinulostriatus Gr.

T 12e *Productus curvirostris* Schellw. (12, p. 33; 13, p. 31)
Squamularia sp. (12, p. 76; 13, p. 31)
S. cf. *pulcherrima* Gemm. (12, p. 75)
Athyris (*Cleiothyridina*) *royssii* (L'Eveile) (12, p. 110; 13, p. 31)
Limatulina tungtzeensis Gr. (12, p. 155; 13, p. 31)

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§ Figures in parentheses refer to List of References. (F), (G), etc., refer to lists in "List of Fossils identified by different authorities, not given in any existing publications".

* Those fossils were identified by A. W. Grabau.

T 13	*Pseudomonotis* sp. aff. *P. griesbachi* Bittner. (40, p. 8)
	Pecten sp. (40, p. 8)
	Gonodon (?) (40, p. 8)
T 16	*Michelinia abnormis* Huang (28, p. 97)
T 17	*Serpula* (?) (40, p. 8)
	Pseudomonotis sp. aff. *P. griesbachi* Bittner (40, p. 8)
T 18b	*Wentzelella elegans* Huang (28, pl. iv, fig. 3)
T 20a	*Chonetes substrophomenoides* Huang (30, p. 3; 31, p. 102)
	Linoproductus sinosus Huang (30, p. 43; 31, p. 102)
	L. interruptus Huang (30, p. 44; 31, p. 102)
	L. kiangsiensis (Kayser) (30, p. 46; 31; p. 102)
	Spinomarginifera kueichowensis Huang (31, p. 102)
	Aulosteges dalhousi Davidson ? (31, p. 102)
	Parakeyseringina? sp. (30, p. 97; 31, p. 102)
	Lyttonia cf. *nobilis* Waagen (31, p. 102)
	Athyris (*Cleiothyridina*) cf. *globulina* Waagen (31, p. 72, 102)
	Pugnax pseudoutah Huang (31, p. 64, 102)
T 20b	*Schellwienella regularis* Huang (31, p. 25, 102)
	Chonetes substrophomenoides Huang (31, p. 102)
	Linoproductus kiangsiensis (Kayser) (30, p. 46; 31, p. 102)
	Pugnax pseudoutah Huang (31, p. 64, 102)
	Streblopteria sp. nov.*
T 20e	*Pseudomonotis* sp. aff. *P. griesbachi* Bittner (40, p. 8)
T 38	*Schellwienia* sp. nov. (G)
	S. verniuilli Schellw. (G)
T 39	*Chonetes Latesinuata* var. *tsunyiensis* Huang (30, p. 2)
	C. chonetoides? (Chao)
	Productus (*Dictyoclostus*) cf. *gratiosus* Waagen (30, p. 33)
	P. (*D.*) cf. *tartaricus* Tschernyschew (30, p. 34)
	P. (*D.*) sp. b (30, p. 36)

	Linoproductus fusiformis Huang (30, p. 45)
	Plicatifera? minor (Schellwien) (30, p. 38)
	Striatifera mongolica (Diener) (30, p. 51)
	Pustula (*Waagenoconcha*) sp.
	Krotovia (*Avonia*) *janus* Huang (30, p. 55)
	Squamularia cf. *calori* (Gemmellaro) (31, p. 38)
	S. asiatica Chao (31, p. 40)
	Martinia triquetra (Gemmellaro) (31, p. 48)
	M. cf. *glabra* (Martin) (31, p. 49)
	Hustedia grandicosta (Davidson) (31, p. 79, *H. remota*)
T 41	*Schellwienia* sp. nov. (G)
	Tetrapora nankingensis Yoh (29, p. 17; 28, p. 107)
	Lophophyllum (?) sp. (29, p. 17)
	Probably young stage of *Lophophyllum kayseri* (F)
T 43	*Ampyx* sp. (43, p. 33)
T 48	*Lyttonia* sp. nov.*
T 53	*Pseudomonotis* sp. aff. *P. griesbachi* Bittner (40, p. 8)
	Avicula (?) (40, p. 8)
T 54	*Lingula* sp. (40, p. 9)
T 56	*Avicula*
T 57	*Dibunophyllum nontabulatum* Huang (28, p. 47)
	Corwenia chiuyaoshanensis Huang**
	Chonetes spinulostriatus Gr. (13, p. 31)
	Bellerophon sp. 2 (13, p. 32)
T 58	*Martiniopsis orientalis* Tsch. (13, p. 32; 12, p. 94)
	Dielasma subelongatum Grabau (13, p. 32)

* These fossils were identified by A. W. Grabau.

** Identified by T. K. Huang.

T 59 *Streptorhynchus* sp. 1 (V. 23) (12, p. 23; 13, p. 32)
Linoproductus cora (d'Orb.) (12, p. 42)
Productus sp. c (12, p. 44)
Plicatifera lipoensis Gr. (12, p. 46)
Spiriferella sp. (12, p. 85)
Dielasma subelongatum Gr.
D. cf. *moelleri* Tschern. (V. 122) (12, p. 122)
Schizodus tatingensis Gr. (12, p. 53)

T 61 *Michelinia abnormis* Huang (28, p. 97)
Martiniopsis orientalis Tschernyschew (12, p. 94; 13, p. 32)
Dielasma subelongatum Gr. (12, p. 117; 13, p. 32)
D. truncatum Waagen (12, p. 123; 13, p. 32)
D. cf. *curvatum* Tschernyschew (12, p. 123)
D. tatingense Gr. (12, p. 130; 13, p. 32)
Bellerophon sp. 1 (12, p. 157; 13, p. 32)
Euomphalus mongolicus Gr. (12, p. 159; 13, p. 32)
Naticopsis khoovensis Waagen (12, p. 164; 13, p. 32)

T 62a *Squamularia asiatica* Chao (12, pl. v, fig. 4)
Dielasma subelongatum Gr. (12, p. 117; 13, p. 32)

T 62b (13, p. 32)
Orthotichia cf. *morganiana* (d'Orb.) (12, p. 9)
Productus davidii Bayen (12, p. 40)
Squamularia asiatica Chao (12, p. 71)

T 63 *Schellwienia exilis* (Deprat) (G)
S. douvillei Colani (G)
S. ambigua Deprat (G)

T 64 *Schellwienia douvillei* Colani (29, p. 33)
Neoschwagerina craticulifera var. *rotunda* (var. Deprat) (=*N. minoensis* Deprat em. Ozawa) (36, pl. iv, fig. 1; 29, p. 33)

Verbeekina pseudoverbeeki Deprat (29, p. 33)
V. verbeeki Geinitz (G) (Colani 36, pl. iv, figs. 5, 6)
Sumatrina annae Volz (29, p. 33)
S. multiseptata Deprat (G)

T 65 *Chonetes* sp. (30, p. 7)
Spinomarginifera kueichowensis Huang (30, p. 56) (29, p. 43)
S. pseudosintanensis Huang (30, pl. v, fig. 16) (29, p. 43)
S. chengyaoyenensis Huang (30, p. 63, 29, p. 43)
Martinia squamularioides Huang (31, p. 50) (29, p. 43)
Pugnax pseudoutah Huang (31, p. 64) (29, p. 44)
Athyris timorensis (Rothpletz) (31, p. 69; 29, p. 44)
Hustedia grandicosta (Davidson) (29, p. 44; 31, p. 79) = *H. remota* (Eichwald)
Temnocheilus sp. (cephalopod)*

T 66 (40, p. 9)
Avicula
Gervilleia?
Protoschizodus cf. *subaequalis* de Koninck

T 67 (40, p. 9)
Protoschizodus cf. *subaequalis* de Koninck
Gonodus (?)
Streptorhynchus kayseri Schellwien

T 68 (31, p. 101)
Parenteletes sinensis Huang (31, p. 10; 29, p. 44)
Kiangsiella pectiniformis (Davidson) (31, p. 21; 29, p. 44)
Linoproductus sinosus Huang (30, p. 43; 29, p. 44)
L. kiangsiensis (Kayser) (30, p. 46; 29, p. 44)
L. fusiformis Huang (29, p. 44)
Pustula (*Waagenoconcha*) *abichi* Waagen (29, p. 44)
Spinomarginifera pseudosintanensis Huang (30, p. 61; 29, p. 44)

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* Identified by A. W. Grabau.

	Pugnax pseudoutah Huang (29, p. 44; 31, p. 64)
	Hustedia grandicosta (Davidson) (29, p. 44; 31, p. 79, = *H. remota* Eichwald)
	Spirigerella cf. *grandis* (Davidson) (29, P. 44)
T 69	*Martinia* cf. *orbicularis* (Gemmellaro) (31, p. 52)
	Dielasma cf. *numulus* Waagen (31, p. 82)
T 70	*Pseudomonotis* sp. aff. *P. clarai* (40, p. 9)
	P. griesbachi (40, p. 9)
T 71	*Pecten* sp. (40, p. 9)
	Lima (40, p. 9)
	Pseudomonotis (?) (40, p. 9)
T 73d	(31, p. 102)
	Linoproductus kiangsiensis (Kayser)
	Spinomarginifera cf. *jisuensis* (Chao) (30, p. 64)
	Oldhamina cf. *squamosa* Huang
	O. grandis Huang
T 73e	(VI, 13, p. 33)
	Martinia incerta Tschern. (12, p. 88)
	Athyris timorensis var. *mongoliensis* Gr. (12, p. 105)
	Dielasma subelongatum Gr. (12, p. 117)
	Edmondia yachihoensis Gr. (12, p. 154)
T 74	*Oxytoma* (?) (40, p. 9)
	Lima (?) (40 p. 9)
T 76	(31, p. 102)
	Orthotichia sp. (31, p. 6)
	Streptorhynchus kayseri Schellwien (31, p. 15)
	Chonetes substrophomenoides Huang
	Spinomarginifera kueichowensis Huang (30, p. 56)
	Lyttonia sp.
T 77	*Pustula* (*Waagenoconcha*) *pseudoirginae* Huang (30, p. 52)

T 78	*Michelinia* cf. *siyangensis* Reed (28, p. 94)
	Caninia liangshanensis Huang (F)
T 80	a, *Myophoria* sp. (40, p. 9)
	b, *Pseudomonotis* (?) (40, p. 24), *Myophoria* sp. (40, p. 10)
T 81	*Pecten* (?), *Myophoria* (?) (40, p. 10)
T 82	*Oldhamina squamosa* Huang (30, p. 74; 31, p. 104)
T 83	*Terebratula* sp. 1
	T. cf. *biscuffardinata* Schlotheim.
T 84a	(40, p. 10)
	Pentacrinus sp.
	Dielasma sp.
	Avicula
	Pecten sp. aff. *P. tenuistriatus* Goldfuss var. *schlotheimi* Giebel
	Spondylus sp.
	Modiola sp. 1
	M. sp. 2
T 84b	*Discina* s. lat. (40, p. 10, 15)
	Anodontophora (?) (40, p. 10)
T 85	*Lepidopteris ottonis* (Gopp.) Schimper (44, p. 8)
	Cf. *Podozamites* sp. (44, p. 9)
	Cf. *Pityophyllum* sp. (44, p. 9)
T 86	*Caninia intermedia* Huang (28, p. 38)
	Camerophoria selliformis Gr. (13, p. 33; 12, p. 13)
	Tylothyris cristata (Schlotheim) (13, p. 33)
T 86a	*Michelinia kueiyangensis* Huang (F)
T 88	*Bigenerina* sp. §
	Neofusulinella sp. §
	Michelinia kueiyangensis Huang (F)
	Schizophoria indica (Waagen) (12, p. 7)
	S. cf. *juresanensis* Tschern. (13, p. 33)

§ Identified by K. H. Hsu

T 89 *Corwenia chihsiaensis* (Yoh)**
Productus (*Dictyoclostus*) aff. *gratiosus* Waagen (30, 32)
Lyttonia nobilis Waagen**

T 90 *Pseudomonotis tenuistriatus* Bittner (40, p. 10, 25)
P. sp. aff. *P. decidens* Bittner (40, p. 10, 26)
Boreosomus sp. (40, p. 10, 36)
Ophiceras sinense Tien (45, p. 8)
O. tingi Tien (45, p. 9)
O. cf. *demissum* Oppel (45, p. 10)
Pseudosageceras paomochungense Tien (45, p. 24)
Orthoceras sp. (40, p. 10; 45, p. 40)

T 91a Ammonoid gen. et. sp. ind.
Paralegoceras sp.***

T 92 *Ophiceras* sp. aff. *chamunda* Diener (45, p. 11)
Clypeoceras vidarbhi var. *falciplicatum* Tien (45, p. 14)
Meekoceras kueichowense Tien (45, p. 16)
M. evolutum Tien (45, p. 17)
M. ellipticum Tien (45, p. 19)
Xenodiscus cf. *rigidus* Diener (45, p. 26)
Pleuronautilus subquadrangulatus Tien (45, p. 37)
Nautilus sp. 1 (45, p. 39)

T 93 *Clypeoceras vidarbhi* var. *falciplicatum* Tien (45, p. 14)

T 95 (13, p. 33)
Camerophoria selliformis Gr. (12, p. 13)
Chonetes spinulostriatus Gr. (12, p. 27)
Chonetes sp. a (12, p. 32)
Productus curvirostris Schellwien (12, p. 33)
Plicatifera lipoensis Gr. (12, p. 46)

** Identified bv T. K. Huang.

*** Identified by T. H. Yin.

Athyris sp. nov. 1 (E)
A. sp. nov. 2 (E)
Dielasma cf. *elongatum* (E)
Striatifera sp. (E)

T 96 *Dibunophyllum tushanense* Chi (6, p. 38; 8, p. 7)

T 96a *Chaetetes lungtanensis* Lee et Chu (6, p. 48; 8, p. 7)

T 98 *Lingula* sp. nov. (B)

T101 *Neoschwagerina craticulifera* (Schwager) (29, p. 33) (G)
Sumatrina annae Volz (29, p. 33) (G)
S. multiseptata Deprat (29, p. 34) (G)
Verbeekina verbeeki Deprat (29, p. 34) (G)
V. pseudoverbeeki Deprat (29, p. 34) (G)
Martinia cf. *uralica* Tschern. (12, p. 90; 13, p. 22)
Martinia sp. (12, p. 94; 13, p. 22)
Martiniopsis convexa Tschern. (12, p. 96; 13, p. 22)
Athyris timorensis var. *mongoliensis* Gr. (12, p. 105; 13, p. 22)
A. (*Cleiothyridina*) *royssii* L'Eville (12, p. 110; 13, p. 22)
Dielasma subelongatum Gr. (12, p. 117; 13, p. 22)
D. tatingense Gr. (12, P. 130; 13, P. 22)
D. gigantum Gr. (12, p. 134; 13, p. 23)
D. lungliense Gr. (12, p. 127)
D. cf. *curvatum* Tschern. (13, p. 128)
D. truncatum Waagen (12, p. 123)
Ophalotrochus cf. *whitneyi* Meek (12, p. 163) (13, p. 23)

T102 *Palaeophyllites* cf. *steinmanni* Welter (45, p. 36)

T103 *Lophophyllum kayseri* Huang (28, p. 25)
L. kayseri var. *minor* Huang (28, p. 27)

T103b *Lophophyllum zaphrentoides* Huang (28, p. 28)
L. kayseri Huang (28, pl. ii, fig. 4)

T103d	*Euomphalus kweitingense* Gr. (12, p. 161; 13, p. 34)
	Macrochilina cf. *avellanoides* de Kon. (12, p. 167; 13, p. 34)
T103g	*Verbeekina verbeeki* Deprat (G)
	Neoschwagerina multicircumvoluta Deprat (G)
	N. craticulifera Schwager (G)
	Sumatrina sp. (G)
	Schellwienia douvillei ? Colani (G)
	Fusulina inflata ? Colani (G)
T103i	*Michelinia* cf. *placenta* Waagen et Wentzel (28, p. 99)
	M. siyangensis Reed (13, p. 33)
	M. microstoma Yabe et Hayasaka (13, p. 33)
	M. sp. (F)
	? *Monilopora* sp. nov. (F)
	Spirigerella interrupta Gr. (12, p. 116; 13, p. 34)
T103j	*Michelinia microstoma* Yabe et Hayasaka (28, p. 92; 29, p. 17)
	M. sp.(F)
	Michelinia siyangensis Reed (13, p. 33; 29, p. 17)
	M. placenta W. et. W. (13, p. 33)
T103k	*Corwenia parachihsiaensis* Huang (28, p. 51; 29, p. 17)
	Stylidophllum volzi (Yabe et Hayasaka)(28, p. 65; 29, p. 17)
	S. kueichowense Huang (28, p. 70; 29, p. 17)
T103m	*Caninia tzuchiangensis* Huang (28, pl. 1, fig. 9)
T193n	*Lophophyllum amygdalophylloides* Huang (28, p. 31)
	Waagenophyllum wengchengense Huang (28, p. 50)
T104	*Lophophyllum kayseri* Huang (F)
	Michelinia placenta W. et. W. (F)
T105	*Caninia liangshanensis* Huang (F)
	Michelinia siyangensis Reed (F)
	M. favositoides Girty (F)

	Monilopora sp. nov. (F)
T107	Cup coral (B)
	Spirifer tingi Gr. (B)
	Spirifer sp. (more plicae than *S. tingi*) (B)
	Retzia sp. nov. 1 (B)
	Whitefieldella ? sp. (B)
T107a	*Streptelasma* sp. (B)
	Favosites cf. *basaltiformis* (B)
	Spirifer tingi Gr. (B)
	Retzia sp. nov. 2 (B)
T108	*Lingula lounanensis* Mansuy (B)
	L. cf. *cuneatiformis* Gr. (B)
	Modiomorpha crypta Gr. (B)
	M. sp. nov. 1 (B)
T109	*Modiomorpha* sp. nov. 2 (B)
	Modiomorpha crypta Gr. (B)
	Illaenus sp. (B)
T110	*Spirifer hsiehi* Gr. (B)
	Retzia sp. (B)
	Atrypa sp. (B)
T117	*Spirifer* sp. (B)
	cf. small *S. tingi* type but not certain (B)
T118	*Atrypa aspera* Schlotheim (B)
	Spirifer ? sp. (B)
T119	(29, p. 48; 31, p. 99)
	Productus sp. d. (30, p. 37)
	Linoproductus cf. *chianensis* (Chao) (30, p. 50)
	Pustula (*Waagenoconcha*) sp.
	Lyttonia grabaui Huang (30, p. 96)

Squamularia inaequilateralis (Gemmellaro) (31, p. 31)
S. asiatica Chao (31, p. 40)
Spirifer mahaensis Huang (31, p. 41)
Martinia triquetra Gemmellaro (31, p. 48)
Uncinulus timorensis (Beyrich) (31, p. 61)
Terebratuloidea cf. *davidsoni* Waagen (31, p. 66)
Terebratuloidea depressa Waagen (31, p. 68)
Notothyris ? sp. nov. (31, p. 85)

T119a (31, p. 104)
Parenteletes sinensis mut. *transversus* Huang (31, p. 14; 29, p. 48)
Productus yangtzeensis ? Chao (29, p. 48)
Spinomarginifera kueichowensis Huang (30, p. 56)
Uncinulus timorensis (Beyrich) ? (31, p. 61)

T120 (31, p. 100)
Schellwienella ruber (Frech) (31, p. 23)
S. acutangula Huang (31, p. 24)
Productus margaritatus Mansuy (30, p. 30)

T123 (29, p. 18)
Polythecalis yangtzeensis var. *polygonalis* Huang (28, p. 86)
Allotropiophyllum sinense Grabau (28, p. 41)
Wentzelella timorica (Gerth)
Monilopora dendroides Yoh (F)
Michelinia vermispinosa Huang (28, p. 102)
Productus nankingensis (Frech) (31, p. 97)

T124 (31, p. 105)
Productus (*Dictyoclostus*) sp.
Plicatifera sp. (30, p. 41)
Linoproductus fusiformis Huang (30, p. 45)
L. sp.

	Martinia cf. *orbicularis* (Gemmellaro) (31, p. 52)
T125	*Michelinia* cf. *indica* Waagen et Wentzel (28, p. 98)
T126	*Syringopora* sp. (B)
	Dalmanella sp. 1 (B)
	Dalmanella sp. 2 (B)
	Illaenus sp. C. (B)
	Coronocephalus or *Acidaspis* (B)
T126a	Crinoid plates (B)
	Dalmanella sp. (B)
	Whitefieldella sp. (B)
	Trilobite fragments (B)
	Trilobite cheeks, (*Acidaspis* ?) (B)
T132	*Spirifer sinensis* Grabau (B)
T135	*Campophyllum* sp. nov. B (D)
	Fascephyllum sp. (B)
	Amplexus ? sp. (B)
	Atrypa aspera Schlotheim (B)
	Spirifer sp. (B)
T135a	*Phacellophyllum caespitosum* Goldfuss var. *breviseptatum* Frech (C)
	Stromatoporella γ (C)
	Stromatoporella eifeliansis Nicholson (9, p. 288, 301)
T136	*Schellwienella crenistria* var. (B)
	Composita cf. *globularis* Phillips (B)
T137	*Pagodacrinus* sp. 2 (B)
	Aulopora or *Hederella* (B)
	Streptorhynchus?
	Productus sp. 1 (B)
	Productus sp. 2 (B)
T137a	*Rhipidomella* sp. (B)

	Schizophoria striatula Schlotheim (B)
	Productus semireticulatus (B)
	Atrypa desquamata Sowerby (B)
T141	*Grypophyllum isactis* Frech (C)
	Pexiphyllum sp. nov. (D)
T142	*Spirifer* (*Plectospirifer*) cf. *takwanensis* (Kayser) (B)
	Gastropod (B)
	Goniatites (B)
T143	*Columniphyllum* sp. nov. (C)
T144	*Orbiculoidea*? (B)
	Leptostropha macarthyi Grabau (B)
	Schizophoria sp. (B)
	Atrypa sp. (B)
	Spirifer sp. (B)
T145	*Columniphyllum* sp. nov. (C)
	Amphipora ramosa (Phillips) Schulz (9, p. 288, 312)
T146	*Schizophoria* (B)
T147	*Stromatoporella eifeliensis* Nicholson (9, p. 288, 301)
T148	*Columniphyllum darwini* Frech (C)
	Anastylostroma kueichowense Chi (9, p. 288, 296)
T149	*Spirifer* cf. *multistriatus* Grabau (B)
T151	*Amplexus* sp. (cf. *hercinicus* Roemer) (C)
	Cyathophyllum (*Columniphyllum*) *douvillei* Frech var. *minor* or *minus* Chi (C)
T153	*Diphyphyllum* sp. nov. (C)
T154	*Spirifer multistriatus* (B)
	Atrypa sp. nov. (B)
T155	cf. *Amphipora* (α) (C)
T156	*Phacellophyllum* sp. nov. (C)
	Grypophyllum cf. *isactis* Frech (C)

	Stromatoporella ∢ (C)
	Amphyllum asiatica (D)
	Clathrodictyn ∢ (C)
	Grypophyllum sp. nov. (D)
T157	*Phacellophyllum caespitosum* Goldfuss (C)
	Ceratophyllum ceratites Goldfuss (C)
	Pexiphyllum sp. nov. (D)
T157a	*Phacellophyllum* sp. nov. (C)
T158	*Temnophyllum* (D)
T158b	*Grypophyllum* cf. *schwelmense* Wedkd. (C)
	Temnophyllum sp. nov. (D)
T159	*Phacellophyllum* sp. nov. (C)
	Phacellophyllum caespitosum Goldfuss (C)
	Grypophyllum sp. (C)
	Certophyllum lindströmi Frech (var. nov.) (C)
T160	*Phacellophyllum minus* (D)
	P. sp. nov. (C)
T162	Soft shales (B)
	Edmondia sp. (B)
	Orbiculoidea (*Roemerella*) sp. (B)
	Calcareous beds (B)
	Schizophoria sp. nov. (B)
	Atrypa aspera Schlotheim (B)
	Athyris or *Meristella* (B)
T163	*Cyathophyllum vermiculare* Goldfuss (C)
	Glossophyllum sp. nov. (D)
T164	*Grypophyllum* sp. (C)
	Alveolites (*Coenites*) *reticulatus* Stein (C)
	A. (*Coenites*) *reticulatus* Stein or sp. nov. (C)
	A. suborbicularis Lamarck (C)
	Schizophoria striatula Schlotheim (B)
	S. sp. nov. (B)
	Athyris vettala var. nov. (B)

	Atrypa aspera Schlotheim (B)
	A. aspera var. nov. (B)
	Emanuella takwanensis (Kayser) (B)
	Spirifer (Plectospirifer) fongi Gr. or sp. nov.
T165	*Clathophyllum* sp. nov.[1] (C)
	Thamnophyllum sp. nov. (D)
T166	*Amphipora* sp. nov. (D)
	Amphipora (C)
	Stromatopora (C)
	Stromatopora crassa Chi (9, p. 288, 307)
	Alveolites subequalis E. & H. (C)
T169	*Composita subtilita* Hall var. nov.
	C. argentia (B)
	Orthoceras, large, annulated species (B)
T170a	*Ptenophyllum* sp. nov. (D)
	Favosites cf. *digitatus* (B)
	Caninia or *Bothrophyllum* (B)
	Chaetetes (?) (C)
	Peterophyllum heterophyllum mut. *torguatum* (C)
	Atrypa desquamata var. *auriculata* Hayasaka (B)
	Reticularia sp. nov. (B)
	Stringophyllum normale Wdkd. (C)
	Crinoid stems (B)
T170b	*Favosites* sp. (B)
	Grypophyllum cf. *normale* Wdkd. (C)
	Alveolites (Coenites) sp. (C)
	Stromatopora concentrica (C)
	Stromatopora typica v. Rosen (9, p. 288, 306)
	Productella productoides Grabau (B)
	Atrypa desquamata Sowerby (B)
	A. desquamata auriculata Hayasaka (B)

1. Mr. Y. S. Chi considers this as representing a new genus and name it *Actinophyllum*.

	Reticularia sp. nov. 1 (B)
	Plectospirifer takwanensis Kayser (B)
	Lophospira augustipegmatis Grabau (B)
	Hormotomina sp. nov. (B)
	Actinostromata asiatica Grabau (B)
T170c	*Reticularia* sp. nov. 1 (B)
	Modiomorpha sp. (B)
T170d	*Favosites* ? sp. 1 (B)
	Favosites sp. 2 (B)
	Calamopora goldfussi E. et H. (C)
	Alveolites (*Coenites*) sp. (C)
	Grypophyllum sp. nov. (C)
	Halia sp. nov. (C)
	Atrypa desquamata Sowerby (B)
	Plectospirifer cf. *heimi* Grabau (B)
T171a	*Productella productoides* Grabau (B)
T171b	*Stromatoporella* sp. (C)
	Stromatopora crassa Chi (9, p. 288, 307)
	Cyathopaedium (*Calophyllum*) sp. (C)
	Pachypora sp. (B)
	Spirifer sp. indet. (B)
	Uncites sp. (B)
	Stringocephalus sp. nov. 1 (B)
	S. obesus Grabau (B)
T171c	*Athyris* sp. nov. 1 (B)
T171d	*Calamopora* sp. (C)
	Columniphyllum douvillei Frech (C)
	Favosites or *Pachypora* (B)
	Alveolites (*Coenites*) sp. nov. (C)
	Concardium sp. nov. (B)
	Stringocephalus sp. nov. 2 (B)

T171e	*Athyris* cf. *concentrica* ? v. Buch (B)
	Cryptonella ? sp. (B)
T171g	Crinoid stem
	Amplexus sp. (cf. *hercinicus* Roemer) (C)
	Emanuella ? sp. (B)
	Meristella ? sp. (B)
T171h	*Phacellophyllum caespitosum* Goldfuss var. nov. (C)
	P. caespitosum var. *breviseptata* Frech (C)
	Pachypora sp. (C)
	Calamopora reticularis de Blaim (C)
	Chaetetes [*Monticulipora* (*Heterotrypa*) *crinalis* Schlüt] sp. nov. (C)
	Meristella? sp. (B)
	Spirifer sp. nov. 1 (B)
T171i	*Chonetes orientalis* Loczy (B)
	Reticularia cf. *maureri* ? Holzaphel (B)
T172	*Stromatopora* sp. nov. (C)
T173	*Amphipora asiatica* (D)
	A. sp. indet. (C)
	Cyathophyllum caespitosum (D)
T174	*Reticularia pachyrhynchoides* (B)
T175	*Amphipora* sp. (C)
	Atrypa sp. nov. (B)
	Loxonema robusta Grabau (B)
T175a	*Campophyllum* sp. (C)
	Atrypa sp. (B)
	A. sp. nov. (B)
	Loxonema robusta Grabau (B)
T176	*Cyathophyllum basaltiforme* (D)
	C. (*Thamnophyllum*) sp. (D)
	Thamnophyllum sp. (C)
	Ceratophyllum ceratites (?) (C)

Phacellophyllum caespitosum var. nov. (C)
P. irregulare Grabau (B)
P. sp. nov. (C)
Fasciphyllum breviseptatum Frech (B)
Coenites (C)
Campophyllum sp. (C)
Aulopora sp. (B)
Syringopora sp. (C)
S. sp. (B)
Atrypa sp. nov. (B)
A. aspera var. nov. (B)
Reticularia cf. *maureri* Holz (B)
Spirifer multistriatus Grabau (B)
Sp. sinensis (mut.) (B)

T177 *Centrophyllum* (B)
Streptophyllum sp. (S)
Phacellophyllum sp. (C)
P. caespitosum or sp. nov. (C)
Eridophyllum sp. 1 (B)
E. sp. 2 (B)
Stromatopora (B)
Stromatopora sp. (C)
Stromatoporella sp. (C)
Pexiphyllum (?) (C)
Syringopora sp. (C)
S. ? or *Depasophyllum* (B)
Campophyllum (*Apolothophyllum*) sp. (C)
Ceratophyllum sp. nov. (C)
C. sp. (C)
Cyathophyllum? sp. 1 (B)
Michelinia sp. (B)

T177a *Schizophoria macfarlani* var. (B)
Atrypa aspera var. nov. (B)
A. aspera mut. (B)
Atrypa sp. 1 (B)
A. sp. 2 (B)
A. sp. 3 (B)
Spirifer yunnanensis Mansuy (B)
Spirifer sinensis mut ? (B)
Gypidula sp. nov. 1 (B)
G. sp. nov. 2 (C)
Cryptonella cf. *whidborni* (B)
Bellerophon cf. *striatus* de Gr. and de Vern. (Mansuy) (B)

T178 *Stromatopora beuthii* Bargatzky (9, p. 228), *Parallelopora beuthii* (Bargatzky) Kuhn, (9, p. 299)

T179 *Stromatopora* (B)
Syringopora sp. (C)
Amphipora (C)
A. asiatica (D)

T180 *Orthoceras* (B)

T181 *Cystophrentis kolaohoensis* Yü (69, p. 21, 50)
C. flabelliformis Yü (69, p. 21, 51)
Syringopora cf. *reticulata* Goldfuss (7, p. 9, 23)
S. cf. *ramulosa* Goldfuss (7, p. 15, 23)
Phacellophyllum sp. (C)
Amphipora (C)
Amphipora sp. nov. (D)
Schellwienella crenistria (B)
S. sp. nov. (B)
Spirifer sp. nov. 2 (B)
Sp. sp. nov. 3 (B)
Sp. cf. *bisulcatus* (B)

Aviculopecten sp. (B)

T182 *Eumophalus* sp. 1 (B)

Worthenia sp. 1 (B)

Worthenia sp. 2 (B)

T183 *Syringopora distans* (Fischer) (7, p. 15, 23)

S. gigantea Thomson (7, p. 14, 23)

Goniatites sp. 1 (B)

G. sp. 2 (B)

G. sp. 3 (B)

T184 *Pseudouralinia tangpakouensis* Yü (69, p. 21, 59)

Pseudou. tangpakouensis var. *simplex* Yü (69, p. 21, 60)

Lophophyllum ashfellense var. *regulare* Yü (69, p. 21, 30)

Syringopora cf. *ramulosa* Goldfuss (7, p. 11, 23)

Schizophoria sp. nov. 2 (B)

S. sp. (B)

Productus hemisphericus Sow. (B)

Pr. longispinus (B)

Pr. sp. nov. 1 (B)

Marginifera sp. nov. 1 (B)

M. sp. nov. 2 (B)

Spirifer sp. nov. 2 (B)

Sp. bisulcatus (B)

Sp. sp. nov. 3 (B)

Martiniopsis sp. nov. (B)

Camarotoechia cf. *trilatera* de Kon. (B)

C. praepleurodon (B)

Athyris squamigera de Kon. (B)

A. sp. nov. 2 (B)

Reticularia sp. (B)

R. sp. nov. 2 (B)

Rhynchopora sp. nov. (B)

Bellerophon sp. (B)

Spirorbis sp. (B)

	Euomphalus ? sp. (B)
	Pelecypod (B)
T185	*Pseudouralinia gigantea* Yü (69, p. 21, 60)
	P. irregularis Yü (69, p. 21, 61)
	Productus semireticulatus (B)
	Pr. sp. nov. 2 (B)
	Pr. sp. (B)
	Pr. cf. *costatus* (B)
	Spirifer bisulcatus (B)
	Sp. sp. nov. 3 (B)
	Brachythyris pinguis var. *rotundata* Sowerby (B)
	Pterinopecten sp. (B)
	Crinoid stems ? (B)
T186	*Syringopora* cf. *reticulata* Goldfuss (7, p. 9, 23)
T187	*Schizophoria* sp. 1 (B)
	S. sp. 2 (B)
	Productus longispinus (B)
	Pr. cf. *semireticulatus* (B)
	Pr. sp. (B)
	Pr. sp. nov. 3 (B)
	Marginifera sp. nov. 3 (B)
	Spirifer trigonalis Martin (B)
	Sp. sp. nov. 3 (B)
	Rhipidomella michelini L'Evill
	Rhipidomella michelini var. nov. (B)
	Athyris royssi L'Eville (B)
	A. (*Cleiothyridina*) *squamidula* de Kon. (B)
	Leptaena analoga (Phill.) (B)
T188	*Pseudouralinia irregularis* Yü (69, p. 20, 61)
T189	*Campophyllum* (D)
	Syringopora cf. *reticulata* Goldfuss (7, p. 8, 23)

	Sy. geniculata Phillips (7, p. 12, 23)
	Sy. gracilis Kayserling (7, p. 19)
T190	*Caninia vesicata* Yü (69, p. 20, 54)
	Kueichouphyllum heishihkuanense Yü (69, p. 20, 74)
	K. heishihkuanense var. *ephippium* Yü (69, p. 20, 75)
	Lithostrotionella kueichouensis Yü (69, p. 20, 102)
	Composita subtilita var. nov. (B)
T191	*Syringopora ramulosa* Goldfuss (7, p. 10, 24)
T191a	*Daviesiella* sp. nov. 1 (B)
	Productus giganteus (B)
T192	*Caninophyllum costatum* Yü (69, p. 21, 57)
	Syringopora geniculata Phillips (7, p. 12, 24)
	Sy. gracilis Kayserling (7, p. 19)
T193	*Caninophyllum costatum* Yü (69, p. 57)
	Cryptospirifer sp. nov. 1 (B)
	Lochengia or *Brachythyris ufensis* ? (B)
T194	*Lithostrotion* (*Siphonodendron*) cf. *irregulare* var. *jungtungense* Yü (69, p. 21)
	Productus semireticulatus (B)
	Pr. sp. (B)
	Phaneroptinus sp. nov. (B)
	Meekospira sp. nov. (B)
	Bellerophon sp. (B)
	Gastropods (B)
T196	*Kueichouphyllum heishihkuanense* Yü (69, p. 21, 74)
	Dibunophyllum vaughani Garwood et Goodyear (69, p. 21, 128)
	Productus (*Kansuella*) cf. *maximus* (B)
	Daviesiella llangelliensis Davidson (B)
T196a	*Daviesiella comoides* (Davidson) (B)
	D. llangelliensis Davidson (B)
	D. cf. *llangelliensis* (B)
T197	*Daviesiella comoides* (Davidson) (B)
	Athyris ingens var. *kansuensis* Grabau (B)

T198 *Daviesiella comoides* (Davidson) (B)
Orthotetes sp. (B)

T199 *Daviesiella* cf. *llangelliensis* Davidson (B)
D. sp. nov. (B)
D. comoides or sp. nov. (B)
Productus sp. nov. 4 (B)
P. giganteus (B)

T203 (13, p. 23)
Schizophoria indica (Waagen) (12, p. 7)
Orthotichia derbyi Waagen (12, p. 10; 13, p. 54)
Camerophoria subglobulina Phillips (12, p. 15)
Streptorhynchus lenticularis Waagen (12, p. 20)
S. sp. 2 (12, p. 24)
Chonetes cf. *variolatus* d'Orbigny (12, p. 29)
Strophalosia cf. *longa* Netchaschew (12, p. 56)
Camarotoechia wynnii (Waagen) (12, p. 57)
Terebratuloidea heteroplicata Gr. (12, p. 59)
T. minor Waagen mut. α Gr. (12, p. 60)
T. minor Waagen mut. β Gr. (12, p. 60)
T. cf. *triplicata* Kutorga (12, p. 65)
T. depressa Waagen (12, p. 66)
T. quadriplicata Gr. (12, p. 63)
T. depressa var. *kweichowensis* Gr. (12, p. 67)
T. cf. *davidsoni* Waagen (12, p. 69)
T. inflata var. *tripliradiata* Gr. (12, p. 70)
Spirifer cf. *rectangulus* Kutorga (12, p. 78)
S. tastubensis Tschern. (12, p. 97)
S. cf. *tastubensis* Tschern. (12, p. 81)
Ambocoelia cf. *urii* Fleming (12, p. 86)
Martiniopsis inflata Waagen (12, p. 98)
Uncinella minor Gr. (12, p. 102)

Hustedia remota Eichw. (12, p. 103)
H. indica Waagen (12, p. 104)
H. grandicosta Davidson (12, p. 105)
Athyris timorensis var. *mongolica* Gr. (12, p. 105)
A. planosulcata var. *uralica* Gr. (12, p. 108)
Spirigerella derbyi var. *kweichowensis* Gr. (12, p. 113)
Dielasma elongatum (Tschern.) var. *orientalis* Gr. (12, p. 135)
D. cf. *truncatum* Tschern. (12, p. 126)
Heterolasma payuensis Gr. (12, p. 136)
H. plicata Gr. (12, p. 138)
Hemiptychina himalayensis (Dav.) (12, p. 139)
Morrisina sparsiplicata (Waagen) var. *nana* Gr. (12, p. 141)
Notothyris warthiformis Gr. (12, p. 148)
Beecheria sublaevis (Waagen) (12, p. 148)
Payuella obscura Grabau (12, p. 150)

T204 *Caninia buxtonensis* var. *concava* Yü (69, p. 22, 53)
Productus sp. (E)

T204a *Daviesiella lochengensis* Gr. (E)
Athyris gerardiformis Gr. (E)

T205 *Martiniopsis inflata* Waagen (12, p. 98; 13, p. 24) (E)
Athyris gerardi Diener (E)

T209 (13, p. 34)
Streptorhynchus cf. *broilii* Gr. (12, p. 21)
Chonetes spinulostriatus Gr. (12, p. 27)
Marginifera longispina var. *orientalis* Chao (12, p. 47)
Squamularia sp. (12, p. 76)

T210* *Spirifer* sp. nov.
Athyris (Cleiothyridina) gerardi Diener
Sanguinolites sp. nov.

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* Fossils of this locality are identified by A. W. Grabau.

	Euomphalus sp. nov.
T211	*Schellwienia granum avenae* ? Romer (G)
	Fusulinella inflata Colani (G)
	Neofusulinella girandi Deprat (G)
T211a	*Doliolina lepida* Schwager
T212	(13, p. 14)
	Orthotichia derbyi Waagen (13, p. 54)
	Linoproductus cora (d'Orb.) (13, p. 123)
	Martinia uralica var. *longa* Tschern. (13, p. 233)
	Dielasma mapingense var. *minor* Gr. (13, p. 261)
	D. cf. *elongatum* Tschern.
T212a	*Schellwienia japonica* Gümbel var. (G)
	S. japonica var. *truncata* Ozawa (G)
	S. ambigua Deprat (G)
	S. delicata, now *Triticites delicatus*
	Doliolina lepida Schwager (G)
T213	*Linoproductus cora* d'Orb. (13, p. 15, 123)
T216	*Schellwienia japonica* Gümbel (G)
T217	*Schellwienia japonica* Gümbel (G)
T218	(13, p. 15)
	Neofusulinella girandi Deprat (G)
	Lophophyllum marginale Chi (13, p. 42)
	Koninckophyllum nantanense Chi (13, p. 42)
	Rhipidomella uralica var. *minor* Gr. (13, p. 49)
	R. cf. *uralica* Tschern. (13, p. 51)
	R. crassistriata Grabau (13, p. 52)
	Schizophoria supracarbonica Tschern. (13, p. 53)
	? *Orthotichia derbyi* Waagen (13, p. 54)
	Orthotichia ? *mapingensis* Gr. (13, p. 61)
	Aulacophoria ? *ruga* Gr. (13, p. 63)
	Parenteletes interstrialis Gr. (13, p. 63)

P. mirabilis Mansuy (13, p. 64)
Laevicamera sella (Kutorga) (13, p. 87)
L. pentameroides (Tschern.) (13, p. 88)
Chonetes uralicus Moeller (13, p. 96)
Productus subtuberculatus Gr. (13, p. 111)
P. gratiosus Waagen (13, p. 115)
P. gratiodentalis Gr. (13, p. 118)
Linoproductus aagardi Toula (13, p. 132)
L. sp 2 (13, p. 133)
Buxtonia mapingensis Gr. (13, p. 138)
Echinoconchus mapingensis Gr. (13, p. 148)
Waagenoconcha humboldti (d'Orb.) (13, p. 149)
Krotovia pustulata Kayserling (13, p. 150)
Marginifera gaominensis Gr. & Yoh (13, p. 156)
M. typica var. *tenuistriata* Gr. (13, p. 160)
M. pusilla var. *mapingensis* Gr. (13, p. 162)
M. ? biloba Gr. (13, p. 170)
Plicatifera chaoi Gr. (13, p. 171)
P. crenulata Gr. (13, p. 174)
Squamularia asiatica Chao (13, p. 184)
S. subrostrata Gr. (13, p. 190)
S. extensa Gr. (13, p. 196)
Spirifer fasciger Kayserling var. *simplex*. Gr. (31, p. 199)
S. (*Brachythyrina*) *rectangulus* Kutorga (13, p. 208)
S. (*Brachythyrina*) *rectangulus* mut. *tachysinosus* Gr. (13, p. 211)
S. quadriradiatus de Vern. (13, p. 216)
S. (*Munella*) *nikitini* Tschern. (13, p. 217)
S. cf. *supramosquensis* Nikitin (13, p. 219)
Tylothyris pyramidata (Tschern.) (13, p. 225)
T. laminosa var. *sterlitamakensis* (Tschern.) (13, p. 277)
Martinia corculum Kutorga (13, p. 229)

	Martinia incerta Tschern. (13, p. 231)
	Athyris (*Cleiothyridina*) *nantanensis* Gr. (13, p. 256)
	Dielasma mapingensis Gr. (13, p. 257)
	Notothyris nucleolus Kutorga (13, p. 280)
	Limatulina cf. *tungtzeensis* Gr. (13, p. 299)
	Geronticeras latum Gr. (13, p. 213)
T219	*Schellwienia japonica* Gümbel var. (G)
	Doliolina sp. (G)
	Fusulinella inflata Colani var. (G)
T220	*Schellwienia japonica* Gümbel (G)
	S. ambigua Deprat (G)
	S. complicata Schellwien (G)
	S. japonica var. *truncata* Ozawa (G)
	S. solida (Colani) (G)
	S. sp. nov. (G)
	S. sp. nov. (G)
T222§	*Xenodiscus* sp. ind. 1
	Xenodiscus sp. ind. 2
	Xenaspis ? sp.
	Nautilus (*Aganites* ?) sp.
T223	*Meekella* cf. *kayseri* Jaeckel
T224*	*Meekella* cf. *kayseri* Jaeckel
	Aulosteges sp. nov.
	Neoproetus sp. nov.
T225	*Pagodicrinus* sp. 2 (B)
	Leptaena analoga var. nov. (B)
	Chonetes latesinuata var. nov. (B)
	C. sp. 2 (B)

§ Identified by C. C. Tien.

* Identified by A. W. Grabau.

	Spirifer sp. nov. 4
	Reticularia ? (B)
T226	*Neofusulinella bocki* ? Möller (G)
	Lophophyllum sp. nov. (F)
	Dibunophyllum sp. (F)
T227	*Michelinia* sp. nov. (F)
	Verbeekiella sp. (F)
T229a	*Fusulinella* (*Staffella*) *angulata* Colani (G)
	Fusulinella (*Staffella*) *struvii* Möller (G)
	Staffella spharoidea Möller (G)
	Levicamera athyriformis Gr. (12, p. 18; 13, p. 24)
	Chonetes chaoi Gr. (12, p. 30; 13, p. 24)
	C. hardrensis var. *nantanensis* Gr. (12, p. 31; 13, p. 24)
	Productus gratiosus Waagen (12, p. 34; 13, p. 24)
	P. gratiodentalis Gr. (12, p. 36; 13, p. 24)
	P. sp. d. (12, p. 44; 13, p. 24)
	P. sp. e. (12, p. 45; 13, p. 24)
	Echinoconchus decemundatus Gr. (12, p. 45; 31, p. 24)
	Marginifera morrisi Chao (12, p. 52; 13, p. 24)
	M. typica var. *septentrionalis* Tsch. (12, p. 55; 13, 24)
	Squamularia asiatica Chao (12, p. 71; 13, p. 24)
	Spirifer subnikitini Gr. (12, p. 84; 13, p. 24, 220)
	Martinia incerta Tsch. (12, p. 88; 13, p. 24)
	Athyris timorensis var. *mongoliensis* Gr. (13, p. 24)
	Notothyris cf. *nucleolus* (Kut.) (12, p. 147; 13, p. 24)
	Notothyris cf. *uralica* Tsch, (12, p. 147; 13, p. 24)
T230	(31, p. 105)
	Fusulina *
	Doliolina *

* Identified by A. W. Grabau.

