Bulletin

OF THE

Geological Society of China

Vol. XV. June, 1936 No. 2.

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PUBLISHED QUARTERLY BY THE SOCIETY
942, CHUKIANG ROAD, NANKING

中國地質學會會誌第十五卷第二期目錄

民國二十五年六月印行

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Geological Society of China

Vol. XV. June, 1936. No. 2.

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Bulletin of the Geological Society of China

Vol. XV *No. 2*

ÜBER DIE ALTKARBONISCHE FLORA DER PROV. KIANGSU MIT BESONDERER BERÜCKSICHTIGUNG DES ALTERS DES WUTUNG QUARTZITES*

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EINLEITUNG

Das Alter des Wutung Quartzites in Ost-China wurde früher von v. Richthofen als dem Devon angehörig betrachten. Yih, Liu, und Chao hielten es aber für "Lower Silurian" (Niagaran) (Vgl. Grabau 1923-1924 S. 365). Prof. Grabau hat es richtig zu "Dinantian" d. h. Altkarbon[1] gestellt (Grabau l. c. S. 250). Die gesammte Dicke dieses Quartzites wird nach den Autoren etwa 600 m. geschätzt. Vor einigen Jahren haben Gothan und Sze Gelegenheit mehrere charakteristische altkarbonische Pflanzen aus verschiedenen Fundorte in der Prov. Kiangsu zu beschreiben. Die Pflanzenführende Schichten liegen fast über dem Wutung-Quartzit und unter dem dinantischen Ching-Ling-Kalk wie z. B. an die Fundorte Kao-Li-Shan, Chih-Yen-Shan und Tsui-Tzu-Shan (Lungtan). Anfangs 1934, nach einem Vorschlag von Prof. J. S. Lee, machte ich eine Studienreise in der Prov. Kiangsu und fand die Pflanzenführende Schichten der Fundorte Shih-Tan-Shan und Chung-Shan am Ufer des bekannten Sees (Taihu, in dem Distrikt Wu-Shi 無錫) sogar in (order zwischen) dem Quartzit selbst. Zwischen den genannten beiden Fundpunkten habe ich noch neue interessante altkarbonische Flora aus Pao-Kia-Shan gesammelt. Die Schicht hier ist ebenfalls zwischen dem Quartzit selbst und das Gestein ist dasselbe wie das des ganz nahe gele-

* Received for publication in March 1936.

1 In einem späteren Nachtrag, hat er die Möglichkeit angegeben, dass das Alter des Quartzites spätestes Silur oder Devon sein könnte (Grabau l. c. Supplement S. 400-442).

genen Shih-Tan-Shan und Chung-Shan, d. h. ein kieseliger, feiner, glimmerhaltiger Sandstein. Dadurch wurde sich die Annahme Prof. Grabaus richtig bestätigt. Dass das Alter des Wutung-Quartzit oder mindesten der obersten Teil desselben zu Altkarbonisch d. h. zu Dinant (oder Kulm) gehört, ist daher kaum zu zweifeln, und dies gilt auch wohl für die Pflanzenführende Horizonte an dem Fundort Kao-Li-Shan die, wie gesagt, gerade über dem Quartzit liegen. Auffallend ist das Vorkommen von *Lepidodendron mirabile* Nath. erw. Goth. aus einer Schicht über dem Horizont mit *Sphenophyllum lungtanense* Gothan und Sze in Lungtan (Tsui-Tze-Shan). Diese sonderbare Art von *Lepidodendron* wurde bisher nur an zwei Stellen der Erde gefunden, die so weit auseinander liegen, nämlich aus dem Kulm von Spitzbergen und in der Gegend von Nanking. In Lungtan stammen die Fossilien aus dem untersten Unterkarbon, aus den höchsten Schichten der "Wutung Series", der überlagernde Chingling-Kalk gilt als Tournai von Europa. Wie bereits erwähnt, ist die Schicht mit *Sphenophyllum lungtanense* G. u. S. und *Lepidodendron leeianum* G. u. S. stratigraphisch unter der Schicht mit *Lep. mirabile* Nath. *Lep. leeianum* trug richtig mehr unterkarbonisches Gepräge, aber *Sph. lungtanense* mit derartigen grossen, breiten umgekehrt keilförmigen Blätter ist überhaupt aus Verwandtschaft der Permokarbonischen Sphenophyllen in Europa so wie auch in Zentral-Shansi, wie Gothan und Sze schon früher diese Meinung auseinandergesetzt haben. Derartige Formen von Sphenophyllen kommen nirgends auf der Welt in älteren Karbonschichten vor, sondern sie weisen klar auf jungkarbonisches oder gar permisches Alter. Wenn man die Gesamtheit der europäischen bekannten Arten von Sphenophyllen überblickt, ergibt sich, dass die ältesten Formen sehr stark zerteilte oder zerschlitzte, feine, kleine Blätter besessen haben, während bei den jüngeren und jüngsten Formen die Vergrösserung und Flächigkeit des Blattes mehr und mehr zunimmt. Das Vorkommen von *Sph. lungtanense* in dem altkarbonischen Horizont in Lungtan ist daher sehr bemerkenswert, und wird vorläufig als eine "Anomalie" betrachtet werden. Man wird noch weitere Aufsammlung an verschiedenen Fundpunkten machen müssen und die dortige strati-

graphische Verhältnisse genauer zu studien um das herrschende Rätzel zu lösen.

Das Quartzit ist recht weit verbreitet in Ost-China besonders in Prov. Kiangsu, so ist eine grosse Entdeckung weiterer altkarbonischen Pflanzen noch zu erwarten.

Wegen der Mangelhaftigkeit der Literatur[1], gebe ich im Folgenden nur eine kurze Beschreibung der von mir gesammelten altkarbonischen Pflanzen aus dem Fundort Pao-Kia-Shan am Ufer des Taihu Sees in Kiangsu.

Beschreibung der Arten.

Sphenopteris (? Rhodea) sp.

Taf. 2, Fig. 11.

Obgleich es sehr unsicher ist, ob das abgebildete Fiedernfragment zu *Sphenopteris* gehört, habe ich es doch bis auf weiteres aufnehmen wollen. Man hat zuerst den Eindruck, dass es zu irgend einer *Rhodea*-Art (z. B. *R. subpetiolata* etc.) gehören könne, da die Fiederchen haarfeine zeigen, doch lässt sich wegen der zu fragmentarischen Erhaltung, eine genauere Bestimmung nicht ausführen. Unter der Lupe sieht man deutlich eine Ader an die fein zerschlitzten linealen Lappen durchlaufend. Man kann ebensogut das Exemplar als einen *Sphenopteris* denken, da derartige zerschlitzte, lineale Blättchen bzw. Lappen wohl auch an einigen *Sphenopteris*-Arten bekannt sind, wie z. B. *Sph. coemansi* Andræ, *Sph. affinis* L. u. H., *Sph. bifida* L. u. H., *Sph. teiliana* Kidston etc.

Sphenopteris taihuensis Sze (sp. nov.)

Taf. I, Fig. 1-4; Taf. 2, Fig. 12; Taf. 3, Fig. 11; Taf. 4, Fig. 4; Taf. 5, Fig. 6; Taf. 6, Fig. 1-2.

1 Einige wichtige Literatur, wie Stur's Culmflora und Nathorst's Zur Palæozoischen Flora Spitsbergens etc. etc. sind mir leider nicht zugänglich.

Es liegen von dieser Art mehrere Exemplare vor. Die Hauptspindel ist hin und hergebogen und mit alternierenden Fiedern erster Ordnung ansitzend (Taf. 1, Fig. 1). Die Fiedern zweiter Ordnung sind ebenfalls alternierend, rechtwinkelig angefügt und gefiedert. Die Fiederchen (d. h. die Fiedern letzter Ordnung) sind typisch sphenopterisch, klein, mehr oder weniger eiförmig bis dreieckig, mit zarter Aderung, zu mehr oder weniger dreieckigen bis etwa parallelrändigen Fiedern zweiter Ordnung zusammengestellt, meist in etwas spreizende, meist umgekehrt keilförmige, stumpf, sich meist berührende Lappen zerlegt. Aderung so gut wie unsichtbar, doch sieht man unter der Lupe an einigen Fiederchen die Mittelader sehr deutlich, diese ist in der Nähe der Basis etwas stärker, dann allmählich schwächer und fast ebenso fein wie die Seitenadern, unter sehr spitzem Winkel der Rachis entspringend. Die Seitenadern sind ebenfalls schräg aufsteigend, ein- gelegentlich auch zweimal geteilt (Taf. 6, Fig. 1, 2). Seitenteile (d. h. Fiedern zweiter Ordnung) locker an der Achse, Fiederchen selbst dichter. Wedel wahrscheinlich ziemlich gross. Achse mit 2 Langsfurchen, ohne Querriefen oder sonstige Skulpturen, ganz schwach flexuos.

Auf der Taf. 4, Fig. 4 habe ich einen dickeren Stengel abgebildet. Der Stengel ist am oberen Ende einmal gabelig verzweigt, nach unten zu teilt er sich wahrscheinlich noch einmal. Es ist zu bemerken, dass der linke Gabelzweig auf einer mit dem rechten correspondierenden Stelle einen kleinen Zweig aussendet (Taf. 4, Fig. 4 a), wenn dies auch nicht sehr deutlich auf der Photographie zu sehen ist. Diese Erscheinung erinnert mehr oder weniger an die Diplotemema-Gruppe, doch glaube ich dies nicht der Fall zu sein. An die Stelle, wo die vermeitlich untere Gabelung (Taf. 4, Fig. 4 b) stattfindet, scheint es mir das von zwei Exemplare zufälligerweise zusammengelegt haben. Es fragt sich jedenfalls, ob hier unterhalb der Verzweigungsstelle (Gabelung) noch einen dickeren gemeinsamen Stiel gehaben haben.

Ich habe wegen der Benennung der Exemplare eine Zeitlang geschwankt, ob man die Pflanze zu der Gattung *Sphenopteridium* bringen könne. Bei genauerer Untersuchung, habe ich an einigen gut erhaltenen Fiederchen die Mittelader nachweisen können, wenn auch diese recht

schwach ausgegrägt ist. (Taf. 6, Fig. 2). Auch das für diese Gattung charakteristische beblätterte Fussstück habe ich in dem Material nicht gefunden. So kann man doch richtiger die vorliegenden Exemplare eher zu der Form-Gattung *Sphenopteris* stellen.

Nach dem ganzen Habitus, erinnert unsere Art wohl an die von Nathorst als *Sphenopteridium keilhaui* aus dem Oberdevon der Bäreninsel (1902, S. 13, Taf. 2, Fig. 3-13). Doch entbehren die Fiederchen bei der genannten Art die Mittelader und scheinen möglicherweise behaart gewesen zu sein. Auch die Spindelreste der Bäreninsel-Art zeigen deutliche lockere Punktierungen. Die Identität der beiden Formen muss darum abgelehnt werden.

Auf weitere Vergleichung mit anderen bekannten Arten, verzichte ich hier, da mir hier zu wenig Literatur zugänglich ist. Dass aber hier eine neue Art vorliegt, glaube ich ganz sicher.

Fruktifikation (? n. g.)

Taf. 1, Fig. 5-7.

Von den vielen interessanten Pflanzenfossilien, die an dem Fundort gesammelt sind, gehören die jetzt zu besprechenden zu den eigentümlichsten unter den Farnen. Es liegen mehrere Exemplare vor, die an die Fruktifikation erinnern. Schwieriger ist es dagegen, wegen der fragmentarischen Beschaffenheit der Reste, zu entscheiden, zu welchem Typus der Fruktifikation dieselben gehören. Man sieht an einigen Exemplaren, die Sporangiensammlungen welche an eine sehr dünne wiederholtgegabelte "stiel"-artige Partie sitzen. Gewöhnlich sind die Sporangien so dicht gedrängt, dass von einem Träger nicht zu sehen ist.

Was die äussere Gestalt derselben betrifft, so scheinen sie den einzelnen Sporangien von *Scolecopteris elegans* Zenk. recht ähnlich zu sein, sie sind länglich eiförmig, vorne zugespitzt. Die aussere Wand der Sporangien ist durch die Erhaltung recht undeutlich, doch scheint sie die gewöhnliche Skulptur der palaeozoischen Marattiaceensporangien ähnlich zu sein. Man kann zuerst die Reste mit der von Nathorst als *Cephalo-*

pteris (früher als *Cephalotheca* genannt) beschriebenen Form aus dem Oberdevon der Bäreninsel vergleichen. Unsere Stücke erinnern dann besonders an das auf Nathorst's Taf. I, Fig. 35 abgebildete Exemplar. Da aber die Erhaltung unserer Exemplare zu unvollständig ist und die für diese Gattung charakteristischen sterilen und fertilen Wedel oder Wedelteile in unserem Material nicht nachgewiesen sind, wollen wir die Identität unserer Form mit derselben offen lassen. Die Sporangiensammlungen bei *Cephalopteris* sind auch viel grösser und mehr kopf-und kugelförmig. Auch die von Autoren als *Crossotheca* und *Calymmotheca* beschriebenen Formen haben etwas ähnliche Gestalt. *Crossotheca* wurde wohl von mehreren Authoren und zwar besonders von Kidston als pollenträgendes Organ primitiver Gymnospermen (Pteridospermen) gehalten und *Calymmotheca* wird jetzt meist auch als Samencupulae gewisser Pteridospermen angesehen werden. Gothan glaubt aber dies nicht. Ob unsere Form mit diesen beiden etwas zu tun hat, scheint zweifelhaft. *Crossotheca* zeichnet durch die scheibenförmige Anschwellung des Stiels aus und hat deshalb mit unserer Form weniger Ähnlichkeit. Zum Vergleich in Frage kommende Form ist von Lesquereux und Zeiller angegebene Typus der *Calymmotheca asteroides* Lesqu. Ee sind spreitenlose, einmal fiederige Wedel (? Wedelteile), deren Seitenachsen unten und oben je eine Reihe gestielter Sori tragen, die je mit etwa 6 sternförmig ausgebreiteten Sporangien von *Crossotheca* Habitus versehen sind. Unsere Form unterscheidet sich aber dadurch, dass mehrere Sporangien (oder Sporangiensammlung) büschelförmig an eine recht dünne wiederholt-gegabelte Stielpartie gesetzt sind. Jedenfalls kann man sagen, dass sich unsere Form mit Rücksicht auf die Sporangien an andere Marattiaceengattung des Palaeozoikums anschliesst. Sonst scheint auch die Form einen ganz neuen bisher unbekannten Typus darzustellen. Da die Form an unserem Fundort mit *Sphenopteris taihuensis* n. sp. vergesellschaftlich vorgekommen ist und auf meisten Stücken die beiden Arten (oder Formen) nebeneinander liegen, schliesse ich, dass die beiden zusammengehören mögen.

Lepidodendron aff. *leeianum* Gothan u. Sze (? n. sp.)

Taf. 2, Fig. 1-6; Taf. 3, Fig. 1, 2; Taf. 5, Fig. 1,2.

Die häufigste Pflanze unter dem Material ist die hier beschriebene Art *Lepidodendron* aff. *leeianum* G. u. S. (? n. sp.). Blattpolster sehr langspindelförmig, schmal, oben mehr oder weniger abgerundet, unter sehr zugespitzt, in sehr steilen Schrägzeilen stehend, an jungen Zweigen sich fast gegenseitig berührend oder ganz schwach gebändert, an älteren Zweigen mit recht breiten Bändern dazwischen, zuletzt Blattpolster vollständig getrennt und die dazwischen befindliche Rindenoberfläche mehr oder weniger schräg-langsrunzelig. Bei älteren Stammreste geht die Langsrunzelung in sehr fein maschenförmige über, nach Art der *Dictyoxylon*-Rindenstruktur (Taf. 2, Fig. 2, 3). Der Zwischenraum zwischen den Blattpolstern kann bei älteren Stammen ca. bis 3-4 mal so breit als das Polstern werden. Die Blattnarben sind nicht sehr deutlich sichtbar, unter der Lupe, sind sie anscheinend rhombisch, fast so breit wie das Polster. Auf der Blattnarbe anscheinend 3 Närbchen. Blattnarben im obersten Teil oder wenigstens im oberen Drittel des Polsters, auf älteren Rindenflächen oft scheinbar fast am oberen Ende des Polsters, da der obere Polsterteil allmählich undeutlich wird (Taf. 2, Fig. 2, 3) Ligulargrube nicht deutlich sichtbar. Transpirationsöffnungen scheinen auch zu fehlen. Die Blattpolster zeigen an allen unseren Stücken im unteren Teil eine sehr stark ausgeprägten Mittellinie (Mediane). die recht tief eingesenkt ist, fast bis zur unteren Spitze verlaufend.

Einmal verzweigte jüngere Äste sind bekannt (Taf. 3, Fig. 2; Taf. 5, Fig. 1) ältere Stamme fast unverzweigt. Auf einigen Exemplaren, sieht man noch deutlich am Rand des Stengel die langen schmalen Blättchen, (Taf. 2, Fig. 4) die recht senkrecht am Stengel ansitzen, mit einer deutlichen Mittelader.. Die Blätter von kleinen oder jüngen beblätterten Zweige sitzen fast schräg am Rand des Stengels an (Taf. 5, Fig. 2). Auch sind einige entrindete Stengelreste vorhanden, und zwar in *Bergeria+Knorria* Zustand. Die Wülste sind auch hier dicht gedrängt, ebenfalls in sehr steilen Schrägzeilen stehend, mit einer Einkerbung an

ihrem Gipfel, wohl dem Leitbündeldurchtritt entsprechend (Taf. 2, Fig. 6; Taf. 5, Fig. 1).

Aus demselben Fundpunkten sind mehrere Blütenzapfen gesammelt worden, die wir unten als *Lepidostrobus grabaui* n. sp. beschrieben werden. Dass diese Zapfen zu unserem *Lepidodendron* gehören, ist wohl anzunehmen.

Die Erhaltung der Art genügt nicht zur eindeutigen Bestimmung, da die Arten dieser Gruppe mit langen Polstern und Bänden dazwischen ziemlich schwierig zu bestimmen sind. Man kann wohl nur sagen, dass solche *Lepidodendron*-Arten viel mehr unterkarbonisches Gepräge tragen. Ich habe zunächst den Eindruck, als ob die vorliegenden Stengelreste mit dem früher von Gothan und Sze beschriebenen *Lepidodendron leeianum* von dem Fundort Tsui-Tzu-Shan in Lungtan identisch wären. Das öberen Ende des Blattpolsters der vorliegenden Form scheint mehr abgerundet zu sein und die Mittelfurchen bzw. Mittellinien oder Mediane sind mehr scharf ausgeprägt als bei *Lep. leeianum* G. u. S. Auch die Blütenzapfen wenn sie überhaupt zu unserem *Lepidodendron* gehören, sind länger und schmäler und mehr zigarrenförmig. Es kann sein, dass auch hier eine neue art vorliegt, doch ist die Erhaltung zur Begründung nicht ausreichend. Die Form steht *Lepidodendron leeianum* G. u. S. jedenfalls sehr nahe, ich führe sie deshalb vorläufig nur als *Lepidodendron* aff. *leeianum* G. u. S. (? n. sp.) auf.

Die meisten zum Vergleich in Frage kommenden Arten finden sich im Unterkarbon wie z. B. *Lep. spetsbergense* Nathorst aus Spitzbergen, *Lep. nathorsti* Kidsten Ms. aus Schottland, *Lep. glincanum* Eichwald des Urals, und *Lep. kidstoni Nathorst, Lep. jaschei* Roemer etc. Die Verwandtschaft der genannten formen mit *Lep. leeianum* wurde früher von Gothan und Sze ausführlich auseinandergesetzt (1933, S. 15-19), verzichte ich hier darauf noch weiter einzugehen.

In einer späteren Arbeit, glaubte Gothan (1933, S. 107) dass *Lepidodendron leeianum* aus Lungtan mit dem von einem Fundpunkt etwa 200 m. westlich gefundenen *Lepidodendron mirable* Nath. erw. Goth. vereinigen kann, weil die erstere Art möglicherweise die jüngere Stamm-

partie der letzteren darstellt. In der Schicht in Lungtan, wo *Lep. mirable* recht häufig vorkommt, kommen zwar einige jüngere Zweige vor, die mehr oder weniger an *Lepidodendron leeianum* erinnern. (z B. Gothan 1. c. Taf. XVI, Fig. 5; Taf. XVII, Fig. 1-3). Man kann aber nicht behaupten oder beweisen, ob derartige jüngere Exemplare überhaupt im grossen und ganzen mit dem typischen *Lep. leeianum* identisch sind, weil die Schicht mit *Lep. leeianum* und *Sphenophyllum lungtanense* stratigraphisch tiefer als deren mit *Lep. mirable.* (Vgl. Sze, Fussnote in Gothan 1. c. S. 107) ist, und wo *Lep. leeianum* recht häufig vorkommt, bisher noch kein einziges Exemplar von dem typischen *Lep. mirable* nachgewiesen worden ist. Nach meiner Ansicht, ist die Runzelung von *Lep. leeianum* viel feiner und mehr netzförmig als deren von *Lep. mirable* und erinnert mehr an die *Dictyoxylon*-Rindenstruktur. Jedenfalls stellt *Lep. mirable* eine besondere Art dar und hat mit *Lep. leeianum* und der vorliegenden Form nicht zu tun, schon durch die viel grobe unverkennbare runzlige Zickzackstruktur und durch die fast bis zur Unkenntlichkeit verschwundene Blattpolster. Auch an unserem Fundort, habe ich recht häufige, sowohl jüngere als auch älter Stammpartie von *Lep.* aff. *leeianum* bemerkt und gesammelt, kein einziges Exemplar davon erinnert etwas an *Lep. mirable,* so muss die Identifizierung der beiden Formen noch mit der grössten Reserve angesehen werden.

Lepidostrobus grabaui Sze (sp. nov.)

Taf. 2, Fig. 7; Taf, 3, Fig. 3-5; Taf. 4, Fig. 1; Taf. 5, Fig. 3; Taf. 6, Fig. 3-4.

Ausser dem oben beschriebenen *Lepidodendron* aff. *leeianum* (? n. sp.) befinden sich unter dem material von dem Fundort noch mehrere *Lepidostrobus*-ähnliche Blütenreste, die nicht sehr gut erhalten sind. Es ist ja bekannt, dass die in Abdrücken erhaltene Lepidostroben überhaupt schwierig zu bestimmen sind. Es liegen davon mehr al 20 Exemplare vor, die alle fast dieselbe Grösse zeigen. Die Zapfen sind ganz schmal, etwa zigarrenförmig, die ausgewachsenen Exemplare haben eine Länge von 8-10 cm und eine Breite von I cm, sie sind gleichmässig und dicht von Blätter (Sporophylle) bedeckt. Die Sporangien sind durch die Erhaltung nicht genau sichtbar, anscheinend nur bis 4 mm lang und nur

[mm hohe. Die freie Sporophyllpartie sind schräg aufgebogen bis zum 8-10 mm lang und nur I mm breit. Sporenverhältnisse unbekannt. Die meisten Exemplare bestehen aus einem Mittelteil, in dem man etwas verdeckt durch eine trübenglassigtalkige Masse, eine Achse bemerkt. An einigen Stücken sieht man noch die Achse recht deutlich, sie ist etwa 1½ mm breit mit schwach lepidodendroider Skulptur, also mit einer Art von spiralig angeordneten Polstern, an der die zahlreichen Sporophylle ansassen. Die Sporophylle gingen zunächst wagerecht und horizontal von der Achse ab. Die Basis der schmalen freien Sporophyllpartie ist dreieckig verbreitert, was man sowohl bei quergestellten als auch mehr flachliegenden Blätter bemerkt, sodass das Sporophyll, wenigstens an der Basis, mehr oder weniger dickfleichig gewesen sein dürfte. Einige Zapfen sitzen noch an einem Sprossende an, das lange, dünne etwas geschwungene, ebenfalls einaderige Blätter trägt, die ganz wie die sterilen Blätter von unserem *Lepidodendron* aff. *leeianum* ähnlich sind. Auf einem Stückn sitzen zwei Zapfen nebeneinander unter einem spitzen Winkel an einer Sprossende an (Taf. 3, Fig. 3). Die Achse des genannten Sprossendes besitzt ebenfalls schwäche aber deutliche Polsterbildung. Die Polster hier sind ebenfalls langspindelförmig und erinnern sich an denen von *Lepidodendron* aff. *leeianum*.

Dieser *Lepidostrobus* sieht ganz anderes aus als *Lepidostrobus ungulatus* G. u. S. aus dem Fundort Chih-Yen-Shan (Distrikt Kiangning) wo die Sporophylle am Gipfel scharf zurückgekrümmt sind (Gothan u. Sze 1933, S. 2, Taf. I, Fig. 4-6). Auch der *Lepidostrobus* von Lungtan ist unähnlich, da die Zapfen dort mehr kurzeiförmig und nicht schmal, zigarrenförmig sind.

Hirmer hat in seinem Handbuch mehrere *Lepidostrobus*-Arten aufgeführt (1927, S. 229-231), die meisten Arten stammen von dem mittelen und oberen Oberkarbon her. Es scheint *Lepidostrobus*-artige Blütenzapfen im Kulm order Altkarbon noch sehr wenig bekannt zu sein. Mangels einer Abbildung in Hirmer's Handbuch, lässt sich eine Vergleichung mit unserer Art nicht sagen.

Eine andere ebenfalls durch ihre kurze zigarren-förmige Gestalt auffallende Art der Blütenzapfen des *Lepidodendron* wurde von Susta

aus den unteren Karviner Schichten in Schlesien bekannt gemacht, und als *Lepidostrobus silesiacus* beschrieben worden ist (1927, S. 2, Taf. 1, Fig. 4). Diese Art unterscheidet sich von unserer durch die etwas breitere und kürzere form der Zapfen und ausserdem scheinen die freie Sporophyllpartie nicht so lang und so zugespitzt als denen von unserer Art zu sein. Die Sporenverhältnisse von dieser Art sind ebenfalls unbekannt.

Dass hier eine neue Art vorliegt, ist ohne Zweifel, da derartige schmale und kleine zigarrenförmige Formen in der Literatur überhaupt noch sehr wenig beschrieben worden sind. Ich benenne diese Art nach dem grossen Geologen Herrn Prof. A. W. Grabau, Professor des Geologischen Institut der Nationalen Universität Peking, dem wir soviel für die Kenntnis der chinesischen Stratigraphie und Palaeontogie verdanken: *Lepidostrobus grabaui* Sze (sp. nov.).

