中央地質調查所

地質彙報

第十號

民國十七年一月

總目

北京京華印書局代印

刊E 2/10

地 質 彙 報

10 卷 1957年

¥ 5.00

地質彙報第十號

目次　　頁數

地質彙報　目次

綏遠大青山煤田地質

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緒言

首先研究大青山煤田者、爲翁詠霓所長。翁所長於民國四年夏因農商部准士默特總管之請、乃前往調查、當時因注重鑛產、於地質雖間有未詳盡之處、然於煤田之分布狀況、及地質構造之繁雜情形、已悉得其概要焉。(見地質調查所地質彙報第一號綏遠地質鑛產報告)作者於民國十四年秋冬間復至大青山考察地質、歷一月餘、是役利用綏遠都統署測繪所所製十萬分之一地形圖、頗稱利便、結果除將煤田內岩層各採集化石與山西大同煤田詳細分列比較外、並測一較詳之地質圖及二十餘剖面圖、藉以推定岩層之構造。茲爲敍述便利起見、分爲地層構造地形鑛產四章、論之如左。

地層

大青山煤田附近之岩層、除火成岩外約可分爲六系。

元古界　五台系

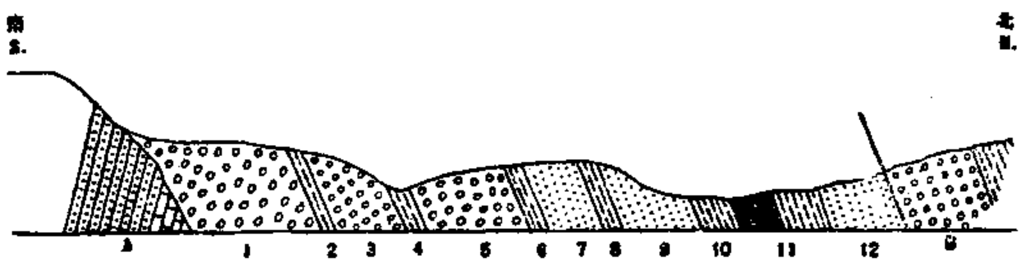
煤田附近最古之岩層與維理士氏在山西五台縣一帶所稱之五台系極相似、故仍稱五台系、以便易於比較。其組織可分二部、一爲片麻岩及結晶片岩、片理皆極清晰、(第二版甲圖)傾斜隨處可測、且分布甚廣、歸化盆地以北綿亙於煤田之前者、率屬此系、中以片麻岩爲尤夥、片岩惟于薩拉齊縣西北五達溝內頗有露出處。二爲大理岩及石英岩、此等岩層在薩拉齊縣城北水晶溝內恒夾於片麻岩中、然露頭最多處、每在大青山足與歸化盆地接近部分、如綏包路畢克齊車站西北之鶻鵝山、察素齊車站西北之古城一帶、以及討子號車站

西北之白石頭溝門、公吉板車站西北之東圍等處、所見皆是。惟在察素齊北之珠爾溝及小西溝內、則大理岩與石英岩皆沿逆褶斷線陷落於中侏羅紀及上侏羅紀紅色頁岩砂岩中、而在薩拉齊縣城西北谷滿銀店之北、大理岩又直出於石炭二疊紀煤系之下、面積亦甚廣。

第一圖

薩縣童盛茂村南馬地灣子附近石炭二疊紀煤系剖面圖

Fig. 1. Section of the Permo-Carboniferous coal series at Ma Ti Wan Tzu S. of Tung Shêng Maó, Saratsi.



元古界石灰岩及石英岩 A. Neo-Proterozoic limestone & quartzite

二疊三疊紀礫岩及紅色頁岩 B. Permo-Triassic conglomerate & red shale

石炭二疊紀　下煤系

薩拉齊縣城西北童盛茂村南有石英岩及淺灰色石灰岩一致傾向西南約八十度、不整合覆於其上者、爲石炭二疊紀煤系、傾斜東北約七十度、(第一圖及第二版乙圖) 此種石灰岩變質雖甚淺、然與石炭二疊紀煤系顯呈不整合觀、故亦當屬五台系。在五達溝內石灰岩與煤系接觸處亦同、惟傾斜度相差甚微耳。煤系之組織爲礫岩砂岩頁岩及煤層等、尤以礫岩爲特著、全系僅厚約百公尺。在童盛茂村南馬地灣子附近 (第一圖) 其岩層組織自下而上如左。

一　石英礫岩、

二　黑色頁岩、

三　石英礫岩、

四　黑色頁岩、

五 石英礫岩、

六 黑色頁岩、

七 灰色礫岩狀砂岩、

八 黑色頁岩、

九 白色礫岩狀砂岩、

一—九共厚約七十六公尺

十 黑色砂質頁岩厚約六公尺、富含植物化石、據作者已採取之標本、約略鑒定其種名爲Neuropteris flexuosa Brongniart, sphenopteris sp. 及 cordaites sp.等、

十一 黑色頁岩及煤層、 共厚約十三公尺、

十二 白色礫岩狀砂岩、 厚約十一公尺、

右剖面總厚僅一百零六公尺、除少許黑色頁岩外、大部爲礫岩。按石炭紀及石炭二疊紀煤系之在山西者、往往厚達三百餘公尺、且其下部恆含海成石灰岩層、此處所見不惟厚度大減、海成石灰岩亦完全絕跡、僅代以礫岩層、足證山西石炭紀期內之海面似未嘗侵入大青山一帶、而其石炭二疊紀期內之沼澤、僅至大青山即已達崖岸矣。

石炭二疊紀煤系僅見於大青山煤田之西部、一在薩縣大炭壕童盛茂石匠窰子一帶、二在谷滿銀店沙鍋窰子一帶、（第二圖）於谷滿銀店附近曾採得植物化石頗夥、茲經約略鑒定其種名如左。Pecopteris arborescens Schloth, Sphenophyllum oblongifolium, Sphenophyllum thoni Zeil, 及 Annularia brevifolia Brongniart

等三在五達溝海流素溝等處。（第三圖）

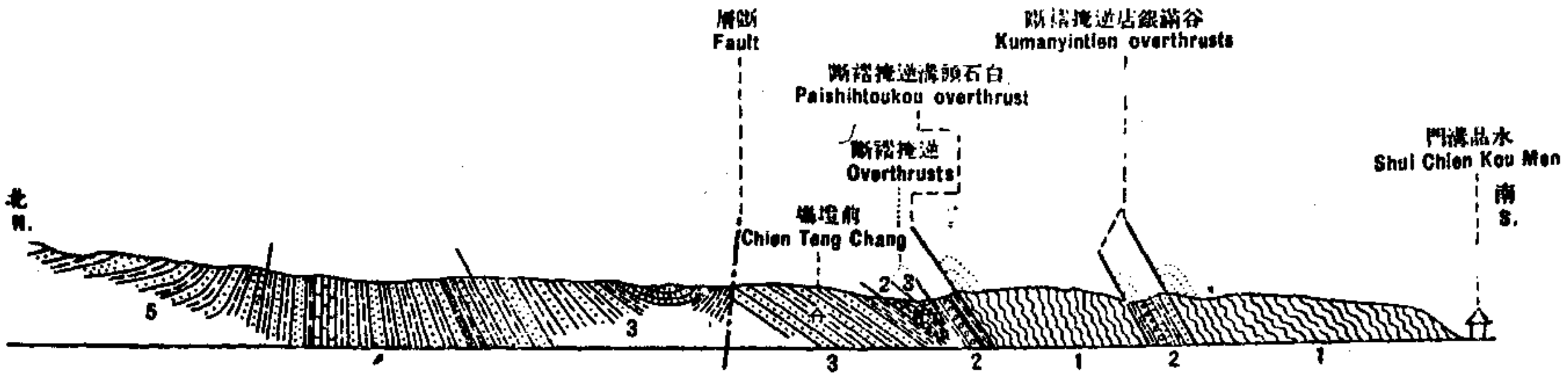
第二圖

水晶溝地質剖面圖

Fig 2. Section along the valley of Shui Chien Kou.

平面縮尺十萬分之一

Horizontal scale 1:1000,000



元古界片麻岩及大理岩 1. Proterozoic gneiss & marble.

石炭二疊紀煤系 2. Permo-Carboniferous coal series.

二疊三疊紀及三疊紀紅色頁岩與砂岩 3. Permo-Triassic & Triassic red shale & sandstone.

下侏羅紀煤系 4. Lower Ju-assic coal series.

中侏羅紀及上侏羅紀紅色頁岩與砂岩 5. Middle & Upper Jurassic red shale & sandstone.

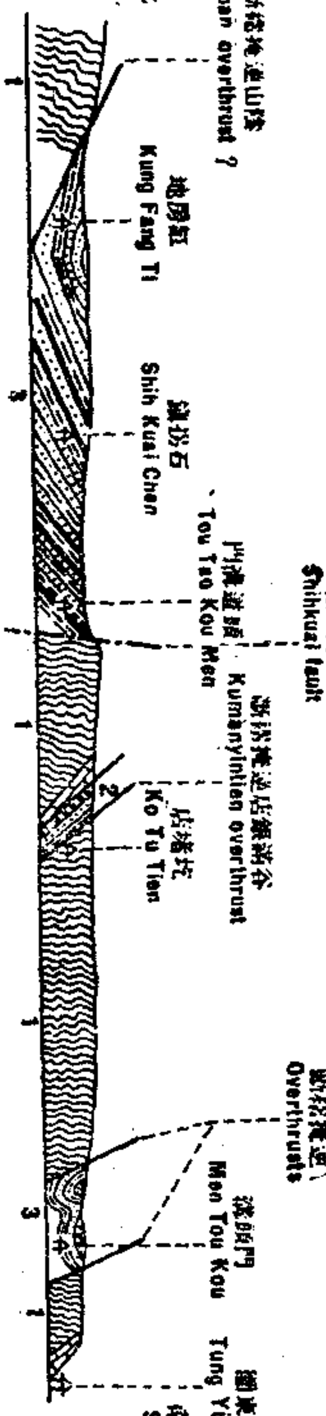
第三圖

五達溝地質剖面圖

Fig. 3. Section along the valley of Wu Ta Kou.

平面縮尺十萬分之一

Horizontal scale 1:100 000



元古界五台系 1. Wutai system.　石炭二疊紀煤系 2. Permo-Carboniferous coal series.　下侏羅紀煤系 3. Lower Jurassic coal series.

二疊三疊紀及三疊紀　紅色頁岩及砂岩

二疊三疊紀及三疊紀紅色岩層在巴兔溝內童盛茂村附近位於石炭二疊紀煤系之上、（第四圖）其底部岩層爲石英礫岩、頗似與其下煤系不連續者。東至水晶溝內前燈場附近紅色岩層雖皆倒置、然與石炭二疊

紀煤系接觸之情形仍相同。(第二圖)惟在歸化城北温家窰附近、此種紅色岩層竟直覆於元古界五台系

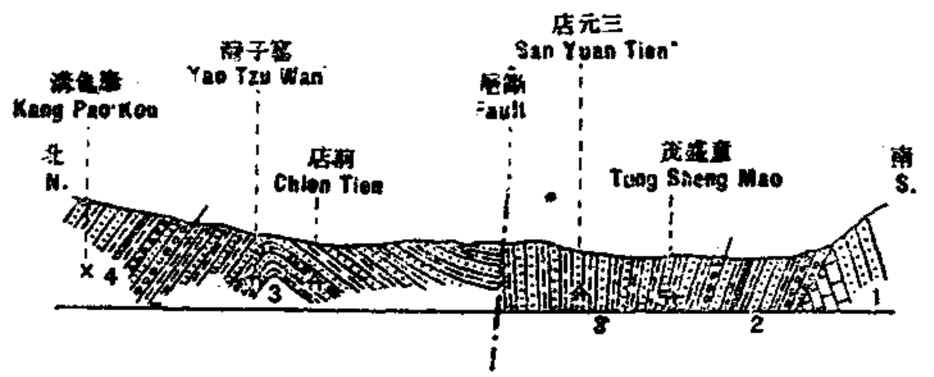
第四圖

巴兔溝內童盛茂康包溝間地質剖面圖

Fig. 4. Section between Tung Sheng Mao & Kang Pao Kou along the valley of Pa Tu Kou.

平面縮尺五萬分之一

Horizontal scale 1:50,000



元古界石灰岩及石英岩
1. Proterozoic limestone & quartzite.

石炭二疊紀煤系
2. Permo-Carboniferous coal series.

二疊三疊紀及三疊紀紅色頁岩與砂岩
3. Permo-Triassic & Triassic red shale & sandstone.

下侏羅紀煤系
4. Lower Jurassic coal series.

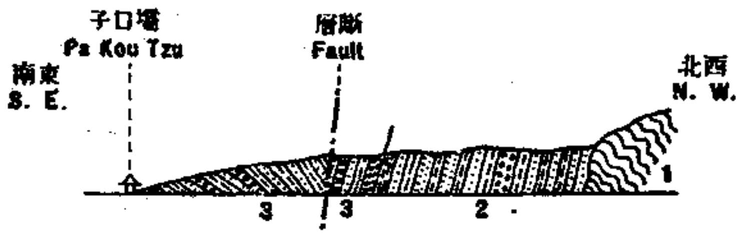
第五圖

歸化城北壩口子温家窰一帶地質剖面圖

Fig. 5. Section between Pa Kou Tzu & Wen Chia Yao on the north of Kui Hua Chêng.

平面縮尺十萬分之一

Horizontal scale 1:100,000



元古界片岩及大理岩
1. Proterozoic schist & marble.

二疊三疊紀及三疊紀紅色頁岩與砂岩
2. Permo-Triassic & Triassic red shale & sandstone.

下侏羅紀煤系
3. Lower Jurassic coal series.

之上、而呈不整合觀、(第五圖)於此更可間接證明其與石炭二叠紀煤系之關係、固非連續者矣。紅色岩層以紅色礫岩砂岩與頁岩相間組織之、其總厚度雖如第二第四第五等圖所示、因岩層褶曲斷裂、不易詳測、然

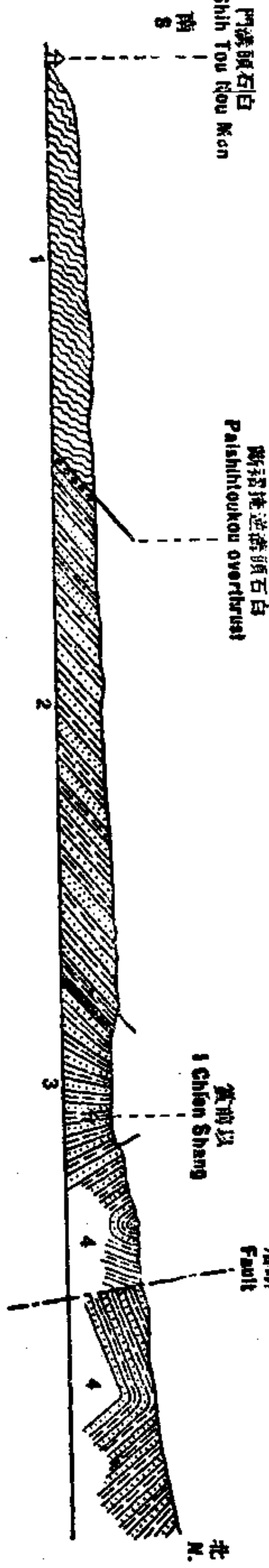
約計在四百至六百公尺之間。其中雖未採得化石、然與山西陝西境內石炭二疊紀煤系及侏羅紀煤系間之紅色岩系位置性質相較、（參看中國地質圖太原榆林幅說明書）其時代當屬于二疊三疊紀及三疊紀。紅色岩層分布于薩縣東北麥達溝白石頭溝內之黑土壩前瑙包以前賞一帶者、（第六圖）西界花崗岩、大部

第六圖 白石頭溝地質剖面圖

Fig 6. Section along the valley of Pai Shih Tou Kou.