Caninia sp. (F)
Productus cf. *gratiosus* Waagen (13, p. 24; 30, p. 33; 31, p. 105)
Linoproductus cora (d'Orb.) (13, p. 24; 30, p. 41; 31, p. 105)
L. cancriniformis (Tschern.) (13, p. 24; 30, p. 42; 31, p. 105)
Squamularia sp. (13, p. 24)
Athyris sp. (13, p. 24)
Myalina sp.*
Temnocheilus sp.*
Phillipsia sp.*

T231 *Verbeekina douvillei*
Tetrataxis sp.**
Bigenerina sp.**
*Verbeekina verbeeki***
V. sp. nov. (G)

T234 *Schellwienia japonica* Gümbel (G)
Enteletes kayseri Waagen*
Meekella sp.*
Chonetes squama var. nov.*
Aulosteges sp. nov.*
Neoproetus sp. nov.*

T235 *Popanoceras* sp.
P. cf. *simile* Hawil
Agathiceras cf. *kishanense* Gr.
Propinacoceras sp.
Agathiceras sp.
? *Orthoceras*

T236 *Fusulinella* (*Neofusulinella*) *compressa* Ozawa (G)
Endothyra bowmani Phillips (G)

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* Identified by A. W. Grabau.

** Identified by K. H. Hsu

	Tetrataxis sp. (G)
	? *Cyathophyllum* sp. (F)
T238	*Camarotoechia* or *Leiorhynchus* (B)
	Reticularia ? (B)
	Athyris (B)
	Pelecypods 2 (B)
	Pterinea sp. (B)
	Styliolina (B)
	Tentaculites (B)
	Phacops (B)
T238a	Pelecypods, crushed (B)
T238b	*Stringocephalus burtini* Defrance (B)
	Meristella ? crushed (B)
	Lepidodendroid ? (B)
T239	*Tentaculites* sp. (B)
T241	*Schellwienia longissima* Möller (27; 29, p. 81) (G)
	S. simplex ? Schellwien (27; 29, p. 81) (G)
	Cribrostomum (G)
	Caninia trinkleri Schindewolf (27; 29, p. 81)
	? *Caninia kungchishanensis* Huang (27; 29, p. 82)
	Amygdalophyllum nantanense Huang (27; 29, p. 82)
	Cyathophyllum cystitabulatum Huang (27; 29, p. 82)
	Pachypora sp. nov. (F)
	Lithostrotionella sp. nov. (F)
	Productus sp. (B)
T242	(13, p. 16)
	Nantanella mapingensis Gr. (13, p. 72)
	N. mapingensis mut. *robusta* Gr. (13, p. 75)
	N. mapingensis mut. *alpha* (13, p. 77)
	N. mapingensis mut. *beta* (13, p. 77)
	N. mapingensis mut. *gamma* Gr. (13, p. 77)
	N. mapingensis var. *uniplicata* Gr. (13, p. 78)

N. mapingensis var. *pentaplicata* Gr. (13, p. 78)
N. quadriplicata Gr. (13, p. 80)
N. elegantula Gr. (13, p. 82)
Levicamera ? martinioides Gr. (13, p. 89)
Streptorhynchus pelargonatus Schlotheim (13, p. 92)
Meekella cf. *timanica* Tschern. (13, p. 96)
Productus boliviensis d'Orb. (31, p. 99)
P. grünewaldti Krotow (13, p. 103)
P. mammatus Keyserling (13, p. 107)
P. subtuberculatus Gr. (13, p. 111)
P. nantanensis Gr. (13, p. 114)
P. konincki de Vern. (13, p. 121)
Linoproductus simensis Tschern. (13, p. 124)
Juresania kweichowensis (Chao) (13, p. 143)
Waagenoconcha humboldti (d'Orb.) (13, p. 149)
Marginifera typica var. *tenuistriata* Gr. (13, p. 160)
M. timanica Tschern. (13, p. 165)
Plicatifera chaoi Gr. (13, p. 171)
Uncinunellina wangenheimi (Pander) (13, p. 175)
Squamularia rostrata (Kutorga) (13, p. 188)
S. subrostrata Gr. (13, p. 190)
S. extensa Gr. (13, p. 196)
Spirifer fasciger var. *simplex* Gr. (13, p. 199)
S. orientalis Chao (13, p. 203)
S. subnikitini Gr. (13, p. 220)
Martinia corculum (Kutorga) (13, p. 229)
M. sinensis Gr. (13, p. 231)
M. semiglobosa Tschern. (13, p. 235)
M. semiplana Waagen (13, p. 237)
M. semiplana var. *asinosa* Gr. (13, p. 241)
Martiniopsis cathaysiensis Gr. (13, p. 242)
Athyris aviformis Gr. (13, p. 255)

Dielasma juresanense Tschern. mut. *antecedens* Gr. (13, p. 266)
D. juresanense var. *minor* Grabau (13, p. 267)
D. indentum Gr. (13, p. 268)
D. itaitubense Tschern. (13, p. 271)
D. modelleri Tschern. (13, p. 273)
D. cf. *giganteum* Tschern. (13, p. 276)
D. bisulcatum Gr. (13, p. 279)
Notothyris nucleolus (Kut.) (13, p. 280)
N. nucleolus var. *rugosa* Gr. (13, p. 282)
N. mapingensis Gr. (13, p. 283)
Streblopteria magnini Mans. (13, p. 294)
Liebea mapingensis Gr. (13, p. 296)
Plethomytilus ? nantanensis Gr. (13, p. 298)
Modiola ? sp. (13, p. 300)
Paromphalus mapingensis Gr. (13, p. 302)
Spiroraphella tingi Gr. (13, p. 305)
S. wongi Gr. (13, p. 307)
Naticopsis costellatum Gr. (13, p. 309)
Geronticeras separatum Gr. (13, p. 313)
G. dubium Gr. (13, p. 314)
Palaeocapulus permianus (13, p. 311)
Omphalonema multispiralis Gr. (13, p. 308)
Orthoceras sp. (13, p. 316)

T243 *Schellwienia ominensis* Ozawa (G)
Lithostrotionella sp. nov. (F)
Campophyllum sp. (F)
Pachypora sp. (F)
Productus gratiodentalis Grabau (12, p. 36; 13, p. 24)
P. manchuricus Chao (12, p. 38; 13, p. 24)
Squamularia asiatica Chao (12, p. 71; 13, p. 24)
Beecheria sublaevis Waag. (12, p. 148; 13, p. 24)

T246	*Verbeekina* sp. (G)
	Verbeekina pseudoverbeeki Deprat (G)
T247	(13, p. 34)
	Martiniopsis orientalis Tsch. (12, p. 94)
	Athyris timorensis var. *mongoliensis* Gr. (12, p. 105)
	Dielasma tatingense Gr. (12, p. 130)
	Mongolina subdieneri Gr. (12, p. 143)
	Bellerophon compressus Gr. (12, p. 156)
	Holopella trimorpha Waagen (p. 166)
T247a	(13, p. 34)
	Athyris (*Cleiothyridina*) *pectinifera* Sowerby (12, p. 111)
	Nucula ? *lipoensis* Gr. (12, p. 150)
T247b	*Stylidophyllum volzi* (Yabe & Hayasaka) mut. β Huang (28, p. 69; 29, p. 18)
	S. chaoi Huang (29, p. 18)
	Polythecalis langpoensis Huang (28, p. 90; 29, p. 18)
	Geinitzella tabula Huang (29, p. 18)
	Spirifer cf. *quadriradiatus* de Vern. (12, p. 83; 13, p. 35)
T248	*Syringopora* cf. *ramulosa* Goldfuss (7, p. 11, 24)
	S. geniculata Phillips (7, p. 12, 24)
	Reticularia ? sp. (B)
T249	*Pseudouralinia tangpakouensis* Yü (69, p. 22, 59)
	Syringopora repens Stuckenberg (7, p. 16, 24)
T249a	*Syringopora* cf. *reticulata* Goldfuss (7, p. 9, 24)
	S. lipoensis Chi (7, p. 21, 24)
	S. parallela (Fischer) (7, p. 24)
T251	*Syringopora* or *Tetrapora**
	Productus (*Striatifera*) sp.*
	P. cf. *striatus* (E)
T252	*Schwagerina* sp. (G)

* Identified by A. W. Grabau.

T254	*Spirigerella obesa* Huang (31, p. 77)
T255	*Fusulinella inflata* Colani (G)
	Waagenophyllum indicum var. *kueichowense* Huang (28, p. 48)
T256	*Meekoceras* sp. nov.§
T257	*Meekoceras* cf. *jolinkens* Krafft. (45, p. 21)
T260	*Amygdalophyllum* (probably young stage of *A. nantanense* Huang (F))
T261	*Reticularia* ?*
T261a	*Leptaena analoga* (Phillips)*
T263	(8, p. 6)
	Koninckophyllum trisectum Chi (6, p. 13)
	K. grabaui Chi (6, p. 13)
	Campophyllum lipoense Chi (6, p. 22)
	Clisaxophyllum sp. (6, p. 24)
T264	(13, p. 25)
	Schizophoria cf. *juresanensis* Tschern. (12, p. 6)
	Orthotichia cf. *morganiana* (Derby) (12, p. 9)
	Camarophoria selliformis Gr. (12, p. 13)
	Streptorhynchus cf. *pelargonatus* Schloth. (12, p. 22)
	Chonetes latesinuatus var. *miaokouensis* Chao (12, p. 28)
	Marginifera cf. *timanica* Tschern. (12, p. 49; 13, p. 165)
	M. sp. (12, p. 56)
T265	Verbeekiella sp. (F)
T266	*Hungarites* sp. nov.*
	H. cf. *middlemissi* Diener*
T267	*Staffella sphaerica* Abich (G)
	S. sp. nov. (G)
	Eoverbeekina intermedia Lee (36, p. 18)
T268	*Wentzelella subtimorica* Huang (28, p. 59)
T269	*Staffella inflata* (Colani) (G)

§ Identified by C. C. Tien.

* Identified by A. W. Grabau.

Stylidophyllum volzi (Y. & H.) mut. α Huang (28, p. 69)
Corwenia lipoensis Huang (28, p. 52; 29, p. 18)
Productus cf. *magniplicatus* Huang (13, p. 35)
Plicatifera lipoensis Gr. (12, p. 46; 13, p. 35; 29, p. 18)
Marginifera cf. *lipoensis* Gr. (12, p. 51; 13, p. 35; 29, p. 18)
Squamularia rostrata Kutorga (12, p. 74; 13, p. 35; 29, p. 18)
Martinia incerta Tschern. (12, p. 88; 13, p. 35; 29, p. 18)
Spiriferella grandis Waagen (12, p. 114; 13, p. 35; 29, p. 18)
Naticopsis khoovensis Waagen (12, p. 164; 13, p. 35)

T270 *Schellwienia confusa* L. & C. (G) (=*Staffella confusa* L. & C.)
S. minima Schellw. (G)
S. compacta L. & C.
Schwagerina sp. nov. (G)

T271 *Schellwienia pusilla* Schellwien (G)
S. sp.
Schwagerina princeps var. *magae-sphaerae* Colani (G)
Kionophyllum dibunum Chi (6, p. 40; 8, p. 6)

T271b *Gshelia elliptica* Chi (6, p. 17; 8, p. 6)
Caninia nikitini Stuckenberg (6, p. 19; 8, p. 6)
Siphonodendron kueichowense Chi (6, p. 26; 8, p. 6)
Lithostrotionella tingi Chi (6, p. 28; 8, p. 6)
Cystophora typica Chi (6, p. 31; 8, p. 6)
Productus (*Striatifera*) sp. nov. 1 (E)
P. (*Striatifera*) sp. nov. 2 (E)
P. (*Linoproductus*) *tenuistriatus* de Vern. (E)
Choristites wangchuchueni Chao (E)

T272 *Histiophyllum thomsoni* Chi (6, p. 15; 8, p. 6)
Siphonodendron sp. nov. (6, p. 27; 8, p. 6)
Gen. et sp. nov. (Aberrant Lithostrotiontidae) (6, p. 32; 8, p. 6)
Dibunophyllum yüi Chi (6, p. 39; 8, p. 6)
Syringopora sinensis Chi (6, p. 46; 8, p. 6)

Corwenia cf. *chutsingensis* Chi (6, p. 272; 8, p. 6)
Spirifer (*Brachythyris*) *simenensis* Tsch. var. nov. (E)
Martiniopsis sp. nov. (E)
T274 *Schellwienella crenistria* mut. nov. (B)
Chonetes sp. nov. (B)
C. hardrensis mut. nov. (B)
C. sp. nov. 2 (B)
Productus sp. nov. 1 (B)
Pr. yunnanensis Loczy (B)
Pr. nystianus de Koninck (B)
Pr. cf. *striatus* Fischer (B)
Pr. semireticulatus Martin (B)
Echinoconchus sp. nov. 1 (B)
E. sp. nov. 2 (B)
Marginifera viseeniana Chao (B)
Squamularia sp. nov. (B)
Spirifer sp. nov. 5 (B)
Sp. sp. nov. 3 (B)
Martiniopsis sp. nov. (B)
Martinia sp. 2 (B)
Spiriferina sp. nov. (B)
Athyris sp. nov. 5 (B)
Syringothyris distans Sowerby (B)
Reticularia mesoloba var. nov. (B)
R. ambocaelia (B)
Ambocoelia sp. nov. 1 (B)
T275 *Kueichowpora tushanensis* Chi (7, p. 22, 24)
Prismatophyllum carbonicum Yü (69, p. 22, 78)
T277 *Streptorhynchus* (B)
Schellwienella (B)
S. sp. (B)

	Dielasma ficum M'Coy (B)
	Composita sp. (B)
	Gastropods (B)
T278a	*Campophyllum* (?) (C)
	Syringopora sp. (C).
	Omphipora sp. (C)
T278b	Corals (compound) (B)
	Loxonema sp. (B)
	Athyris (B)
T278c	*Stromatopora* sp. indet. (C)
	Fasciphyllum sp. (B)
	Atrypa aspera Schlotheim (B)
	Spirifer sinensis Gr. (B)
	Sp. yunnanensis Loczy (B)
T279	*Dielasma* sp. (B)
	Cyrtoceraconic cephalopod (B)
T280	*Orbiculoidea* cf. *nitida* Phillips (B)
	Argentia (B)
	Schuchertella sp. nov. 2 (B)
	S. sp. nov. 3 (B)
	Schellwienella crenistria mut. nov. (B)
	Reticularia imbricata mut nov. (B)
	Composita globularis Phillips (B)
	C. subtilita var. nov. (B)
T280a	*Cystophrentis kolaohoensis* Yü (69, p. 22, 50)
	Composita globularis Phillips (B)
	C. subtilita var. nov. (B)
	C. argentia (B)
T281	*Pseudouralinia tangpakouensis* Yü (69, p. 21)
T282	*Lophophyllum* ? sp. (69, p. 32)
	Lithostrotion (*Siphonodendron*) *irregulare* Phill. (69, p. 93)

	Dibunophyllum shangchaiense Yü (69, p. 129)
	Aspidophyllum tushanense Yü (69, p. 130)
	Productus (*Kansuella*) sp. nov. 5 (B)
T283	*Neofusulinella girandi* Deprat (G)
	Tetrataxis sp. (G)
	Gerthia minor Chi (6, p. 9; 8, p. 7)
	Caninia simpliseptata Chi (6, p. 19; 8, p. 7)
	Dibunophyllum tushanense Chi (6, p. 38; 8, p. 7)
	Echinoconchus elegans var. nov. (B)
	Daviesiella sp. nov. (E)
T284	*Verbeekina verbeeki* Geinitz (G)
T285	*Schellwienia longissima* Möller (29, p. 81) (G)
	Schwagerina princeps var. *magnaesphaerae* Colani (29, p. 81) (G)
	Fusulinella sp. (29, p. 81)
	Martiniopsis orientalis Tschern. (13, p. 25)
	M. cf. *lutugini* Tschern. (12, p. 99; 13, p. 25)
	Euomphalus cf. *nora* Grabau (13, p. 25)
T286a	*Schellwienia* sp. (G)
	Geinitzella sp. nov. (F)
	Marginifera cf. *timanica* Tschern. (12, p. 49; 13, p. 165)
	Ambocoelia cf. *urii* Fleming (12, p. 86)
	Mongolina subdieneri Grabau (12, p. 143)
	Euomphalus nora Grabau (12, p. 158)
	E. mongolicus Grabau (12, p. 159)
T286b	Indeterminable (supposed to be *Allotropiophyllum sinense* Gr.) (F)
	Camarophoria mutabilis Tschern. (12, p. 16; 13, p. 35)
	Productus cf. *sinensis* Gr. (13, p. 35)
	Pr. sp. (12, p. 42)
	Squamularia asiatica Chao (12, p. 71; 13, p. 35)

	Martinia mongolica Gr. (12, p. 92; 13, p. 35)
	Morrisina sparsiplicata Waagen var. *nana* Gr. (12, p. 141; 13, p. 35)
	Ambocoelia cf. *planoconvexa* Shumard (12, p. 88; 13, p. 35)
T288	*Koninckophyllum tushanense* Chi (6, p. 12; 8, p. 7)
	Histiophyllum cf. *thomsoni* Chi (6, p. 15; 8, p. 7)
	Axophyllum centrotum Chi (6, p. 35; 8, p. 7)
	Multithecopora yohi Chi (6, p. 47; 8, p. 7)
	Productus sp. nov. (E)
	Striatifera striata var. nov. (E)
	Striatifera compressa var. nov. (E)
	Squamularia asiatica Chao (E)
	Martiniopsis sp. nov. (E)
	Athyris (*Cleiothyridina*) sp. nov. 1 (E)
	Athyris cf. sp. nov. 2 (E)
T290	*Syringopora geniculata* Phillips (7, p. 12, 24)
	S. parallela (Fischer) (7, p. 18, 24)
T290a	*Syringopora geniculata* Phillips (7, p. 12, 24)
T291a	*Michelinia pectiniformis* Huang (28, p. 100)
T292a	*Dibunophyllum reticuliforme* Yü (69, p. 22, 130)
T295	*Clisaxophyllum grossinum* Yü (69, p. 22, 111)
T296	*Syringopora* cf. *reticulata* Goldfuss (7, p. 9, 24)
	S. ramulosa Goldfuss (7, p. 10, 24)
	Daviesiella llangollensis Davidson
	Productus sp. nov. 2 (B)
	Cryptospirifer sp. nov. 2 (B)
	C. sp. nov. 3 (B)
	Productus inflatus Tschern. (B)
	Spirifer (*Brachythyris*) *ufensis* Tschern. (B)
T296a	*Merophyllum* sp.*

* Identified by C. C. Yü

	Thysanophyllum sp.*
	Productus yunnanensis Loczy (B)
	Athyris (*Cleiothyridina*) sp. nov. 3 (B)
	Worthenia sp. nov. (B)
T296b	*Thysanophyllum circulocysticum* Chu emend. Yü (69, p. 20, 41)
	T. asiaticum Yü (69, p. 20, 42)
	Yabeella magnicystosa Yü (69, p. 20, 77)
	Lithostrotion (*Siphonodendron*) *curvatum* Yü (69, p. 20, 99)
	Syringopora ramulosa Goldfuss (7, p. 10, 24)
T296c	*Daviesiella* cf. *llangollensis* Davidson (B)
T296d	*Arachnolasma cylindricum* var. *multiseptatum* Yü (69, p. 20, 36)
	Kueichouphyllum sinense Yü (69, p. 20, 71)
	Lithostrotion (*Siphonodendron*) *irregulare* var. *jungtungense* Yü (69, p. 20, 96)
T297	*Arachnolasma sinense* (Yabe et Hayas.) (69, p. 19, 34)
	A. cylindricum var. *multiseptatum* Yü (69, p. 19, 36)
	A. equiseptatum Yü (69, p. 19, 37)
	Yuanophyllum kansuense Yü (69, p. 19, 46)
	Cyathophyllum stutchburyi var. *merophylloides* Yü (69, p. 19, 67)
	Kueichouphyllum sinense var. *gracile* Yü (69, p. 19, 72)
	Diphyphyllum muticystatum Yü (69, p. 19, 82)
	D. platiforme Yü (69, p. 20, 84)
	Schellwienella sp. nov. (B)
	Chonetes papillionacea Phillips var. nov. (B)
	C. papillionacea mut. nov. (B)
	Productus maximus (B)
	Pr. edelburgensis Phillips (B)
	Pr. corrugatus M'Coy (B)
	Pr. cf. *giganteus* (B)
	Echinoconchus elegans M'Coy (B)

* Identified by C. C. Yü

	Martinia sp. nov. (B)
	M. sp. 1 (B)
	Reticularia sp. (B)
	Squamularia sp. (B)
	Ambocoelia sp. nov. 2 (B)
	Athyris (*Cleiothyridina*) sp. nov. 3 (B)
T298	*Arachnolasma tingfanense* Yü (69, p. 19, 40)
	Kueichouphyllum heishihkuanense Yü (69, p. 19, 74)
	Siphonodendron petalaxoidea Yü (69, p. 19, 100)
	Daviesiella comoides (Davidson)
	D. sp. nov. 2 (B)
	D. sp. nov. 3 (B)
	Productus giganteus mut. nov. (B)
	Athyris (*Cleiothyridina*) sp. nov. 4 (B)
	Solenopora sp. (B)
	Worthenia sp. (B)
T298a	*Productus* sp. nov. 4 (B)
	P. giganteus (B)
T298b	(69, p. 19)
	Depasophyllum convexum Yü (69, p. 85)
	Lithostrotionella spiniformis Yü (69, p. 102)
	Clisaxophyllum vesiculosum Yü (69, p. 108)
T301	*Diphyphyllum* (*Depasophyllum*) *hochangpingense* Yü (69, p. 22, 86)
T302	*Hapsiphyllum* sp. (B)
	Lithostrotion sp. (B)
	Productus giganteus ? (B)
	Martinia or *Martiniopsis* sp. (B)
	Loxonema sp. (B)
	Euomphalus sp. (B)

T302b *Kueichouphyllum sinense* var. *gracile* Yü (69, p. 22, 72)

T304 *Fusulinella* sp. (G)

Streptorhynchus pelargonatus (Schlotheim) (31, p. 17)

T305 Problematicum (cf. *Scyphia caniensis*) (40, p. 11)

T306 *Lophophyllum kueichowense* Huang (28, p. 30; 31, p. 98)

Schizophoria parenteletiformis Huang (29, p. 52; 31, p. 1, 98)

Orthotichia marmorea (Waagen) (29, p. 52; 31, p. 6, 98)

Spinomarginifera pseudosintanensis Huang (29, p. 52; 30, p. 61; 31, p. 98)

Lyttonia nobilis Waagen (29, p. 52; 31, p. 98)

Spiriferina multiplicata mut. α Huang (29, p. 52; 31, p. 59, 98)

Uncinulus timorensis (Beyrich) (29, p. 52; 31, p. 61, 98)

Hustedia indica (Waagen) (29, p. 52; 31, p. 78, 98)

Hemiptychina sparsiplicata Waagen (29, p. 52; 31, p. 83, 98)

Notothyris cf. *warthi* Waagen (29, p. 52; 31, p. 87, 98)

Aviculopecten alternatoplicatus Chao var.*

A. sp. nov.*

Bellerophon sp.*

Soleniscus sp.

Aclisina sp.*

T307 *Fusulina pseudoprisca* Colani (G)

Oldhamina squamosa Huang (31, p. 104)

T307a *Linoproductus kiangsiensis* (Kayser)**

T307b *Oldhamina squamosa* Huang (30, p. 74)

Squamularia grandis Chao

T308 *Schellwienia* sp. (G)

Squamularia indica (Waagen) (31, p. 38)

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* Identified by A. W. Grabau.

** Identified bv T. K. Huang.

T309 *Strophalosia costata* Waagen*

T311 *Schellwienella kweichowensis* Gr. (12, p. 25; 13, p. 35)
Linoproductus tenuistriatus de Vern. (12, p. 42; 13, p. 35)

T311a *Schellwienella kweichowensis* Gr. (12, p. 25; 13, p. 35)
Productus (*Marginifera*) *typica* var. *elongatus* Huang (30, p. 23)

T312 *Pseudomonotis teilhardi* Patte (40, p. 11)
P. (?) cf. *speluncaria* Schlotheim (40, p. 11)

T314 *Pseudomonotis* (?) (cf. *P. tenuistriata* Bittner) (40, p. 11)
Pecten (?) (40, p. 11)
Myophoria sp. (cf. *M. goldfussi* et. "*M.* cf. *inaequicostata*" du Yunnan) (40, p. 11)
Cyrenide (?) comparable à des formes crétacées (40, p. 11)
Lamellibranche (40, p. 11)

T315 *Productus yangtzeensis* Chao

T316 *Amplexus* sp. (F)
A. cf. *arundinaceus* Lonsdale (28, p. 39)
Spirigerella obesa Huang (31, p. 77)

T318 *Productus yangtzeensis* Chao (31, p. 98)
Linoproductus kiangsiensis (Kayser) (30, p. 46)
Plicatifera minor ? (Schellwien) (31, p. 98)
Chonetes sp.*
Pustula (*Waagenoconcha*) cf. *abichi* (Waagen) (31, p. 98)
Lyttonia cf. *richthofeni* (Kayser) (31, p. 98)

T319 (40, p. 11)
Modiola (?)
Cyrenide (?)
Ostracodes

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* Identified by A. W. Grabau.

T320	(40, p. 11)
	Spirorbis sp.
	Lima sp. aff. *L. costata* Münster
T320a	*Lima* sp. (cf. *L.* (*Plagiostoma*) *marrotiana*) (40, p. 12)
T321	*Pterinopecten* sp. aff. P. *papyraceus* Sowerby (40, p. 12)
T323	*Chonetes* ? (40, p. 12)
T325	(43, p. 33)
	Ogygites yunnanensis Reed
	Illaenus tingi Sun
	I. feilaishihensis Sun
	I. cf. *punctulosus* Salter
	I. balclatchiensis Reed
	I. cf. ,, Reed
	I. sp.
	I. cf. *portlocki* Salter
	Lichas browni Sun
	Calymene tingi Sun (sp. nov.)
T331	*Mizzia velebitana* Schubert (G) (plant fossil)
T331a	*Marginifera typica* Waagen*
	Lyttonia sp. nov.*
T333	*Favosites gotlandica* Lamarck var. *multipora* Lonsdale (A)
T334	*Streptelasma whittardi* Smith (A)
T343a	? *Tryplasma* sp. (A)
T344	(13, p. 36)
	Meekella ufensis Tschern. (12, p. 26; 13, p. 36)
	Athyris timorensis var. *mongoliensis* Gr. (12, p. 105; 13, p. 36)
T345	*Martinia* sp. nov.*
T346	*Unio* sp. (40, p. 12)

* Identified by A. W. Grabau.

TW10	*Beyrichia tingi* Patte
	Pseudomonotis wangi Patte
	Myalina (?)
	Lima (?)
TW11	*Lima* or *Pseudomonotis* (?) (40, p. 12)
TW12	*Myophoria* sp. rappelant *M. goldfussi* (40, p. 12)
TW21	*Productus yangtzeensis* (?) Chao (29, p. 52)
	Pustula (*Waagenoconcha*) *abichi* (Waagen) (29, p. 52; 30, p. 54)
	Lyttonia tenuis Waagen (29, p. 52; 30, p. 95)
TW22	*Lyttonia* sp. nov.*
TW22a	*Squamularia indica* (Waagen)*
TW23	*Staffella* sp. nov. (G)
	Staffella inflata (Colani) (G)
	Verbeekina sphara Ozawa (G)
TW24	*Michelinia favositoides* Girty (F)
	Michelinia cf. *microstoma* Yabe et Hayasaka (29, p. 17)
	Tetrapora elegantula Y. & H. (28, p. 105; 29, p. 17)
	Stylidophyllum denticulatum Huang (28, p. 73; 29, p. 17)
TW25	*Monilopora dendroidea* Yoh (29, p. 18)
	Michelinia abnormis ? Huang (F)
	Michelinia sp. (29, p. 18)
	Stylidophyllum volzi (Y. & H.) (28, p. 65; 29, p. 18)
	S. kueichowense Huang (28, p. 70; 29, p. 18)
TW27	*Syringopora* sp.§
	Schellwienella crenistria mut. nov. (B)
	S. sp. nov. (B)

* Identified by A. W. Grabau.

§ Identified by Y. S. Chi

	Schuchertella sp. nov. 1 (B)
	Composita globularis Phillips
	C. subtilita var. nov.
	Gastropod & pelecypod
TW28	*Actinostroma* ?, minute gastropods (B)
TW30	*Atrypa* sp. nov. (B)
	Pelecypod (B)
TW31	*Amplexus* sp. (B)
	Stromatopora sp. (B)
	Campophyllum (?) (C)
	Diptophyllum (Hall) sp. (C)
	Parallelopora sp. (C)
	Cyathophyllum (*Thamnophyllum*) sp. nov. (D)
	Atrypa aspera Schlotheim (B)
TW32	*Michelinia* sp. (B)
	Plagiopora sp. (C)
	Spirifer multistriata Grabau (B)
TW33	*Spirifer sinensis* (mut. *S.*=*S. chaoi* ?)
TW35	*Amplexus* ? sp.
	Stringocephalus burtini Defrance
TW36	*Athyris fultonensis* (Vettata) (B)
	Stringocephalus obesus Grabau (B)
	Emanuella ? sp. (B)
	Pachypora cf. *reticulata* (Reed) (C)
TW39	*Amphipora asiatica* (D)
TW40	*Enteletes* sp. nov. (E)
	Productus sp. nov. (E)
	Squamularia asiatica Chao (E)
TW43	*Cystophora* sp. nov.**

** Identified by T. K. Huang.

	Campophyllum cf. *vigilans* Reed **
TW45	*Syringopora geniculata* Phillips (7, p. 12, 24)
TW47	*Knorria* sp. (44, p. 2)
TW52	*Clisiophyllum wangi* Yü (69, p. 22)
	Lophophyllum aff. *altaicum* Weber (69, p. 22)
	Chonetes semireticularis Chao (B)
	Productus yunnanensis Loczy (B)
	Pr. corrugatus M'Coy (B)
	Martiniopsis sp. (B)
	Athyris (*Cleiothyridina*) *ingens* var. *kansuensis* (B)
	Leperditia (B)
	Plicatifera sp. (B)
TW52a	*Productus* (*Kansuella* ?) sp. nov. (E)
	Daviesiella sp. nov. (E)
	Martiniopsis sp. nov. (E)
TW52b	*Aspidophyllum tushanense* Yü (69, p. 22)
TW53	*Heterocaninia* ? *tahopoensis* Yü (69, p. 22)
TW53a	*Daviesiella* sp. (E)
	Camarophoria cf. *mutabilis* Tschern. (E)
	Productus manchuricus var. nov. (E)
TW54	*Productus* sp. c (30, p. 37; 31, p. 105)
	Krotovia (*Avonia*) *janus* Huang (30, p. 55; 31, p. 105)
TW54a	*Parenteletes* cf. *sinensis* Huang (31, p. 104)
	Krotovia (*Avonia*) *janus* Huang
TW55	*Oldhamina grandis* Huang (30, p. 84; 31, p. 104)
TW56?	*Productus yangtzeensis* ? Chao**
	Lyttonia tenuis Waagen**
TW57	*Michelinia* cf. *siyangensis* *Reed* (28, p. 94)
TW58	*Taihungshania brevica* Sun (43, p. 33)
	Illaenus chichiangensis Sun (43, p. 33)
TW63	*Favosites gotlandica* var. *gotlandica* Lamarck (A)

** Identified by T. K. Huang.

IV. LIST OF FOSSILS IDENTIFIED BY DIFFERENT AUTHORITIES, NOT GIVEN IN ANY EXISTING PUBLICATIONS.

A. Silurian Corals from Kueichou and Szechuan
*Identified by C. C. Wang**

T333 *Favosites gotlandica* Lamarck var. *muthipora* Lonsdale

T334 *Streptlasma whitterdi* S. Smith

T343a ? *Tryplasma* sp.

TW63 *Favosites gotlandica* var. *gotlandica* Lamarck

B. Silurian, Devonian and Carboniferous Fossils
Identified by A. W. Grabau and C. C. Tien

TW27 *Schellwienella crenistria* mut. nov.
S. sp. nov.
Schuchertella sp. nov. 1
Composita subtilita Hall var. nov.
Composita globularis Phillips
Gastropod & pelecypod.

TW28 *Actinostroma* ?
Minute gastropods

TW30 *Atrypa* sp. nov.
Pelecypod

TW31 *Amplexus* sp.
Stromatopora sp.
Atrypa aspera Schlotheim

TW32 *Michelinia* sp.
Spirifer multistriata Grabau

TW33 *Spirifer sinensis* (mut. *S. chaoi*?) Grabau

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*C. C. Wang 王鏗昌

TW35	Coral (*Amplexus* ?) sp.
	Stringocephalus burtini Defrance
TW36	*Athyris fultonensis* (Vettata)
	Stringocephalus obesus Grabau
	Emanuella ? sp. (punctate brach. valve)
TW52	*Productus yunnanensis* Loczy
	Pr. corrugatus M'Coy
	Plicatifera sp.
	Chonetes semicircularis Chao
	Martiniopsis sp.
	Athyris (*Cleiothyridina*) *ingens* var. *kansuensis*
	Leperditia sp.
T 98	*Lingula* sp. nov.
T107	Cup coral
	Spirifer tingi Grabau
	Spirifer sp. (more plicae than *S. tingi*)
	Retzia sp. nov. 1
	Whitfieldella ? sp.
T107a	*Favosites* cf. *basaltiformis*
	Streptelasma sp.
	Spirifer tingi Grabau
	Retzia sp. nov. 2
T108	*Lingula lounanensis* Mansuy
	L. cf. *cuneatiformis* Grabau
	Modiomorpha crypta Grabau
	M. sp. nov. 1
T109	*Modiomorpha* sp. nov. 2
	M. crypta Grabau
	Illaenus sp. (impression)

T110	*Spirifer hsiehi* Grabau
	Retzia sp.
	Atrypa sp.
T117	*Spirifer* sp.
	cf. small *S. tingi* type but not certain
T118	*Atrypa aspera* Schlotheim
	Spirifer ? sp.
T126	*Syringopora* sp.
	Dalmanella sp. 1
	D. sp. 2
	Illaenus sp. c.
	Coronocephalus or *Acidaspis*
T126a	Crinoid plates etc.
	Dalmanella sp.
	Whitfieldella sp.
	Trilobite fragments
	Trilobite cheek (*Acidaspis* ?)
T132	*Spirifer sinensis* Grabau
T135	*Amplexus* ? sp.
	Fascephyllum sp.
	Spirifer sp.
	Atrypa aspera Schlotheim
T135a	*Cyathophyllum* (*Phacellophyllum*) sp.
T136	*Composita* cf. *globularis* Phillips
	Schellwienella crenistria var.
T137	*Pagodicrinus* sp. 2
	Sulopora or *Hederella*
	Streptorhynchus ?
	Productus sp. 1

	Productus sp. 2
T137a	*Rhipidomella* sp.
	Schizophoria striatula Schlotheim
	Productus semireticulatus
	Atrypa desquamata Sowerby
T142	*Spirifer* (*Plectospirifer*) cf. *takwanensis* (Kayser)
	Gastropod
	Goniatite?
T144	*Orbiculoidea* ?
	Schizophoria sp.
	Leptostropha macarthyi Grabau
	Atrypa sp.
	Spirifer sp.
T146	*Schizophoria* sp.
T149	*Spirifer* cf. *multistriatus* Grabau
T154	*Spirifer multistriatus* Grabau
	Atrypa sp. nov.
T162	Soft shales
	Edmonia sp.
	Orbiculoidea (*Roemerella*) sp.
	Calcareous beds
	Schizophoria sp. nov. 3
	Atrypa aspera Schlotheim
	Athyris or *Meristella*
T164	*Schizophoria striatula* Schlotheim
	S. sp. nov. 1
	Atrypa aspera Schlotheim
	A. aspera var. nov.
	Emanuella takwanensis (Kayser)

	Athyris vittata var. nov.
	Spirifer (Plectospirifer) fongi Grabau or sp. nov.
T169	*Composita subtilita* Hall var. nov.
	Orthoceras, large, annulated species
T170a	Crinoid stems
	Caninia or *Bothrophyllum*
	Favosites cf. *digitatus*
	Atrypa desquamata var. *auriculata* Hayasaka
	Reticularia sp. nov.
T170b	*Favosites* sp.
	Actinostroma asiatica Grabau
	Productella productoides Grabau
	Atrypa desquamata Sowerby
	A. desquamata var. *auriculata* Hayasaka
	Plectospirifer takwanensis (Kayser)
	Reticularia sp. nov. 1
	Stringocephalus burtini Defrance
	Lophospirina angustipegmatis Grabau
	Hormotomina sp. nov.
T170c	*Reticularia* sp. nov. 1
	Modiomorpha sp.
T170d	*Favosites* sp. 1
	F. sp. 2
	Atrypa desquamata Sowerby
	Plectospirifer cf. *heimi* Grabau
T171a	*Productella productoides* Grabau
T171b	*Pachypora* sp.
	Spirifer sp. indet.
	Uncites sp.
	Stringocephalus sp. nov. 1
	S. obesus Grabau

T171c	*Athyris* sp. nov. 1
T171d	*Favosites* or *Pachypora*
	Conocardium sp. nov.
	Stringocephalus sp. nov. 2
T171e	*Athyris* cf *concentrica*? Buch
	Cryptorella ? sp.
T171g	Crinoid stem
	Emanuella ? sp.
	Meristella ? sp.
T171h	*Spirifer* sp. nov. 1
	Meristella ? sp.
T171i	*Chonetes orientalis* Loczy
	Reticularia cf. *maureri* ? Holzaphel
T174	*Reticularia pachyrhynchoides*
T175	*Atrypa* sp. nov.
	Loxonema robusta Grabau
T175a	*Atrypa* sp. (fine plication)
	A. sp. nov.
	Loxonema robusta Gr.
T176	*Syringopora* sp.
	Phacellophyllum irregulare Grabau
	Fasciphyllum breviseptatum Frech
	Aulopora sp.
	Atrypa sp. nov.
	A. aspera var. nov.
	Spirifer multistriatus Grabau
	Sp. sinensis (mut) Grabau
	Reticularia cf. *maureri* Holz.
T177	*Centrophyllum* sp.

	Eridophyllum sp. 1
	E. sp. 2
	Syringopora ? or *Depasophyllum*
	Campophyllum sp.
	Cyathophyllum ? sp. 1
	Michelinia sp.
	Stromatopora sp.
T177a	*Schizophoria macfarlani* var.
	Gypidula sp. nov. 1
	G. sp. nov. 2
	Atrypa aspera var. nov.
	A. aspera mut. nov.
	A. sp. 1
	A. sp. 2
	A. sp. 3
	Spirifer yunnanensis Mansuy
	Spirifer sinensis mut. ?
	Cryptonella cf. *whidborni*
	Bellerophon cf. *striatus*
T178	*Stromatopora*
T179	*Stromatopora*
T180	*Orthoceras*
T181	*Schellwienella crenistria*
	S. sp. nov.
	Spirifer cf. *bisulcatus*
	Sp. sp. nov. 2
	Sp. sp. nov. 3
	Aviculopecten sp.

T182	*Euomphalus* sp. 1
	Worthenia sp. 1
	W. sp. 2
T183	*Goniatites* sp. 1
	G. sp.
	G. sp.
T184	*Schizophoria* sp. nov. 2
	S. sp.
	Productus sp. nov. 1
	Pr. hemisphaericus Sow.
	Pr. longispinus
	Marginifera sp. nov. 1
	M. sp. nov. 2
	Spirifer sp. nov. 2
	Sp. bisulcatus
	Sp. sp. nov. 3
	Reticularia sp. nov. 2
	R. sp.
	Martiniopsis sp. nov.
	Camarotoechia cf. *trilatera* de Kon.
	C. praepleurodon
	Athyris sp. nov. 2
	A. squamigera de Kon.
	Rhynchopora sp. nov.
	Pelecypods
	Bellerophon sp.
	Euomphalus ? sp.
T185	*Spirorbis* sp.

	Crinoid stems
	Productus semireticulatus
	Pr. cf. *costatus*
	Pr. sp.
	Spirifer sp. nov. 3
	Sp. bisulcatus
	Sp. (*Brachythyris*) *pinguis* var. *rotunda* Sowerby
T187	*Pterinopecten* sp.
	Rhipidomella michelini var. nov.
	Schizophoria sp. 1
	S. sp. 2
	Leptaena analoga Phillips
	Productus sp. nov. 3
	Pr. longispinus
	Pr. sp.
	Pr. cf. *semireticulatus*
	Marginifera sp. nov. 3
	Spirifer sp. nov. 3
	Sp. trigonalis Martin
	Athyris (*Cleiothyridina*) *squamidula* De Kon.
	A. royssi L'Eville
T190	*Composita subtilita* var. nov.
	C. orgentia
T191a	*Daviesiella* sp. nov. 1
	Productus giganteus
T193	*Cryptospirifer* sp. nov. 1
	Lochengia or *Brachythyris ufensis?*
T194	*Productus semireticulatus*
	Pr. sp.
	Phanerotinus sp. nov.

	Meekospira sp. nov.
	Bellerophon sp.
	Gastropods
T196	*Daviesiella llangelliensis* Davidson
	Productus (*Kansuella*) cf. *maximus*
T196a	*Daviesiella comoides* (Davidson)
	D. llangelliensis (Davidson)
	D. cf. *llangelliensis* (Davidson)
T197	*Daviesiella comoides* (Davidson)
	Athyris ingens var. *kansuensis* Grabau
T198	*Daviesiella comoides* (Davidson)
	Orthotetes sp.
T199	*Daviesiella* cf. *llangelliensis* (Davidson)
	D. cf. *comoides* or sp. nov.
	D. sp. nov.
	Productus sp. nov. 4
	Pr. giganteus
T225	*Pagodicrinus* sp. 2
	Leptaena Analoga var. nov.
	Chonetes latesinuata var. nov.
	Chonetes sp. 2
	Spirifer sp. nov. 4
	Reticularia ?
T238	*Camarotoechia* or *Leiorhynchus*
	Reticularia ? crushed
	Athyris
	Pelecypods 2
	Pterinea sp.
	Styliolina

	Tentaculites
	Phacops (pygidium)
T238a	Crushed pelecypods
T238b	*Meristella* ? crushed
	Stringocephalus burtini Defrance
	Lepidodendroid ?
T239	*Tentaculites* sp.
T241	*Productus* sp.
T248	*Tetrapora* or *Syringopora*
	Reticularia ? sp.
T249	*Tetrapora* or *Syringopora*
T249a	*Syringopora* or *Tetrapora*
T274	*Schellwienella crenistria* mut. nov.
	Chonetes hardrensis mut. nov.
	C. sp. nov. 1
	C. sp. nov. 2
	Productus sp. nov. 1
	Pr. Yunnanensis Loczy
	Pr. nystianus De Koninck
	Pr. cf. *striatus* Fischer
	Pr. semireticulatus Martin
	Echinoconchus sp. nov. 1
	E. sp. nov. 2
	Marginifera viseniana Chao
	Spirifer sp. nov. 5
	Spirifer sp. nov. 3
	Reticularia mesoloba var. nov.
	R. ambocoelia
	Ambocoelia sp. nov. 1

	Martiniopsis sp. nov.
	Martinia sp. 2
	Spiriferina sp. nov.
	Squamularia sp. nov.
	Syringothyris distans Sowerby
	Athyris sp. nov. 3
	Streptorhynchus
T277	*Schellwienella*
	S. sp.
	Composita sp.
	Dielasma ficum M'Coy
	Gastropods
T278b	Coral (compound)
	Athyris
	Loxonema sp.
T278c	*Fasciphyllum* sp.
	Atrypa aspera Schlotheim
	Spirifer yunnanensis Loczy
	Sp. sinensis Grabau
T279	*Dielasma* sp.
	Cyrtoceraconic cephalopod
T280	*Orbiculoidea* cf. *notida* Phillips
	Schellwienella crenistria mut. nov.
	Schuchertella sp. nov. 2
	S. sp. nov. 3
	Reticularia imbricata mut. nov.
	Composita globularis Phillips
	C. subtilita var. nov.
	C. argentia

T280a	*Composita globularis* Phillips
	C. subtilita
	C. argentia
T282	*Productus* sp. nov. 5
T283	*Echinoconchus elegans* M'Coy var. nov.
T296	*Productus* sp. nov. 2
	Cryptospirifer sp. nov. 3
	Productus inflatus Tschern.
	Spirifer (Brachythyris) ufensis Tschern.
T296a	*Productus yunnanensis* Loczy
	Athyris (Cleiothyridina) sp. nov. 3
	Worthenia sp. nov.
T296c	*Daviesiella* cf. *llangelliensis* Davidson
T297	*Schellwienella* sp. nov.
	Chonetes papillionacea Phillips var. nov.
	C. ,, ,, mut. nov.
	Productus maximus
	Pr. edelburgensis Phillips
	Pr. corrugatus M'Coy
	Pr. cf. *giganteus*
	Echinoconchus elegans M'Coy
	Martinia sp. nov.
	Martinia sp. 1
	Reticularia sp.
	Squamularia sp.
	Ambocoelia sp. nov. 2
	Athyris (Cleiothyridina) sp. nov. 3
T298	*Daviesiella comoides* (Davidson)
	D. sp. nov. 2

	D. sp. nov. 3
	Productus maximus
	Productus giganteus mut. nov.
	Athyris (*Cleiothyridina*) sp. nov. 4
	Solenopora sp.
	Worthenia sp. nov.
T298a	*Productus* sp. nov. 4
	Productus giganteus
T298b	Gastropod
T302	*Hapsiphyllum* sp.
	Lithostrotion sp.
	Productus giganteus?
	Martinia or *Martiniopsis* sp.
	Loxonema sp.
	Euomphalus sp.

C. *Devonian Fossils*

Identified by Y. S. Chi

T135a	*Phacellophyllum* caespitosum* Goldfuss var. *breviseptata* Frech
	Stromatoporella γ
T141	*Grypophyllum** isactis Frech
T143	*Columniphyllum** sp. nov.
T145	*Columniphyllum* sp. nov.
	Amphipora (α)
T147	*Stromatopora* α
T148	*Columniphyllum darwini* Frech
	Stromatopora α
T151	*Amplexus* sp. (cf. *hercinicus* Roemer)

* Those marked with * were formerly considered as *Cyathophyllum*.