Sphenophyllum pseudotenerrimum Sze (sp. nov.)

Taf. 2, Fig. 8-10; Taf. 3, Fig. 6-10; Taf. 4, Fig. 2,3. Fig. 5.6; Taf. 5, Fig. 4,5; Taf. 6, Fig. 5.

Es liegen von dieser Art mehrere gut erhaltene Exemplare vor. Die Dicke der Stengel kann wenigstens bis etwa 10 mm betragen, die meisten sind jedoch bedeutend schmäler von 5 mm bis kaum 1, was ja selbstverständlich auf Zweige verschiedener Ordnung deutet. Die Oberfläche der Internodien ist beinahe immer gerippt und zwar so 2 oder 3 Rippen besonders hervortreten. Die Länge der Internodien wechselt, das grösste derselben (Taf. 5, Fig. 4) ist etwa 8 cm. Die Stengel sind an den Nodiallinien deutlich angeschwollen, der Austritt der Zweige oberhalb der Nodiallinie ist ebenfalls deutlich. Einige Narben, die zuweilen unter der Nodiallinie zu sehen sind, rühren wohl von den Blätter her. An schmäleren Stengeln sieht man die Blattquirle deutlich an den Nodiallinie ansitzend. Einige Blattquirle sind isoliert gefunden. Die Blätter sind feingabelig zerschlitzt, gewöhlnlich zwei bis dreimal, oft am Zipfel noch einmals gegabelt, beinahe haarfein, doch ist mit der Lupe deutlich eine Ader zu erkennen. Die Zahl der Blätter ist sehr gross, doch ist es

schwierig zu entscheiden, ob es sich um ein Blatt oder um das Segment eines Blattes handelt. Fruktifikation unbekannt. Nach dem Aussehen der Blätter und Stengel, schliesst sich unsere Art an die ältesten Formen von *Sphenophyllum* wie z. B. *Sph. tenerrimum* Ettingshausen aus dem Kulm und unteren Produktiven Karbon in Europa und *Sph. subtenerrimum* Nathorst aus dem obersten Oberdevon der Bäreninsel. Von übrigen Charakteren welche unsere Art von den genannten beiden Arten zu unterscheiden scheinen, kann hervorgehoben werden, dass die Blattquirle viel grösser, und dass die Blätter verhältnismässig länger und mehrmals gabelig geteilt sind. In wie weit diese Verschiedenheiten nur durch die äusseren Verhältnisse und den Erhaltungszustand bedingt sind, lässt sich allerdings nicht sagen. Eine ähnliche Art, die unsere Art und *Sph. tenerrimum* sehr nahe steht, ist *Sph. trichomatosum* Stur aus dem mittleren Oberkarbon in Oberschlesien. Diese Art soll sich wesentlich durch die Fruktifikation von *Sph. tenerrimum* unterscheiden, auch soll die Stengel punktiert sein, wohl Anheftungsstellen von Haaren. Auch zeichnet *Sph. myriophyllum* Crépin aus dem mittleren Oberkarbon in Saarbecken durch die fein zerschlitzten Blätter aus. Die Internodien dieser Art sind meist sehr dick und die Blätter sehr lang, am Grunde meist nur einmal gegabelt, oft verhältnismässig stark und bogig. *Sph. arcticum* Nathorst aus dem Kulm von Spitzbergen soll ebenfalls fein zerschlitzte Blätter bessen haben. Die Art wird im Hirmer's Handbuch S. 361 aufgeführt, doch ist leider die originale Literatur von Nathorst mir nicht zugänglich, so ist die Vergleichung derselben mit unserer Form nicht möglich.

Schon aus dem Fundort Shih-Tan-Shan, der nicht weit von Pao-Kia-Shan liegt, haben Gothan und Sze eine Anzahl langgliedrige Stengel abgebildet und als *Sphenophyllum sp.* (? n. sp.) bezeichnet (Gothan u. Sze 1933 S. 9 Taf. 2, Fig. 3,4,5;). Damals bemerkten wir an den dünnern manchmal auch an dickeren Stengeln, wo die Verzweigung stattfindet, öfter relativ kurze, bald stummelförmige bald mehr oder weniger hakenförmig gekrümmte steife, einfache Blätter sitzen. Wir haben also damals die gegabelten Blätter nicht bemerkt. Da aber das Gestein, von dem die Pflanzen herstammen, der beiden Fundorten fast dasselbe ist, glaube ich

dass die Stengelreste von Shih-Tan-Shan sicher aus derselben Schicht herstammen und dass sie sicher zu der vorliegenden Art gehören. Die ungegabelten Blätter rühren wohl einmal von dem schlecht Erhaltungszustand des Materials und zweimal von der damaligen unvollständigen Sammlung her.

Annularia (?) paradoxa Sze (sp. nov.)

Taf. 6 Fig. 6

Mit grössten Bedenken, habe ich das abgebildete Exemplar zu der obigen Gattung gestellt.

Blattquil in einer Ebene ausgebreit, typisch sternförmig. Blätter ziemlich schlank, 2.5 cm lang und nur 1 bis 1½ mm breit, dicht gedrängt, lineal bis lineallanzettlich, fast pfriemenförmig, vorne zugespitzt, mit einer deutlichen Mittelader. Die Blätter scheinen am Grunde zu einen scheibenförmigen Ring verbunden zu sein.

Das Vorkommen dieser eigenartigen Form in unserem Fundort ist sehr bemerkenswert, da die *Annularia*-arten noch nirgendswo aus den kulmischen Schichten bekannt sind. In Europa treten die meisten Arten vom Westfal durch Stephan bis zum Rotliegenden auf, wie z. B. *Ann. stellata, Ann. pseudostellata, Ann. radiata* etc. *Ann. stellata* ist eins der häufigsten Pflanzenfossilien des oberen Oberkarbons und Rötliegenden und trifft auch schon in den höchsten Schichten des mitteleren Oberkarbon auf (z. B. Saarbrücker Flammkohle). In Shansi kommt die Art in "Yuemenkou Series" und in Kaiping in "Chaokochuang Series" vor. *Ann. pseudostellata* kommt in Europa in tieferen Schichten und zwar aus oberer Teil des mitteleren Oberkarbons (Saarrevier Fettkohle) vor. In Shansi ist die Art durch ein zweifelhaftes Exemplar in "Yuemenkow Series" vertreten. *Ann. radiata* ist in Europa ausserordentlich häufig im mitteleren Oberkarbon und ist hier die häufigste *Annularia*, die aber nicht in das obere Oberkarbon hinaufgeht. Andere chinesische Formen wie z. B. *Ann. mucronata* Schenk, *Ann. crassiucula* Halle, *Ann. gracilescens* Halle etc, die in dem Perm von Shansi ("Upper and Lower Shihhotze Series") recht häufig vorgekommen sind, haben noch weniger Ähn-

lichkeit mit unserem Exemplar. Dementsprechend verzichte ich darauf näher einzugehen.

Nach dem Habitus, steht unsere Form besonders *Ann. pseudostellata* Potonié nahe, da diese Art ebenfalls durch die Pfriemförmigen Blätter ausgezeichnet ist. Die Identität der Beiden, scheint aber zweifelhaft, weil die Blätter von *Ann. pseudostellata* noch mehr linealförmig und lockerer (d. h. mit geringerer Blattzahl im Wirtel) sind.

Eine andere zum Vergleich in Frage kommende Form ist *Protannularia laxa* (Dawson) (1871, S. 31, Taf. VI, Fig. 64) aus dem Oberdevon von Canada und ich habe eine Zeitlang überlegt, ob ich unser Exemplar mit dieser Gattung vereinigen könnte. Bei genauerer Besichtigung erweisen sich die Blätter bei *Protannularia* meist schmäler und lockerer, nicht so gleichmässig, also sind sie z. T. länger, z. T. kürzer, z. T. einfach, z. T. sogar gegabelt, hin und her gekrümmt. Die Zugehörigkeit unseres Exemplares zu *Protannularia* ist deshalb ausgeschlossen. Ausserdem wurde *Protannularia* von einigen Authoren wenigstens z. T. zu den Algen gestellt (Vgl. Arber 1921, S. 76). Dass unser Exemplar keine Alge ist, braucht nicht weiter gesagt zu werden.

Merkwürdig ist jedenfalls, dass diese Form in einer so alten Schicht vorkommt, umsomehr, dass im dem Fundort ausser *Sphenophyllum pseudotenerrimum* n. sp. gar keine anderen Pflanzen von Articulatales bekannt sind.

Ich habe zuerst gedacht, das es möglich wäre, dass hier überhaupt die Blätter von *Lepidodendron* vorliegen, dann wären die Blätter hier genau wie bei *Annularia* quer erhalten, und deshalb in einer Ebene ausgebreitet. Dies glaube ich aber jetzt nicht, weil die Blätter durchaus lineallanzettlich und nicht lineal und parallelrändig als bei denen von *Lepidodendron*, und ausserdem scheint es auch sehr zweifelhaft, ob so lange Blätter an einen so schmälen *Lepidodendron*-Stengel (der ja auf dem Exemplar nicht erhalten ist) ansitzen können. Ich bringe deshalb das Exemplar mit ? vorläufig zu der Gattung *Annularia* und erwarte auf zukünftiges Material aus demselben Fundort. Man wird natürlich bei der nächsten Sammlung besonders auf solchen Formen achten müssen.

Schlussbemerkungen

Was das geologische Alter der Pflanzenführenden Schichten betrifft, so spricht alles dafür, dass es sich um Altkarbon bzw. Kulm handelt. Ein Blick auf die Flora genügt zu zeigen, dass von einer Devonablagerung nicht die Rede sein kann. Die Flora besteht aus I. *Sphenopteris taihuensis* n. sp. 2. *Sphenopteris (Rhodea?)* sp. 3. *Sphenophyllum pseudotenerrimum* n. sp. 4. *Lepidodendron* aff. *leeianum* (? n. sp.) 5. *Lepidostrobus grabaui* n. sp. und 6. *Annularia(?) paradoxa* n. sp. Am wichtigsten für die Beurteilung des geologischen Alters sind die *Sphenophyllum*-Stücke. Es handelt sich zwar um eine neue Art, doch kommen nirgends auf der Welt derartige *Sphenophyllum*-Form in jüngeren Karbonschichten vor, sondern sie weisen klar auf altkarbonisches oder gar oberdevonisches (Vgl. S. 146) Alter. Dass aber die Schicht nicht zu dem Oberdevon gehören kann, wird von dem *Lepidodendron* aff. *leeianum* mit derartigem Blütenzapfen *(Lepidostrobus grabaui)* bewiesen, da die Gattung *Lepidodendron (*und *Lepidostrobus)* nirgendswo in den devonischen oder präkarbonischen Schichten vorkommt. Wie schon in der Einleitung hervorgehoben (S. 136) trugen derartige Formen mehr unterkarbonisches Gepräge, wenn auch keineswegs ausschliesslich, da Formen wie *Lep. wedekindi* im mittleren Karbon und Formen von *Lep. rimosum* die ebenfalls Beziehungen zu unserer Formen haben, bis ins Obere Westfal bekannt sind, so noch aus Saarbrücker Karbon, das dem westfal C angehört. Wenn man also auch auf das *Lepidodendron* für die Feststellung des geologischen Alters nicht viel geben mag, so ist doch soviel sicher, dass die Gattung niemals und nirgends im Devon vorkommt, und dass es sich in unserer Schicht nicht mehr um einen Horizont älter als Karbon handeln kann. Auch die neue Art von *Sphenopteris (Sph. taihuensis)* ist von Interesse, weil die Form auch mehr älteren Eindruck macht. Nach dem Habitus erinnert die Form sogar an *Sphenopteridium*, (Vgl. S. 139), die wohl mehr für Kulm wenn auch seltener für Oberdevon leitend ist. Auch die *Rhodea*-artige Form [*Sphenopteris (?Rhodea)* sp.] ist recht wichtig, da derartige Fiederchen-Formen mit stark zerschlitzten, linealen, schmälen, einaderigen Lappen wohl auch mehr für Altkarbon charakteristisch sind. Auf das *Annularia* legen wir hier kein besonderes

Gewicht, weil nur ein einiziges Exemplar vorliegt, und weil die Bestimmung noch recht unklar ist.

Es ist aber recht merkwürdig, dass in den kulmischen oder altkarbonischen Schichten an verschiedenen Fundorten in Prov. Kiangsu bisher noch keine Spur irgend eines archaeopteridisches Farns gefunden hat, wie *Cardiopteris, Adiantites, Rhacopteris* und auch *Sphenopteridium* usw. Man kann wohl daran denken, dass das Fehlen derartigen Typen auf Zufall beruht, aber diese Annahme hat etwas Gezwungenes. Derartige Gattungen sind durchaus robuste Formen, die sich an den Fundorte und in dem Gestein ebenso gut hätten erhalten können oder müssen, wenn sie da gewesen wären. Im Verein mit dem Verhalten der Calamiten muss man sich mit der Tatsache befreunden, dass diese echt kulmischen Visé-Formen an den verschiedenen Fundpunkten in Kiangsu überhaupt fehlen. (ausgenommen wohl dem *Annularia(?). paradoxa* n. sp.). Diese Sonderbarkeit hängt wohl von edaphischen und pflanzen geographischen Verhältnisse ab, da wir auch in Europa an verschiedenen Stellen finden, dass im jüngsten Kulm die genannten Charakterpflanzen der Visé-Flora ebenfalls bereits fehlen. Dies gilt z. B. für den Mährisch-Schlesischen Dachschiefer und den Waldenburger Kulm der Gegend von Landeshut in Niederschlesien und im Kulm bei Gittelde am Harz usw. Man wird also nicht nur wegen des Fehlens der genannten Formen an unseren Lokalitäten auf ein jüngeres Alter der Schichten gegenüber den sonstigen Fundpunkten der europäischen Kulm-flora kommen. Die Deutung des Fossilations der verschiedenen Fundorten in Kiangsu erscheint im Rahmen der sonst bekannten Tatsache am besten so vorgenommen zu werden, dass man die Schichten als Altkarbon oder Kulm (vielleicht Altunterkarbon) anspricht, da die Schichten wie gesagt, zwischen und über dem Wutung-Quartzit und unter dem Chingling-Kalk, das wohl nach der Fauna als Tournai gilt, liegen.

Wie ich bereits am Schluss der Einleitung hervorgehoben habe (S. 137), wird man noch weitere Aufsammlungen an den verschiedenen Fundorten machen müssen um noch einigen Sonderbarkeiten zu erklären, wie z. B. das Vorkommen von *Sphenophyllum lungtanense* in Langtan, *Annularia(?) paradoxa* in dem verliegenden Fundort und das Fehlen von

archaeopteridischen Formen an allen unseren Lokalitäten wie *Cardiopteris, Sphenopteridium, Adiantites, Rhacopteris* u. s. w.

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BEMERKUNG

Soweit nichts anders angegeben, sind die Figuren in nat. Gr. dargestellt. Sämtliche Originale befinden sich in "National Research Institute of Geology," (Acad. Sinica) Nanking.

Tafel I

TAF. I.

Fig. 1-3. *Sphenopteris taihuensis* Sze (sp. nov.)
Fig. 2, 3. Partie des Vorigen vergrössert (in ca. 3/1 nat. Gr.)

Fig. 4. *Sphenopteris tailhuensis* Sze (sp. nov.)

Fig. 5-7. Fruktifikation. (? n. g.). Fig. 7. in ca. 3/1 nat. Gr:

Tafel II

TAF. 2.

Fig. 1-3. *Lepidodendron* aff. *leeianum* Gothan u. Sze (? n. sp.)
Fig. 2,3. Partie des Vorigen vergrössert (in ca. 3/1 nat. Gr.)

Fig. 4-5. *Lepidodendron* aff. *leeianum* Gothan u. Sze (? n. sp.)
Fig. 4. Mit langen, schmalen Blättern.

Fig. 6. *Lepidodendron* aff. *leeianum* Gothan u. Sze (? n. sp.)
Eine innere und zwar *Bergeria* + *Knorria*-Rindenfläche.

Fig. 7. *Lepidostrobus grabaui* Sze (sp. nov.)

Fig. 8-10. *Sphenophyllum pseudotenerrimum* Sze (sp. nov.)

Fig. 11. *Sphenopteris (Rhodea?)* sp.

Fig. 12. *Sphenopteris taihuensis* Sze (sp. nov.)

Tafel III

TAF. 3

Fig. 1-2. *Lepidodendron* aff. *leeianum* Gothan u. Sze (? n. sp.)
Fig. 2. Verzweigte junge Zweige.

Fig. 3-5. *Lepidostrobus grabaui* Sze (sp. nov.)
Fig. 3. Zwei Zapfen sitzen hier nebeneinander unter einem spitzen Winkel an einer Sprossende an.

Fig. 6-10. *Sphenophyllum pseudotenerrimum* Sze (sp. nov.)

Fig. 11. *Sphenopteris tailhuensis* Sze (sp. nov.)

Tafel IV

TAF. 4

Fig. 1. *Lepidostrobus grabaui* Sze (sp. nov.)

Fig. 2,3. *Sphenophyllum pseudotenerrimum* Sze (sp. nov.). Platte und Gegenplatte.

Fig. 4. Verzweigter, dicker Stengel von *Sphenopteris taihuensis.*

Fig. 5-6. Schmälere Stengelreste von *Sphenophyllum pseudotenerrimum.*

Tafel V

TAF. 5.

Fig. 1-2. *Lepidodendron* aff. *leeianum* Gothan u. Sze (? n. sp.)
Fig. 1. Verzweigte junge Zweige in *Knorria*-Zustand.
Fig. 2. Mit schmalen langen Blattern.

Fig. 3. *Lepidostrobus grabaui* Sze (sp. nov.)

Fig. 4-5. Fig. 4. *Sphenophyllum pseudotenerrimum* Sze (sp. nov.). Gerippter Stengel mittlerer Grösse mit dem Anfang eines Astes; Fig. 5. Schmäler Stengelrest.

Fig. 6. *Sphenopteris taihuensis* Sze (sp. nov.)

Tafel VI

TAF. 6.

Fig. 1-2. *Sphenopteris taihuensis* Sze (sp. nov.)
Fig. 2. Partie des Vorigen vergrössert (in ca. 3/1 nat. Gr.), mit ± deutlicher Mitelader.

Fig. 3-4 *Lepidostrobus grabaui* Sze (sp. nov)

Fig. 5. *Sphenophyllum pseudotenerrimum* Sze (sp. nov.)

Fig. 6. *Annularia? paradoxa* Sze (sp. nov.)

ÜBER EIN VORKOMMEN VON *RHACOPTERIS* IM KULM DER PROV. KWANGSI*

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In einer Mitteilung von Herrn Dr. S. S. Yoh besitzt die geologische Staatsanstalt von Kwangtung und Kwangsi, Kanton ein merkwürdiges Exemplar aus dem Fundort Hsi-Wan (西灣) in Kwangsi, das von dem genannten Autor provisorisch als *"Cardiopteris"* bestimmt wurde (1933, S. 39). Die Gattung ist bisher in Ostasien unbekannt und die kulmischen Pflanzen bei uns sind sehr spärlich gefunden worden, einigen Lokalitäten in Prov. Kiangsu ausgenommen, deren Flora breits von Gothan und Sze bekannt gemacht worden sind (Gothan u. Sze 1933, S. 1-40, Gothan 1933, S. 105-112, Sze 1936, S. 135). Durch die freundliche Zusandung von Dr. S. S. Yoh, habe ich die Gelegenheit das Exemplar näher zu untersuchen.

Es handelt sich um ein dunkeles Schiefergestein mit schlecht erhaltenem Pflanzenrest. Dass aber die Bestimmung von Dr. Yoh kaum richtig ist, geht aus der ganzen Form hervor. Bei *Cardiopteris* sind die Fiedern (oder Blätter) meist recht gross, rundlich bis langlich-herzförmig, am Grunde scharf eingeschnürt, im grossen und ganzen also *Neuropteris*-Habitus aufweisend. Aderung ausgesprochen fächerig, Stengel meist mit deutlichen Querriefen. Dass die erwähntenen Merkmale an dem vorliegenden Exemplar nicht zu beobachten sind, liegt auf der Hand. Es handelt sich hier um anscheinend nur einmal-fiederige Wedel, an beiden Seiten je eine Reihe von ziemlich grossen Fiedern tragen, die am Grunde keilförmig eingeschnürt und auffallend asymmetrisch sind. Die Fiedern überlappen sich öfter einwenig, stehen jedenfalls ziemlich dicht übereinande. Unterer Rand gerade, oberer gebogen, etwa 3-5 cm lang, anscheinend unzerteilt und kaum gelappt. Aderung fächerig, mehrfach geteilt bis zum Rand. Rachis sehr flach, ohne Streifung und Querriefung. Fertile Fiedern unbekannt.

* Received for publication in March 1936.

Das vorliegende Stück beansprucht ein besonderes Interesse, es ist allerdings nur ein einziges und sind keine weiteren Stücke dieser Art gefunden worden. Es stammt von den Schichten, welche zwischen zwei Kalkstein liegen. Das überlagernde Kalk gilt auf Grund der Fauna als Namurian oder Moscovian ("Middle Carboniferous") und der unterliegende Kalk als Viséan. So dürften die Pflanzenführenden Schichten der Lokalität mit dem Kulm von Europa equivalent zu sein.

Derartige Form wurde gewöhnlich, wenn sie überhaupt im Kulm vorkommt, als *Rhacopteris* bezeichnet. Die Gattung *Rhacopteris* (von ῥάκος=zerschlissenes Tuch) wurde zuerst von Schimper 1869 aufgestellt (Traité de Paleont. Veget. I, S. 481). Der Typus dieses Genus ist *Asplenites elegans* Effingsausen (1852, S. 15, Taf. 3, Fig. 1-3, Taf. 4, Fig. 1-3). Die Form ist durch die folgenden Merkmale ausgezeichnet: Wedel einfach gefiedert, lang, mit schmalen Gesamtumriss. Die Fiedern annähernd symmetrisch, sehr genähert, alternierend, verkehrt eiförmig oder verlängt keilförmig, sitzend, stark eingeschnitten-gelappt, mit fächerartig auseinandergehenden ± linealspitzigen Lappen. In die Fiedern treten jeweils eine grosse Anzahl gleichstarker Adern ein. Diese Art *R. elegens* Ett. sowie eine ganz ähnliche Form *R. asplenites* Gutb. (einschliess lich auch *R. busseana* Stur) mit beiderseits stark zerschlitztem Rande der Fiedern kommen nur im mittleren Oberkarbon einiger Kohlenbecken in Europa vor (z. B. Böhmen, Saargebietes, etc.) Die später von verschiedenen Autoren zu *Rhacopteris* gebrachten Formen oder Arten sind aber recht unähnlich und wenig typisch, wie z. B die Exemplare Kidstons *R. lindseaeformis* Bunb. *R. inaequilata* Göpp., *R. transitionis* Stur, *R. robusta* Kidst., *R. dichotoma* kidst., *R. petiolata* Göpp. und *R. subcuneata* Kidst. *R. geikiei* Kidst. aus dem Unterkarbon von Grossbritanien so wie noch einige in Deutschland und anderen Fundorte in Europa vorkommende Arten z. B. *R. panniculifera* Stur und *R. aequilata* Göpp. etc. Alle diese Arten kommen aber im Unterkarbon vor (Calciferous Sandstone Series oder Kulm). Die Fiedern der genannten Arten sind aber mehr asymmetrich im Umriss und nur am oberen Rande gelappt oder zerschlitzt, der untere Rand ist dagegen *ganzrandig*. Ob es richtig ist, alle diese Arten oder Formen zu *Rhacopteris* (d. h. zu den Typus *R.*

elegans Ett. aus dem mittleren Oberkarbon) zu bringen, ist eine andere Frage*, soll auch hier nicht entschieden werden. Gothan führt die beiden Typen in Leitfossilien III, S. 32-33 zusammen als *Rhacopteris* auf, spricht sich aber über die Zweifelhaft der Identität der beiden aus ("Ob die ältere und jüngere Formen wirklich zusammengehören, ist unsicher"). Hirmer bringt in seinem Handbuch die ältere Typen d. h. *R. lindseaeformis* etc. zu der Gruppe *Anisopteris* und die jüngere zu der Gruppe *Eurhacopteris* (1927, S. 664).

Unser vorliegendes Exemplar aus Kwangsi schliesst sich jedenfalls mehr an die älteren d. h. an die kulmischen *Rhacopteris*-Arten (Gruppe *Anisopteris*) an, schon wegen der asymmetrisch gebauten Fiedern mit ziemlich geraden unteren Rände. Ob aber hier eine neue Art vorliegt, sei vorläufig dahingestellt, da das Exemplar zu fragmentarisch ist. Man kann vielleicht dasselbe mit einigen Exemplaren von Kidston vergleichen, doch wie gesagt, ist die Erhaltung zu unvollständig um eine sichere Bestimmung zuzulassen. ich bezeichne deshalb vorläufig das Exemplar als *Rhacopteris (Anisopteris)* sp. (? n. sp.)

Es sei noch darauf hingewiesen, dass die von Autoren als *Noeggerathia*‡ im oberschles. und sachs. Karbon und Perm beschrieben Formen ebenfalls unser Exemplar Ähnlichkeit haben, und dies gilt auch wohl von *Plagiozamites* im Permokarben und *Otozamites* vom Rhät bis zum Kreide. Die Umgrenzung zwischen diesen drei Gattungen und *Rhacopteris* ist sehr klar und deutlich und man wird bei der Bestimmung diesen vier Gattungen miteinander kaum verwechseln können wenn überhaupt bessere erhaltene Exemplare vorliegen. Wenn aber ein un-

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* Walton hat sogar einige Pflanzen mit runden und ganzrändigen Fiedern zu *Rhacopteris* gebracht wie z. B. *R. ovata* W. und R. *circularis* W. aus New south Wales (ebenfalls "early Carboniferous" Vgl. Seward 1931, S. 195, Text-fig. 57 a,b). Diese Formen sind noch weniger *rhacopteridisch* und haben vielleicht mit dieser Gattung nichts zu tun.

‡ Zum Vergleich mit *Noeggerathia*, kommt unser Exemplar nicht in Frage, da die Fiedern (oder Blätter) bei dieser Gattung ± spiralig ansitzend sind, während die Fiedern bei unseren Exemplar mehr "lateral" inseriert erscheinen.

vollständiges Exemplar wie unser vorliegt, dann ist die Bestimmung recht schwierig, ob es sich wirklich um *Rhacopteris* oder um den bereits erwähntenen drei Formen handelt. Unter solchen Zustanden muss man lie Bestimmung der Pflanzenfossilien auf die stratigraphischen Verhältnisse und auf die dort zusammenvorkommende Pflanzenassociation stützen.