平面縮尺十萬分之一

Horizontal scale 1:100,000



元古界五台系

1, Wutai system.

二疊三疊紀及三疊紀紅色頁岩與砂岩

2. Permo-Triassic & Triassic red shale & sandstone.

下侏羅紀煤系

3. Lower Jurassic coal series.

中侏羅紀及上侏羅紀紅色頁岩與砂岩

4. Middle & Upper Jurassic red shale & sandstone.

變爲石英岩及板岩、其分布于畢克齊西北之黑牛溝內者、如（第七圖）所示、多被斷裂、在歸化城北温家窰毫賴溝五素圖等處、則岩層傾斜大致頗有規則。（第五圖）

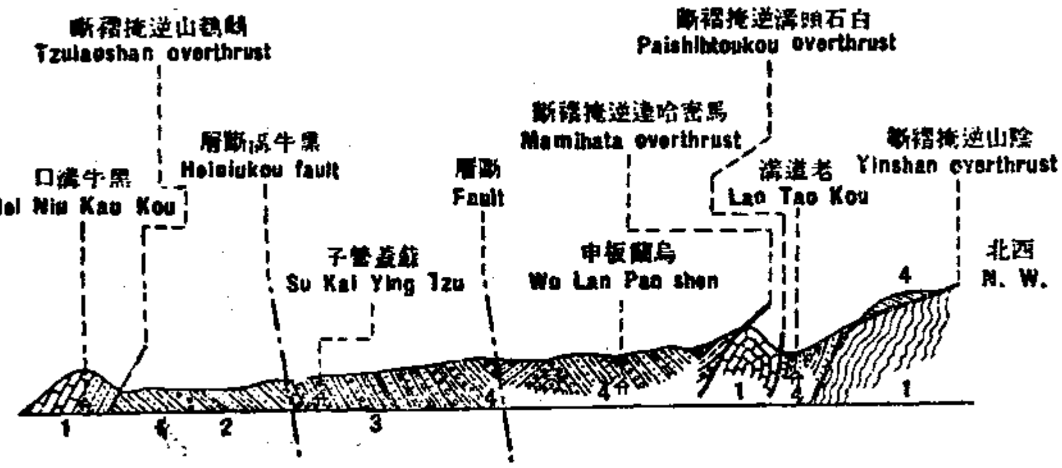
第七圖

黑牛溝地質剖面圖

Fig. 7. Section along the valley of Hei Niu Kou.

平面縮尺十萬分之一

Horizontal 1:100,000



元古界片麻岩大理岩及石英岩

1. Proterozoic gneiss, marble & quartzite.

二疊三疊紀及三疊紀紅色頁岩與砂岩

2. Permo-Triassic & Triassic red shale & sandstone.

下侏羅紀煤系

3. Lower Jurassic coal series.

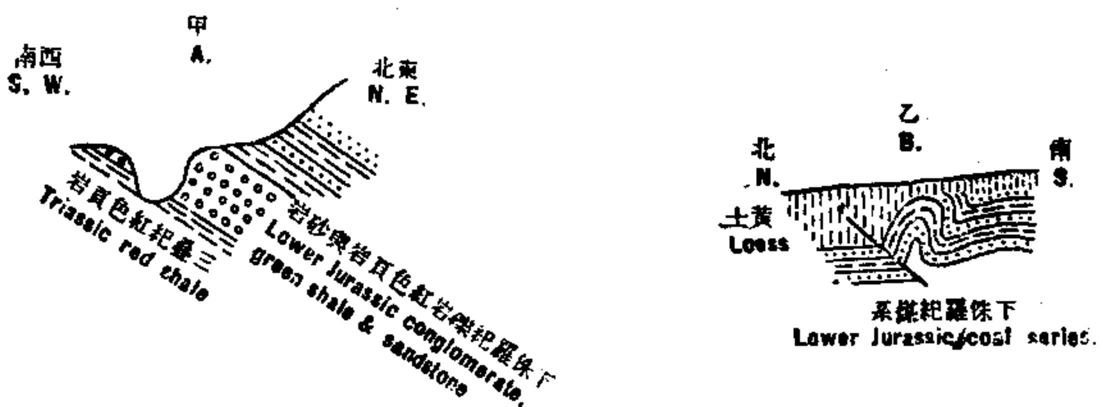
中侏羅紀及上侏羅紀紅色頁岩與砂岩

4. Middle & Upper Jurassic red shale & sandstone.

下侏羅紀　上煤系

下侏羅紀煤系爲別于石炭二疊紀之下煤系、故謂之上煤系。其岩層大部爲綠色頁岩砂岩礫岩煤層等、總厚可達四百公尺。在巴兎溝內之康包溝附近（第四圖及第三版甲圖）其底層爲礫岩、礫石多石英岩、明於下侏羅紀之初、地形上曾受變動、故僅爲粗礫石之沉積、在歸化城北毫賴溝附近如第八圖甲所示、亦呈同樣之現象。上煤系露出之區、在歸化城北者爲壩口子附近、（第五圖）在畢克齊西北者爲黑牛溝附近、（第七圖）南限于斷層、岩層露頭頗不完整、在察素齊北者爲東溝西溝內之柳樹灣一帶、岩層受擠壓頗甚。而煤系露出最廣者、爲自討子號車站北之大溝西經以前賞把總窰子三道壩中老窩鋪壋包溝達石拐鎮一帶、（

第八圖
臺賴溝東地質剖面圖
Fig. 8. Section E. of Hao Lai Kou.



第二第三第四第六圖）于大溝附近更煤系內含石灰岩一層、厚約二三尺、于三道壩北見煤系上部夾石灰岩六七層、並含有魚類化石、雖因標本保存不甚完全、難資鑑定、然在中國西北部最初于下侏羅紀煤系內採得淡水動物化石者此也。上煤系除上述各區外、在公積板車站北斗林沁溝五達溝谷滿銀店楊圪塅等處、（第九第十第三圖）凡零星露頭率被逆褶斷破裂而陷落于片麻岩片岩之中。作者此次在五達溝及石拐鎮東北于接近煤層之灰色砂質頁岩內、又在楊圪塅等處、皆採得植物化石多種、足以確定煤系之時代。玆經約略鑑定如下、 Cladophlebis cf. acutangula, Baiera sp., Czekanowskia rigida Heer, Podozamites lanceolatus Heer, Asplenium whithyense Heer, 及 Coniopteris sp. 等。

中侏羅紀及上侏羅紀　紅色頁岩及砂岩

中侏羅紀及上侏羅紀岩系之底層、在畢克齊北喇嘛洞溝口及黑牛溝內如第七第十一圖所示、爲紅色礫岩、礫石多片麻岩、在白石頭溝內以前賞北及水晶溝內、則恒屬紅色頁岩、（第二第六圖）皆位于下侏羅紀煤系之上、尚未顯不連續之跡。其岩層組織在水磨溝黑牛溝珠爾溝東溝西溝一帶、爲紅色礫岩砂岩及紅色頁岩、尤以礫岩爲著、（第三版乙圖）岩層

摺皺頗烈、(第七及第十二圖)而東溝西溝附近岩層因一部鄰接花崗岩已受變質作用變爲石英岩及板

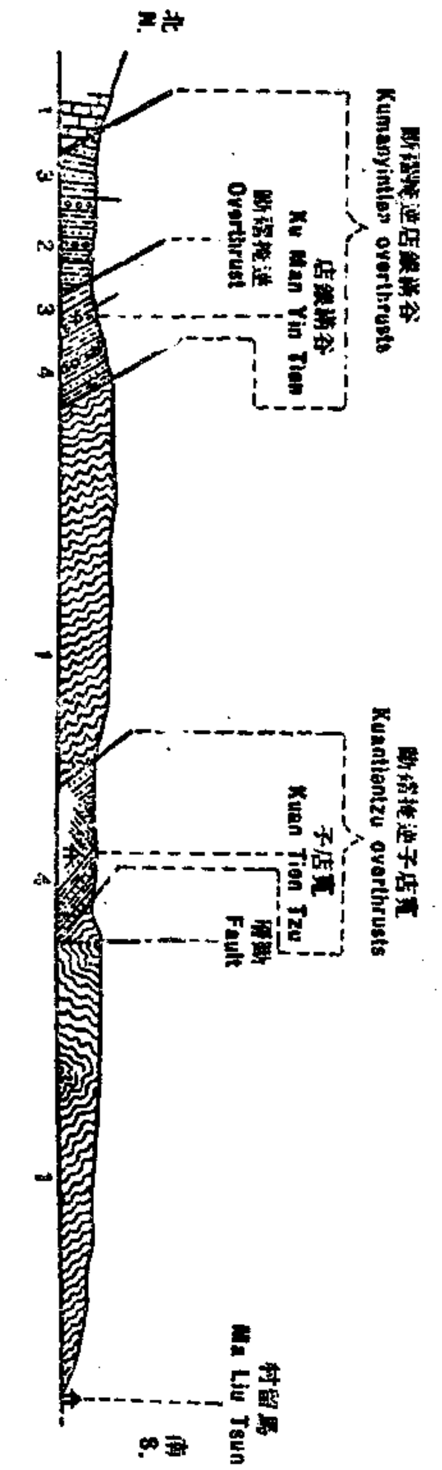
第九圖

巴兎溝內寬店子谷滿營店一帶地質剖面圖

Fig. 9. Section between Ma Liu Tsun & Ku Man Yin Tien along the valley of Pa Tu Kou.

平面縮尺五萬分之一

Horizontal scale 1:50,000



1. Wutai system. 2. Permo-Carboniferous coal series.
3. Permo-Triassic & Triassic red shale & sandstone. 4. Lower Jurassic coal series.

岩等。惟石拐煤田之北後小壩子得勝溝及胡洞兒一帶、則以藍色或紅色頁岩及砂岩爲特著、摺曲及小斷層

亦夥。(第二及第六圖)

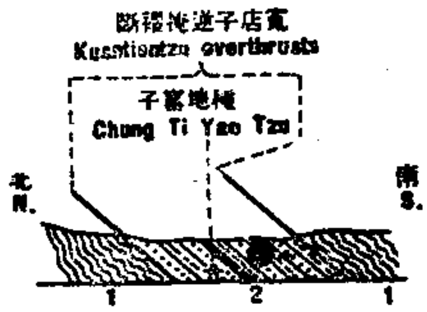
第十圖

小斗林沁溝地質剖面圖

Fig. 10. Section along the valley of Hsiao Tou Lin Chin Kou.

平面縮尺五萬分之一

Horizontal scale 1:50,000



元古界片麻岩

1. Proterozoic gneiss.

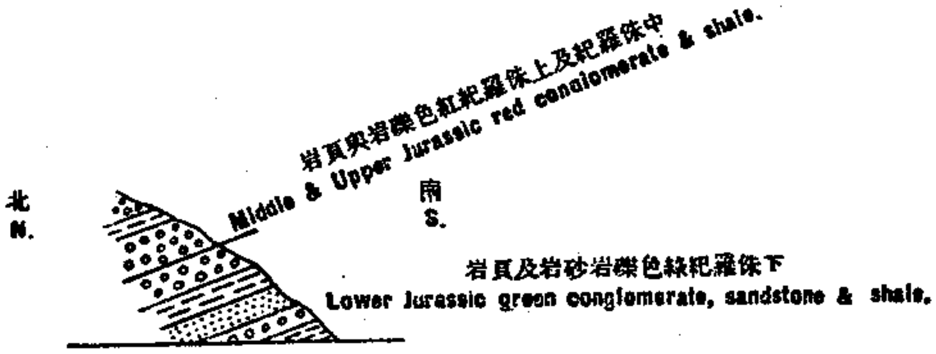
下侏羅紀煤系

2. Lower Jurassic coal series.

第十一圖

喇嘛洞溝口岩層剖面圖

Fig. 11. Section at the mouth of the valley of La Ma Tung Kou.



全系厚度在調查區內頗不易估計、約略言之、大抵在五百公尺以上其所以易與下侏羅紀煤系區分者、因全部岩層率呈紅綠色。雖于其中尚未發見化石、但與陝西北部下侏羅紀煤系上有化石地層（參考中國地質圖太原榆林幅說明書）之位置及岩石性質相較其時代自應屬于中侏羅紀及上侏羅紀也。

第四紀　泥炭層及沖積層

沖積層除少許見于大青山各溝內、大半分布于歸化盆地。其組織爲沖積黃土沙土及礫石等、兼含有泥炭層。

泥炭曾經開採者三處、一在台格木車站西南裁生霍拉哥氣大里包一帶、二在二道河子附近、三在討子號東南、中以台格木車站西南泥炭區爲最大、其岩層剖面如第十三圖、泥炭距地面僅三四尺、上覆以含淡水介殼

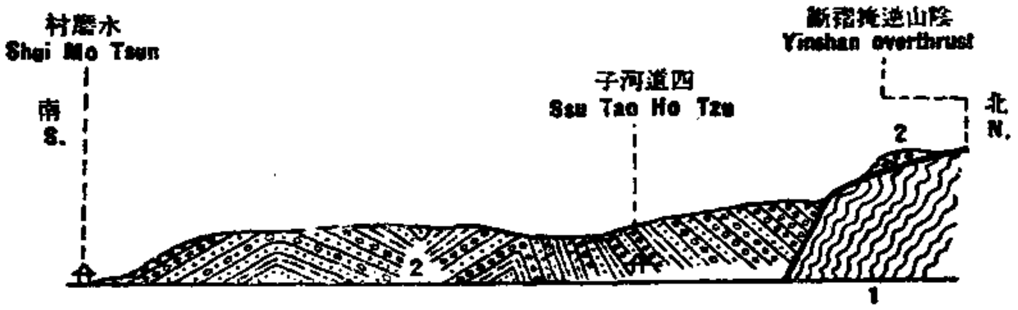
第十二圖

水磨溝地質剖面圖

Fig. 12. Section along the valley of Shui Mo Kou.

平面縮尺五萬分之一

Horizontal scale 1:50,000



元古界片麻岩及大理岩

1. Proterozoic gneiss & marble.

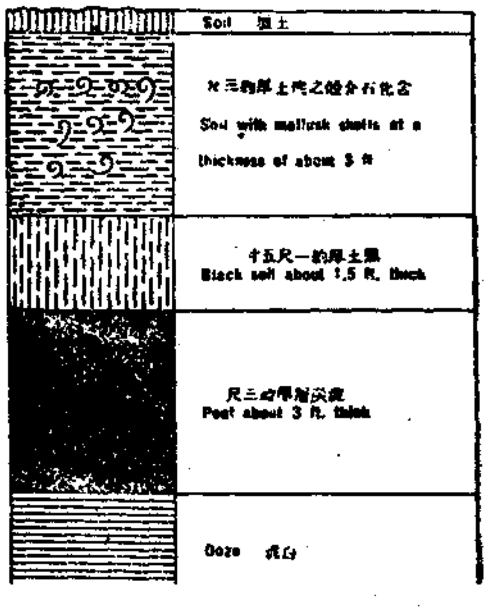
中侏羅紀及上侏羅紀紅色礫岩砂岩與頁岩

2. Middle & Upper Jurassic red conglomerate, sandstone & shale.

第十三圖

台格木車站西南產泥炭土層柱形圖

Fig. 13. Section through the peat deposit S. W. of the Tai Ko Mu station of Suipao Railway.