	Columniphyllum douvillei Frech var. nov.
T153	*Diphyphyllum* sp. nov.
T155	cf. *Amphipora* (α)
T156	*Phacellophyllum* sp. nov.
	Grypophyllum cf. *isactis* Frech
	Stromatoporella α
	Clathrodictyn α
T157	*Phacellophyllum caespitosum* Goldfuss
	Ceratophyllum ceratites Goldfuss
T157a	*Phacellophyllum* sp. nov.
T158b	*Grypophyllum* cf. *schwelmense* Wdkd.
T159	*Phacellophyllum* sp. nov (=T157a)
	Grypophyllum sp. (cf. T158b)
	Phacellophyllum caespitosum Goldfuss
	Ceratophyllum lindströmi Frech (var. nov.)
T160	*Phacellophyllum* sp. nov.
T163	*Cyathophyllum* (s.s.) *vermiculare* Goldfuss
T164	*Grypophyllum* sp.
	Alveolites (*Coenites*) *reticulatus* Stein
	A. (*Coenites*) *reticulatus* Stein or sp. nov.
	A. suborbicularis Lamarck
T165	*Actinophyllum** gen. et sp. nov.
T166	*Amphipora* β
	Stromatopora α
	Alveoites subequalis E. et H.
T170a	*Chaetetes* (?)
	Stringophyllum normale Wdkd.
	*Pterophyllum** *heterophyllum* mut. *torguatum*
T170b	*Grypophyllum* cf. *normale* Wdkd.

	Alveolites (*coenites*) sp.
	Stromatopora concentrica
T170d	*Grypophyllum* sp. nov.
	Halia sp. nov.
	Calamopora goldfussi E. et H.
	Alveolites (*coenites*) sp.
T171b	*Stromatoporella* sp.
	Cyathopaedium (*Calophyllum*) sp.
T171d	*Columniphyllum douvillei* Frech
	*Calamopora*** sp.
	Alveolites [or *Caenites*] sp. nov.
T171g	*Amplexus* sp. (cf. *hercinicus* Roemer)
T171h	*Phacellophyllum caespitosum* Goldfuss (var. nov.)
	P. ,, ,, ,, var. *breviseptatum* Frech
	Calamopora reticularis de Blaim
	Pachypora sp.
	Chaetetes (*Heterotrypa*) *crinalis* Schlut. sp. nov.
T172	*Stromatopora* (s. s.) sp. nov.
T173	*Amphipora* sp. indet.
T175	*Amphipora* sp.
T175a	*Campophyllum* sp.
T176	*Phacellophyllum* sp. nov.
	P. caespitosum var. nov.
	Campophyllum sp.
	Ceratophyllum ceratites (?)
	Thamnophyllum sp.
	Coenites (*Alveolites*)
	Syringopora sp.
T177	*Ceratophyllum* sp. nov.

**Those marked with ** were formerly considered as *Favosites*.

	C. sp.
	Streptophyllum (nom. nov.) sp. (?)
	Campophyllum (*Apolothophyllum*)
	Phacellophyllum sp.
	P. caespitosum or sp. nov.
	Pexiphyllum (?) sp.
	Syringopora sp. β
	Stromatoporella sp.
	Stromatopora sp.
T178	*Stromatoporella* sp.
T179	*Syringopora* sp. γ
	Amphipora sp.
T181	*Phacellophyllum* sp.
	Amphipora sp.
T278a	*Campophyllum* (?)
	Syringopora sp.
	Amphipora sp.
T278c	*Stromatopora* sp. indet.
TW31	*Campophyllum* (?)
	Diptophyllum sp.
	Parallelopora sp.
TW32	*Plagiopora* sp.
TW36	*Pachypora*** cf. *reticulata* (Reed)
TW39	*Amphipora* sp. indet.

D. Devonian Corals

Identified by Y. C. Sun

T135	*Campophyllum* sp. nov. B
T141	*Pexiphyllum* sp. nov.
T156	*Amphipora asiatica*
T156	*Grypophyllum* sp. nov.

T157	*Pexiphyllum* sp. nov.
T158	*Thamnophyllum*
T158b	*Thamnophyllum* sp. nov.
T160	*Cyathophyllum minus*
T163	*Glossophyllum* sp. nov.
T165	*Thamnophyllum* sp. nov.
T166	*Amphipora* sp. nov.
T170a	*Ptenophyllum* sp. nov.
T173	*Amphipora asiatica*
	Cyathophyllum caespitosum
T176	*Cyathophyllum* (*Thamnophyllum*) sp.
T176	*Cyathophyllum basaltiforme*
T179	*Amphipora asiatica*
	Syringopora sp. nov.
	Campophyllum
T181	*Amphipora* sp. nov.
T189	*Campophyllum*
TW31	*Cyathophyllum* (*Thamnophyllum*) sp. nov. B
	Cyathophyllum (*Thamnophyllum*) sp. nov. C
	Thamnophyllum sp.
TW39	*Amphipora asiatica*
1428	*Neostringophyllum*
	Amphipora asiatica
	Cyathophyllum douvillei
1429	*Amplexus* sp.
	Spongophyllum
	Pachypora
1430	*Pachypora* sp. nov.

E. Supposed Weiningian Fossils

Identified by A. W. Grabau

T 96	*Athyris* sp. nov. 1
	A. sp. nov. 2
	Dielasma cf. *elongatum* Schloth.
	Striatifera sp.
T203	*Orthotychia derbyi* Waagen
	Spirigerella derbyi Waagen
	Martiniopsis inflata Waagen
	Terebratuloidea minor Waagan mut. Grabau
	T. heteroplicata Grabau
	Aulacothyris trochilus Eichwald
	Dielasma elongatum Schoth.
	Athyris planosulcata Phill. var. *uralica* Grabau
	Spirifer cf. *rectangulus* Kutorga
T204	*Productus* sp.
T204a	*Daviesiella* sp. nov.
	Athyris sp. nov. 2
T205	*Martiniopsis inflata* Waagen
	Athyris girardi Diener
T229a	*Marginifera morrisi* Chao
	Spirifer subnikitini Grabau
	Productus gratiosus var. *occidentalis* Schellwien
	Productus gratiosus Waagen
	Athyris sp. nov. 3
	Chonetes chaoi Grabau
	Squamularia asiatica Chao
	Chonetes hardrensis var. *nantanensis* Grabau

T243	*Productus manchuricus* Chao
	Pr. gratiosus var. *occidentalis* Schellwien
	Beecheria sublaevis (Waagen)
	Squamularia asiatica Chao
T251	*Productus* cf. *striatus*
T271	*Striatifera* sp. nov. 1
	Striatifera sp. nov. 2
	Linoproductus tenuistriatus Vern.
	Choristites wangchuchueni Chao
T271b	*Choristites wangchuchueni* Chao
T272	*Spirifer* (*Brachythyris*) *simensis* Tsch. var. nov.
	Martiniopsis sp. nov.
T283	*Daviesiella* sp. nov.
T288	*Athyris* (*Cleiothyridina*) sp. nov. 1
	Martiniopsis sp. nov.
	Squamularia asiatica Chao
	Athyris cf. sp. nov. 2
	Productus sp. nov.
	Striatifera compressa var. nov.
	Striatifera striata var. nov.
TW40	*Squamularia asiatica* Chao
	Enteletes sp. nov.
	Productus sp. nov.
TW52a	*Productus* (*Kansuella* ?) sp. nov.
	Daviesiella sp. nov.
	Martiniopsis sp. nov.
TW53a	*Daviesiella* sp.
	Camarophoria cf. *mutabilis* Tschern.
	Productus manchuricus var. nov.

F. Additional Permian Corals

Identified by T. K. Huang

T 41	Probably young stage of *Lophophyllum kayseri*
T 78	*Michelinia* cf. *siyangensis* Reed
	Caninia liangshanensis Huang
T 86	*Caninia* cf. *liangshanensis* Huang
T 86a	*Michelinia* sp. nov.
T 88	*Michelinia* sp. nov.
T103i	*Michelinia placenta* W. and W.
	Michelinia sp.
	? *Monilopora* sp. nov.
T103j	*Michelinia* sp.
T104	*Lophophyllum kayseri* Huang
	Michelinia placenta W. and W.
T105	*Caninia liangshanensis* Huang
	Michelinia favositoides Girty
	Michelinia siyangensis Reed
	Monilopora sp. nov.
T123	*Monilopora dendroidea* Yoh
T226	*Lophophyllum* sp. nov.
	Dibunophyllum sp.
T227	*Michelinia* sp. nov.
	Verbeekiella sp.
T230	*Caninia* sp.
T236	? *Cyathophyllum* sp.
T241	*Amygdalophyllum nantanense* Huang
	Caninia kungchishanensis Huang
	Pachypora sp. nov.
	Cyathophyllum cystitabulatum Huang

	Lithostrotionella sp. nov.	
	Caninia sp. (the same as found in T230)	
T243	*Lithostrotionella* sp. nov.	
	Campophyllum sp.	
	Pachypora sp.	
T260	*Amygdalophyllum* (probably young stage of *A. nantanense*)	
T265	*Verbeekiella* sp.	
T286a	*Geinitzella* sp. nov.	
T286b	Indeterminable (supposed to be *Allotropiophyllum sinense* Grabau)	
T316	*Amplexus* sp.	
TW24	*Michelinia favositoides* Girty	
TW25	*Monilopora dendroidea* Yoh	
	Michelinia abnormis ? Huang	

G. *Fusulines*

Identified by J. S. Lee and H. Chen

TW23	*Staffella* sp. nov.
	Staffella inflata (Colani)
	Verbeekina sphara Ozawa
T 12c	*Schellwienia douvillei* (Colani)
	Neoschwagerina craticulifera Schwager
T 38	*Schellwienia* sp. nov.
	Schellw. verneuilli Schellw.
T 41	*Schellw. optima* sp. nov.
T 63	*Schellw. exilis* (Deprat non Schwager)
	Schellw. douvillei Colani
	Schellw. ambigua Deprat
T 64	*Verbeekina verbeeki* Geinitz
	V. pseudoverbeeki Deprat
	Neoschwagerina craticulifera var. *rotunda* (var. Deprat) (=*Cancellina primigena* Hayden)

	N. *margaritae* Deprat
	Sumatrina annae Volz
	S. multiseptata Deprat
T 88	Cannot be determined.
T101	*Neoschwagerina craticulifera* Schwager
	Sumatrina annae Volz
	Sumatrina multiseptata Deprat
	Verbeckina pseudo-verbeeki Deprat
	Verkeekina verbeeki Geinitz
T103g	*Verbeekina verbeeki* Deprat
	Neoschwagerina multicircumvoluta Deprat
	Neoschwagerina craticulifera Schwager
	Sumatrina sp.
	Schellwienia douvillei? Colani
	Fusulinella inflata? Colani
T211	*Schellwienia granum avenae*? Roemer—Upper Permian
	Fusulinella inflata Colani—Permian
	Neofusulinella giraudi Deprat—Permian
T212	*Schellwienia japonica* Gümbel
T212a	*Schellwienia japonica* Gümbel var.
	Schellwienia japonica var. *truncata* Ozawa—Permian
	Schellwienia ambigua Deprat—Upper Permian
	S. sp. nov. [now *Triticites delicatus*]
	Doliolina lepida Schwager—Middle Permian
T213	Not determined.
T216	*Schellwienia japonica* Gümbel—Permian
T217	*Schellwienia japonica* Gümbel—Permian
T218	*Neofusulinella giraudi* Deprat—Upper Permian
T219	*Schellwienia japonica* Gümbel var.
	Doliolina sp.

	Fusulinella inflata Colani var.—Permian
T220	*Schellwienia japonica*
	Schellw. ambigua Deprat
	Schellw. complicata Schellwien
	Schellw. japonica var. *truncata* Ozawa
	Schellw. solida (Colani)
	Schellw. sp. nov.
	Schellw. sp. nov.
T226	*Neofusulinella bocki?* Möller.
T229a	*Fusulinella (Staffella) angulata* Colani—Moscovian.
	Staffella sphaeroidea Möller—Moscovian.
	Fusulinella (Staffella) Struvii Möller.
T231	*Verbeekina douvillei* Colani
	Verbeekina verbeeki Deprat
	Verbeekina sp. nov.
T234	*Schellwienia japonica* Gümbel
T236	*Fusulinella (Neofusulinella) compressa* Ozawa—Permian
	Endothyra bowmani Phillips.
	Tetrataxis sp.
T241	*Schellwienia longissima* Möller—Uralian
	Schellwienia simplex Schellwien—Uralian.
	Cribrostomum sp.
T243	*Schellwienia omiensis* Ozaka—Upper Permian
T246	*Verbeekina* sp.
	Verbeekina pseudoverbeeki Deprat—Permian
T247	No good.
T247b	Not determined.
T252	*Schwagerina* sp.
T254	Not determined.

T255 *Fusulinella inflata* Colani—Permian

T267 *Staffella sphaerica* Abich

Staffella sp. nov.

T269 *Staffella inflata* (Colani)

T270 *Schwagerina* sp. nov.

Schellw. confusa sp. nov.

Schellw. minima Schellw.

Schellw. compacta sp. nov.

T271 *Schellwienia pusilla* Schellwien—Uralian

Schellwienia sp.

Schwagerina princeps var. *magnae-sphaerae* Colani—Upper Carboniferous.

T283 *Neofusulinella giraudi* Deprat—Upper Permian.

Tetrataxis sp.

T284 *Verbeekina verbeeki* Geinitz—Permian.

T285a *Schellwienia longissima* Möller—Upper Carboniferous—Permian?

Schwagerina princeps var. *magnae-sphaerae* Colani—Upper Carboniferous.

T286a *Schellwienia* sp.

T303 No good.

T304 *Fusulinella* sp.

T307 *Fusulina pseudo-prisca* Colani—Uralian—Permian

T308 *Schellwienia* sp.

T311 No good

T316 Nothing

T331 *Mizzia velebitana* Schubert

1325 *Schellwienia douvillei* Colani

Doliolina lepida Schwager

Neofusulinella giraudi Deprat

1359a *Fusulinella inflata* Colani.

J. S. Lee's letter to V. K. Ting

April 13, 1931.

My dear Ting,

Sorry to have delayed your material. I have looked the slides through in haste, and named the determinable sections in the accompanying table. New species are comparatively few. And few of the common species in my sections are represented. This is rather disappointing.

Your fauna looks as a whole rather high in the Permian. I do not see any trace of the Moscovian fauna. Uralian probably absent. TW23, T267 and T269 belong to the same horizon, the only horizon well developed in the Nanking Hills. T270 represents the lowest type of forms among the lot, probably lowest Permian. Judging from the faunal character, T38 is probably the next higher zone. T64 and T101 are probably equivalent.

I got rather run down, and am thinking to have a rest in Kuling for a month or two. Will leave here on the 22nd or 23rd. Please give me the succession of your zones by express letter.

Yours,

J. S. Lee

V. CLASSIFICATION OF GEOLOGICAL FORMATIONS OF KUEICHOU ACCORDING TO DR. V. K. TING

Cambrian.

Loushankuan limestone = Ichang limestone of the Gorge District of the Yangtze. Named after Loushankuan, famous pass north of Tsunyi.

Ordovician.

Yangtienwo shale (probably including the Meitan shale). Named after a small place north of Sungkan near the Szechuan-Kueichou border. It is the equivalent of the Neichia shale.

Matishih limestone = *Orthoceras* limestone. So named in allusion to the curious markings on bedding planes of the limestone which resemble horseshoe or "Mati".

Silurian.

Chiutienya shale. Named after a small place near the Szechuan-Kueichou border. This is the lower part of the Silurian sequence and is mainly graptolite-bearing. It is the equivalent of the "Lungma Shale" of the Gorge District.

Shihniulan limestone. Also named after a small locality near the Szechuan-Kueichou border. It is the middle part of the Silurian sequence and is practically equivalent to the Lojoping series of the Gorge District.

Hanchiatien shale. Named in like manner. It is the upper part of the Silurian sequence and is probably not eqinvalent to the Shamao formation of the Gorge District.

*Devonian.**

Tushan group (Givetian of Europe), well-developed in the Tushan district.

(1) *Pangchai sandstone*[1] with *Leptostrophia*

(2) *Chipao limestone*[2] (horizon of *Stringocephalus obesus*)

(3) *Sungchiachiao sandstone*[3]

(4) *Chiwochai limestone*[4] (horizon of *Stringocephalus burtini*)

Maochai group. This is Upper Devonian and is well-developed in the Maochai area in Tushan district.

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*The Lower Devonian as well as the Lower Middle Devonian (*Calceola sandalina horizon*) seems wanting in Kueichou.

1 邦寨砂岩 2 鷄泡石灰岩 3 宋家橋砂岩 4 鷄窩寨石灰岩
All these names are place names in the Tushan district.

(1) *Wangchengpo formation*[1] with *Spirifer sinensis*. Named after a small place of that name near Tushan.

(2) *Yaoso limestone*[2]. Named in like manner.

Fengninian or Lower Carboniferous.

Aikuan group (Tournaisian). Named after a small place south of Tushan.

(1) *Kolaoho series*[3] (*Cystophrentis* zone). Named after a small place south of Tushan.

(2) *Tangpakou series*[4] (*Pseudouralinia* zone). Named in like manner.

Tatang group (Viséan). Named after Tatanghsien in Kueichou.

(3) *Chiussu series*[5] (*Thysanophyllum* zone). Named after a village in the Tatang district.

(4) *Shangssu series*[6] (*Yuanophyllum* zone). Named after a village south of Tushan.

Middle and Upper Carboniferous (Lower Permian).

Laokanchai limestone. This is equivalent to Ting's Weiningian which however might include the Uralian.

Maping limestone. This was considered by Ting in the field as Upper Permian. Such an opinion was held by him until the year 1933 when he and Grabau finally consented with Huang in shifting the Maping limestone to the Uralian.

Permian.

Kuanyinai limestone[7] = Yangsin limestone. Named after a small place north of Sungkan near the Szechuan-Kueichou border.

Wantze coal series = Luipakou coal series. Named after Wantze in the Tungtzu district.

Gastrioceras shale or limestone. This occurs between the Permian coal series and typical Triassic limestone and is usually met with in southern Kueichou. Since it often contains ammonoid shells (which are indeterminable) Dr. Ting named it *Gastrioceras* shale, thinking

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1 望城坡層 2 堯梭石灰岩 3 猓狫河系 4 湯耙溝系 5 舊司系 6 上司系 7 觀音崖石灰岩

that it might be the equivalent of the *Gastrioceras zitteli* horizon of of Hupeh (Paoan shale). As we understand it now, this formation is most probably equivalent to the Talung series of Kuangsi, belonging to uppermost Permian. Thus the term *Gastrioceras* shale is a misnomer.

Triassic.

Yulungshan limestone. Named after Yulungshan, a picturesque hill near the city of Tating.

Santaoho shale. Named after Santaoho, a small place on the Szechuan-Kueichou border. It is the partial equivalent of the Feisienkuan series of Szechuan.

Maotsaopu limestone. Named after a small place north of the city of Tsunyi.

Sungtzekan shale. Named in like manner. This and the Maotsaopu limestone form the Chialingchiang limestone of Szechuan.

Sanchiao limestone. This is the limestone occurring immediately below the Rhaetic *Lepidopteris* sandstone at Sanchiao near Kueiyang. Ting considered it as Upper Permian but all available stratigraphical as well as paleontological data point to its Upper Triassic age.

Chiupantze sandstone. Named after the Chiupantze pass on the Szechuan-Kueichou border. It is the equivalent of the Hsiangchi series but without workable coal seams.

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VII. EXPLANATION OF SECTIONS

(See Pls. 39:KSA1, 40:KSA2, 41:KSA3)

(*For the explanation of symbols of geological formations please see geological map.*)

39:KSA1, Fig. 1. Section from Chuipantzu, Szechuan to Sungkan, Kueichou.

Fig. 2. Section near Liangfengya south of Sungkan, Kueichou; direction of section about N 65° W.

Fig. 3. Section from Sinchan to Papapu, Tungtzuhsien, Kueichou.

Fig. 4. Section of Panshan, near Tungtzu. Pl_1, Pl_2, Pl_3; different members of the Lopingian; Ty, Yulungshan limestone.

Fig. 5. Section from Tungkungssu to Tsunyi. (a), alternating beds of grey platy limestone and yellow, brown and grey thin shales [=Tsu], b, brown grey hard limestone [=Tm], c, purple and greenish shales intercalating with some greenish grey thin beds of limestone [=Ts], d, greyish blue limestone, partly oolitic [=Ty], e, yellowish brown and ferruginous soft sandstone, yellow and grey fragile shales, silicified blackish limestone and coal seams [=Pl], f, massive bluish grey limestone with a certain amount of black chert [=Py], g, yellow brown shale [this is Silurian according to later observers.], h, greyish compact limestone with characteristic markings locally known by the name of *Matishih* or "horse-shoe stone", which is widespread in Kueichou and contains beautiful specimens of *Orthoceras* [=Oo], i, Buff sandy hard and yellow soft shales with a seam of greyish crystalline limestone [=On].

Fig. 6. Section from Pailakan to Meitzuao, Jenhuai, Kueichou.

Fig. 7. Section from Lupanchang, Jenhuaihsien to Takusinchang (now Chinshahsien).

Fig. 8. Section from Takusinchang to Chiensi.

Fig. 9. Section south of Yaochiho, from Shuichinwan to Mahuangching, showing Lower Permian limestone (Py) and *Lyttonia* coal series (Plc.) thrusted upon Triassic shale

(Tsu); the thinning out of the Santaoho purple shale (Ts) from the left side towards the right side of the section is also indicated.

Fig. 10. Section across the coal-field south of Kueiyang from Taopaifang westwards.

Fig. 11. Section from the Agriculture School S. of Kueiyang to Lungtengpu. a—greyish green and brown platy limestone and shale (=T), b—black and grey limestone intercalated with greyish brown and black coaly shales [probably Carboniferous as understood now], c—massive whitish grey limestone with more or less chert (=Py), d—sandy yellowish brown and blackish shales containing thin coal seams, e—black thin-bedded silicified [siliceous ?] limestone (d-e=Plc.) f—yellowish green shales (=Plt).

Fig. 12. Section from Paomuchung to Lunglihsien. 1—greyish thinbedded limestone, 2—fossiliferous thinbedded limestone with small cavities filled with dark brown petroleum, 3—grey limestone, 4—greyish platy limestone, 5—yellowish green shales intercalated with thin slaby limestone, 6—black thin-bedded silicified limestone, 7—sandy shales and soft sandstone, 8—massive bluish and whitish grey limestone with certain amount of black chert, 9—black shaly limestone intercalating with black thin shales, 10—quartzitic sandstone and shales occasionally intercalating with some thin limestone. 1—5, "Permo-Triassic", 6-7, Lopingian; 8-9 Yangsinian; 10, Lower Carboniferous.

Fig. 13. Section at Changtso, S.W. of Kueiyang showing succession of coal series. a—cherty thinbedded limestone, b—coal seam 0.4-0.6 m (Tienpi), c—sandy shale with thin limestone, d—coal seam 0.9 m (Tachia), e—yellow and grey fragile shale, f—coal seam 0.3 m (Timei), g—sandstone and shale.

Fig. 14. Section at Tangfangchieh, near Paichin. a—Lower Carboniferous, b—Middle Carboniferous to Lower Permian.

Fig. 15. Section from Kueiting to Machiatun.

Fig. 16. Section from W. of Yangchang to Hsiamajo, showing succession of Lower Carboniferous. a—dark grey shaly limestone, b—sandstone and variegated shales with fragments of plant remains, c—grey shaly limestone, d—sandstone, e—dark grey thinbedded limestone, f—quartzitic sandstone and sandy shale.

40:KSA2, Fig. 17. Section from Chinchenghsia to Mengkuan, south of Kueiyang.

Fig. 18. Section from Wengchengchiao to Kueitinghsien.

Fig. 19. Section at Wengchengchiao showing detailed succession of fossiliferous Permian (compare Fig. 18):—

Rock character	*fossil coll.*	*thickness*
1. Yellowish grey shales, sandstone and sandy shales		
2. Greyish black thin-bedded cherty limestone	T103a	
3. Thin-bedded cherty limestone with some thin shale	T103b	
4. Somewhat massive cherty limestone	T103c	
5. Thin-bedded shaly limestone with fossil	T103d	
6. Covered		
7. Massive blackish grey limestone with calcite veins	T103e	40 m
8. Massive grey limestone with crinoid stems 9. Blackish grey limestone with calcite veins	T103f	30 m
10. Reddish yellow limestone		
11. Greyish black shaly limestone		80 m

12.	Massive grey limestone	T103g	30 m
13.	Compact grey limestone with a small amount of black chert	T103h	30 m
14.	Reddish brown and grey limestone	T103i	30 m
15.	Massive bluish black limestone with some white calcite		
16.	Light grey limestone free from chert		10 m
17.	Grey massive limestone	T103j	12 m
18.	Brownish grey limestone with a small amount of chert		24 m
19.	Whitish compact limestone		30 m
20.	Blackish limestone intercalating some thin black shales		10 m
21.	Massive black limestone	T103k	24 m
22.	Whitish grey limestone		10 m
23.	Blackish shaly limestone	T103l	10 m
24.	Brownish grey limestone with some chert.	T103m	40 m

Fig. 20. Section from Lopushih to Chingtaokuan, Kueitinghsien.

Fig. 21. Section of Mangshan W. of Tuyunhsien.

1.	Thin-bedded shaly and flinty limestone, shale and sandstone.	
2.	Massive and flinty coralline limestone	180 m
3.	Light grey quartzitic sandstone with traces of plants	200 m
4.	Whitish and pinkish, partly siliceous, crystalline limestone	85 m
5.	Reddish and pinkish quartzite	370 m
6.	Brown sandy shale and soft sandstone	
7.	Thin coal seams (10 cm) and black shale (2 m)	
8.	Hard quartzite	

9. Dark grey shaly limestone with ostracods ... }
10. Light grey limestone .... } 170 m
11. Grey platy and sandy limestone .... }
12. Whitish and reddish hard quartzite .... 400 m
13. Grey crinoidal limestone
14. Covered
15. Grey highly siliceous and semi-crystalline limestone

Fig. 22. Section east of Tuyunhsien, showing folding in Lopingian.

Fig. 23. Section from Kaochi to Mulaopu, Tuyunhsien.

Fig. 24. Section from Mapo to Panpienchieh between Tuyun and Pachai, showing succession of Cambrian rocks.

Fig. 25. Section from near Panpeinchieh to Pachaihsien.

Fig. 26. Section of Lower Carboniferous and Permian, W. of Lianglukou N. of Tushanhsien.

a. Gray and green shales and thin-bedded limestone, b. Yellow sandstone, shale and black thin-bedded cherty limestone, c. Massive grey limestone with black shaly limestone and some black shales at base, d. Yellow brown sandy shale and quartzitic sandstone, e. White crystalline *fusulina* limestone, f. Quartzitic sandstone and sandy shale, g. Greyish blue thin-bedded limestone, h. Unfossiliferous and impure limestone interbedded with shales.

Fig. 27. Section showing succession of Devonian strata at Chiwochai, NE of Tushan city.

Fig. 28. Section from Chiussu to Lingtang, east of Tatanghsien.

Fig. 29. Section from Chiussu to Tatang showing succession of Lower Carboniferous strata.

Fig. 30. Section near Touti north of Tatang.

Fig. 31. Section at Tuchiao north of Tingfanhsien showing structure in Permian strata.

Fig. 32. Section from near Paichin to Tingfanhsien.

Fig. 33-35. Section from west of Pingchou through Yachou to Ling (compare Fig. 28). The three sections should be arranged in the order AB-BC-CD.

Fig. 36-37. Section from Pamaochung through Pingchou to Motaoshih (to be continued with Fig. 35).

Fig. 38. Section from Maochai, west of Tushan to Pamaochung showing detailed succession of Carboniferous-Permian strata.

(1) Black shaly limestone with black shale, containing fossils (T170 a-d) [this is not shown in section], (2) Unfossiliferous impure limestone and shale. (3) Black thin-bedded limestone and shales with fossils (T280, T280a) in the upper beds, (4) Yellowish grey sandstone and quartzite with some poor preserved brachiopods. (5) Black shaly limestone with corals (T281). (6) Quartzitic sandstone and sandy shales. (7) Grey limestone with corals (T281a). (8) Quartzite. (9) White and grey fine clay. (10) Blackish gray shaly limestone (T282). (11) Massive grey crystalline limestone. (12) Greyish compact limestone. (13) Light grey limestone. (14) Thin-bedded, pinkish white semi-crystalline limestone with fossils (T283). (15) Light grey massive and brittle limestone. (16) Quartzitic sandstone. (17) Light and blackish gray limestone (T284). (18) Black and yellow shales and thin-bedded cherty limestone.

Fig. 39. Section of Tushan eastward along a deep ravine (with fossil localities T171a-i). 1—dark grey shaly limestone and shale, 2—quartzite and shaly sandstone, 3—grey limestone, 4—impure shaly limestone, 5—blackish grey thin-bedded limestone, 6—dark grey impure limestone, 7—thin-bedded grey limestone, 8—blackish grey limestone, 9—pinkish limestone with calcite veins, 10—greyish black shaly limestone and shales, 11—yellowish green shale, 12—thin-bedded limestone, 13—thin-bedded calcareous sandstone and quartzitic sandstone.

Fig. 40. Section from Tushan to Tangpakou (direction nearly N-S) showing succession and fossil horizons of Devonian and Lower Carboniferous formations.

Fig. 41. Section from Fangkun to Chichang showing the formation from Permian down to Devonian (to be continued with Fig. 44).

1. Blackish grey shaly limestone inter-bedded with shales. 2. Hard dark blue limestone and shales more or less silicified, fossils. 3. Dark blue limestone with thin shales (T275 & T276). 4. Yellow brown sandstone and sandy shales. 5. Blackish grey shaly limestone and black shales (T273 & T274). 6. Shaly sandstone and shales. 7. Massive light gray, white and pinkish crystalline limestone (T271—T232). 8. Sandstone and silicified limestone. 9. Blackish gray limestone with more or less chert (T268, 269, 270). 10. Yellow, brown and grey shales with bands of sandstone and thin limestone, containing impure, irregular, very thin coal seams. 11. Blackish and silicified flinty limestone crowded with well preserved *Schwagerina* (T267). 12. Grey and thin bedded limestone intercalating with some shales, towards the base replaced by a zone of sandy, silicified and rusty shales or shaly limestone in which *Gastrioceras* can be easily found (T266). 13. Highly folded shales of red, green and yellow colours with fragments of *Gastrioceras*.

41:KSA3, Fig. 42. Section through Shangssu and Heishihkuan, Tushanhsien.

Fig. 43. Section from Touti to Liuchai, Tatanghsien (compare Fig. 30)

Fig. 44. Section from Lipo to Fangtsu passing Shuian (to be continued with Fig. 41).

a—upper part mainly red, green and yellow shales in alteration, lower part grey thin-bedded limestone with thin shaly intercalations, *Gastrioceras* occurring in the whole series, b—sandy shale, sandstone, thin-bedded cherty limestone and occasional coal seams, c—massive greyish limestone with more or less chert, d—whitish massive and semi-crytalline limestone becoming shaly towards the base, e—quartzitic sandstone and shale with traces of plant fossils, f—red sandy shale, clay and gravels.

Fig. 45-47. Section from Lipo to Fangtsun passing Shuiti (compare Fig. 44).

Fig. 48. Section from Payu to Matao S. of Tushan showing fossil horizons.

Fig. 49. Section at Shangtiehken S. of Tushan (compare Fig. 48).

Fig. 50. Section at Mawang between Hsiassu and Nanchai.

Fig. 51. Section at Tungchiao, N. of Nanchai.

Fig. 52. Section of La-ao (拉坳) on the Kueichou Kuangsi border.

Fig. 53. Section of an unknown place possibly nearly Weichai (see Fig. 59.).

Fig. 54. Section from Mangchang to S. of Heini near the Kueichou-Kuangsi border.

Fig. 55. Section of Nantan, Kuangsi (general direction N45° E). 1—silicified thin-bedded limestone and intercalating sandy shales, 2—quartzitic sandstone, 3—massive light grey and semicrystalline limestone, 4—dark blue limestone occasionally with calcite veins, 5—yellow brown shaly sandstone, platy limestone and greyish yellow spotted schist, 6—greenish grey schist, slabby limestone and shales, 7—highly silicified limestone with some yellow brown shales.

Fig. 56. Section of an unknown place.

Fig. 57. Section of La-aoho (compare Fig. 52).

Fig. 58. Section through part of the limestone range between La-ao and Weichai showing folding of strata.

Fig. 59. Section from W. of Weichai to E. of Pahui, Lipohsien.

Fig. 60. Section to the west of Weichai showing succession and thickness of Lower Carboniferous strata on the western limb of the Weichai anticline (compare Fig. 59).

Fig. 61. Columnar section showing stratigraphic succession in the Sungkan-Chiupantzu area, N. Kueichou.

[This and the following sections were prepared by Y. L. Wang. Unfortunately, neither Ting nor Wang gave descriptions of lithological characters of formations shown in these sections. But, since the patterns for lithology as adopted are self-explanatory, the drawback is not great.]

Fig. 62. Columnar section of an unknown area in S. Kueichou.

Fig. 63. Columnar section of Takusinchang (new Chinshahsien) Chiensihsien.

Fig. 64. Columnar section showing succession of Lower Carboniferous in the Tatang-Chiussu area, S. Kueichou.

Fig. 65. Columnar section showing Devonian-Carboniferous strata at Tehluching, Pachaihsien.

Fig. 66. Columnar section showing Permian fossil horizons of Wengchengchiao, Kueitinghsien.

Fig. 67. Columnar section showing stratigraphic succession N. of Tushanhsien.

Fig. 68. Columnar section of the Fangtsun-Chichang area.

Fig. 69. Columnar section of the Lipo-Fangtsun area.

Fig. 70. Columnar section of the Niutachang area, Kueiyanghsien.

Fig. 71. Columnar section of Panshan, Tungtzuhsien.

Geological Reconnaissances in Szechuan, Yunnan and Kueichou*

By

T. K. Huang

RECONNAISSANCE IN SOUTHWESTERN SZECHUAN, NORTHWESTERN KUEICHOU AND PART OF YUNNAN

(October 30 to December 18, 1929)

With Plate 42: HM and Plate 43: HS1, 44: HS2, & 45: HS3

The Environs of Suifu [2, 4]**

Süchowfu or Suifu is officially known as Ipinghsien. It is situated at the junction of two mighty rivers, the Chinshachiang and the Minchiang. The Chinshachiang is the main stream and runs in SW-NE direction; it possesses a swift current and a turbid water. The Minchiang comes from the NW and joins the main at a right angle at which the city of Suifu lies. This latter is a large commercial city to be reckoned as one of the four or five largest cities in the province of Szechuan. Steamers of 200-300 tons' capacity come up from Chungking and can proceed up-stream to as far as Chiatingfu in the summer months. To the south a paved road leads to Chaotungfu and Tungchuanfu in the province of Yunnan and finally to Yunnanfu, the capital of that province. It is the only thoroughfare by which the communication between Yunnan and central China is possible. Suifu is thus appropriately called the gate of Yunnan.

Two mountain ranges about 300 meters in height are visible at Suifu, both striking NE-SW and extending for a score of miles in both directions. One is found just north of the city and is mainly formed by strata of the Jurassic period. The other called Tsichinshan[1] is situated at 10 li or so south of the city and consists of rocks of the same age. I shall describe the sections seen along the Minchiang and on the road to Tsichinshan.

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* This report, written in 1932 in accordance with instructions of Dr. V. K. Ting, should form part of the report of the Geological Expedition to the Southwestern Provinces of China.

**Figures in brackets refer to list of works at end of report. 1 七金山

Going north from Suifu one finds at Wushenkung[1] green and grey thick-bedded sandstone dipping at 30° to the NW. Further northwest along the right bank of the Minchiang continuous outcrops of grey sandstone strata alternating with clay shale beds are to be met with. Plant fragments (Loc. No. 1450),* such as species of *Podozamites* and *Pterophyllum,* occur in these beds, proving the early Mesozoic (probably Liassic) age of the sandstone formation [14]. The mean strike of the sequence is N 40° E and the mean dip is 22° to the NW. Conformably overlying these rocks are yellow sandstone and yellow shale frequently calcareous and with poorly preserved bivalves probably of the *Unio* group. These beds will have to be considered as Lower Cretaceous in age, being contemporaneous with the wide-spread Kueichou (Tzukuei) Series of the Szechuan Red Basin. Further up-stream red clay-shale beds with frequent intercalating yellow sandstone seams crop out along the river, while red sandstone strata are continually met with in the red shale series. These sandstone beds are massive and frequently distinctly cross-bedded, the thickest bed of them being more than 20 m. Still further north, red clay-shale predominates but this is extensively covered by recent alluvium, out-crops being rarely found.

Along the left bank of the river the section is essentially the same as what has been said. Going northwest from the village Tiaohuanglou[2], which is just opposite Wushenkung, Jurassic sandstones were observed to be underlain by red beds of the Kueichou Series. Then an alluvial plain intervenes and the strata are mostly covered. Toward the north one can clearly see a prominent escarpment rising some 300 m above the plain and stretching in both eastern and western directions for an unknown distance. This was observed to be composed of massive brick-red sandstone dipping at 7° or less toward the north and forming virtually vertical cliffs in striking contrast with the underlying red clay-shales. The section from Tiao-huanglou to Shihyen (as the escarpment is called) though broken at places can be reconstructed from that seen along the right side of the river. It shows a typical section of the red beds of Szechuan. Near the base of the series are strata of alternating yellow sandstones and red clay-shales with intercalations of yellow cal-careous clay-shale, these lying with apparent conformity upon the Jurassic sandstone. After this basal series and for the greater part of the whole sequence red clay-shale and thin red sandstone strata predominate, with a dip first not less than 30°, then

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* Figures designated as "Loc. No." refer to locality numbers of collections of fossils made by author. Most of these collections are still not studied and are kept in the basement of the Survey's building at 9 Pin-Ma-Ssu, Peiping.

changing to 20°, then to 15° and finally to 7° when the clay-shale series ends. The last series is the massive cliff-forming sandstone already mentioned. This is apparently in conformable contact with the underlying beds, but the sudden change in lithological characters is rather striking. As is revealed by my travel from Tzuliutsing[1] to Suifu this sandstone formation is of wide-spread distribution along that route [2].

Now turning back to Tiaohuanglou we shall consider the character of the Jurassic formation. Coal mines are visible just east of the village and on the slope of the sandstone ridge which strikes N 40° E. The country rock is chiefly yellow or grey sandstones with intercalating grey shale, dipping at about 25° to the NW. The coal seams are very thin, [each]* no more than 2 feet thick. Apparently only 1 seam is being worked. Well-preserved plants including a peculiar form of the type of *Neocalamites* have been collected.

As one goes south-eastward from Tiaohuanglou along the right bank of the river one will soon observe that the moderately north-dipping sandstones are succeeded by steeply south-dipping sandstones of similar character. The contact between these two groups is not observable, but it can be inferred that a fault of some magnitude occurs along the southern slope of the range. This is clearly indicated by the steep escarpment of the range facing to the south and by the fact that the sandstone sequence on the north is much thicker than that on its south which is only some 100 meters thick. This fault is probably of the reversed type, the northern sequence being thrust against the southern. Further down-stream red clay-shales and massive sandstones reappear, these overlying the Jurassic sandstone conformably as in the case with the sections already alluded to. The succession of these strata is already given in my work on the "Geology of the Tsinlingshan and Szechuan" published in 1931 [2, also 4].

Before leaving Suifu for Kueichou I have made an excursion to the Tsichinshan range. I crossed the Chinshachiang near one of the southern gates of the city. The first outcrops met with on the opposite side of the river are well-bedded red clay-shale dipping gently (less than 10°) to the south. Further southward additional beds of red clay-shale were seen, all dipping in the same direction. On account of the fact that these red beds are soft, they were quickly denuded and low isolated hillocks were carved from these beds. Near a small stream the red beds suddenly change their dip, this time striking N 33° E and dipping 50° NW. The result is

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* Words or phrases in brackets are added in by the author in May 1945.

the development of an asymmetrical syncline with its steep limb on the south. Going further southward no change in the position of the beds was seen. These steep-dipping red beds end as one approaches the northern slope of the Tsichinshan whose crest is formed of massive beds of Jurassic sandstone.

From Suifu in Szechuan to Chenghsiunghsien in Yunnan [see also 5 & 16] (October 30 to November 10)

On the 30th of October I left Suifu for Chenghsiunghsien in Yunnan. I took a boat down the Yangtze River to the town of Nankuang thence I proceeded southward along the course of the Nankuang River. The Yangtze at Suifu flows in a SW—NE direction for 2 or 3 li, then it bends around and runs in a NW-SE direction for another 5 or 6 li to the village of Nankuang. The rocks observed along the river all belong to the Cretaceous Kueichou Series. They are mostly red clay shale with frequent intercalating seams of red sandstone. The red shale beds were eroded to form low hills and flat patches of fertile lands are developed among them, these being extensively cultivated for rice growing. The structure from Suifu to Nankuang is an asymmetrical syncline with gentle-dipping strata in the northern but steep-dipping strata (60° or more) in the southern limb. A slight overturning occurs near the axis which passes through the middle of that portion of the Yangtze which flows in a NW-SE direction. This syncline is undoubtedly the eastern extension of the one met with in my trip to the Tsichinshan. The trend of the axis is about N 45° E. (See Pl. 43:HS1, Fig. 1).

Approaching Nankuang one observes two prominent rocky reefs in the middle of the mighty river. They are formed of massive yellow sandstone striking N 47° E and dipping at 61° to the NW. They are said to cause great trouble to the navigation of down-going vessels and form the first dangerous rapids between Suifu and Chungking. Just south of these reefs and on the southern bank of the river coal mines appear. The coal is obtained from a series of yellow and grey sandstones mingled with beds of grey clay-shale. Apparently only one seam is being worked. A good amount of fossil plants were collected from these beds by Mr. Y. T. Chao and myself during a previous trip to this region (Loc. No. 1451) [14].

Nankuang is situated at the junction of the Nankuang River and its main stream. This small river possesses a sufficient amount of water and is navigable with small boats from Nankuang to Yokou[1], a distance of 40 li. Since the direction

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of the river is nearly S-N while that of the Tsichinshan range is NE-SW it cuts right across the latter and a marvelous gorge carved from Jurassic sandstone strata is thus formed. It is through this gorge that our route passes. The structure as revealed by this gorge is a simple anticline developed exclusively within the Jurassic sandstones. I say it is simple. It is so in a general way but it is really very complicated in detail. At first the northern limb of the anticline dips at 15° to the NW. Going a little southward the dip rapidly [decreases] and in a short distance the strata appear horizontal. 2 or 3 li further south these horizontal beds suddenly assume a southern dip of no less than 35°. The strike however remains nearly the same, *i.e.,* N 45° E. It is to be noted that this anticline, though of the open simple type, has its two limbs steeply inclined. This inclination is not originated from a gradual change of curvature of the sandstone strata but is caused by an abrupt [bending]. Such a structure is of frequent occurrence in the Red Basin of Szechuan and indeed most of the anticlinal flexures met with in the region are of this type. Coal seams occur in the southern limb of the anticline and is being mined by the natives. (See Pl. 43:HS1, Fig. 2).

Leaving the gorge the route still follows the course of the Nankuang River which runs in a N-S direction. Overlying the coal-bearing sandstones and shales are beds of red shale and yellow sandstone belonging to the Cretaceous period. The dip of strata gradually lessens. Toward the village Liuchiaosin[1] red sandstones appear, striking NNE-SSW and dipping about 25° to the SE. Then red clay shale strata follow up to about 4 li from Kanchipu[2], all dipping gently to the SE. Toward Kanchipu the strata gradually appear to dip in the opposite direction. The dip is about 8° to the NE near the village. Looking to the east one can see in the distance a high ridge rising abruptly from the low hilly country of the soft red shale. This is apparently formed of massive sandstone strata of the same character as observed at Shihyen north of Suifu. I consider the sandstone as [belonging to the Chengtsiangyen Formation (Kiating Series of Heim)].

Southward from Kanchipu red shale beds were continually met with until Yokou when the Nankuang River turns to the west. My route departed from this river and followed a tributary which runs in a south by east direction. Outcrops of the red beds series were only to be seen, these dipping first at 18° then at 41° to the NW. Then the series ends and rocks of the coal-bearing formation came into view. These are mostly yellow and grey sandstones and are excellently exposed

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north of the village Liangchiangkou[1]. The strike is N 60° E and the dip is 30°-40° NW. Coal seams occur near the base of the sandstone formation and are being worked. The entire series is estimated at 500 m [in thickness].

At Liangchiangkou the first outcrops of limestone were met with, these underlying the sandstone conformably. It is a fine textured, well-bedded grey limestone apparently devoid of fossils. Going south from Liangchiangkou similar limestone strata were seen, dipping at 28° to the NW. The dip however gradually lessens and the strata become horizontal in a short distance. Then they begin to dip in the opposite direction. Obviously an open anticline is at hand (Pl. 43: HS1, Fig. 3). Near the axis of the anticline which is about N 60° E grey shaly strata were found intercalating in the limestone series. One li south of the small place Chuansintien[2] the limestone ends and beds of the Jurassic coal-bearing formation reappear. At the contact the limestone was observed to dip at 20° SE. The outcrop width of the Jurassic sandstone is about 800 m. Following upon this is a series of red clay-shale with thick seams of cross-bedded sandstone. These are in turn followed by softer red beds of the Kueichou Series. The strike is N 65° E and the dip is 33° SE at Potaoli[3]. It then gradually lessens and becomes horizontal. Further south however the red beds begin to dip to the NW. Thus a flat synclinal is formed in the red beds. Gently rolling hills are carved from these soft strata while flat areas are also developed. The village Shahoyi[4] just lies on one of these flats.

Between Shahoyi and Huatanchang[5], a distance of 20 li, only red beds are to be observed. The strata in the vicinity of the latter place are horizontal. Further south however they begin to assume a northerly dip which at first is 5° but later increases to 30°. The strike is generally NW-SE. About 3 kilometers south of Huatanchang the red beds series ends and yellow sandstones of the Jurassic begin to appear. These strike N 76° W and dip at 36°-40° NE. They form a low but uniform range north of the village Likantang[6]. At the latter place I heard that coal is being mined from somewhere in the range and that coal is also obtained from the other range situated just south of the place and is of a quite different character.

Already at Likantang strata of light grey thin-bedded limestone crop out conformably under the Jurassic sandstone. They appear as the same limestone observed near Liangchiangkou and are probably of Triassic age. Going southward an

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alluvial plain of 500 m intervenes so that the character of the limestone formation is not known. At the southern margin of the plain the first outcrops of purplish red shale were found, striking N 76° W and dipping 42° N. The road then climbs up a steep slope formed by a thick series of purple shale, green shale and shaly sandstone all dipping in the same direction. These strata are easily recognizable by their peculiar color and by the fact that they are uniformly thin-bedded. Fossils were hunted for but without success. The relation between them and the Triassic limestone is not known but for structural reasons they are most probably concordant. The total thickness of the series is no less than 400 m.