Dr. Yoh teilt mir mit, dass er an dem Fundort ausser demgenannten Exemplar noch einige ganz schlecht erhaltene Stücke von *Calamites* gefunden hat. Diese Stücke hat er mir leider nicht geschickt. Es fragt sich aber, ob die von Dr. Yoh als *Calamites* angedeuteten Stücke wirklich zu der Gattung gehören können oder nicht. Man muss zuerst diese Stücke genauer untersuchen, ob die charkteristischen Rippen an den Nodiallinien durchlaufend sind oder alternierend. Wenn dies richtig beweisen werden könnte, so handelt es sich hier vielleicht eher um *Asterocalamites**, dann würde das kulmische Alter fur die Pflanzenführende Schicht des Fundortes noch deutlicher hervortreten.

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* Diese Annahme kann natürlich bei der Mangelhaftigkeit der gefundenen Fossilreste nur mit Reserve geäussert werden, kann aber nach allem einen hohen Grad von Wahrscheinlichkeit für sich beanspruchen. Wenn aber später die Stücke richtig zu der Gattung *Asterocalamites* angehörig bewiesen werden, so beansprucht dies such ein grosses Interesse, weil diese Gattung ebenfalls in Ostasien bisher unbekannt ist. (Vgl. auch Yoh 1933, S. 39)

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ON THE CENOZOIC GEOLOGY OF ITU, CHANGLO AND LINCHÜ DISTRICTS (SHANTUNG)*

By C. C. Young (楊鍾健)

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Introduction

Since many years the occurrence of Early Pleistocene fossiliferous red loam (wrongly interpreted generally as "loess") was known, north of the Taishan range, along the Tsinan-Tsingtao railway. Chiefly in the Itu district several fossiliferous localities had been reported, and an appreciable number of fossils described, for instance by Zdansky[1] and Matsumoto[2]. No earlier Cenozoic formation however was supposed to have been found in that area.

Therefore it was a surprise to Mr. M. N. Bien and myself when visiting, in the fall of 1934, the geological department of the Cheloo University (Tsinan) under the direction of Prof. Scott, to see among other interesting specimens, a series of remarkably well preserved fossil plants and fishes, evidently of Tertiary age, reported as having been found near Linchü in North Shantung[3].

Later on (spring 1935) Dr. W. H. Wong was informed that some "dragon bones" had been recently unearthed in Changlo which is approximately in the same area.

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* Received for publication in March 1936.

1 Zdansky, O. 1925, Fossile Hirsche Chinas. Pal. Sin., Ser. C, Vol. 2, Fasc. 3, P. 48.

2 Matsumoto, A 1926. On some fossil Cervids from Shantung, China. Sc. rep. Tohoku Imp. Univ. Sendai, Japan. Vol. X, No. 2, P. 27.

———— 1926. On a new fossil race of Big-horn sheep from Shantung, China. ibid. P. 39.

3 This collection was given to Prof. Scott by Dr. Hayes, at Tenghsien. According to Dr. Hayes the fossils had been collected by Dr. Paul Bergen in December 1909.

A closer examination of the region was evidently necessary, and I carried it out in May 1935. The aim of the present note is to give a short preliminary account of the results of this survey, which resulted not only in collecting a rich Cenozoic flora, but also in gathering several other important data bearing on the Cenozoic history of Shantung.

It is my pleasure to express here my deepest gratitude to Prof. Scott, and to P. Fakart and P. Feng for their kind and valuable help during my journey.

1 The Cretaceous Beds of N. Shantung (Chingshan Series)

The general geology of northern Shantung has already been reported on elsewere, chiefly by H. C. Tan[1]. It is not the aim to discuss this subject in detail here. But before I start in the description of the Cenozoic sediments with which this paper is chiefly concerned, I feel it is necessary to say a few words on the Cretaceous beds which form mostly the floor of the younger deposit in the area.

All the outcrops of Cretaceous beds observed by me in the Changlo-Linchü district belong to the Lower Cretaceous *Chingshan series* of Tan, a formation consisting chiefly of tuff-conglomerates and tuffs interbedded with andesitic lavas and clays. In the vicinity of Fangshan and west of Changlo (N. of Lingshan), the beds are almost horizontal, slightly dipping towards the plain (north). But in the place W. of Shangling, where the Chingshan series lie on the Sinian strata, it dips about 30° N.E.

Physiographically speaking, the Cretaceous beds usually form a series of low ranges, or rather a mature plain, which represents most probably the Tanghsien surface as already noticed by us in the Ssushui-Wenho area[2]. This mature surface is especially well developed in S.

1 H. C. Tan, Explanation to the Geological Map of China, Peking Tsinan Sheet. 1924. and

———— New researches on the Mesozoic and Early Tertiary Geology in Shantung. Bull. Geol. Surv. China. No. 5, Part II, 1923.

2 Young and Bien. Cenozoic geology of the Wenho-Ssushui District of Central Shantung. Bull. Geol. Soc. China, Vol. XIV, No. 2. 1935.

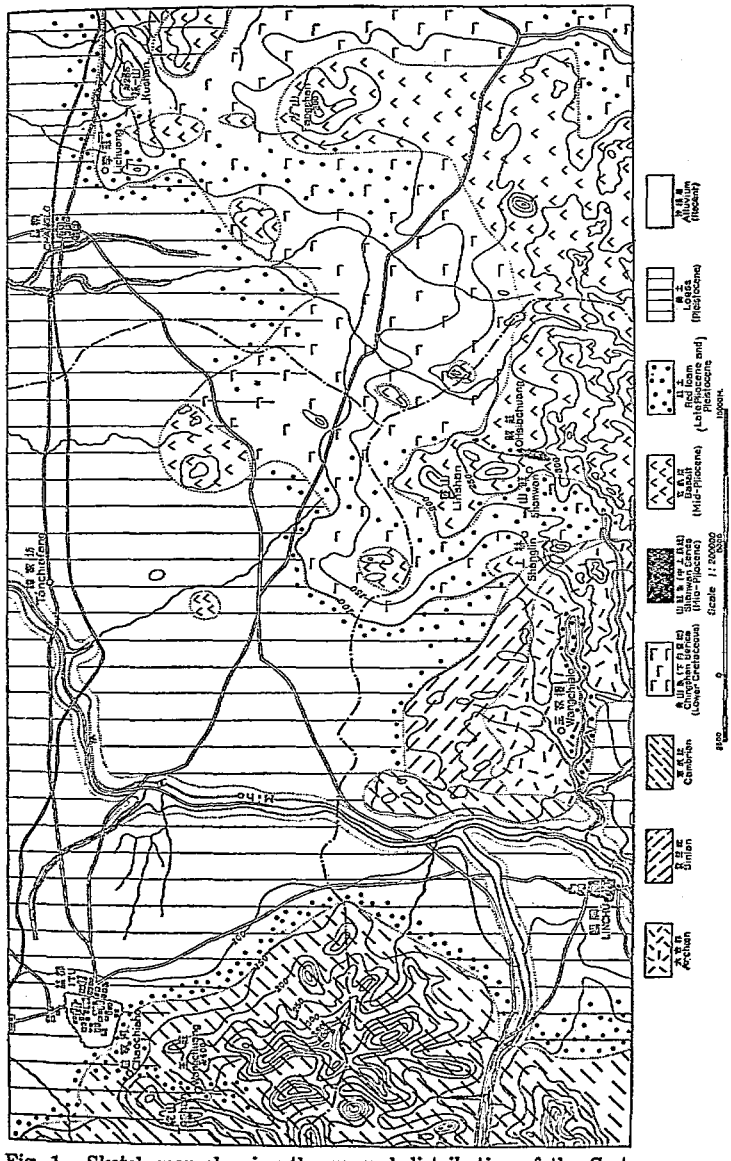

Fig. 1. Sketch map showing the general distribution of the Cretaceous and Cenozoic formations in the Itu-Changlo-Linchü area.

Chiaohsien and other parts of E. Shantung where the Wangshih (Upper Cretaceous) and Chingshan series are well developed. On the other hand, the block faulting so commonly found S. of the Taishan range is entirely absent here. The Cretaceous beds lie uncomformably, in sedimentary contact, on the other various old formations. As already noticed by Tan, the Upper Cretaceous beds (Wangshih series) are only slightly undulated, making very gentle synclines and anticlines (Tan, 1923. Pl. III).

Above these Cretaceous formations, none of the Early Tertiary horizons developed in Central Shantung has been found so far in the area under discussion.

2. The Shanwang (Miocene?) Series

As stated above, the chief aim of my trip in N. Shantung was to visit the site where Tertiary plants and fishes had been reported to occur. This locality was found about 70 li E. of Linchühsien, 2 or 3

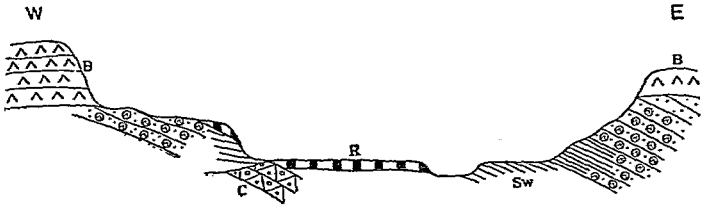

Fig. 2. A section across the Chiehchiaho Valley, showing the relation of the Shanwang series with the older and younger formation. B. Basalt, C. Cretaceous (Chingshan series), L. Loess, R. Reddish loam, SW. Shanwang series. Note the grading of the shaly series into the sandy series.

li N.E. of the village Shanwang (山旺). At this place, the fossiliferous series is exposed as a narrow and limited strip along a valley called Shieh-chiaho (解家河), leading to the village Shihchiachuang (解家莊) and running approximately in a N.E.-S.M. direction. With the exception of a N.E. opening, the valley is practically bounded on all sides by low basaltic hills. The series overlies (without any apparent angular uncomformity) the

Chingshan series (Cretaceous) but is uncomformably capped by horizontal basalt. The beds are distinctly tilted, dipping generally some 35 degrees N.E. But owing to the great difference of weight between the lower shaly part and the upper sandy part of the formation, the beds are often affected by local small faults. Observed from a distance, the series may easily be either concealed by the basaltic flow so extensively developed in that area, or wrongly regarded as the upper part of the Chingshan series. Estimated thickness of the exposure: 400 m.

According to their lithological characters, and also according to their palæontological content, the sediments are really separable in two parts, a shaly one and a sandy one, the stratigraphical value of which is discussed below.

1. *The shaly part.* Close along both sides of the valley many excellent exposures of tuffaceous shales are exposed, admitting (chiefly in their lower part) some layers of green marls. The shales are exceptionally thin-bedded, papyraceous, being therefore known by the local people as Wanchuanshoe (the book of ten thousand volumes)[1]. Their color is generally greyish white; but a somewhat darker coloration, grey or even sometimes black is also noticed but only rarely. Apart from the river course and from the gullies, the beds are often either concealed by later superficial deposits, or as discussed below, replaced by sandy and coarser sediments.

The entire marly and shaly series is fossiliferous; but in the marls and in the lower part of the series, the organic remains are often dissolved, so that only the impressions of them can be seen. The best horizon for collecting fossils is therefore the upper part. The fossils look exceptionally fine, when the shales are still wet. But they are inclined to split when dry, a condition which renders collecting difficult. Owing to the exceptional fine structure of the shales most of the fossils are exceedingly well preserved. Even the tadpoles, the skin of the frogs,

1 The papyraceous shales are a diatomaceous earth, the botanical study of which has been undertaken by Dr. B. Skvortzov. Most abundant are the frustules of *Melosira granulata* (Ehr.) Ralfs. A paper by Dr. Skvortzov will be published in the Bulletin.

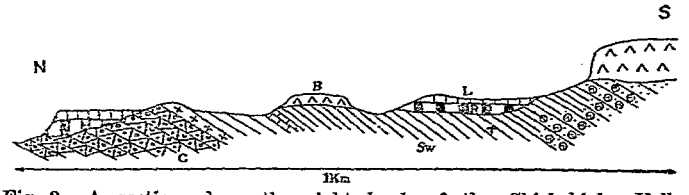

Fig. 3. A section along the right bank of the Chiehchiaho Valley (abbreviations as in fig. 2). T. Place where fossil plants and fishes etc. were mostly collected.

the insects and the impression of flowers are most beautifully indicated. Most of the fossils are plants (leaves), amongst which no less than 21 genera, including 47 species have already been recognised by Dr. H.H. Hu, in charge of the description:

Salix spp. (two species)
Carya spp. (4 species)
Quercus spp. (5 species)
Carpimus spp. (5 species)
Zelkova spp. (2 species)
Morus spp. (2 species)
Ulmus sp.
Sassafras sp.
Lindera spp. (2 species)
Spiræa sp.
Sorbus? spp. (2 species)
Leguminosites spp. (4 species)
Alchornea spp. (3 species)
Pistacia spp. (2 species)
Ilex sp.
Acer spp. (4 species)
Tilia sp.
Firmiana sp.
Catalpa spp. (2 species)

Ceratophyllum sp.
Antholithis sp.

As a conclusion of his preliminary study, Dr. Hu draws attention to the fact that this collection represents a subtropical flora, not unlike that found at the present day in the Yangtze Valley, this likeness being specially indicated by the presence of *Sassafras, Carya, Lindera, Ilex, Zelkova* and *Alchornea.* After careful comparison, Hu believes that the age of the flora is probably Miocene in age, which is in full accord with both our geological and palæontological observations.

In addition to the plants, several animal remains were recovered form the shales:

Insects:

Cycad sp.

Amphibia:

Rana basaltica Young (sp. nov.)

Pisces:

Leuciscus miocenicus Young and Tchang
Barbus linchuensis Young and Tchang
Barbus scotti Young and Tchang
Pseudorasbora macrocephala Young and Tchang

All these forms are now being studied and will shortly be described.

2. *The sandy part.* A short distance away from both sides of the river, the shaly series in no longer to be seen but instead is replaced by a yellow gravel mixed with rather consolidated sands. The pebbles are sometimes as large as a fist. Both the pebbles and the sands consist chiefly of granitic or metamorphosed rock, a fact suggesting that during the deposition of this series outcrops of archæan rocks were exposed nearby. In fact, a large archæan mass is still observable only a few li W. from Shanwang. Another marked feature is the presence of abundant basaltic boulders throughout many parts of the series. This shows clearly that during the deposition of the beds, the volcanic activity had already started, preceding the faulting of the beds and the spreading

of the big basaltic flow. Along the west side of the valley pits were made by natives several years ago for searching peat in the sandy beds, but without definite result. It is of course possible that, as told by the local people, a small amount of coal is found. But we were not able to collect any piece of it ourselves, as most of the pits are now destroyed and covered by cultivation.

Just as the shales, the sandy-gravel of Shanwang is fossiliferous, but instead of plants and smaller animals, it contains rich remains of large mammals. Many highly mineralized bones can be collected along the small gullies and slopes of the hills. A preliminary determination of the fossils so far recovered by us is given in the following list:

Carnivora:

A large Amphicyonid.

Perissodactyla:

A tetradactyle *Aceratherium.*

Artiodactyla:

Two primitive Cervids, one of them resembling closely a Tung Gur form (*Platybelodon* beds of Inner Mongolia), the other one is decidedly of antilocaprin affinity.

Testudinata:

A very big turtle (perhaps two species).

This fauna as well as the plants distinctly point to a Miocene age of the deposits.

Stratigraphical relations between the shaly and the sandy part. Between the shaly and the sandy parts of the Shanwang series, the relations are mostly obscured by a cap of later sediments and by minor local dislocations. On the whole, the shales seem to underlie the sands. Yet, in the SE exposures of the formation, the two formations seem to grade distinctly one into the other. Both of them in addition contain basaltic elements, and both are referable by their fossils to the same Miocene age. Our impression is therefore that they correspond merely to two successive stages in a single sedimentary sequence. They form a single stratigraphical unit.

3. The Basalt

Immediately above the Shanwang series extends the protecting cap of baslt, actually observable in angular uncomformity, either with the shaly or with the sandy part of the sediments below. Unquestionably the "Miocene" sediments have been warped and planned before the outpouring of the basaltic flow.

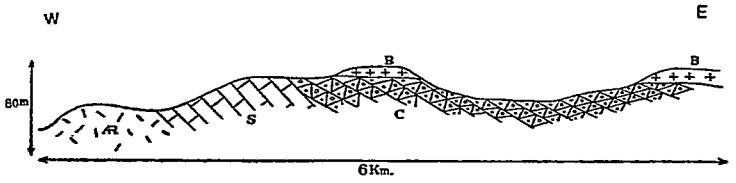

Fig. 4. A section from E. of Wangchialo from Shanglin to Shanwang showing the general geological formations. Ar. Archæan, B. Basalt. C. Cretaceous, S. Sinian limestone.

Mineralogically, the basalt of Shanwang (an olivine basalt)[1] has the same composition as the other basalts found along the coast, either in N. Shantung (Fangshan), or in Central Shantung, south of the Taishan range[2], or in Kiangsu[3]. The general dip of the basaltic flow is gently towards N.E. As shown by our fig. 1, the rock is widely distributed in the S.E. part of the here described area, a fact suggesting the vicinity of a line of fracture. Wherever the Shanwang series is absent, the basalt lies directly over the Chingshan series of Lower Cretaceous age. Its age might well be Lower Pliocene.

1 The writer is indebted to Mr. C. C. Chang for examining the specimens of basalts collected in the locality.

2 Young and Bien. Cenozoic Geology of the Wenho-Ssushui Districts of Central Shantung. 1035. Bull. Geol. China, Vol. XIV, No. 2.

3 Teilhard and Young. The Cenozoic Sequence in the Yangtze Valley. 1935. ibid. P. 163.

4. The Reddish Loam

The reddish loam is well developed along the foot of the hilly ranges of the district as shown roughly in our map. Three places are of special interest:—

1. *Lichuang near Changlo.* S. E. of Changlo, along the slope of the range the reddish loam, sometimes very sandy, remains as patches left by erosion. In one of the gullies dissecting the formation, a short distance E. of Lichuang, a beautifully preserved skull of Bovid was found by the natives some time ago, and is now kept in the Public Educational Bureau in the city. This is the very specimen which was mentioned in 1935 to Dr. W. H. Wong as a "dragon bone". At first glance we recognised it as belonging to a most characteristic type of Water-Buffalo (horn-cores short and sharply trihedral) already found a year ago by the

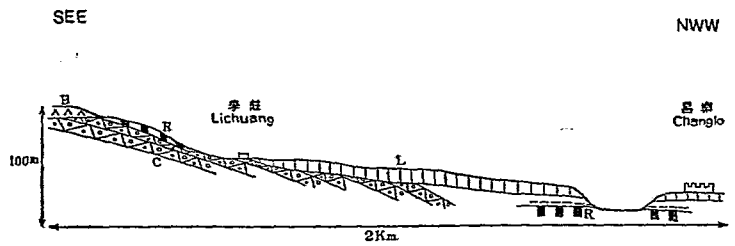

Fig. 5. Section S.E. of Changlo city. B. Basalt, C, Cretaceous. R, Reddish loam. L, Loess. The dotted line indicates a concretionary layer below Loess.

Cenozoic Laboratory technicians in the Reddish clays of Mienchih (W. Honan) (this form will be shortly described). We visited the site ourselves, but did not find any interesting bone, with the exception of several teeth and vertebræ. One upper molar and a lower jaw with teeth preserved of a Bovid, and fragmentary limb-bones of

Cervids were collected by our technicians about 2 li E. from the same place. The reddish loam is therefore fossiliferous, although rather poor. The *pre-Loessic age* of it we could positively ascertain, taking advantage of the new deep cuttings made along a road close to the city.

At the foot of Fushan, the reddish loam series begins with characteristic basal conglomerates. Most of the boulders and pebbles found are basalt, not much rolled but deeply weathered. A post-basaltic age of the series is quite evident.

2. *Itu area.* S.W. of the city of Itu at Chingshuichian (清水澗) in the reddish loam capping directly the Cambrian limestone, a broken tooth of Elephant was found recently, according to information given us by Bishop Meinzans. The reddish loam is especially well developed over the district extending between Toshan and Yumenshan, and many fossils are reported from this area. With exception of one place, S. of Wangchiachuan, where a dark red clay is exposed along the river bottom *below*

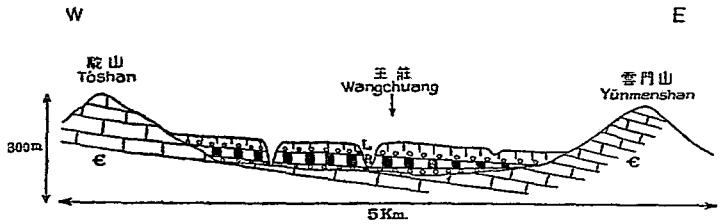

Fig. 6. Section acoss Toshan and Yunmenshan. C. Cambrian limestone. R. Reddish loam with basal gravel, L. Loess with basal gravel.

the reddish loam and its basal conglomerates, all the exposures we observed correspond to the generalized section given in textfigure 6. This dark red clay may be Lower Pliocene in age, but no fossil has been observed in it. The reddish loam on the contrary, seems to be very fossili-

ferous. All the fossils described by Matsumoto[1], Zdansky[2] and Pearson[3] come from this area. They represent the following forms:

(Pearson) - *Sus* sp. Yenchiachuan

(Zdansky) - *Pseudaxis magnus* (the antler from Loc. 24, S. Mienchihshan and Kochuan)

(Matsumoto)
- *Cervus* (Sika) *nippon leptodus* (Koken)[4]
- *Cervus* (Sika) *hortulorum* Swinhoe
- *Cervus* (Cervus) *canadensis songaricus*
- *Ovis ammon shantungensis* Mat. (Wanchiagna, probably Wanchiachuan)

That Zdansky's classification of *Pseudaxis magnus* wrongly includes a great number of thicked-jawed deer *(Euryceros)*, I have already suggested some years ago[5]. The Cervids described by Matsumoto are aiso described in a confusing way. Matsumoto himself noticed that his *Cervus nippon leptodus, C. hortulorum* and *C. canadensis*, correspond to *Pseudaxis grayi, Rusa pachygnathus* and *Cervus canadensis* respectively (ibid. P. 37). Using our present knowledge of the fossil Cervidæ of China, the faunal list of Itu has to be revised as follows:—

Sus sp.
?*Pseudaxis magnus* Zd. (the antler of local. 24. S. only)
Pseudaxis grayi Zd. *(Cervus nippon leptodus)*

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1 Matsumoto, H. On some fossil Cervids from Shantung, China. Sc. Rep. Tohoku Imp. Univ. Sendai, Japan. Vol. X, No. 2, 1926 and On a new fossil race of Big-horn Sheep from Shantung, China. ibid.

2 Zdansky, O. Fossile Hirsche Chinas. Pal. Sin., Ser. C, Vol. II, Fasc. 3, 1925, P. 46.

3 Pearson, H.S. Fossil Suidae from China. Pal. Sin., Ser. C, Vol. V, Fasc. 5, 1928,

4 Some isolated teeth of Hipparion were also described by Mat-Sumoto, (on *Hipparion richthofeni* Koken) SC. Rep. Tohoku Imp. Univ., Vol. X, No. 4, 1927. But the localities are all uncertain. Some were purchased from Chinchou (Itu). They are therefore not included in this list.

5 Young, C.C. On the Artiodactyla from the *Sinanthropus* site at Choukoutien. Pal. Sin., Ser. C, Vol. VIII, Fasc. 2, 1932, P. 62.

Euryceros pachyosteus Young (part of *Pseudaxis magnus* and *Cervus canadensis*)

Euryceros flabellatus Young (type of Locality 13 of Choukoutien)

Ovis shantungensis Mats.

In addition, the *Bubalus* skull of Changlo belongs without any doubt to the same faunistical block. The relations are obvious with the upper red clays (*Siphneus tingi* beds) of other parts of North China. With the exception of *Ovis shantungensis* all these forms are found in Choukoutien. The reddish loam of Shantung is probably therefore for the most part of a "Choukoutien age", a small lower part representing possibly somewhat older beds if *Ovis shantungensis* proves to be really an index form for the Nihowan beds.

3. *The sandy beds of Wanchialou area.* Along the road from Linchü to Shanwang also, the reddish loam is well developed over the slopes we passed, although most of it has been already washed away. Along the valley near Wangchialo we found however a markedly different facies of deposits below the loess and above the archæan mass (fig 7). At this

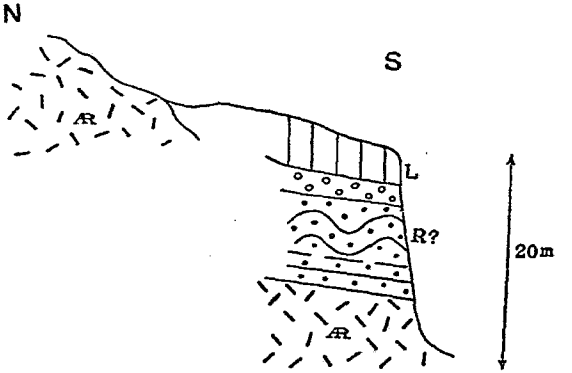

Fig. 7. Section E. of Wangchialo. Ar. Archæan, L. Loess with basal gravel, R? Sands and gravel (locally contorted), probably a river-facies of the reddish loam.

place, the formation is composed mainly of small gravels and sands of a white grayish coloration. Most of the elements are of igneous origin, evidently derived from the archæan rocks. In the middle zone these sandy beds look somewhat contorted. Owing to the smallness of the exposure, I could not decide whether this disposition is simply due to local compression, or to cross-bedding appearence, or whether on the contrary it should be considered as an indication of tilting.

No fossil was found at this very exposure; but some remains of a decidedly Late Cenozoic looking *Ovis* (lower jaw) and fragments of other undeterminable mammal bones have been collected by our technicians from Chunchiaho in Shaling a few lis S. from there. I regard this series therefore as the lake or river facies of the reddish loam, although the possibility of it being equivalent to the Shanwang series is not absolutely excluded.