類化石之泥土、而泥炭本層內、往往亦含同樣之化石。凡有泥炭之區、恆成低凹草地、本地人察看泥炭之法、以水泉之有無爲斷、倘土面墳起、旁有細微水泉、炭層必佳、蓋泥炭能藏水、故泥炭厚處恆有細水泉也。

附述花崗岩及安山岩

花崗岩露布于察素齊西北萬家溝西溝之間（第二版丙圖）安山岩則略呈南北向之岩脈狀、侵入于二疊三疊紀及三疊紀岩層內、翁所長報告中已詳述之。（見地質彙報第一號）至二侵入體之地質時代、因在西溝內侏羅紀及上侏羅紀岩系曾受花崗岩之變質作用、故二者如爲同時之侵入體、似至早應在侏羅紀以後。按山西境內之侵入火成岩、往往與中白堊紀摺皺有連帶之關係（見中國地質圖太原榆林幅說明書）大青山距山西甚近、或者其侵入岩之活動、亦屬同時歟。

構造

大青山地層之構造、約可分爲摺皺斷層平層三部、而摺皺又可別爲元古界地層摺皺與石炭二疊紀至中侏羅紀及上侏羅紀地層摺皺。斷層則自元古界以迄中侏羅紀及上侏羅紀地層皆有之、平層惟限于第四紀地層焉。

摺皺

一、元古界地層摺皺

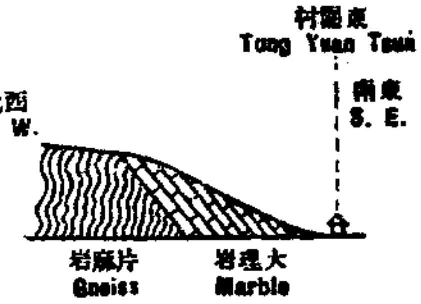
元古界之片麻岩片岩及大理岩石英岩等、在大青山煤田與歸化盆地之間者、多傾向南及東南、但局部之小摺皺甚夥。他若在歸化城北温家窰附近之片岩及大理岩、則傾向西北、（第五圖）水磨溝內之片麻岩及大

理岩傾向西南、（第十二圖）巴兔溝內在寬店子以北之片麻岩及大理岩多傾向東或直立、（第九圖）•石拐鎮北之片岩、則傾向西北、其變異無常乃如此。傾角恆由四十度至直立皆有之、尤以五十度爲最常見、僅水磨溝內之傾角、小至三十度者乃例外耳。

第十四圖

五達溝內東園村西北元古界大理岩與片麻岩之不整合

Fig. 14. Unconformity between Proterozoic gneiss and marble N. W. of Tung Yuan Tsun.



巴兔溝內在馬留村之北、片麻岩及片岩示顯著之外斜層、（第九圖）且由此至谷滿銀店之間、五台系中逆掩摺斷甚夥、惟俱在片麻岩內、不易考察。黑牛溝內在老道溝村附近、元古界大理岩成一急峻外斜層。（第七圖）五達溝內東園西北、元古界大理岩與片麻岩顯示不整合之接觸、如第十四圖所示。

二、石炭二疊紀至中侏羅紀及上侏羅紀地層之摺皺

自石炭二疊紀直至中侏羅紀及上侏羅紀地層、皆共同一致摺皺、故合論之。大青山煤田摺皺約可分爲四部。一在歸化城北壩口子温家窰五素圖一帶、（第五圖）岩層略成一內斜層、其南翼除東南端因接近歸化盆地僅露出下侏羅紀煤系、緩向北傾外、其西翼及北翼皆由二疊三疊紀及下侏羅紀岩層組成、悉傾向東南甚急。二由水磨溝東經黑牛溝珠爾溝至西溝等處、計長約四十餘里、再西踰花崗岩侵入體、（參考第一版平面圖）起自前小壩子大溝、西經以前賞把總窰子三道壩胡洞兔堖包溝童盛茂直達石拐鎮一帶、共長約一百一十

餘里。岩層則包有石炭二疊紀至中侏羅紀及上侏羅紀、除因局部摺皺或斷層發生變動外、皆大致北傾、最普通之斜角、約由十度至六十度。三自以前賞南之白石頭溝起、西經前壚包以至老窩鋪、長達六十里、岩層由石炭二疊紀至下侏羅紀煤系之一部、悉例置南傾、其斜角以三四十度爲最常見。四爲沙鍋窰子谷滿銀店揚圪壕及寬店子種地窰子等處之二狹帶區、岩層爲石炭二疊紀及下侏羅紀煤系、多向南及東南傾斜、其傾角率由二十度至六十度。除上所述外、大青山煤田最稱複雜之變動爲他處所稀見者、厥爲逆掩摺斷、茲將其較重要者、分述于左。

白石頭溝逆掩摺斷　此摺斷爲大青山重要煤田之南界。自西至東經由水晶溝內之前壋塌附近、東北行經中保圪素、復東向延長至白石頭溝以東。以摺斷面之傾斜方向在白石頭溝內最爲明顯、（第六圖）故稱爲白石頭溝逆掩摺斷。其摺斷線之走向、在前壋塌中保圪素之間、爲西南—東北、在中保圪素白石頭溝一帶、爲西—東。作者初疑爲普通斷層、繼見斷綫似與其北二疊三疊紀岩層之倒置有直接關係、故知爲逆掩摺斷。觀于南部之元古界五台系每與其北之二疊三疊紀岩層直接接觸、而石炭二疊紀煤系轉被覆壓于摺斷面之下、則其摺斷距之偉大、可想見也。摺斷綫之長、已確定者約達六十餘里、但如第一版平面圖所示、自白石頭溝沿摺斷綫而東、經花崗岩與二疊三疊紀岩層之接觸、再東經西溝東溝直至老道溝、（第七圖）摺斷綫頗有連屬之趨向、果爾則摺斷綫長度、共可達百餘里。而其摺斷距似愈東愈增、以老道溝附近爲最大。

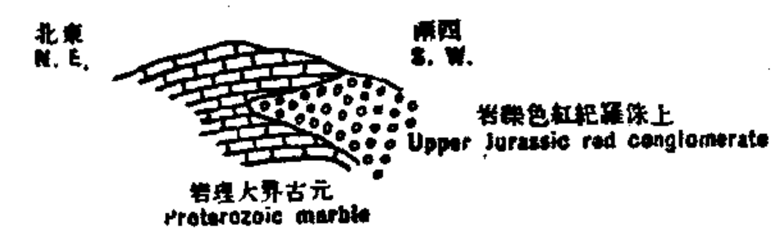
陰山逆掩摺斷　大青山煤田之北界爲陰山逆掩摺斷、起自包頭東北之鷄毛窰子、中經缸房地胡洞兔至後小壩子、更東逾花崗岩侵入體、經老道溝喇嘛洞以達水磨溝東南、摺斷綫共長達二百里、中間雖因一部經花

斷岩體、摺斷情形不易窺察、然老道溝與後小壩子間之逆掩摺斷、方向位置皆列于一直綫之上、當爲同一摺斷、始無疑也。又摺斷綫走向、大致自西而東、與岩層走向略相平行、僅在缸房地胡洞兎之間、一部稍呈西南東北向。欲詳此逆掩摺斷之狀況、宜參考第三第七及第十二等圖、而第七及第十二圖在老道溝與四道河子北、皆于片麻岩之上、露出中侏羅紀及上侏羅紀頁岩或礫岩、尤爲逆掩摺斷之明證。惟沿摺斷綫在缸房地北、則以下侏羅紀煤系與元古界片岩接觸、在胡洞兎後小壩子喇嘛洞等處、皆以中侏羅紀及上侏羅紀岩層與元古界片麻岩接觸、似亦可以正斷層解說之、則尙有待於詳細調查耳。但如逆掩摺斷之說不謬、則大青山煤田附近、除白石頭溝逆掩摺斷、此又當爲第二主要綫矣。

第十五圖

馬密哈達東北上侏羅紀紅色礫岩擠入元古界大理岩之接觸

Fig. 15. Upper Jurassic red conglomerate partly thrusted into Proterozoic marble N. E. of Ma Mi Ha Ta.



馬密哈達逆掩摺斷　在白石頭溝摺斷之東北端、（即珠爾溝上游）其南之元古界以大理岩爲多。在大理岩南馬密哈達東北中侏羅紀及上侏羅紀紅色礫岩一部擠入元古界大理岩之內、（第十五圖）此處大理岩變動極烈、傾斜不明、幾成塊狀、顯成一逆掩摺斷、故畀斯名。其摺斷綫東北經烏蘭板申之北、（第七圖及第三版丙圖）西南經東溝西溝、計長三十餘里。

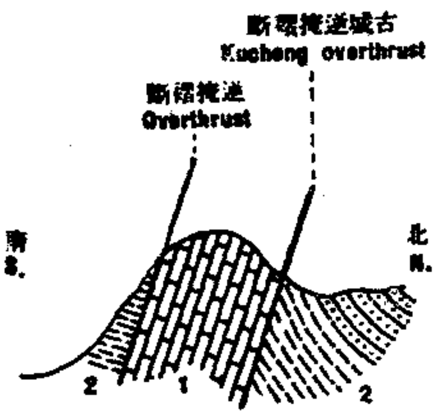
古城逆掩摺斷　察素齊西北古城北如第十六圖所示、元古界大理岩向北倒疊于二疊三疊紀岩層之上、其南復爲二疊三疊紀紅色頁岩所蔽覆、而頁岩于此似與大理岩面成直角、致

大理岩南北各構成逆掩摺斷、茲以在大理岩北者名古城逆掩摺斷。其摺斷線東西延長約達十餘里、與岩層走向略呈平行狀。

隝鴹山逆掩摺斷　畢克齊西北組成隝鴹山之元古界石英岩及大理岩、向北倒積于二疊三疊紀岩層之上、如第七圖所示、構成一逆掩摺斷。在黑牛溝口于大理岩東南、曾有二疊三疊紀岩層露出者、明示大理岩倒覆于二疊三疊紀岩層之上、及一部被侵蝕、而其下二疊三疊紀之岩層乃暴露也。此逆掩摺斷頗有西向與古城逆掩摺斷連屬、而爲一大逆掩摺斷之勢、深望將來詳細研究大青山地質構造者、特加注意焉。

第十六圖　古城北地質剖面圖

Fig. 16. Section N. of Ku Chêng.



1. 元古界大理岩 Proterozoic marble.
2. 中侏羅紀及上侏羅紀紅色頁岩與砂岩 Middle & Upper Jurassic red shale & sandstone.

寬店子逆掩摺斷　大青山山脈內最特異之現象、爲時代較新之地層中、忽夾有較古之岩層、或較古之岩層中忽夾有較新之地層。在山之東部者如在馬密哈達北及東溝西溝一帶、元古界大理岩夾于中侏羅紀及上侏羅紀岩層中者已述如前。而在山之西部如寬店子及種地窖子等處、則下侏羅紀煤系夾入于元古界片岩及片麻岩之中、呈東西狹帶狀、初察之頗似煤系界於二平行正斷層之間、組成所謂槽形斷層者、但細考之、狹帶狀之岩層摺皺極烈、（第三及第九圖）殆由卷入於元古界地層中而然也。況在寬店子南（第九圖）片麻岩一部顯被推擠由南北移覆於下侏羅紀煤系之上、更足明狹帶狀煤

系、係由二平行逆掩摺斷所致、特其摺斷之狀況、有時或不易察耳。又狹帶狀煤系與夾煤系之元古界片麻岩、在地形上高度皆略相等、亦足爲煤系界於二逆掩摺斷之證、蓋煤系帶如係界於槽形正斷層、則其上下移動應甚巨、而煤系帶既爲下降之區、亦當成一低陷地域、因大青山一帶之斷層時代皆甚新也。

谷滿銀店逆掩摺斷　自水晶溝西經沙鍋窰子谷滿銀店楊圪墶直至海流素溝、元古界地層中亦夾一東西狹帶煤系、與前所述之狹帶略成平行、而位於其北、共長約四十餘里。此狹帶組織最異者、在谷滿銀店以東屬石炭二疊紀煤系、以西至楊圪墶則屬下侏羅紀煤系、再西至海流素溝復爲石炭二疊紀煤系、而谷滿銀店附近更露出二疊三疊紀紅色岩層少許、於是合石炭二疊紀至侏羅紀岩層於一狹帶之中、其構造之複雜、頗難索解。然細察之、又與寬店子種地窰子等處之狹帶極相似、故亦應界於二平行逆掩摺斷之間、茲即名爲谷滿銀店逆掩摺斷、惟在海流素溝僅南界於一逆掩摺斷耳。又察第二第三及第九圖、凡煤系狹帶與元古界地層之接觸、煤系恆有被片岩及片麻岩等掩覆之傾向、益證明煤系狹帶實出於二逆掩摺斷之間、非出於槽形斷層之間也。

右述逆掩摺斷之外、作者於野外調查時、在各溝內又恒見較小之逆掩摺斷或摺皺如左、

一、毫賴溝　歸化北壩口子盆地之西有毫賴溝、其東如第八圖乙所示、下侏羅紀煤系一部被擠推由南向北灣曲覆於他煤系平層之上、恰構成一逆掩摺斷。

二、水磨溝　由水磨溝東北入溝至四道河子附近、六七里之內、中侏羅紀及上侏羅紀岩層摺皺極烈。（第十二圖）先呈一外斜層、繼以內斜層、近四道河子有一傾角不等之外斜層、南翼傾角僅三十度左右、北翼則達

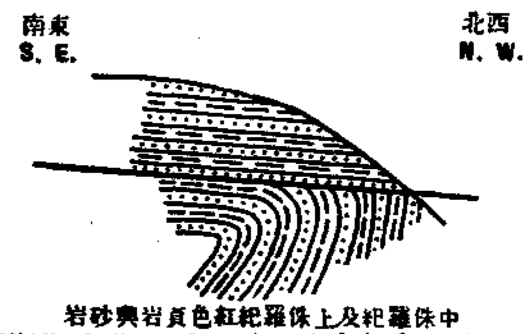
七十度、摺軸皆略示東西向。

三、黑牛溝　在黑牛溝蘇蓋營子烏蘭板申之間、（第七圖）中侏羅紀及上侏羅紀岩層初爲一內斜層、西北

第十七圖

烏蘭板申東南之逆掩摺斷

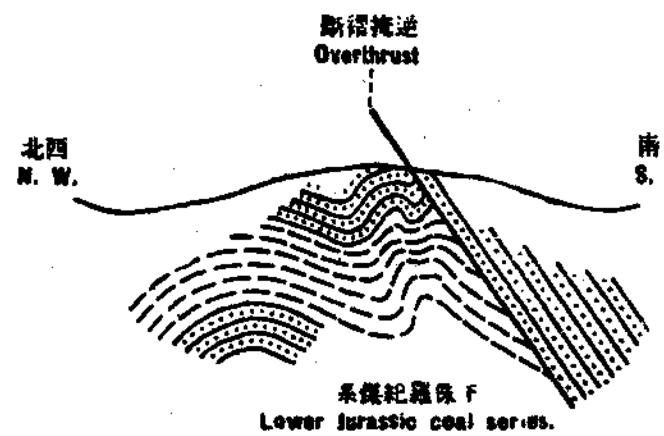
Fig. 17. Overthrust S. E. of Wu Lan Pan Shen.