Immediately underlying the purple and green series are beds of grey clay-shale and grey and green sandstone with at least two seams of anthracitic coal, which is being mined by the natives. The worked seam is said to be very thick probably not thinner than 3 Chi. By verbal communication from the miners it appears that coal is not only mined here but also from other parts in the same hill range. The coal-bearing series is followed by massive limestones with *Schwagerina* [This should be *Neoschwagerina*]. I recognized at once that the limestone is Permian while the coal-bearing strata were supposed to be late Permian or Lower Triassic.

The Permian Limestone is well-developed in the vicinity of the village Lungwan[1] which is located in an E-W valley developed in the limestone. The limestone is dark grey or black in color, massive in structure, and distinctly bituminous. After weathering it often appears white, and pointed white peaks of the limestone are here and there to be seen as one looks toward the direction of the strike. The most interesting point I noticed is that near the contact with the coal-bearing strata the limestone, which dips at 60° to the N, is covered with a thick coating of dirty black, oily material. It smells a distinct petroleum smell and when the limestone is struck by the hammer the smell is all the more stronger. The limestone however is not porous but is traversed by numerous open joints. The whole sequence of limestone is estimated at 500 m (maximum thickness).

Going southward from Lungwan the road climbs another steep slope. The first outcrops met with on this slope are beds of grey shale intercalating with impure limestone seams. These beds were observed to lie under the Permian limestone with apparent conformity but their characters are so much unlike the latter that they are at once recognized as a different formation. Further up the slope grey and green calcareous shales were continually met with. I hunted for fossils and succeed-

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ed in collecting a good deal of small brachiopods (mostly of the genus *Chonetes*) and some trilobites (Loc. No. 1453). Among the latter is the species *Coronocephalus rex* Grabau which has been considered as an index fossil of the Silurian rocks of the Yangtze Valley. Thus I knew at once I have crossed the Permian and descended into the Silurian.

At first the Silurian strata strike N 80° E and dip 65° N. Then the dip gradually decreases and in 2 or 3 li distance the strata appear horizontal. Then they began to dip in the opposite direction. Evidently the Silurian strata form an anticline on both limbs of which occur Permian limestones (Pl. 43 : HS1, Fig. 4). The limestone of Lungwan forms the northern limb while another limestone ridge lying south of the anticlinal range forms the southern limb. The limestone of the latter is the same massive Permian limestone as that of Lungwan. It strikes about N 5-3° W and dips 15° to the SW, forming a conspicuous ridge marked by vertical cliffs rising abruptly above the soft shales of the underlying Silurian formation. In the latter there is developed a strike valley into which the road descends, and then follows it southeastward for 5 li. Then it quickly ascends the limestone escarpment and descends again into the main valley of the river at Kunghsien[1]. At the base of the massive limestone some corals including *Tetrapora elegantula* var. *kunghsienensis* (var. nov.) were collected (Loc. No. 1452) [8].

The small city of Kunghsien lies on the right bank of the Anningho, which flows northward passing Changninghsien and enters the Yangtze near Chianganhsien. To the east and to the west of the city high ridges appear. The eastern ridge is made of the Permian limestone which at Kunghsien strikes N 15° W and dips 60° W. The foundations of the city are laid entirely on this limestone which forms a prominent hill just in the middle of the city, on which a beautiful temple is built. At the northern gate I have collected [fusulines] from the limestone. The western ridge is composed of softer strata mostly purple shales and sandstones of Triassic age (the same as those found north of Lungwan). Between these latter strata and the Permian limestone there is a series of grey and black shale and sandstone with workable coal-seams. Actual coal mines were observed just on the hill slope opposite Kunghsien. There the strata strike N by W and dip at 45° W. The coal is anthracite and is used for [domestic purposes] only. The seams are generally thin, the thickest being no more than 3 ft. I have hunted for fossils at the mines but only bad impressions of plants were seen. The succession at Kunghsien is roughly given in the accompanying section (Pl. 43 : HS1, Fig. 5).

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1 珙縣

Going south from Kunghsien the road approximately follows the left bank of the Anningho. The strata of the Permian limestone and of the coal-bearing formation were gradually crossed over and in a short time the road comes in the belt of the Triassic purple beds in which it keeps until at Choutsun[1] when it crosses these beds and comes in thin-bedded limestones. At Choutsun the valley of the Anning River is bounded in the east by a ridge of purple beds while in the west another limestone ridge appears, this being composed of thin-bedded light grey limestones of Triassic age. The contact between the limestone series and the purple shale series is not a sharp one. The shaly beds gradually become calcareous, at the same time their color also fades away gradually so that a formation of grey limestone comes into existence. Thus it can be seen the limestone and the shale really form one unbroken series; no accurate boundary line could be drawn between them. At Choutsun the strata nearly strike N-S, dipping moderately to W.

Leaving Choutsun the road still follows the western bank of the river which persists to flow in a northerly direction. The formations however gradually change to strike NW-SE so that about 1 li north of Yentsingchi[2] the Triassic limestone series ends and the road begins to ascend a steep hill-spur formed of thick-bedded yellowish grey sandstones of the Jurassic period. These strike N 45° W and dip 45° SW. The sandstone is of the same character as the Jurassic sandstones met with since leaving Suifu, but there is a reduction of shaly strata while coal-seams are characteristically absent. Going south from Yentsingchi one is attracted by the deep red color of the mud filling the gullies on the left bank of the river and in a short time one reaches the contact between the Jurassic sandstone and the overlying red clay-shale and sandstone of Lower Cretaceous age.

Leaving the contact between the red beds and the Jurassic sandstone the road still follows the course of the river which now turns abruptly to SE. Thus it once more crosses the Jurassic formation and comes into the domain of the Triassic limestone. Going south from Titungchang[3] the road leaves the course of the river and climbs a high ridge of the limestone. The strike of the strata undergoes a rapid change. One kilometer below Titungchang they strike at N 43° W and dip 20° SW, but near the village the strike changes to N 75° W the dip being 27° S, while south of the village the strike is N 50° E and the dip 48° NW. Apparently a closed synclinal in the Triassic limestone occurs at Titungchang.

From Titungchang to Shuitangtzu[4] the road ascends a steep slope in Triassic limestone striking prevailingly NE-SW. From Shuitangtzu to the pass of Aikou[5]

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1 周村 2 鹽井溪 3 底洞場 4 水塘子 5 隘口

(850 m) the Triassic limestone first dips gently to the north, then it appears horizontal at Yuhuangkuan[1], and finally it dips to the south. Thus the structure is evidently a broad anticline. From Aikou to Shanglochang[2], a distance of 15 li, only limestone strata are met with, these assuming a prevailing strike of N 30° E and an average dip of 10° to SE.

Leaving Shanglochang the road crosses a stretch of alluvial plain and soon comes into the eastern bank of a big river. This is the upper course of the Nankuangho along whose lower course I have proceeded some days before. Up to Losintu[3] the road leads in a prevailingly SSE direction, keeping to follow the river course. The strata met with all belong to the Triassic limestone formation, dipping gently to N. Thus they form with the limestone strata north of Shanglochang a broad syncline whose axis passes somewhere near the latter village. Going south from Losintu one leaves the course of the river and climbs a slope of purple shale strata which immediately underlie the Triassic limestone. The strike is N 50° E and the dip is 24° NW. The strata are prevailingly deep red or purple in color and frequently calcareous while thin limestone beds occur in the upper part of the formation. About 4 li S of Losintu the purple beds are succeeded downward by a thin formation of green strata. The top of this formation is marked by a thick stratum of green calcareous shale which, on account of its resistance to weathering, forms a prominent ridge and looks from a distance closely like a stratum of limestone (See Pl. 43:HS1, Fig. 6). Under this is a sequence of green shale dipping about 15° N. Immediately underlying these green strata is the Permian coal-bearing series which finds extensive outcrops in the vicinity of Lopiao[4].

Lopiao is 15 li south of Losintu. It is a prosperous market town larger than all the towns between Suifu and Chenghsiunghsien. The country around Lopiao is comparatively flat and open. Hills are low and subdued, being formed in the soft strata of the coal-bearing series. To the north one sees a prominent ridge capped by the calcareous shale stratum mentioned above. It strikes ENE-WSW. Near its foot coal mines are to be seen. The coal occurs in a series of grey shale and sandstone with plant remains. At a mining pit near the road-side the strata strike N 73° E and dip 28° N. The coal is anthracitic, with a good lustre and being obtainable in large lumps. The number of seams is unknown. Only one seam of 2-3 Chi thick is being worked. The coal field appears rather extensive, since 15 or 20 li eastward at a place called Lohai[5] good anthracitic coal is said to be worked and there seems little doubt that the coal seam in the latter locality is a

1 玉皇觀 2 上羅場 3 羅星渡 4 洛表 5 洛亥

continuation of that seen at Lopiao. I got the impression that the Lopiao coal field is the largest and best seen since I left Suifu. At Lohai sulphur is also obtained probably by burning pyritic concretions from the coal series.

Going south from Lopiao the road ascends a gentle slope which is essentially the dip slope of the coal-bearing series (Pl. 43:HS1, Fig. 6). The hills are low and the solid rocks are mostly covered. But judging from isolated outcrops it can be said that the strata crossed from Lopiao to Hochiayen[1] are grey shales, black shales, and fire clays, all gently dipping to the N or horizontal. Coal pits are seen here and there but no workable coal seams occur. At Hochiayen a prominent hill of more than 100 m appears on the left side of the road. It is formed of green and grey shale strata capped by a thick stratum of green calcareous shale much resembling limestone. Coal pits are seen at the foot of the hill. It is inferred that the capping bed is the equivalent of that seen north of Lopiao while the coal seam worked here is the main seam. The relation is shown in Pl. 43:HS1, Fig. 8.

As one looks to the west from Hochiayen one sees 2 or 3 li away a deep canyon the walls of which are not formed of strata of the coal series but of massive limestones, dipping very gently to the N. It seems certain that these are the Permian limestone which, as far as our experience goes, invariably underlies the coal-bearing series.

Going south from Hochiayen the road passes through a country of low hills thickly covered by bushes. Grey and black shale and occasionally sandstone are to be met with while abandoned coal pits are scattered here and there. About 8 li due south of Hochiayen one comes to a pass of 1030 m elevation [aneroid reading] which marks the end of the dip slope and the beginning of an escarpment of Permian limestone. Descending the latter one first observes a peculiar greenstone of a dark green color and fine texture. It contains numerous large vesicles often filled up by secondary quartz. It seems certain that this rock represents an ancient basaltic lava and here-after I shall call it the Permian basalt. The thickness of this basalt is less than 40 m. It is immediately underlain by the massive Permian limestone with beautifully [preserved fusulines] (Loc. No. 1451). The limestone exhibits its normal characters as before. It strikes N 87° W and dips 30° N (See Pl. 43:HS1, Fig. 8). After descending the limestone escarpment one climbs the dip slope of another formation. At first thick-bedded whitish quartzitic sandstones are met with, striking EW and dipping 25° N. The contact between the sandstone and

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1 何家岩

the limestone is perfectly concordant. Underlying the sandstone (which is less than 100 m) is a series of soft green shales which form another escarpment at Liangfengya[1]. The topographic features observed at this place are striking. To the north the Permian limestone with its overlying basaltic lava forms a high ridge striking nearly E-W and extending in both directions for an unknown distance. To the south lies a deep longitudinal valley which is succeeded in the south by a lofty range, the boundary range between Szechuan and Yunnan. White limestone cliffs appear in this range, suggesting that the Permian limestone occurs there owing to the development of a major anticlinal structure. From Liangfengya to Wangchang[2] the strata seen are green shales and grey shales with numerous Silurian fossils (Loc. No. 1455). The strike is N 84° E and the dip is 37° N.

Wangchang is situated near the junction of two streams, one flowing due east and the other coming down from the southern boundary range. It is nearly on the axis of an anticline whose centre is dominated by Silurian shales while Ordovician strata are also known. The circumstance deserves some detailed descriptions (See Pl. 43:HS1, Fig. 7). Northeast of the village on the opposite bank of the stream there is a small isolated hill from which the following section was observed:

1. Grey shale, St. N 80° E, dip 46° N.
2. Light yellow plastic clay (1 & 2 Silurian).
3. Impure, somewhat silicified, grey and greenish grey limestone, St. N 55° E, dip 40° SE.
4. Light grey quartzitic sandstone.

Apparently No. 3 is in fault contact with the Silurian shale. This same limestone is seen 1 li west of the village on the southern bank of the stream which flows due east. There it strikes N 75° E and stands nearly vertical. The age of 3 and 4 is hard to determine. I have carefully hunted for fossils in the limestone but without success. Just south of the village at a stone bridge the same grey quartzite as (4) is again met with striking N 80° E and dipping 76° S. This is directly followed by grey shales and shaly limestones of the Silurian, containing a seam of light yellow plastic clay identical to (2). It is thus supposed that No. 3 and 4 underlie the Silurian shale and their age is either Ordovician or Silurian. Later on I have observed limestones of Ordovician age possessing the peculiar characters of (3), so I conclude that (3) and possibly (4) belong to the Ordovician. It is further thought that the Ordovician strata form the axis of the anticline along

1 涼風埡 2 王場

which a normal [reversed?] fault occurs, bringing the Ordovician in contact with the Silurian of the northern limb. This axial fault essentially determines the direction of the longitudinal stream which is responsible for the formation of an anticlinal valley.

Going south from Wangchang the road follows the course of the northerly stream already mentioned. The strata met with are grey shales and thin shaly limestone dipping steeply to S. 2 li south of the village the road passes through a gorge with precipitous cliffs formed of Permian limestone. This formation, strange to say, appears unusually thin here, being no more than 200 m. It strikes E by N and dips at 65° S. Its lower part is massive as usual but its upper part becomes rather thin-bedded. With my previous experience I expected to find, first basaltic lava, followed by a coal-bearing formation. This is not the case. The limestone is not followed by basalt but by a series of massive sandy strata, slightly metamorphosed and deserving the name of greywacke. No coal seams nor black shaly strata are found in it. The greywacke is followed by some grey and green shales which are followed in turn by green and purple shales of the Triassic system. These strata strike by N [?] and dip about 80° S. In the purple shale well-preserved pelecypods occur in abundance (Loc. No. 1456) [12]. The Triassic purple shale ends south of Sanchaho[1].

Leaving Sanchaho the road climbs a very steep slope which ends at the pass of Szulipo[2]. The distance between these two points is less than 1.5 km but the difference in elevation is tremendous, about 500 m (750 m for Sanchaho, 1250 m for Szulipo). So the ridge of Szulipo, which is formed of Mesozoic strata, is the highest and most prominent since leaving Suifu. It marks the boundary between Szechuan and Yunnan.

Just south of Sanchaho one observes thin-bedded limestone overlying the purple shale. These are to be taken as the Triassic limestone formation seen in previous sections. The interesting point to note is that this formation here is very thin, so thin that it did not attract my attention, though on previous occasions it is 400 m or even 600 m in thickness. The meaning of such a thinning out of the formation is not known. Conformably overlying this is Jurassic sandstone, being mostly thick-bedded yellow sandstones with intercalations of grey shales. The total thickness of this sandstone is estimated at 400 m. This is concordantly followed by an immense sequence of red beds, striking nearly E-W and dipping 70° S.

1 三岔河 2 四里坡

These are mostly red clay-shales with frequent intercalations of red sandstones perfectly similar to the Cretaceous red beds at Suifu and elsewhere.

Descending the pass of Szulipo one observes continuous outcrops of yellowish sandstones and red clay shales, this time dipping at 35° N. From Szulipo to Huangshuiho[1] red clay shales and sandstones predominate, all dipping about 35° N. It appears certain that the Szulipo ridge is a synclinal mountain, the centre of the syncline being occupied by Cretaceous red beds. It is also evident that the folding of these strata must have occurred in post-Cretaceous or at least in late Cretaceous time.

South of Huangshuiho the red beds are succeeded underneath by the Jurassic sandstone, which strikes N 80°-85° E and dips about 35° N. Here the sandstone contains considerable amount of grey shale but coal seams are not seen. Further south Triassic limestones come into view, the strike and dip remaining the same. In the vicinity of Huachiupa[2] best outcrops of the limestone can be seen, these being identical in lithological characters to those seen in previous sections. It is interesting to note that here the Triassic limestone occurs in its typical phase and its thickness is considerable, not less than 400 m, while at Sanchaho 10 li north of this place it dwindles to less than 100 m.

Proceeding south from Huachiupa one soon crosses the limestone formation and comes in the domain of the Triassic purple shale series. As is the case with previous sections the purple shale, instead of forming low hills like the Silurian shale, constitutes a prominent ridge across which the road has to go. This is the ridge of Kuanyinpo[3], 1300 m above sea. At the pass numerous pelecypod remains were collected (Loc. No. 1516) [12].

Descending Kuanyinpo one begins to observe a series of green shales with coal seams. The coal however is poor and is not extensively mined. There appears no sharp contact for the coal-bearing series and the purple shale strata. In reality the one seems to merge into the other. Further south Permian limestone appears, striking nearly E-W and dipping moderately to N. This formation here is very thick; its upper smaller part is mainly a thin-bedded limestone while the lower greater part is dominated by massive dark limestones with frequent chert bands.

South of Kolopa[4] the road follows the course of a stream which first flows westward and later turns to the south just south of the village. Near the bend of

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黃水河 2 花楸壩 3 觀音坡 4 稞羅壩

the stream course Silurian strata appear under the Permian limestone. They strike N 80° E and dip 36° N. At first the strata are chiefly yellow sandstones with seams of sandy limestone in which occur numerous gastropods. Later on yellow shaly members become dominant while near the base of the formation black graptolite shales come into view. The latter are obtainable in thin slabs of one centimeter thickness. The texture is rather coarse so that the graptolites though very abundant are all poorly preserved (Loc. No. 1517).

Conformably underlying the graptolite shale is a limestone formation. It is a uniformly bedded grey to greyish green pure limestone with peculiar "mud-crack" structures on the bedding surfaces. The thickness of this formation is considerable but since it is cut by a fault in the south the real thickness cannot be measured. The road, first cutting across the strike, now turns eastward in a strike valley the northern slope of which is entirely occupied by the Ordovician limestone. Immediately south of this valley is a prominent limestone ridge striking WNW-ESE. This ridge is crossed south of Muwafang[1] where the road turns abruptly southward, and is found to be composed of massive Permian limestone. Between this limestone and the Ordovician limestone is a belt of Silurian shale which has been squeezed into a chaotic state by the two competent formations. The Permian limestone dips steeply N or stands vertical. Huge pillars are formed of it, rising abruptly above the low hills of the underlying and overlying shaly strata (See Pl. 43:HS1, Fig. 8). The limestone is succeeded by a series of grey sandy shale with coal seams, striking N 50° W and dipping 70° N. This is again followed by the Triassic purple shale up to Panchiukou[2], the strike and dip remaining unchanged. Apparently the strata from Muwafang to Panchiukou are overturned.

South of Panchiukou the road passes through a gorge cut in vertical beds of Triassic limestone which strike N 60° W. Further south the road ascends a hill formed of Triassic limestone dipping gently to S. This limestone and that forming the gorge are probably in fault contact. Further on similar limestone strata are met with striking N 60° E and dipping 50° NW. At Patsiaowa[3] the limestone is succeeded by the Triassic purple shale which forms another prominent ridge, being separated from the limestone ridge by a deep valley. Following the purple shale is a series of green sandy shale and grey shale with coal seams, striking nearly E-W and dipping 65° N. This is again succeeded downward by the Permian limestone, strike and dip remaining the same.

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1 木瓦房 2 斑鳩溝 3 芭蕉窪

Going south from Siaolochiao[1] the road leads in a SW direction, which is essentially the direction of the strike of the Permian limestone. The latter now dips moderately to SE forming an anticlinal with the limestone north of Siaolochiao. At Yushaho[2] the limestone ends and the coal-bearing formation begins to appear. From Yushaho passing Lianglukou[3] to Niukuentang[4] the road crosses low hills and valleys formed entirely of the coal-bearing strata. These are mostly green and grey shales and sandstones with thin coal seams. Coal pits are seen here and there. At Siaoluchin[5] two li from Niukuentang outcrops of dark green porphyritic basalt are found. The rock is usually weathered into angular fragments strewn on the hill slopes. The strike and dip of the basalt is not known but its overlying grey shales strike nearly S-W and dip at 25° N.

Crossing the basaltic lava one comes into the region of massive Permian limestones. The limestone as usual is dark grey or blue black in color, uniformly thick-bedded and highly bituminous. The strike is variable while the dip is gentle. At Santishui[6] the limestone appears horizontal. Corals including *Tetrapora* and *Michelinia* are found in it (Loc. No. 1518) [8]. Leaving Santishui the road descends a steep slope on the massive limestone and soon reaches a flat country dominated by Silurian shales. This latter formation however is very thin and is quickly crossed. Underlying the shale is the Ordovician limestone which strikes N 45° W and dips at 17° NE. This belt is crossed in a distance of less than 3 li when the limestone is succeeded by a formation of light grey or greenish clay with *Orthis calligramma* and other fossils. This clay is extraordinary fine, being entirely free from sandy material. It turns highly plastic when saturated with water. On account of the fossils found this formation may be considered as a partial equivalent of the Neichia Shale of the Yangtze valley while the overlying limestone may be correlated with the Orthoceras Limestone of the same locality (Pl. 43:HS1, Fig. 9).

Kumangpu[7] lies in an open country with an elevation of 1450 m. The topographic configuration in the vicinity shows an advanced stage of maturity. The valley is open, the hills are low and are covered by a thick residual soil. To the west there rises a gentle dome-like massif of Lower Ordovician limestone [Ichang Limestone]. To the east a uniform ridge of Silurian sandstone marks the sky-line. I am going to describe these formations in some detail. Going SE from Kumangpu one sees a stretch of flat country dotted with rice fields. In the immediate east a ridge of Ordovician limestone appears. This strikes NNW-SSE and dips gently

1 小羅脚 2 雨沙河 3 兩路口 4 牛滾塘 5 小鹿頸 6 三滴水 7 古芒鋪

to the east. These outcrops are actually continuous with those found when leaving Santishui. The thickness of the formation is estimated at 150 m. At the place where a beautiful archway is built one turns east, crossing a small stream flowing in the same direction. Soon the belt of the Ordovician limestone is passed and one comes into the Silurian shales. The contact between the shale and limestone is seen and is found to be conformable. The Silurian begins with calcareous grey shale with intercalations of shaly limestone. Then there follow yellow clay-shales and thin yellow or brownish sandy shales with abundant fossils; the species recognizable in the field are *Coronocephalus rex* Grabau, *Strophomena* sp., *Climacograptus* sp. etc. (Loc. No. 1519). The series is ended by a succession of yellow sandstone with characteristic "amygdaloid" holes. It is due to the resisting power of this sandstone that a prominent ridge has been formed. All these strata strike N 30° W and dip 12° NE. Their total thickness is about 170 m (See Pl. 43: HS1, Fig. 9). Directly following upon the Silurian is a massive limestone formation with typical Lower Permian fossils. Owing to the massiveness and the habit of jointing of these limestone strata they often form huge pillars and pointed peaks with the development of a characteristic zigzagging sky-line by the appearance of which one can always recognize the Permian limestone even from a distance. Near the contact between the Permian and Silurian a large pond occurs. This is the reservoir for the stream mentioned above. Bushes and weeds grow and thrive around this pond while wild fowls appear in an impressing number.

Immediately west of Kumangpu the Ordovician fossiliferous whitish clay above described is followed downward by yellow and brownish sandstones intercalated with calcareous sandstones on which numerous trails are seen while trilobite fragments are also found. These are succeeded by dark green and violet shales with thin limestone layers. The sequence totals about 160 m (?). Further west an immense succession of thick-bedded grey limestones appears; all dipping gently toward Kumangpu. The age of these two formations is hard to determine. The calcareous sandstones and green shales resemble strata of the Lower Cambrian and at one time I have taken them as such. But the fact that they underlie the *Orthis calligramma* beds concordantly is sufficient evidence to repudiate this correlation. I strongly believe now that like the *Orthis calligramma* beds they are the partial equivalent of the Neichia Shale of the Yangtze valley and that the thick limestone formation which underlies them is to be correlated with the Ichang Limestone.

Going south by east from Kumangpu the road runs in a flat country with rolling hills formed of Ordovician shales and sandstones. Toward Laokuankou[1]

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1 老關口

beds of quartzitic sandstones were observed to strike EW and dip at 12° N. Leaving Laokuankou the road makes a steep descent to a valley in which a small stream flows to the east. On descending dark green and purple shales were observed, these intercalating with thin and compact layers of limestone. A serious hunting failed to reveal recognizable fossils. Curiously enough, these strata, though really belonging to the Ordovician, are lithologically identical to the Cambrian Manto Shale of other parts of the country. In the valley bottom whitish silicified limestone strata appear. These are no doubt the same as seen west of Kumangpu (Pl. 43 : HS1, Fig. 11). Crossing the valley the road soon ascends a slope on which green shale and sandstone are again met with, this time appearing nearly horizontal. Then the road makes another descent to Matienkou[1].

The topography between Kumangpu and Kuankou is interesting (Pl. 43 : HS1, Fig. 10). Looking back from Kuankou toward the north one sees an open country marked by a flat, nearly peneplaned surface whose elevation above sea-level is about 1500 m. On this surface there occurs a thick soil cover, no rock exposures being observable. Numerous gullies are developed below this surface, these probably representing a stage of mature dissection subsequent to the peneplanation. To the northeast one sees in the distance a uniform ridge formed of Silurian strata gently dipping to the east, while in the far distance rows of Permian limestone pillars appear, marking a dog-teeth-shaped sky-line. These formations, being more resistant than the Ordovician shales, have not been planed down to the level of the peneplane.

Matienkou lies in the valley bottom of a stream which flows from SW to NE. Northwest of this valley lies the nearly peneplaned range of Ordovician shale and its underlying limestone, which I have just crossed. The limestone seems to form the core of an elongated dome—flanked by the Ordovician shales. To the southeast a high and uniform range striking NE-SW appears and seems to bar the way through which the traveller must pass. I shall describe the formations constituting this range presently.

At Matienkou the whitish grey clay with *Orthis calligramma* makes its appearance. In this clay graptolites, mainly *Climacograptus, Dicellograptus, Phyllograptus,* etc., occur in abundance (Loc. No. 1520). Immediately overlying it is the Ordovician limestone (equivalent of the Orthoceras Limestone) which forms a ridge just NE of Matienkou. From the latter place to Panchiao, a distance of 5

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1 馬店溝

li, the road follows the course of the river which here flows on the boundary between the Ordovician shale and limestone. Then the road turns nearly due south and begins to climb the high range mentioned above. At first massive grey to greenish grey limestones are met with dipping to the SW. These belong to the Ordovician Orthoceras Limestone, but it is interesting to note that here the thickness of this limestone is unusual, being more than 200 m. Then grey shales of the Silurian are crossed. The dip is about 14° to the SE. This formation is very thin and almost escaped my notice. Following upon this comes the massive Permian limestone which is again capped by a thin sheet of porphyritic basaltic lava. The formation of the high ridge is to be attributed to the occurrence of these Permian formations. When the steep slope (called Tsiangchunpo) is ended one comes on a plateau on which strata of the Permian coal-bearing series find wide distribution. Isolated hills of Triassic purple shale are here and there dotted on this plateau, these being surrounded by green and grey shales with coal seams extensively mined by the local people. Leaving Tsiangchunpo the road leads in a due south direction for 15 li to Chenghsiunghsien[1]. The strata met with *en route* belong to the Permian coal-bearing series and its overlying Triassic green and purple shales (Pl. 43:HS1, Fig. 11). These strata are essentially horizontal or only gently tilted and it is due to this fact that coal-bearing shales are found in the gullies or around the hills while Triassic beds are only found higher up on the hills themselves. The most prominent of these hills is the Wutungshan[2] (also called Wufungshan) just north of the district city. This is composed of horizontal beds of Triassic purple shale in the upper part and grey and yellow shales and fire-clays in the lower part. Two heavy seams of light grey limestone occur in the purple shale while anthracite coal seams are mined from the grey shales.

The coal in the Wutungshan and Tsiangchunpo areas has been extensively mined. Coal pits both active and abandoned are innumerable. Indeed it is the second time since I left Suifu that I met an extensive coal-field, the first being seen at Lopiao. The local miners report the coal to be of excellent quality while the people of Chenghsiung also boast of their coal treasure as being non-surpassed by any in adjoining districts. A serious consideration of the value of this coal field is therefore necessary. It appears that though there may be several coal seams in existence only one main seam is workable. The thickness of this seam is not determined but comparing the verbal communications of the miners I suppose it is about 1 m. The most important coal-producing locality is Wutungshan. This is a

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1 鎮雄縣 2 霧通山

monadnock formed of horizontal strata, having a cross section no more than 2 or 3 km. square. Thus it is seen at once that the coal reserve is insignificant. The other hills are usually smaller than the Wutungshan and are isolated from one another and consequently the coal obtainable from these hills is, in the mind of the mining engineer, also of neglegible quantity. Concerning the areas around Chenghsiunghsien, Maniaoho[1] and other places, the prospect is even more disappointing since the coal-bearing formation in these areas is for the greater part eroded or else is partitioned by numerous ravines and gullies. Consequently no large reserve can be expected from these regions. In short, the coal in the vicinity of Chenghsiunghsien is of little economic value. [The coal field in the flat syncline lying to the east of Chenghsiunghsien however might turn out to be of great importance. See geological map].

Chenghsiunghsien is a district city belonging to the province of Yunnan. It is situated on a plateau, with an elevation of 1570 m. A small stream running from NW to SE flows just south of the city and turns southward. It is on the walls of the canyon made by this stream that the Permian basalt and its underlying Permian limestone are exposed. Descending the canyon one soon finds under the grey shales of the coal-bearing formation a dark green porphyritic basalt with numerous amygdaloids. The thickness of the basalt as measured by the aneroid is 45 m. Immediately underlying this is a thick-bedded, purplish grey, highly bituminous limestone which gives a strong petroleum smell when struck with the hammer. This limestone only occurs near the base of the canyon wall so it cannot be observed when one stands on the plateau. It dips to the SE at 5°. Fossils are abundant especially in its top part (Loc. No. 1521) [7]. These are mostly brachiopods but fusulines are also common. The latter chiefly belong to the genus *Doliolina* with a size of a big soya-bean. It is interesting to note that when this *Doliolina* limestone, as it might be termed, is struck with the hammer, these beautiful fossils will jump out from the rock matrix and can be collected by just picking them up.

The physiographic features around Chenghsiunghsien are worth noticing. To the north one observes a nearly peneplaned plateau dotted with monadnocks rising abruptly from the general level to a height of 200 m. To the southwest there is found an ideal peneplane marked by an even sky-line. This peneplane is not continuous but is subsequently finely dissected. It is traversed by diversified

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1 馬尿河

canyons and gullies. It appears certain that the peneplane represents a stage of advanced erosion and that subsequent to this uplifting took place and a second cycle of erosion set in resulting in the development of the diversified gullies (See Pl. 43:HS1, Figs. 12 & 13).

From Chenghsiunghsien in Yunnan to Pitsiehhsien in Kueichou.

(November 15 to November 18, 1929)

It is a common saying in Kueichou and in this part of Yunnan that "the sun never shines for three days"[1]. This I found to be true. Day after day it rains. When occasionally it stops raining the bad effects of the rain still exist. The worst thing is with the roads. These are nothing but trails or foot-paths with no pavements. After raining they get muddy and where the road crosses a shaly formation the mud often becomes 1 or 2 feet deep. Thus one can see the difficulty confronting the geologist working in these regions. I have experienced this difficulty in proceeding from Chenghsiunghsien to Pitsiehhsien and for this reason I must apologize for the imperfections of my observations.

Leaving Chenghsiunghsien I proceeded directly eastward, passing Liangshuikou[2], and after crossing a deep valley ascended the ridge of Siaoyakou[3] at an elevation of 1800 m. On the left side of the road is a prominent range formed of purple shale and limestone seams. This is really the eastern continuation of the Wutungshan. On the right is a deep valley in which the coal-bearing series makes its appearance. On the opposite side of this valley one sees another group of hills formed of the same strata as found in the range on the left side. At the place where the road crosses the valley coal-bearing shales crop out, these being immediately overlain by purple shales and sandstone, all appearing horizontal. Ascending the slope of Siaoyakou horizontal beds of purple shale are continually met with. Leaving Siaoyakou the road first descends a steep slope, then it crosses a river and reaches Pochi[4]. Standing on the river bridge one observes that the river course is bounded by vertical walls of basaltic lava. The walls however are no more than 30 or 40 meters high and are succeeded by a gentle topography carved in the soft beds of the coal-bearing series. Here no coal pits are to be seen. The basalt and the coal-bearing series appear to dip gently to SW, so that 2 or 3 li west of Pochi Triassic purple shales are again met with, these forming the centre of a flat

1 天無三日晴 2 涼水溝 3 小埡口 4 播箕

synclinal. Farther SW the road follows the course of the river mentioned above. At first grey and green shales are seen, dipping about 15° to NE. Coal pits occur here and there along the strike, marking the distribution of the coal-bearing series. Then basalt appears and then the Permian limestone. A conspicuous gorge of about 4 li is formed in this limestone. This may be called the Erlungkuan[1] gorge; it serves as the boundary line between Yunnan and Kueichou. The structure of the limestone is an anticline of an abnormal type. The strata in both limbs stand almost vertical while the strata in the central part remain nearly horizontal. That is to say, the strata, passing from the limbs into the centre, have to make an abrupt turn of 90°. This is clearly shown in the accompanying section (See Pl. 43:HS1, Fig. 14). At Erlungkuan the limestone strikes N 55° E and dips at 65° SW.

Leaving Erlungkuan the road still follows the course of the river, crossing a thin sheet of basaltic lava and its overlying coal-bearing shales. Then it leaves the river course and passes over a hill spur formed of Triassic purple shales, striking N 53° E and dipping 60° SW. Then it again comes into a valley and follows the course of another river. This latter flows from the SW to the NE, *i.e.,* it flows in the opposite direction of the Erlungkuan river. The two become confluent just below the hill spur which the road crosses. After passing over the Triassic purple shale an immense sequence of Triassic limestone makes its appearance. On account of the fact that the river cuts across the strike at right angles a beautiful section of the limestone series is obtained. Lithologically it may be divided into two parts; the lower part consists of impure thin-bedded limestone with frequent intercalations of shale, while the upper part is dominated by thick-bedded grey limestone weathering to a yellowish tint. The upper part is further distinguished by the porosity of the limestone and by the presence of cavities in it, the appearance of this limestone being closely similar to calcareous tufa deposit. The total thickness of the limestone sequence is not determinable but it is at least 700 m.

Since leaving Erlungkuan the prevailing strike of the formations is observed to be NE-SW. The dip is steep, being 65° to the SW at first, but later it becomes reduced until at Wuchiatun[2], 7 li from Erlungkuan, the strata appear horizontal. From Wuchiatun to Panpienchieh[3] a flat anticlinal formed by the upper part of the Triassic limestone is crossed. Leaving Panpienchieh the road persists in a SW direction while the course of the river deflects to the SE. Thus the direction of the course of the river is along the strike but that of the road is perpendicular to

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1 二龍關 2 吳家屯 3 半邊街

the strike. It is owing to this fact that a beautiful succession of strata from the Triassic to the Ordovician (?) is observed from Panpienchieh to Yehko[1], a distance of 10 li. I shall describe this section in some detail.

Southeast of Panpienchieh the lower part of the Triassic limestone (No. 1, Pl. 43:HS1, Fig. 15) is exposed. It strikes N 52° E and dips at 40° NW. Underlying it comes the Triassic purple shale (No. 2). This is divisible into two parts; the upper part is dominated by uniformly thin-bedded calcareous purple shales while the lower part contains purple shales alternating with green shales and occasionally sandstones. A heavy sandstone stratum is observed in the lower part, this forming a prominent ridge on both sides of the valley in which the road passes. Concordantly underlying these strata there appear grey and green shales of the Permian coal-bearing series (No. 3) in which coal seams do occur and are mined by the local people. The coal however is of inferior quality. The coal series, as usual, is followed downward by a thin stratum of basalt (No. 4) which is in turn underlain by the Permian limestone (No. 5), dipping at 35° NW. After crossing the Permian limestone one comes into a narrow belt of dark grey or black clay-slate 20-40 m in thickness (No. 6). The slate is carbonaceous and the natives have tried to obtain coal from it but apparently without success. Indeterminable plant impressions also occur in the slate. Underlying this comes a thick sequence of uniformly bedded, more or less silicified, light grey limestone (No. 7). Each bed is from 1 to 2 feet thick. No fossils of any description have been found after serious hunting. The limestone strikes N 63° E and dips 33° NW, but the dip gradually lessens and appears nearly horizontal near Yehko. The base of the formation is not exposed.

The silicified limestone and its overlying black slate are new formations not met with before. Since they underlie the Permian concordantly I have formerly considered them as Carboniferous. Now I have reasons to believe (to be given in a later chapter) that the limestone is the equivalent of the Ichang Limestone of Ordovician [Cambrian] age and that the slate belongs to the basal Permian.

At Yehko a small stream enters a cave in Permian limestone. It marks a fault line (Pl. 43:HS1, Fig. 15) which separates the Permian limestone from the Ordovician [Cambrian] limestone. The former strikes NNW-SSE and dips at 15° SW. Leaving Yehko the road turns directly southward to Huangnichung[2]. Isolated hills of horizontal Permian limestone are seen on the left side of the road, these standing on a platform of Ordovician [Cambrian] limestone. Black slaty beds

1 野角 2 黄泥冲

frequently occur on this platform and around the Permian limestone hills. From Huangnichung to Tangkuanchung[1], a distance of 20 li, the road keeps going in an easterly direction. The strata met with *en route* are nothing but the limestones of supposed Ordovician [Cambrian] age. The strike is, at first, nearly E-W, then it changes to N 75° E and then to N 45° E. The dip is gentle, 5-15° to the SE. Leaving Tangkuanchung the road leads in a NE direction for 5 li, then it turns abruptly SE. The strata seen are still the Ordovician [Cambrian] limestones, striking N 30° E and dipping 20° SE. About 2 li from the bend of the road the Ordovician [Cambrian] limestone ends and the basal Permian beds appear. A detailed section of this formation is given in the following (Pl. 43:HS1, Fig. 16):

A = Ordovician [Cambrian] limestone

B = Basal Permian shales, about 40 m.

B_1 = Hematitic sandstone locally rich in hematite.

B_2 = Black and grey clay-slate about 20 m. The black part is carbonaceous and contains thin pyritic layers. The grey part contains characteristic pisolites.*

B_3 = Fine, whitish quartzite, 5 m.

B_4 = Yellowish brown shale, 10 m.

C = Permian limestone.

The natives have tried at different places to get coal from this formation but without success. Concordantly following these strata is the Permian limestone which here occurs in its characteristic phase, forming pointed hills and awe-inspiring pillars. It strikes N 45° E and dips 50° SE. It is directly followed by the coal series, the basalt sheet being absent here. The coal series is dominated by green shale and clay slate with sandy members. Near the top a stratum of impure limestone occurs; this will be fully dealt with presently. The coal series is as usual overlain by a series of purple shale which strikes N 45° E and dips 50° SE and

1 唐官冲

* Specimens of this pisolitic rock collected by the author were studied in the laboratory of the Geological Survey (then in Peiping) by Mr. Y. T. Nan (南延宗) who declared that the rock is *bauxite*. Thus the first discovery of bauxite was made in November 1929 near Pitsieh-hsien, western Kueichou. Unfortunately neither Mr. Nan nor the author published anything concerning this important discovery—T. K. H., May 1945.

forms a prominent and uniform ridge at Peichenkuan[1] through which the road must pass (Pl. 43: HS1, Fig. 17). At Peichenkuan one overlooks in the southeast a broad and open valley in which lies the prosperous city of Pitsiehhsien[2].

Pitsiehhsien is the largest city in northwestern Kueichou. It is a city of commercial and political importance. To the north a paved road connects it with Süyunghsien[3] in Szechuan while another main road leads southwestward to Weininghsien[4]. In the southeast is the city of Tatinghsien[5] with which it is connected by a motor road built recently. Structurally the city lies in the centre of a flat, NE-SW trending syncline of Triassic formations. A small river coming from the NW cuts across this syncline and flows toward the SE. The valley of this river is open, with a valley bottom covered by a thick alluvial soil extensively cultivated as rice fields. A more or less continuous range of Triassic purple shale occurs in the northwest, extending for miles to the NE and to the SW. To the southeast another range is seen in the distance, also striking NE-SW. This is composed of the same purple shale formation occurring in the SE limb of the Pitsieh syncline. I have made three side excursions from Pitsiehhsien, which are described below.

I have proceeded along the motor road toward Tatinghsien for 15 li. The Triassic limestone west of the city have been observed to dip to SE. Just east of the city however these same strata dip at 30° to the NW. Evidently they form a synclinal structure with its axis passing through the city. Proceeding ESE for 10 li thin-bedded Triassic limestones are continually met with, these forming a gentle anticlinal flexure complementary to the major syncline. The prevailing strike observed so far is NE-SW. Further SE the strike gradually changes and finally assumes a constant value of S 70° E with a dip of 40°-50° to the NW. I know that this strike must be constant at least for 20 li because I noticed that the purple shale range, which marks the direction of the strike, continues in a SE direction as far as the eye can reach.

I have mentioned that the river at Pitsieh comes from the NW, while the prevailing strike of the formations is NE-SW. Naturally one could expect to get an excellent geological section up the valley of this river. Such a section was actually obtained and will be described here. Proceeding northwest along the river thin-bedded Triassic limestones are first met with, striking N 55° E and dipping 50° SE. A small waterfall is formed on these limestones. These are underlain by purple and green shales which are in turn succeeded by shales of the coal-bearing

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1 北正關 2 畢節縣 3 敘永縣 4 威寧縣 5 大定縣

series. The purple shale constitutes a ridge but the coal-bearing strata occupy a flat country. Further beyond is another ridge of Permian limestone with its basal shales and sandstones which are again underlain by the Ordovician [Cambrian] limestone. The succession is best shown in the accompanying section (See Pl. 43:HS1, Fig. 18):

1) Thick-bedded silicified limestone [Cambrian]
2) Black carbonaceous shale and sandstone 40-50 m.
3) Massive Permian limestone with [*Neoschwagerina*] at the top, dip 35.° Thickness about 350 m.
4) Coal-bearing series about 170 m. It consists of yellow and grey shales and sandstones with frequent intercalations of fire-clays and coal seams. Very thin basaltic lava sheets occur in the lower part.
5) Rather massive, impure limestone about 20 m. *Lyttonia, Productus* and other brachiopods occur in abundance (Loc No. 1322) [7, 9, 10].
6) First green then purple, fine and compact calcareous sandstone, 250 m. The rock is exceedingly hard and resistant to weathering. It is the ridge-forming factor of the "purple shale" series.
7) Strata of similar characters as 6) but thin-bedded and shaly, about 150 m. These are the typical "purple shale".
8) Thin-bedded Triassic limestone, St. N 55° E, dip 50° SE.

The occurrence of a limestone (No. 5) immediately above the coal-bearing shales is of great significance. This limestone, being highly impure, is frequently weathered to a porous shaly rock from which well-preserved fossils can be easily collected. Beautiful specimens of *Lyttonia* occur abundantly and can be collected at will. The *Lyttonia* fauna is undoubtedly of Permian age and has been considered to represent the Middle Permian by stratigraphers working in Chinese territory. Thus the Permian age of the coal-bearing series (hereafter it will be called the *Lyttonia* coal series) is certain. In previous occasions this coal-bearing formation consists entirely of shaly and sandy strata, limestone members being absent. Here it is the first time to observe a limestone on the top of the formation. Later on we shall see that the formation becomes gradually more and more calcareous in central Kueichou until it is almost entirely dominated by limestone.

The Permian formations in the Pitsiehhsien area have been observed at Loufungya[1], some 10 li west by north of the city. At the latter place there are numerous

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1 樓峰埡

coal pits from which good anthracite is obtained. At one of the pits at Kuashan the following section is noticed (Pl. 43:HS1, Fig. 19):

1) Massive Permian limestone.
2) Grey and yellow shales with thin coal seams and plant remains (Loc. No. 1321) [14].
3) Thin basalt sheet.
4) Shales with the main coal seam at present actively worked.
5) Covered by talus.
6) Massive impure limestone with *Lyttonia* (Loc. No. 1322) [9, 10].
7) Fine and compact, green and purple sandstone with small pelecypods (Loc. No. 1323) [12].

It will be noticed that the succession here is practically the same as seen along the Pitsieh river. The occurrence of a thin basalt sheet is interesting. At first I doubted if the rock is really basaltic lava, but after careful examination I convinced myself that it is so.

Coal mines in the Pitsiehhsien area—Though the basal shales and sandstones of the Permian limestone formation is susceptible of containing coal, repeated attempts to obtain coal from them have failed. All the coal consumed in the city comes from the mid-Permian shales underlying the *Lyttonia* limestone. Three important localities produce the Permian coal, namely, Loufungya, Lingfungszu[1] and Haiszuping[2]. The first and second are adjoining localities 10 li west of the city and the third is 20 li north of the city. I have visited the first two which will be briefly described.

The purple shale range of Pitsiehhsien extends south-westward for an unknown distance. On the escarpment of this range (which is on the western side) the coal-bearing shales are extensively exposed in a long belt. The numerous coal pits of Loufungya and Lingfungszu are situated just along this belt. Several seams of fire clay occur in the shales and it is above these clays that coal seams are found. The thickness of these seams however is generally inconsiderable. It was reported by the miners that the thickest seam is 3 Chi but I have measured the main seam at Kuashan to be 1.7 Chi (1 Chi approximately equals 32 cm.). At the latter place the greatest mine gives a daily output of 1300-3900 catties or roughly 1 metric

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1 靈峰寺 2 海寺坪

ton. The coal is an anthracite of greyish black color, with frequent inclusions of pyrite. It burns with little smoke and has a great heating value. The thickness of the main coal seam must be very variable, since near Peichenkuan, less than 4 km. from Loufungya, the coal-bearing formation is apparently devoid of coal seams, no coal pits being seen there.