4. *Shanwang area.* In the Shanwang area the reddish loam is extensively developed, and less destructed by erosion. In its thickest part the formation may reach 20 meters or even more. But in the

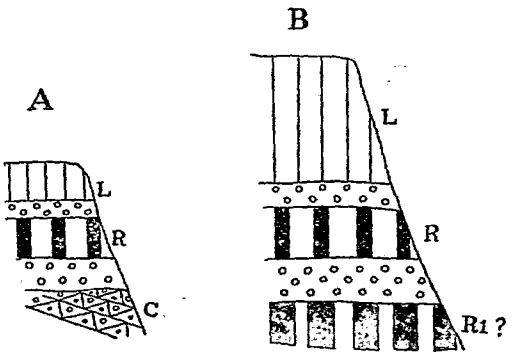

Fig. 8. A. section of Chiehchiaho, B. Section near Wangchiachuan, C. Cretaceous, R_1? Dark red clay, R. Reddish loam with basal conglomerates, L. Loess with basal gravel.

Chiehchiaho valley itself, where the Shanwang series is developed, they are again less extensive, and represented only by a few remnants observable under the loess. Wherever the loessic cap is absent, the destruction is still going on. In several places, the basal gravel of the reddish loam contains an abundance of basaltic pebble.

Remarks on the distribution of the reddish loam. All along the mountainous ranges or the border of depressions in Shantung, the reddish loam is more or less developed, its presence depending chiefly on the local conditions of erosion. The formation is especially well developed south of Tsinan and in S. Lingtzehsien. From the former places some teeth of Bovids, and other bones are reported. In Peimashan along the Tientsin-Pukou line, many fissures with red breccia are found in the limestone quarries, but so far no determinable fossil has been found. For the south of the Taishan range, we have already published some observations made in the Wenho-Ssushui district[1]. Since that time, a few fossils (mostly limb bones of deer) have been collected by our technicians from Koulitsun, Laiwuhsien, this fact proving that S. of the range also the beds are not entirely barren of fossils. An important difference to be noted between North and Central Shantung is the absence in the former of the Early Tertiary deposits (Kuanchuan series) occurring in the latter. Neither did we observe in N. Shantung the superficial zone of alteration with manganese-iron pisolites, coating the Tertiary beds in Central Shantung.

5. The Loess

As in most parts of N. China, the loess usually coats the previous old formations. The basal gravels are in most cases present. Near Changlo, there is a layer of loess like-deposits with plenty of concretions, lying on the reddish loams. This particular layer seems to indicate a rewashing of the reddish loam with accumulations of concretion, and would thus represent the basal part of the loess.

1 Young, C. C. and Bien, M. N. Cenozoic Geology of the Wenho-Ssushui districts of Central Shantung. 1935. Bull. Geol. Soc. China, Vol. XIV, No. 2.

A secondary loess and various types of late alluvial deposits are developed everywhere along the river valleys and other depressions.

Summary and Conclusions

As a summary of these observations, the Late Mesozoic and Cenozoic sequence in N. Shantung can be briefly expressed as follows:

	N. Shantung	S. Shantung
Holocene	Recent deposits	Recent deposits
Middle Pleistocene	Deposition of Loess (Chingshui Stage)	Loess
Lower Pleistocene and Upper Pliocene	Deposition of the reddish loam (Z. Erosion)	Reddish loam
Pontian	Basalt flow (no lateritization) (Tanghsien stage)	Basalt Period of lateritization
Middle or Upper Miocene	Deposition of Shanwang Series with volcanic activity	Bajada breccia
Lower Tertiary	Big uncomformity	Kuanchuang series
Cretaceous	Deposition of the Upper Cretaceous Series	

The most remarkable differential character between the two areas is the total absence of typical Kuanchuang series in N. Shantung. Of

course, it is not absolutely excluded that the upper Cretaceous beds of this region (the Laiyang series) may include some Lower Tertiary horizons not yet identified. In any case, due to the absence of marked block faulting in N. Shantung, the "Bajada breccia" is not represented in the area. We suppose that this particular facies is replaced by the Shanwang series.

Another important difference between N. and Central Shantung is the absence in the former of the protracted soil-forming process (lateritization and formation of iron-manganese pisolithes) so characteristically observed S. of the Taishan range over the Tertiary beds. The northward extension of the conditions favourable to this process seems to be entirely stopped by the Taishan range, a true arid climate having apparently prevailed at that time in N. Shantung. The residual gravels observed in so many places in the Wenho-Ssushui area (Central Shantung) are also scarcely found North of the Taishan. The karstic surface in the limestone regions is however well formed, for instance in S.E. of Changchiu.

In spite of the above mentioned differences the whole history of the Shantung is mainly the same. In contrast to Shansi, Shensi and Kansu provinces, conditions seem to have been relatively quiet then (after the great Miocene block-faultings) throughout the whole Late Cenozoic time.

A MIOCENE FOSSIL FROG FROM SHANTUNG.

By

C. C. Young (楊鍾健)

(Cenozoic Laboratory, National Geological Survey of China)

Among a large collection of plants, insects, fishes, turtles and mammals recently collected by the author near Lingchühsien, Shantung, a well preserved fossil frog and numerous impressions of tadpoles are of a particular interest, and require a special description. The specimens were found in the lower shaly part (paper-shales) of the Miocene (?) series of Shanwang, N. Shantung. (cf. C. C. Young, On the Cenozoic geology of Itu, Changlo and Linchü Districts, Bull. Geol. Soc. China, Vol. XV p. 171).

Description

Family Ranidæ

Genus *Rana* L.

Rana basaltica Young (sp. nov.)

The print and counterprint of the fossil are beautifully preserved on two pieces of papyraceous shale, the impression of a small fish *(Pseudorasbora macrocephala)* also being seen on the fragment where the leg of the frog is missing. The general outline of the body is clearly indicated in brown on the light colored shale, and the bones distinctly marked in the body by a darker coloration.

The *skull* has a general triangular shape, the anterior-posterior length being decidedly shorter than the maximum breadth of the posterior part of the skull. The more delicate bones are slightly damaged; but on the whole the skull is well preserved. Traces of small teeth can be observed.

There are 9 *vertebrae,* the two first ones somewhat damaged or covered by the pectoral girdle. Diapophyses almost completely preserved.

Received for publication in March 1936.

As in the recent species of this genus, the second vertebra (that is the first after the atlas) has the strongest diapophyses. On account of a slight shifting of the vertebrae, the shape of the neural spine is somewhat distorted on the specimen.

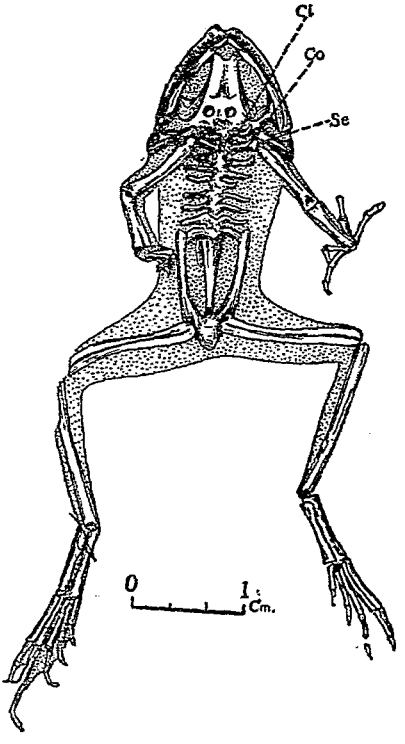

Fig. 1. *Rana basaltica* Young (sp. nov.). The entire body in ventral aspect. The fresh impression, dotted; bony skeleton, solid lines. Cl. Clavicula, Co. Ceracoid, Se. Scapula. × 2.

Pectoral girdle incompletely preserved. The supra-scapular bone seems to be indicated only by its proximal end, where it connects with the scapula. Both scapulae and coracoid are preserved, and in natural position. The claviculae are also probably represented by two slender bones (fig. 1) in front of the coracoid, unless these pieces correspond

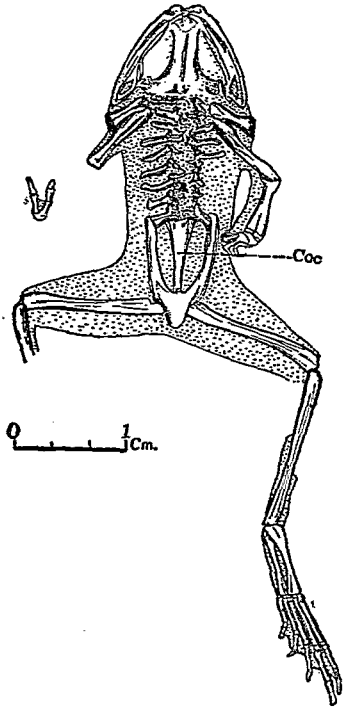

Fig. 2. *Rana basaltica* Young (sp. nov.). Coc. Coccyx. × 2. Other explanations are in text figure 1.

to some disaphyses of the vertebrae. The epicoracoid, omosternum and sternum can not be traced clearly amongst the other bones.

The *fore-limbs*, with exception of a few phalanges, are all represented on the print or on the counterprint. No appreciable difference with those of the living Asiatic species, with this exception perhaps, that the radio-ulna is proportionally longer.

The most interesting part of the fossil is the *pelvic girdle*, which, together with the coccyx, is well preserved. This part of the skeleton is characterized by a short and massive general architecture. The anterior maximum breadth of the pelvic girdle is about the same as in *R. asiatica*, yet its total length is shorter by more than one half.

Hind limbs perfectly preserved, especially the left tarsus. Even the outline of the web is distinct. The web does not reach the tip of the phalanges, approaching the condition found in *Rana agilis*. The tibio-fibula is a little longer than the femur. The total length of both together is shorter than the body length.

Measurements:	*Rana basaltica*	*Rana asiatica* (Choukoutien)	*Rana asiatica*
Length of the head.....	11.2 mm	15 mm	16 mm
Max. posterior breadth.....	9.5 mm	15 mm	16 mm
Length from the tip of the skull to the posterior end of the pelvic girdle (including the outline of the body).....	29 mm	49 mm	42 mm
Length of humerus.....	?9 mm	14.5 mm	10 mm
Length of radio-ulna.....	5.3 mm	10 mm	9.5 mm
Length of the pelvic girdle...	10 mm	18 mm	17.5 mm
Anterior breadth of the same	7 mm	7 mm	8 mm
Length of femur.....	12.5 mm	20 mm	20.5 mm
Length of tibio-fibula.....	14.5 mm	22.5 mm	21.5 mm
Length of the foot.....	17.5 mm	34 mm	31 mm

Tadpoles There are 8 tadpoles present in our collection. Some are well preserved. The eyes and the outline of the impression are clearly shown. However it is difficult to define the detailed structure. Length, 26 mm. Maximum breadth of the head, 7 mm.

Comparisons and Conclusions

The closest living form which we can compare with our fossil specimen is *Rana asiatica*. And yet, as shown by the above description and measurements, several important differences can be easily traced between the two forms. Although smaller than *R. asiatica*, the Miocene form has relatively thicker limb bones, its shorter size being largely due to the shortness of its massive pelvic girdle. In addition, its skull, longer than wide, is more pointed. On the basis of these differences, we attribute our specimen to a new species, *Rana basaltica*, this name referring to the particular condition of the site of the discovery. It is interesting to observe here that, in the intertrappean blue shales (Cretaceous?) of India, near Bomay, fossil frogs and tadpoles occur in exactly the same conditions of preservation as in Shantung.

Only three fossil *Rana* were known so far in China: *Rana hipparionum* Schlosser[1] from Ertemte, Chahar (limb bones), and *Rana nigromaculata* and *R. asiatica* from Locality 3 of Choukoutien (limb bones). Three of them are geologically younger than our form. The stratigraphical distribution of the Chinese fossil *Rana* may be summarized in the following list:—

Pleistocene	*Rana asiatica* Bedriga *Rana nicromaculata* Hallawell Loc. 3, Choukoutien.
Pliocene	*Rana hipparionum* Schlosser. Ertemte.
Miocene	*Rana basaltica* Young. Shanwang.

1 Schlosser, M. 1924. Tertiary Vertebrates from Mongolia. Pal. Sin., Ser. C, Vol. I, Fasc 1, p. 96.

2 Bien, M.N. 1934. On the fossil Pisces, Amphibia and Reptilia from Choukoutien Localities 1 and 3. Pal. Sin., Ser. C, Vol. X, Fasc. 1, p. 12.

Explanation of

Plate I

PLATE I.

Fig. 1 and 1a. *Rana basaltica* Young (sp. nov.). Seen from the original slab. × 2.

Fig. 2. Tadpole in dorsal aspect. × 2.

FOSSIL FISHES FROM THE SHANWANG SERIES OF SHANTUNG*

By C. C. Young (楊鍾健) and T. L. Tchang (張春霖)

(Cenozoic Research Laboratory, National Geological Survey of China and The Fan Memorial Institute of Biology)

For every detail concerning the discovery and the stratigraphy of the rich fossiliferous Shanwang series in E. Linchühsien, we shall refer the reader to the geological report published by one of the authors (C. C. Young) in the Bull. Geol. Soc. China, Vol. XV, p. 171. Be it sufficient to say here that after the fossil flora which amounts to more than one thousand specimens, the fish fauna represents the most important part of the Shanwang collections. The original association of the fish with the plants is absolutely sure, both fish and leaves being occasionally impressed in the same plate of shale[1]. Most of the fishes were collected in the white greyish tuffaceous paper shales. A few of them however have been found in the thicker dark grey marly shale occurring in the lower levels of the paper shales.

Although numerous, the collected specimens represent a small number of forms: four species only (all new), belonging to three genera can be definitely recognised and are described in the present paper. All of them belong to the family Cyprinidæ.

Description of the Species

Family Cyprinidæ

Genus *Leuciscus* Klein

Leuciscus miocenicus Young and Tchang (sp. nov.)
(Pl. I, Fig. 1)

* Received for publication in March 1936.

1 According to earlier information, it was wrongly assumed that the plants were found in Shanwang and fishes in Lingshan, some 5 li N. of Shanwang. Lingshan is also a basaltic hill, but there the basalt lies directly over Cretaceous beds without any trace of the Shanwang series.

This interesting fish is represented by only one individual, impressed in two (positive and negative) plates of shales. The following description is based on the better print.

Length of head (with opercular apparatus) 3 in length of body, depth of body 3⅛ in length of body without caudal; diameter of eye 3½ in length of head; mouth terminal, slightly vertical; operculum large, rectangular in outline; preoperculum smaller than operculum; inter-

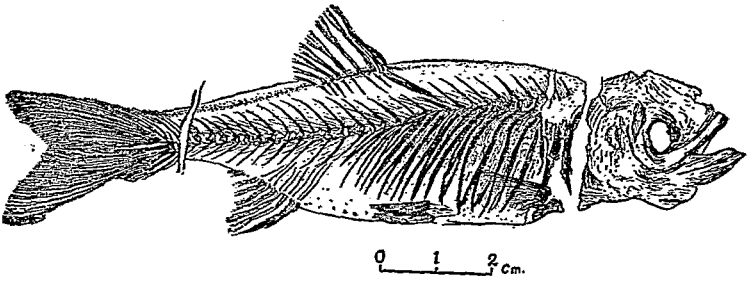

Fig. 1. *Leuciscus miocenicus* Young and Tchang (sp. nov.). Right side aspect. Nat. size.

operculum triangular; vertebræ 34-35 and a hypural at the end; ribs 14 pairs; about 10 interneural spines under dorsal; 9 interhæmal spines about anal; dorsal fin without spines, with 3 simple rays and 7 branched ones, its origin much nearer caudal base than end of snout, behind ventral origin; anal with 3 simple and 8 branched rays, its origin behind dorsal; pectoral fin not reaching ventral; ventral fin not reaching anal; caudal forked, each lobe with 10 longer and 6 shorter rays.

Measurements:

Depth of body before dorsal	30 mm
Total length of body	135 mm
Length of body without caudal	103 mm
Length of head	35 mm
Length of dorsal base	13 mm
Length of anal base	10 mm
Length of pectoral	15 mm
Length of ventral	14 mm
Length of longest ray of caudal	28 mm

The genus *Leuciscus* is now distributed in Kansu, Honan, Shensi, Suiyuan and the Liaoho region, but rarely in Hopei province, and no record exists concerning the presence of this genus in the Shantung area. It is a Paleo- and Neoarctic type.

On account of the geographical isolation and some characteristic features (different head length and body depth) we consider it as a new species for which the name *Leuciscus miocenicus* Young and Tchang (sp. nov.) is proposed, indicating the geological horizon of this interesting fish-bearing series.

Genus *Barbus* Cuv.

Barbus linchüensis Young and Tchang (sp. nov.)

(Pl. I, Fig. 2)

About 16 pieces of young and adult (mostly fragmentary) specimens can be referred to this species. The important characters and descriptions of the best specimen are given below. Unfortunately the original was a little damaged after the picture and sketch were taken.

Anterior part of head broken, posterior part present; depth of body about $2\frac{1}{3}$ in body length, length of head about 2.5-3 in body length without caudal; suborbitals large; preoperculum smaller than

operculum; interoperculum triangular; operculum large, rectangular in outline; diameter of eye 3½ in length of head; lateral line present; 26 scales on lateral line, 5 between dorsal and lateral line and 5 between lateral line and ventral base; vertebræ about 27 in number; interneural spine 14 under dorsal; interhæmal spines 7 above anal; about 14 pairs of ribs; dorsal fin with 11 branched rays and 4 simple ones, the last simple ray strong and serrated; the dorsal origin nearer caudal base than end of snout, before ventral origin; anal fin with 5 branched and 3 simple rays, the last simple one strong and serrated, its origin behind dorsal fin; pectoral not reaching ventral; ventral not reaching anal; caudal deeply forked, each lobe with 10 longer and 6 shorter rays.

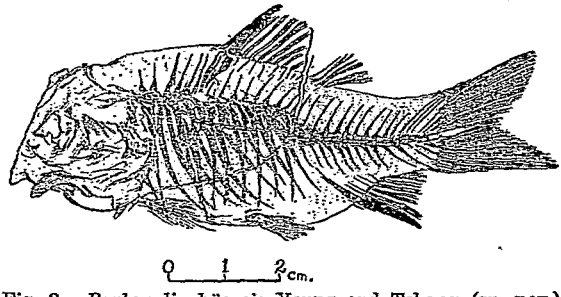

Fig. 2. *Barbus linchüensis* Young and Tchang (sp. nov.). Left side view. Nat. size.

Measurements:

Depth of body before dorsal	32 mm
Length of body from posterior margin of preoperculum to caudal base	58 mm
Depth of head	27 mm
Diameter of eye	9 mm
Length of dorsal base	19 mm
Length of anal base	6 mm
Length of pectoral	13 mm
Length of longest ray of caudal	22 mm

The above mentioned characters (number of dorsal rays and anal spine, etc.) differ remarkably from those of the most closely related forms. We incline to name it *Barbus lingchüensis* (sp. nov.).

Barbus scotti Young and Tchang (sp. nov.)

(Pl. II, Fig. 1)

A second species of this genus is represented by 13 specimens of young and adult individuals, several of them are well preserved. The description based on the best specimen is given as follows:

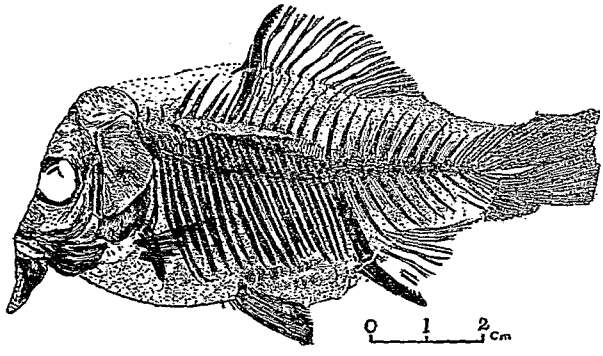

Fig. 3. *Barbus scotti* Young and Tchang (sp. nov.). Left side view. Nat. size.

Anterior part of head and posterior part of caudal fin broken; depth of body about 2 in. length of body, length of head about 3 in. length of body without caudal; diameter of eye about 3½ in. length of head; preoperculum smaller than operculum; operculum large, rectangular in outline and with radial grooves; interoperculum triangular; lateral line present; about 29 scales on lateral line, 5 between it and dorsal, and 5 between it and ventral; interneural spines 12-13; interhæmal spines 6-7;

dorsal fin with 11 branched rays and 4 simple ones, the last simple ray strong and serrated, its origin behind that of the ventral; anal fin with 5 branched and 3 simple rays, the last simple one strong and serrated; caudal deeply forked, each lobe with 10 longer rays and 6 shorter ones; pectoral reaching ventral; ventral not reaching anal.

Measurements:

Depth of body before dorsal	44 mm
Length of body posterior margin of preoperculum to caudal base	70 mm
Diameter of eye	9 mm
Length of dorsal base	21 mm
Length of anal base	8 mm
Length of pectoral	20 mm
Length of ventral	16 mm

Owing to some important characters (number of dorsal rays, anal spine and origin of dorsal, etc.) we consider this also as a new species for which the name *Barbus scotti* Young and Tchang (sp. nov.) is proposed. The species is given in honor of Prof. Scott in Cheeloo University who has helped us very much during our trip in Shantung and sent us a list of the first collection of Shanwang fish, kept in his department.

The distribution of the genus *Barbus* is limited to subtropical and tropical regions of the old continent. In China species of this genus are found in Hangchow, Canton, Yunan, Hainan, Fukien, Chekiang and all along the Yangtze river from Szechuan down to Shanghai, but never north of that region. The record of fossil *Barbus* in Shantung, north of Taishan range, is therefore of great interest, since it indicates some important change of fauna, and consequently of climate since the Miocene time.

Genus *Pseudorasbora* Bleeker

Pseudorasbora macrocephala Young and Tchang (sp. nov.).

(Pl. II, Fig. 2)

This is by far the most common fish found in Shanwang, represented as it is by at least 80, mostly complete specimens. The following description is based on one of the best specimens.

Depth of body 5 in length of body; length of head 3¼ in length of body without caudal fin; mouth vertical; eye large; operculum larger than preoperculum; vertebræ about 34; 14 pairs of ribs; dorsal fin without spinous rays, with 7 branched and 4 simple rays, its origin nearer caudal base than end of snout, opposite to ventral fin; anal with 3 simple and 6 branched rays; pectoral not reaching ventral; ventral not reaching anal; caudal forked.

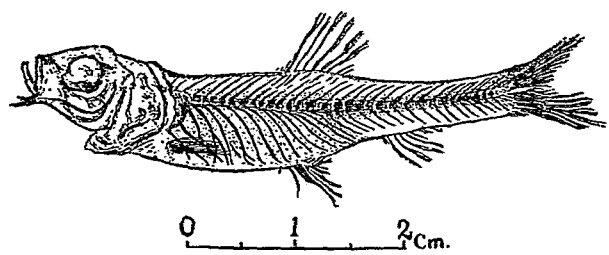

Fig. 4. *Pseudorasbora macrocephala* Young and Tchang (sp. nov.). Left side aspect. × 2.

Measurements:

Length of head	14 mm
Depth of body	9 mm
Total length of body with caudal	54 mm
Length of dorsal base	5 mm
Length of anal base	4 mm
Length of pectoral	9 mm
Length of ventral	6 mm
Length of longest ray of caudal	8 mm

For this species which is mainly characterized by its comparatively large head the name *Pseudorasbora macrocephala* Young and Tchang (sp. nov.) is proposed.

The genus *Pseudorasbora* is commonly found both in N. and S. China, also in Japan.

Summary. All the described four species are new on account of the differences mentioned above. With exception of the last named genus, the other two genera seem to be absent in Shantung now, and may be regarded as extinct at least from the Shantung area. The fish fauna of Shanwang therefore affords some new data concerning the zoogeographical distribution of this group and the climate of that time.

A Summary of Cenozoic Fossil Fishes in China

Up to a recent date, fish remains were rare in China. Even in many cases, for instance in Ertemte and in the Nihowan beds of Sanmen, etc., they were only known by fragments of teeth and vertebræ. In *Tailcu (Carassius auratus)* and in Mongolia, *(Pappichthys mongoliensis* and *Rhineastes grangeri)* they were however better represented. Recently only a very rich fish fauna was discovered from a fissure in Choukoutien, which is now under study. A stratigraphic distribution with geographical remarks of the fish remains of China is summarized in the following table:—

Pleistocene	*Ctenopharyngodon idellus* Cuv. and Valen., Loc. 3, Choukoutien. Bien[1].
Pliocene	*Cyprinus* sp. *Ctenopharyngodon* sp. *Hypophthalmichthys* sp. } Sanmen. Bien.[2] *Carassius auratus* L. Taiku[3]. Cyprinid indet. Ertemte[4]. *Barbus szechuanensis* Tchang[5]. *Barbus brevicephalus* Chang sp. nov. } Loc. 14, Choukoutien.
Miocene	*Leuciscus miocenicus* Young and Tchang *Barbus linchüensis* Young and Tchang *Barbus scotti* Young and Tchang *Pseudorasbora mærocephala* Young & Tchang *Rhineastes grangeri* Hussakof (Tungur)[6] } Shanwang.
Eocene	*Pappichthys mongoliensis* Hussakof[6] *Catostomus* sp. Cyprinid vertebræ } Shara murum *Pappichthys mongoliensis* Hussakof (Ulan Shireh)[6] *P.* ? *mongoliensis* (Indin manha)
	With exception of *Pappichthys* which is a genus of Amiidæ, all the other fishes belong to *Cyprinidæ*. From the Pliocene on no difference seems to exist between the fossil and living species.

1 Bien, M. N. On the fossil Pisces. Amphibia and Reptilia from Choukoutien Localities 1 and 3. Pal. Sin., Ser. C. Vol. X, Fasc. 1.

2 Bien, M. N. Cenozoic Deposits of the lower Huangho valley. Bull. Geol. Soc. China, Vol. XIII. p. 441.

3 Tchang, T. L. Notes on a fossil fish from Shangsi. Bull. Geol. Soc. China, Vol. XII, p. 467.

4 Schlosser, M. Tertiary Vertebrates from Mongolia. Pal. Sin., Ser. C, Vol. I, Fasc. 1, 1924, p. 97.

5 Personal communication of Prof. H. C. Chang.

6 Hussakof, L. Fossil fishes collected by the Central Asiatic Expeditions. Amer. Mus. Nov., No. 553, 1932.

SOME NEW OBSERVATIONS ON THE CENOZOIC GEOLOGY NEAR PEIPING*

By C. C. Young (楊鍾健) and M. N. Bien (卞美年)

(Cenozoic Laboratory of the Geological Survey of China)

Our knowledge in the past few years concerning the general geology of the Western Hills has been greatly improved. A detailed report with geological maps is now being prepared by the members of the Geological Survey of China. Regarding the Cenozoic geology however, very little has been added to our knowledge of this area, although there are many important problems that have to be solved.