第十八圖

前小壩子西南之逆掩摺斷

Fig. 18. Overthrust S. W. of Chien Hsiao Pa Tzu.



翼及東南翼傾角皆略相等、惟中心一部爲斷層所破、繼伴以外斜層、西北翼傾角稍急、摺軸皆由東北趨西南。在烏蘭板申東南如第十七圖所示、更有紅色頁岩及砂岩一部由東南向西北擠推、時見灣曲及斷裂之痕、平覆於直立岩層之上、有如逆掩摺斷者然。

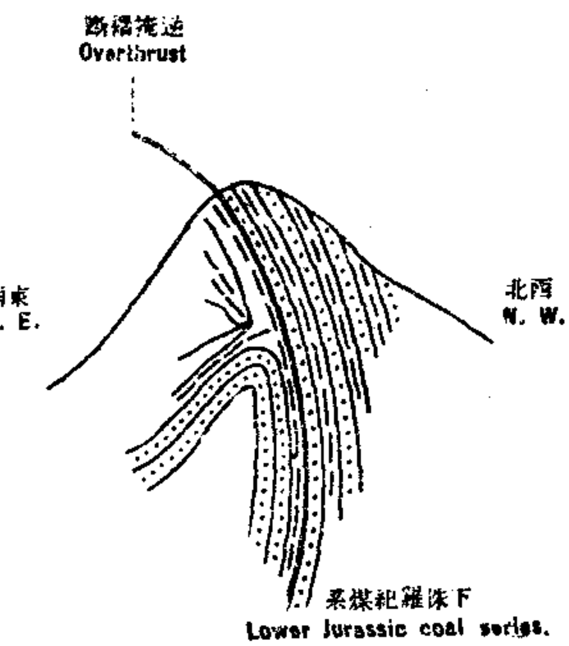
四、萬家溝　在萬家溝上流前小壩子西南、如第十八圖所示、下侏羅紀煤系中之砂岩、向西北逆出於煤系中頁岩之上、而構成一極明顯之逆掩摺斷。

五、白石頭溝　在白石頭溝內以前賞西南、如第十九圖所示、下侏羅紀煤系一部由向西北、一部則顯逆掩摺斷之跡。又如第六圖所示、在以前賞南下侏羅紀煤系及二疊三疊紀岩層皆倒置而傾於南、其北之中侏羅紀及上侏羅紀岩層、則構成一內斜層、兩翼傾角均約六七十度、再北復構成一傾角不等之外斜層、南翼傾角僅二十度、北翼則達五十度、摺軸皆略東西向。

第十九圖

以前賞西南之逆掩褶斷

Fig. 19. Overthrust S. W. of I Chien Shang.



六、水晶溝　水晶溝內自石炭二疊紀以至下侏羅紀煤系、雖皆倒置傾向東南、然於此倒置之中、在前瞪場北二疊三疊紀岩層復自現一淺內斜層、如第二圖所示、特面積甚小耳。

七、巴兎溝　巴兎溝內在寬店子附近、下侏羅　煤系於七百公尺距離之間、曾顯示一外斜層及一內斜層、摺軸亦略東西向或東東北西西南向、兩翼傾角平均各約四十度。（第九圖）又如第四圖所示、二疊三疊紀岩層在前店窰子灣一帶、自構成一外斜層、兩翼傾角各約三十餘度、摺軸方向與前略同。

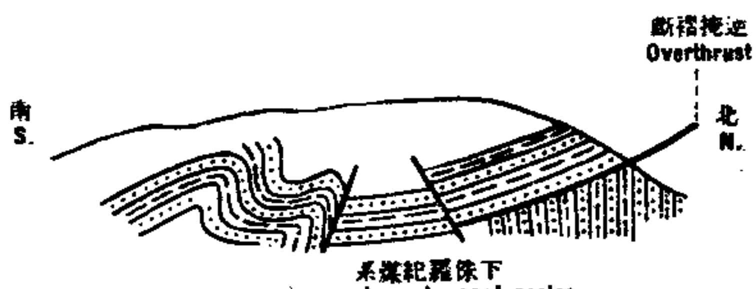
八、五達溝　五達溝內在門頭溝村之北、下侏羅紀煤系除一部由南向北灣曲外、復有一部被擠推而北移、橫

臥他部直立岩層之上、如第二十圖所示、恰構成一逆掩摺斷。更如第三圖所示、門頭溝附近之下侏羅紀煤系、於短距離之內、曾組成二內斜層、中隔以外斜層、摺軸仍爲東西向、凡北翼傾角恒較南翼稍急。若再沿五達溝深入至石拐鎮紅房地一帶、下侏羅紀煤系則自現一等傾之淺內斜層、兩翼傾角僅十度左右、摺軸走向仍與前同。

第二十圖

五達溝內門頭溝村北之逆掩摺斷

Fig. 20. Overthrust N. of Men Tou Kou Tsun.



摺皺結論

統觀大青山煤田附近岩層之走向、大致略趨東西、各摺皺軸之走向、及逆掩摺斷之摺斷線、亦各與此略同、有如互相平行者然。最顯著者爲陰山白石頭溝古城及寬店子等逆掩摺斷及水磨溝白石頭溝巴兔溝與五達溝等處所見之摺皺是也。又統察各逆掩摺斷之狀況、可斷定摺皺時之橫推力、大部由南向北、如第八圖乙及第九第十七第十八第二十等圖所示、皆一部岩層由南向北積叠於他部之上、而傾角不等之摺皺、如在水磨溝白石頭溝等處、皆北翼較南翼傾斜急峻、此明證也。又如白石頭溝至老窩舖一帶、岩層之倒置南傾、亦爲南來之橫推力向北擠推過甚使然耳。

摺皺之時期約可分爲二、一爲元古界岩層摺皺之時期、蓋自元古界岩層經石炭二疊紀直至中侏羅紀及上侏羅紀岩層、皆屬不整合、其摺皺時期自當較古、大抵不離乎元古界以後石炭二疊紀以前者近是。大青山一帶距山西甚近、故其地層摺皺、或與山西有連帶之關係、攷山西元古界地層

分舊元古界五台系及新元古界滹沱系二組、而五台系之摺皺、則在新元古界滹沱系沉積之前、（參考中國地質圖太原榆林幅說明書）觀此則大青山五台系摺皺之時期、愈可明瞭矣。但如第十四圖所示、五台系中大理岩亦與片麻岩爲不整合接觸、則似五台系中之摺皺、又可分爲數期、第作者尚未詳細研究及此、故暫從略。二爲石炭二疊紀至中侏羅紀及上侏羅紀岩層摺皺之時期。此種摺皺卽侏羅紀岩層亦受影響、其不受影響者在調查區域內只有第四紀冲積層、故此種摺皺之時期、自應在侏羅紀之後、第四紀之前。如更欲嚴格以求之、莫若與山西相當之岩層摺皺比較之爲便、按山西石炭紀至侏羅紀岩層摺皺之時期爲中白堊紀、（參考中國地質圖太原榆林幅說明書）而大青山煤田附近岩層之東西向摺皺軸、雖與山西境內相當岩層之南北向摺軸、適成一正角、然大青山煤田與山西大同煤田相距旣近、岩層組織又全相似、愈不能不設想其岩層之摺皺、與摺皺動力發生之時期、兩地有連帶之關係。假若所設想爲不謬、則大青山煤田內之石炭二疊紀至中侏羅紀及上侏羅紀岩層摺皺時期、亦應屬於白堊紀矣。

大青山摺皺方向與其鄰近區域摺皺之關係

以上皆專論大青山之地質構造、乃發見中生代造山運動之方向、係自南向北之平移、因而發生摺皺倒置及逆掩摺斷諸現象。茲更擬推而廣之、進而研究大青山摺皺方向與其鄰近區域摺皺之關係、並先將其鄰近區域摺皺方向約略分述于左、以資比較。此種鄰近區域東南包有山西及河南北部之太行山霍山與呂梁山等、南達秦嶺、西及賀蘭山郞山烏拉山等。（第二十一圖）

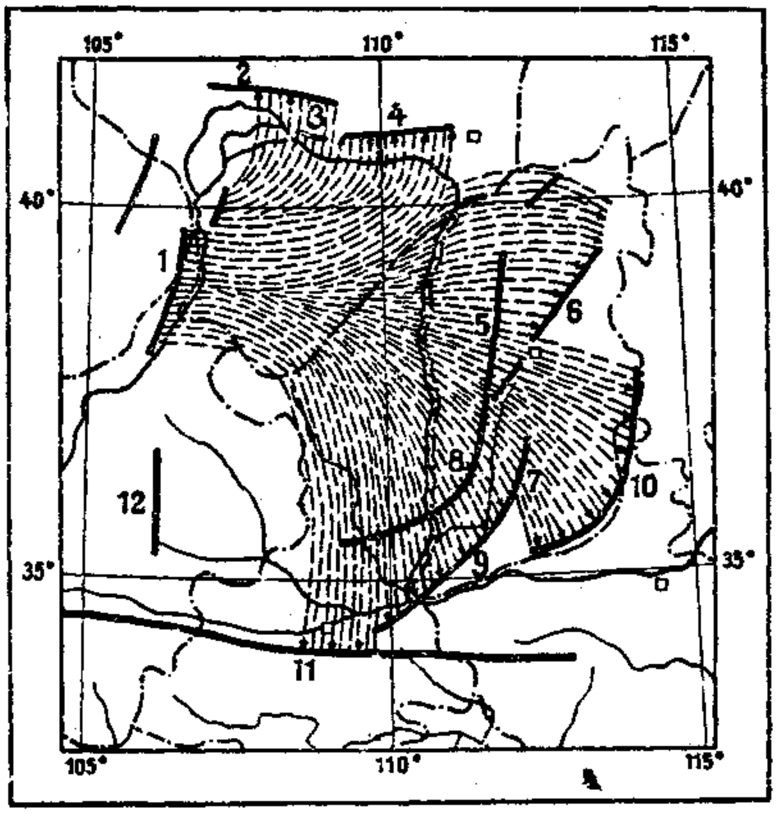
山西及河南北部摺皺之方向在作者所著之太原榆林幅中國地質圖說明書及河南武安涉縣林縣安陽一

帶地質報告（彙報九號）中雖未特別論述、然細察重要摺皺如呂梁太行外斜層等其摺軸恆稍顯向東南灣曲。又凡外斜層如呂梁太行離石等其東南翼恆較西北翼傾斜稍急、頗足據之以推想摺皺方向大致由西北而東南、或由西而東偏南。

第二十一圖

中國西北部地殼摺皺方向圖

Fig. 21. A map showing the directions of orogenic movement in N. W. China.



中生代期內地殼摺皺力之方向
Directions of orogenic movement during late Mesozoic time.

1. 賀蘭山脈 Ala Shan　2. 郎山 Scheiten Ula　3. 烏拉山 Ula Shan　4. 大青山 Ta Ching Shan
5. 呂梁山 Lü Liang Shan　6. 擊州山 Chi Chou Shan　7. 霍山 Ho Shan　8. 羅雲山 Lo Yün Shan
9. 中條山 Chung Tiao Shan　10. 太行山 Tai Hang Shan　11. 秦嶺 Tsin Ling　12. 隴山 Lung Shan

若一參閱維理士氏之中國地質調查記、彼在直隸山西北部所述之逆掩摺斷亦爲此說之一證。

秦嶺之摺皺向經維理士氏勘測已足證明由北而南。（參考維氏中國地質調查記）賀蘭山摺皺經翁詠霓所長調查、始確定由西向東。翁所長之報告雖尚未印刷、然對于賀蘭山地質構造、曾爲下列之簡略說明。

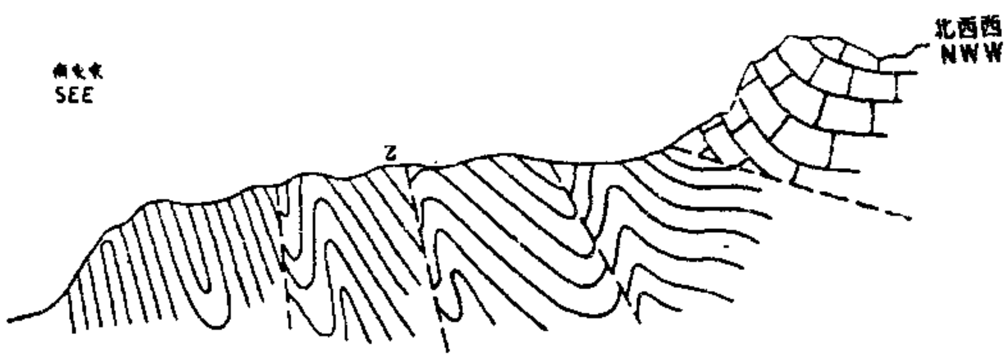
賀蘭山地質先經俄勃洛索夫氏（Obroutchef）研究、認明有自西向東之大摺斷、特于地質時代頗多錯誤、亦未將構造情形繪圖紀載。迨至一千九百二十一年調查、始在宿嵬口內爲較詳之觀察、知組成山頂之石灰岩

完全與南口石灰岩無異、其下有時更露石英岩、間現雨點漣痕與南口所見者亦同、故其時代當屬震旦紀無

第二十二圖

賀蘭山宿嵬口理想剖面圖(翁文灝調查)

Fig. 22. Idealized section of Ho Lan Shan (Ala Shan) in the Su Wei Kou valley (W. H. Wong)

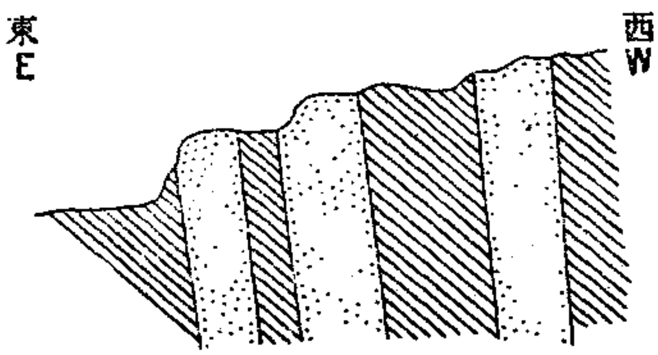


震旦紀 1. Sinian system.　　變質石炭紀 2. Metamorphosed Carboniferous.

第二十三圖

賀蘭山石炭紀岩層之一部剖面(翁文灝調查)

Fig. 23. A section in the metamorphosed carboniferous in Ho Lan Shan (Ala Shan) (W. H. Wong)



砂岩與片岩相間地層傾斜北六十西八十五度片理傾斜南八十西四十五度

Sandstone alternating with schist, strata dip N60 W, 85°; schistosity dip S80° W, 45°

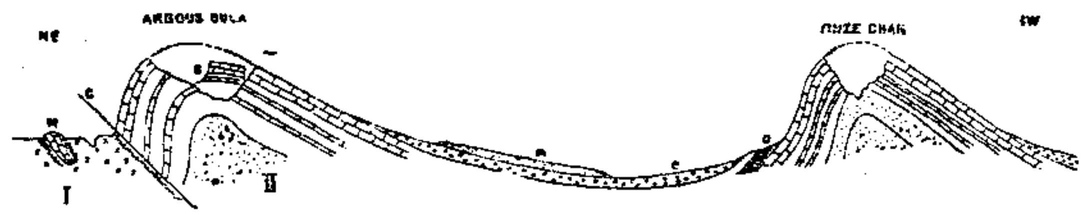
疑。此外復有石炭紀岩層、變質極深、特仍保存植物化石、如 Calamites sp. 及 Lepidodendron sp. 等。其中摺曲與斷層甚夥、第二十二圖僅表其大概、實際構造之複雜殆有過之、往往片理與層理不易分別、有時地層粗細相差較多處、始可辨認、例如第二十三圖所示。摺皺方向無論從大體構造推測（如第二十二圖）或從詳細結構論述（第二十三圖）

皆可證明其自西向東。

第二十四圖

昂香山與椅子山地質構造想像圖(德日進氏調查)

Fig. 24. Ideal section through the Arbous Oula and the Yinze Shan.