From Pitsiehhsien in Kueichou Crossing the Chishuiho to Süyunghsien in Szechuan

(November 23 to November 30, 1929)

Leaving Pitsiehhsien the road leads in a northeastern direction following the strike of the formations which is about N 60° E. From Pitsiehhsien to Maochichang[1], a distance of 25 li, the road runs in a strike valley in which only outcrops of the Triassic thin-bedded limestone are observed, dipping rather steeply to the SE. On the left hand one sees a uniform range apparently formed of purple shale strata which weather away into a purplish red soil covering the dip slope of the range. Two li east of Maochichang the road abruptly turns to the NW, and crosses a pass on the Triassic purple shales. The latter here strike N 45° E and dip 70° SE. Underlying the purple series comes the *Lyttonia* bed which here is not represented by a limestone but by a calcareous grey shale weathering yellow. This is again underlain by grey and yellow shales and sandstones with fire clays. Three coal seams are reported to occur in the series. No basalt sheets are seen. Next comes the massive Permian limestone after which a thin formation of black shale and sandstone, as usual, makes its appearance. This is followed by the thick-bedded silicified Ordovician [Cambrian] limestone. All the above formations assume a prevailing strike of NE-SW and dip steeply to the SE. The Ordovician [Cambrian] strata are quickly crossed and the road comes into shales of the coal-bearing series. I recognized at once that a fault of considerable magnitude must have occurred. This fault is supposed to be a dip fault, bringing the mid-Permian shales in contact with the Ordovician [Cambrian] and the Triassic purple shale with the Permian limestone.

Leaving the fault the road runs nearly on the contact between the coal-bearing shales and the Permian limestone for a time then it comes into the region of the latter until Pachaiping[2]. The strata strike N 30°-40° E and dip moderately

1 毛鷄廠 2 八寨坪

to the SE. At Pachaiping, overlying the Permian limestone with *Schwagerina* [*Neoschwagerina*] occurs the mid-Permian coal series consisting of grey and yellow clay-shales intercalated with seams of sandstone and fire clay. Coal seams occur at several horizons. At the top of the series is a limestone formation weathering into a yellow or brown sandstone-like stuff, therein *Lyttonia* and other fossils are found in abundance. Leaving Pachaiping the Permian limestone is soon crossed and sandstone and quartzite of the basal Permian come into view, striking N 34° E and dipping 42° SE. Underlying this comes the thick-bedded Ordovician [Cambrian] limestone which forms a steep slope. Ascending the slope one reaches Maliuping[1] at an elevation of 1520 m. The topographic features around Maliuping are similar to those of Chenghsiunghsien. The country is flat or only gently rolling, with an extensive and thick cover of residual clays. Here and there occur isolated rounded hills serving as monadnocks for the peneplane. On account of the soil cover no exposures of rock formations can be observed. At Chinyingshan[2] one sees in the NW a continuous ridge probably of horizontal beds of Ordovician [Cambrian] limestone while in the southeast another ridge of Permian limestone can also be observed. From Chinyingshan to Tutiya[3] Ordovician [Cambrian] limestones seem to prevail but the strike and dip are not determinable owing to frequent covering by soil. Going north from Tutiya a succession of thick-bedded quartzite is found, striking N 25° W and dipping 40° E. Then the road follows the course of the Lengshuiho[4] which flows to the north. On the eastern bank of this river massive Permian limestone appears, dipping apparently to the east. On the western bank however thin-bedded grey limestones are observed, striking N 30° W and dipping 37° NE. This limestone is quite unlike the Permian limestone but has some resemblance to the upper Ordovician limestone seen at Kumangpu. The relation between this limestone and the quartzite mentioned above is not determined. Near Muchuchin[5] the Permian limestone is in direct contact with the supposed Ordovician limestone, a stratum of black calcareous shale marking the contact. Near the base of the Permian limestone *Schwagerina* [?] and *Michelinia* are collected.

From Muchuchin to Tsingshuitang[6], a distance of more than 80 li, the road essentially follows the strike of the Permian formations. It runs either in the upper part of the Permian limestone or on the contact of the latter with the *Lyttonia* coal series. The Permian limestone does not appear different from the previous sections but the *Lyttonia* coal series and its overlying strata undergo some noticeable lithological changes in the range of this distance. I shall describe the geological details

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1 麻柳坪 2 金銀山 3 土地埡 4 冷水河 5 母猪頸 6 清水塘

according to well marked sections. Between Muchuchin and Yentzukou[1] the strata first strike N by W then due NS and finally N 45° E at Yentzukou. The dip is generally from 40° to 50° E. Curious enough, the Permian limestone does not form a ridge as might be expected; it is the purple shale series overlying the *Lyttonia* bed that forms a continuous high ridge. Near the foot of this ridge the coal-bearing series occurs while numerous mining pits are seen here and there along the ridge. Active mining is seen at Sienhsienwan[2] and at Yentzukou. At these places the following sections are observed (Pl. 44 : HS2, Fig. 20):

1) Permian cherty limestone.
2) Grey shale and sandstone with coal seams.
3) 30 m of grey limestone with fossils (*Lyttonia* bed).
4) Green and purple sandstones and shales.
5) Greenish grey thick-bedded limestone (30-40 m at Yentzukou, much thicker at Sienhsienwan).
6) Typical purple shale.
7) Triassic limestone.

From Yentzukou to Sankushui[3] the prevailing strike changes to N 55°-60° E and the dip is 30°-40° SE. The road keeps running in the upper part of the Permian limestone which is succeeded by the coal-bearing series and Triassic purple shale series as usual. The lower part of the latter formation however becomes more and more calcareous, forming white limestone cliffs whenever a stream cuts across these formations. From Sankushui to Tsingshuipu[4] the strata suddenly turn around so that the road cuts right across the coal series, the purple shale formation being crossed in a distance of less than 1 km. The structure needs some explanation. At Sankushui one sees two prominent ranges of Triassic purple shale, one in the north and the other in the south. They are joined up at Tsingshuipu forming a smooth semicircular arc. To the west is another arc of Permian limestone which occupies the flanks of a dome-shaped mountain probably formed of Ordovician and Silurian strata. Between the Permian limestone arc and the arc of the purple shale is a valley in which coal-bearing shales make their appearance. The strike of the strata from Sankushui to Tsingshuipu is nearly N-S, the dip being gentle to the E. I consider the structure as a sharply pitching anticline with its axis directed E-W, passing Sankushui and Tsingshuipu.

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1 燕子口 2 先賢灣 3 三股水 4 淸水舖

Leaving Tsingshuipu the road turns to the NE. Outcrops of typical purple shale are met with, dipping about 10° E. Then strata of well-bedded light grey limestone occur. The strike changes now to N 60° W and the dip is 25° NE. Further north the deep valley of the Chishuiho[1] appears into view. On the opposite side of the valley one sees a conspicuous high range, the range of Suehshankuan[2], rising abruptly from the Chishuiho to a height of no less than 1000 m. It is through this range that our route has to pass. Descending the Chishuiho valley one observes a thick sequence of thin-bedded Triassic limestone with a prevailing strike of N 35°-40° W and dip of 20°-30° NE. Roughly speaking this slope is the dip slope of these limestones.

The town of Chishuiho is situated on the northern side of the river which bears the same name. This is the largest river in northwestern Kueichou. It marks the boundary between Szechuan and Kueichou provinces. At Chishuiho its course runs from the WNW to the ESE. Its water is unusually clear and is deep green in color. The discharge is considerable but owing to the frequent occurrence of cataracts navigation seems impossible for this part of the river. The most interesting fact to be noted is that the valley of the river approximately coincides with a major synclinal structure of the formations (Pl. 44 : HS2, Fig. 21). The Triassic limestones seen from Tsingshuipu to Chishuiho form the southern limb of the syncline while those of Suehshankuan form the northern limb. In the centre of this syncline Jurassic sandstones are well developed; these occur north of the river, they being absent on the southern side. Outcrops of these sandstones are observed 2 li east of the town where they form a high cliff rising abruptly from the river. They are horizontal and are underlain by horizontal beds of Triassic limestone. The two formations are concordant. As a rule the sandstones are thick-bedded, yellow in color and very coarse in texture. There are no shaly members nor coal seams occurring in the formation.

The topography of the Chishuiho valley represents two distinct features of physiographic development, an early mature stage of erosion followed by a young stage of vertical cutting. This is shown by the accompanying sketch (see Pl. 44 : HS2, Fig. 22).

Ascending the northern slope of the Chishuiho valley scattered blocks of yellow Jurassic sandstone are continually met with. True outcrops however are very rare. Judging from the sandstone ridge appearing on the left side of the route

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1 赤水河 2 雪山關

it can be said that the Jurassic beds dip gently toward the valley and consequently the slope which one is ascending is a dip slope of the formations. About half way of the slope the sandstones give way to a thick succession of Triassic limestones, striking nearly E-W and dipping 25° to the S. About 1 li from Suehshankuan the limestone ends and the Triassic purple shale begins. At the pass of Suehshankuan (1550 m) the purple shale strikes N 80° W and dips 33° S. From Suehshankuan northward older Palaeozoic formations appear and it is in these formations that some of the most intricate foldings are met with.

Descending Suehshankuan a section of the Permian formations is observed as follows (Pl. 44:HS2, Fig. 23):

1) Purple shale and sandstone with thin limestone intercalations.

2) 25 m of fossiliferous marine limestone with *Lyttonia* (Loc. No. 1460).

3) Shale and sandstone with coal.

4) 3 m of basalt.

5) Massive cherty Permian limestone, strike E-W, dip 33° S.

Going north from Kuanti[1] the Permian limestone is soon crossed and greenish grey limy shales of the Silurian appear. The latter is observed to be concordant with the Permian limestone. Further north Silurian and Ordovician strata come into view. Intricate overthrusts are developed in these formations. They are shown in the following section (Pl. 44:HS2, Fig. 24).

P = Massive Permian limestone.

S = Silurian

Sh = Greenish grey or yellowish, thin calcareous shale with occasional thin limestone seams.

Ss = Fossiliferous limestone (more than 20 m) with *Halysites, Favosites* and other corals.

Sc = Graptolite shales

g_2 = Upper graptolite shale, prevailingly green but occasionally yellow and grey shale.

g_1 = Lower graptolite shale; black, well-bedded sandy shale.

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O = Ordovician

Oo = 25 m of well-bedded greenish grey limestone with characteristic "mud-crack" structures on bedding plane. *Orthoceras* and large gastropods seen on polished sections.

On = First grey and yellow thin shale, then green fissile shale with intercalations of thin limestone and brownish yellow sandstone. Graptolites occur in the green shale while species of *Orthis* are found in a surprising number on the sandstone. Typical exposures are seen in the vicinity of Fungshuichiao[1].

€i = Thick-bedded limestone with *Cameroceras* and *Ophileta* (?) near the top. Base not exposed.

(For fossil horizons and localities see Pl. 44:HS2, Fig. 24).

Two overthrusts are observed between Kuanti and Moni. One occurs half-way between Kuanti and Fungshuichiao. It brings the *Orthoceras* limestone (Oo) over Silurian graptolite shale (Sc). The other is found near Tienpaopao[2]. There the Lower Ordovician limestone [Cambrian] is thrust against Silurian shales (Sh). The thrusts are directed from the south to the north. All the formations assume a prevailing strike of EW and a dip of 30° or more to the S. South of Fungshuichiao the strata are further disturbed by a dip fault. The relationship is best shown in the accompanying diagram (Pl. 44:HS2, Fig. 25).

Leaving Moni one begins to observe isolated outcrops of thick-bedded grey limestone with a prevailing strike of N 80° W and dipping steeply (60°-70°) to the N. Further north a northerly dip prevails. It is at once recognized that we are passing over a major anticlinal structure whose axis is located somewhere near Moni. That thick sequence of strata from the Suehshankuan range to Moni forms the southern limb of the anticline while those strata occurring north of the latter village forms the northern limb. The thrusts above described are secondary structures subordinate to the major structure of the anticline. 2 or 3 li north of Moni the Ordovician limestone [Cambrian] is followed by green shales and sandstones strongly disturbed and locally folded. These are again succeeded by the characteristic *Orthoceras* limestone which stands nearly vertical. Here one notices a decidedly unharmoneous relation between the formations occurring on the left side of the road and those on the right side. On the left the Ordovician shales and *Orthoceras*

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1 風水橋 2 田包包

limestone just alluded to form low hills but on the right a prominent hill of massive Permian limestone makes its appearance. The limestone strikes E-W and dips gently to the N. It is underlain by strongly disturbed green shales of probably Silurian age. Near the contact the limestone strata gradually steepen and appear to stand vertical on the top of a hill (See Pl. 44 : HS2, Fig. 26). There is developed a cave in the limestone into which a stream flows. The relationship is explained by a dip fault which brings older formations on the left in contact with younger ones on the right. The fault-line approximately coincides with the road.

Further northward Permian limestones occur also on the left side of the road, these forming a ridge extending westward as far as the eye can reach. Ascending this ridge one soon observes horizontal strata of Permian limestone. Horizontal or gently folded limestones prevail until north of Heinishao[1] when grey shales of the mid-Permian coal-bearing series and its overlying *Lyttonia* limestone come into view. These beds form a flat synclinal which is soon passed and the road once more comes into the domain of Permian limestone. At first the strata strike NW and dip gently to SW. Toward Yingpan[2] however they become horizontal and remain so till the valley of Chanti[3]. Sink holes are of common occurrence in the limestone region.

About 5 li south of Chanti the road begins to descend a deep E-W valley in which a stream flows toward the east. The upper part of the walls of this valley is formed of Permian limestone gently dipping in opposite directions. The lower part and the valley bottom are occupied by Silurian strata. Thus this valley can be considered as a "window" [inlier] for the Silurian. At the southern slope of the valley Silurian grey shales appear, dipping moderately to the S. In the middle of the valley there occurs a thin formation of thin-bedded limestone (probably equivalent to Ss of the previous section) striking N 70° W and dipping 52° N. This is followed by green and grey shales dipping in the same direction. Then massive Permian limestones appear forming an escarpment striking E-W. Toward the NE however this same escarpment seems to strike NE-SW.

It appears that the Silurian beds essentially form an anticline. The fact that a stratum of limestone (Ss) occurs in the northern limb but is absent in the southern limb is worth noticing. Since the anticline is less than 3 km. in width the relationship cannot be explained by variation in lithological characters. I strongly suspect

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1 黑泥哨 2 營盤 3 站底

the existence of an unconformity between the Permian and Silurian formations (See Pl. 44: HS2, Fig. 27).

Going north from Chanti continuous outcrops of massive Permian limestone are met with. They strike prevailingly NE-SW and dip to the NW. North of Pushih[1] the limestone is succeeded by shales and shaly limestone with coal seams. Above the coal-bearing beds is another sequence of thick-bedded limestone forming an escarpment on the left side. This is probably the replacing member of the basal part of the Triassic purple shale series. Dark brown iron nodules are found in pockets in the massive Permian limestone just below the coal-bearing shales. The ore has been mined and smelted by the natives.

Toward Wangchengpo[2] one expects to find outcrops of Triassic formations. But instead one observes continuous outcrops of massive Permian limestone forming a low pass at Miaoerkuan[3]. Further north as far as Shuangtsing[4] Permian limestones prevail. The disappearance of the Triassic purple shale and its underlying limestone is probably due to the occurrence of a fault somewhere near Wangchengpo. [This fault is unnecessary].

From Shuangtsing to Lowo[5], a distance of 20 li, the road leads in a NNW direction, crossing strata of the Permian limestone. These limestones often appear so massive that they do not show traces of bedding-plane. 3 li southeast of Lowo they appear to strike NNE-SSW and dip 40° SW. Lowo lies on the southern side of a big stream flowing to the NW. To the north there rise prominent hills of Silurian strata. To the southwest an escarpment of Permo-Triassic formations appear striking NNW. It is along the foot of this escarpment that the natives have dug pits to obtain coal from the mid-Permian coal series. The succession of the Permo-Triassic strata is observed at Tishui[6], 5 li NW of Lowo:

1) Massive Permian limestone with *Neoschwagerina* at top.
2) Coal series, lower part with sandstones, middle largely shales with fire clays and coal seams, upper chiefly covered.
3) Thick-bedded greenish grey slaty limestone purplish at lower part.
4) Purple shale of the Triassic.

At Tishui one observes some characteristic topographic features. To the west and southwest there rise prominent hills formed apparently of horizontal or gentle

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1 蒲氏 2 望城坡 3 猫兒關 4 雙井 5 落窩 6 滴水

dipping beds of the Triassic purple shale and its underlying limestone. These hills form a more or less continuous semicircular ridge which is cut in the southwest by the mighty Yungningho[1]. A continuous belt of black soil dotted with numerous coal pits occur along the foot of this ridge, marking the outcrops of the Permian coal-bearing series. The area surrounded by this semicircular arc is dominated by a plateau with numerous low and isolated hills formed of Permian limestone which appears horizontal. Sink holes are of common occurrence on this plateau. The development of such a topography is undoubtedly due to the presence of a flat anticlinal structure whose axis pitches gently to the west.

Crossing the Permian limestone plateau one soon comes into the valley of the Yungningho which flows due north and along whose course the road runs. A beautiful geological section from the Permian to the Cretaceous red beds is observed in the canyon of this river. All the formations strike N 70°-80° E and dip from 35° to 45° N.

Süyunghsien is commonly known as Yungning or Yungninghsien. It consists of two cities, one situated on the western and the other on the eastern bank of the river Yungningho, 360 m above sea-level. The western part is known as Chuancheng or Szechuan city whilee the eastern part as Kueicheng or Kueichou city. Small boats heavily loaded with cooking salt come up-stream from Luchow to be unloaded here. The salt is then transported by human bearers or pack animals to Kueichou for distribution. Indeed the prosperity of the city chiefly depends on this salt trade.

Yungning lies near the southern margin of the Red Basin of Szechuan. Red beds are extensively developed in its vicinity. These are mainly soft red clay shales lying nearly horizontal or gently tilted and forming low isolated hills with flat areas between, exhaustively cultivated. The lower part of the red series contains members of red sandstone while toward its base heavy yellow sandstone seams alternate with the red clay-shale. Its contact with the Jurassic sandstone, as observed at Tiaoyutai[2], is a conformable one, red clay-shales lying directly on the sandstone. It is interesting to note that the dip of the strata from Tiaoyutai to Yungning varies gradually and imperceptibly. At first they dip at 45°, then 30°, then 20° and finally the dip decreases to a few degrees near the city. Going north from the city these same strata appear horizontal until Toutang[3] when they begin to dip in the opposite direction at 5°. Thus the red beds constitute a very gentle syncline in the vicinity of Yungning.

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1 永寧河 2 釣魚台 3 頭塘

Looking east from the city of Yungning one sees in the distance a high ridge with bright red vertical cliffs covered on top with a thick growth of bushes. This ridge, rising some 400 m above the river level, is entirely formed of massive bright red sandstone lying almost horizontally and apparently concordantly upon the soft red clay-shales of the [Lower] Cretaceous red series. Beautiful columnar jointing is developed in the sandstone resulting in the formation of conspicuous pillars or barnacles resembling those found in Permian limestone regions. I did not have the opportunity to examine the sandstones more closely but I believe they constitute a formation quite separable from the underlying red beds. It is supposed that they are equivalent to the sandstones occurring north of Suifu.

Before leaving Yungning I have spent one morning in going to Toutang, 10 li north of the city. All the strata met with *en route* belong to the Cretaceous red beds. At a commanding point at Toutang I can see in the far distant north no prominent ranges or high plateau. All that can be seen is an endless stretch of soft red hills, only one or two red sandstone ridges appearing now and then, breaking the monotony. So I conclude that there are no Palaeozoic or early Mesozoic formations occurring between Yungning and the Yangtze River. This conclusion is supported by the report of travellers who informed me that no "Tashan" or great mountain occurs on the main road from Yungning to Luchow.

From Süyunghsien to Kulinghsien

(December 10 to December 12)

The first third of the distance from Yungning to Kulinghsien coincides with my route from Pitsiehhsien to Yungning. So I shall begin my description at the village of Lowo from which the two roads diverge. Going east from Lowo the road follows the course of a river tributary to the Yungningho. Outcrops of massive Permian limestone appear along the banks of the river with a prevailing NW-SE strike, dipping steeply to the SW. Further east the strike gradually changes to E-W and finally to NE-SW. Thus a semicircular arc is formed by the Permian limestones. To the north Silurian shales and limestones appear. They underlie the Permian limestone and thus seem to form a core of a dome-like structure. At Tengchanping[1] the road ascends a steep hill-spur. At first coal-bearing shales are met with, then Triassic purple shale. Further southeast Triassic limestone appears. These formations constitute a basin complementary to the dome above stated. Toward Tsienchuping[2] Triassic limestones still prevail but since it was getting

1 燈盞坪 2 箭竹坪

dark their structural relationships could not be observed. 2 li east of Tsienchuping the Triassic limestone is succeeded by purple shale, all striking E-W and dipping 25° N. The purple shale as usual forms a ridge across which the road passes and descends into a strike valley. Purple shale forms the northern wall while Permian limestone forms the southern wall of this valley. The mid-Permian coal series occurs in the valley bottom. Going east from Yuanchiakou[1] for 10 li the same condition prevails. The succession of the Permo-Triassic formations seen 2 li east of Yentiwan[2] is as follows:

1) Thick-bedded cherty Permian limestone
2) Grey shales with anthracite
3) Thick-bedded cherty mid-Permian limestone
4) Purple shale, lower part hard and sandy
5) Thick-bedded Triassic limestone

(Note that the coal-bearing series here is dominated by marine limestone).

Then the course of the stream which we are following turns to the NE so the road runs in the same direction. The strata are observed to strike N 75° W and dip 35° N. Toward Toyaokuan[3] the Triassic formations are succeeded by Jurassic yellow sandstones with grey shale intercalations, strike and dip being unchanged. The thickness of the Jurassic sandstone is estimated at 280 m.

Pottery works at Teyaokuan.

At Teyaokuan on the eastern side of the river there is erected a pottery works. Two hours' examination reveals the following facts:

Material for the molds: the material used in making the molds is a rather pure white kaolin-like clay obtained from a kaolin-bearing sandstone found in the upper part of the Jurassic formation. I have visited one of the quarries of the sandstone. When fresh it is milky white in color, very coarse in texture. Quartz grains and kaolin seem to be the essential constituents while black and white mica flakes are occasionally seen. This kaolin-bearing sandstone is called Changtsaoshih[4] by the workmen.

Material for the glaze: The engineer in charge told me that three things are used for making the glaze. These are Fungkoushih[5], Huashih[6] and Fangchiaishih[7]. The first is a variety of the kaolin-bearing sandstone used for molds.

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1 袁家溝 2 煙地灣 3 得要關 4 長槽石 5 封口石 6 滑石 7 方解石

The second is simply talc mixed with coaly material. [It is now known that this "talc" or Huashih is halloysite]. It is obtained in the mid-Permian coal-bearing series. The third is a pure calcite probably [taken from] the calcite veins in the Permian limestone. These three materials are ground to fine powder and mixed up before use.

Material for the painting: Most of the pottery have to be painted. The painting is done exclusively with cobalt oxide bought from Japan. The color is deep blue and is called "Tsinghua". The cobalt oxide costs about 80 cents per "liang" *i.e.*, 1/16 of a catty.

Operation: Lumps of kaolin-bearing sandstone are obtained by quarrying. These are ground to powder with water mills. Put the powder into tanks half-filled with water. Disturb the water so that the fine particles of kaolin become suspended. Let the milky water go into another tank in which the kaolin particles will settle down after a sufficient elapse of time. By this method the sand grains of the sandstone are separated from the kaolin particles which form a plastic clay at the bottom of the tanks. This clay is then ready for making molds. When the molds become dry they have to be painted. Then glaze is applied. The molds are put into a large furnace and heated to a cherry red color for 24 hours. After the heating the furnace is gradually cooled down. The products are then ready for the market.

The furnace: The furnace of this pottery works is quite modern. It is built entirely of fire bricks of a good enduring quality. It is about 10 m high and is as large as one ordinary room. It has a spaceous hearth and a brick chimney. The fuel is largely twigs of pine trees. No coal is used.

Products: Only low grades of pottery are produced from the Teyaokuan works. These however find a good market in the neighbouring districts. The products are chiefly rice-bowls, soup-bowls, dishes, spoons and cups. The name of the company is I-chi[1]. The chief engineer at the beginning of the enterprise was a native of Kiangsi who was supposed to be well acquainted with pottery technique. Now a local expert is in charge of the work.

From Teyaokuan to Kulinghsien[2], a distance of 40 li, the road still follows the course of the river which runs to the NE at first, then turns to E by S, then to the NE again and finally meanders in a prevailingly E by S direction for 20 li

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1 怡記 2 古藺縣

to Kulinghsien. The strata met with *en route* belong to the Cretaceous red beds series, with a prevailing strike of N 65° W. The dip near Teyaokuan is 30°-40° NE but it gradually decreases to 12° toward Kulinghsien.

The city of Kulinghsien lies on the southern bank of a river which for lack of a proper name may be called the Kulingho. After catching several tributaries at Kuling the Kulingho becomes a large stream east of the city. It enters the Chishuiho at Taipingtu[1] whence small boats can proceed down-stream to Chishuihsien[2]. The country around Kulinghsien is open, with comparatively low hills of soft red clay-shale and red sandstone. To the north one sees in the distance a high plateau with characteristic bright red cliffs undoubtedly formed of horizontal red sandstones equivalent to those seen at Süyunghsien. These sandstones appear to be in concordant relation with the underlying red clay-shales.

2 li NE of Kulinghsien is a place called Tungtung[3] where copper is said to have been worked some years ago. I have visited this place and found a white sandstone stratum intercalated in the red clay-shales. Malachite coatings are occasionally seen on the sandstone but they are of a trifling quantity.

From Kulinghsien in Szechuan Crossing the Chishuiho to Tatinghsien in Kueichou

(December 14 to December 18)

At Yungninghsien I received the frightful news that Mr. Y. T. Chao was killed by bandits in Yunnan. I immediately wired to Dr. V. K. Ting, leader of our Kueichou-Yunnan expedition. At Kulinghsien I received Dr. Ting's reply, instructing me to proceed as quickly as possible to Tatinghsien where he waited for my arrival. With my heart filled with sorrow and with a short time available I made a very rough reconnaissance between Kulinghsien and Tatinghsien. Some of the observations in this route therefore are imperfect and some of the important structural features might have been overlooked. Nevertheless, I believe, with my previous experience, my identification of the formations is essentially correct.

Leaving Kulinghsien the road runs directly southward along the course of a tributary of the Kulingho. For 7 or 8 li continuous outcrops of the Cretaceous red beds are met with, these striking nearly EW and dipping about 40° N. The strata are mostly red clay-shales and sandstones. Near the base of the series yellow

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1 太平渡 2 赤水縣 3 銅洞

clay-shale members appear as intercalations in the red clay-shales. Farther south Jurassic sandstones come into view, striking N 80° W and dipping 38° N. They appear to be concordant with the red beds. Underlying the sandstone comes a thick sequence of Triassic limestone which as usual is underlain again by purple shale and sandstone. At Mayuan[1] a sequence of well-bedded limestone with shaly intercalations near the base lies under the purple shale, striking N 80° W and dipping at 30° N. This is undoubtedly the mid-Permian coal series which here becomes dominantly calcareous. South of Mayuan the road climbs a limestone cliff of the river gorge. The limestone is the massive Permian limestone which is crossed in a distance of 2 li. Then green and yellow shales with intercalations of thin limestone appear, striking N 70° W and dipping 20° N. Silurian fossils were collected from the shales. Further south the stream splits into two branches and it is in the valley of the southwestern branch that the road descends. At a stone bridge horizontal strata of thick-bedded limestone occur, these underlying the Silurian conformably. Natural sections of Orthoceran cones are seen on weathered surfaces of the limestone as well as on stone tablets made from the same material, proving its equivalence to the *Orthoceras* limestone observed in previous sections. The *Orthoceras* limestone however only forms an [inlier] so that toward Siaoshui[2] Silurian shales reappear. All the hills in the vicinity are composed of Silurian shales and limestones. Going south from Siaoshui the road still follows the course of the stream which ends at a pass 20 li south of Siaoshui. Silurian strata are continually met with *en route*, all lying almost horizontal. Some of the high hills on the left side of the road are capped by horizontal beds of massive limestone, apparently belonging to the Permian limestone formation.

Descending the pass the road follows the course of a southerly stream for about 10 li. Horizontal Silurian strata are continually met with. Some of the limestone seams contain inumerable fossils chiefly *Favosites, Halysites* and other corals. Toward the south *Orthoceras* limestone is observed on both sides of the stream course. Leaving the stream the road turns to SW and crosses a ridge probably of Silurian limestone but it was quite dark so that I am not sure of the identification.

At Peisha[3] one looks to the east and observes a thick stratum of Permian limestone lying perfectly concordantly upon the Silurian shales. The formations strike N 80° E and dip about 20° to the S. Leaving Peisha one first ascends a slope on Silurian strata, then comes into the Permian limestone, then again into the

1 麻淵 2 小水 3 北沙

Silurian shale and finally into the Permian limestone striking E-W and dipping moderately south. The structure is rather complicated, that showing in the map may not represent the real situation. The Permian limestone is followed as usual by the mid-Permian coal series which here is dominated by limestones, coal-bearing shales being almost entirely absent. At Tutikuan[1] pass one observes purple shales striking N 66° W and dipping 35° SW. South of Tutikuan Triassic limestones appear, strike and dip remaining the same. Crossing the Triassic formations the road descends a steep slope of Jurassic yellow sandstones and grey shales. Near the end of this slope red clay-shales and red sandstones make their appearance, dipping at 30° S. They overlie the Jurassic concordantly. Then the road turns SE and runs in the bottom of a deep valley in which lies the large village of Matitan[2]. The valley of Matitan essentially coincides with a steep syncline formed of Mesozoic formations. In the centre of this syncline Cretaceous red beds chiefly red clay-shales and sandstones occur in abundance. Like the Jurassic and Triassic these red beds are strongly disturbed, dipping at 30° S in the northern limb and standing nearly vertical in the southern limb of the syncline. So it is certain that the folding occurs after the formation of these strata (Pl. 44:HS2, Fig. 28).

From Matitan to Tahokou[3] the road passes through a deep gorge in which nearly vertical beds of Triassic and Jurassic formations are observed. These constitute an isoclinal anticline with an axis striking E-W. An anticlinal range is developed.

At Tahokou one ferries across the Chishuiho, which here flows to the due east. The valley is exceedingly deep. To the north one sees the anticlinal range above mentioned while to the south another high range rises abruptly 400-500 m above the level of the river (470 m above sea). Like the valley of Matitan the Chishuiho valley also coincides with a steep syncline in the centre of which Cretaceous red beds again come into view. They strike due E-W and dip at 65° to the S on the northern limb but stand vertical on the southern limb.

Crossing the Chishuiho the road ascends a steep slope on Triassic limestones. These strike E-W and stand vertical. It is interesting to note that the limestones are in direct contact with the red beds; the Jurassic sandstone seems absent. This is supposed to be the result of thrusting from the south. Further up the limestones begin to dip south with a constant angle of 40°. Conformably overlying the limestones there occurs a series of Triassic purple shale, strike and dip remaining the

1 土池關 2 馬蹄灘 3 大河口

same. This is again followed by well-bedded limestones and coal-bearing shales dipping steeply to the S. Then a prominent ridge of massive Permian limestone appears in view, striking E-W. The dip of that part of the limestone which is in contact with the coal-bearing strata is not determinable so that it is not known whether the limestone is in normal relation or in fault contact with the latter. But it is certain that the formations seen south of Chishuiho are overturned to the north.

Crossing the Permian limestone ridge one observes coal-bearing strata striking E-W and dipping 50° S. These are conformable and therefore are in normal relation with the underlying limestone. Then Triassic purple shale and Triassic limestone follow one upon the other, all striking E-W and dipping at 50° S. Further south the Triassic limestones begin to dip to the N, thus forming a synclinal. Two li north of Lungchangying[1], the Triassic limestone comes in direct contact with mid-Permian limestone, the purple shale being omitted. To the east however one sees purple shale strata appearing on an escarpment capped by Triassic limestone. It is supposed that a strike fault is responsible for the abnormality.

Going southwest from Lungchangying the road ascends the dip slope of Permian limestone which strikes W by N and dips at 15° N. Coal pits are seen at the foot of this slope marking the position of the mid-Permian coal-bearing series. Up to Liangshuitsing[2] gentle-dipping Permian limestones are continually observed. At Liangshuitsing they strike E-W and dip 15° N.

It is to be noticed that north of Lungchangying the structure is dominated by close folds and frequently thrusts. From Lungchangying southward however close folding is absent. Gentle folds represented by flat synclines, anticlines and basins become the rule while mile after mile one sees horizontal strata, constituting a huge plateau which begins at Lungchangying extending to Tatinghsien and further south.

Going south from Liangshuitsing isolated outcrops of carbonaceous shales are met with. These probably belong to the basal Permian shales seen in the route from Chenghsiunghsien to Pitsiehhsien. Further south very gentle dipping thick-bedded silicified limestones occur. I suppose these belong to the Ordovician limestone (Ichang Limestone). Toward Tashihpan[3] characteristic Permian limestones reappear, lying almost horizontal. Owing to darkness I was unable to ascertain the relation between the Permian and Ordovician [Cambrian] limestone. Toward Sanpa[4] the Permian limestone strikes N 20° W and dips 15°-20° NE. It gradually

1 隆昌營 2 涼水井 3 大石板 4 三壩

appears thin-bedded and shaly until black shales and sandstones occur near Sanpa. Coal pits are seen here and there but true coal-seams are not found. Sanpa is situated in an open and flat country developed in the basal Permian shales. Here and there one sees isolated hills capped with massive Permian limestone. To the south there rises a prominent ridge formed of Permo-Triassic formation across which the road has to pass. Near the foot of this ridge appears the massive Permian limestone above which one observes mining pits dug in the coal-bearing shales. It is in these shales that anthracite coal is actually obtained while the basal Permian shales at Sanpa offer no prospects and so do not deserve attention. The coal-bearing shales are followed by well-bedded limestones and purple shale which is again overlain by Triassic limestones, all striking N 42°-45° W and dipping 45° SW. From Tashihpao[1] to Piaoertsing[2] only Triassic limestones are seen, these forming a flat synclinal pitching to the E.

Piaoertsing, being 1780 m above sea-level, is the highest point reached between Kulinghsien and Tatinghsien. Though it is only a village it is larger and more prosperous than many of the hsiens or district cities in Kueichou. Its prosperity is due to one reason: it is one of the distribution centres of the Szechuan salt.

Going south from Piaoertsing one descends into a valley developed along the contact between the Triassic limestone and the purple shale. The former forms a vertical cliff on the right side of the stream while the latter also constitutes a ridge on the opposite side. 5 li south of Piaoertsing the purple shale is suddenly cut out by the Triassic limestone which dips at 40° to the S by E. Further south continuous outcrops of Triassic limestone are met with, striking NE and dipping moderately to the SE. Then the road crosses a low pass marked by a strike fault. West of this fault appears Triassic limestone striking NE-SW and dipping 20-25° SE. East of the fault line massive bituminous Permian limestones occur dipping in the opposite direction. The latter is followed by coal-bearing shales marked by numerous pits. Toward the southwest the Triassic limestone gradually becomes horizontal while at the same time purple shale strata appear beneath it. The purple beds however are soon crossed and the road leads to a pass on well-bedded greenish grey limestone which underlies the former conformably. Descending the pass one reaches the village of Tachilang[3]. A prominent escarpment of the limestone just

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1 大石包 2 瓢兒井 3 打鷄廊

mentioned appears in the east of the village. I learnt later from Dr. V. K. Ting that he called this limestone the Panshan limestone*.

The Panshan [Yülungshan] limestone occurring in the vicinity of Tachilang is nearly horizontal. To the west one observes a series of hills formed of light grey thin-bedded limestones. These I take to be the Triassic limestone which is evidently in fault contact with the Panshan limestone. Going south from Tachilang the road runs in a valley the eastern slope of which is dominated by Panshan limestone while on the other side appears the Triassic limestone. Then the road deflects to the southwest and ascends a plateau of Triassic limestone. Further southwest it descends into another valley which it soon crosses. The strata here strike nearly E-W and dip 18-20° N. Then a thin formation of purple shale (less than 100 m) appears. This is again underlain by the Panshan limestone. The succession is shown in the accompanying section (see Pl. 44 : HS2, Fig. 29).

Tc = Thick-bedded Triassic limestone

Tf = Purple shale

Pl_2 = Panshan limestone [Yülungshan Limestone]

Pl_1 = Coal-bearing shales

Py = Massive Permian limestone

The village of Kuochang[1] lies on massive Permian limestone strata. To the southwest there appears a prominent ridge of Panshan limestone extending southwestward for an unknown distance. The foot of this ridge is marked by patches of black soil and occasionally by mining pits testifying to the occurrence of a coal-bearing shale underlying the Panshan limestone. To the north one sees another similar ridge. The region to the east is occupied by the Permian limestone across which the road is now to pass. From Kuochang to near the Yülungshan[2], a distance of 25 li, more or less continuous outcrops of massive dark grey bituminous limestone are met with. These appear nearly horizontal. This Permian limestone

* By an understanding between Dr. Ting and me, the term Panshan Limestone, which was originally applied by Ting to include the Permian limestone above coal-bearing beds, was abandoned, while another term the "Yülungshan Limestone" (from Yülungshan of Tatinghsien) was put in its stead.—T. K. H., May 1945.

1 鍋廠 2 玉龍山

plateau is characterized by a late mature topography dominated by isolated low rounded hills. It is, so to speak, a badland topography developed on a grander scale. Here and there are patches of yellowish residual soil covering the hill slopes or filling the innumerable gullies. To the west the Panshan limestone ridge seen at Kuochang still continues. To the south a flat topped hill, or monadnock, appears on the distant horizon. This is the Yülungshan. As one proceeds south this hill gradually increases in size until it bars the way by which one has to pass. Climbing the western slope of the Yülungshan, sandstones, grey shales and fire-clays are met with, these lying upon the Permian limestone concordantly. Upon these occur strata of well-bedded limestone forming the larger part of the Yülungshan.

Tatinghsien lies on the plateau of the Permian limestone. To the northeast appears the Yülungshan which continues southward forming a more or less continuous ridge passing east of the city. To the west there is a deep canyon in which runs a mighty steam dashing toward the southwest. On the opposite side of this stream there rises another high ridge formed of the Panshan limestone while still higher ridges are seen behind it in the far distance. The geological formations occurring at Tatinghsien may be summarized in the following section (See Pl. 44 : HS2, Fig. 30).

1) Massive pure whitish grey limestone locally silicified. *Doliolina* occurs in abundance in the top part (Loc. No. 1325) [7].

2) Grey shales and fire-clays with coal seams. May contain thin limestone strata.

3) Massive grey limestone with *Lyttonia* and *Productus*.

4) Black-grey clay-shale with seams of typical nodular limestone and indeterminable plants.

5) A stratum of limestone similar to (3) and with fossils (Loc. No. 1324) [7].

6) Thin-bedded green and grey shaly limestone, usually sandy and occasionally purplish, containing pelecypods.

7) Thin-bedded fine-textured grey limestone with pelecypods (T66, T67) [12].

RECONNAISSANCE IN THE DISTRICTS SOUTHWEST OF KUEIYANG

(January 10 to February 5, 1930)

Geology of the Meitanyao[1] Coalfield, Kueiyang.

The village of Meitanyao is about 30 li SW of Kueiyang and is situated on a more or less dissected plateau 1400 meters above sea-level or 300 m. above Kueiyang. Within a radius of 10 li from this village there are numerous coal-producing localities; the important ones are Shihtouchai[2], Haotzuwan[3], Lintung[4], Wufentien[5], Tapo[6], and Maolichuang[7].

Shihtouchai and Haotzuwan are about 1 li from Meitanyao and are separated by a small range. The coal seam mined at both localities occurs below a cherty limestone stratum and has an average thickness of 1 meter (actually measured). Only one company, the Chienlungmeitanchang[8] belonging to the provincial government, is engaged in actual mining work. Its maximum daily output is 10 tons. Most of the coal used in the Kueiyang Arsenal and the Electric Company is from this locality.

Lintung is about 5 li south of Meitanyao. There are three seams occurring in this locality. The middle seam has a thickness of 1 meter minus 0.5 meter of shale parting, that is, a real thickness of 0.5 meter. It is actively mined. The upper seam is too thin to be worked but the lower seam is 0.7 m thick according to my measurement of its outcrops (which is not very reliable).

Wufentien is 12 li SW of Meitanyao, and is the farthest of all the localities. The coal seam mined is the thickest however; it has a rather uniform thickness of 1.3 m. Numerous native pits are at work and the coal obtained is burnt into coke on the spot.

Tapo is 6 li SW of Meitanyao. Coal was extensively mined there formerly but mining has ceased at present. It is said that three seams occur there, the middle one being the thickest and the best.

Maolichuang is 5 li east of Meitanyao and lies on the road from Kueiyang to the latter place. The coal seam mined here is the same as that of Lintung.

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1 煤炭窰 2 石頭寨 3 蒿子灣 4 林東 5 五份田 6 大坡 7 毛栗莊 8 黔隆煤炭廠

Structural Relations:—The mid-Permian coal-bearing strata essentially form a broad syncline with its axis directed NNE-SSW and passing about 3 li west of Meitanyao. In its centre there occurs a belt of thin-bedded Triassic limestone (Fanshan [Yülungshan] Limestone) which lies upon a thin formation of yellow *Gastrioceras* shale. Below these is the first stratum (15—20 m) of cherty limestone which forms the limbs and dips at 10—20° toward the axis. The coal seam mined at Shihtouchai and Haotzuwan occurs just below this limestone, which may be called the upper limestone formation. About 100 m (?) below this is the lower limestone formation below which occurs another workable coal seam, dipping usually at a low angle (5—10°). The coal from Lintung, Wufentien, Maolichuang and probably Tapo comes from this horizon.

Thus we distinguish two coal-bearing horizons, one upper below the upper limestone formation and one lower below the lower limestone formation. In the upper horizon there is only one workable coal seam with a thickness of 1 m. In the lower horizon there are three seams but only one is workable at Wufentien and two may be worked at Lintung. The worked seam in the former place is 1.3 m but in the latter it is 0.5 m.

Rough Estimates of Reserve:*—Let us assume that the coal field for the upper horizon is 1.5 km wide and 2.5 km long (measured from the map). Since the dip is very gentle all the coal in this can be worked. Then the reserve will be 4,500,000 metric tons. The coal field for the lower horizon is much more extensive. Suppose it is 4 km. wide and 6 km. long, and take the average thickness of the seam (or seams) as 1.2 m. The reserve will be 34,500,000 metric tons. Then the total reserve will be 39,000,000 metric tons.

The coal field for the lower horizon is adjacent to those surveyed by Mr. Y. L. Wang so that an accurate calculation can only be obtained when these are taken into consideration.

From Kueiyang to Anshun [6, 21]

(January 10 to 14, 1930)

While Dr. V. K. Ting goes into southern Kueichou with Messrs. S. Y. Tseng and Y. L. Wang I proceed southwestward from Kueiyang to Anshunhsien. A fine motor road has been built recently connecting the two cities. It is decided that the motor road should be followed. In so doing not only can I draw my

* For analysis of the coals see [11].

route maps much quicker but better exposures are also to be seen along the newly opened cuts of the road. Since the geology between Kueiyang and Tsingchenghsien has already been investigated by our joint party during the last days of December, 1929, my actual surveying work begins at Tsingchenghsien.

Leaving Tsingchenghsien the road runs in a prevailingly SW direction in a strike valley carved from Triassic limestones. These are thin-bedded light grey or whitish limestone more or less silicified. They strike prevailingly NNE-SSW and dip 40°—50° W on the western side of the road. In the hills east of the valley however the limestone is observed to dip distinctly to the E or SE. Evidently we are dealing with an anticline whose axis nearly coincides with the road. Such a situation prevails until Houluchang[1] when the valley appears more open with low flat-topped hillocks covered with a brownish soil. It seems that these hills are made of thin-bedded shaly limestones and shales which, being easily weathered away, give rise to a late mature surface. At Sinchiao[2] by the side of a river strata of silicified limestone are observed to strike N 31° E and dip 37° SE. From Sinchiao to Yalungpa[3] low hillocks are still to be seen. These are invariably covered by a brownish yellow soil. Isolated outcrops of Triassic limestone and shale are seen now and then, striking N-S and dipping gently to the W. Southwest from Yalungpa one observes prominent limestone hills to the west of the road. The strata strike N-S or N by E and dip steeply (50°) to the W. To the southeast a continuous ridge of Triassic limestone appears in the distance, the strata dipping to the E. Thus we are still going on an anticline of Triassic limestones.

From Yalungpa to Hsiayingkuan[4], a distance of 8 li, one first passes through limestone strata striking N-S or N by E and dipping 45°-50° W. Then they begin to dip in the opposite direction until Hsiayingkuan where they strike N by E and dip 40° E. The structure is clearly a close syncline in Triassic limestones. These latter often form isolated conical hills rising 50-150 m above the general ground level. Passing Hsiayingkuan the road runs directly to the west in an open and flat country for about 5 li. Then it enters a chain of hills composed entirely of Triassic limestones. They strike N by E and dip moderately to W. It appears certain that we have crossed another anticline since leaving Hsiayingkuan. After entering the hilly region the road soon ascends a low pass at which the Triassic limestone is seen to be a massive, dense, light liver-grey limestone with pelecypods and small gastropods. The limestone gives a petroleum smell at a blow of the

1 後六場 2 新橋 3 鴨隴壩 4 下營觀

hammer. It strikes N-S (?) and dips 10° W. A little westward greyish brown and purplish shales are seen at a cut. These are crumpled and their relation with the limestone is not determined. Then the road turns SW into a valley which opens into the main valley of Pingpahsien[1]. Isolated outcrops are only to be seen in this valley. At first a massive micaceous grey sandstone with very thin coaly lenses appears on the right side of the road. A little southward one observes purple and reddish clay-shales underlaid by a conglomerate with small well-rounded sandstone and limestone pebbles. These strike ENE and dip gently to NW. It is confirmed by later investigation (see below) that the sandstone just mentioned is equivalent to the Jurassic sandstone of the Red Basin while the red and purple shales belong to the Cretaceous red bed series, the conglomerate above described serving as a basal conglomerate lying disconformably on the sandstone.

The geological structure in the eastern environs of Pingpahsien is rather complicated. It will be made clear by two observed sections, one passing the prominent conical hill 1 li east of the city and the other being made a little further north. The southern section is as follows (Pl. 44 : HS2, Fig. 39):

1) Well-bedded dense grey limestone, not silicified, St. N 28° E, dip 55° W.
2) Yellowish brown shale strongly disturbed.
3) Massive coarse light grey sandstone, bedding not clear (2 and 3 being in thrust contact with 1, see Fig. 40).
4) Red clay and grey clay mostly covered.
5) Deep yellow soft sandstone. It is micaceous, coarse and massive, being identical to the sandstones found at Sanchiao, west to Kueiyang.
6) Thick-bedded grey semi-crystalline limestone with petroleum smell. It is equivalent to the limestone seen at the low pass above mentioned.