Recently, some interesting facts regarding the Cenozoic history in the mentioned area have been gathered by the authors of the present paper. Some fossil remains similar to the Choukoutien fossiliferous deposits were also collected by the technicians of the Cenozoic Laboratory. In the following lines we shall try to summarize our observations and hope to throw some light on the discussion of the Cenozoic physiography and the late Tertiary deposits in the vicinity of Peiping.

1. The High Gravel Deposit of Chaoyangtung, Shangfangshan, Fangshanhsien

About 40 li W.S.W. of Choukoutien, there is a famous and picturesque place called Shangfangshan. The beauty of the landscape there is mainly due to a quite young topography which is caused by a later dissection. The old worn mature surface represented by smooth peaks and gentle slopes and easily reconstructable mature valley is still recognizable. The old land surface can therefore be reconstructed by connecting those smooth valleys and slopes. On the dissected side, there are numerous caves among which the largest and famous cave Yungshuitung (雲水洞) is composed of at least seven chambers and more than 1

* Received for publication in February 1936.

kilometer long. We have also prospected at least ten other caves in this area. All of them are partly covered by old and recent stalagmites but none of them contains any real deposits except Chaoyangtung (朝陽洞).

The Chaoyangtung is situated about half way from Toushuissu to Yungshuitung on the southern side of the high pillar-like peak so clearly seen from the temple. This is the highest cave we have visited in the area: about 800 m. above the Hopei plain and 300 m. above the nearest valley bottom. Its dimensions are small: about 3 m. wide, 4 m. long, and 3.5 m. high (there is apparently an artificially excavated part at the end). But a most interesting feature is that, sticking to both lateral walls and in the deepest parts of the cave, patches of well rounded, true river-gravels, and sands, are still preserved. The largest pebbles of this moderately cemented conglomerate reach the size of an apple: mostly limestone with a few quartzite, associated with fragments of quartz. This gravel deposit, curiously similar lithologically to the "Upper gravel" of Choukoutien[1], represents evidently the residual part of an old filling which was subjected to dissection before the deposition of younger sediments also observable on the floor of the cave.

These later deposits, rather loose, consist of a reddish to yellow grey loam, mixed with limestone fragments. They are about 70 cm thick, and contain a few, poorly mineralized fossils, such as a foot bone of deer and other less determinable pieces. Evidently it is a much younger formation than the conglomerate, and represents a product of subaerial sedimentation.

Significance of the Chaoyangtung gravels. The above described gravel surely has no relation with the recent drainage, firstly because the site is at least 300 m. higher than the adjacent valley bottom, and secondly because most of the boulders and gravels of the present valley are large and subangular. It is also impossible to imagine that some pebbles might have been rolled along the slopes and secon-

1 Black, Teilhard, Young and Pei, 1933. Fossil Man in China. Mem. Geol. Surv. China, Ser. A, No. 11, and Teilhard and Pei, New discoveries in Choukoutien 1933-34. Bull. Geol. Soc. China, Vol. XII, No. 3, P. 370.

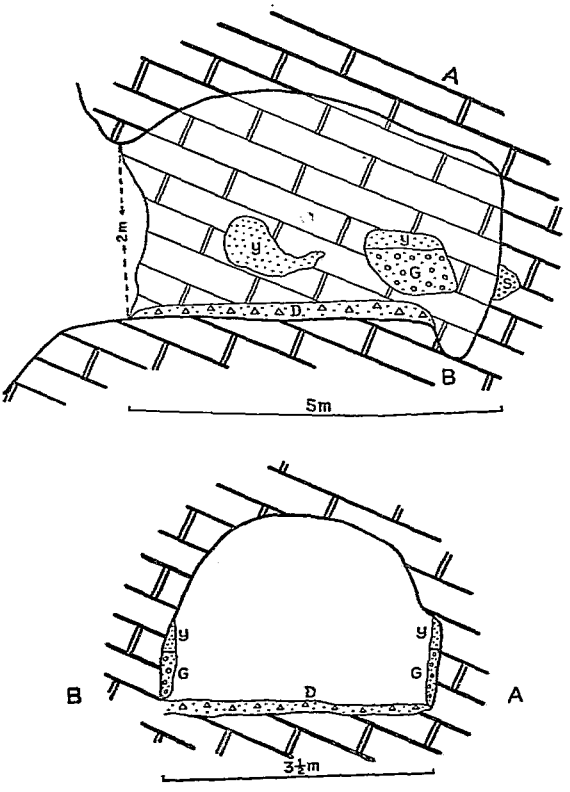

Fig. 1. Longitudinal (above) and transversal section of the Chaoyang-tung. D. débris, G. gravels, S. sands, Y. yellow and grayish later deposits. A-B. shows the relative position from where the transversal cross-section has been taken.

darily accumulated in the cave. The only sound explanation is that the gravel was deposited in the cave at the time when the old mature surface was not yet dissected by the steep modern valleys. They represent a feature belonging at least to the Tanghsien topography. Consequently they are at least Pliocene.

Correlation with the Upper Gravels of Choukoutien. As stated above, the Chaoyangtung conglomerate curiously has the same characters (composition, coloration, consolidation...) as the Upper Conglomerates of Choukoutien. At an elevation of 800 m., we find in this cave an

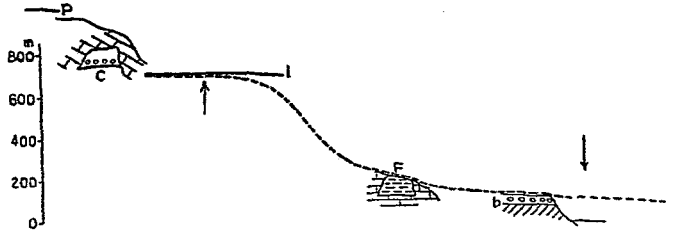

Fig. 2. An ideal sketch showing the relative position of the Chaoyangtung gravels (C), Fish pocket of Choukoutien (F) and the boulders at the top of the low ridges at the foot of the Western Hills (b). The elevation is indicated in meters at the left side. P. Peitai Summits, i. the supposed intermediate physiographical stage. The dotted line with arrows showing the warping of the old Tanghsien surface.

exact duplication of the conditions so often recorded in the foothills of the Hsishan (Choukoutien, Mentoukou valley, etc.): a sub-aerial fissure deposit succeeding to a water-laid deposit[1].

A rather bold hypothesis is therefore suggested by the facts, namely that all these fissure gravel-deposits, either found at 70 m. (Choukoutien), or at 100 m. (Mentoukou valley), or at 800 m. (Chaoyangtung), belong to the same and single sheet, more or less disrupted by later fault movements. In which case, a differential movement of several

1 Black, Teilhard, Young and Pei, 1933. Fossil Man in China. Mem. Geol. Surv. China, Ser. A, No. 11.

hundred meters (due probably to a sinking of the plain) should have happened, along the Western Hills, *as recently as in the middle or at the end of Pliocene*[1].

As a more conservative (but, we think, less probable) alternative interpretation of the facts is that it might be admitted that the Chaoyangtung gravels are older than the Choukoutien Upper gravels, and that they were already in existence and already uplifted some 700 meters over the Choukoutien Hills, when those were still under the floods responsible for the deposition of their high gravels (and Fish-bearing sands). In such a case, their age would be pre-Pliocene (Oligocene or Eocene).

2. The Boulders Capping the Fore-hills of Hsishan

Along the foot of Hsishan, especially in the Touli-Changsintien area, several low ridges of tilted Upper Cretaceous and Lower Tertiary

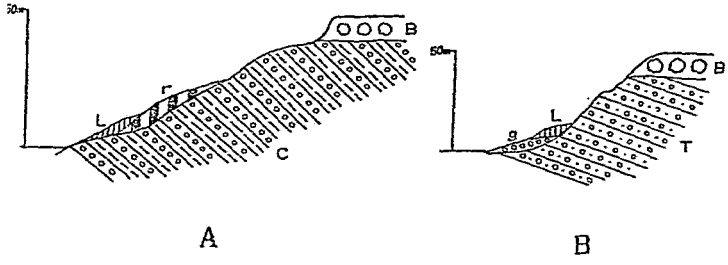

Fig. 3. A. section near Touli and B. near Changsintien, showing the boulder and gravels at the top ridge of the low hills. C. Tiaochishan Series (Cretaceous), T. Changsintien gravels, B. boulders, r. reddish loam, g. gravels, L. loess.

1 This assumption would fit remarkably with the results of a recent boring in Tientsin, showing that the Hopei plain has been sinking more than 800 meters in the course of the Pleistocene and also with traces of folding observed in the sediments of the Fishpocket of Choukoutien.

beds emerge over the plain[1]. These ridges run 30-50 meters above the river beds which separate them presently. And yet on their top, well rounded boulders are frequently observed. These boulders, evidently derived from the closely seated mass of Hsishan (limestone, quartzite, sandstone), are variable in size. The largest of them reach 1-2 feet in diameter. But more usually they are of the size of a human head. And they even occur eventually associated with smaller pebbles. How are we to explain the presence of such blocks in such an elevated position?

The only possible interpretation is to admit that we are dealing here with the remains of an old fan originally deposited over an erosional surface formerly connecting the summits of the present ridges. The dissection of this fan surely took place before the "Choukoutien times" (Lower Pleistocene, in the sense this term is used so far by the Geological Survey), since red clays of a Choukoutien type occur along the flanks of the ridges. The deposition of the boulders has therefore to be regarded as at least Sanmenian (or earlier in the Pliocene), so that the formation is probably roughly contemporaneous with the Upper gravels of Choukoutien (and consequently also perhaps with the cave-conglomerate of Chaoyangtung). Concerning the age of the underlying erosional plain, nothing can be positively suggested, since there is no sediment left on it establishing, for instance, that this surface represents the post-Miocene surface of the Tanghsien stage.

3. New Fossiliferous Fissure-deposits in Hsishan

In the course of the past year several new fissure-deposits have been located and briefly investigated in the Western Hills by the technicians of the Cenozoic Laboratory (one of them, near Huiyu, seems to have been known by Dr. Andersson). The main results of this survey are as follows:

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1 Hsieh, C. Y. Note on the geology of Changsintien-Touli area, S. W. of Peiping. Bull. Geol. Soc. China, Vol. XII, P. 513.
cf. Young C. C. A Review of the Early Tertiary Formation of China. Ibid., Vol. XIII. P. 4

a. HUIYU AREA

Huiyu, some 10 lis west of Sanchiatien (near Mentoukou), is an important center of limequarries, in Ordovician limestone. In this area four sites at least have been discovered.

1. Hokou (後溝), some 2 lis west of Huiyu. Fissures filled with red clay and breccia. Specimens recovered:

Moschus moschiferus var. *pekinensis* Young. A left lower jaw with milk dentition and a few isolated teeth.

?Hydropotes sp.. A right jaw, a few isolated teeth and several broken limb-bones.

Cricetinus varians Zdansky. Fragments of skull and some lower jaws.

Mus sp. Two lower jaws.

Bufo sp. The distal end of a tibio-fibula.

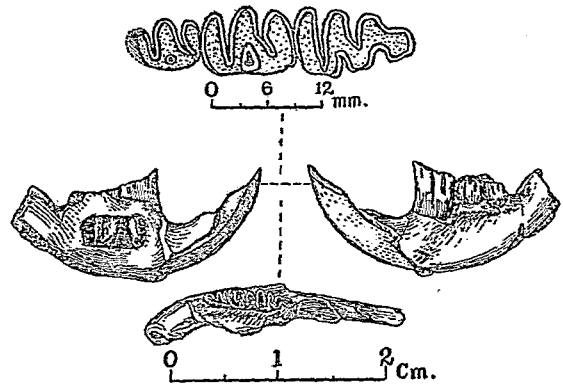

Fig. 4. *Prosiphneus* cf. *sinensis* Teilhard and Young. Right lower jaw found at Hokou, near Huiyü. × 2.

In addition to these fossils of a clear Choukoutien type, most surprisingly a well preserved lower jaw of *Prosiphneus* cf. *sinensis* T.

and Y. of a typical Pontian form (text-fig. 4) was collected. On the specimen the three molars are clearly rooted, and the shape of the crown perfectly recognisable.

Pending further examination of the site, we suspect that this specimen was not collected in the brecciated pockets containing the bulk of the fauna, but in one of the much older *gravel-pockets* which (according to our own previous observations) are frequently found in the Huiyu quarries, cut by the later brecciated pockets, at a level of some 100 meters above the present Hunho. If so, the fossil would turn to be an important evidence for dating these gravel-pockets, and consequently the entirely similar gravel-pockets, and "Upper gravels" of Choukoutien[1].

2. Hsinglungshan (興隆山), about one li S. of Huiyu, fossils were found in a fissure deposit composed mainly of hard breccia.

Carnivora indet. Some phalanges of rather large carnivora.
Sus sp. Some isolated teeth.
Pseudaxis sp. Teeth only.
Hystrix sp. One lower P_4.

No characteristic form can be recognized from this locality. It belongs most probably to the same horizon as Loc. 1 of Choukoutien.

3. Shanshenmiao (山神廟), about 2 lis S. E. of Huiyu.

Limbs of Chiroptera.

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1 As a possible consequence of the presence of *Prosiphneus sinensis* in the gravel-pockets of Huiyu if we may be forced to regard the gravel-pocket of Locality 12 of Choukoutien (cf. Teilhard and Pei, Bull. Geol. Soc. China, Vol. XII, p. 370) as older than we thought: Pontian instead of Sanmenian. But it is possible also that the gravel-pockets of the Hopei border represent many different stages of the Pliocene erosions, for instance:

Final Pliocene (Sanmenian)..... Locality 12 of Choukoutien.
Middle Pliocene.... Gravel pocket of Tangshan, with *Prosiphneus intermedius* T. and Y. (cf. Pei, Bull. Geol. Soc. China, Vol. IX, p. 371).
Lower Pliocene (Pontian)..... Huiyu pocket with *Prosiphneus sinensis* and Fish pocket of Choukoutien.

Sus sp. One broken metacarpal.
Fragments of jaw of undeterminable rodents.

Lepus sp. A broken skull. Much shorter and smaller than the skull I have described from Huiyu but the size of the teeth is about the same. The crowns of the teeth are somewhat damaged to permit a detailed description.

4. Chiunchuang (軍莊), about 3 lis S.W. of Huiyu, one cave containing deposits of red clay.

Ursus sp. A lower molar.
Hyæna indet. An upper incisor.
Rhinoceros sp. Broken teeth.

Pseudaxis cf. *grayi* Zdansky. Represented by one skull fragment with the antler fairly well preserved, the right side being nearly complete. The main beam is not directed sideward as much as in the typical *Pseudaxis grayi;* but the middle tine is situated close to the upper fork of the antler just as in the above mentioned species. The size is somewhat smaller. In many respects, (size, relative position of the middle tine) the antler looks very much like a *Pseudaxis* antler recovered from Loc. 13 of Choukoutien. A full comparison will be made when the remains of the latter locality are described. Besides the antler several upper and lower jaws, isolated teeth and fragments of limb-bones were recovered referable to the same species. Some teeth considerably larger in size indicate the possible presence of a second species of deer.

b. TAHUICHANG AREA

Also a big lime center near Peiping. Many caves and fissures, (fossiliferous and unfossiliferous) are exposed by the quarrying work, two of which only are worth mentioning:

1. Taoyao (道窯), about 5 lis N.W. of Tahuichang. A fissure deposit of breccia and red clay. Only some close undeterminable teeth and limb-bones of *Pseudaxis* were recovered.

2. Shihfotsun (石佛村), about 6 lis N.W. of Tahuichang. A fissure deposit composed of red clay and sands.

Chiroptera. Represented by at least two species, *?Hesperopternus* (lower jaws) and *Myotis* (skull fragments).

Ursus augustidens Zdansky. A lower M_1.

Martes sp. A right lower jaw. (fig. 5.)

Hydropotes sp.

Phasianus sp. a.

Phasianus sp. b.

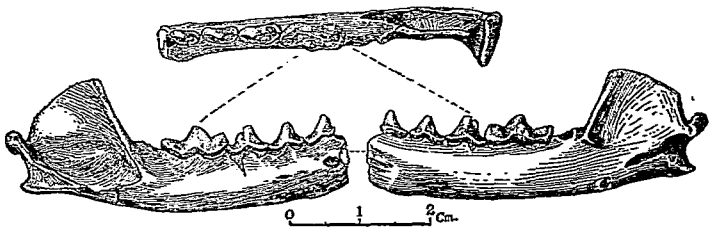

Fig. 5. *Martes sp.* Right lower jaw from Shihfotsun. Slightly enlarged.

The matrix of this locality is decidedly more sandy and the fossils are highly fossilized. Although no characterized form was found, it is however possible that this site may represent a somewhat older age.

On the whole, all these recent observations made in the Ordovician areas along the foot of the Western Hills point to a mere extension of the conditions found in the Choukoutien area: same types of fissures, and the same complicated succession in their age.

A MONGOLIAN AMBLYPOD IN THE RED BEDS OF ICHANG, (HUPEH)*

By P. Teilhard de Chardin and C. C. Young (楊鍾健)

(Cenozoic Laboratory of the Geological Survey)

In 1934, a bone bed was located by the authors of the present note in the sandstone immediately overlying the lacustrine limestone of Yangchi, near Ichang (see Teilhard and Young, 1935, fig. 1). At the beginning of 1936 Mr. L. P. Chia of the Cenozoic Laboratory was sent to investigate more carefully the locality. And the result of his research was the unexpected find of the large part of a skull of *Eudinoceras* (*Eudinoceras* cf. *kholobolchiensis* Osb. & Granger), a typical Upper Eocene form of Mongolia.

The double aim of this note is to give a description of the specimen, and to insist on the geological consequences of the discovery.

1. Description of the Fossil

Apparently the skull found by Mr. Chia was originally complete in the sediments. But it has been more than half destroyed by the water of the Yangtze. The remaining part includes the left side of the muzzle, the left orbit, a portion of the temporal fossa, and the complete zygomatic arch up to the mastoid apophysis. Two incisors (I1 and I2), sticking to a fragment of premaxillary, the canine, and a damaged upper molar (displaced from its alveolus) are preserved. To the same animal belong surely a lower P2, and probably an atlas. A lower canine was found at some distance, and represents another individual.

Skull (s. fig. 1)

Muzzle Carnivore-like, with a strong maxillary boss, and a marked nasal boss, above the canine. Sutures of the nasal bones indistinct backward. Jugal extending as far as up to the half of the zygoma. A prominent lachrymal tubercle on margin of orbit which is rather small,

* Received for publication in March 1936.

(but not so shallow, it seems, as in *Eudinoceras kholobolchiensis*). Probably no post-orbital process on the frontal side, and surely not on the jugal side.

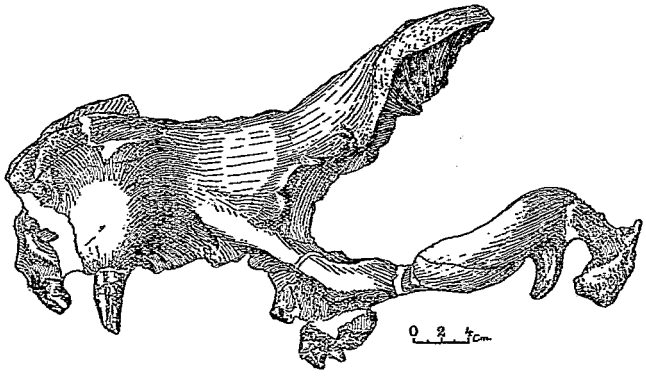

Fig. 1.—*Eudinoceras* cf. *kholobolchiensis* Osb. & Gr. Left side of the skull. Reduced to a fourth. The molar is displaced in the matrix from its natural place.

TEETH (s. fig. 2)

Two first incisors strong, spatulated (very much like the one in Osb. and Granger, 1932, fig. 4), set a distance apart from each other.

Upper canine moderately strong (female individual?), straight, square-angled, flattened antero-posteriorly (very much as in Osb. and Granger, 1932, fig. 2).

Upper molar (M2?) rather broken, but sufficiently preserved for showing the characteristic *transverse* crests of the crown.

Lower P2 of a typical *Coryphodon* type: elongated, and with a well indicated trigonid.

Lower canine strong, square in section, too much worn for a detailed description. Possibly from a male individual.

ATLAS (s. fig. 3)

Disformed by compression. The lateral wings are mostly broken but seem to have been rather narrow. Anterior margin tunnelled (and not notched) for the passage of the nerve. Articular surface for epistropheus broad (50 mm.) and shallow.

Maximum breadth of distal articulation surface, 150 mm.

Maximum breadth of articulation with the condyles, 140 mm.

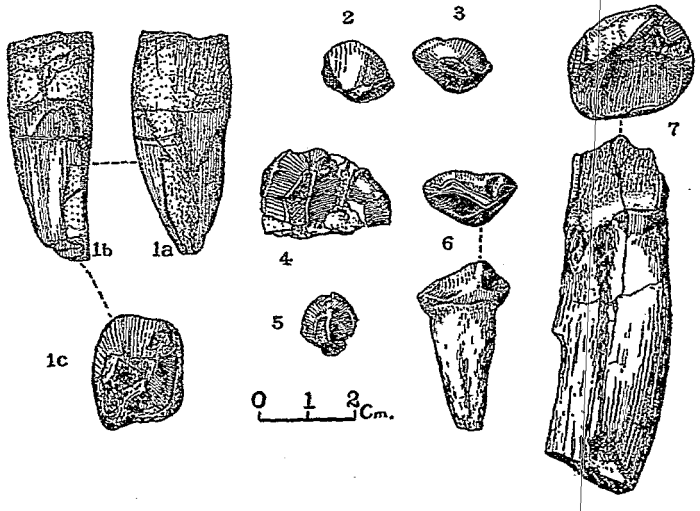

Fig. 2.—*Eudinoceras* cf. *kholobolchiensis*. *1a*, upper canine, posterior view. *1b*, id. external view. *1c*, id. top view. *2*, and *3* first and second upper incisor, top view; the two teeth are illustrated as they are set in natural distance on the premaxillary. *4*, a broken left molar (external half of crown). *5*, a fragment of the same (or of another) molar. *6*, lower right P2, external and top views. *7*, lower left canine, internal and top views. Slightly reduced.

DIMENSIONS

	Eudinoceras from Yangchi	*Eudinoceras kholobolchiensis*[1]
Length from the mastoid process (posterior margin) to the canine (anterior margin)	395	400 mm.
Length between the lachrymal tubercle (posterior margin) to the canine (anterior margin)	160	157
Maximum height of the orbit	68	48?
Height of I1 and I2 (crown)	11 & 11	
Length of I1 and I2 (from side to side)	13 & 17	
Thickness of I1 and I2 (antero-posterior)	13 & 11	
Height of lower canine (crown)	33	
Length (antero-posterior)	17	
Breadth (transversal)	22	
Length of molar	25	30?
Length and breadth of lower P2	19 & 11	
Length and breadth of lower canine	23 & 19	

COMPARISONS

By its main characters (shape of the skull, dentition, etc.) the above described specimen is most evidently an Amblypod, differing sharply from the Oligocene *Hypercoryphodon* (see Osb. & Granger 1932) by its short skull, humped muzzle and two-crested molars, but otherwise practically identical (even in size) with *Eudinoceras kholobolchiensis* Osb. & Granger 1931, found by the American Expedition in the Upper Eocene of Western Gobi.

1 The dimensions of *E. kholobolchiensis* are approximative, being measured on the figures given by Osborn and Granger.

We shall therefore refer it to this latter species, although it might happen that the shape of the upper premolars when known may prove that the Yangchi form in reality belongs to another Mongolian Upper Eocene species, *E. mongoliensis* Osborn 1924 (cf. Osborn & Granger 1931), the skull of which is still unknown, or even to a new species.

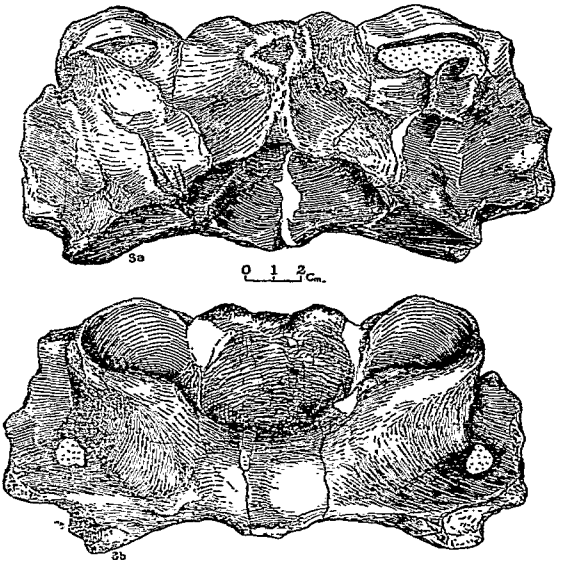

Fig. 3.—*Eudinoceras* cf. *kholobolchiensis* (?). Atlas, *a*, from above, and *b*, from below. Reduced a half.

2. Geological Conclusions

a) The discovery of an *Eudinoceras* near Ichang confirms definitely the Cenozoic age of the Upper Red Beds of W. Hupeh, and places them in the Upper Eocene (Irdin Manha of Mongolia). The same conclusion had been reached already for the Hsichuan beds of SW. Honan

(Teilhard, 1930) basing on the presence of another Upper Eocene form of Mongolia (Irdin Manha), *Lophioletes* sp.

b) In the case of Ichang, this demonstration of the Upper Eocene age of the Red Beds is evidently restricted to the horizons found *above* the second (or upper) conglomerate (see Teilh. and Young, 1935, fig. 1). The underlying sandstone and first (or lower) conglomerate may still be (and probably are in fact) Upper Cretaceous.

c) In case that the tooth found in the Red Beds of Changsintien near Peking really belongs to an Amblypod (see Young, 1934, fig. 4), this order of mammals would prove to have been largely distributed over China in Early Cenozoic times.

d) In any way, the fact that the two only mammals so far known in the Red Beds of Central China are both Mongolian forms indicates with some probability that, at the end of the Eocene, the Tsinling were largely levelled down (by the strong erosion responsible for the deposition of their Early Tertiary conglomerates)—and that *a single*, probably swampy, *peneplain* extended itself from the Western Gobi down to the present Yangtze basin.

e) Further more, since the Ichang Upper Red Beds suggest a lake-deposit, and in addition are decidedly tilted, there is a strong presumption that the Yangtze was not yet existing as a river, under its present form at the end of Eocene, but that its modern route East of the Gorges has been opened during the Upper Cenozoic. The present drainage of the Yangtze has to be connected with a deep rejuvenation of the Eocene topography.