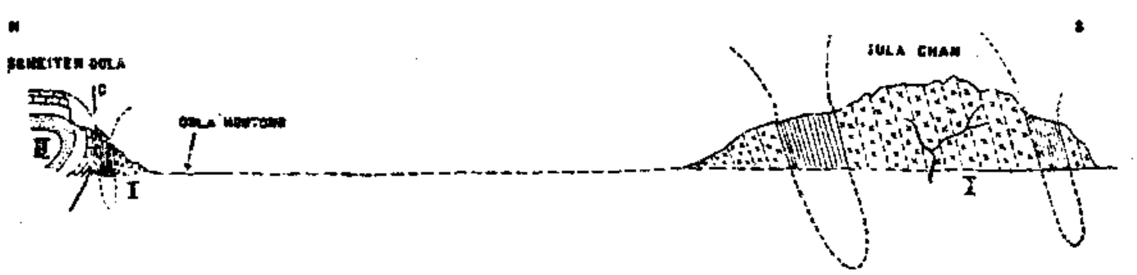
I五台系.II元古界岩層.O奧陶紀板岩.C上石炭紀砂岩與礫岩.m中生界砂岩.C摺斷面

I. Wu Tai system II, Palæozoic (chiefly pre-Carbrian? quartzites and limestones). o, Ordovician slates. c, Stephanian sandstones and conglomerates. m, Mesozoic sandstones. M, sheet of pre-Cambrian limestone and mylonite. C, thrust surface, G. Tsouoze Chan ("Genghis enril"). (Teilhard de Chadin)

第二十五圖

烏拉山與郎山地質構造想像圖(德日進氏調查)

Fig. 25. Ideal section through the Oula Shan and the Scheiten Oula

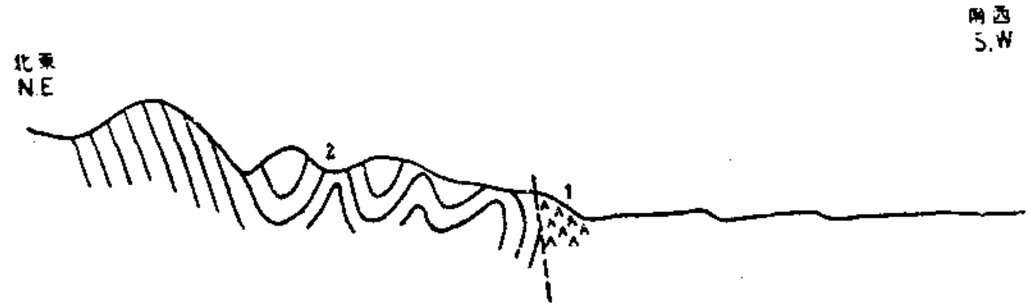


I五台系 II元古界地層 c摺斷面

I, Wu Tai system (cristalline rocks and marbles). II, Palæozoic (pre-Cambrian?). C surface of Contact. (Teilhard de Chadin)

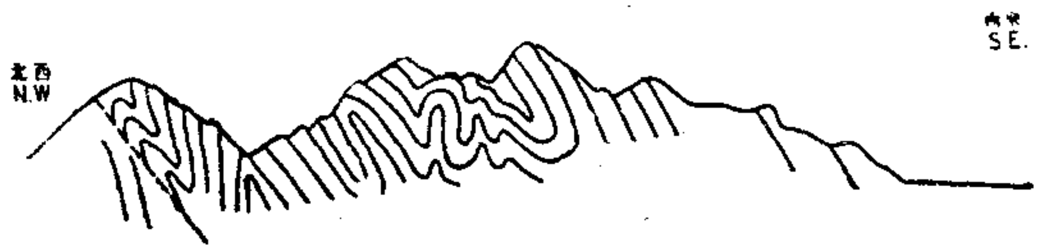
賀蘭山之東北、渡黃河爲椅子山及昂香山。該二山之地質構造、據德日進氏(P. Teilhard de Chardin)研究、如第二十四圖所示、組成不等傾之二外斜層。其一東北翼皆較急、顯示元古界岩層被推向東北而摺皺。(參考一千九百二十四年法國地質學會彙報第二十

第二十六圖
烏蘭忽洞北色爾騰山溝中地質構造(翁文灝調查)
Fig. 26. Structure visible in a valley of Scheiten Ula north of Wulan Hutung (W. H. Wong)



五台系 1: Wutai system　震旦系 2. Sinian system

第二十七圖
大佘太北色爾騰山震旦紀石灰岩摺皺構造(翁文灝調查)
Fig. 27. Folded Structure of the Sinian limestone in Scheiten Ula north of Ta Shei Tai (W.H. Wong)



四卷第四期德氏鄂爾多斯高原附近地質觀察及中國地質學會誌第三卷第一期德氏鄂爾多斯西北南三部附近地質)郞山(東部亦名色爾騰山)與烏拉山均位于大青山之西、昂香山之東北。其地質初爲俄勃洛索夫氏及德日進氏勘測皆謂向南摺皺、德氏並列有地層剖面如第二十五圖所示。自作者發見大青山之摺皺爲由南向北、以互列東西走向連接之山嶺、其摺皺相反若此、于是乃發生最難解之問題。特翁詠霓所長一千九百二十一年之調查、曾在色爾騰山(郞山之東部)德氏研究相近之地點、測有較完備之剖面、如第二十六圖及第二十七圖等所示、皆顯郞山之摺皺大致亦應由南向北、與作

者大靑山之摺向完全相合、此篇即本斯說。

統察所述之各摺皺方向、頗可證明俄氏與德氏常謂組成黃河套以北以西山嶺之岩層、各向南向東摺皺、以鄂爾多斯爲其聚合點之說爲錯誤。然總計各摺皺山脈悉列于鄂爾多斯與陝北高原之周圍、高原本部反摺皺甚少、恆近平層。此種現象之解說、頗似賀蘭山之摺皺力、乃一部經昂香山東至鄂爾多斯、與陝北之高原、即以高原爲中心、轉向北東南、呈一半橢圓形而散布其動力、如第二十一圖所示。大靑山郞山烏拉山及秦嶺各當半橢圓南北長徑之兩端、曾受急烈之推擠、故生成大靑山之多數逆掩摺斷、及急傾小摺皺。山西與河南北部當半橢圓之短徑、則被施以較緩慢之壓力、故生成山西一帶廣闊緩傾之大摺皺。若用抽象方法論述、全部構造恰如一闊底之大內斜層、實際上此種內斜層在山西如寧武內斜層等已數見不鮮。鄂爾多斯與陝北高原爲闊底大內斜層之摺軸、大靑山郞山與秦嶺各爲大內斜層之南北兩端、賀蘭山與呂梁山霍山太行山等則爲大內斜層之東西兩翼、不過構生此大內斜層之動力自西而東、故先施之于西翼耳。

以上解說之難題、乃在綏遠東部岩層之走向。蓋如所設解說不謬、則綏遠以東之岩層應一致走向西北—東南、方能連合大靑山北向之摺皺、與山西東南向之摺皺而呈一弧形。但實際上雖此一帶地質尚未詳細調查、然終恐難與此理想完全相合。特有一事實須宜注意、大靑山與鄂爾多斯高原及綏遠盆地中間界一大斷層。（大靑山斷層）故在太原榆林幅中國地質圖說明書中之陝北內斜層、無古生界上部岩層或中生界底部岩層組成向南傾斜之北翼。又此大斷層在綏遠城東之眞確終點現在尙未探悉、是以綏遠東即原有走向西北—東南之岩層、亦能一部爲此斷層所切割而失蹤。

又賀蘭山與隴山摺皺向及隴山與秦嶺摺皺向之關係、現在皆尙未明瞭、故研究中國西北部摺皺方向變遷之問題、不無多少困難。但隴山之摺皺、翁所長在中國地質學會誌第六卷第一期內論中國東部中生代以來之地殼運動及火山活動時、已證明其屬第三紀中期時代應較新、于此當可暫置不論。總之作者解說不惟可藉以了解賀蘭山區鄂山區大青山區秦嶺區及山西河南北部區各摺皺方向不同之關係、並可藉以推定各區摺皺之時代、應屬于同一時期。

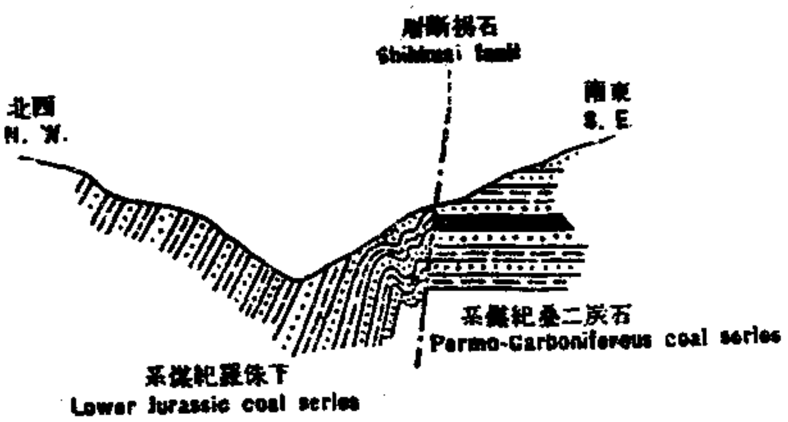
斷層

大青山煤田附近除摺皺外、斷層亦甚夥、試將斷層中較重要者分述如左。

大青山正斷層　歸化盆地與大青山之間、爲大青山正斷層、走向略近東西、仰側居斷線之北、正當歸化盆地之北界。若沿綏包間鐵路望之、巍然于盆地上聳立如牆、綿亙空際、中藏深澗、明爲斷層之斷壁。其斷線之長、在綏遠包頭間、計達二百四十里、在綏遠以東恐尙有百餘里。斷層之上下移動、在包頭討子號間及台格木車站附近推算、五台系組成之山脊、高出盆地面已達四五百公尺、其深達于地下者、尙未計及、則移動之巨、可想而知。在畢克齊察素齊一帶及壩口子附近、直接與盆地面接觸者、爲中生界岩層、而元古界地層幾全被掩于盆地之下、其上下移動尤當偉大。但在包頭以西、及綏遠東數十里以外、移動有漸減之趨向、故盆地之地形幾全易爲山嶺矣。

石拐正斷層　石拐煤田之南、自雞毛窰子東經頭道溝門至天義公一帶、斷層共長達四十里、走向東西、仰側居斷線之南。在仰側之岩層、大部爲元古界片麻岩、僅其東端有石炭二疊紀煤系及二疊三疊紀頁岩與砂岩

等俯側之岩層、則概屬侏羅紀煤系。表示斷面狀況最顯明者、爲第三及二十八圖。其上下移動約由數公尺至七百公尺。



第二十八圖
天義公東地質剖面圖
Fig. 28. Section E. of Tien I Kung.

大溝正斷層　在萬家溝內之大溝及前小壕子附近見下侏羅紀煤系與花崗岩接觸處、受變質作用極微、當爲斷層關係、茲名爲大溝正斷層。其斷線方向爲北北東南南西。斷線之兩端、假若以陰山及白石頭溝兩逆掩摺斷交切而終止、其長度約在二十里以上。其仰側爲花崗岩、居斷線之東東南。其上下移動不易估計、因以前所述之斷層、皆爲走向斷層、此獨爲斜向斷層也。

柳樹灣地壘　在察素齊以北西溝內柳樹灣附近、下侏羅紀煤系呈一東西狹帶狀、長達十餘里、南北各以斷層關係而與中侏羅紀及上侏羅紀岩層接觸、下侏羅紀煤系則爲上升之區、因以組成地壘構造。但煤系易受侵蝕、故在地形上反視若微低凹耳。

黑牛溝正斷層　黑牛溝內蘇蓋營子南二疊三疊紀岩層與下侏羅紀煤系作斷層之接觸、如第七圖所示、茲名此斷層爲黑牛溝正斷層。沿斷線至珠爾溝口則二疊三疊紀岩層與上侏羅紀岩層直接接觸、而下侏羅紀煤系全失蹤焉。故斷層之上下移動愈近珠爾溝口愈有增加之趨向、大約由數十公尺至四百餘公尺。斷線之長已測知者、約可達十餘里、呈向北灣曲狀。仰側居斷線之北、在地形上

仰側與俯側之高度、無顯著之差異。

大青山各溝內局部之小斷層亦頗多。例如在壩口子北如第五圖所示、下侏羅紀煤系中構成一小斷層。在水晶溝內前壋墕北及巴兎溝內三元店北如第二及第四圖所示、二疊三疊紀岩層中亦各有小斷層等是也。

斷層結論

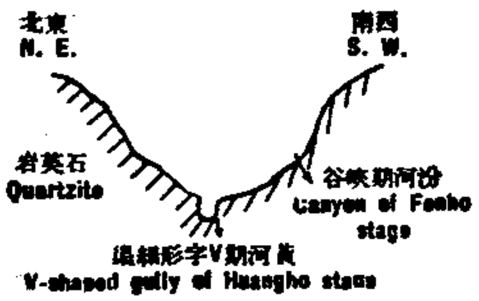
綜上所述、如大青山斷層石拐斷層及柳樹灣地壘等皆走向東西而互相平行、且與所切割岩層之走向、及各摺皺軸或逆掩摺斷之摺斷線、亦大部互相平行、僅大溝斷層略與所切割之岩層稍成斜角、爲例外耳。壩口子北下侏羅紀煤系中之斷層、及前壋墕與三元店北二疊三疊紀中之斷層、皆有突破岩層摺皺之迹足證斷層生成之時代在摺皺之後。又大青山斷層、仰側極高峻、且臨以急澗、更足證斷層乃甚新者。但其割裂之岩層最新爲侏羅紀、則從大青山一帶觀察斷層之時代、亦僅能知其在侏羅紀以後而已。至欲論其詳、仍不得不仿研究大青山摺皺時代之方法、而與山西斷層爲比較。且大青山斷層除斷線走向恆爲東西、與山西斷層走向、略成正角外、其他由仰側俯側構成之地形等現象、俱極相似、亦自有比較之必要。今知山西斷層之生成爲洪積統、（中國地質圖太原榆林幅說明書）然則大青山煤田內斷層亦殆爲同時之產物、而屬於洪積統歟。

地文

大青山一帶之地形、大致可分爲二期、一爲壯年期、相當於維理士氏在直隸山西所稱之唐縣期、一爲幼年期、相當於維氏之汾河期、（一千九百零七年維氏中國地質調查記卷首）及作者在山西所稱之黃河期。（中國地質圖太原榆林幅說明書）茲試將作者野外調查時所見地形之現象、各論如左。

歸化盆地　該盆地爲歸化綏遠包頭諸大城所在之地、亦卽綏遠特別區最富庶之地域、大致成一三角形、東西最長處約達三百餘里、南北最寬處約達一百五十里、大部爲大黑河之沖積平地、故多可耕植。盆地北界大青山、勢極崇峻、其東南界、則岡嶺起伏環列、勢稍低殺、其西南帶以黃河、坡阜更爲平緩。盆地之面微呈波浪形、近山地尤甚、平均高出海面約達一千一百公尺、滿載土壤、微低凹之區、有時產泥炭、如在台格木車站西南及討子號東南是也、其低凹特甚者、恆終年爲水所浸、而變爲海子、如討子號車站南之西海子是也。河流穿過盆地、其谷岸率呈淺緩紆曲之致。盆地之成因、初覩之頗似大黑河之侵蝕谷、然細考盆地與大青山構成之關係、乃知盆地正居大青山斷層之俯側、而爲沿斷線陷落之區也。

第二十九圖
近萬家溝口之河谷形
Fig. 29. Features of the valley near Wan Chia Kou K'ou.