(Note: the conglomerate bed seen along the motor road ought to occur at the base of (4); it is here covered by red soil).

The northern section is as follows (Pl. 44 : HS2, Fig. 40):

1) Thick-bedded limestone.
4) Red clay corresponding to (4) in the southern section.
5) Yellow sandstone correseponding to (5) in the southern section.

(Note that (2) and (3) are missing in this section).

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1 平壩縣

That the limestone (1) is thrusted against the red clay series is proved by (a) the limestone as well as the red clay-shale is strongly disturbed at the contact and (b) there is omission of beds as seen in the northern section. That the red clay-shale series is unconformable with the underlying sandstone is also suggested by (a) the sandstone appears as a wedge, it being at least 200 m in thickness in the south but becoming 30-40 m in a distance of less than 1 li and (b) a basal conglomate occurs.

The city of Pingpahsien lies in an open valley in which a stream flows to the southwest. To the east appear subdued hills of Triassic limestone, dipping prevailingly to the west. To the west there occurs a prominent ridge formed of thick-bedded whitish grey more or less silicified limestones. These are nearly horizontal or dipping very gently to W. To the northeast the valley seems to be closed up by a group of hills composed of the same limestone. A narrow stretch of low soft hills appears in the valley, representing the red clay-shales and soft sandstones above described. As explained already the limestone strata on the western side of the valley are in thrust contact with the formations on the eastern side. The former are much like the latter in lithological characters and for reasons to be given later I also consider them as belonging to the Triassic. In view of the fact that the Triassic limestone series is unusually thick (not less than 700 m) it remains to be determined if the limestones on the west and those on the east side of the Pingpahsien valley belong to the same horizon.

Leaving Pingpahsien the road first runs in a SSW direction, then it turns to the SW (about S 65° W) for nearly 40 li to Shihpanfang[1]. The road is almost level, no high passes or deep valleys being crossed. Thick-bedded light grey or whitish limestones are continually met with, these appearing essentially horizontal. The limestone is frequently silicified and extensively jointed, weathering into characteristic angular fragments. It forms typically conical hills rising some 100-150 m in height above the road level. Generally these hills are isolated and scattered in a disorderly manner. At times however they form a more or less continuous chain parallel to the road thus forming a "valley" which however does not imply the true sense of the word. At Shihpanfang the limestone becomes thin-bedded and can be easily obtained in slabs. The local people use these slabs to cover the roofs of their dwellings These roofing limestones as they might be termed are of a better quality than the ordinary roofing slates as they endure weather better.

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1 石板房

Going southwest from Shihpanfang one observes a flat country dotted with soft hillocks. It is probable that the latter are formed of Triassic shales and shaly limestones but on account of the wide-spread soil-cover no outcrops can be found. To the west and to the south conical limestone hills occur, indicating the presence of the thick-bedded limestone previously observed. It is supposed that the structure is a flat dome formed in Triassic shaly strata which are surrounded by the overlying limestone.

Going southwest from Taitzuchieh[1] characteristic conical limestone hills reappear. They are formed of exactly the same limestone as seen southwest of Pingpahsien. From Taitzuchieh to the city of Anshun similar topographic features prevail. The strata observed are nothing but Triassic thick-bedded limestone, gently tilted or nearly horizontal. Toward Anshun however the hills appear less numerous and the country becomes more open.

The city of Anshun lies on a local peneplane on horizontal limestone strata. Here and there one observes conical hills serving, as it were, as guards of the city which is the commercial centre of southwestern Kueichou. A soil-cover is present on the peneplane but this is quite thin and is largely residual, it being not deposited by rivers as is the case with alluvium.

The fossiliferous bed of Loszushan[2]—2 kilometers east of the village of Toupu[3], which is 10 li east of Anshun city, there occurs among numerous conical hills a hill called Loszushan or Gastropod Hill, which has long been known to the natives as being a hunting place for fossil gastropods. In 1928 Mr. S. S. Yoh has visited this hill and reported its geological significance. [See S. S. Yoh: Geological reconnaissance of W. Kueichow, Bull. Geol. Surv. China, no. 12, 1929]. My observations on this hill are given below:

The Loszushan is really composed of two hills each having a height of 139 m as measured from the surface of the ground (Pl. 44:HS2, Fig. 41). It consists of horizontal strata of thick-bedded, fine-textured, compact, more or less silicified limestone. The color of the limestone is generally light grey or whitish but at places it appears reddish grey. The silicification varies in degrees at various points. All the strata from the bottom to the top appear to be unfossiliferous except the topmost stratum of 2m thickness which is full of gastropod remains (Loc. No. 1331) [12]. These possibly belong to the genus *Natica*. Besides the gastropods I have found a *Belemnite*-like shell of an undeterminable character. Mr. Yoh thinks that the limestone is of Tertiary age but I have reasons to believe that it is Triassic.

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1 袋子街 2 螺螄山 3 頭舖

From Anshunhsien to Chihchinhsien

(Jan. 14 to Jan. 18)

Going west from the city of Anshunhsien the road runs in a flat country dotted here and there with limestone hills. The strata remain essentially horizontal until about 15 li from the city when they begin to take an appreciably easterly dip (10°). Toward Huapaifang[1] thin-bedded limestone and shaly limestone strata appear below the thick-bedded group, these again remaining horizontal. West of Huapaifang the road descends quickly into a low country in which conical hills of thick-bedded limestone are again met with. The strata now all dip about 20° E. The contrast between the flat country east of Huapaifang and the hilly country west of it is so striking that a normal fault is supposed to be responsible for this abrupt change in topography. About 3 li west of Ikoshu[2] greenish grey shales and shaly limestones appear below the thick-bedded group, these dipping gently to E. The country becomes once more flat and open, while conical limestone hills are characteristically absent. Toward Sankuaitien[3] the shaly group ends and the thick-bedded group reappears. The country at once becomes hilly with prominent limestone hills rising 150-200 m above the road level. From Sankuaitien to Putinghsien[4] these conditions prevail.

Leaving Putinghsien the road runs in a NNW direction in a country of thick-bedded limestone hills. Toward Chiehpai[5] thin-bedded limestone with shaly members prevail. 5 li south of the latter place there occurs a shaly limestone on the bedding surfaces of which are seen numerous peculiar worm tracks. Previous experience tells me that such worm track structures are characteristic of the shaly group of the Triassic limestone series (the Sungtzekan shale of Dr. Ting). I have also observed slabs of the same limestone in the city of Putinghsien on which there are bivalves identical with those found at Chikangchiao.

Leaving Chiehpai the road runs directly north descending into the valley of the Sanchaho[6]. Nearly horizontal beds of thin-bedded limestone and shaly strata are continually met with. At Sanchaho one observes outcrops of green shale gently dipping to SE. From Sanchaho to Pingshang[7] the road ascends a slope on the same thin-bedded Triassic limestones all dipping gently to NW. From Pingshang to Luotungpo[8], a distance of 8 li, the road leads in a NNW direction. The country is very hilly, the hills being composed of thick-bedded Triassic limestone dipping now to NW and now to SE. Apparently local anticlines and synclines are deve-

1 花牌坊 2 一棵樹 3 三塊田 4 普定縣 5 界牌 6 三岔河 7 平上 8 糯東坡

loped. Leaving Luotungpo a steep descent carries one into a deep valley in which the mid-Permian coal-bearing strata make their appearance. These are excellently exposed in the vicinity of a bridge called Wenchiachiao[1].

The coal-bearing series at Wenchiachiao strikes ENE-WSW and dips about 30° S. It occupies the bottom of a valley south of which there rises a prominent escarpment of Triassic limestone. The coal-bearing strata are largely grey shales, brown sandy shales, fire clays with workable coal seams. In the upper part several massive impure bituminous limestone seams occur, these being highly fossiliferous (Loc. No. 1330). Immediately above these strata is a sequence of thin-bedded green shaly limestone which is overlain by the thick-bedded Triassic limestone. The character of the green limestone suggests its identity with the limestone of Yülungshan, Tatinghsien.

Leaving Wenchiachiao the road passes through a gorge in which excellent outcrops of Permian basalt and massive limestone are seen. Owing to the fact that the direction of the road is perpendicular to the strike the thickness of the basalt is easily estimated. Taking its outcrop width as 500 m and its average dip as 33° its thickness is calculated at 250 m. It is a dark green or greenish grey rock, frequently porphyritic. Its lower part is distinctly bedded but its upper part is massive. Amygdales are of frequent occurrence in the middle of the formation. Concordantly underlying the basalt appears the massive Permian limestone which forms a distinct ridge south of Hsiungchiachang[2]. Immediately north of Hsiungchiachang is another high ridge of the same Permian limestone dipping in the same direction. Apparently the two ridges are in fault contact. Just west of Hsiungchiachang outcrops of massive quartzite (this may be completely silicified limestone) are seen, striking N 49° E and dipping 70° NW. The relation of this quartzite and the Permian limestone is not ascertained.

Going NE from Hsiungchiachang the road leads in a valley bounded by two limestone ridges mentioned above. On the left side of the road outcrops of basalt begin to attract attention (Pl. 44:HS2, Fig. 42). Further east basalt prevails, this time occupying the entire ridge on the north. On the southern side of the valley coal pits and patches of black soil appear, marking the occurrence there of the coal-bearing shales. These latter are observed to overlie conformably upon the basalt as seen in the hills further east. Then the road turns to the north and ascends the basalt ridge which soon it crosses. Toward Chuantungpa[3] massive

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1 文家橋 2 熊家場 3 穿洞壩

Permian limestone appears under dark green basalt, striking NE-SW and dipping 25° SE. The limestone forms another characteristic ridge to the south of Chuantungpa. Caves are developed in the limestones. Leaving Chuantungpa one first crosses a narrow belt of flat country and comes to meet outcrops of massive whitish quartzite similar to that found at Hsiungchiachang. Above the quartzite lies Permian limestone striking NE-SW and dipping 24° NW. The quartzite and limestone constitute a ridge parallel to that at Chuantungpa. These two ridges are in fault contact. Two li north of Chuantungpa the road crosses the limestone ridge and descends into a deep valley with vertical walls of gentle-dipping Permian limestone. Going northwest from a small village called Shatzupo[1] the road ascends another steep slope. On the lower part of this slope massive Permian limestones are met with, dipping very gently to NW. On the upper part of the slope however outcrops of dark green basalt come into view. The bedding of the basalt is not observable but it may be inferred from the sections seen at Hsiungchiachang that it is conformably laid upon the Permian limestone. The thickness of the basalt is roughly estimated at 60 m. Amygdales occur abundantly in the upper part. Near the pass, which the road is crossing, a stratum of green rock with small pebbles appears just on top of the basalt. On account of the fact that this green rock has a superficial resemblance to the basalt I have in the field considered it as such. Mr. H. S. Wang found fossils probably radiolarias in the specimen which I collected. The origin of this rock then is to be seriously considered.

Crossing the pass above mentioned the road runs on a plateau overlooking into a deep valley on the right side. The rocks are chiefly covered by soil. But it can be said with certainty that they are chiefly grey shales and sandstones of the mid-Permian coal-bearing series. Abandoned coal pits are seen here and there. The contact of these shales and the green rock above described is not observed but is supposed to be conformable.

From Chuchang[2] to Funghuangshan[3] isolated exposures of brown shales and grey shales are now and then met with. The hill of Funghuangshan seems to be composed of these strata capped by a thin formation of well-bedded impure limestone (apparently the upper part of the mid-Permian and part of it may even be equivalent to the limestone of Yülungshan). Funghuangshan is some 1800 m above sea and is the highest place reached in my trip from Kueiyang to Chihchinhsien. At the time of my arrival it was largely covered by snow so that detailed observations of it cannot be made.

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1 沙子坡 2 豬場 3 鳳凰山

Going northeast from Funghuangshan the road descends a long slope first gradually then abruptly into a deep valley leading to the city of Chihchinhsien[1]. At first mid-Permian shales and thin limestones are seen. Then massive Permian limestones appear, these being horizontal and forming vertical cliffs bounding the deep valleys. I have made an "off-shoot" observation from Piniah to the southeast. I reached Shenchiapa[2] about 5 li from Piniah. At that place brownish yellow iron nodules are obtained from pockets in the massive Permian limestone, and are smelted for pig iron. The limestone strikes NE-SW and dips 20° NW. It forms a ridge east of Shenchiapa and it is probable that this ridge is continuous with the one at Chiaohuatsing southeast of Chihchinhsien to be described below.

At Pochiao[3] the descent on the long slope of Funghuangshan is ended. The road then leads in a northerly direction in a valley bounded by vertical walls of horizontal massive Permian limestone. Such a topographic feature persists until Chihchinhsien where the valley opens out

The Environs of Chihchinhsien.

The city of Chihchinhsien lies in the centre of a flat syncline formed of Lower Permian limestone striking NE-SW. Here and there isolated patches of grey and yellow shales occur on top of the limestone hills representing the erosion remnants of the coal-bearing series. In the massive limestone there are caves in which "Lungku" or fossil mammalian bones are said to occur. I have visited one of these caves but did not succeed in getting any Lungku. Extensive exploration by a competent vertebrate palaeontologist however is likely to achieve good results in these cavernous regions. The geological structure will be made clear by two side excursions described below.

Going west from the city one observes low hills of massive Permian limestone. A thin veneer of grey and brown shale and fire clays is to be found on top of the hills. Crossing the shales the road descends into a valley in which a stream coming out from caves flows to the NE and turns east passing the northern gate of the city. Going southwest along the valley continuous outcrops of massive Permian limestone are seen, striking NE-SW and dipping 10° SW. To the west one observes a prominent ridge formed of the same limestone dipping about 30° SE. At Tamai[4] one sees coal-bearing strata mostly shales and limestone in direct contact with the massive Permian limestones. The former takes an appreciable dip to the NW, but the latter possesses a SE dip as already noted above. Evidently the coal-bearing

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1 織金縣 2 謝家壩 3 坡脚 4 大脉

strata are in fault contact with the massive limestone. The coal is a rather pure anthracite and is mined by the natives. The seams are however very thin and irregular.

Another side excursion from Chihchinhsien is made to a place called Kuoti[1], 25 li SE of the city, where silver ore is said to occur. Going southeast from Chihchinhsien the road soon leads into a canyon with perpendicular walls of Permian limestone which is slightly tilted to the NW. Then the road ascends a slope and comes into a region of brown and grey shales with irregular coal seams. Coal pits are scattered here and there. The coal-bearing beds however form only a thin veneer and after a distance of 3-4 li is transversed massive Permian limestones again come into view. The limestones form a uniform range to the south. This range strikes NE-SW and continues toward the southwest to as far as the Funghuangshan (as remarked above). In meeting this range the road turns to the east for 2 li and then it descends into a deep canyon called Chiaohuatsing[2]. This is developed in the massive limestone which strikes NE-SW and dips 16° NW. Limestone caves are frequently seen in the walls of the canyon. A natural bridge of limestone is also observed on the western side of the valley. The limestone furnishes fossils both in the upper and lower part. In the upper part (Loc. No. 1328B) *Wentzelella paracanalifera* sp. nov. and species of *Michelinia* are found while in the lower part (Loc. No. 1328A) I have collected *Corwenia* sp. and *Verbeekina verbeeki*? [probably *Nankinella*].

Leaving Chiaohuatsing the road begins to climb a dip slope on which beds of massive whitish grey quartzite appear. The contact between the latter and the Permian limestone is seen to be concordant. The road then crosses a low pass and comes into black sandy shales and brown and green thin shales striking N 45° E and dipping 23° NW. These beds form with the overlying quartzites an escarpment. To the southeast of this escarpment massive or thick-bedded grey limestone strata appear dipping to the SE. These limestones closely resemble the Triassic limestone and may be identical to the latter. If so, it must be supposed that they are in fault contact with the quartzites and shales. Near Kochungwu[3] grey and brown shale and black coaly shale intercalating with fossiliferous massive black limestone seams occur. They are in conformable contact with the Triassic lime-

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1 果底 2 叫化箐 3 戈中塢

stone just mentioned and therefore are in fault contact with the quartzites (Pl. 45: HS3, Fig. 43).

Leaving Kochungwu the road leads in a prevailingly ENE direction in a valley the bottom of which seems to be composed of mid-Permian shales. To the NW there appears a ridge probably formed of massive limestone while to the SE is another limestone ridge composed of Triassic limestones striking E-W and dipping 15° S. 3 li NE of Kochungwu the road crosses a low pass at which one observes massive silicified limestone overlain (?) by brown sandy shales of the coal series. The former appears to be the chief constituent of the northern ridge above mentioned. Its characters differ markedly from the Lower Permian limestone. This ridge continues to the north of Kuoti and further to Suehchiachai[1], where it is observed to consist of massive whitish grey fine-textured quartzite lying nearly horizontal.

To the east of Kuoti there occur hills of massive black limestone with *Schwagerina* [?]. I do not doubt the Permian age of the limestone (Loc. No. 1329) but its relation with the silicified limestone and quartzite of the northern ridge remains to be determined. It may be suggested that the latter represent a local phase of the massive Permian limestone but I am inclined to think that they belong to a different geological age. Near Suehchiachai one finds floats of black or dark grey slate and fine sandstone in the bottom of the gullies. Though no outcrops are seen I think these rocks underlie the massive quartzites above stated. Argentiferous galena occurs in the latter in the form of irregular masses or rarely in cubes.

The age of the galena-bearing strata is not determined. Apparently it is older than the Permian limestone. Is it Carboniferous?

Chihchinhsien is known in Kueichou as a coal-producing centre. As far as I know the coal-fields of Chihchinhsien are of little economic value. The Funghuangshan is said to be the most promising locality. But being an isolated hill on a Permian limestone plateau its structural features are quite disappointing. A second locality is Tamai where the coal seams are thin and irregular as already alluded to above. A third locality is Shihpanpo[2] near Kuoti. Unfortunately I did not visit the coal mines at this place in person. But judging from the statements of the local people this coal-field is also of little economic importance.

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1 薛家寨 2 石板坡

RECONNAISSANCE IN THE DISTRICTS EAST OF KUEIYANG

(Feb. 14 to Mar. 13, 1930)

From Kueiyang to Chiuchow

(Feb. 14 to Feb. 21)

Going east from Kueiyang one passes through a flat country thickly populated and extensively cultivated. To the north appears the Tungshan[1], an isolated prominent hill composed of thick-bedded Triassic limestone apparently dipping toward the city of Kueiyang. At the beautiful temple of Shuikouszu[2], rather massive silicified light grey limestones are observed striking E-W and dipping 23° S. Then the road crosses a magnificent bridge built on the Nanmingho[3] and begins to ascend the gentle slope of Wangchengpo[3]. To the north on the opposite side of the river there rises a high hill, the Sienjentung[5], formed of limestones of the same character as observed at Shuikouszu. To the south limestone hills are again seen, these being composed of massive dark grey limestone without showing distinct stratification. The limestone looks very much like the massive Permian limestone and most probably it is such. This being accepted, this limestone and that occurring on the northern side of the river must be in fault contact. This fault probably passes along the course of the river in the north but it follows a sharp-demarcated gully on the southwest of Wangchengpo. At Tangpakuan[6] thick-bedded cherty limestone with Permian fossils appears striking S 8° W and dipping 31° E. Coal is mined in black shales near the contact between this limestone and the limestone of Wangchengpo. It seems certain that this limestone corresponds to the massive Permian limestone underlying the coal-bearing series as observed elsewhere in Kueichou. What then is the age of the coal-bearing strata seen underlying this limestone? The probability is that the latter is thrust against the coal-bearing shales of mid-Permian age which normally succeed the massive Permian limestone at Wangchengpo. [This coal-bearing formation is probably Carboniferous or basal Chihsia].

Going east from Tangpakuan one soon comes into a country of low soft hills composed of shaly strata of the mid-Permian coal-bearing series. These are chiefly brown and grey shales and sandstones dipping prevailingly to the east at 5°-15°.

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1 東山 2 水口寺 3 南明河 4 望城坡 5 仙人洞 6 湯粑關

Abandoned mining pits are here and there to be seen. Toward Yunkuanpo[1] thin-bedded, rether shaly limestone striking N 30° E and dipping 18° SE makes its first appearance, this overlying the coal series with apparent conformity. Further east similar thin-bedded limestones prevail. The bedding surfaces of the limestone are provided with numerous small nodules giving a characteristic appearance to the rock. Minute flexures and overfolds are of common occurrence in the limestone. Then thick-bedded light grey Triassic limestones appear dipping very gently to the east. At Yüliangchiao[2] where a stream flows towards the north, thick-bedded, fine-textured, light grey limestones are observed to be minutely folded. Though the strata met with from Yunkuanpo to Yüliangchiao appear essentially horizontal, they are not infrequently overfolded and possibly locally thrusted.

From Yüliangchiao to Takuan[3], a distance of 10 li, the country is dominated by a mature topography dotted with low limestone hills and traversed by meandering streams. East of Lolimu[4] whitish semicrystalline limestones appear. These stand horizontal. Toward Takuan similar limestones prevail, forming isolated conical hills. From Takuan to Yunglopu[5] the road turns to the east by north, crossing continuous outcrops of Triassic limestone which remains horizontal.

At Yunglopu nearly horizontal beds of thin limestone and shale make their appearance. The limestone is greyish white in color, dense and fine-textured. It occurs in beds of a thickness of from a few inches to 1 foot. The shale is liver grey or slightly purplish. Numerous well preserved pelecypods are found in it (Loc. No. 1332) [12]. The most interesting fact to be noted is that the thin limestones are oil-bearing. Oil is locked in the pore-spaces and when the limestone is broken with the hammer oil comes out as a thin coating upon the freshly broken surfaces. It is light yellow, and smells like ordinary crude oil. Another fact worth noting is that the broken fragments of the limestone often show cross sections of small Ammonites of the size of a copper or silver dollar (See Pl. 45 : HS3, fig. 44). The central chamber of the shells invariably contains a good quantity of oil, this being likewise locked in the pore spaces of the porous rock. Unfortunately continued search for well-preserved Ammonites failed, but I have seen big Ammonites impressions 4 inches in diameter on the building stones of the farm houses.

Leaving Yunglopu thin-bedded Triassic limestones reappear, striking N 65° E dipping 14° SE. Evidently these strata lie conformably upon the fossiliferous

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1 雲關坡 2 魚梁橋 3 大關 4 羅吏目 5 永樂堡

beds at Yunglopu. From Yunglopu to near Maochang[1] similar strata predominate, remaining horizontal or only gently tilted. Near Maochang the limestone forms an escarpment under which brown shales with coal seams make their appearance. It is reported that only one seam of 1 chi thickness is mined. The coal is bituminous, burning with much smoke and with long flame. It is usually obtained in small chops, very rarely in lumps.

From Maochang to Paochiangho[2] the road crosses a small plateau whose surface is covered by a thick soil mantle so that no outcrops of solid rocks can be seen. It is however supposed that the plateau is composed of horizontal beds of the coal series. From Paochiangho to Kaolimu[3] isolated exposures of the coal series are here and there observed. To the north there occurs a uniform ridge striking NE-SW. To the south a similar ridge is found also striking NE-SW. It is thought that these are formed of massive Permian limestone dipping toward the road, that is to say, they form a synclinal structure.

Going northeast from Kaolimu the road descends into a strike valley in which brown shales interbedding with cherty limestones are found. 3 li NE of Kaolimu I found fossils (Loc. No. 1333) [9] in impure limestone seams by the side of a small stream. The collection includes a beautiful *Oldhamina* and it becomes evident that the valley in which the road runs is occupied by the coal-bearing series. This same condition prevails until Siaokulung[4], 15 li from Kaolimu. To the north the massive Permian limestone ridge persists, striking NE-SW, and dipping apparently to SE. To the south occurs a belt of hills thickly covered by bushes. These are probably formed of shaly strata of the mid-Permian. South of Siaokulung horizontal thin-bedded limestones appear on top of conical hills. Evidently these mark the centre of a synclinal structure.

At Takulung the topographic features undergo a great change. To the north, east and south, high limestone hills appear, forming a semi-circular or rather parabolic arc encircling a region of low hills formed of shales of the coal series and capped by thin-bedded limestone. It is without doubt that the high hills are composed of massive Permian limestone which we shall deal with presently.

Leaving Takulung the road first crosses a stream, then it ascends a steep slope on which massive Permian limestone strata are found, striking S 20° E and dipping 36° SW. Thus the slope is really the dip slope of the limestone. Ascending

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1 毛場 2 泡江河 3 高梨木 4 小谷壠

the slope one reaches a pass at 1390 m. To the north is Mount Taitzushan[1] composed of horizontal beds of massive limestone. Leaving the pass the road descends into the valley of Sinchiao[2]. The Permian limestone as well as its overlying coal-bearing series appears, dipping prevailingly to the SE. It is plain then that the range of Taitzushan is an anticlinal range. Leaving Sinchiao thin-bedded dense limestone come into view, striking NE and dipping 10° SE. Further east the road crosses a flat country dotted with thin-bedded limestone hills. East of Simaho[3] the same limestones begin to dip to the NW at 22°. Thus the structure from Sinchiao to the east of Simaho is a flat syncline which is complementary to the Taitzushan anticline. 7 li SE of Simaho coal is mined from between two limestone seams which dip at 15°-20° to the NW. It is reported by the miners that the worked seam sometimes reaches a thickness of one "chang" or 10 Chinese feet. The coal is bituminous, looks dull and greasy, usually obtainable in lumps.

The structure of the Simaho coal field is ideal. If the report of the thickness of the coal seam is reliable the value of this coal field must be immense. Further investigation is necessary.

From the east of Simaho to Panpienchieh[4] the road passes through a country in which outcrops of the coal-bearing series are continually met with, these lying essentially horizontal. In the deep valley by the right side of the road however exposures of massive Permian limestone are seen. At Panpienchieh, the latter predominates. From Panpienchieh to Lantienwan[5], a distance of 15 li, massive limestones prevail, lying nearly horizontal. At Lantienwan the limestone strikes ENE and dips 15° S. Leaving Lantienwan the road follows the direction of a ridge whose southern slope is marked by strata of black bituminous sandy shales striking N 65° W and dipping 30° S as measured near Lantienwan. Further east massive limestones reappear. West of Shuiwei[6] it strikes N 20° W and dips 25° E. At Shuiwei thin-bedded light grey limestones appear. They strike N 10° E and dip 38° E. They are equivalent to the supra-coal series limestone seen elsewhere. East of Shuiwei massive silicified greyish white Triassic limestone occurs. This is thrust by the Permian limestone from the southeast as observed in the valley east of the village. At Tsingkanglao[7] the Permian limestone strikes N by E and dips 45° E. Leaving Tsingkanglao the road makes a steep descent into the canyon of the Tsingshuichiang, a large river flowing from the south to the north. Precipitous cliffs are formed by the limestone. Crossing the river the road goes due east follow-

1 太子山 2 新橋 3 洗馬河 4 半邊街 5 濫田灣 6 水尾 7 青崗老

ing the course of a tributary stream which, like its master stream, is provided with vertical walls. The stratigraphy and structure between the Tsingshuichiang and Tamawo[1] is better shown by the accompanying section (Pl. 45:HS3, Fig. 45):

Pl = Massive grey Lower Permian limestone.

Po = Black bituminous shale, strike S 22° E, dip 13° W.

Pm = Middle Permian.

- P_1 = Well stratified limestone having a tendency to become massive; thin beds frequently occur. Chert nodules numerous.
- P_2 = Impure marly limestone with *Lyttonia* and other fossils (Loc. No. 1335).
- P_3 = Massive limestone with beautiful chert bands.
- P_4 = Impure grey thick-bedded cherty limestone with *Productus*, etc. (Loc. No. 1334).

T = Thin-bedded dense light grey limestone with a shaly base. Concordant upon P_4. Age Triassic.

It is to be noted that the coal-bearing formation is almost entirely represented by limestones, shaly members being very rarely seen. The overlying Triassic (?) thin-bedded limestone also appears in its typical phase. Another note-worthy fact is that the Permian limestones are in perfectly concordant relation with the overlying thin-bedded limestone. That a line of demarcation does exist between the two formations is not only shown by the difference in lithological characters but also can be proved by the fact that *Productus* and other characteristic Palaeozoic species suddenly disappear when the Permian series is ended. No fossils of any description are found in the thin-bedded series though after careful searching.

From Tamawo to Liangchiapu[2] the road runs over a hilly country in which continuous outcrops of Lower Permian limestone are met with. The prevailing strike is N 25° W and the dip 12° W. To the south there occurs a deep canyon on the opposite side of which high hills of Permian limestone appear. Leaving Liangchiapu the road descends the escarpment of the massive limestone and comes into a valley on the walls of which occur strata of a peculiar character. These are massive, fine-textured, light grey quartzitic sandstones whose structure and habit of

1 大麻窩 2 梁家堡

weathering closely resemble ordinary limestone strata. The dip is gentle to the SW. Apparently these strata underlie the Permian concordantly. In the valley bottom floats of greenish marly limestone with brachiopods were found. Further eastward the road passes through a deep canyon with perpendicular walls formed of massive or thick-bedded limestone strata. The characters of these strata are striking. They are light grey or whitish in color, semi-crystalline in texture and more or less silicified. They are brittle and highly jointed, weathering into sharply angular fragments. Those who have seen the lump salt produced from the salt wells of Szechuan must agree in stating that the freshly broken pieces of the limestone closely resemble the salt lumps. From Liangchiapu to Niupo[1] these limestone strata prevail, these being essentially horizontal.

One li south of Maitoutsing[2] a bed of light grey limestone with curious spheroidal concretions occurs in the massive silicified limestone series. Ordovician [?] brachiopods are found in the limestone (Loc. No. 1337). It becomes evident that the limestone strata occurring between Maitoutsing and Liangchiapu belong to the Ordovican [and Cambrian] system. A little distance from the place where I found the brachiopods there is a small hill composed entirely of green fissile shales with fossils. The collection includes a species of *Asaphus* and some graptolites which according to Dr. Y. C. Sun belong to the Ordovician (Loc. No. 1336). The relation between the shale and the limestone is not known but it is supposed that the former overlies the latter. Just east of this hill is a deep valley with vertical walls of Ordovician [Cambrian?] limestone. At the bottom, apparently below the limestone, minor outcrops of grey sandy shale and black coaly shale occur, these being strongly crushed and crumbled. Plant impressions are seen in the shaly beds. At Maitoutsing massive Permian limestone makes its appearance. I know it is Permian because I have found *Schwagerina* [?] and other fossils in it (Loc. No. 1338). With the Ordovician limestone it is in fault contact as can be observed southwest of the village. It is suggested that the Ordovician limestone and its overlying green shales are thrust from the east against the Permian limestone and the coaly shales which are most probably the basal shales of the Permian limestone.

Leaving Maitoutsing the road runs to the north on a plateau formed of Permian limestone. Toward Maoliping[3] one observes silicified brittle limestone (Ordovician) on the right side but Permian limestone occurs on the left side. The road then is just on the fault line. To the west there rises a massive mountain with an

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1 牛坡 2 埋頭井 3 毛栗坪

elevation of 400 m above the road level. This is the Yunwushan or Cloud Mountain which is presumably made of Permian limestone. Northeast from Maoliping the road descends into a valley with Permian limestone (proved by the occurrence of *Schwagerina* [*Neoschwagerina*?] and *Productus*) on the left side and Ordovician [Cambrian]* limestone on the right side. The former strikes N 65° E and dips 10° SE. About 5 li from Maolichuang on a limestone hill, the Ordovician [Cambrian] limestone is clearly observed to be in fault contact with the Permian, the Ordovician striking NW and dipping 9° NE. Thereafter Ordovician limestone prevails until north-east of Machangho[1] at a pass where it gives way to Permian limestone. On a small hill near the pass the massive Lower Permian limestone is underlain by a thin formation of pyrite-bearing quartzitic sandstone with intercalations of carbonaceous slaty shale, the actual contact being marked by a bed of brown iron stone. These are in turn underlain by the Ordovician limestone concordantly.

Leaving the pass the road descends the dip slope of the Permian limestone which strikes nearly N-S and dips 16° E. This formation here is unusually thin, not over 100 m. Following upon it is a series of clay-shales and brown sandstone with intercalations of limestone. Near Huangchiawan[2] *Lyttonia* and *Productus* are found in impure calcareous grey shales striking N 15° E and dipping 24° E. Abandoned coal pits are seen on the hill slopes. At Huangtushao[3] yellowish brown soft shales occur (Pl. 45: HS3, Fig. 46). These represent the "*Gastrioceras*"-bearing horizon in other localities of Kueichou. Conformably overlying there appear thin-bedded light grey limestones, gradually replaced by thick-bedded members. The strike is N 36° E and the dip 18° E. Further east as far as Tsewu[4] Triassic limestones prevail. These form a broad syncline.

2 li east of Tsewu thin-bedded limestone with characteristic small nodules (similar to those seen near Simaho) occurs, striking N 30° W and dipping 21° W. At Yaolotien[5] the thin-bedded limestone ends and grey shale and limestone strata begin. Coal is obtained from the shale but of inferior quality. Further east massive Lower Permian limestone comes into view. This is unusually thin and is soon crossed. At Pahsiangping[6] massive fine quartzite occurs. This is closely similar to ordinary limestone strata especially in weathering habit. I strongly su-

* All these "Ordovician limestones" are probably Cambrian, belonging to the Ichang Limestone.

1 馬場河 2 黃家灣 3 黃土哨 4 自伍 5 么落田 6 巴香坪

spect that the quartzite is nothing but completely silicified limestone. Near the contact with the Permian limestone black shale is found.

From Pahsiangping to Tayen[1] the country is flat, no exposures of solid rocks being observable. At Tayen massive limestone strata occur, striking N by W and dipping to W. The limestone is grey, usually crushed, and sometimes completely silicified; it is traversed by numerous calcite veins, which render the rock like marble. From Tayen to Suantangchai[2] similar limestones prevail. The strike is prevailingly NW and the dip 20° SW. The limestone is frequently iron-stained and broken into angular fragments. In lithological characters it is not unlike the Triassic limestone seen on the route from Kueiyang to Anshun. One li east of Suantangchai the structure appears rather complicated. The accompanying sketch will make the situation clearer (see Pl. 45:HS3, Fig. 47):

1) Silicified massive limestone dipping SW.
2) Compact green shale weathering brown, with *Redlichia* (Loc. No. 1339).
3) Grey thick-bedded limestone conformable? with (1).
4) Greyish quartzite sandstone weathering brown.
5) Thin and thick-bedded limestone often oolitic.

The occurrence of *Redlichia* points to the Lower Cambrian age of the shales. It is the first time in Kueichou that Cambrian fossils are discovered. The shale is probably in fault contact with the silicified limestone but the nature and extent of the fault is not determined. Below the quartzitic sandstone (4) occurs a thick sequence of massive pure grey limestone with characteristic iron stain. The strike is N 30° W, the dip 36° SW. The appearance of the limestone is unlike all but the massive Permian limestone to which it cannot be equivalent because it underlies the *Redlichia* shales. It differs from the Permian in the presence of iron stain and in the absence of petroleum smell when struck with the hammer. I have carefully hunted for fossils in it but without success.

East of Chipakan[3] the road descends a prominent escarpment formed of the above-stated limestone which is underlain by a different sequence of strata. These are greyish green shales, sandy shales and sandstones with a notable amount of red shale intercalated in the upper part of the sequence. The most characteristic feature

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1 大岩 2 酸湯寨 3 鷄爬坎

of the series is the presence in it of a distinctly banded quartzitic slate. The bands are alternately dark and white and have a thickness of a few milimeters to 1 centimeter. The base of the series is not exposed, so its thickness cannot be measured. The exposed part from the escarpment to Tatiehkuan[1] must be over 200 m. For convenience in description we shall call it the *Tatiehkuan Series**. The contrast between the topography developed in the Tatiehkuan series and that developed in the overlying massive limestones is very striking. Prominent escarpment and long rock ridges are frequently formed by the limestone while isolated rounded soft hills are characteristic of the shales. The limestone region is invariably devoid of trees while the shale region is covered by thick bushes. It is not to be supposed that the shales always occupy low country and we shall see later that high mountains can also be developed in the Tatiehkuan Series. The age of the Tatiehkuan Series is not precisely determined. Its lithological character suggests the Manto Shale of Lower Cambrian but no fossils of any description have been found after exhaustive hunting.

Leaving Tatiehkuan green shales and beautifully banded quartzitic slates are continually met with. Then the road again goes into the massive limestone region. The limestone strikes N 35° W and dips at 30° SW, it being in fault contact with the Tatiehkuan Series. 5 li NE of Tatiehkuan the road again descends the limestone escarpment and comes into a deep valley in which a river flows to the SE. The limestone strikes N 35° W and dips gently to S. Immediately underlying the limestone occurs a black fissile shale which is underlain by a thick succession of greyish green shale, these being exposed on the lower part of the escarpment. Crossing the river one observes outcrops of quartzitic sandstone with characteristic black and white bandings. These strata all belong to the Tatiehkuan Series. Standing on the stone bridge some impressive topographic features can be seen. To the south rises the high escarpment with white cliffs of limestone which has been already crossed. To the east one observes a chain of hills capped with massive limestone dipping gently toward the river. Below the limestone cap soft shaly beds make their appearance (See Pl. 45 : HS3, Fig. 49). A thick stratum can be seen in the

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1 打鐵關

* It appears certain that the Tatiehkuan series, characterized by banded slates and quartzites, already belongs to the Sinian or even to the lower Sinian or "Hsiachiang System" of Y. L. Wang (see Wang: Sinian glaciation and the stratigraphy of the Hsiachiang System in southwestern China, MS.). As I understand it now, the banding of the slates might represent glacial varves.—T. K. H., May, 1945.

shaly series, protruding out from the smooth slopes of the shaly beds. This stratum is actually met wtih about 4 li north of the river on a hill slope which is essentially on the level with this stratum occurring on the hills further east. It is a massive silicified brittle limestone occurring as an intercalation in the Tatiehkuan Series. The strike and dip of the limestone is not determined.

Crossing the limestone stratum one observes continuous outcrops of greyish green shale and black shale similar to those seen south of the stone bridge above mentioned. Then the road descends into a valley leading NE to Shangtang[1]. On the left side one sees a prominent limestone hill composed of massive grey limestone identical to the limestone of Chipakan. This hill is isolated and appears to be surrounded by shales of the Tatiehkuan Series. The structure is curious. If we suppose the limestone is in fault contact with the shale the fault will be a circular one which is unlikely to be met with in this province. I suggest that the two formations are in normal relation, the limestone forming an inlier of a synclinal basin.

Below the limestone black slaty shale occurs. Further north continuous and extensive outcrops of black shale are met with as far as Shangtang. On the opposite (eastern) side of the valley however a thick stratum of silicified limestone appears, it being the equivalent of the limestone observed before. Quite near Shangtang thin-bedded dark grey limestone strata occur below (?) the black shale, striking N 45° W and dipping 26° SW.

Leaving Shangtang the road runs in a NE direction following a deep valley on both sides of which are exposed strata of greyish green fine quartzitic sandstone and slaty shale, weathering brown. The strata are more or less metamorphosed. Lithologically they are identical to the Tatiehkuan Series. About 6 li NE of Shangtang this series ends and red conglomerates first come into view. It is a limestone conglomerate composed of large more or less angular pebbles of grey limestone and rarely quartzitic sandstone. The pebbles are cemented by a red limestone while the base of the conglomerate is marked by a red clay. The conglomerate is undoubtedly unconformable on the Tatiehkuan Series which here strikes N 40° W and dips 30° SW. Going further east limestone conglomerates are continuously met with. These appear to be massive and look like massive limestone strata when viewed at a distance. The strike is N 55° W and the dip 14° NE. At a place where a stream flows to the SE, massive red sandstone strata appear, forming cliffs

1 上塘

30-40 meters in height. The sandstone is coarse and frequently conglomeratic. It overlies the conglomerate, striking N by E and dipping 6° S. Crossing the stream the road passes through hillocks carved from red sandstones and red clays. Further east red clays predominate, sandstones becoming less and less. Then the road descends a terrace of the red beds and comes on the alluvial plain of Chiuchow[1]. The terrace is low, not over 20 m. Gravel pockets are seen on it now and then.

The city of Chiuchow or Laohuangping[2] lies on the southern bank of a river which is a tributary of the upper Yuanshui. It is the end point of navigation of this river. Small boats proceeding upstream from Chengyuanhsien[3] reach the city where the native products of Kueichou are to be loaded and shipped to Hunan for market. According to the narrative of the boatmen endless limestone gorges are to be passed through in going downstream and it is supposed that marvellous geological sections can be obtained along this river. Exploration in this direction therefore is much to be desired.

The Chiuchow river* forms a genuine alluvial plain near Chiuchow. It is no less than 20 li in length and 10 li in width. So far as I know it is the only alluvial plain occurring in Kueichou. Its formation is entirely due to the development of Tertiary red beds. The red clays and red sandstones above described, being soft and incoherent, are easily torn away by the numerous mountain streams so that a locally mature topography is formed. The streams coming down from the mountains however still retain their vigor on meeting the mature surface where their velocity is suddenly decreased and consequently the rock flour—the sands and clays— carried in suspension is dropped down, forming the alluvial plain as we see it to-day. Structurally speaking therefore Chiuchow is situated in a red basin surrounded by high mountains of Lower Palaeozoic formations. This basin is not only characterized by red beds but also by red beds topography, that is, a topography of isolated low soft red hills with the characteristic absence of continuous ridges. Like the Red Basin of Szechuan the Chiuchow red basin is extensively cultivated by the farmers. Rice fields are seen everywhere while the higher hilly regions are utilized for cotton plantation.

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1 舊州 2 老黃平 3 鎮遠縣

* The name of this river is not known and is called by this name for convenience of description.

River terraces are of frequent occurrence in the red basin of Chiuchow. These are low, usually less than 20 m in height. Their terrace character is often destroyed by extensive cultivation so that they do not come out into prominence. As a good example of these terraces I will mention that on which the city of Chiuchow lies. It is formed of red clay-shales, rising abruptly on the bank of the river. A river-laid gravel is frequently met with on these terraces as mentioned already.

The mountains surrounding the red basin of Chiuchow are composed of two formations, the Cambro-Ordovician limestone and its underlying Tatiehkuan Series. The former constitutes a prominent ridge to the north of the city and the latter forms high mountains with pointed peaks on the northwest. As usual the limestone is massive, more or less silicified. It is dark grey at places but whitish grey at others. The Tatiehkuan Series consists of grey and greyish green shales, shaly sandstone and finely banded quartzite. These are metamorphosed to a greater or less extent. Ten li north by west of the city the top of the Tatiehkuan Series is marked by a black shale of less than 100 m thickness. It immediately underlies the massive limestone. I have spent 2 or 3 hours in searching for fossils in it but failed. The natives are of the general belief that the black shale contains coal and that coal is not produced in this country only because that the people do not have the capital. Being of Cambrian or even Sinian age the shale is of course not coal-bearing. It is true however that these Cambro-Ordovician strata contain cinnabar. I have got from a trustworthy gentleman a piece of limestone in which are embedded beautiful crystals of cinnabar. He informs me that the specimen comes from the vicinity but he could not remember the exact locality. The limestone is metamorphosed and completely silicified. It looks exactly like the Cambro-Ordovician limestone [Ichang Limestone] described in previous pages. At Tsinchai[1] 10 li NW of the city cinnabar is also reported to occur. I went to the spot and found detached weathered crystals of cinnabar in greyish green slaty sandstone belonging to the Tatiehkuan Series.

From Chiuchow to Yüchinghsien

(Feb. 24 - Feb. 27)

From Chiuchow I proceeded directly eastward passing Taiwengpu[2] to Lolang[3] whence I turned north to Yüchinghsien[4]. Leaving Chiuchow the road first runs in a country of low hillocks of red beds for 3 li when it enters a more hilly region of limestone. At the base of the red beds occur massive conglomerates [better call-

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1 秦寨 2 代翁舖 3 羅朗 4 餘慶縣

ed breccias] with unusually angular limestone pebbles, striking N 40° E and dipping 28° NW. It directly overlies the Cambro-Ordovician limestone which strikes N 55° W and dips 15° SE. Their contact is marked by a profound unconformity (See Pl. 45 : HS3, Fig. 50). Going further eeast continuous outcrops of silicified grey limestone are met with, strike constantly changing but dip remaining gentle. The limestone is identical in lithological characters to the limestone occurring between Liangchiapu and Papatsin. Leaving Taiwengpu similar limestones are seen. Toward Lolang the following section is observed (Pl. 45 : HS3, Fig. 51):

1) Massive light grey limestone with circular depressions resulted from the weathering away of small nodules.

2) Rather thin-bedded dense grey limestone with brachiopods and crinoids (St. N 8° E, dip 20° E) (Loc. No. 1340).

3) Minor greyish green shale.

4) Thick-bedded limestone followed by thin-bedded reddish impure limestone with green shale lamellae. Fossils very numerous (Loc. No 1340A).

5) Massive light grey more or less silicified limestone. May be in thrust contact with the preceding.

6) Same as (5)

The fossils [are distinctly of Ordovician age].

From Lolang to near Chungchiaoho[1] the road runs on a plateau on which extensive outcrops of massive, more or less silicified, grey limestone are continually met with. The prevailing strike is N by E and the dip 20° or more to E. Then the road descends into the canyon of the Chungchiaoho with vertical walls of Ordovician [Cambrian] limestone. The canyon however opens out on two narrow belts in which occur softer shaly beds. The situation is best shown in the accompanying section (Pl. 45 : HS3, Fig. 52):

1) Thick-bedded and massive grey limestone with sparse cherty nodules and with the curious concentric concretions as seen in the Cambro-Ordovician limestone at Maitoutsing.

2) Impure greenish grey shaly limestone with brachiopods.

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1 中橋河

3) Red and green thin shales with numerous brachiopods, gastropods and trilobites in the green part (Loc. No. 1341C). [I remember that specimens of *Yangtzeella* were found here.]

4) Thin and well-bedded first greenish grey then red argillaceous limestone with *Orthoceras* and brachiopods (Loc. No. 1341B).

5) Massive grey semicrystalline limestone forming white cliffs on both sides of the river. Brachiopods and a peculiar coral-like fossil occur in abundance (Loc. No. 1341A). This limestone appears to be perfectly concordant upon the preceding strata.