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THE CHENGTU CLAYS— DEPOSITS OF POSSIBLE LOESSIAL ORIGIN IN WESTERN AND NORTHWESTERN SZECHUAN BASIN*

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and

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Introduction

Heim and Bowles (2)[1] have described the occurrence of loessial deposits in the mountain valleys and on the high plateaus northwest of Tachienlu, in the region commonly known as the Tibetan Borderland; but so far as we know, no-one has reported any loessial material within the Szechuan Basin proper. We are not yet prepared to report such deposits with complete assurance, but we have collected data which seem to us strongly indicative that they exist and that they are distributed intermittently over a wide area in the western and northwestern parts of the Basin.

During the autumn of 1935 we spent a few days studying these deposits together. Dye had previously observed them in a number of places over a period of many years, and had been puzzled as to the explanation of their probable origin. We therefore made a special effort to study them in the light of modern soil science with the hope of find-

* Received for publication in March 1936.

1 From the account of Bowles it seems that J. H. Edgar F.R.A.J., of the China Inland Mission has known of these deposits for many years and it was he who first called attention of scientists to them.

ing a satisfactory solution to the problem of their genesis. This paper is the result of our preliminary studies.[1]

The investigation was carried out concurrently with the study of the broader soil groups of the region between Chengtu and Mienyang. We wish to acknowledge the helpful cooperation and assistance of Dr. C. Y. Tschau and Mr. L. T. Chu of the Soils Division of the National Geological Survey of China, who accompanied us while most of the work was being done.

Physiographic Background

In the term "Szechuan Basin" we mean to include that great region of rolling hills and low mountain ranges which extends from near Wushan on the east, to Kuanhsien and Yachow on the west, and from the high mountains of the Kansu and Shensi borders of Szechuan on the north, to the mountain ranges which mark the borders of Hupeh, Kweichow and Yunnan on the south. The great heights of the Tibetan borderlands make a somewhat sharper line of demarkation of the limits of the Basin than the comparatively lower ranges which flank the other side. The structure of the Basin has already been described by many other writers and there is no object in going into lengthy reviews of these works. In a conversation, on one occasion, Dr. V. K. Ting described the Szechuan Basin as a synclinorium with broad synclines and short sharp anticlines superimposed on a great syncline. These anticlines and synclines extend in a roughly northeast-southwest direction, and toward the east, the remnants of the short, steep anticlines form low mountain ridges which tower above the rolling hill lands of the synclinal troughs and minor anticlines.

The famous Chengtu plain, which has also been described by many writers and lecturers, lies in western Szechuan Basin, between a low range of mountains, known as the Lungts'üani hills (龍泉驛山)

1 Following the suggestion of Prof. A. W. Grabau, we are proposing the name "Chengtu Clays" for these materials of probable wind-blown origin.

and the eastern edge of the Tibetan Borderlands. Dye has described this plain elsewhere (3), bringing out the fact that it is a complex, intermontane alluvial fan which is still in the process of aggradation. The southern part of the plain is being watered and built up by the distributaries of the Min River (岷江), while the northern part receives contributions of water and silt from several smaller rivers such as the Ts'ingshuiho (清水河), Pêyuho (白魚河) and Shihtingho (石亭河) which flow out from the western mountains.

In many places—more notably north, east and southeast of Chengtu city—the plain is interrupted by an older topography of undulations and low hills. The higher of these hills, such as those 15 or 20 li north of the capital city, are made up of reddish purple, tilted shales and sandstones of probable Cretaceous age, capped by a deposit of strongly waterworn quartzite cobble stones of much more recent deposition. These cobble-capped hills reach a height of 60 meters or more[1] above the general level of the plain (unfortunately no barometric readings were obtained for these hills), and are obviously remnants of a former peneplain, the geologic age of which can only be fixed by careful study. Flanking these hills on the north are lower, flat-topped hills which perhaps have a common altitude of 30 or 40 meters above the plain. The still lower hills and undulations seem to represent another peneplain stage which probably immediately preceded the present epoch of fan building.

Farther north—between Lochiang and Mienyanghsien cities, it is possible to trace 5 fairly distinct stages of peneplanation and terrace development—these stages being the most noticeable near the larger rivers, where terrace remnants give a clue to the physiographic history. In riding by motor car from Chengtu to Mienyang, these stages were observed and their relationships with the possible loess deposits were so striking that it was decided to make barometric determinations of the respective relative altitudes of the different terrace remnants and hilltops which represent the different stages. A profile of the road with repre-

1 Barbour estimates the height of these hills to be 30 to 60 meters above the Chengtu plain (Mem. Geol. Surv. China, Series A, No. 14, p. 38).

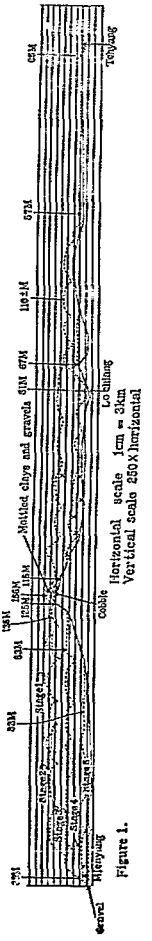

Figure 1.

Figure 1. The solid line is an approximate profile of the road between Mienyang and Tehyang. The total distance, including curves, is 67 Km. between these cities. The vertical scale is 250 times the horizontal scale. × marks indicate the known areas of probable loessial material. The numbers indicate the heights in meters of various places above Mienyang city. Dotted lines indicate the different physiographic stages of peneplanation and terrace building.

sentations of terrace and peneplain remnants is shown in Figure 1. It is unfortunate that we have barometer readings for only one direction along the road. We are thus unable to make corrections for local barometric variations which may have interfered with the accuracy of the work but these readings have been corrected for the barometer variations at Chengtu for the same day and are probably not far wrong. In spite of deficiencies we believe the results to be reasonably good, since the 5 stages of development were observed and recorded within two or three hours' time between Mienyang and the highest hills between that city and Lochiang.

In the profile (Fig. 1) the highest hills (Stage 1) represent the oldest peneplanation stage of the region examined. The only hill of this stage examined was capped by a cobble and clay deposit of a maximum thickness of 41 meters. The cobble horizon lay directly on eroded, nearly horizontally bedded, purplish red to reddish purple shales and sandstones. It has a variable thickness up to 15 or 20 meters and is overlain by 20 meters or more of yellow and red reticulately mottled clays with some layers of gravel (SeeFig. 2 B).

The color of this material is due to soil-forming processes which have been acting over a long period of time. This old soil belongs to a group which has been called "podzolized red earths" (7) in other parts of China; and perhaps part of it might be assigned to the "yellow earth" group of Europe and the United States. (This yellow earth is not to be confused with the "huang-tu" or North China loess, which is an altogether different thing).

There are relatively few of the highest hills of Stage 1 in the region, and we do not know whether the others are similarly capped with cobble and reticulate clays, but it is altogether reasonable to suppose that at least some of them have such caps.

Stage 2 is represented by a large number of more or less flat-topped ridges of very wide extent and must represent a very long period of erosion during which peneplain No. 1 was largely cut away. It will be readily seen from the profile that this second stage was at least partly developed on the older cobble layer but we do not know to what extent this is true. It is quite probable that sandstone shelves may mark some of the hilltops of this stage.

The hills of Stage 3 occur along the larger rivers and their tributaries and do not extend far back into the higher hills. Some of these terrace remnants are capped by cobbles and clay inherited from Stages 1 and 2, and some are rock terraces of sandstone, left behind when the rivers cut their way down into deeper strata.

Stages 4 and 5 are clear-cut river terraces but are also very restricted in area as in the case of Stage 3. Similarly with Stage 3, also, they are partly made up of inherited and reworked cobble deposits and partly of rock terraces. The latter are especially common in the Mienyang-Lochiang region because of the nearly horizontal position of the purplish red sandstone and shale bedrocks.

The river valleys near Mienyang are rather narrow, although, including the alluvial fans along their sides, they sometimes reach a width of more than a mile. The side streams bring in more material than the

rivers can remove and so the valleys are bordered by gently sloping fan deposits. There are narrow flood plains along the larger rivers which are occasionally flooded during heavy rains. In general, however, these rivers seem to be gradually entrenching themselves.

On the other hand, the Chengtu plain is being built up, at varying rates in different parts, rather than being cut down. Near Chengtu, Dye (3) estimates that the land surface has been built up at the rate of 6 inches (15 cm.) a century during the past 3,000 years, more or less. In the field we found indications that this rate of accumulation will probably not hold good for all the plain, but that the rate of alluviation varies considerably in different parts. There can be no doubt, however, that the plain is being built up an amazing rate of speed if we think in terms of geological time.

Even on a hasty journey through Szechuan it is easy to observe that a similar series of physiographic stages is traceable in nearly all parts of the Basin. From very imperfect observations along the motor road between Chungking and the Kweichow border, it would seem that still older peneplain remnants exist, and that more stages of physiographic development are represented than we have the time and the space to describe here. These conditions have been discussed in Barbour's Memoir (1).

The Deposits of Possible Loessial Origin (Chengtu Clays)

We have devoted several pages to the discussion of the physiographic background in order to make clear our reasons for believing that the deposits we wish to discuss are very probably of loessial (i.e. wind-blown dust) origin. We believe many of our readers will agree that such an explanation is the most reasonable one to fit the case; but we must caution ourselves and our readers that only a part of the field has been explored and that future investigations in other parts of the Basin may prove that some other explanation is more probably correct.

At the present time the Chengtu clays essentially comprise a subsoil of brownish yellow to grayish yellow sticky and plastic clay which

contains lime concretions of *"shachiang"*[1] and "loess puppet" types. The surface varies in color from dark or very dark brown on the unirrigated areas to yellow-brown on the eroded hillsides. The reaction of the surface soil varies from moderately acid to neutral, while that of the brownish yellow subsoil is usually neutral or only slightly acid. The lime concretions occur at the surface on eroded spots, but in only slightly disturbed areas are usually more than 3/4 meter from the surface. At Mienyang, on the river terrace (Stage 4), they occur throughout the deposit to a depth of 12 or 15 meters where there is contact with the old river cobble deposit (See Fig. 2-A).

These lime concretions apparently formed as the result of the working of soil forming processes in which lime was leached from near the surface and deposited in the subsoil. The confusing part about such an explanation is that it is not usual to find "pedocal" soils of this sort in a region of such a humid climate as that which prevails in these parts. This confusion disappears, however, when we carefully study the lime concretions and the soil surrounding them. We find that the soils, as we have already stated, are usually slightly acid, and all of the free lime which one normally finds distributed through the subsoil of a pedocal, has been leached away, and one can get effervescence with acid only in the concretions themselves—or sometimes in the cracks of the deeper subsoils. The pitted condition of many of the concretions shows that they are now in the process of being dissolved. In all probability they would have disappeared long ago were it not for the fact that the material around them is a heavy, sticky clay which becomes almost impermeable to water when it has once become thoroughly wet. This has protected the concretions from dissolution for a long period of time.

1 *"Shachiang"* is a term applied to lime concretions found in certain soils of northern Anhwei Province. These concretions are locally known by this name because of their resemblance to ginger roots. A literal translation of the word is "sand ginger". Shaw (5) used the term as a name for the soils in which these concretions are found, using the spelling "sajong". Our orthography conforms to the Wade system of romanization.

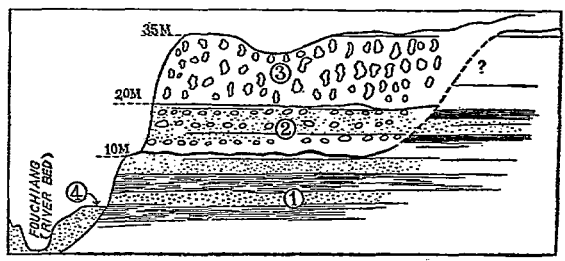

Fig. 2 A

Fig. 2-A. Rough cross section of terrace at Mienyang, looking southward. 1 is nearly horizontal Cretaceous (?) purplish sandstones and shales. 2 Gravel and sand strata. 3 "Chengtu Clays", of probable loessial origin, and containing "loess puppet" lime concretions. No gravel. 4 Recent flood deposits of Fouchiang. Vertical scale much greater than horizontal. Heights given in meters above flood plain.

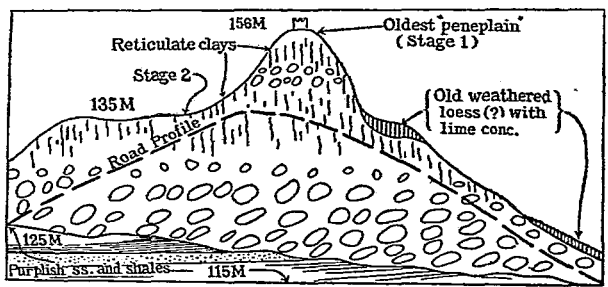

Fig. 2 B

Fig. 2-B. Details of hilltop on the motor road 14½ miles southwest of Mienyang showing gravel and cobble beds and old reticulately mottled red and yellow clays with pockets of "Chengtu Clays". Cobble beds lie unconformably on purplish red sandstones and shales of probable late Cretaceous age. Vertical scale greatly exaggerated. Altitudes given are in reference to high water level in the Fouchiang at Mienyang.

It seems almost certain, then, that the lime concretions were formed under arid or semi-arid climatic conditions, when the rainfall was insufficient to cause the lime to be carried away in subsoil waters; but sufficient, only, to carry it into the subsoil where concretions were developed. Such large numbers of concretions as we find here, still remaining under climatic conditions unfavorable for their existence, seem to indicate that the parent material was, in all probability, quite calcareous; and probably also may not have been much different in composition from the calcareous loessial deposits of northwestern China. It is also within reason to suppose that the texture of the original deposit may have been "lighter", that is to say, it may have contained a higher proportion of silts and very fine sands which have since been weathered into clays. This could easily be true if we assume that many of the silt and sand particles comprised grains of feldspars, hornblends, etc., which would weather into clays. Such an assumption is reasonable in a region near the Tibetan borderland where fresh minerals are being rapidly exposed and powdered by erosion. On the other hand, the high lime content of the original material may have caused the coagulation of the colloidal clays with the consequent development of an only *apparent* light texture which is now so common in the loess deposits of the Northwest. Many soils of loessial origin in Honan, Shensi and Kansu have the appearance and "feel" of loams, silt loams and even sandy loams, when mechanical analyses prove that they actually belong to the silty clay or clay classes. When the excess of lime is leached away, such soils become sticky and heavy and lose their properties of friability.

The Chengtu clays, so far as we have observed them, nowhere show any evidence of stratification even in very deep horizons. It is true that they occasionally contain a few quartzite cobbles or pebbles, but *these occur only where they have been mixed into the material by the farmers.*

An argument against the yellowish concretionary "Chengtu Clays" being an old loess deposit is that they do not have a well defined columnar structure which is so commonly associated with loess. It has been the observation of the first author in many widely distributed regions, that

the true loess-column structure is nearly always associated with a porous and nearly always strongly calcareous material; and, furthermore, this structure is common in strongly calcareous materials which are entirely of alluvial origin of decidedly variable textures. When calcareous loessial deposits have long been leached under humid climatic conditions, they tend to lose their columnar form. Examples of such changes may readily be seen in the Siashu loams (Barbour's terminology) of Nanking (whether they are truely of loessial origin is still in question), and in the leached loessial deposits of the Mississippi Basin, U.S.A.[1]

The forgoing descriptions give, in a general way, the characteristics of the deposits. It is now of interest to note their distribution. Following the motor road north from Chengtu, the first deposits of this type may be noticed in a deep ditch 5 or 6 li north of the north gate of the city. The land here is undulating but is irrigated and devoted to rice. Recent deposits of alluvium cover the edges of the material and silt from irrigation water is building up the surface immediately above. Farther north,—about 15 li from the north gate of Chengtu, the land is more undulating and the proportion of loess-like deposit is greater. In some places there are very low outcrops of reddish purple

1 At this point it is certain that many geologists will raise objection on the ground that the Siashu materials (they are comprised more of clays than of loams, according to soil terminology) do have vertical cleavage. In the Memoirs on the iron deposits of the Yangtze Valley, Hsieh *et al* (4) have published a photograph of the Siashu materials as an illustration of their vertical cleavage. A close examination of this photograph shows that, while the cleavage is nearly vertical, there is a lack of a clear-cut development of true columns which are so characteristic of the N.W. China loess. The Siashu clays (loams, according to Barbour) do have a well-defined prismatic structure, especially where the colloidal content is high, and there may be some less leached horizons which have well developed columns. These facts, however, cannot be used as arguments against the loessial origin of the Siashu materials, since weathering in humid climates is likely to change their character. We are strongly inclined to believe the Siashu formation to be an old wind deposit and are thus able to agree with the majority of other investigators.

shale and sandstone which lie unconformably below it. The deposit varies greatly in thickness and pockets of it flank the lower slopes of Moupanshan, a remnant of cobble-capped old peneplain, 18 li north of the city. If the deposit formerly covered the entire area, much of it has been removed by erosion, and the hillsides are mostly the sites of outcrops of the purplish shales—already mentioned. Occasional pockets of rounded boulders and cobbles on the same slopes are inherited from the river deposits which were laid on the old peneplain and have now been largely eroded away. On the top of the old peneplain remnant (Moupanshan), there is a thin deposit of this same yellowish, concretionary loess-like material, which in places has been partly mixed with underlying gravel and cobbles by farming operations.

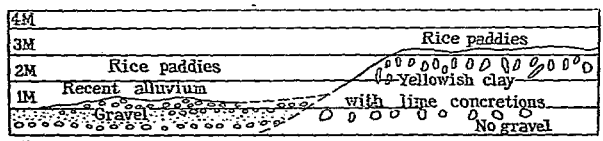

Fig. 3.

Figure 3. Road cut 6 li north of Tehyanghsien city, showing relationships between probable loess (yellowish clay) and alluvial deposits.

Conditions similar to those just described occur intermittently along the road between Chengtu and Lochiang, and especially notable deposits were observed just south of Liang-shan (town) (See Plate I-A and B) and again about 6 li north of Tehyanghsien city. At the last-named place the brownish yellow concretionary clay deposits occur in a low terrace-like position on a broad plain, and on the lower slope of the terrace the moderately recent gravel and silt deposits overlap these materials (See Fig. 3).[1]

1 Since the data just given were recorded, Dye has made a trip alone, recently, to the exposed old topography lying slightly above the aggrading alluvium of the Chengtu Plain. Plate I-A shows the village of Kao-tien-tzû (高店子), some six miles southeast of Chengtu City. This village is located on a ridge of this old

The road profile (Fig. 1) shows the approximate distribution of the supposed old loess deposits in relation to the physiography of the region. It will be noted that the deposits occur almost haphazardly from the river terraces, nearly to the tops of the highest hills. The thickest deposit we were able to measure occurs on the 35-meter terrace (Stage 4), directly south of Mienyang city. In this place the thickness is about 15 meters and the material is underlain by stratified gravel and cobble.

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topography. The photograph reveals the general peneplain level which is some 200 feet, possibly, above the small streams. On the hill tops are found river-worn cobbles and pebbles, many of which are 12 to 18 inches in diameter. These are inherited from the days of peneplanation and some are still found *in situ* on the tops of the knolls between the "loessial deposit" and the purple brown materials beneath. Workmen were breaking up quantities of these cobbles, collected from the beds of the *slow* streams, for surfacing the auto-road. The picture reveals reservoirs of "winter water" which permit of rice being planted in the spring before the seasonal rains.

The whole countryside appears to have been eroded to the configurations as revealed in the photograph. The purple brown material was then covered with a mantle of the loessial materials, some 10 feet in thickness. Since that time the (?) small streams have undercut some of the slopes very slightly, but enough to expose the purplish materials.

The lime concretions are almost everywhere in evidence. They are sometimes found in the *upper levels* of the original purplish material, but practically never in lower depths. These lime concretions are more readily seen in the yellowish covering.

In some ways it is more satisfactory to study the deposit of the yellowish material on these undulating hills than it is on the cleanly terraced hills out the north road from Chengtu City.

On many hill tops acres of surface are covered with the yellowish material without exposure of the old purplish materials. It would seem that the topographical contours have changed but little from those of the days immediately preceding the addition of the yellowish covering. To be sure, the covering has worn thin in places, so as to reveal the old surface.

Plate I-B, a photo of fresh graves, is informing. The camera plate holder is placed in the shallow trench where the

If the material occurred only in terrace positions and around the bases of hills, it would be fairly easy to conclude that it was deposited by rivers or lakes. Even with such an interpretation it would be difficult to explain the absolute lack of assortment or stratification. But, in fact, we find the deposit from very near flood plain levels almost to the tops of the highest hills, and from this fact, combined with other evidences already brought forward, it would seem that wind must, in all probability, have been the agent of deposition.

Dye has observed at least 4 dust storms at Chengtu during the last 25 years, during each of which the air became very dry and filled with yellowish dust. Such storms may last 3 or 4 days. During the same period of years there were many minor dust falls which caused red sunsets for several days on each occasion. These infrequent storms can have little effect on the nature of soils because of their minute deposits which would easily be leached of their lime in few months of

next coffin will be placed. The larger cobbles in the center and at the left are water-worn. They had been dug out of the shallow trench where they had lain at a depth of 14 inches. The red and yellow materials had generally mixed with the cobbles and pebbles at that level. Above there was a covering of 8 to 10 inches of the yellowish material. The concretions were interspersed all through this material and are still *in situ* at the sides of the trench. Two concretions, placed on a clod of the intermix of red and yellow splotched material, show their irregular shape. These are to be seen immediately to the left of the plate holder in the picture. The sods for shaping up the graves were skinned from the surface of the knoll. Those sods taken from the foreground and from the right of the picture are of the yellowish loessial materials, while the grave of which the corner is seen in the foreground is of reddish sods taken from the left of the picture—where the reddish-purple materials are exposed. The fine materials placed on the tops of the graves are of both kinds with concretions and a very few smaller river-worn pebbles. These were dug from the contact level. Practically all of the land surface that drains into the upper "winter water" reservoirs is of the yellowish probable loessial material (Chengtu Clay). This material seems to cover most of the low hills between Chengtu and the Lung-chien-i hills and is very useful for making reservoirs for storing water.

rainy weather; but they may represent vestiges of former greater and more significant dust storms.

The purplish red sandstones and shales of the region are more or less calcareous in many places and it might be argued that they comprise the parent material of the Chengtu Clay deposits. Such a theory seems untenable since we find a tremendous area of entirely different soils derived from these materials; and, still more important, since we find many places where there is a sharply unconformable contact between the two materials. Furthermore, the Chengtu Clays also occur, as we have already pointed out, lying on the cobble deposits of the old peneplain surfaces—above the purplish materials.

The accompanying map (Fig. 4) which, in addition to Szechuan, includes small areas in Shensi and Kansu, shows the known distribution of the probable loessial deposits of western and northwestern Szechuan Basin, and also indicates certain deposits in Shensi Province, south of the Tsinling range which are probably of the same origin. These deposits were reported by Mr. K. C. Hou (6) who made a hasty reconnaissance of some of the soils of southern Shensi. We believe it probable that these Shensi deposits form one of the connecting links between the loess of Northwestern China and the weathered loessial deposits of Szechuan Basin. Figure 5 is a map of the district around Lung-chien-i village. The Chengtu Clays form a blanket over the low hills, but do not extend very far into the higher hills at this place.

Origin of the Materials

If these be wind deposits, what is the origin of the dusts of which they are comprised? Such a question cannot be answered with certainty, but it is possible to advance plausible theories. If the epochs of loessial accumulation were much dryer than the present—and this seems to be an almost foregone conclusion—then it is reasonable to suppose that at least semiarid conditions prevailed around the periphery of the zone of greatest dust accumulation. Northwestern and western Szechuan would fall in such a position. Under these conditions it is almost certain that the more violent and wide-spread of the dust storms of North China

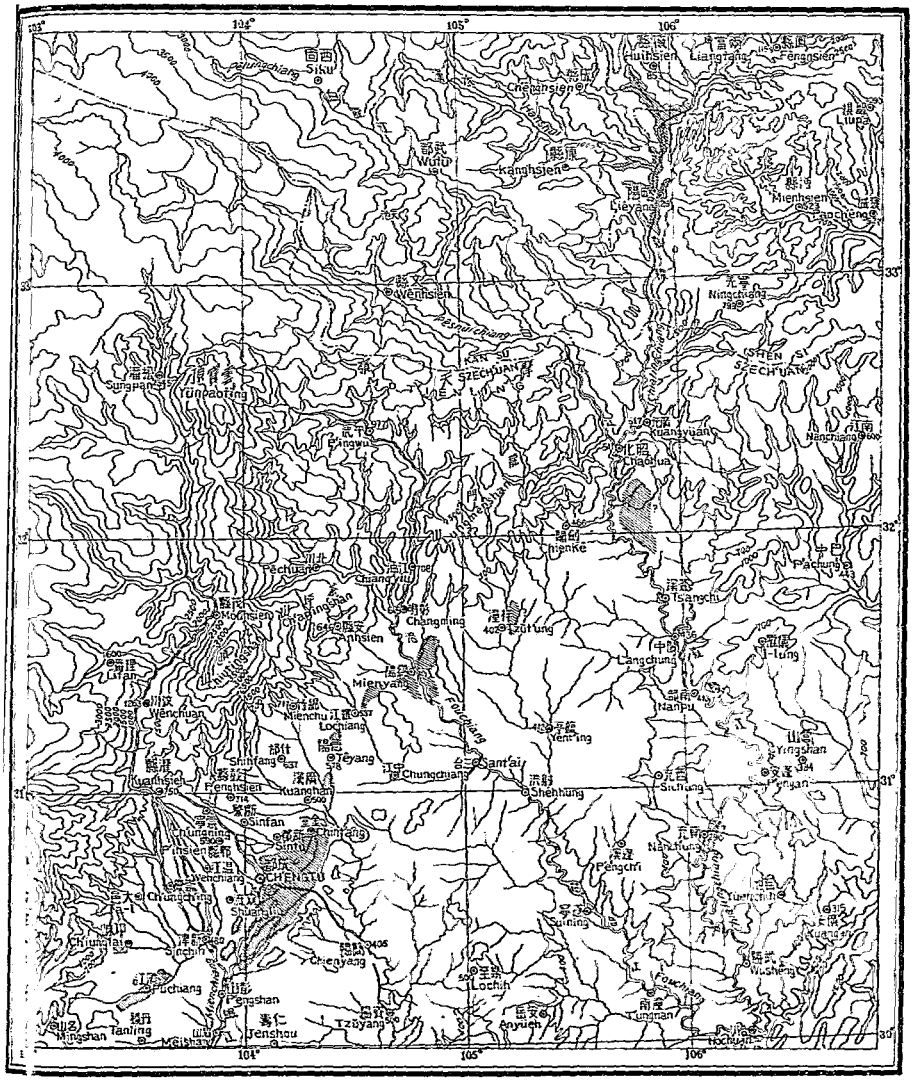

Figure 4. Map of parts of Szechuan, Kansu and Shensi. Hachured areas indicate the approximate known distribution of the "Chengtu clays". Areas of doubtful identity are indicated by question marks. The area shown in Shensi Province was mapped by K. C. Hou, who classified it as light brown loessial material. It seems to be transitional in physical character between the "Chengtu clays" and the slightly weathered loess of the Northwest.

and eastern Tibet would carry well over into the edge of the Basin, bringing with them significant quantities of dust. The present infrequent and more or less inconsequential dust falls are probably vestigial remnants of ancient and more violent storms.