大青山　就大致言之、大青山之地形、本係一高原、惟爲深溝分割、因有前山後山之別、亦各具特異之形態。前山爲以前賞三道壩中老窩鋪一帶煤田與歸化盆地間之部分、卽大青山之主幹。凡穿過前山之重要溝渠、如萬家溝白石頭溝麥達溝水晶溝巴兔溝斗林沁溝及五達溝等、率自北而南、與山脊之走向略成正角、谷形悉爲深峽、例如沿白石頭溝水晶溝及巴兔溝等旅行者、只見兩岸壁立、峰巒如峙、（第四版甲圖）髣髴乎山西之汾河期幼年谷復投影於眼前也、聞麥達溝內更多瀑布、其谷形之幼穉、益爲明顯。近萬家溝口如第二十九圖所示、河谷之發育似可分爲二期、一爲汾河期之峽形、一峽形谷底復被侵蝕、成V字形之細渠、此種細渠、當爲地面最近向上撓屈之徵、考其時當與黃河期爲近。又在白石頭溝門北相距約五里之龍潭、見汾河期之峽谷

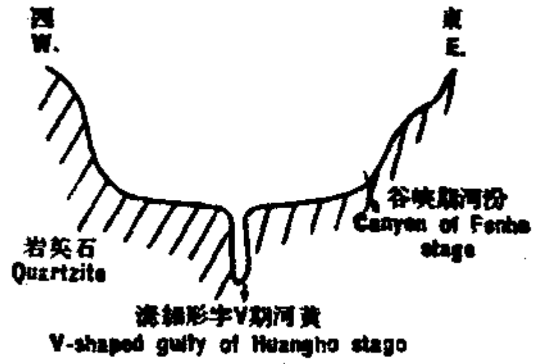
內有數小瀑布、各高約三四尺、亦刻有V字形細溝、如第三十圖所示、自當仍屬於黃河期、此皆明大青山之前山、其局部撓屈作用、正方興而未艾也。

大青山後山爲以前賓三道壩中老窩鋪一帶煤田以北之地域。在此地域內重要之溝谷、其方向每近東西、與山脈及岩層之走向、約略平行、而與前山之溝渠則成正角、偶或爲前山南北向之河流所銷蝕、致一溝分而爲二、流向相反、中成低緩之分水嶺、然登高遠望、谷之原形仍歷歷可辨、例如由水晶溝內之東溝門、沿東西向之溝、至麥達溝內之前嵤包、所經東二壩附近之黃土分水嶺是也。且後山東西向之溝谷、形率寬緩、或厚覆土壤、能通牛車、要皆相當於壯年唐縣期之寬谷而已、介於寬谷間之山脊、則低緩圓平、亦每覆以土壤、高出谷底恆在百餘公尺左右、例如在三道壩北所見、上侏羅紀之岡阜是也。綜覽各現象、後山地形大都屬於唐縣期、但寬谷間之山脊、或爲南北向之溝渠所穿割、而成深峻之谷者亦有之。

第三十圖

白石頭溝門北相距約五里之龍潭谷形

Fig. 30.Features of the valley 5 li N. of Pai Shih Tou Kou Men.



礦產

歸化盆地以北產煤之地域、通稱爲大青山煤田、實則含有石炭二疊紀及下侏羅紀兩種煤系。如以煤系露出狀況論、則可分爲七煤田、自東而西、即壩口子煤田、黑牛溝煤田、柳樹灣煤田、石拐煤田、童盛茂煤田、楊圪塄煤田及寬店子煤田是也、中以石拐煤田爲最大、煙煤與無煙煤並產、而柳樹灣煤田僅產無烟煤、壩口子煤田及

黑牛溝煤田則產半烟煤其餘產烟煤、試論述之。

壩口子煤田　該煤田位於歸化城之北偏西、距城約二十里。下侏羅紀煤系露出面積計達三十二平方里。岩層傾角約由三十度至七十度惟概屬煤系之下部故中無厚煤層。據舊日採煤者言煤層厚度僅由數寸至尺許本地稱爲肥煤卽半烟煤因煤層太薄易虧本現已無採者、調查時只見煤田中遺有數廢窰而已。煤田距歸化雖近、似無開採價值故鑛量亦弗及焉。

黑牛溝煤田　畢克齊西北十餘里爲黑牛溝煤田占有下查房蘇蓋營子一帶。下侏羅紀煤系露頭共長達七千公尺。岩層傾角平均約五十度。所採肥煤層厚約一二尺、調查時僅有二三小窰口爲農民自己開鑿、供冬日燃燒之用、產額極微。若以煤層之平均厚度爲半公尺、可採深度爲五百公尺、則全煤田煤之儲量、約亦不過二百九十萬噸。

棚樹灣煤田　察素齊北約二十里爲棚樹灣煤田、下侏羅紀煤系露頭起自老窰上東經棚樹灣東溝窰上以至珠爾溝窰上共長達六千餘公尺、岩層摺皺錯亂特甚。珠爾溝窰上所採煤層厚約二尺、東溝窰上所採煤層有二、各厚約一二尺、棚樹灣附近所採者係下層厚達四尺、均屬無烟煤。作者在棚樹灣所採之煤樣經工業試驗所分析之結果如左。

水分	揮發物	焦炭	固定炭	灰分	灰色	焦性	熱量
一、四六	三、四四	九五、一〇	七九、八六	一五、二四	淺黃	不黏結	七〇四六

據此灰分似太多。茲以煤層之平均厚度爲一公尺、則煤田計儲無烟煤一千一百七十萬噸。珠爾溝窰上有窰

兩座、出煤尚多、惟窰廠附近小斷層甚夥開採時不無困難耳。東溝窰上亦有小煤窰三四座、其出煤最旺之窰、在柳樹灣之東、名福谹窰、察其所產之額、恐已踰全煤田產量之半矣。煤井概係斜洞、採煤用包工方法、凡工人自窰洞內出煤一擔重約百斤、得工資銅元十枚、火食由窰主供給、煤均在窰廠售出、每兩筐爲一擔、重約五十斤、值銅元三十枚、平均每斤值制錢六文、即每噸值洋三元。

煤之運輸悉賴驢騾拖馱及大車、以珠爾溝東溝西溝爲其交通之孔道、故三溝口皆設有煤稅分卡、大抵拉煤一套車納稅銅元六十七枚、二套車納一百枚、用騾拖煤、每頭須納稅十四枚、驢十枚。大部皆銷於察素齊畢克齊及歸化城一帶、每年產額約達五千噸。

石拐煤田　石拐煤田位於薩縣之北、屬下侏羅紀、殊爲重要、普通用以代表大青山煤田者即此也、東起自大溝、西經以前賞六道壩老窩鋪達石拐鎭一帶、煤田共長達一百二十里。大溝老窩鋪之間、煤系傾角普通約由四十度至六十度、老窩鋪石拐鎭一帶、煤系傾角約由五十度至十度左右、頗有愈西傾斜愈緩之趨向。大溝附近所採煤層厚約四尺、惟中間時隔薄石層、且多煤氣、窰洞內往往燃爆傷人。六道壩附近所開煤層厚度約由四尺至一丈、中老窩鋪之煤層亦爲四尺。石拐鎭一帶之煤層、窰中人言有七層、自下而上如左、

一、墻節煤　厚約三尺（煤厚一尺六寸　石層厚一二尺　煤厚一尺二寸）

砂石　厚約四尺

煤層　厚約一尺因太薄恆棄而不採

砂石　厚約八九丈

二、中大節煤　厚約六尺

三、四尺煤　厚約四尺（中多隔以薄石層）

四、花石節煤　厚約四尺（中隔石層）

五、底大節煤　厚約七尺

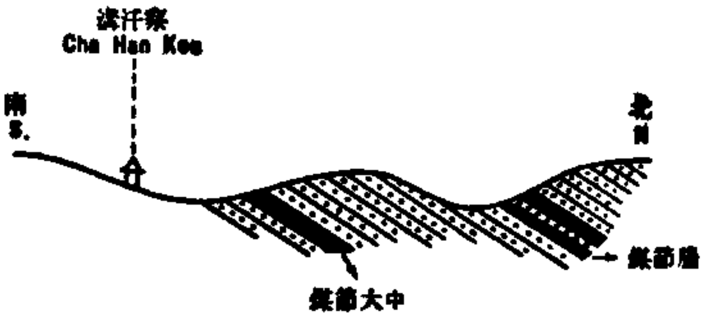
六、底甘小節子煤　厚約二尺

調查時石拐鎭附近所採、皆爲壋節煤及中大節煤、中大節煤開採最盛、凡較重要之煤窰、皆採此層、在石拐鎭東北之兩煤層、如第三十一圖所示、層序甚爲明顯。若以煤質論、則石拐煤田分烟煤與無烟煤兩種、中以麥達溝爲之界。麥達溝以東、由六道壩直至大溝、所產皆係無煙煤、且多係碎末、本地人名爲煤、以別于西部之炭、在以前賞老虎溝所採煤樣分析之結果如左。

第三十一圖

石拐鎭東北約二里許煤層現露剖面圖

Fig. 31. Outcrops of the coal seams 2 li N. E. of Shih Kuai Chên.



水分	揮發物	焦炭	固定炭	灰分	色	焦性	熱量
一、四〇	四、八〇	九三、八〇	八四、二六	九、五四	肉紅	不團結	七三五〇

麥達溝以西在葫蘆斯太石拐鎭等處、皆係煙煤、尤多大塊、本地人稱爲炭、以別于東部之煤、率能煉焦、（第四版乙圖）石拐鎭附近中大節煤二次分析之成分如左。

水分	揮發物	焦炭	固定炭	灰分	色	焦性	硫黃	熱量

一,四四	三,三〇二	六五,五四	五六,六二	八,九二	棕色團結	〇,〇一二七	七七五一
一,四四	三,六八、	六一,六八	五一,六一	一〇,〇七	赭紅團結	〇,四二	七八九四

茲以大溝六道壩間煤層之平均厚度爲一。五公尺、煤系露頭計長三十二里、仍以五百公尺爲可採深度、應儲無煙煤二千零三十萬噸。而胡蘆斯太中老窩鋪等處煤系露頭計長四十三里、煤層之平均厚度仍與前略同、應儲煙煤二千七百三十萬噸。中老窩鋪以西至石拐鎮一帶、煤系露頭尙達三十餘里、煤層層數及厚度悉大增加、若以壩節煤及中大節煤爲標準、暫以三公尺爲煤層之平均厚度、則石拐鎮一帶計儲煙煤五千八百五十萬噸。總計石拐煤田烟煤儲量達八千五百八十萬噸、連無煙煤共達一萬萬零六百一十萬噸。惟此係最小之儲煤量、僅就作者野外調查時正在開採之煤層推計之、若以石拐鎮附近之七層煤統算在內、兼以老窩鋪大溝之間、或有尙未經探知之他煤層、則煤田全部儲量或能達二萬萬噸乎。

大溝附近最著之煤窰爲萬豐窰及萬隆窰、皆用土法開採、斜洞中製石梯以備上下、每梯高約七寸。其窰廠組織普通設寫賬二人、把總一名、把總即土礦師、除由窰主供給火食外、每日別給工資制錢六千、專任在窰洞內指導採煤。又水頭一名水工數名、專任在洞內治水、水工每日得工資約合制錢二百文、其火食由窰主供給。採煤工人各約六七十名、工作時三人爲一幫、一人在洞內挖煤、二人往外拖煤、所得工資三人均分、由洞內拖出煤一擔重約十斤得工資制錢十文。一人一次約可拖七八擔、工人火食統係窰主供給。萬豐萬隆二窰廠每日出煤各約二千擔、賣煤時亦以擔計算、每一擔重十斤值制錢五十文、即每噸約値洋二元五角。煤之轉運以大車爲多、普通單套車可裝煤六七十担、二套車可裝百擔、沿萬家溝東南行四十里、出溝口銷售于歸化一帶。以

前賣採煤之地點爲大南溝及老虎溝、運煤悉用驢騾窰廠賣煤時以驢騾馱計算、每騾能拖二百斤約付煤價七百文、驢能拖一百三四十斤付煤價五百文。大部經白石頭溝行四十里銷售于討子號一帶、惟溝內路頗難行、距溝口五里許有龍潭之險、拖煤者至此必踰一嶺曰墻上者、始克達討子號。白石頭溝西之麥達溝路更險阻、驢騾亦不能通行、故六道壩與胡蘆斯太之煤、不南銷于歸化盆地、而竟北銷于後山、聞煤在窰廠售價每斤約値錢三四文。中老窩鋪及康包溝之煤、雖能經水晶溝及巴兎溝以運銷于薩縣城、然因其南各有他煤田與之競爭、故產額甚微。再西至石拐鎭附近、乃爲全煤田產煤最旺之區、調查時較大之煤礦公司有二、仍完全土法開採。最著者爲漢南公司、在石拐鎭設有廠長庶務會計各一人驗票二人催股銀一人、在包頭則設總公司辦公處駐經理協理各一人。共有窰洞八口、一名孔字窰、工人二百餘名、每日約出炭六萬斤、（公司之最大煤窰）二、名永益窰、工人約四十餘名、每日約出炭一萬六千斤。三三合窰工人四十餘名、每日出炭一萬四千餘斤。四永順窰、工人五十餘名、每日出炭計達二萬斤。五德益窰、有工人十餘名、每日出炭約四千斤。六、對合窰、工人亦十餘名、每日出炭約四千斤。七、益順窰、工人四十名、每日出炭約達一萬六千餘斤。八福壽窰、停工未採。總計每年共可產炭二千餘萬斤。工人每名日可得工資洋五角、由窰主供給火食。各窰於一年之中、只正二三四九十十一十二等八個月與工採煤、其餘月份率多停歇。所產大塊炭在窰廠售出、每百斤約値洋二角、卽每噸約値洋三元二角、小塊炭每百斤約値洋一角五分、即每噸値洋二元四角、平均大塊炭約居十分之六。凡窰戶賣洋十元、公司得分一元、名爲一九股、蓋各窰之洞口、皆係窰戶所開鑿、採煤工人亦係窰戶僱定、所謂公司者、僅領有礦區執照而獲十分一之淨利而已。較次于漢南公司者爲冀昌公司、有出炭之平洞二口、工人共約二

百四十名、岔戶計有七家（即傭工採煤之窰戶）每日約出炭七萬斤每年約產炭一千二百萬斤、炭在窰廠每百斤約値洋一角六分。凡岔戶賣洋十元、公司得分二元、名爲二八股、蓋此皆係公司開窰洞、岔戶採煤、其組織頗類似大同煤田內之貨房與人伙櫃也。各公司多恃大車運煤、一南出五達溝行三十餘里銷于鄂爾格遜及公積板一帶、一西南出大東溝行六十里銷于包頭。