Leaving Chungchiaoho the road makes a steep ascent to Chinkeng[1] whence it turns to the north by east, following a strike valley to the north of Pengshui[2]. Crumbled beds of shaly limestone and greyish green shale are met with in the valley bottom while the hills on both sides are formed of massive limestone strata. Near Pengshui fossils (Loc. No. 1342) were collected from the shaly limestone, these including the characteristic *Yangtzeella poloi* (Martelli) and a rare species of graptolite probably belonging to the genus *Dictyonema*. North from Pengshui the road passes through massive limestone region to Peiyenchung[3]. The strike is N 70° E and the dip 18° SE. Leaving Peiyenchung the road first turns to the NW then it leads in a due north direction to Niutachang[4]. The country is flat, with very low hillocks covered with thick soil. Exposures of more or less silicified grey limestone are now and then met with. They are nearly horizontal.

Leaving Niutachang the road turns to the NW passing through a hilly country in which only limestone strata similar to those above described are met with. They are horizontal or only gently tilted. At Malungao[1], 6 li from Niutachang, a rather thin-bedded grey limestone occurs, striking N 30° E and dipping 54° W. This is followed by a nodular limestone with pure limestone nodules and impure shaly matrix, striking N 30°-40° E and dipping steeply W. Then brownish yellow shales occur. *Redlichia* and other characteristic Cambrian fossils are found in the shale (Loc. No. 1343). The nature of the contact between this *Redlichia* shale and the limestone is not determined. At Taping[6] massive dark grey limestones appear, the lithological character being identical to that of the limestone seen at Chipakan. This limestone seems to lie concordantly upon the *Redlichia* shale but this is not certain. From Taping to the basin of Yüchinghsien similar lime-

1 金坑 2 朋水 3 白岩冲 4 牛大塲 5 馬龍坳 6 大坪

stones are continually met with; the strike is prevailingly N 20° W and the dip 12°-18° E.

As soon as the road begins to descend into the basin of Yüchinghsien conglomerate beds come into view. These are almost exclusively formed of angular pebbles of the Cambro-Ordovician limestone occurring nearby. They dip toward the basin (to the north) and thus lie unconformably upon the Cambro-Ordovician limestone. Descending the slope one reaches the small alluvial plain of Yüchinghsien, on which low hills of red sandstone and red clay are developed. I recognized at once that the city of Yüchinghsien lies in a red basin similar to the red basin of Chiuchow though much smaller.

From Yüchinghsien to Tzuchianghsien

(Feb. 28 to Mar. 8)

The basin of Yüchinghsien is more or less circular or slightly elongated in shape. It is small, not over 5 km in diameter. The river Yüchingshui coming from the southwest crosses the basin and flows into a series of gorges in the north. Patches of alluvium are developed along the river in the red basin which is surrounded in all sides by high mountains formed of Lower Palaeozoic [and possibly Sinian] strata. I have examined these formations in three different routes: the southern route from Niutachang to Yüchinghsien being already described, the western route which leads to Tzuchianghsien, and the eastern route which will be described immediately.

Going northeast from Yüchinghsien the road first crosses the Yuching River and passes through a small alluvial plain. Then it turns to the east following the course of a tributary to that river. Red conglomerate and red sandstone are continually met with along the valley. The conglomerate is almost exclusively composed of limestone pebbles. It is massive, appearing like massive limestone as viewed at a distance. Toward Manchi[1] one sees prominent hills, the Laoyinyen, to the north of the valley. These are formed of gentle-dipping (?) massive limestone underlain by greenish sandy shale and brown quartzite, the former being occasionally conglomeratic. These strata are like nothing but the Tatiehkuan Series. At Manchi a gneissic quartzite (resembling dense intrusive rock) and greyish green sandy slate occur, striking N by W and dipping 18° SW. A little further east on the northern side of the river massive limstones are met with, striking N 35° W.

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1 滿溪

The relation between these and the quartzite is not known but it is certain that the limestones are continued westward to Laoyinyen. From Manchi to Shangpingku[1] the geology is peculiar. On the northern side of the stream occurs massive limestone forming cliffs immediately rising on the bank of the stream, while on the southern side continuous outcrops of greyish green quartzitic sandstone and green slates come into view, dipping away from the limestone. These sandstones and slates undoubtedly belong to the Tatiehkuan Series* but what is their relation with the limestone? They appear neither to overlie nor to underlie the latter. Thus they are probably in fault contact, the stream course marking the fault line. One li west of Shangpingku I have made the following observation: thin-bedded green and purplish quartzitic sandstone occurs on the southern wall of the valley, striking nearly E-W and dipping 40° S; on the northern side there are thin-bedded impure, occasionally oolitic limestones underlying massive grey limestone with an appreciable dip to the N.

East of Hsiapingku on a hill spur on the northern side of the stream I found abundant *Yangtzeella poloi* (Loc. No. 1344) in a greyish green calcareous shale which overlies a reddish shale. The strike is N 30° W and the dip 30° N. The relation of the fossiliferous beds with the massive limestone further west is not determined owing to soil cover. But it is safe to assume that the former overlies the latter. Looking east from Shangpingku one sees endless hills of massive limestone dipping to the E or SE. The limestone is equivalent to that occurring near Niutachang and elsewhere. It is to be remembered that the *Yangtzeella poloi* beds and their equivalents are followed by the Permian limestone as seen in previous sections. But the limestone occurring east of Shangpingku is quite unlike the Permian, so its age becomes a problem. I suppose that it is nothing but the Cambro-Ordovician [Cambrian] limestone which here is thrust against the shales.

Now let us begin our description of the western route. Going northwest from Yüchinghsien the road first crosses an alluvial plain, then it passes through

1 上平谷

* Though the occurrence of the Tatiehkuan Series (Sinian) in the Manchi-Shangpingku area cannot be doubted, its areal distribution is not known and on this account it is not shown on the geological map. It is possible that the alleged fault contact between the limestone and the sandstone represents the Sinian-Hsiachiang System unconformity described by Y. L. Wang, but the character of the limestone is more like Cambrian and is therefore in disagreement with such an interpretation.—T. K. H., May 1945.

hillocks of red clays and red sandstone. 6 or 7 li from the city the red clays are succeeded by red conglomerates which overlie strata of massive grey limestone. The latter is crushed and crumbled so that its orientation is not determinable. In a distance of 300 m this limestone is crossed and beds of grey and greenish grey slate and sandy slate come into view, striking N 68° E and dipping 39° SE. Then the road goes directly to the NW ascending a slope and reaches Tuantienshu[1]. Argillaceous and arenaceous strata mostly green sandstones and slates are continually met with. Black flint beds are also seen in the series while near Tuantienshu purple and red clay-slates occur, striking N 70° E and dipping 70° S. At Tuantienshu one observes a prominent limestone escarpment to the northwest at the foot of which are numerous mining pits. The natives tried to obtain coal from a highly carbonaceous black shale but without success. The black shale overlies a series of green slaty shale, forming a continuous sequence with the strata found east of Tuantienshu. I have no doubt about the identity of this sequence with that occurring near Shangtang and Tatiehkuan, *i.e.*, the Tatiehkuan Series*. Thus the escarpment-forming limestone immediately above the black shale is to be referred to the limestone of Chipakan.

Leaving Tuantienshu the road turns to the due west for 10 li to Siaotsai[2]. Continuous exposures of grey and green sandy slates are met with. Just south of Siaotsai I found massive light grey silicified limestone striking nearly E-W and dipping to the N. It appears to underlie the sandstone and slate series north of Siaotsai. Leaving Siaotsai the road ascends a steep slope and reaches the pass Tutiao[3]. Silicified limestone strata occur on the south, striking E-W or WNW and dipping steeply N. On the north however the Tatiehkuan Series dominates. Since the limestone is identical to the Supra-Tatiehkuan limestone in character it is supposed that it is thrust by the Tatiehkuan Series from the north. This thrust is local and west of Tutiao the succession becomes normal, the limestone being underlain by black shale. Descending Tutiao continuous outcrops of brown and black sandy shales are found on the northern side of the valley, St. WNW and dip 40° S. On the opposite side the massive limestone forms an escarpment. Approaching Siaoho[4] the road descends into a vally in which a river flows to the NW. On the southern bank of this river the Tatiehkuan Series strikes NE-SW and dips 20° SE. At Siaoho there occur three hills formed of massive dark grey more or less crystalline limestone surrounded by sandy and shaly beds of the Tatiehkuan Series. To the

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1 斷顛樹 2 小腮 3 土地坳 4 小河

*The areal distribution of the Sinian is probably much greater than that shown on the map.

northwest a more or less continuous ridge is seen, this being composed of the same limestone. Occurring within the Tatiehkuan Series this limestone cannot be equivalent to the Supra-Tatiehkuan limestone. What is its stratigraphical position however remains unsolved.

Going west from Siaoho the road follows the course of the river to Niuchangtsui[1]. Red clay shales are now and then seen *en route*, striking N 50° E, while the hills on both sides of the valley are formed of the Tatiehkuan Series. One li west of Niuchangtsui the road turns to the south at first then it swings to the SW and reaches Siyen[2] after crossing a high pass. The strata met with *en route* are slates and sandstones belonging to the Tatiehkuan Series, all remaining essentially horizontal*.

At Siyen one observes high limestone hills to the south and a pagoda-like limestone hill in the immediate west. Going west from Siyen the road follows a valley and passes near the foot of this hill. This is composed of massive dark grey nearly horizontal limestone, underlain by brown shales and sandstones. Further up the valley continuous massive limestone hills occur on the south while strata of the Tatiehkuan Series are found in the north as well as in the valley bottom. At Peishachi[3] a yellowish shaly sandstone strikes N 70° W and dips 19° E. Then the road ascends a slope and comes on the plateau of Sungping[4]. On the slope the Tatiehkuan Series dominates but the rocks are mostly covered. One or two small hills of massive limestone are seen. About 3 li NE of Sungping, outcrops of yellow and green shales are met with. These are in very thin beds and weather into a characteristic orange color. They are very fine-textured and appear to be ideal for preserving the delicate structures of fossil animals. A hunt is immediately persecuted. Species of *Redlichia* and small *Obolella* are found in abundance (Loc. No. 1345) proving the Lower Cambrian age of the strata. A little to the west is a hill of massive dark grey limestone similar to the Supra-Tatiehkuan limestone in appearance. This limestone may be in fault contact with the *Redlichia* shales. Owing to the thick soil cover and the occurrence of local flexures in the shale, no reliable strike or dip can be measured. Approaching Sungping a prominent ridge appears on the north. Judging from the floats coming down from

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1 牛場嘴 2 西堰 3 白沙溪 4 松坪

*Though sandstones and slates of the Sinian Tatiehkuan Series are extensively developed, between Siaotsai and Siyen, they are not separable from the Cambrian occurring frequently with them and are therefore not shown on the geological map.—T. K. H., May 1945.

the ridge, it is probably composed of calcareous sandstones and thin limestones. These are grey in color, weathering brown and often micaceous. They are gently tilted toward the NW. On the south there are low hills of Cambrian shales and some higher ones of limestone. One li east of Sungping I found the massive grey limestone lying concordantly on yellow *Redlichia* shales striking N by E and dipping NW. The strange thing is that the massive limestone is absent on the northern side where calcareous sandstones prevail. Is this due to a change in facies?

Leaving Sungping the road runs to the southwest in a country of mature dissection dotted with low limestone hills. The strata met with are mostly well-bedded silicified limestones with minor intercalations of shale. The sequence is the same as seen east of Chiuchow and its Cambro-Ordovician age cannot be doubted. The prevailing strike is N by E, the dip ranging from 20° to 45° NW. This same condition prevails until Houchang[1].

Leaving Houchang the road runs directly westward following the course of a small stream. Outside Houchang massive silicified limestone is met with. The limestone is brittle and well-jointed, broken into angular fragments. Its lithological characters are identical to the Cambro-Ordovician limestone seen elsewhere. The strike is NE and the dip to the NW. At Hsiaszu[2] the silicified limestone strikes N 53° E and dips 17° W. [Floats of this limestone with fossils (Loc. No. 1346) were found nearby]. About half li west of Hsiaszu there rises a hill which is formed of a totally different kind of limestone. It is a massive dark grey limestone with sparse chert nodules, giving out a strong petroleum smell when struck with the hammer. Fossils are found in it (Loc. No. 1347) [7], these proving the limestone to be the equivalent of the massive Permian limestone observed in previous sections. This formation is unusually thin, not over 40-50 m. It occupies a narrow belt striking nearly N-S I have carefully measured the strike and dip of the formation on the top bed in which occur beautiful specimens of ***Productus***. The strike is N 5-9° E and the dip 9° W. As noted above the strike of the Cambro-Ordovician is prevailingly NE, and the dip being at least 17° NW. I strongly believe that this discordance both in strike and dip is caused by an unconformity between the Permian and Cambro-Ordovician. It is unfortunate that the exact contact is not seen on account of soil cover (see Pl. 45: HS3, Figs. 53 & 54).

Just above the Permian limestone one sees numerous coal pits marking the occurrence of coal-bearing shales on the spot. Further west the road still follows

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1 猴場 2 下司

the course of the stream. The valley is open and the country is flat, with low hills occurring now and then. The strata met with belong to the mid-Permian coal-bearing series. About 2 li west of Yapo[1] massive Permian limestone appears, striking N 16° E and dipping 15° E. Evidently we have crossed a flat syncline in Permian formations. In a distance of one kilometer the Permian limestone is crossed and Ordovician [Cambrian] limestones reappear. The top of the latter is marked by a stratum of greyish black iron-stone about 20 m thick. The strike is N 5-10° E and the dip is gentle to the E. No appreciable discordance is observed between the Permian and the Ordovician [Cambrian]. Toward Mulaoping[2] Cambro-Ordovician limestones prevail. The stream whose course we have followed enters a cave east of Mulaoping.

Leaving Mulaoping the road descends into a deep valley developed in the Cambro-Ordovician limestones which here strike N 10° E and dip 17° E. Crossing the valley outcrops of red conglomerate composed of limestone pebbles are seen. Further west at Sinchaiyao[3] red clays appear, these lying conformably upon the conglomerate. From Sinchaiyao to Panpuho[4] red conglomerates and red clays are continually met with. These red beds appear to have filled an old valley formed in the Cambro-Ordovician limestones. Descending into the Panpuho one observes red conglomerates with angular limestone pebbles lying unconformably on massive dark grey limestone. Crossing the Panpuho the road turns into a side valley up which it goes. Massive limestones appear on both sides of the valley while the valley bottom is strewn with [blocks of] red conglomerates. Just at the place where the by-stream enters the master stream there stands a beautiful, pointed pillar of red conglomerate. This is called by the local people the Wenpishan[5]. Finishing the ascent one reaches Yütsiupa[6]. Going southwest from Yütsiupa one observes a belt of massive limestone hills. Then grey shales and fire-clays occur, coal being mined from them. Floats of cherty limestone are also seen. It becomes evident that we have crossed the Cambro-Ordovician and come into the domain of the Permian formations. From Yütsiupa to Shanwangmiao[7] the road passes over an undulating surface with isolated outcrops seen now and then. At Shanwangmiao massive Lower Permian limestone reappears. In it I have found corals and brachiopods (Loc. No. 1348). Crossing the Permian the road descends an escarpment and reaches Kaochien[8]. Thick-bedded more or less silicified and iron-stained limestones are extensively developed in the vicinity of the village. These underlie the Permian limestone concordantly and are equivalent to the Cambro-Ordovician limestone. I have found

1 鴨坡 2 木老坪 3 新寨窰 4 板布河 5 文筆山 6 魚鰍壩 7 山王廟 8 高梘

numerous well-preserved brachiopods (Loc. No. 1349) [9] on the building stones of some farm house. The rock is a characteristically red, impure, thin-bedded limestone, apparently coming not far from the vicinity. The lithological characters of this rock are different from all the formations previously met with. Its stratigraphic position therefore appears to be an enigma. [Later study of the fossils shows that the limestone still belongs to the Permian.]

From Kaochien to Chungping[1], a distance of at least 30 li, the road runs on a plateau on which horizontal or gentle dipping strata of thick-bedded silicified limestone (Cambro-Ordovician) are continually observed. Some 4 li west of Chungping grey shales and fire-clays occur, while the presence of coal is indicated by numerous mining pits. Then massive Permian limestones come into view. The Permian formations however are soon crossed and Cambro-Ordovician limestones reappear. Whether the Permian strata form a flat syncline or occur on the downthrow of a normal fault [thrust?] is not determined, but I think the latter case is more probable. The silicified limestone just below the Permian strikes N 52° W and dips 22° E. Further westward extensive outcrops of Ordovician [Cambrian] limestone are met with, these forming a plateau on which the road runs. West of Chatien[2] the road descends into a deep canyon which it follows for 2 li or so, then it again ascends the plateau, reaching Hualichang[3]. The limestone which forms the canyon strikes NE and dips 18° NW.

Going southwest from Hualichang one observes outcrops of massive limestone dipping gently to NW. This limestone undoubtedly belongs to the Cambro-Ordovician series but it is interesting to note that it is dark grey, occasionally banded and nodular, its appearance being not unlike some of the mid-Permian limestone seen in previous sections. Further west brown and grey shales appear as intercalations in the limestone. I have searched for fossils but failed. About 5 li from Hualichang the road begins to descend into the deep valley of the Lowangho[4], a big river flowing from the south to the north. It is the main stream of the Nanminho at Kueiyang and the Tsingshuiho crossed in my route from Kueiyang to Chiuchow.

Leaving the Lowangho the road follows a side valley up which it goes. Massive Cambro-Ordovician limestones occur on both sides of the valley. About 3 li from Lowangho the road crosses a low pass at which the limestone ends and a different formation begins. The limestone forms an escarpment running from the

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1 中坪 2 茶店 3 花梨場 4 樂旺河

north to the far distant south. The underlying formation consists of greenish grey shales dipping gently to the E. In a distance of 3 li the green shale is succeeded downward by light grey fine quartzite, striking N 35° W and dipping 52° NE. Further west on the banks of the Wengchaoho[1] thin-bedded grey clay-slates occur striking N 43° W and dipping 27° SW. West of Wengchao[2] one observes a series of grey sandstone and sandy shale striking N 20° E and dipping 35° E. These are underlain by yellow and grey shales, the rock resembling in lithological characters the *Redlichia* shales previously seen. The strike is about E-W and the dip 30° S. Well laminated light grey shales prevail up to Tsingkou[3] when a thick stratum (about 100 m) of highly silicified light grey limestone comes into view, forming a uniform ridge across which the road is to pass. The limestone is conformable upon the shale which strikes N 14° E and dips 10° S.

Looking east from Tsingkou one sees a prominent, nearly N-S striking limestone escarpment in the far distance extending for miles toward the south. This is the Cambro-Ordovican limestone seen east of Wengchaoho. In the southeast there rise hills of a soft tone formed of shaly or sandy strata which we have already dealt with in the preceding paragraph. These hills are invariably capped by a limestone stratum whose outcrops can be traced from the south of Wengchao to Tsingkou where it is actually observed. It forms a semicircular arc indicating that the structure we have crossed is a dome. That this limestone is not observed east of the Wengchaoho may be due to two alternative causes: It may be replaced by shaly strata or it is cut by a fault which brings the Cambro-Ordovician limestone in contact with the grey shales. I would say that the latter case is more probable (See Pl. 45: HS3, Fig, 55)

Leaving Tsingkou the road ascends a gentle slope on which Lower Cambrian shales are exposed. The sequence is best shown in the accompanying sections:

1) Light grey shale.

2) About 100 m massive silicified limestone*.

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1 翁招河 2 翁招 3 箐口

*This limestone as well as its overlying black shale (3) belongs, in all probability, already to the Sinian while the submetamorphic areno-argillaceous sequence below the limestone is to be compared with the "Hsiachiang System" of Y. L. Wang or with the Kunyang Series of P. Misch. (See Y. L. Wang: Sinian glaciation and the stratigraphy of the Hsiachiang System of southwestern China (MS.), and P. Misch: Sinian stratigraphy of central eastern Yunnan, Nat. Univ. Peking, Contributions no. 4, Kunming, 1942.) Compare also Tatiehkuan Series (*vide supra*).

3) Well-bedded black shale St. N 14° E, dip 20° W.

4) Yellow and dark green or brownish green shales with minor intercalations of red shale.

5) Dark grey or dark green sandy shale, shaly sandstone and impure limestone.

6) Green and yeollow shale with abundant *Redlichia* (Loc. No. 1350). St. N 20° E, dip 26° W.

7) 15 m thin-bedded grey limestone.

8) Yellow and green shales with *Redlichia.*

9) Thick-bedded grey limestone, St. N 15° E, dip 25° W.

10) Thin-bedded, slightly silicified limestone with minor whitish shaly intercalations (typical Cambro-Ordovician).

The above sequence is beautifully exposed along a deep canyon just north of Tsingkou.

Cambro-Ordovician limestone is extensively developed from Peihotsin to Taotzuwo[1] where a fault occurs in the limestone series. This is inferred from the abrupt change in dip and from the fact that the limestones west of the fault line are strongly disturbed. About 4 li SW of Taotzuwo the Cambro-Ordovician limestone ends and the Permian limestone begins. Both the Permian and the Cambro-Ordovician strike about N 60° W and dip to the NE (about 25°), their contact being apparently concordant. So at first I took the Permian as part of the Cambro-Ordovician. But careful observation shows the presence of undoubted Permian. This is not only proved by the occurrence of fusulines in the limestone but also shown by its strong petroleum smell. The obvious conclusion is that the Cambro-Ordovician is thrust over the Permian.

The Permian limestone is underlain by about 15 m of grey clay shale and iron-stone with poor plant remains. Poor coal is said to occur in the shale while abandoned coal pits can be observed by the road side. Immediately underlying the basal Permian shale the Cambro-Ordovician limestone reappears striking NWW and dipping NE. Near Tungshang[2] on the [hill] slopes one observes floats of a

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1 桃子窩 2 洞上

reddish yellow rock containing pisolites.* The nature and position of this peculiar rock is not known. From Tungshang to Tzuchianghsien[1] only Cambro-Ordovician limestones are to be seen (See Pl. 45:HS3, Fig. 55).

From Tzuchianghsien to Kouchangpa on the Kueiyang-Tsunyi Main Road [3]

(March 10 to March 12)

At Tzuchianghsien I was informed that coal is produced at some place southwest of the city. I made an excursion in that direction at once and obtained some interesting results.

The city of Tzuchianghsien stands on a well-dissected plateau composed of Cambro-Ordovician limestone. Going southwest from the city one observes thin-bedded silicified limestones, striking N 5-15° E and dipping 23° E. West of Singchai by an easterly stream the first outcrops of grey or black shale with *Ptychoparia* (Loc. No. 1351A) are met with, St. N-S, dip 23° E. Then green shales come into view. Lower Cambrian fossils including *Redlichia* are found in abundance in this shale (Loc. No. 1351). Further southwest similar green shales occur until Tatiehshao[2]. The prevailing strike is N 10° E and the dip 34° SE. North of Tatiehshao patches of black carbonaceous shales are found. Same black shales occur south of Tatiehshao in an E-W valley. Though the strike and dip of these shaly strata cannot be measured, their outcrops mark a continuous belt of black soil which is directed nearly N-S. So it is inferred that the prevailing strike is N-S. About two li south of Tatiehshao limestone hills appear. In the limestone I have found *Michelinia* sp. and *Fusulinella gigas* proving the Permian age of the limestone (Loc. No. 1352) [7]. The limestone is massive so that its orientation cannot be accurately determined but I have roughly measured its strike to be N 36° W and its dip 14° SW. It becomes at once evident that the Permian limestone and the Cambrian shales are in discordant relation. I strongly believe that the former lies unconformably on the latter (See Pl. 45:HS3, Fig. 55).

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* This pisolitic rock appears to be the same as that found west of Pitsiehhsien (*vide supra*). Occurring probably on top of the Cambrian limestone or at the base of the Permian, its stratigraphic position is comparable to the bauxite found recently near Kueiyang.—T. K. H., May 1945.

1 紫江縣 2 打鐵哨

Determined to return to Kueiyang, it was at first planned to go directly southward from Tzuchianghsien. Later the magistrate informed me that Peimatung[1], the famous quicksilver mining locality, is only 40 li west of the city. I then decided to investigate that place whence I could proceed to Chatso[2] and follow the newly built highway to Kueiyang. I left Tzuchianghsien on March 11. On previous days it has snowed heavily. The hills were already covered. On the day of my departure another heavy snowfall broke out and this rendered it impossible for me to carry out my ordinary routine. I was forced to abandon my compass and sketching board surveying and use the 1/200,000 scale map published by the Military Survey Bureau as my base. Geological observations were also made in the roughest way. So I must apologize for the inadequate and inaccurate observations made from Tzuchianghsien to Peimatung.

The geology between Tzuchianghsien and Peimatung is simple. The strata met with all belong to a limestone formation. The limestone is thick-bedded, more or less silicified, and grey or light grey in color. It seems certain that it is the Cambro-Ordovician limestone seen in previous sections.

The village of Peimatung lies in a valley in which a stream flows to the east. On both sides there rise hills formed of Cambro-Ordovician limestone from which cinnabar is mined. Numerous mining pits are seen all round the village especially near the foot of the hill just north of the village. Most of these are said to be abandoned pits of the Min dynasty. At present only two pits are in active operation. The country rock is surely a part of the Cambro-Ordovician limestone but it has altered its ordinary appearance by metamorphism. It looks like a massive grey or black clay-slate, being calcareous and argillaceous. The cinnabar occurs as red particles evenly distributed in the rock or as a thin coating. No well-formed crystals are to be found. The actual cinnabar-bearing rock appears to be the same as the metamorphosed clay-slate and its distribution is very irregular. It is impossible to calculate the reserve of the deposit even if the percentage of the mineral is accurately determined. The mining and metallurgical operations are as follows.

The cinnabar-bearing rock is drilled by the native method. Powder is put into the drill holes. The rock is then blasted into lumps which are further reduced into small pieces by hammering. These are ready for the furnace. The body of the furnace is built of ordinary clay, about 4 feet high and 3 feet across. On top

1 白馬洞 2 札佐

of it (See Pl. 45:HS3, Fig. 56) is set an earthen-ware bulb one foot or more in diameter. Another similar blub is fixed at one side. Both are entirely air-tight except for a peep hole on top of the side bulb. Below this latter is the hearth in which are put coal bricks (powdered anthracite mixed with clay). The ore comes on a grate and occupies a great part of the furnace body. The coal is ignited and the ore heated. The reduction process goes on until most of the quicksilver is condensed on the inner surface of the bulb while a small part is collected from the side bulb. The engineer in charge said to me that the completion of the reduction process is indicated by the absence of moisture around the peep hole. It is reported that one charge produces a maximum of one "liang" of quicksilver and that 5 charges may be worked in 24 hours. One catty (16 liang) costs about 5 Yunnan dollars (4 dollars Mex.).

Going west from Peimatung one observes massive grey limestone striking N 22° E and dipping 30° E. The limestone is attractively red in color and frequently oölitic. The appearance of the oölitic strata looks not unlike those in the Middle Cambrian of North China. Concordantly underlying the limestone are grey and green shales and green thin sandstones. The sandstone is often shaly and splendidly micaceous. Up to Sinchai[1] dark green and grey shales prevail. West of Sinchai silicified light grey limestones appear. These are locally oölitic striking N 10° E and dipping 45° E. Black clay-slates are found above the silicified limestone; their contact is however not observed. It seems certain that the green and black shaly formation belongs to the Lower Cambrian shales seen in previous sections. The limestone is the equivalent of the Cambro-Ordovician limestone, forming the western limb of an anticline whose eastern limb is at Peimatung. Going west of Sinchai light grey silicified limestones are continually met with. They dip gently to the W. At Matikuan[2] massive dark grey limestones occur. At first I took them as part of the Cambro-Ordovician series. But as soon as I observed coal-bearing grey shales south of Matikuan I began to realize that the limestone at Matikuan is really the massive Permian limestone. As my time was limited I have not had the opportunity to re-investigate that place. It is supposed that the Permian limestone as usual lies unconformably or at least disconformably upon the Cambro-Ordovician series. The coal series is soon crossed and thin-bedded limestones begin to attract attention at Tuimenwan[3]. The limestone is pure, grey and fine-textured. Though it is thin-bedded the bedding planes are frequently tightly closed so that the rock appears massive. The strike is probably W by N and the dip gentle to S. Then

1 新寨 2 馬蹄關 3 對門灣

thin-bedded Triassic limestones are continually met with as far as Kouchangpa[1]. From the latter place I went directly south following the highway to Kueiyang. Since it was pre-arranged that our party should follow this road on our return journey [from Kueiyang to Chungking] I did not attempt to make observations when I left Kouchangpa.

RECONNAISSANCE IN NORTHEASTERN KUEICHOU IN THE DISTRICT EAST OF TSUNYIHSIEN [18, 19]

(March 29 to April 8)

By Y. L. Wang and T. K. Huang

From Tsunyihsien to Meitanhsien

(March 29 to April 1)

From Tsunyihsien to Tsingchengchiao to be reported by Mr. Y. L. Wang.

From Tsingchengchiao to Pachitan By T. K. Huang—At the stone bridge of Tsingchengchiao there crops out the Lower Permian limestone with *Fusulinella gigas* (?), dipping gently to E. One li east of Tsingchengchiao the Permian limestone strikes N 20° E and dips 55° SE. Beautiful and unusually large specimens of *Schwagerina* occur in abundance (Loc. Nos. 1353-1353A). 2 li further east the massive limestone is succeeded by grey shales and cherty limestone beds with poor coal, striking N 15° W and dipping 28° E. On the cherty limestone I saw beautiful chrysanthemum-like chert nodules. Further east grey and black shales and impure bituminous limestones occur; *Lyttonia* and other characteristic fossils are found in the limestone (Loc. No. 1353B) [7]. They strike N 26° E and dip 24° E. Not far above the *Lyttonia* bed greyish black and brownish yellow banded shales are met with. Excellently preserved pelecypods are found in these beds (Loc. No. 1355) [12]. Then there follow thin-bedded grey or bluish grey limestones with thin intercalations of yellow and grey shales in which occur small brachiopods and pelecypods (Loc. No. 1354) [12]. It appears certain that this horizon is equivalent to the Panshan limestone [Yülungshan limestone] of Dr. Ting (See Pl. 45 : HS3, Fig. 58). East of Huangtsunpa[2] the fossiliferous beds are succeeded by unfossiliferous thin-bedded grey limestones striking N 10° E and dipping 10° E. At Tawotang purple shales come into view, striking N 10° W to N 8° E and dipping 10°-14° E. East of Tzutsaokou these are followed by evenly bedded Triassic limestone striking

1 狗場壩 2 黃村壩

N 7° W and dipping 20° E. Two li east of Pakuaitu[1] the limestone series ends and dark grey and yellowish grey shales with frequent limestone seams make their appearance. Pelecypods and *Spiriferina* are found in the shales. It is supposed that this horizon represents the Sungtzekan shale of Dr. Ting. The strike is N 15° E and the dip 30° E. These are concordantly followed by red and purplish green shales with 2 seams of impure yellow limestone and one seam of dense limestone in which occur pelecypods. At Tashihpan[2] horizontal purplish red clay-shales prevail, constituting low and isolated hills. These red beds are identical in lithological characters with the red beds of Szechuan and may be mistaken for such. Since they are to be met with in later sections I propose to give them the name *Supra-Sungtzekan red beds.*

East of Tashihpan grey shales and thin limestones reappear striking NS and dipping 82° W near Chishui[3]. Further east well-bedded Triassic limestones come into view, striking N 15° E and dipping 40°-50° W. Evidently we are dealing with an asymmetrical syncline whose eastern limb is steepened. The axis of the syncline passes at Tashihpan. Then the road crosses a low pass at which the Triassic limestone strikes N 10° E and dips 33° E. Descending the pass the road enters an E-W valley at the entrance of which (where there is a water mill) the Sungtzekan shale crops out striking N 5° E and dipping 60° E. Thus the structure east of Chishui reveals itself as a closed anticline.

The Sungtzekan shale is followed by the Supra-Sungtzekan red shales which are again followed by thin-bedded grey limestones whose character and appearance are not unlike the Triassic limestone below the Sungtzekan shale. This we shall call the *Post-Sungtzekan limestone.* The prevailing strike is N 10° E and the dip 70° E.

East of Hsiatzuchang[4] the Post-Sungtzekan limestone dips 25° W. At Siaotangpo the limestone is underlain by the Supra-Sungtzekan red shale which strikes nearly N-S and dips about 30° W. It is clear that the Post-Sungtzekan limestone and its underlying shales form a syncline whose axis passes near Hsiatzuchang.

East of Siaotangpo the Post-Sungtzekan limestone reappears, striking N 5° W and dipping 76° E. This limestone and the red shale are probably in fault contact. Further east the limestone again dips at 54° W. At Chinkuei the Supra-Sungtzekan shale is again met with, dipping steeply west. From Chinkuei to Tienpa[5] the Sungtzekan shale and its underlying Triassic limestone come into view all

1 八塊土 2 大石板 3 溪水 4 蝦子場 5 田壩

dipping (54°) to W. East of Tienpa the strata once more dip to the E at 40-50°, until Pachitan[1] where the Post-Sungtzekan shale makes its last appearance. The structure from Siaotangpo to Pachitan is evidently an anticline with its axis at Tienpa.

From Pachitan to Somikung to be reported by Mr. Y. L. Wang.

From Somikung to Meitanhsien by T. K. Huang. Going east from Somikung[2] one observes isolated hills formed of massive Lower Permian limestone which strikes N 45° E and dips 20° SE. To the north there rises a prominent ridge on which well-bedded, probably limestone strata are seen to dip under the Permian. These, by reference to later observations, belong to the Matishih limestone of Ordovician age. Toward Shihhuiyao[3] the road descends into a valley on the right side of which the Permian limestone strikes E-W and dips gently to S. Immediately below this appears fossiliferous yellow shales striking E-W and dipping 10° S. Graptolites, trilobites and brachiopods occur in abundance (Loc. No. 1361A), proving beyond doubt the Silurian age of the shale. The Silurian formation however is very thin, not over 40 m. Its outcrops are only to be found now and then in the valley bottom.

At the low pass Fenshuiya[4], Silurian shales occur on the left side while Permian limestone forms a prominent hill on the right side. The shale strikes S 65° E and dips 28° S; the limestone is massive and its orientation is not determinable. Below the Permian limestone are seams of impure limestone in which I found *Favosites, Halysites* (Loc. No. 1361B) and other Silurian corals. The relation between the Silurian shale and the Silurian limestone is not known. Near a small temple below the Silurian shale typical reddish Matishih limestone comes into view, striking S 65° E and dipping 20°-28° S. At another place the strike is measured at S 80° E and the dip 21° S.

Descending Fenshuiya the road turns to the N by E passing over the flat country of Yenkungpa[5]. Several isolated hills dot the flat surface, these being composed of massive Permian limestone which strikes NE and dips 32° NW. To the west the Ordovician limestone ridge still persists, the strata on the ridge appearing to dip to the NW (?). Since the Permian limestone at Yenkungpa also dips to NW it is supposed that the Permian and Ordovician formations are in fault contact. The existence of this fault is proved by observations at Nanshantung[6], 2 li NE of

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Yenkungpa. At this place an isolated hill appears on the right side of the road. A section through this hill shows the following:

1. Massive Permian limestone concordantly lying on
2. Silurian shales with fossils.
3. Reddish Matishih limestone St. NE, dip 30° SE.
4. Thick-bedded silicified limestone.

In the high hills occurring on the right side of the road the Permian, Silurian as well as the Matishih limestone are entirely wanting. The hills are formed of massive, silicified light grey limestone whose appearance closely resembles the salt lumps from Tzuliutsing, Szechuan. The strike is N by E and the dip 10° W. I am sure that this limestone is the equivalent of (4) in the above section. The fact that it forms high mountains on the left side of the road but is only to be found at the foot of the hill on the right side is explained by a normal fault.

From Nanshantung to Huangchiapa[1] the road follows the course of the Meitan river which flows from the SW to the NE. Exposures of silicified limestone are now and then to be met with. The strike is prevailingly N 30° E and the dip about 24° NW.

From Huangchiapa to Meitanhsien[2] the road runs in the open valley of the Meitan river with a valley bottom partly filled by alluvial deposits and partly dotted with low hillocks of silicified limestone. To the northwest there rises a continuous high range striking NE-SW. This is apparently composed of thick-bedded limestones (Cambro-Ordovician) dipping to the W. To the east there is another prominent range formed of similar limestones. Thus the topography between Nanshantung and Meitanhsien can be summarized as: an open valley bounded by two NE-SW striking high ranges of Cambro-Ordovican limestone.

Two li NE of Huangchiapa at a quarry by the river silicified limestones strike N 25° E and dip 25° NW. At the place where the road crosses a large by-stream of the Meitan river the limestone strikes N30° E and dips 50° NW. Eastward the strike abruptly changes to nearly E-W, dipping 20° S. It is inferred that a fault occurs. Further northeast the NE strike is resumed. 2 li north of Lungwangmiao on a small hill the limestone appears massive and is reddish in color. It strikes N 40° E and dips 20° NW. Near this hill by the road side exposures of

1 黃家壩 2 湄潭縣

brownish yellow micaceous sandstone and greenish grey calcareous shale are met with. These are mere intercalations of the thick Cambro-Ordovician series. [Ordovician fossils found from limestone blocks forming the city wall of Meitanhsien, Loc. No. 1362].

From Meitanhsien to Hsinglungchang by T. K. Huang. Leaving Meitanhsien the road goes to the SE following the course of a by-stream of the Meitan river which cuts a gorge through the southeastern range of the Meitan river valley. This range, though very prominent in the south of the city, becomes subdued and eventually disappears toward the NE. At Wanshoukung[1] the first outcrops met with are dark brown sandy shales with trilobite fragments, striking N 40° W and dipping 17° SE. Further on, dark green sandy shales appear, striking N 45° E and dipping 17° NW. The appearance of these strata strongly suggests their Cambrian age but reliable Cambrian fossils are not found. Near a stone bridge one observes well-bedded limestones forming the northern wall of the valley while sandy shales constitute the hills south of the same. All these beds strike nearly E-W and dip 10° N. Evidently the difference in lithological characters between the strata occurring in the north and those in the south cannot be explained by a fault but simply by an abrupt change in lithology.

At Kuanyintung[2] massive dark grey limestones occur, these frequently changing into shaly beds. Going SE from Kuanyintung for a distance of 5 li, the road passes over a hilly region in which massive dark grey limestones are continually met with, lying horizontal or dipping gently to W. These limestones bear a striking resemblance to the Permian limestone. They possess however characteristic red iron stains and do not emit a petroleum smell under the hammer as the Permian limestone does. Further southeast the country appears flatter and the relief much softer, the hillocks being extensively covered with a residual soil. The underlying solid rocks are greenish and yellowish shales with numerous trilobites including the genus *Ptychoparia* (Loc. No. 1363). Thus the Cambrian age of the shales becomes evident. But it remains to be determined whether they belong to the Lower or to the Middle Cambrian.

Going southeast from Sinchai[3] monotonously thin-bedded limestones appear, striking N26° E and dipping 40° NW. Then brownish yellow sandy shales occur, striking N20° E and dipping steeply NW. Further southeast until Hsinglungchang[4] continuous outcrops of thick-bedded silicified limestones are met with, these

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1 萬壽宮 2 觀音洞 3 新寨 4 興隆場

being strongly disturbed so that their strike and dip can not be accurately determined. At Hsinglungchang a prevailing NE-SW strike is obtained, the dip being to the SE.

The structure between Meitanhsien and Hsinglungchang is a broad anticline cut by a number of strike faults. The axis of the anticline is marked by the *Ptychoparia* shale above mentioned.

From Meitanhsien to Tuichaya by T. K. Huang. Going west from Meitanhsien the road first passes through a flat country, then it crosses a hilly region, reaching Kuanyen[1] in the valley of a by-stream of the Meitan river. The strata met with *en route* are thick-bedded more or less silicified limestone alternating with thinner beds and occasionally with shaly members. In the first 5 li or so between the city and Maotsaoping the strike is variable, usually E-W but frequently changing to NW. The dip is gentle, 4°-15° to the S. Between Maotsaoping and Kuanyen a uniform strike is met with. It is N23°-35° E. The dip varies between 6° and 22° to the W. West of Kuanyen the road first goes in a flat country for 3 li, then it begins to climb the high escarpment of Wulipo[2]. It is on this escarpment that excellent exposures of the formations from the Cambro-Ordovician to the Silurian can be observed. This is best shown by the accompanying section (Pl. 45:HS3, Fig. 59):

1) Thick-bedded slightly silicified whitish grey limestone, strike N 30° E, dip 33° NW.
2) Thick-bedded grey limestone with numerous *Leptaena*? sp. (Loc. No. 1365B). This is exactly the same limestone as seen west of Lolang, Huangpinghsien.
3) Limestone similar to (2), with two shaly intercalations. *Cameroceras* and gastropods (probably *Ophileta*) occur in abundance (Loc. No. 1365A)
4) Green fissile paper shales with brachiopods and graptolites including *Didymograptus, Phyllograptus,* etc. (Loc. No. 1366A). [This is the "Meitan shale" of C. C. Yü, see 22].*

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1 官堰 2 五里坡

* My collections at Wulipo, which are large and systematic, were intended for my own study. While I was staying in Europe, C. C. Yü took much interest in this material and published in 1933 a brief note on it [22]. He did not consult me, however, on the creation of the new term "Meitan shale", a term which in my opinion is quite unfortunate.—T. K. H., May 1945.

5) About 20 m of impure shaly nodular limestone with large brachiopods, gastropods and cephalopods (Loc. No. 1366B). [This is the *Lesueurilla* bed of C. C. Yü, see 22].

6) Brownish grey shales with fossils (Loc. No. 1366C). [It is probably this horizon which furnished *Yangtzeella.*]

7) End of ascending, yellow thin-bedded sandstone weathering brown.

8) Green shale and brown sandy shale.

9) Yellowish grey calcareous shale. Strike N 35° E, dip 20° NW.

10) 20-30 m Matishih limestone, [Orthoceras limestone].

11) Silurian greyish green shales and thin brown sandstones with fossils (Loc. No. 1367A).

12) Grey limestone with *Favosites*, etc. (Loc. No. 1367B)

13) At Yenping[1], Silurian shales.

14) Massive Lower Permian limestone.

It is to be noted that the Silurian, which is no more than a score of meters thick at Shihhuiyao, 30-40 li SW of Yenping, attains a thickness of 300-400 m. This fact favors the existence of an unconformity between the Permian and Silurian. The angular discordance however is so slight that it cannot be detected by ordinary field method. The detection of the unconformity becomes even more difficult in this case because the Permian limestone is so massive that it does not show regular bedding planes.

Going west from Yenping the road gradually descends into a valley in which it keeps running for five li, then it ascends a steep slope, reaching Tuichaya. The Lower Permian limestone is ended about 4 li west of Yenping when thick-bedded cherty limestones with shaly intercalations appear, striking N 50° E and dipping 40° NW. One coal seam of one chi thickness occurs in the lower part of the series. Above the mid-Permian comes thin-bedded limestone, the Panshan [Yülungshan] limestone, striking N 32° E and dipping 30° W. At Shuitsinwan[2] the same limestone strikes N 58° E and dips 38° SE, and further N 50° E/42° SE. Evidently we are crossing an anticline in Permo-Triassic formations. Then mid-Permian cherty limestones reappear, striking N 40° E and dipping 38° SE. Toward Tui-

1 岩坪 2 水晶灣

chaya the mid-Permian beds strike N 40° E and dip 42° NW. At Tuichaya the Panshan [Yülungshan] limestone comes into view. Thus the structure between Shuitsinwan and Tuichaya is an anticline.

From Tuichaya to Chengchang to be reported by Mr. Y. L. Wang.

From Chengchang to Suiyanghsien by T. K. Huang. Chengchang[1] lies in the centre of a syncline formed of Triassic formations. To the west there appears a uniform ridge of Triassic purple shales across which our route has to pass. Going northwest from the town, well-bedded limestones are met with. About 3 li's distance the limestones are succeeded downward by purple shales striking N 35° E and dipping 62° SE. Then thin-bedded limestones occur, first striking N 80° W later N 65° E, the dip being about 20° SE. At Tsiangchiatientzu coal-bearing shales and sandstones occur, striking N 35° E and dipping 32° SE. The coal obtained from the native pits is called "Kangmei" and is very poor in quality. From Tsiangchiatientzu to Kuanluchang[2] the road crosses a plain surface on which no outcrops can be seen. West of Kuanluchang the road ascends a steep slope. At the beginning of the ascent Lower Permian limestones are met with, striking N 35° E and dipping 13° SE. Further up the slope Silurian green shales occur, these being followed downward by limestones with *Favosites*, striking N 70° E and dipping 26° SE. Descending the pass the Matishih limestone appears. Here it is unusually thick, much over 100 m. The upper part is provided with the characteristic Matishih markings but the lower part is devoid of these and is greenish grey in color. A small dip fault occurs along the route, bringing the Silurian beds on the left in contact with the Matishih limestone on the right. After crossing a thin formation of shaly strata one comes into the domain of the Cambro-Ordovician limestone. Near a small temple *Cameroceras* occurs abundantly in the limestone which here strikes N 45° E and dips 23° SE. Further northwest the road comes into the alluvial plain of Suiyanghsien.

From Suiyanghsien to Kengchiachai to be reported by Mr. Y. L. Wang.

From Kengchiachai to Pengchiawan by T. K. Huang. Kengchiachai lies in the deep canyon of a big stream flowing to the SE. Going west from the village the road follows the course of this stream on both sides of which rise precipitous cliffs formed of silicified Cambro-Ordovician limestones striking NE-SW and dipping gently (8°-16°) to W. Similar conditions prevail until west of Chienpa[3] when the silicified limestones are followed by thick-bedded grey limestone with *Camero-*

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ceras, etc. Chert bands are sparingly developed in the limestone. The strike is N 28° E and the dip 14° NW. Further north-west Ordovician shales come into view until the foot of the Siangpitzu[1] cliff where typical Matishih limestone makes its appearance, striking N 16° E and dipping 14° NW. Near Sanhsienshui at the place where the road crosses a small stream the Matishih limestone is immediately followed by black carbonaceous shales with innumerable graptolites. Further up the slope Silurian strata are continually met with. The Silurian here allows a four-fold division lithologically. The lowest horizon is the black graptolite shale already mentioned (Loc. No. 1369A). The second division is represented by green and yellow shales with graptolites and other fossils. The third is chiefly thin-bedded limestone full of corals (Loc. No. 1369B). The fourth and last comprises red and green shales with pelecypods (Loc. No. 1369C).