In such a case we should expect the greater part of the dust to have come from what is now northwestern Szechuan and southeastern Chinghai and Kansu. Loess deposits are common in these regions and have been described by travelers (2).

One method of transportation of dust to a given locality is by a system of relays. Such a method is well illustrated in the loess deposits along the Yellow River in Honan. Presumably the dust of this region was originally blown out of the Mongolian and Ordos desert regions and the greater part deposited in Ninghsia, Shensi and Shansi. Step by step part of the dust moved southeastward toward Honan, resting for longer or shorter periods en route. In many cases the deposits of Ninghsia, Shensi and Shansi were eroded away by the rivers and spread out along the flood plains of their lower courses, only to be picked up again by the wind and blown to nearby hills and terraces. This process is still very active all through the loessial region and was observed by the first author (8), particularly along the Yellow River in northern Honan and along the Wei River in Shensi.

In the process of relaying the loessial material from its original source by the methods just outlined, there is a strong tendency for horizontal assortment to take place. The fine floury materials are most easily transported and of these, the ones with lowest specific gravity tend to be carried farthest, while heavier sand grains remain behind. The heavy sands will creep along the lower areas and move slowly, while the fine materials will be carried farther and higher by the winds. This is a principle already so well known as to scarcely warrant further discussion[1].

1 Dr. J. H. Jeffrey of the China Inland Mission at Mowkung reports (verbal information) that there are many more or less violent local dust storms in the various valleys of the Tibetan Borderlands

The many rivers coming down from the Tibetan borderlands of western Szechuan still bring with them large amounts of materials, part of which were originally of loessial origin. At present the alluvial fans are too wet throughout almost the entire year for the winds to pick up dust from them, but conditions were undoubtedly different during the periods of greatest dust movements in China, and these river flood plains may then have contributed an important share of the materials for the winds to move to their present position.[1]

Conclusion and Questions

We find it difficult to reach any other conclusion than that the deposits under discussion in this paper are of windblown loessial origin, and that they were made subsequent to the 4th stage of physiographic development illustrated in Figure 1, and prior to the recent fan-building of the Chengtu Plain.

Such a conclusion as the above necessarily leads to another one, viz., that if the deposit is of wind-blown origin, then the climatic con-

which seem to come from different points of the compass. They seem to bear no relation to the winds of the upper atmosphere which, by the direction of movement of the higher clouds seem to be almost constantly from S.W. to N.E. These local dust storms occur on the intermediate and lower slopes of the mountains within the narrow valleys, where a local arid climate prevails. Probably some of the dust of the infrequent dust storms on the Chengtu plain may come from this source but it is doubtful in the total quantity is significant during the present period.

1 Recently, L. T. Chu reported verbally that the Chengtu clay occurs not only as a blanket over most of the low hills between the Lung-chien-i hills, as has already been observed by Dye, but he also found strips of it on the 35-meter terraces of the rivers eastward as far as Nanchung, about one hundred miles east of Chengtu. As more and more evidence comes in it seems that this material occurs largely on the eastward sides of the larger rivers and flood plains and that much of it may be locally blown dust, picked up from the river flood plains by westerly or northwesterly winds. At the present time strong winds are exceedingly rare, and so the Chengtu Clay may possibly be considered as fossil evidence of a former dry and windy climate in the region.

ditions must have been much dryer at the time of deposition than they are at present—the present humid climate being radically different from the one which then prevailed.

We should like to be able to correlate the age of these deposits with the better known loessial series of northern China, but our data are scarcely sufficient for that purpose, nor is either of us sufficiently conversant with the different subdivisions of the loessial deposits and their interrelations to make any very definite statements along this line. It is quite conceivable that more detailed study may reveal more than one epoch of deposition. The deposit of the material on the 35-meter terrace at Mienyang would indicate a fairly recent age, say, corresponding to the *Malan* stage. But even here our evidence is insufficient. We need fossils and more detailed physiographic material before drawing conclusions too freely.

Upon consulting Figure 1, it is evident that, if the material in question is of windblown origin, it must represent a long period of drought between a former humid climatic condition and the present moist climate. The reticulately mottled yellow and red clays of the very old topography evidently were well developed before the deposition of the loessial material. Their development was checked during the dry period but is now resumed. Evidence of this may be seen in the gradual leaching of the loessial (?) deposits and in the more rapid development of strongly acid soils on materials which are less resistant to soil forming processes, than these sticky yellow-brown concretionary clays. Specifically we refer to more or less reticulately mottled acid soils derived from the sandstones and loamstones of Cretaceous age in various parts of the Basin. Such soils may be found on gently sloping hills where erosion has been slow and soil forming processes have been active a long time.

One of the most intriguing questions that follows in the wake of the probable existence of loessial material in this region is the influence it may have on ancient man. Did man live in the Szechuan Basin at the time these deposits were accumulating? What was his mode of life and

means of subsistence? Did these early men prefer dry climate and steppe life to that of the forests? Had man learned to cultivate the soil at this early date? These and many more questions force themselves upon us, and in all probability, many of them can never be answered; but with careful studies of the deposits and of fossils and archæological relics possibly included in them, it may be possible to open a new and entrancing field of investigation.

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Explanation of

Plate I

PLATE I

A. Kaotientzŭ (高店子) village, about 6 miles southeast of Chengtu, situated on a low hill of the strongly undulating "old topography". Hilltops, representing an old peneplain surface, average about 200 feet above the small streams. Underlying materials are mostly purplish red Cretaceous sandstones and shales, with a scattering of rounded cobbles and gravel inherited from the old peneplain. The whole area is capped by a more or less continuous blanket of "Chengtu clays" of probable loessial origin which varies from less than a meter to 3 or 4 meters thick. Irrigation ponds are constructed in the impervious "Chengtu clays". Photo by D. S. Dye.

B. New graves at Kaotientzŭ, excavated in "Chengtu clays" where they come into contact with the Cretaceous rocks. Lime concretions are scattered through the soil near the plate-holder. The cobble stones were lying directly on the Cretaceous materials and had been covered by the loess-like material (Chengtu clay). Some lime concretions formed among the cobbles as a result of the leaching of the overlying blanket of material. These concretions are now being gradually dissolved. For further details, see the footnote on page 235. Photo by D. S. Dye.

Explanation of

Plate II

PLATE II

II-A. Lime concretions in "Chengtu clays" near Lienshan, south of Têyang. Note the small pits on the concretions, indicating that they are in the process of being leached away. The pick handle is a little more than 40 cm. long. Photo No. 161-7, by J. Thorp.

II-B. Cloddy structure of "Chengtu clays". The upper horizons tend toward prismatic structure. Note the pitted white lime concretions. Photo 161-8, by J. Thorp.

QUELQUES OBSERVATIONS GEOLOGIQUES AU HSISCHAN, NORD-OUEST DE PEIPING CHINE*

YANG-KIEH

(Service géologique de Chine)

I DISCORDANCE DE LA SERIE DE KIOULONSCHAN SUR LE CALCAIRE CAMBRO-ORDOVICIEN DU CHENTZESCHAN

A l'automne du 1933, aussitôt que je suis venu à Pékin, le docteur Wong, directeur de notre Service, a très aimablement organisé une excursion géologique dans la région de la station séismique de Tch'ioufon. laboratoire accessoire de ce même établissement, situé à quarante kilomètres environ au Nord-Ouest de Peiping. Ses batiments sont construits sur la zone périphérique occidentale du massif granitique de Yanfan[1] où le métamorphisme de contact paraît assez intense, et nous avons observé que les roches transformées par des actions dynamo-thermiques présentent des caractères très particuliers. Pour étudier l'origine de cette formation, l'auteur et un de nos jeunes collègues, M. Hsiung sommes, un mois après revenus à la région en question, et avons recueilli de nombreux échantillons bien intéressants; mais nous n'avons pas encore précisé leur âge. Dans l'automne suivant, j'ai fait une troisième excursion dans ce même endroit et trouvé que la zone métamorphisée de Tch'ioufon-Tachieutze est identique à celle du Chentzeschan, Sud-Est de la première. Ensuite, l'auteur a observé que les roches du Chentzeschan ressemblent beaucoup à celle de Paichiatannanschan. Le terrain de cette montagne n'a subi aucun métamorphisme et appartient certainement à la série jurassique de Kioulonschan. Alors la zone de Tch'ioufon-Tachieutze est incontestablement du même âge. D'ailleurs, les couches de Tachieutze se prolongent

* Received for publication in March 1936.

1 Mem. Geol. Sur. of China. Ser. A, No. 1, p. 33, 1920; Bull. Geol. Sur. of China. No. 11, p. 22, 1928; Bull. Geol. Soc. of China. Vol. VII, No. 3-4, p. 239, 1928.

jusqu'au village de Yintaokéou, en passant par Takon, à une distance assez grande du massif granitique, et où les roches présentent des propriétés typiques de celles de la Montagne de Kioulon.

Mais il faut remarquer que la série de Kioulonschan de la chaîne du Chentze repose en discordance sur le cipolin cambro-ordovicien et suporte par chevauchement la série de Yanchiatun, houiller permo-carbonifère. Certain géologues n'ont pas observé ces phénomèmes tectoniques et se basent uniquement sur la disposition stratigraphique: les uns considèrent ainsi le Chentzeschan comme Ordovicien, et les autres, comme Permien.

Dernièrement, en 1935, j'ai visité les autres parties du Hsischan et prouvé que mes observations précédentes paraissent bien correctes. Je vais exposer dans cette note le resultat obtenu pendant les excursions de ces dernières années, et décrire simplement la section de Chentze-schan-Paichiatannanschan qui est suffisante pour démontrer des particularités géologiques de la région étudiée. Ma description commence du Nord au Sud, car les couches plongent en général au Sud (localement au Sud-Sud-Est ou Sud-Sud-Ouest).

Au pied septentrional du Chentzeschan, on observe d'abord, le granite (fig. 1,—1), zone périphérique méridionale du massif de Yan-fan, ensuite, le cipolin, calcaire cambro-ordovicien métamorphisé, de 50 à 80 m. d'épaisseur (—2). Puis du Nord au Sud de cette montagne, une large bande de roches très spéciales et plus ou moins métamorphisées: schistes gris noir avec des intercalations de schiste gréseux, de grès et de conglomérat (—3). Les schistes renferment souvent de petits nodules vert-olive d'épidote, leur contour tantôt bien limité, tantôt confus; les conglomérats, à ciment souvent schisteux, contiennent des galets blancs de marbre et des galets noirs d'andésite et de schiste compact; dans certains grès, on trouve des grains de sable volcanique. Au pied méridional de la montagne considérée, une couche de conglomérat à gros galets quartziques et andésitiques, comprend aussi du ciment volcanique (—4). Entre le Chentzeschan et le premier pic de Paichiatannanschan, se trouve le Shisinlin (treize cols) où il y a un accident tectonique. Grâce à cette

fracture, affleure une très mince couche de schiste charbonneux à andalousite, série de Yanchiatun, houiller permo-carbonifère (—5), et sur lequel, on observe rudimentairement du grès (Trias) de la série de Hunmiaolin (—6). Au-dessus, apparait un épais banc d'andésite (avec du tuf) (—7), large de 120 m. environ, couverte par quelques mètres de schiste noir, série houillère de Mentoukéou (—8). Ensuite, vient un complexe de terrains: conglomérat, grès verdâtre, schiste violacé, etc. (—9). Ces roches renferment abondamment des matériaux volcaniques et sont accompagnées par plusieurs minces veines (filon couche) d'andésite. Au

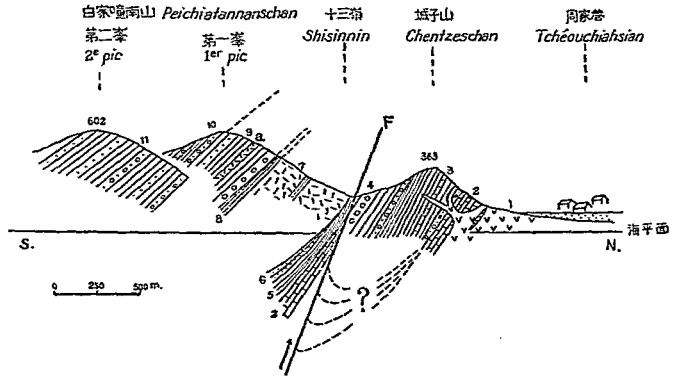


Fig. 1. Section de Chentzeschan-Paichiatunnanschan: montrant la série de Kioulonschan du Chentzeschan (3,4) reposant en discordance sur le calcaire cambrien ou cambro-ordovicien (2) et supportant, après un accident tectonique, la série de Yanchiatun (5) et de Honmiaolin (6). 1, granite de Yanfan, 7, dépôts volcaniques, 8, série de Mentoukéou, 9,10 et 11, partie inférieure de la série de Kioulunschan renfermant de minces veines d'andésite (a), F, plan de faille.

sommet de ce premier pic, une couche de schisto-conglomérat violacé (—10) supporte des schistes généralement de la même couleur (—11), et qui comprennent souvent des nodules calcitiques gris ou jaune-pâle. Au-dessus de ces derniers, se trouve une autre épaisse formation schisto-

gréseuse et partiellement conglomératique, dont les caractères lithologiques sont, outre la couleur devenue gris-verdâtre, très comparables à ceux des roches sousjacentes. Elle se prolonge vers le Sud et se joint à la la série jurassique de Kioulonschan de la chaîne de Lonuntze-Chipao. Il paraît évident que les couches 9, 10, 11 et les suivantes appartiennent entièrement à la même série.

En résumé, la section dérite ci-dessus nous montre trois points essentiels: 1°. les roches métamorphisées du Chentzeschan présentent des propriétés lithologiques très comparables à celles de la partie inférieure de la série de Kioulonschan du Paichiatannanschan, et appartiennent

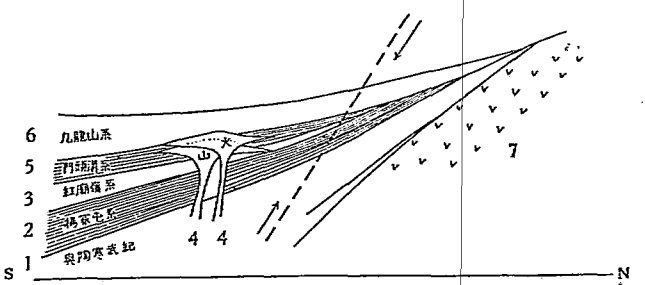


Fig. 2. Section théorique, zone périphérique méridionale du massif granitique de Yanfan qui serait le noyau anticlinal et où les divers groupes de terrains reposent l'un sur l'autre, en zigzag. Dans l'intervalle de la série de Kioulonschan et de celle de Hunmiaolin se trouve le premier volcan du Hsischan. La ligne interrompue indique l'endroit où a eu lieu l'accident tectonique. 1. Cambro-ordovicien; 2, Série de Yangchiatun; 3, Série de Honmiaolin; 4, volcans, 5, Série de Mentoukéou; 6, Série de Kioulonschan; 7, Granite de Yanfan.

certainement à cette même série; 2°. la série de Kioulonschan du Chentzeschan repose sans accident tectonique sur le calcaire cambro-ordovicien: il y a évidemment une discordance; 3°. le Jurassique du Chentzeschan supporte par une fracture le houiller permocarbonifère: ceci prove le chevauchement de ce dernier sur le premier.

Pour interpréter ces phénomèmes structuraux, je propose l'hypothèse suivante. Le massif granitique du Yanfan représenterait un noyau

brachyanticlinal monté en plusieurs stades successifs, les nombreux groupes de terrains se superposant en forme zigzaguée dans la zone périphérique (fig. 2). Avant le dernier stade de l'ascension du magma de ce dernier, la zone de bordure, plus fragile qu'ailleurs, aurait été disloquée par les mouvements tectoniques. Il semble que cette fracture présente une faille inverse (fig. 3) dont la lèvre affaissée (p, Paichiatannanschan) est chevauchée sur la lèvre

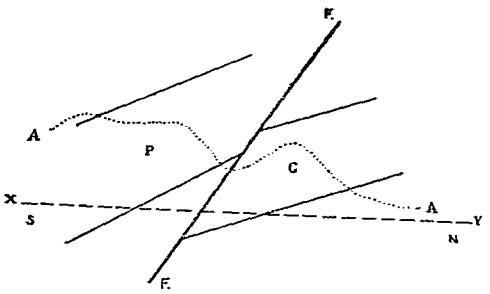


Fig. 3. Section théorique montrant la relation tectonique du Chentzeschan et du Paichiatannanschan: FF, plan de faille inverse, la lèvre affaissée (p, Peichiatannanschan) chevauchée sur la lèvre soulevée (c, Chentzeschan); AA, surface topographique actuelle, XY, niveau de la mer.

soulevée (c, Chentzeschan); mais il est encore plus probable que cet accident montre un pli-faille inverse (fig. 4) qui a eu lieu pendant une des dernières phases d'orogénèse de Yenschan, Crétacé-Eocène: les forces tangentielles de la partie méridionale étant plus grandes que celles de la partie séptentrionale, le pli est déjeté vers le Nord.

Dernièrement, nous avons prouvé que la zone de Tch'ioufon-Tachieutze paraît identique à celle du Chentzeschan qui est la partie inférieure de la série de Kioulunschan. Alors, les roches de la première appartiennent sans doute à la même série jurassique.

II Le Premier Volcanisme Mesozoïque du Hsischan, anterieur a la Serie de Kioulonschan et posterieur a la Serie de Honmiaolin

Dans la montagne de l'Ouest de Pékin, on a observé de nombreux affleurements d'une roche éruptive qui paraît généralement verte et se trouve souvent au-dessus de la série de Honmialin et au-dessous de la sèrie de Mentoukeou[1]. D'après sa disposition stratigraphique et ses caractères lithologiques, nous l'avons d'abord regardée comme une intrusion de diabase, en forme de filon couche (sill), injectée dans les couches sédimentaires; et son âge paraît postérïeur à la série de Kioulonschan, car dans la partie inférieure de cette dernière, apparaissent

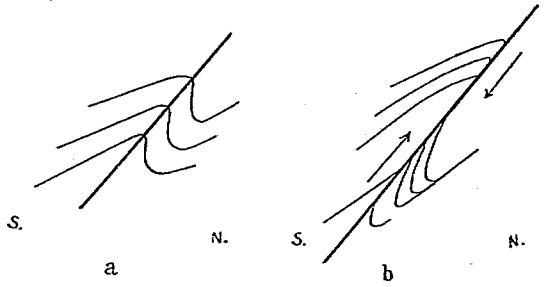


Fig. 4. Section théorique interprétant la tectonique du Chentzeschan: a, anticlinal déjeté stade antérieur de la dislocation, b, anticlinal faillé, stade définitif et postérieur de l'accident, les flèches indiquant le sens de mouvements.

de minces veines diabasiques. Depuis lors, certains géologues out pensé que les couches renfermant des filons de la roche considerée, appartiennent à la sous-série de Shuangtsüan[2], partie supérieure de la série de Honmiaolin, de sorte que l'âge de la diabase serait antérieur à la série de Kioulonschan. Quoi qu'il en soit, personne ne regardait la roche en question comme volcanique.

1 Mem. Geol. Surv. of China. Ser. A, No. 1, p. 33, 1920.
2 Bull. Geol. Soc. of China. Vol. XII, No. 4, p. 491, 1933.

Dans ces dernières années, au cours d'explorations géologiques au Hsischan, j'ai souvent rencontré la prétendue diabase, et je vais montrer, par l'étude de trois gisements, qu'elle doit être regardée, non comme une intrusion profonde, mais comme une extrusion.

1. Dans le Sud de Heilontan-Paichiatan et au versant séptentrional de Chipaoschan, se trouve une large bande de roche foncée, dont la masse se montre très hétérogène. Les parties compactes présentent au microscope des caractères de l'andésite, les amas poreux sont de la lave, et les zones schisteuses, du tuf et des débris consolidés. En outre, les couches qui se trouvent au-dessous et au-dessus de cette bande n'ont subi aucun métamorphisme. Il semble ainsi que ces roches représentent des matériaux d'un volcan ancien. Je crois que celui-ci se place dans une période antérieure à la série de Kioulonschan et postérieure à celle de Honmiaolin. Les deux sections, Heilontan-Chipaoschan (fig. 5) et

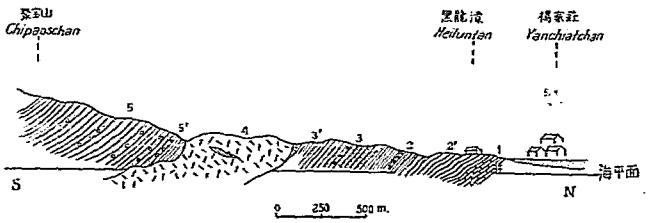


Fig. 5. Section de Heilontan-Chipaoschan: 1, calcaire ordovicien, extrémité de la petite butte de Heilontan, #, soure; 2, série de Yanchiatun, partie inférieure (2') remfermant de beaux cristaux de chiastolite; 3, série de Honmiaolin, partie supérieure (3') devenant schisteuse; 4, roches volcaniques avec inclusion schisteuse; 5, série de Kiolonschan, (5'), schiste gris violacé.

Paichiatan-Chipaoschan (fig. 6) démontrent bien sa disposition stratigraphique. Les couches sont généralement inclinées au Sud ou au Sud-Sud-Ouest, de sorte que les terrains plus anciens se trouvent à la partie située la plus au Nord.

(a) Dans l'extrémité séptentrionale de la première section, apparaît un petit affleurement de calcaire ordovicien (fig. 5—1) abondamment fissuré, d'où sorte la fameuse source de Heilontan (étang du dragon noir). Il supporte la série de Yanchiatun (—2) dont la partie inférieure subit le métamorphisme de contact et referme de très beaux cristaux de chiastolite (—2'). Les grès proprement dit de Honmiaolin (—3) reposent en concordance sur ce houiller permo-cabonifère; au-dessus, un complexe de schistes noirâtre, gris, violacé, etc., et de grès partiellement conglomératique (—3'). Sur ces derniers, affleurent les roches volcaniques considérées (—4), de 200 m. environ d'épaisseur; elles sont d'abord couvertes par un schiste gris et légérement violacé (—5'), puis par un épais groupe de schiste, de schiste gréseux, de grès, de grès conglomératique, etc. (—5). Ceux-ci appartiennent à la série jurassique de Kioulunschan.

(b) A Paichiatan, on observe d'abord le calcaire ordovicien (fig. 6—1), faillé en deux tronçons; dans la fente se trouve un mince filon de microdiorite (g) et un petite écaille de schiste à andalousite (—2'), du Permien. Puis les séries de Yanchiatun (—2), et de Honmiaolin (—3) présentent les mêmes caractères que ceux des terrains du Sud de Heilontan. La partie supérieur du grès proprement dit de Honmiaolin devient aussi schisteuse (—3'), il y a, outre des schistes gris-noir, quelques couches violettes et blanchâtres qui paraissent des cendres volcanique légérement consolidés. En effet, ces derniers sont accompagnés de minces veines (sill) d'andésite. Au-dessus, l'épaisse bande de roches en question (—4) supporte la série de Kiolonschan (—5) dont la première couche est un conglomérat à galets d'andésite, de dacite, de quartzite, de calcaire ordovicien, etc.; dans les couches suivantes apparaissent quelques veines de microdiorite et d'andésite.

2. Dépuis Shisinlin jusqu'à Hsianyu en passant par Mon-o, une large zone de roches éruptives présentent les mêmes propriétés que celles de la bande du Sud de Heilontan-Paichiatan. Mélange de microdiorite, d'andésite, de lave poreuse, de tuf et d'agglomérat. Par suite d'un accident tectonique, cette zone repose sur des couches qui appartiennent à des séries diverses. Dans la partie orientale de Shisinlin, les

roches volcaniques considérées (fig. 1—7) se trouvent sur le houiller permo-cabonifère (—5) et le grès proprement dit de Hunmiaolin (—6); à l'Ouest de ce col, elles sont en contact avec un groupe de schiste, partiellement charbonneux, de grès conglomératiques, etc.; enfin à partir de ce dernier endroit jusqu'au Sud de Mon-o, les terrains sous-jacents de la lave andésitique signalée sont formés de grès et de schiste gréseux, brunviolet, qui seraient la partie supérieure de la série de Honmiaolin. Au contraire, les terrains qui se trouvent au-dessus de la zone signalée, paraissent très normaux, la série de Mentoukéou (—8) supporte celle de Kioulonschan (—9, 10, 11).

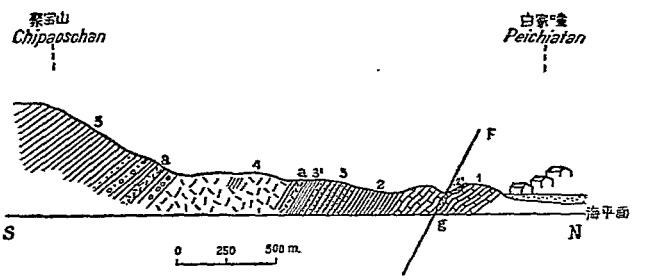


Fig. 6. Section de Peichiatan-Chipoaschan: 1, calcaire ordovicien faillé, dans la fente se trouve une microdiorite (g) et une petite écaille de schiste permien à chiastolite (2'); 2, série de Yanchiatun; 3, série de Honmiaolin, partie supérieure schisteuse renfermant de minces veines d'andésite (a); 4, dépôts volcaniques; 5, série de Kioulonschan, partie inférieure comprenant aussi de petits filons de microdiorite ou d'andésite (a).