煤稅皆取自運煤者、故萬家溝白石頭溝水晶溝巴兎溝及五達溝等各溝口俱設有煤稅分卡、但麥當溝內之煤銷于後山、其稅卡獨設于把總窰子、石拐鎭附近因有西銷之煤、故亦設有稅卡焉。煤田各部產額、僅據此次所調査之材料、頗感不足、若以各窰開採及運銷之情形約略估之、則大溝附近每年約可產無烟煤九千噸、以前賞附近約產無烟煤七千噸、六道壩及葫蘆斯太等處約產無烟煤與烟煤共五千噸、中老窩鋪及康包溝一帶共可產烟煤四千噸、石拐鎭附近可產烟煤四萬噸、統計石拐煤田每年約可產無烟煤一萬八千噸、烟煤四萬七千噸、即共爲六萬五千噸。

童盛茂煤田　中老窩鋪及康包溝之南爲童盛茂煤田、屬石炭二疊紀。其煤系露頭分布于大炭壕童盛茂石匠窰子哈拉溝中保圪素一帶、共長約三十餘里、岩層傾角平均各約六十度。含有煤一層、在童盛茂南馬地灣子附近煤層之露頭厚達六公尺、烟煤能煉焦、俗稱臭炭、而稱石拐煤田下侏羅紀煤系之煤爲香炭。用此名稱向本地人探求石炭二疊紀與侏羅紀二煤系之分布、殊少錯誤、然則亦得以此爲地質時代異同之標識矣。作者在大炭壕所採集之臭炭分析成分如左、

水分	揮發物	焦炭		灰色	焦性	硫黃	熱量
		固定炭	灰分				

一、二六	二二、六八	七六、一六	六六、五四	九、六二	淡黃色	團結	〇、〇一六二	七六八五

若以煤田內煤層之平均厚度爲三公尺、則煤田全部計儲烟煤三千七百八十萬噸。煤田內僅在石匠窰子及大炭壕附近、有數煤窰從事開採、產額似不甚旺、約計每年不過二千噸。轉運悉用驢騾拖馱石匠窰子之煤、多經水晶溝鎖于薩縣城、而大炭壕之煤、則一部經大斗林沁溝鎖于公積板、特爲量甚微耳。

揚圪塄煤田　該煤田位于童盛茂煤田之南、自東而西、按煤系之地質時代、可別爲三部。東部分布於水晶溝沙鍋窰子谷滿銀店等處、屬石炭二疊紀煤系、長約十五里、岩層傾角約由六十度至直立。含煤一層、厚約二公尺、係烟煤、亦名臭炭。若以二百五十公尺爲可採深度、其儲煤量約達四百五十萬噸。僅在沙鍋窰子附近略有開採者、年產約達千噸、用驢騾拖馱經阿道亥溝鎖於薩縣城附近。中部分布於谷滿銀店揚圪塄之間、長約十二里、屬下侏羅紀煤系、岩層傾角約二十度。煤層平均厚約一公尺半、稱爲香煤。若以可採煤層之寬度爲五百公尺、當儲烟煤五百八十萬噸。在揚圪塄附近開採頗盛、所採之煤及所煉之焦化驗成分如左。

水分	揮發物	固定炭	灰分	灰色	焦性	焦炭	硫黃	熱量
〇、八八	二二、八六	七六、〇五	一〇、二二	淺灰	團結	八六、二六	〇、五六	七八六九
〇、〇七	一七、九八	七七、八三	四、一〇	黃褐	團結	八一、九三	〇、五〇	八一四一
焦 〇、〇五	〇、二四	八八、四一	二三、二〇	淡褐	不團結	九九、七一	〇、三〇	七二〇六

最大之煤窰係劉俊耀所開、已領採照、共有工人一百四五十名、凡在窰洞內拖煤者、每名日可拖二十次、每次

約拖八十斤、日可得工資洋五角、因煤窰位置距歸化盆地較近、交通尙便、故煤價亦稍高、平均每斤在窰廠售出約値銅元一枚、即每噸約値洋五元、焦炭每斤約値制錢六七文、即每噸約値洋三元五角、轉運悉用驢騾拖馱經大斗林沁溝銷於公吉板及薩縣城。劉俊耀窰之西、尙有一大煤窰、出煤亦甚旺、大半經小斗林沁溝而銷於公積板。統計煤田中部之產額、每年約達六千噸。煤田西部分布於五達溝內之恆義相房及海流素溝等處、計長約十里、屬石炭二疊紀煤系、與中部揚圪塄之產煤區域本不相連、但地質構造、適同隸於谷滿銀店逆掩摺斷、故並述之。岩層傾角約在五十度左右、煤層平均厚約一公尺。茲以二百五十公尺爲可採煤層之寬度、則計儲烟煤一百六十萬噸。只在海流素溝有煤窰開採、每年約產臭炭一千噸上下、率用驢騾沿五達溝運銷於沙爾沁及鄂爾格遜諸大村。總計煤田全部共儲臭煤與香煤達一千一百九十萬噸、每年煤之產額共達八千噸、以揚圪塄附近產煤爲最著、幾占煤田全部產額四分之三。

寬店子煤田　揚圪塄煤田之南爲寬店子煤田、東起自寬店子西經穰地窰子終於五達溝內之韓同會、共長達二十四里、屬於下侏羅紀、最普通之傾角爲四十度。在寬店子附近開採之煤層有三、上層厚約二尺、中層一尺、下層三尺、均係烟煤、大塊能煉焦。茲以煤層之平均厚度爲二公尺、可採深度爲五百公尺、則煤田儲煤量可達二千四百萬噸。以在寬店子附近開採爲較盛、穰地窰子及韓同會之東、昔日出煤亦頗旺、然當作者調查時產額皆甚微、煤田全部之產煤量、約計每年當不踰三千噸、多半產於寬店子附近、用驢騾拖馱出巴兔溝運銷於薩縣城。

煤田結論

統觀大青山煤田共儲無烟煤達三千二百萬噸、烟煤達一萬六千五百萬噸、總儲量約近二萬萬噸。按含煤系之地質時代區分、則石炭二疊紀煤系約儲煤四千四百萬噸、下侏羅紀煤系約儲煤一萬萬五千三百萬噸。其產額於作者調查時所見情形推之、大青山煤田每年約產無烟煤二萬三千噸、烟煤六萬噸。無烟煤以大溝附近所出爲特旺、烟煤則以石拐鎭附近爲最盛、實則石拐鎭附近產煤之多、爲全煤田之冠。煤在窰廠售出、平均每噸約值洋二元八角、惟運煤者每噸尙須出稅洋三角五分。煤之運輸、除石拐鎭大溝榔樹灣等處、多利用大車外、其餘率以驢騾拖馱爲主、又除六道壩與葫蘆斯太之煤、北銷於後山外、其餘皆南銷於歸化盆地。大抵珠爾溝榔樹灣及大溝之煤、多運銷於畢克齊察素齊及歸化城一帶、以前賞之煤、多銷於討子號附近、石匠窰子沙鍋窰子楊圪㙞及寬店子之煤、多銷於薩縣城及公積板等處、石拐鎭之煤、則多銷於包頭。按大青山煤田適蔓延於綏包鐵路之北、自京綏綏包兩線接軌後、運輸上確已大便利、但攷其實際、開採仍皆襲用土法、總產額尙不及十萬噸、其所以不甚發達之原因、非盡關於交通及人力、實以大同煤田競爭於其東南、致所產之煤、不能運銷於綏遠以東、蓋地勢使然也。

附述產泥炭區域

歸化盆地內產泥炭最著之區、在綏包鐵路台格木車站之西南、本地名爲河炭、分布於沙家營子裁生大小羊羔霍拉哥氣及大里包一帶、自東北而西南共長約二十里、寬約一二里。在台格木西南相距約三里之泥炭廠、所採泥炭層厚度約由一尺至三尺、於此採得之泥炭分析成分如左。

水分	揮發物	焦炭		灰色	焦性	熱量
		固定炭	灰分			

四、八二	五三、九二	四一、二六	一六、四四	二四、八二	草灰不圓結	六一、九二

若以半公尺爲泥炭層之平均厚度、則全區計儲泥炭一千一百萬噸。泥炭之開採、多在春冬、取露天工作方法、全區內舊坑頗夥、凡欲採泥炭者、每採長一丈一尺寬六尺之地、須付地主價洋一元、並納稅二角五分。泥炭濕時如泥乾則堅輕成塊、故泥炭自坑中掘出後、率在炭廠晒乾、（第四版丙圖）然後運至家中積存、以備燃燒、間有用牛車載至歸化城出賣者、每車重約三百斤約值洋六角。

討子號東南亦產泥炭、惟面積甚小、周圍不過三四方里、泥炭層厚僅尺許、上覆土壤深約四尺、凡在此採泥炭者、每採一厘地、凡寬五尺長一丈二尺之地、給地主洋一元三角。又聞討子號東二道河子附近、尚有產泥炭區域、恐面積亦不廣耳。總計所述三泥炭區域、皆沿大青山山麓、自東而西列於一直線之上、此殆與泥炭沉積時之地形有直接關係、欲考察歸化盆地之泥炭分布者、不可不加之意焉。

直隸宣化涿鹿懷來三縣間地質鑛產

譚錫疇

譚君報告重在地質圖之說明、當時譚君等調查注重鑛產、對於地質亦得要領、於該區火成岩觀察則未遑甚詳、近由王君恆升補爲研究、另有報告印於本期彙報研究岩石者當併閱之、　翁文灝附誌

民國七年九月應龍烟鐵鑛公司之邀偕同鑛政顧問安特生、技師朱庭祜、調查三縣地質、並測繪十萬分之一地質圖。一面續探鐵鑛、爲謀鑛業之發展。一面尋察純粹灰岩及煉焦煙煤、爲供煉鐵之需要。於是分頭進行、各執其事。安君詳察宣化煙筒山鐵鑛、並調查懷來新保安一帶地質。朱君由洋河畔向東測勘。作者則往西方進行。數旬事粗畢。合製爲三縣地質略圖。擬刋印成幅、公之於世。顧不能有圖無說。今試摘要敍述、與圖輔行。惟安朱兩君調查區域迄未專著報告。斯編所載、以目觸足踐曾經考察者合之耳食於二君者聯綴而成。其鷄鳴山煤田大半取材於直隸實業廳技術員朱行中君之報告。八寶山煤田多採自王霖之先生之報告。東鏵西爪、難不免錯雜疎漏之譏。然參合比擬、亦未嘗不足資研究者之考鏡耳。

地層

本區域地質粗視之、雖與中國北部各處無甚軒輊、然詳細觀察、構造則殊不簡單。其元古界之灰岩常與中生界之煤系及凝灰礫岩接觸、兩代地層中間、似爲一大缺失、而實則爲斷層接觸、特地層傾折錯亂、不易尋其端倪耳。元古界之石英岩層、在洋河以北烟筒山一帶、尚爲發育、至洋河以南、厚度頓減、在本區域南部、雖稍露蹤跡、然夾雜於薄層頁岩及灰岩之內、殊不占重要部位也。

（一）　地層

元古界上部灰岩層及凝灰礫岩層、發育特著。中生代煤系在本區域中部、暴露亦夥。片麻岩生於本區域南北兩端。石英岩層發育於北部。寒武奧陶紀地層惟八寶山一帶稍有暴露。其他屢經目擊者、則爲含於凝灰礫岩內之火山岩、及包於各地層之侵入岩也。

片麻岩層　片麻岩不僅發育於太古代、在元古界下部亦占重要位置、此中國北部普遍之情形也。宣化各處片麻岩層、直位於含鐵石英岩層之下、是否屬於太古界仰係下元古界之一部、尙有疑義、但實地考察、地層內不含、顯然來自水成之變質岩如大理岩者、並片岩亦未曾目擊、其片理甚粗、長石石英俱備、而雲母稀少、爲一種偉晶花崗片麻岩。則以歸入太古界爲宜。在本區域分佈不廣、占據南北兩端、在北端者、沿烟筒山臥虎山一帶橫嶺之北麓、東西延長約二十餘里。岩石爲片麻岩角閃岩、並有花崗岩及偉晶花崗岩侵入層內。在南端者、沿老君山南坡延長約二十里。沙城以北焦家溝及石河附近、稍有暴露面積不大。上水谷村潭院一帶、亦有露頭南北延長、不及十里、廣僅三數里而已。

石英岩層　屬於新元古界之下部、含有重要鐵層、下覆片麻岩層、上與矽灰岩層緊接。在洋河以北、暴露所在、全層頗厚不下二百公尺。石英岩最發育、內夾可採鐵鑛數層。至洋河以南、厚度頓減、全層總厚不過五十公尺。重要部份爲頁岩、石英岩僅數公尺而已。本層岩石以石英岩石英砂岩石英板岩爲主、有時夾頁岩及薄層灰岩、並含重要鐵鑛。石英岩色白質堅、變質淺時、爲白色石英粗砂岩。分佈於烟筒山臥虎山一帶者頗廣、西自陳家莊迤南起沿山嶺北麓迤而東、至烟筒山南、阻於斷層而盡。烟筒山本部爲本層暴露之區、向東沿臥虎山北麓、經葛峪而東出境。其在黑太山者露頭頗狹。本層下部大致爲石英板岩、上部爲石英砂岩、層甚厚、層面常現

波紋、此淺水沉澱之證也。上爲鐵鑛層、再上爲黑色板岩、安特生博士歸之於矽灰岩層內、但他處石英岩層上部亦常見有黑色頁岩及板岩、此或即石英岩層內之分層歟。在老君山南坡及潭院大房子一帶、極不發育、惟介於片麻岩層及矽灰岩層之間者、稍露石英岩蹤跡、偶見劣等鐵鑛、故劃歸石英岩層內。潭院大房子附近所見露頭均相連續、蜿蜒北向、直至上水谷村之西。其下部與片麻岩接觸者、爲鐵鑛、層薄質劣、雖間有較厚鑛層、而絕不延長、分向左右數武、鐵質驟消、成一種含鐵之紅色粗砂岩。上爲黑棕色及綠色頁岩、內夾薄層灰岩數層、厚各約一二公尺。頂部即石英岩、色白質硬、與烟筒山一帶所見相同。

矽灰岩層　直位于石英岩層之上、大抵成不整合之接觸、石英岩層爲新元古界之下部、本層屬其上部也。全層厚度因未嘗盡其頂端、無由窺悉、即以暴露之部而言、往往組成千餘公尺之高山、地層傾斜通常二三十度、依法估計、約亦近千公尺矣。本層以矽質灰岩爲主、兼有石英岩及頁岩、灰岩內矽質成薄層狀、或卵形、惟在本區域南部、本層內不常含矽質、而質不純潔、多含雜物、頗有別于他層之灰岩。本層分佈甚廣、多組成高山大嶺、位于本區域南北兩部、中隔原野及小平山嶺。在北者爲烟筒山、臥虎山、黑太山一帶、組成橫嶺一道、下部接于石英岩層者、爲矽質灰岩、厚約百公尺、上爲石英岩層、頗厚、其一部、每呈綠色、再上爲矽質灰岩、常夾燧石、爲卵形或層狀。在南者組成一帶山嶺、蜿蜒連亘、或成孤立之山、巍然聳立、其最著者爲黃陽山、黃陰山、老東山、老鶴山、及胡家大山、威叢山、石崖山、富貴山、逾桑乾河爲大南山、筆架山一帶山巔、至潭院之南未盡。東有老君山等處露頭、逾河而北、沿八寶山南麓、再東、組成沙城迤北之山嶺、其沿洋河東岸者、則有鷄鳴山、元寶山、悉爲本層組成。此分佈之概略也。岩石爲矽質灰岩、下部層薄、夾綠色頁岩、上部層厚、不問他層、有時夾赤鐵鑛、由溶液沉