As soon as the ascent on the Siangpitzu cliff is ended massive Permian limestones come into view. These limestones exhibit their ordinary characters and so no description is necessary. About 4 km from Siangpitzu and 2 km from Pengchiawan, at the highest point of this part of the route the Permian limestone ends and mid-Permian coal-bearing series begins. The latter here allows a two-fold division: the upper is a cherty limestone and the lower consists of grey shales with coal seams. A *Gigantopteris* flora is found in the lower division not far from the base of the series. The accompanying section will bear out the relation clearly (Pl. 45:HS3, Fig. 60):

LP — Massive Lower Permian limestone with *Schwagerina* [*Neoschwagerina*] at top.

P_1 — Grey and black shales with thin limestones and coal seams worked by the natives, thickness about 50 m.

G — *Gigantopteris* horizon (Loc. No. 1370) [14].

P_2 — Mid-Permian limestone, often cherty, with *Productus,* etc.

P_3 — Yellowish brown shale (*Gastrioceras* shale)?

T — Thin-bedded limestone (Panshan limestone = Yülungshan limestone).

All these strata have a prevailing strike of N 20° W and a dip of 20° SW. From Pengchiawan to Tungtzuhsien to be reported by Mr. Y. L. Wang.

1 象鼻子

RECONNAISSANCE IN NORTHERN KUEICHOU ALONG A SIDE ROUTE WEST OF THE KUEIYANG-CHUNGKING OFFICIAL MAIN ROAD

(April 11 to April 20)

From Tungtzuhsien to Wenshuicheng.

Whilst Dr. V. K. Ting left Tungtzuhsien for Sungkan on the 11th of April, Mr. S. Y. Tseng and I went north-westward from Tungtzuhsien to Wenshuicheng[1] whence we turned northeast reaching Kanshuicheng in Szechuan on the 20th of April. Our purpose of following this side route was two-fold. First, it was required to know whether the region west of the main road is less mountainous than the eastern regions. Second, it is thought that the geology there is well worth studying and that observations made in that direction will help make clear the geological structures along the main road. We agreed to divide our work. Mr. Tseng was to undertake the topographic surveying while I was held responsible for geological investigation. The results I obtained are described below.

Leaving Tungtzuhsien the road first leads in a southerly direction for 2 li then it turns to the west reaching Panshan[2]. About 250 m north of Kuantuho[3] at right side of the road there occurs Triassic purple shale striking NE and dipping 5° NW. West of Kuantuho on the right side mid-Permian cherty limestones form a bluff striking NE and dipping gently SE. The limestone furnishes fusulines and the characteristic crinoid bulb (?) seen in the supra-coal limestones occurring elsewhere. To the south there rises the Tayinting[2] which is formed of Lower Permian limestone. Between Tayinting and the hills west of Tungtzuhsien there is a stretch of alluvial plain on which a stream flows to the west. This plain is probably developed in the soft shales of the coal-bearing series. At Panshan coal is actually mined and mining pits are to be seen just below a thick limestone seen west of Kuantuho. The limestone strikes N by W and dips gently to NE. Three seams are said to be present, the worked seam having a thickness of 2 chi. The upper most part of the mid-Permian coal series is dominated by grey shales and thin impure limestones with *Lyttonia, Chonetes, Productus,* etc. (Loc. No. 1374) [7]. Immediately above are yellow shales, which are followed by thin-bedded light grey limestone, striking NW and dipping 10° NE. Remains of pelecypods occur abundantly in the yellow

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1 溫水鎭 2 半山 3 官渡河 4 大鷹頂

shale (Loc. No. 1374A) [12]. Dr. Ting calls this formation the Panshan Limestone which is probably of early Triassic age*.

Descending Panshan typical purple shale strata come into view, striking NW and dipping 10° NE. In a distance of 1 li or so the purple shale series is ended while Triassic thin-bedded limestones appear. At Yangliuping[1] the limestone strikes N 50° E and dips 21°-25° NW. One li northwest of Yangliuping the limestone strata begin to appear shaly and greyish shales and thin limestone seams come into view further north, striking N 50° E and dipping 28° NW. Shaly strata persist for 3 li, then sandstone appears. It is a massive coarse yellow sandstone with occasional shaly intercalations, striking N 50° E and dipping 39° NW. Being more resistant to weathering the sandstone forms a continuous ridge through which the stream cuts a deep gorge. Poor plant remains are found in the sandstone. On the basis of stratigraphical succession and lithology I correlate this sandstone with the Jurassic coal-bearing sandstone of the Red Basin of Szechuan.

Immediately above the Jurassic sandstone there occur red clay-shales and yellow clay-shales striking N 47° E and dipping 44° NW. In the shales there are several seams of light grey rather impure limestone with innumerable sections and fragments of pelecypods. One of these seams appears to be especially dense and fine-textured and contains chert bands. Best exposures of the limestone can be seen at Lanpatzu[2]. At Lanpatzuyakou a heavy whitish sandstone stratum is found in the pure red clay-shales, striking N 50° E and dipping 27° NW. Here one observes in the north a prominent sandstone ridge striking NE-SW, rising above a deep valley in which there occurs an extensive red soil testifying to the presence of red beds. From Lanpatzu to Tsingkangyuan[3] the road turns to the NE following the strike of the red beds which are chiefly red sandstones and red clays, striking N50°E and dipping 22° NW. Near Tsingkangyuan the road again strikes a cherty limestone stratum with *Unio*-like bivalves (Loc. No. 1375). At Wanchangkou[4] the top of the Jurassic sandstones is exposed. A pottery works is erected in the valley. My investigations of this works are briefly given below.

The material for making the pottery is a kaolin-bearing sandstone occurring in the upper part of the Jurassic sandstone. It is coarse-grained and milky white in color, and can be recognized easily by the experienced technician. Lumps of this

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* According to Ting's section the Panshan Limestone includes the Permian supra-coal limestone.

1 楊柳坪 2 濫壩子 3 青岡元 4 碗廠溝

sandstone are obtained by quarrying. The lumps are crushed by a specially built apparatus worked by water power. This process reduces the sandstone into fine powder. This powder is stirred with water so that the fine particles of kaolin are suspended while the sand grains drop down to the bottom. The turbid water is then let to drain into another tank or basin in which the kaolin particles will gradually precipitate and form a plastic clay at the bottom. This clay is ready for the making of molds. The glaze is made in this way: Mix lime with the ash of rice husks; the mixture is again mixed with husks and burnt. Put this burnt mixture into stone tanks and stir up thoroughly with water. Let it settle down, forming a fine mud. This is then applied on the dry molds. After the glazing the molds are put into the furnace and heated with wood fuel, for 24 hours. The products are then taken out and ready for the market. The material for making the molds and the process of the manufacture are the same as used in the pottery works at Teyaokuan, Kulinghsien, Szechuan, described in a previous chapter.

Leaving Tsingkangyuan the road turns to the north, crossing a series of red clay-shales, red sandstones and seams of limestone with bivalve fragments. Toward Kuanyinyen Jurassic sandstones appear, striking N 60° E and dipping 65° SE. The sandstones form a ridge through which the road passes. Then Triassic formations come into view, the first outcrops met with being shales and shaly limestones then well-bedded limestones occurring at Linpa. The prevailing strike is N 60° E and the dip 30°-45° SE. From Linpa to Litzupa[1] the road essentially follows the strike of the Triassic limestone which is N 55° E. Leaving Litzupa the road makes a sharp turn to the northwest. The Triassic limestone is soon crossed and purple shales come into view, striking N 60° E and dipping 40° SE. Underlying this there appear thin-bedded limestones with shaly members. This is the Panshan [Yülungshan] limestone of Dr. Ting. This is again underlain by coal-bearing shales in which coal is actually mined in the vicinity of Lungtsuantang[2]. The succession of the Permo-Triassic formations is as follows (Pl. 45 : HS3, Fig. 61):

Tf = Purple shale series.

Ty = Panshan [Yülungshan] limestone.

Tyo = Yellow shale with limestone seams, base of the Panshan limestone.

Plm = A thick stratum of fossiliferous mid-Permian limestone.

Plc = Shales with coal seams.

Py = Lower Permian limestone.

1 栗子壩 2 龍鑽塘

Leaving Lungtsuantang the road crosses a low pass over Lower Permian limestones with a prevailing strike of ENE and dipping 15°-35° SE. One li SE of Peiyangtsing[1] Silurian shales appear. The Silurian here is lithologically divisible into 3 parts. The upper part is represented by grey and green shales with abundant brachiopods chiefly of the *Strophomena* type (Loc. No. 1376). The middle is a limestone with *Favosites, Halysites,* etc. The lower is again composed of green and yellow shales. At Peiyangtsing a thin limestone formation occurs immediately below the Silurian. This is characterized by curious markings on the bedding planes which roughly resemble horse-shoes and so the limestone is called by the natives "Matishih". Underlying the Matishih come yellow and green shales which are again underlain by thin and thick-bedded more or less silicified limestones, equivalent to the Cambro-Ordovician limestone occurring elsewhere. From Peiyangtsing passing Chiupa[2] to Huangnipan[3] the road goes in a NW direction, cutting right across the strike of the Cambro-Ordovician limestones which is NE-SW. The dip is 23°-25° SE between Peiyangtsing and Chiupa but it gradually decreases and becomes 8° SE at Huangnipan. West of Huangnipan, Ordovician, Silurian and Permian formations reappear but in a reversed order. Thus it becomes evident that we are crossing a major anticline which for convenience in description might be called the Chiupa Anticline.

West of Huangnipan the Cambro-Ordovician limestones strike N 55° E and dip 12° NW. Further west they strike N 64° E and dip 14° NW. The limestones are usually silicified but at Chiutsaitung[4] there occur less silicified massive limestones in which I found *Leptaena* (?) and *Cameroceras*. These fossils are exactly the same as found at Wulipo west of Meitanhsien (see p. 684-685). The strike is N 58° E and the dip 25° NW. These limestones are followed by green shales which are overlain by the Matishih, strike and dip remaining the same. Then Silurian strata come into view. Here the Silurian also allows a three-fold division: upper shale, middle limestone and lower shale, all being richly fossiliferous. The basal part of the lower shale is black and contains graptolites. The limestone furnishes beautiful specimens of *Favosites,* etc. The prevailing strike is N 65° E and the dip 25°-28° NW.

Crossing the Silurian, massive Permian strata are met with. The limestone here is surprisingly rich in fossils especially in the middle part. These are mostly corals, including *Michelinia, Lonsdaleia,* etc. (Loc. No. 1377) [7]. West of Wanchiu[5] the Permian limestone ends and the mid-Permian coal series begins. A workable coal seam 2-3 chi in thickness occurs in the shales while pyrite is also

1 白楊井 2 九壩 3 黃泥板 4 九菜洞 5 灣邱

obtained from the same formation and is used for manufacturing sulphur. From Wanchiu to Sinchang[1] a regular succession of the mid-Permian coal series, the Panshan limestone, the Triassic purple shale and the Triassic limestone is met with, all striking N 84° E and dipping about 30° N. About 3 li N. of Sinchang the Triassic limestone is crossed and Triassic shales and thin limestones appear. These strike essentially ENE-WSW, the dip steepens to 50° NW. About 6 li N by W of Sinchang Jurassic sandstones appear striking N 63° W and dipping 57° NE. These are soon crossed and Triassic shaly beds again come into view, striking N 40° E and dipping 60° NW. Owing to the dense fog on that day I was unable to determine the structural relation between the Jurassic and the Triassic but it is suggested that the former is in fault contact with the latter.

Overlying the Triassic shales comes the Jurassic sandstone which forms a conspicuous ridge through which the road passes. The sandstone strikes NE-SW and dips 60°-70° NW. Crossing the ridge one sees to the northwest the high range of Nanshanping[2] which is separated from the sandstone ridge by a deep strike valley, the valley of Tsinku[3]. Crossing this valley one observes the basal part of the Cretaceous red beds which constitute the Nanshanping range. At first red clay-shales and yellow clay-shales occur, intercalating with yellow sandstones. Then green and blackish fissile shales appear, with small bivalves (*Corbicula*) and plant remains (Loc. No. 1378) [12]. Unlike the previous sections limestone strata are not seen.

Ascending Nanshanping continuous outcrops of red clay-shale intercalated with yellowish red cross-bedded sandstones are met with. They strike N 35° E and dip 60°-70° NW. Looking east on the Nanshanping range one sees the characteristic Jurassic sandstone ridge which extends to the southwest for an unknown distance but dies out toward the northeast amongst a maze of red hills evidently formed of red beds. It is supposed therefore that the Jurassic is cut out by a fault in the northeast. This fault is probably continuous with the fault occurring 6 li north of Sinchang. Crossing Nanshanping the road quickly descends into a deep strike valley in which nothing but red clay-shales and red sandstones are to be found. The strata on the eastern slope of the valley dip steeply to NW while those on the western side dip about 30° SE. This dip persists to Changyangpa[4] 10 li from Nanshanping. It appears evident that the range of Nanshanping is composed of Cretaceous red beds which form a steep syncline whose axis passes through the valley above alluded to.

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1 新場 2 南山坪 3 秦谷 4 張揚壩

Near Taotzuping the basal part of the red beds is exposed. This consists of black shales, red and yellow shales and limestone-seams. Fossils are found both in the black shale and in the limestone. West of Taotzuping Jurassic sandstones appear, striking N 35° E and dipping 35°-45° SE. The sandstone as usual forms a ridge on the escarpment of which occur shales and limestones which are underlain by Triassic limestones striking N 35° E and dipping 40°-50° SE. From Changyangpa to Huangkuaya[1] a normal succession of the Triassic limestone, the purple shale, the Panshan limestone, the mid-Permian coal-bearing series, the Lower Permian limestone and the Silurian shales is crossed. The strike is essentially N 25° E and the dip is 50° SE at Changyangpa but gradually decreases to 15° SE near Huangkuaya.

Descending Huangkuaya pass one observes a dense greenish grey limestone immediately underlying the Silurian. This limestone is at least 100 m in thickness. Its position corresponds to the Matishih limestone but the absence of the peculiar markings and the abnormal thickness render correlation doubtful. These variations however are explained by the change in lithological characters. The strike is NE and the dip 12° SE. Underlying the limestone come brownish grey and green shales and sandstones with numerous fossils including graptolites, trilobites, brachiopods and Orthoceran cephalopods (Loc. No. 1379). Best outcrops can be seen along a stream which flows to NW and turns to the SW. Leaving the stream the road ascends a steep slope on which exposures of similar shales with trilobites are met with (Loc. Nos. 1379A-1379B) [13]. The strike of the shales is essentially NNE but they are strongly disturbed and measurements are inevitably local. Then the road comes on top of a high range formed of Cambro-Ordovician limestone. Though outcrops of the latter are to be found in the gullies they are only occasionally seen on the top of the range because of the fact that the green and brown shales form a thin mantle covering most of the limestone.

Going southwest on the high range the road essentially follows its crestline for 5 li then it turns to the NW. At first horizontal strata are met with. Later they begin to dip to the NW. Descending the range thick-bedded limestones with *Cameroceras* and gastropods occur, striking ENE and dipping 5° NW. Further down the dip gradually increases until at Hsiayingkou[2] when they strike N 62° E and dip 26° NW. From Hsiayingkou to Fangchiakou[3] a thick succession of green and brown shales is traversed. At Fangchiakou the Matishih limestone comes immediately above the Ordovician shales, striking N 64° E and dipping 30° NW.

1 黃瓜埡 2 下銀溝 3 方家溝

Here this formation is thin, no more than 30 m. The horse-shoe markings are typically developed while specimens of *Orthoceras* are especially abundant. Some of the latter reach a length of 5 feet and attract the attention of every traveller.

From Fangchiakou to Hochiaochi[1] the road quickly descends into a valley in which excellent exposures of Silurian formations are met with. The Silurian here is especially thick, more than 400 m. As in previous sections it is divisible into three parts. The lower part consists of black and grey shales with innumerable graptolites. The middle part is a thin-bedded limestone with *Favosites, Halysites* and other characteristic corals. It forms a conspicuous ridge with pointed peaks running from the NE to the SW. The upper part is dominated by green shales with abundant brachiopods.

From Hochiaochi to Wenshui[2] the road runs in the canyon of a stream which cuts right across the Permo-Triassic formations and thus a beautiful section can be obtained along the route. From Hochiaochi to Chiaotou[3] the Permian limestone is completely exposed, striking N 70° E and dipping 38° NW. Below Chiaotou the mid-Permian coal-bearing series comes into view. This is of two-fold division: the lower greater part is dominated by grey shales with coal seams while the upper smaller part is a cherty limestone, the two totalling 100 m in thickness. Further down-stream the Panshan [Yülungshan] limestone and the purple shale occur in regular succession with a prevailing strike of N 70° E and dipping 40° NW. At Wenshui extensive outcrops of Triassic limestone are met with.

The direction of the route from Tungtzuhsien to Wenshui is essentially NW while the prevailing strike of the formations is NE-SW, so that the geological section along this route is an ideal one. The regularity in structure and in stratigraphical succession makes this section all the more marvelous. Broadly speaking there are only two major anticlines and two synclines occurring between Tungtzuhsien and Wenshui. These are, named in their natural order, the Wanchang Syncline, the Chiupa Anticline, the Nanshanping Syncline and the Wenshui Anticline. In the centre of the anticlines Cambro-Ordovician limestones are exposed. These are as a rule moderately folded with a dip below 30° and usually about 15°. In the centre of the synclines one invariably finds a thick succession of Cretaceous red beds which are strongly folded dipping steeply toward the axis. Thus we may surmise that the border ranges in the southeastern part of the Red Basin are constituted by NE-SW trending broad anticlines with a core of Cambro-Ordovician formations,

1 河交溪 2 溫水 3 橋頭

these being interlocking with steep synclines in which red beds or Jurassic strata are to be found.

From Wenshui to Kanshui

(April 17 to April 20)

From Wenshui to Kanshui we proceeded in a NE direction, roughly following the strike of the rock formations which are lithologically identical with those met with on previous occasions. No attempt therefore is made here to describe these formations in detail.

Before leaving Wenshui I went to Huangnitsingyakou[1] 4 li NW of the town. The road crosses the Triassic limestone and its overlying shales and shaly limestones and comes into the domain of the Jurassic sandstone which forms a prominent ridge extending both to the NE and to the SW for an unknown far distance. The sandstone strikes N 53° E and dips 35° NW. Crossing the ridge one observes an immense sequence of red beds chiefly red clay-shales and red sandstones immediately overlying the Jurassic. To the north there are chains of hills formed of similar red beds. I realized that north of the sandstone ridge no older formations are to be seen. Thus this ridge may be appropriately considered as the marginal ridge of the red Basin.

Going northeast from Wenshui the road follows a strike valley in which a small river flows to the northeast. For lack of a proper name we may call this the Wenshui river. To the north one sees a continuous ridge formed of Jurassic sandstone while to the south is another ridge on the dip slope of which occur purplish red shales indicating that it is composed of strata of purple shales and shaly limestones. The outcrops actually met with belong to the Triassic limestone. The prevailing strike from Wenshui to Liyuanpa[2] is 70°-80° E and the dip is about 40° NW. At Liyuanpa the Wenshui enters a limestone cave and does not come out until 3 li further east. To the north the Jurassic sandstone escarpment is especially prominent while to the south the purple shale ridge still persists. I have crossed the latter ridge and reached Lienkaipa[3], 6 li from Liyuanpa. It was found that the crestline of this ridge is not made of purple shaly beds but of thin-bedded limestone (the Panshan [Yülungshan] limestone) which forms another escarpment facing Lienkaipa. In the middle of this escarpment the coal-bearing series crops out under the Panshan limestone. Coal is extensively mined here while sulphur is

1 黃泥箐埡口 2 梨園壩 3 連蓋壩

also obtained by smelting pyrite occurring in the coal series. At Lienkaipa Lower Permian limestone is extensively developed. Further south Silurian shales make their appearance.

From Liyuanpa to Lihanpa[1] similar conditions prevail. The Triassic limestone now strikes about N 50° E and dips 35° NW. A cross section at Lihanpa is roughly given as follows:

1) Lower Permian limestone.
2) Mid-Permian coal-bearing series.
3) Panshan [Yülungshan] limestone.
4) Purple shales
   4_1 = Light grey limestone
   4_2 = Purple shale
5) Triassie limestone
   5_1 = Shales and thin-bedded limestones.
6) Thick-bedded Jurassic sandstone.

From Lihanpa to Shihhao[2] the road first follows the Wenshui valley, then it ascends a platform on which the village of Shihhao lies. The strata met with are Triassic limestones, striking N 20-25° W and dipping 16° SW. To the west the Jurassic sandstone escarpment can still be seen. To the east one sees high mountains of the Permian and Panshan limestone with a dip slope covered with red soil derived for the purple shale series.

From Shihhao to Lochiapa, a distance of 30 li, the road leads in a due northerly direction in a region of low limestone hills. The strata seen *en route* all belong to the Triassic limestone. The prevailing strike is N-S or NNE-SSW while the dip is usually gentle, 5-15° W. To the west one can still observe in the distance a uniform ridge of the Jurassic sandstone. To the east however no mountains are to be seen, the Wenshui river passing some 4 or 5 li east of our route. Five li north of Lochiapa the road descends abruptly into the valley of the Wenshui, reaching Yangtu[3] where a by-stream coming from the southwest enters the master stream. The valley of the Wenshui here is a real canyon. Looking southeast from Yangtu one sees the awe-inspiring limestone gorge which can ip every respect match the famous Yangtze Gorges. About 1 li north of Yangtu the Triassic limestones end

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1 李漢壩 2 石壕 3 楊渡

and Jurassic sandstones begin, striking N 60° E and dipping 24° NW. At Lungwangmiao[1] the Jurassic is succeeded by the Cretaceous red beds.

At Maliuwan[2] 2 li east of Lungwangmiao, on the southern bank of the Wenshui, iron ore is obtained from the top part of the Jurassic sandstone which here strikes N 70° E and dips 20° NW. The ore is a hematite of undoubted sedimentary origin. Its average thickness is 1 meter. It is intercalated in thick yellow sandstone strata. 10 li south-by-west from this locality is Tutai[3] where excellent hematite ore is being mined. It seems certain that the Tutai deposit is a continuation of that of Maliuwan, and if the thickness and quality of the ore is uniform, the reserve of the Tutai-Maliwan deposit is of great value. From Lungwangmiao to the foot of the Kaotsienpo[4], Cretaceous red and yellow clay-shales are continuously met with, striking N 78° E and dipping 30° NW. Limestone seams also occur in the red series. Ascending Kaotsienpo red clay-shales and red sandstones prevail, strike and dip remaining unchanged. From Kaotsienpo to Kanshui[5] the dip of the red beds gradually decreases until Kanshui when it becomes 7° NW. The red beds in the vicinity of Kanshui consist of red clay-shales alternating with red or yellow sandstone seams. From Kanshui northward until not far from Chungking only Cretaceous red beds are to be seen, all the older formations being buried under them.

1 龍王廟 2 麻柳灣 3 土台 4 高箭坡 5 兩水

EXPLANATION OF PLATES

(Plate 43:HS1 to Plate 45:HS3)

In all section:

H=Sinian, Є=Cambrian in general, Єs=Shihpai shale, Єi=Ichang Limestone (including *Cameroceras* bed), O=Ordovician in general, On=Neichia Series (including the "Meitan Shale"), Oo=Matishih or *Orthoceras* Limestone, S=Silurian in general, Sc=Chiutienya Shale, Ss=Shihniulan Limestone, Sh=Hanchiatien Shale, CP=Basal Chihsia Coal Measures, Py=Yangsin Limestone, Pyc=Chihsia Limestone, Pym=Maokou Limestone, Pb=Omeishan Basalt, Pl=Chiaotzushan Coal Series (=Wantze Coal Series), T=Triassic in general, Ty=Yülungshan Limestone, Tf=Feihsienkuan Shale, Tc=Chialingchiang Limestone, Tm=Maotsaopu Limestone, Tsu=Sungtzekan Shale, Tsa=Sanchiao Limestone, Jh=Hsiangchi Coal Series (=Chiupantze Sandstone), K=Cretaceous in general, Kt=Tsienfoyen Series (=Tseliuching Series of Arnold Heim), Kk=Kuangyuan Series, Kc=Kiating Series (=Chengtsiangyen Series), E=Old Tertiary.

Figures underlined (*1451, 1483*, etc.) are fossil localities.

1. Sketch showing the structure of the red beds seen along the Yangtze below Suifu.
2. Section along the gorge of Nankuang. J_1=thickbedded sandstones belonging to the lower part of the Hsiangchi Coal Series, J_2=grey sandstones and clay shales with thin coal seams.
3. Section south of Yokou, showing the succession and structure of the Mesozoic formations.
4. Section NW of Kunghsien.
5. Section showing Permo-Triassic succession near Kunghsien.
6. Section through the coal field of Lopiao. m=resistant strata forming cap of ridge.
7. Detailed section at Wangchang. For explanation see text.
8. Structural section from Hochiayen to Siaolochiao, showing the structural features on the Szechuan-Yunnan border. m=Capping bed same as shown in Fig. 6, Pb=dark green porphyritic basalt often with amygdales filled wih white quartz, q=rather pure, thick-bedded,

whitish quartzitic sandstone forming highest member of Silurian. For more details see text.

9. Section at Kumangpu showing the succession of the Palaeozoic formations.
10. Sketch showing the topographic features in the vicinity of Kumangpu. A = peneplaned surface, B = later dissection to maturity, C = ridge formed of Silurian sandstone, D = characteristic sky-line marked by Permian limestone.
11. Section from Kuankou to Chenghsiunghsien.
12. Sketch showing the relief features in the vicinity of Chenghsiunghsien. A = a stage of peneplanation, B = a subsequent stage of fine dissection, *i.e.*, maturity.
13. Sketch of the valley of Pingpa southeast of Chenghsiunghsien, showing mature valley characterized by wide (old) alluvial plain with meandering stream; Permian limestone dipping slightly E.
14. Section along part of the route between Chenghsiunghsien and Pitsiehhsien (from near Erhlungkuan to Panpienchieh).
15. Section between Panpienchieh and Yehko. For explanation see text.
16. Detailed section showing the succession of the basal Permian beds near Pitsiehhsien. For explanation see text.
17. Section along the Peichengkuan road WNW of Pitsiehhsien. CP = black shale and quartzite belonging to the basal Chihsia (= B in Fig. 16), U = unconformity (?) represented by difference in dip angles. L = *Lyttonia* bed near top of coal series.
18. Section NE of Pitsiehhsien along the Pitsiehho, for details see text.
19. Section at Loufungya, Pitsiehhsien, for details see text.
20. Section at Yentzukou, showing the succession of the Permo-Triassic formations, for details see text.
21. Sketch of the valley of the Chihshuiho.
22. Sketch of the Chihshuiho valley, looking SE.
23. Section through the Permian formations N. of Suehshankuan.
24. Structural section from near Suehshankuan to Heinishao, for details see text.
25. Diagrammatic representation of the complex structure at Fungshuichiao. Symbols are the same as in Fig. 24.

26. Section at the limestone cave north of Moni.

27. Section through the anticline of Chanti, showing possible Permian unconformity. Sl = limestone in the Silurian, not seen in the southern limb.

28. Section across the Chihshuiho valley from Tutikuan to Lungchangying.

29. Section near Kuochang. For details see text.

30. Section at Tating showing the succession of Permo-Triassic beds. For details see text.

31. Sketch at Yachiho, looking ENE, showing the Yülungshan Limestone escarpment.

32. Section showing the succession of the mid-Permian strata near Wangchiachuang. 1 = brown and grey shale, 2 = chert limestone with *Gastrioceras, Michelinia* and *Productus*, 3 = shale and thin-bedded limestone, 4 = brown shale (1-4 = Permian, Lopingian); 5 = Triassic limestone.

33. Sketch showing the relation between the Triassic and Permian strata seen NW of Chengsiwei.

34. Section east of Chanchieh. 1 = thin-bedded silicified limestone, 2 = massive white grey silicified limestone, 3 = yellowish brown shale and grey shale with coal seams.

35. Sketch of Kuanyinkuo, near Laowangchung, Tsingchenghsien, showing picturesque hill formed of vertical Permian limestone.

36. Section at Chikangchiao near Tsingchenghsien [1]. O = Red conglomerate (Tertiary), 1 = thin-bedded, reddish silicified limestone, 2 = similar to (1) but more massive, 3 = reddish silicified limestone, 4 = silicified grey limestone weathering brown, 5 = thin-bedded reddish silicified limestone with intercalations of reddish partly silicified shale and shaly limestone, 6 = highly silicified reddish thick-bedded limestone with some intercalations of dark red shale, 7 = 20-30 m not silicified grey limestone with peculiar nodules looking like Würmkalk from the side, pelecypods found, 8 = red silicified limestone, 9 = limestone conglomerate overlain by red clay, 10 = thick-bedded limestone, 11 = thin-bedded reddish silicified limestone.

(For the fossils found in the limestones see E. Patte: Fossils paléozoiques et mésozoiques du sud-ouest de la Chine, Pal. Sinica, ser. B, vol. 15, fasc. 2, 1935).

37. Section between Sanchiao and Touchiao, west of Kueiyang. 1 = Triassic limestone, 2 = massive slightly silicified Triassic limestone, 3 = shaly limestone, 4 = grey clay-shale, 5 = thin-bedded greenish grey limestone and shale, 6 = thin-cherty beds with brown clay-shale, 7 = brown and grey shale with two bad coal seams, 8 = massive grey limestone with black chert bands and fossils, 9 = limestone similar to (8) about 2 m, 10 = brown shale and massive grey cherty limestone, 11 = thin-bedded limestone, 12 = massive dark grey limestone with pockets of calcite and with corals, 13 = massive reddish silicified limestone, fault breccia at contact with (12), 14 = grey shale and brown sandy shale with limestone seams, 15 = thick-bedded whitish grey limestone, 16 = grey shale, 17 = massive coarse sandstone weathering brown with some black shale intercalations, upper part quartzitic, 18 = sandstone similar to (17), 19 = black shale with *Lepidopteris,* 20 = brown sandstone alternating with grey shale, 21 = 4 or 5 seams of greyish limestone (lowest seam is a *lumachelle*) in brown sandy shale, 22 = brown and grey shale often sandy with pelecypods, 23 = Well-bedded light grey limestone with petroleum smell on the blow of the hammer, 24 = greenish grey shale alternating with limestone seams, 25 = greyish white partly silicified thin-bedded limestone. 16-20, Rhaetic-Jurassic; 21-25, 1-2, 13-15, Triassic (21-24, Sanchiao Limestone); 3-12, Permian. Compare T. H. Yin: Yehlangian, Upper Permian or Lower Triassic, Bull. Geol. Soc. China, vol. 16, 1937.

38. Section at Siaokuan, NW of Kueiyang. 1 = massive slightly silicified whitish grey limestone, 2 = thin-bedded shaly sandstone, with *Podozamites,* 3 = red clay, 4 = massive slightly silicified light grey limestone, 5 = massive sandstone similar to (2), 6 = compact red clay, 7 = sandstone stratum in red clay, 8 = red clay similar to (6), 9 = massive yellow quartzose sandstone, about 20 m, 10 = red clay, 11 = 70-80 m massive light grey sandstone, 12 = massive silicified Triassic limestone, 13 = highly disturbed thin-bedded limestone, 14 = massive limestone. 2-3, 5-11, Jura-Cretaceous; 1,4, top Triassic limestone; 12-13, Triassic, 14 = Permian Yangsin Limestone. A thrust plane separates (7) and (8) and also (13) and (14).

39. Section at Pingpahsien. For details see text.

40. Detailed section at the thrust east of Pingpahsien.

41. Section of the Loszushan, Toupu, Anshunhsien.

42. Section from Wenchiachiao to Chuchang showing the structural feature of the Permo-Mesozoic strata. (see also Huang 1932, fig. 11). Q=massive quartzite, probably Carboniferous.

43. Section at Chiaohuatsing, Chihchinhsien. C=shales and quartzites, probably Carboniferous (see text).

44. Cross section of an ammonoid showing inner whorl saturated with oil, nearly natural size.

45. Section through the Tsingshuiho, vertical scale exaggerated. Py=massive grey limestone (Yangsinian); Pl=Lopingian predominantly calcareous, Pl_0=black shale, Pl_1=well-stratified limestone, frequently becoming massive and thin-bedded, Pl_2=impure marly limestone with *Lyttonia*, etc., Pl_3=massive cherty limestone, Pl_4=impure grey cherty limestone with *Productus*, etc. (this might be equivalent to the "*Gastrioceras*" horizon occurring elsewhere in southern Kueichou); Tc=massive slightly silicified light grey limestone possibly equivalent to the Chialingchiang, Tt=thin-bedded, fine and dense limestone possibly equivalent to the Tayeh.

46. Section at Huangtushao, showing the succession of the Permo-Mesozoic formations. CP=basal Chihsia beds: 1=brown iron bed, 2=reddish quartzitic sandstone with small crystals of pyrite, 3=grey and black clay-slate; Pl=Lopingian: 1=sandy and clayey beds mixed with basalt-like layers, 2=grey shale with coal seam, 3=massive limestone, 4=grey marly limestone with *Lyttonia*, 5=brown shale, possibly equivalent to the "*Gastrioceras*" horizon. Note that the Yangsin limestone in this section (Py) is less than 100 m thick.

47. Diagrammatic representation of the Cambrian strata near Suantangchai. For details see text.

48. Idealized section from Pahsiangping to Tatiehkuan. x=massive quartzite, y=mostly covered, Ꞓs=shales with *Redlichia* at Suantangchai (see Fig. 47), Z=Tatiehkuan series. Note that the Permian formations

are exceptionally thin, the Yangsin limestone being marked at the base by shales.

49. Sketch at stone bridge below Tsingkangao, showing the T'atiehkuan series capped by massive Ichang limestone.

50 Unconformity between the red conglomerate and the Cambro-Ordovician limestone east of Chiuchow (Laohuangping).

51. Section west of Lolang. For details see text. (5) is undoubtedly thrust upon (4). Compare with Fig. 52.

52. Section at Chungchiaoho. For details see text.

53. Section from Sungping to Panpuho. Section from Sungping to Panpuho showing structure and unconformity below the Permian. Note the primary thinning-out of the Yangsin limestone (prepared by author in May 1945).

54. Sketch map showing unconformable relation between the Yangsin (mainly if not all Chihsia) limestone and the Cambrian Ichang limestone near Houchang, Wenganhsien. The coarse shading in €i and Pl roughly represents the strike of the respective formations (Compare with Fig. 53 and with Huang 1932, fig. 13).

55. Section from Hualichang to Tatiehshao, showing the succession of the Lower Palaeozoic formations and the unconformity below the Permian limestone. (prepared by author in May 1945).

56. Diagram of the quicksilver furnace used at Peimatung. 1=top bulb, 2=side bulb, 3=body of furnace, 4=charge of ore, 5=coal bricks, 6=peep hole.

57. Sketch of the gorge of the Wuchiang, at Wuchiangtu.

58. Section of the Permo-Triassic formations at Huangtsunpa, near Tsingchengchiao, Tsunyihsien. 1=impure thick-bedded limestone with fossils (Loc. No. 1353B) including *Oldhamina decipiens*, 2=black and brownish yellow banded shale with pelecypods (Loc. No. 1354), 3=thin-bedded, dense grey limestone with thin intercalations of yellow and grey shale, pelecypods found near base (Loc. No. 1355). Compare with Huang, 1932, fig. 8.

59. Section of the Wulipo escarpment, west of Meitanhsien. For details see text. (prepared by author in May 1945)

60. Section 4 li SE of Pengchiawan, Suiyanghsien, showing the succession of Permian strata and the position of the *Gigantopteris* bed. For details see text. Compare with Huang 1932, fig. 9).

61. Section at Lungtsuantang, Tungtzuhsien, showing the succession of the Permo-Mesozoic formations. For details see text.

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編輯緣起

民國二十五年春，丁文江先生逝世不久後的一天，中國地質學會理事會開會。在討論會務時，大家談到如何整理丁先生遺稿的問題。因為丁先生是地質調查所(現經濟部中央地質調查所)的首任所長，并且二十年來一直與該所保持連繫，大家很自然的決定把這整理遺稿之重任交到地質調查所；又因為丁先生的材料大部份是關於雲南貴州兩省的，所以整理的人最好是自己曾到過雲南貴州，或對於這些材料之內容很熟悉。尹贊勳曾經在雲南作過長期的調查，而且那調查計劃大部是丁先生代擬的；黃汲清是丁先生組織的"西南地質調查隊"之一員，對於西南地質問題曾不斷同丁先生討論。所以理事會同人的意見，要把整理遺稿工作交尹黃二人負責，二人當時對這項工作也是默認了的(二人亦出席理事會)。記得那時理事會的主席是翁文灝先生，亦是地質調查所的所長。二十六年夏中日戰事突起，地質調查所隨即西遷。在那幾年中，尹贊勳先在江西服務，後返中央地質調查所任副所長；黃汲清先亦公務繁忙，繼又赴甘肅新疆調查，所以兩人都無暇顧及丁先生遺稿之整理。三十三年春李四光先生來北碚講學(那時地質調查所在北碚)，便中曾向黃汲清提及整理丁稿的事情，并且說丁先生的兄弟文淵先生也曾向他談過這件事，他們都希望負責整理的人能早點把遺稿整理出來。汲清個人亦覺負責太久，應從速償還，隨與尹君商議開始整理工作，同時寫信告訴李丁二先生。記得丁先生曾為此事特來北碚相訪，并曾約地質調查所所長李春昱先生及周贊衡先生一起洽談，對於編輯方法和出版方式等問題都曾討論到。編輯工作就在那年五月裡正式開始。

丁先生遺稿的範圍

丁文江生遺下的科學材料，除有關人類學的由中央研究院吳定良先生整理外，全部交黃汲清保管。此種材料甚為豐富，裝滿一大木箱；這箱子從南京搬到長沙，從長沙搬到重慶，北碚，內容一直沒有動過(中間也有兩次開過箱，一次是由計榮森先生經手的)。不過材料大部零星散亂，雖曾經尹贊勳黃汲清先後予以清點，還是沒有確定一個分類系統來。大體說來遺稿材料可分四種：一是野外筆記，日記，標本登記，地形地質圖件等，這是最原始資料，所以最為可貴；二是已經編成的路線敘述，區域描述(大部是英文)，地質圖幅，地質剖面等，這其中只一部是經丁先生親自校對修改過的；三是其他學人根據丁先生所得材料而撰成的論文和報告，各地化石表亦在此列；四是各地各種照片，其中大部是關於雲南的，一部是丁先生遊歷各地時的風景片，因為目前印刷困難，故全部保留以待將來擇要付印。此外還有一些與地質無關的旅行筆記和遊記，由於丁文淵先生的請求都交給他去整理去了。

丁先生做事十分系統化，在調查地質的時候尤然。每次出去一定有筆記，有時除地質記錄之外還有日記，標本登記，氣象和經緯度測定記錄等等。可惜他的筆跡一般都很潦草，并

且鉛筆記的東西，年多月久，難免模糊。因此，整理他的筆記有時確是一件麻煩的事。現在我們不妨把他的野外記錄的範圍簡略的報告如下。

民國元年滇黔之遊：這次是普通旅行性質，關於地質學的記錄很少，非地質部份已大半在"漫遊散記"裏發表過了。

民國二年正太鐵路沿線調查：這次是同梭爾格和王錫賓在一起。丁先生的記錄很多，所成圖件也異常豐富。他們三人的報告早在"農商公報"上出版，今又重印一次，並且加印一部份地質圖和英文路線敘述。

民國三年雲南之行：這是丁先生初期工作的最重要者，所得標本化石以及野外記錄等十分豐富。丁先生原想根據這些材料做一篇有聲有色的文章，終以事冗不果。我們在本書裡發表的都是一些事實記錄。

民國四年春直隸山西邊境之行：此行經西山齋堂以達蔚縣廣靈一帶，一部份結果已在地質彙報第一號發表。其他記錄都很零星，頗難予以整理付印。

民國四年三次北京西山旅行：前兩次在秋天，後一次在冬天(十二月)。記錄很零星。

民國四年山東之行：此行在十一月中，即在第三次西山旅行之前，曾到泰山和徂徠山一帶，調查嶧縣棗莊煤田可能即在此時。

民國四年底至五年初皖南浙西之行：此行對皖浙邊境地質頗有貢獻，結果記載在"揚子江下游之地質"一書中。

民國六年春河南六河溝之行：爲時甚短，所得材料很零星。

民國六年春湖南江西之行：此行主要目的在調查萍鄉煤田和上株嶺鐵礦，關於後者丁先生有簡報在"中國鐵礦誌"發表。

民國七年山西大同之行：野外工作時間只兩三天。

民國七年豫晉邊境黃河兩岸之調查：此行發現三門系及其動物群。結果見安特生著"中國北部之新生界"。

民國十年熱河北票之行：此行專爲研究北票煤田地質。

民國十一年熱河之行：丁先生從北京到承德，來回走了一趟，沿途察看地質。

民國十一年後丁先生的野外記錄就沒有保存，大概在這幾年裡他也很少作地質旅行。直到民國十七年才有廣西之行，十八年才有西南地質調查隊之組織，這兩次都是大規模的調查，十八九年間的工作且是他生平最得意而且是最後一次的工作。兩次重要結果都記錄在本書中。可惜丁先生死得太早，否則他一定能根據廣西貴州的調查結果發爲議論，寫出洋洋洒洒的絕世妙文。

此外，大家都知道丁先生在北京大學講普通地質的時候，曾經準備下頂豐富的教材，除

去許多採自本國的地質現象的圖件外，似乎還有英文講議。後者經編者多方搜尋不得，而前者雖還有一部份存放在地質調查所圖書館，因非丁先生的創作，故沒有付印於本書中。

編輯工作的分配

丁先生所遺材料太多，故編輯工作決非一人之力所能勝任，今將擔任工作人員題名於下。

雲南材料(包括會理威寧部份)：由尹贊勳主編，邊兆祥協助。張績綿繪圖(一部份圖件之清繪由朱典禮，白青彬，吳經舟三人分別擔任)，車溢湘打字。

廣西材料：由黃汲淸主編，李廣源協助。朱典禮繪圖，車溢湘打字。

四川貴州廣西材料：由黃汲淸主編，秦鼐協助。吳濟舟繪圖(此部淸繪工作最爲繁重)，張務聰亦曾參加一部份工作。打字亦爲車溢湘。

其他材料(包括太行山及中興公司部份)：由黃汲淸主編，張務聰繪圖，韓文蔚打字。

此外黃汲淸的四川雲南貴州邊境調查材料，因是丁文江先生西南地質調查隊工作的一部份，也趁此機會予以編輯發表。

丁先生著作散見於各雜誌者甚多，原想請高振西君撰一著作目錄，後因高君去北平，這樣工作改由諶義睿君擔任，又因參考書之缺乏，諶君亦只能編一地質著作目錄，今附印於書末。

籌欵與付印

民國三十五年春編輯工作告一段落。那時正中書局方面向汲淸表示，很願承印此種著作，并只要求收取少數製版費。不幸上海物價狂漲，正中不敢冒然接受，丁稿的印刷不得不延期。直到同年十月間，經李春昱丁文淵兩先生與汲淸三人詳商後，才決定把稿子帶到北平去印，印刷費用則由李丁二先生向各有關機關募捐。又因物價繼續上漲，才決定一面募款一面付印的辦法。十二月底把文稿交北平友聯中西印字舘排印，圖稿亦於同時交和記印書舘製版。

印刷這樣一部巨著，在印刷進程中，需要經理的事務必定甚多，舉凡編稿，校稿，製版，校版，乃至買紙，送紙，付款，記帳等等瑣事，勢將紛至沓來，決非一人所能勝任，所以除汲淸個人長住北平主持印刷外，并由地質調查所抽調曾鼎乾周慕林二君去平協助。同時商得北平分所高平所長的同意，在分所借大辦公室一間，供黃曾周三人工作之用，另聘繪圖員高維祜一人幫同料理製版事宜。

校對製版工作最爲繁重。文稿之校對最初由汲淸負責，到廣西稿子印完後，因汲淸急於南返，就把工作交給曾鼎乾君。曾君十分謹慎，在汲淸已抵京後，還把貴州稿子中之化石表

和汲清著之"四川雲南貴州地質初勘"稿子之全部航空郵寄來京校對。地質圖之着色分版是全部工作中最困難之一部，幸得周慕林君協助，進行頗爲順利；汲清南返後是項工作就交周君主持。

一部巨著不能不有索引。曾周二君既夜以繼日，忙於印刷，實再無餘暇編製索引。汲清乃與北京大學地質系主任孫雲鑄先生商，由系方撥事務員趙連璧君擔任此種工作(趙君曾任葛利普先生打字員多年)。

道歉與致謝

編者對著者的原稿雖力求"存眞"但在不得已的時候，亦略有刪改；因此可能有失去著者原意之處，這是不能不聲明的。著者野外記錄內容實較本書所記載者爲多，因其中之一部過於零亂，一部字跡太潦草無法讀出，不得不予以刪去。這是編者應向死者道歉的。

這樣一部巨著，不由著者自己主編，而由他人代庖，而且編輯和協助編輯的人先後不下二十位，由此可見書中不洽人意之處必定甚多。最主要的爲編輯方法之不一致，地名人名用法拼法之不一致，化石名稱寫法之不一致等等，都是編者明明知道而來不及改正的。又因爲要趕印，故校對上的錯誤尤不能免。凡此種種，其責任多應由汲清負之。

在本書編印過程中，中央地質調查所所長李春昱先生賜予各種方便；在北平印刷時期中，中央地質調查所北平分所所長高平先生協助特多，幷慨允加雇繪圖員一人助理製版；北京大學地質系主任孫雲鑄先生慨允由打字員趙連璧君編製索引；編者藉此機會均表示十二分的謝忱。北平和記印書舘主持人石承忠君在附圖製版時，能本事事求進步的精神和編者虛心研討；北平友聯中西印字舘經理劉寶枝君也能本同樣精神接受編者對印刷方面的意見；本書能在短期內印製完成，而且成績尙屬滿意，石劉二君的功績是不可埋沒的。最後編者對同事曾鼎乾周慕林二君的負責到底始終如一的服務精神表示衷心的感佩；沒有他們的協助印刷工作是決不能如此順利完成的。

在文稿付印之後，適得翁文灝先生寄來英文稿"丁文江傳略"一文，這正合編者的需要，乃以置於卷首，幷向翁先生致謝。

民國三十六年六月十二日黃汲清記於南京。

丁文江先生地質調查報告

（民國二年至民國十九年間已故丁文江先生在冀晉魯滇桂黔川各省實地考查結果）

附插圖四十四

圖版四十五

經濟部中央地質調查所發行

南京珠江路九四二號

中華民國三十六年六月

（北平友聯中西印字館承印）

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