3. Dans la vallée de Piyuntze et sur la crête située à l'Ouest de Hsiyin apparaît un petit affleurement de roches vertes (fig. 7,—2) qui sont identiques que celles du Sud de Heilontan-Paiciatan et de Shisinlin-Mon-o. J'ai trouvé dans la zone supérieure un vrai agglomérat et de très belles bombes (fig. 7—2' et Pl. I). Celà prouve que ce petit massif vert est certainement volcanique. Dans le Sud, l'alluvion récente couvre entièrement le prolongement de cet affleurement, mais il se joint

probablement à la grosse masse éruptive du Hsianschan. A l'Est, les roches considérées reposent sur un schiste violet-blanchâtre (—1) qui est vraisemblablement la cendre volcanique consolidée et inclinée au Sud on Sud-Sud-Ouest. Les contacts de ces deux terrains ne paraissent pas normaux. Quant aux couches qui se trouvent au-dessus des roches vertes en question, elles présentent une disposition stratigraphique bien régulière. On observe d'abord une intercalation de minces couches de schiste, de grès et de conglomérat (—3). Ce dernier composé de nombreux galets de roches éruptives sous-jacentes. Puis un deuxième

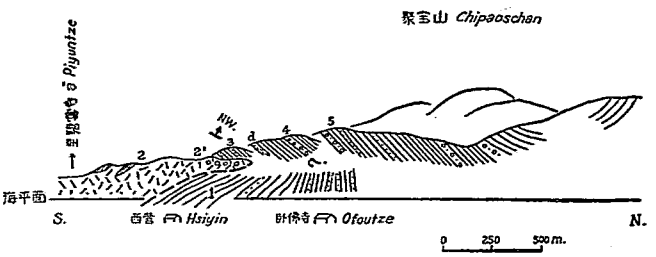


Fig. 7. Section de l'Est-Nord-Est de Piyuntze: les dépôts volcaniques (2) reposant anormalement sur le schiste gris-violacé (1), à leur partie supérieure, un banc de l'agglomérat contenant de bombes (2'); 3, complexe de schiste, de grès et de conglomérat renfermant des matériaux volcaniques sous-jacents; 4, deuxième complexe, sa partie inférieure comprenant un petit affleurement de microdiorite (d); 5, série proprement dite de Kioulunschan.

groupe schisto-gréseux (—4) dont la partie inférieure renferme une intrusion microdioritique (d), et qui paraît généralement verdâtre ou grisatre. L'épaisseur de ces deux zones a environ 200 mètres. Enfin, apparaît la série proprement dite de Kioulonschan (—5).

En résumé, dans ces trois gisements, les roches éruptives étudiées sont incontestablement des dépôts volcaniques se plaçant avant la série de Kioulonschan et après celle de Honmiaolin. Ceci pour les sept principaux caractères suivants:

1. hétérogénéité dans la masse générale,
2. existence du tuf, de l'agglomérat et des bombes,
3. structure souvent microgrenue et felsitique,
4. aspect quelquefois poreux, vacuoles aplaties orientées en sens unique, démontrant la fluidité du magma (coulée de lave),
5. sans actions métamorphiques,
6. absence, entre la série de Hunmiaolin et celle de Kioulunschan, de tout groupe de terrains pouvant arrêter une explosion éruptive, si les roches considérées étaient une intrusion,
7. présence de débris des roches volcaniques signalées dans la sêrie de Kioulonschan, surtout à sa partie inférieure que repose parfois directement sur les dépôts volcaniques; par contre, on n'en observe pas dans les terrains anté-jurassiques.

Explication de
Planche I

PLANCHE I

Bombe strombolienne du premier volcan mésozoïque du Hsischan, échantillon recueilli dans la crête située à l'Est-Nord-Est de Piyuntze. (grandeur réduite $\frac{1}{3}$)

NOTE PRELIMINAIRE SUR LA GEOLOGIE DU WOUTAICHAN (CHANHSI)*

YANG-KIEH

(Service géologique de Chine)

Dans le fameux ouvrage, "Research of China" de B. Willis[1], on trouve que la chronologie géologique du Nord-Est de la province de Chanhsi se comporte des termes suivants:

Classification de B. Willis		Termes généraux et universels		
Shansi series	Coal-measure	Permo-carbonifère	Paléozoïque	
Sinian system	Kikou-limestone	Cambro-ordovicien		
	Manto-shale			
Huto system (Neo-Proterozoic)	Tungyü limestone	=Sinien	Algonkien (Proterozoïque)	Pré-Cambrien
	Totsun slates			
Woutai system (Eo-Proterozoic)	Sitai series Nantai series	Woutai		
	Shitsui series			
Taishan complex (Archean)			Archéen (Agnotozoïque)	

* Received for publication in April 1936.

1 Vol. II, p. 4, 1907, Washington.

Willis divise clairement les terrains précambriens du Woutaichan en deux grands groupes, et chacun porte un nom spécial, systèmes de Houto et de Woutai. Mais l'auteur de cette note, d'après les observations personnelles, arrive à une répartition différent les deux systèmes. Je vais exposer sommairement la Géologie générale de cette montagne.

La chaîne du Woutai est un grand synclinal composée de plusieurs anticlinaux et synclinaux secondaires, et souvent faillés. Ces montagnes s'orientent généralement en direction SW-NE. Sur les versants sud-est et nord-ouest affleurent deux massifs gneissique, noyau anticlinal du Foupinhsien, et celui de Yenmenkuan, leur âge peut être très ancien, j'attribue problématiquement ces roches à l'Archéen.

Vers l'intérieur de cette chaine, se trouvent plusieurs zones à caractères lithologiques très différents, fréquemment séparées les unes des autres par des accidents tectoniques. D'abord du côté sud-est, il y a une très épaisse zone gneissique, avec des intercalation d'amphibolite, de quartzite, de cipolin, etc., correspondant à la "Shitsui series" de B. Willis. Celle-ci apparaît en mince couche insignifiante sur le versant nord-ouest du Woutaischan, où par contre, des schistes verts métamorphiques premment un grand developpement: la zone "Aw" et la "Sitai series" de Willis appartiennent à ce groupe. Au centre de la chaîne de Woutai, se trouve une longue zone de quartzite et de schiste, représentant la "Nantai series" et les "Totsun. slates" de Willis; la bande "An?" et le "Tungyü *limestone*" de ce même auteur font ensemble une très épaisse série, située au Sud-Est de la zone quartzito-schisteuse. L'Algonkien comprendrait ces quatre zones qui porteront les noms suivants: série de Schitsui, série de Taihuai, série de Nantai et série de Paitouan. Enfin, au-dessus de cette dernière, paraît en discordance, la série calcaire de Shitchéouschan, âge certainement cambro-ordovicien, elle suporte à son tour le houiller permo-carbonifère de Hsitienho.

Le tableau ci-point montre la succession des terrains du Woutaischan.

Paléozoïque	Permo-carbonifère	Série de Hsitienho	houiller
	Cambro-ordovicien	Série de Shitchéouchan	calcaire de Shitchéouchan
		(discordance?)	Schiste et grès de Manto
Pré-Cambrien	Algonkien (Protérozoïque)	Série de Paitouan	=Sinien=Néo-Protérozoïque
		Série de Nantai	
		(discordance?)	
		Série de Taihuai	Système du Woutai, sens strict...=Eo-Protérozoïque
		Série de Shihtsui	
		(discordance?)	
	Archéen (Agnotozoïque)	Série de Lontchuain ou de Okéoutchen	=gneiss de Sankanho
		Série de Foupinhsien ou de Yenmenkuan	=gneiss de Taichan

I Archéen ou Agnotozoique="Taichan Complex" de Willis

Au Sud-Est de la chaîne du Woutai, est situé le massif de Foupinhsien. Là on ne rencontre que des gneiss très cristallins feldspathiques et plissés, les intercalations d'amphibolites subissant également un profond métamorphisme. Les roches filoniennes paraissent assez abondantes, surtout des veines de pegmatites, montrant une structure tout fait particulière, qui s'allongent fréquemment suivant la schistosité des gneiss signalés et prennent donc les mêmes plissotements que ceux-ci. Je crois, d'après ces caractères, les gneiss de Foupinhsien, peuvent être comparés aux Migmatites du massif Finlando-Scandinave, décrites par le professeur J. J. Sederholm[1].

La structure migmatitique devient moins en moins marquée dans la partie occidentale du massif de Foupinhsien, mais la cristallinité reste

1 —C.R. XI^e. Cong. géol. Intern., Stockhom, 1912.—Geol. Rundschau, Berlin, IV, 1913, p. 174.

la même. En outre, il y a d'autres propriétés qui caractérisent bien cette série de roches. Grâce aux compressions latérales, les gneiss signalés parraissent très lités et certains grands cristaux de feldspaths à contour oval, sont disposés en rang parallèle à leur schistosité. Le nom de gneiss oeillé peut se donner à ces schistes cristallins.

En résumé, le massif de Foupinhsien comprend en général deux grandes séries de roches différentes: l'une, gneiss migmatitique des environs de la ville de Foupinhsien et l'autre, gneiss oeillés de la région de Lontchuainkuan. Ces deux groupes de gneiss se retrouvent identiquement au Nord-Ouest de la chaine générale du Woutai. La zone de Yenmenkuan correspond à celle des environs de la ville de Foupinhsien et la zons de Okéoutchen, à la région de Lontchuankuan. Il semble bien que les gneiss migmatitiques présentent le faciés de la zone profonde où circulent abondamment les venus magmatique, et les gneiss oeillés, celui de la zone plus superficielle où se manifestent énergiquement des mouvements tectoniques. Comparés aux autres massifs de la Chine séptentrionale, je pense que les gneiss de Foupinhsien et de Yenmenkuan sont assimilables à ceux du Taichan (Province de Schantun) et, les gneiss de Lontchuainkuan et de Okéoutchen à ceux de Sankanho (province de Charar).

II Algonkien ou Protérozoïque—"Woutai system" et "Huto system" de Willis

1 série de schitsui="shitsui series" de willis

Au-dessus de la série de Lontchuaïnkuan, se trouve la série de Schitsui, à la limite de ces deux groupes, on n'observe pas une discordance nette. Les gneiss, de part et d'autre, sont également métamorphises et leurs couches paraissent partout plus ou moins paraclasées ou diaclasées. Mais par certains caractères lithologiques, une coupure est fort facile à établir. Au centre du massif de Foupinhsien se présentent les gneiss cristallins à structure migmatitique, puis à leur partie périphérique occidentale, les gneiss oeillés. Ces derniers, inclinés généralement à l'Ouest-nord-Ouest, affleurent dépuis le région de Lontchuainkuan jusqu'au

village de Tiehpou (Schanhsi) en passant par Chanchenlin. Entre Tiehpou et Takanho, se trouve une série de Gneiss, partiellement encore oeillés, mais en général plus micacés que ceux de Lontchuaïnkuan et souvent passant à des micaschistes feldspathiques; les amphibolites sont aussi moins cristallines. En outre, les quartzites et les cipolins que l'on n'a pas observés dans la zone de Lontchuaïnkuan, prennent un grand developpement.

Je suis en plein d'accord avec Willis pour donner à cette zone le nom de série de Schitsui, partie inférieure de l'Algonkien du Woutaischan. La bande gneissique de Schifou se rattache certainement au groupe de Schitsui, parce qu'elle présente le même faciés. Au Sud-Est de la zone de Okéoutchen-Yukéoutchen, se montre une bande de gneiss à mica plus ou moins chloritisé, qui ont une grande ressemblance avec les roches de la partie supérieure de la série de Schitsui.

2 SÉRIS DE TAIHUAI=ZONE "AW" ET "SITAI SERIES" DE WILLIS

De Peitai à Hsitaï en passant par le Tchuntai, une bande de quartzite feldspathique, accompagné de granite gneissique, diffère totalement de la grande zone de Taihuai composée de schistes verts et inclinés généralement au Nord-Ouest. Ce quartzite appartenant à la série de Nantai, sera discuté dans la section suivants; la zone de schistes verts est l'objet de ce paragraphe: elle paraît très developpée dans la région de Taihuaitchen et se prolonge jusqu'au Sud-Est du Taihsien et de Kouhsien. Je propose, pour cette longue zone de roches métamorphiques, le nom de séris de Taihuai comprenant la zone "Aw" et la "Sitai series" de Willis. La partie sud-est de la série en question est formée par une band de schisto-conglomérat qui passe insensiblement au conglomérat-quartzite de la partie nord-ouest de la série de Nantai. Il semble que ces deux séries sont continues et inséparables; par la disposition structurale, la Nantai se trouve au-dessous de la Taihuai, mais au point de vue stratigraphique et lithologique, la conclusion devient inverse. Alors, la série de Taïhuai, plus ancienne que celle de Nantaï, serait la seconde subdivission, de bas en haut, de l'Algonkien du Woutaischan.

3 SÉRIE DE NANTAI="NANTAI SERIES" ET "TOTSUN SLATES" DE WILLIS

Tectoniquement au-dessous de la série de Taihuai, se trouve une très large zone de quartzite et de schiste, qui est orientée suivant la direction générals NE-SW. du Woutaichan. La partie nord-ouest de cette zone renferme partiellement du conglomérat et passe à la série de Taihuai déjà en question dans le paragraphe 2; sa partie sud-est renferme de minces intercalations calcaires qui sont en relation avec la série de Paitouan. Par suite cette dernière paraît plus jeune que la zone quartzito-schisteuse considérée dont la partie nord-est subit un métamorphisme assez profond, tandis que la section sud-ouest est peu ou presque pas métamorphisée. En se basant sur ces ces caractères Willis a divisé cette zone en deux groupes: "Nantai series" et "Totsun slates". Le premier placé dans le "Woutai system" et le second dans le "Huto system". En réalité, ces deux appartiennent à une même zone, la série de Nantai.

4 SÉRIE DE PAITOUAN=ZONE "AN" ET "TUNGYÜ LIMESTONE" DE WILLIS ="PAIYUNZŬ SERIES" ET "LIUTINGSZŬ SERIES" DE C. C. SUN

Dans le paragraphe 3, j'ai déjà signalé que la partie supérieure de la série de Nantai renferme quelques minces couches de calcaire dolomitique, mais dans la région de Paitouan, cette roche devient très importante. Là se place une grande formation complexe calcaro-schisto-quartzitique qui occupe les environe du village considéré et se prolonge jusqu'au Sud-Ouest du Woutaihsien. Je propose pour cette longue zone le nom série de Paitouan, comprenant la zone "An" et le "Tungyü limestone" de Willis Ce grand géologue semble n'avoir pas assez tenu compte des effets de métamorphisme. Comme dans la série de Nantai, la partie nord-est, plus métamorphisée, est faite de vrais gneiss micacés, de micaschiste, de phyllade; de cipolin, de marbre, de quartzite etc. Mais dans la partie sud-ouest, les mêmes roches sont extrémement peu métamorphisées. Impossible de couper cette unique zone en deux troçons, chacune représentant une série spéciale.

En outre, dans le marbre de Wheilondi, Sud de Nantai, j'ai trouvé des *Gynmosolen*[1], espèce voisine de *Collenia*, et aussi dans le calcaire du Sud de Chicheinchao, Sud-Ouest de Tunyet. Le "Tungyü limestone", lithologiquement réductible à la Zone "An", s'avère ainsi comme représentant le Sinien classique de Chine du Nord. Ce sera notre série de Peitouan.

D'après certains caractères: grande épaisseur, forme structurale etc., la série de Paitouan peut être divisée en plusieurs sous-séries, les noms donnés par C. C. Sun[3] "Paiyunszü series" et "Liutingszü series" ont vraiment une valeur stratigraphique dont je discuterai prochainement.

III Paleozoique

1 Série de Shitchéouchan="Sinian System" de Willis et Blackwelder

Au Sud-Est du Woutaichan, se trouve une grande série calcaire dont la partie inférieure se compose généralement de schiste, de grès, de brèche ou de conglomérat, etc. Blackwelder a, avec raison, attribuè ces terrains au Paléozoïque, et proposé deux noms: "Manto shale" et "Kikou limestone", leur âge est bien cambro-ordovicien. En de nombreux endroits du versant nord-nord-ouest du Woutaichan, la série du Shitchéouchan reste horizontalement sur les terrains plus anciens, où la discordance parait très nette.

2 Série de Hsitienho="Shansi series" de Willis et Blackwelder

Le Calcaire du Shitchéouchan supporte en pseudo-concordance, plusieurs petits bassins houillers, orientés suivant la direction NE-SW., Blackwelder en a proposé le nom, "Shansi series", âge permo-carbonifère.

1 Yang-Kieh. Bull. Geol. Soc. of China. Vol. XIV, no. 3, p. 303, 1935.

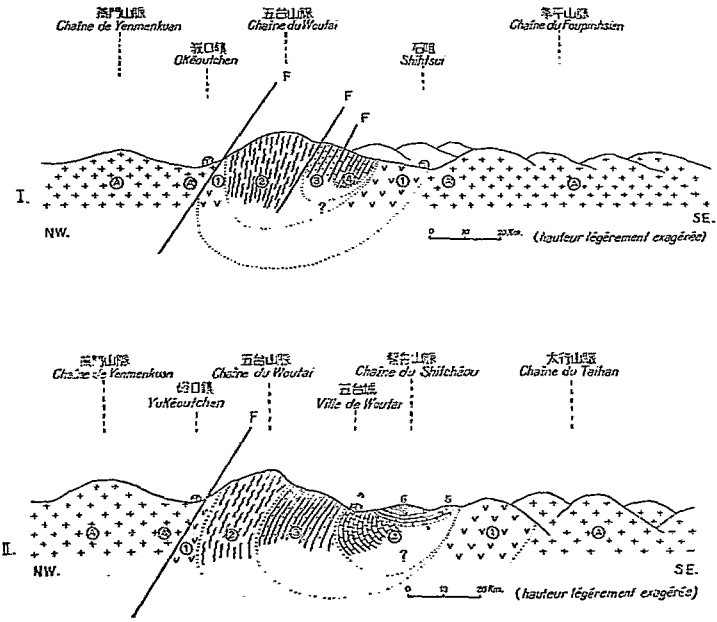
2 A. W. Grabau. Bull. Geol. Soc. of China Vol. I, p. 37, 1922.

3 C. C. Sun. Idem. Vol. II, p. 245.

RÉSUMÉ ET CONCLUSION

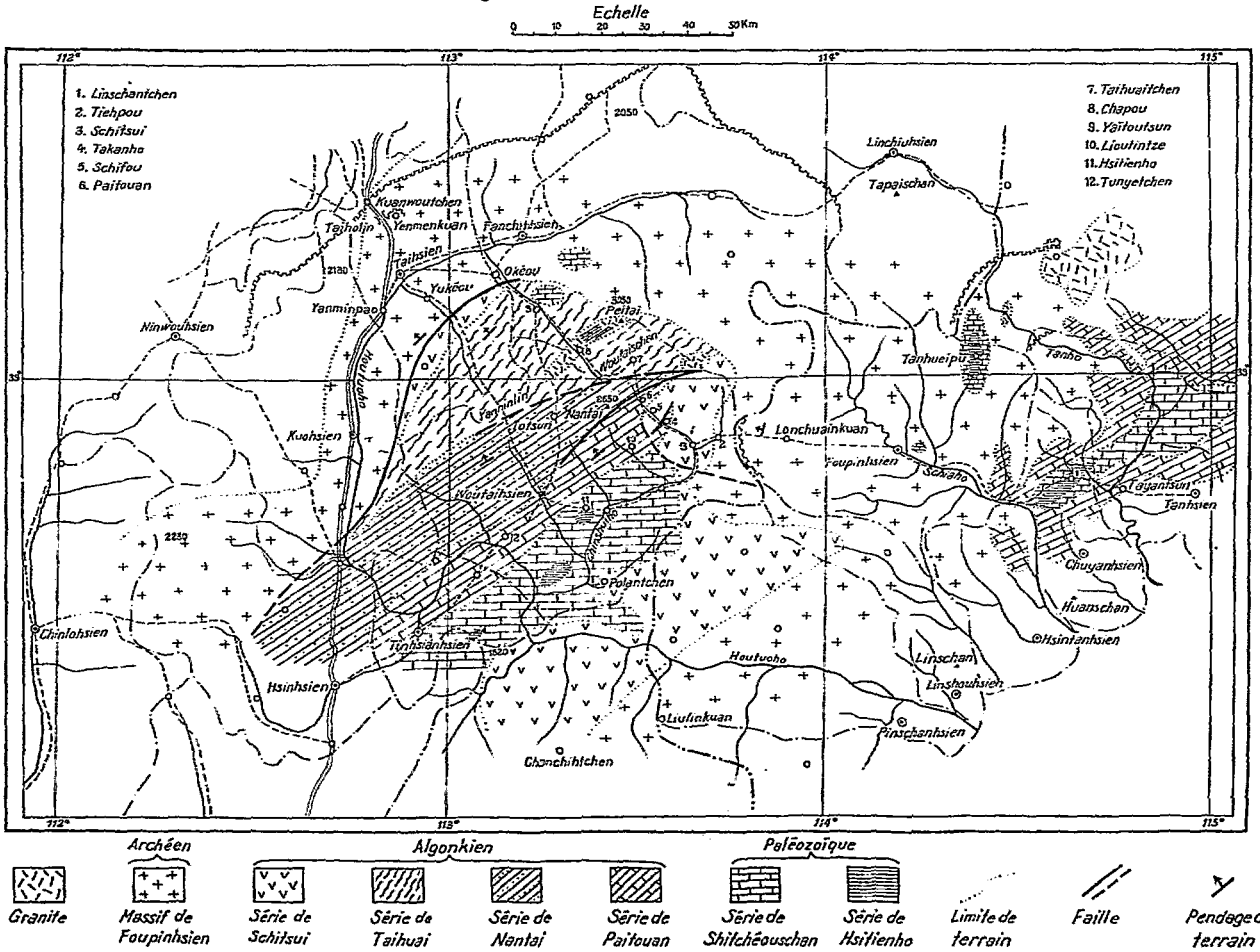
La Géologie de la chaîne du Woutai comprend deux grands groupes de terrains: Paléozoïque et Précambrien qui se divise à son tour en Algonkien et Archéen. Je pense que la disposition stratigraphique de ces terrains antépaléozoïque est très difficile à identifier. Quoi qu'il en soit, les propriétés lithologiques de ces différentes couches nous aident à résoudre l'énigme de l'histoire de la terre. Par exemple, dans la région étudiée, les gneiss migmatitiques de Foupinhsien et de Yenmenkusn, et les gneiss oeillés de Lontchuainkuan et de Okéoutchen forment un groupe représentant problématiquement l'Archéen; les zones de Schitsui et de Taihuai d'une part de Nantai et de Paitouan d'autre part constituent des séries indépendantes, dont la partie supérieure, séries de Nantai et de Paitouan correspondrait au Sinien du professeur Grabau, et la partie inférieure, séries de Taihuai et de Schitsui, au systéme du Woutai, sens striet. Plusieurs granites successifs sont nécessaires pour expliquer le *métamorphisme*.

1 A. W. Grabau. Bull. Geol. Soc. of China. Vol. 1, p. 37, 1922.



Sections schématiques de la chaîne du Woutai, supprimant les accidents locaux: I, partie nord-est, II, partie sud-ouest. A, massif de Foupinhsien et de Yenmenkuan, gneiss migmatitique, A'. zone de Lontchuainkuan et de Okéoutchen, gneiss oeillé; 1, série de Schitsui. 2. série de Taihuai, 3, série de Nantai, 4, série de Paitouan; 5, série de Shitchéouchan, calcaire, 6, série de Hsitienho, houiller. Pas de discordance angulaire surement constatée entre 4 et 5.

Carte Géologique de la Chaîne du Woutaischan(Schansi).



OBITUARY NOTE ON MR. S. W. WANG

By C. Y. Hsieh

The untimely death of Mr. S. W. Wang on Feb. 10th 1936 is certainly a serious loss to the Chinese geology. Although his name is not so well known as others in the geological circle, Mr. Wang has indeed made remarkable contribution to the study of Chinese crystals and minerals. His works on the crystallographic study of topaz, beryl, quartz and orthoclase from various parts of China are of the highest standard and are in many ways comparable to the same type of work done elsewhere. Mr. Wang has written also a monographic treatise in Chinese on crystallographic projection and calculation in which several new methods and formulas were introduced. This was his most painstaking work which took him several years to finish. The last part of the manuscript was in fact done when he was already very sick. How pity it is that Mr. Wang could not see his work published!

Although primarily interested in the laboratory study of minerals and crystals, Mr. Wang was also an enthusiastic field worker. He has made together with Prof. H. C. Tan in 1929 a traverse along the projected railway line from Nanchang to Foochow and he himself alone has studied the geology of western Fukien and southern Kiangsi. In the early summer of 1932 he took a trip to Wutaishan area in Shansi to study the metamorphic rocks there and to collect some topaz and quartz crystals in the Fanchih-Hunyuan district. In 1933 he made a trip to eastern Shangtung to study the gold deposits of Chaoyuan and other areas. This was his last trip and after that his health has become so bad as to prevent him from doing any further field excursion. In spite of being very much handicapped by his physical condition for making extensive mapping work, Mr. Wang could nevertheless grasp in many cases a good understanding of the stratigraphy and tectonics of the region he has passed.

Mr. Wang was born in 1886 at Changting, Fukien. He was graduated in 1919 from the first geological class of the Peking National

University. After graduation, he passed an examination for high civil service officers and was assigned to work as a junior member in the Geological Survey. Mr. Wang had had at that time already a good foundation in mathematics and this was perhaps the reason which has made him to select this difficult subject of crystallographic study. His interest in that line was however, chiefly induced and inspired by Dr. W. H. Wong, who gave him in 1929 the first guidance in crystallographic research and one year later they worked together on the Mongolian and other Chinese topaz. Since then Mr. Wang began to do independent work in crystallographic measurement and research. For a short period in 1933 Mr. Wang was appointed, on the recommendation of the late Dr. V. K. Ting, acting instructor in mineralogy in the Peking National University.

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第十五卷　第二期

中國地質學會誌

民國二十五年六月

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