溷而成、形不規則、厚不及尺、以在下坡地溝中者爲最著、郭家寺南黃陽山腰亦曾目擊。

寒武奧陶紀　在本區域露頭甚少、頗不發育、惟在八寶山南坡、則有類似於寒武奧陶紀地層者、八寶山一隅、作者向未涉足、此節紀述、悉由王霖之先生八寶山煤田報告採擇而得。其言曰「最南之矽灰岩、當爲煤田之最下層、稍北則爲頁岩、初爲灰色、繼爲黑色、最後則現紅色、由此而上、即爲灰岩、厚約六七米突、質極純、用以燒灰、爲貼近煤田之下層、有灰窰在焉、灰窰者、不啻探煤之引線也、」觀此則矽灰岩層上之紅色頁岩、或即他處所見之寒武紀頁岩。惟頁岩下部作黑色、其上爲純灰岩、作者頗多懷疑、蓋寒武頁岩、通常爲棕色赤色紫色或綠色、向未見有爲黑色者。但直隸北部矽灰岩與寒武頁岩之間、往往有黑色頁岩矽岩一層、厚薄不等、時隱時現、直接矽灰岩、與寒武頁岩呈不整合之觀、曾歸入于元古界內。今八寶山黑色頁岩性質位置、頗與此近似。王氏報告內既無顯著分劃、茲暫附麗於紅色頁岩層內、而歸入於寒武紀。又寒武頁岩之上、通常爲不純灰岩、每作鮞狀蠕狀之觀、其距奧陶紀純灰岩頗遠、今八寶山灰岩、質極純、而甚薄、約六七公尺、既不類寒武灰岩、而與奧陶灰岩厚度相差殊甚。作者未曾目覩、不便臆斷、然據圖觀察、或爲奧陶紀灰岩、與上下兩層均成斷層接觸者。寒武奧陶紀地層、懸疑尚多、茲特叙實記述、而參加己意如是。

煤系　煤系屬於中生代侏羅紀、與元古代之矽灰岩層、除八寶山一隅、介有類似之寒武奧陶紀地層外、處處密相接觸。中間地層、渺不可覩。按地層次序、顯然分爲兩組、一自片麻岩層以至石灰岩層、一則煤系及煤系以後之地層也。兩組地層之間、乍視之似爲不整合、詳細觀察、實以斷層相接觸者。惟地層亟經斷折、錯動劇烈、幾全泯其眞跡耳。煤系底部地層、匿跡深藏、未能窺悉、其露出於地表者、大抵可分爲三部、下部盡爲頁岩、層頗薄、

散碎成片、色分棕黑綠紫、不含煤層、內常夾扁豆形石灰質物、橫伏成列、且含黃鐵鑛、土人用以燒硫。中部岩石甚夥、砂岩頁岩礫岩、均占重要部份、可採之煤層、萃集於斯、惟各煤田率受斷層影響、地層彎曲起伏、極不規則、故完整地層剖面、尋獲匪易。就其所處地位及四圍情形觀察、大抵下爲黑色淺綠色頁狀砂岩、黑色頁岩、赤色泥質頁岩、棕色綠色頁岩、及薄層砂岩、次爲礫狀砂岩、間有含灰岩礫石之礫岩、夾矽質物之薄層灰岩上爲淺綠色砂岩、石英質砂岩、含有黃鐵鑛、白灰色粗砂岩礫岩、稍帶赤色、並有淺紅色淺黃色鬆砂岩。上部爲紫綠色頁岩砂岩、（朱君圖中另分爲紫綠岩系茲以暴露不廣、暫附麗於煤系而爲其上部） 亦不含煤層、上即直接凝灰礫岩層矣。所含煤層厚度隨地而異、層數亦各處不同。在八寶山煤田煤層至一二十層之多、而可採者、不過四五層、厚均在五尺以上。鷄鳴山煤田主要煤層、約有三層、薄者約二尺、厚至七八尺。玉帶山煤田通常採者、有煤三層、薄者尺許、厚者約五尺左右。自此而西、各小煤田煤層開採者、均甚薄、約數寸。煤系厚度、以未能窺見全豹、無術測知、只就露出者粗事估計、其下部約爲三百公尺、中部約在二百公尺左右、上部時出時沒、分佈不均、厚度更無從推悉。煤系分佈多沿山麓、大致分爲八區。第一區組成八寶山煤田、位於山之南坡、東西長約二十里、南北廣約二三里、大致煤系中部最爲發育、上下兩部、露頭甚尠。第二區組成鷄鳴山煤田、暴露於山陰、面積不廣、長寬各約四五里、亦以中部發育爲最、上下兩部、大抵闕如。第三區組成大尖山黑太山一帶煤田、面積頗廣、長寬均約十數里、三部大都均發育、而以上部爲最著。第四區組成玉帶山煤田、延長約十數里、下部發育較著、中部惟暴露於玉帶山附近、上部渺不可覩。第五區在黃陽山南麓、成帶狀、延長約十里、盡爲煤系下部、不產煤、間有黃鐵鑛。第六區在老東山南黃陰山西、跨桑乾河兩岸、長寬各七八里、中部較爲發育、下部分佈於王

家樓一帶、盛產黃鐵礦。第七區在大南山北富貴山南、傍桑乾河、長約七八里、寬半之中部分佈較廣、下部暴露於西窰溝北一帶、亦產黃鐵礦。第八區在富貴山西、組成郭家寺煤田面積狹小、長寬各二三里、盡爲煤系中部。

凝灰礫岩層　在吾國北部、暴露頗廣、尤以山東東部直隸北部爲最發育、與各代地層多爲不整合之接觸、或謂之爲斑岩礫岩、或逕以凝灰岩名之、實則兼含凝灰岩礫岩、而更夾有火山岩流、及少許其他水成層也。本區域凝灰礫岩層、約占全區之半、位於煤系之上、不相整合、而與矽灰岩層、成斷層之接觸。下部大抵爲棕紅綠紫各色凝灰礫岩及凝灰岩、並間夾紅色砂岩及薄層頁岩。上部大抵爲棕紅綠各色凝灰岩及凝灰礫岩、常夾棕紫及深綠色火山岩流、或成層形、或現斑狀、間含黑曜石層、內礫石多爲各種火山岩所成、然亦有爲石英岩及灰岩所成者、並偶見片麻岩之巨礫。全層厚度、未能測悉、就暴露者而言、約不下五百公尺、分佈頗廣、位於本區域之中部、或組成原野基礎、或凸爲一帶山嶺、其在洋河桑乾河之間者、與矽灰岩層參差互入、組成之山、爲娘子山、永蓋山雷公山金家大梁大羅山、諸山上部每有火山岩流、顯成絕壁、伴煤系而生者、多在其上。與黃土共生時、則匿其下。在洋河以東、本層多組成平嶺、或沿灰岩山麓、其突起者、爲八寶山、本區域東部最著之山也、至本層時代、以未得化石、暫難確定、但就地層位置比較、及岩石性質觀察、與中國北部各處凝灰礫岩層位置相當、或亦爲屬於白堊紀下部者也。

黃土層　堆積於各種地層之上、在坡地極爲發育、直立劈開面頗顯著、含介殼甚夥、厚自數百尺至二十公尺不等、間有至三十公尺者。分佈頗廣、坡地低地、均爲其暴露之所、最廣處爲洋河以西、直至山麓、洋河以東、逐原野而生存、面積共約千方里。次爲桑乾河以南、直抵山麓、筆架山迤東、老君山四周、均甚發育、面積計約四五百

方里。其他零星棋佈於山谷之間、及山坡之上者、總計亦不下數百方里。

冲積層　沿河岸及山坡低地、屢經目擊、其在黃陽山及桑乾河之間者、面積頗廣、計約數百方里。含粗矽礫石黃土及次生黃土、厚自數公尺至十數公尺不等、有時層甚厚、沿洋河北岸者、直至八寶山南麓、沿泥河北岸者、則有宣化以東冲積層、其他大抵均離河岸不遠、即無復暴露矣。

黃沙　散積於黃土之上、爲風吹河沙堆積而成、沙深數尺、流徙無常、疎鬆乾燥、赤無草木、蓋不毛之地也。惟黃陽山以北洋河西岸有之、面積約六七十方里。

構造

本區域地質構造、頗稱複雜、斷層既多、錯動又烈、最新之凝灰礫岩、常與甚古之矽灰岩相接觸、而介在中間之古生代及中生代地層、則偶一見之。蓋當造山之際、地殼被動最劇、故今斷層之仰側、巍然峙立者、概爲元古地層組成之山脈、其俯側悉爲中生代中期以後之地層、而古生代後期及中生代前期地層、非原未產生、即大都埋沒於深處也。

本區域斷層雖多、而摺疊不甚、地層傾斜大致緩漫、惟近斷層處、斜角往往頗大、茲按地層時期、述其傾斜概況。

片麻岩層曾經目擊者、層理頗不明瞭、即或稍露傾斜踪跡、亦錯綜褶縐、無一定方向之可言。故敘述地層傾斜之變更、此層每不與焉。

石英岩層以暴露於烟筒山臥虎山一帶山嶺之北坡者爲最廣、而地層傾斜、頗有緩急之分。在烟筒山一帶、地層傾斜平緩、斜角約在一二十度之間、至多約不逾三十度、斜向由南而西南而西。在宣化北山北麓者、傾斜甚

急、幾至直立、斜角五十度以下者、頗不多覯、傾斜大致向南。沿臥虎山北坡、地層傾斜頗緩、約爲十度、斜向正南、再迤而東、傾斜緩急不等、由二十餘度至四十餘度、傾斜大致向南、有時稍偏東南。在潭院一帶、地層大致傾向正南、稍偏東或稍偏西、斜角爲二十四度、迤西至大房子一帶、傾斜向西、有時稍偏南、斜角約在二十五度左右、迤北至上水谷村南一帶、大抵無甚變化。矽灰岩層分佈面積最廣、爲斷層劃爲若干區、不相聯絡。故其地層彎曲狀況、區各自異、均不相關。今按區敘述、較爲明易、第一區爲烟筒山臥虎山黑太山一帶橫嶺矽灰岩層、南爲斷層所阻隔、北直接石英岩層、地層傾斜雖局部不免稍有變更、而層向大致與橫嶺方向相合、而爲東西、斜向多爲正南、惟黑太山北麓、臥虎山南坡、有傾斜向北者、斜角頗大。通常均約五六十度、大至八十度、或成直立、而在三十度左右者、間一見之耳。第二區爲黃陽山黃陰山一帶山嶺、東逾洋河、連元寶山以至煙筒山。黃陰山地層傾斜、大抵向南、稍偏西、或稍偏東、斜角在四五十度之間、至其南麓、間有爲直立者、黃陽山西部南坡地層斜向東南、斜角二三十度不等、至頂端變爲東北偏東、斜角頗小、不逾十度、並有成水平者、其山嶺一部地層斜向東南偏南、斜角約二十度、至沈莊東山、斜向不變、角度頗大、爲六十度、再東至黃陽山東部、地層傾斜在山南坡、大致爲西北、或偏西、斜角在四十度左右、迤東有傾向正西斜角爲十二度者。逾河至元寶山煙筒山一帶、地層傾斜大致向南、或稍偏西、或稍偏東、斜角約爲五六十度、其平緩者、亦不下三十度。總之第二區矽灰岩、地層無甚彎曲、惟傾斜方向、局部常有變改、其北近斷層、多作絕壁、南傍斷層、傾角增大。第三區爲老東山老鸛山一帶矽灰岩、地層大致傾向東南、有時稍偏東或稍偏西、斜角由二十度至二十八度。惟近斷層處、角度甚大、幾成直立。第四區矽灰岩、分佈遼闊、在大南山筆架山迤南一帶及富貴山等處、但富貴山成一小區、與大區隔絕、地層

平緩、傾斜大致向南、成十二度角。其大南山一帶、地層傾斜不甚一致、時而西北偏西偏北、時而東南偏東、或直向正東、斜角在二十度四十五度之間、間有成直立者、特局部之變更耳。筆架山一帶、地層傾斜大致向北稍偏西、惟斜角頗大、均在五十度以上。在保岱西山一帶。傾向西北、或偏西、或偏北、斜角自三十度至六十度不等、亦間有傾向正東或正西者、率爲局部變動。至輝耀一帶、地層傾向西北偏西、斜角約四十度。潭院一帶、傾向正北偏西、斜角二十度左右。總之第四區矽灰岩、地層傾斜較爲複雜、局部變動亦甚、惟少重大曲綯褶疊、於全區構造無甚影響。第五區爲威叢山胡家大山一帶、威叢山地層傾斜向南稍偏西方、斜角二十二度。胡家大山一帶、有時斜向西南偏西、斜角六十度、有時爲東北偏東、斜角三十二度。第六區爲石崖山山西北部、地層傾斜東北、稍偏東或東南偏東、斜角由二十度至二十四度、山東南部地層傾斜均爲南稍偏東、斜角在二十度左右。第七區爲雞鳴山、山巍然聳立、狀成絕壁、矽灰岩地層傾斜綦陡、斜角約在八十度以上。第八區爲八寶山一帶、山容多參差、呈懸崖狀、傾斜大致向北、斜角甚大、蓋隱約與鷄鳴山矽灰岩層相連者也。第九區爲本區域東邊矽灰岩、在老君山西坡窩堡以北、地層傾向西北、斜角約三十度、至西南北榆林以北、傾斜方向稍偏西北、而角度略減爲二十二度、此本區域矽灰岩層傾斜之大概也。

寒武奧陶紀地層、惟在八寶山南坡見之、暴露面積頗小其傾斜大抵向北有時偏向西北、或稍偏東北、與矽灰岩層常取同一方向、而傾斜角度亦頗大。

中生代煤系地層暴露所在亦多不連續、分爲數區、每區曲斜狀況、各不相同、第一區爲黑太山煤田、面積狹小、地層直立、層向大致爲東西。第二區爲大尖山一帶煤田、在東部地層傾斜大致向西、或稍偏西北、或稍偏西南、

斜角約二三十度至大不逾三十五度小亦不下十度。在大尖山東坡、地層向東傾斜或稍偏東南、與東部地層大致成一向斜層。在山之西坡、又轉向西南、似曾受附近侵入岩衝撞之影響、斜角均約二十餘度。至煤田南部、地層或傾向正南、或偏西南、或直向正西、斜角較小、約爲一二十度。第三區爲鷄鳴山煤田、在鷄鳴山北麓、地層傾斜大致向北、斜角甚大、約爲六七十度。下花園東南傾斜向東、角度較小、爲四十五度。至下花園東北、地層偏向東南、斜角爲六十五度。第四區爲八寶山煤田、地層傾斜大致向北或偏西北、或偏東北、斜度不等。在東部層近直立、中部斜角在五六十度之間、西部地層較爲平緩、約在三十度左右。第五區爲玉帶山一帶煤田、東部邊際地層傾斜稍形複雜、近玉帶山南麓、大致傾向西南、或稍偏南、或稍偏西、有時直向正西、斜角由二十度至四十度、間有平緩爲五六度者。西部近黃陽山地層傾向東南偏東、斜角頗大、約爲五十度。煤田地層構造大致雖不甚複雜、但局部稍有彎曲、故傾斜不能一律。第六區爲黃陽山南麓煤系地層、大致傾向東南、稍偏南、斜角在四十度左右。第七區爲黃土灣煤田、地層傾斜大致爲西南偏南及東南偏南、有時斜向正南、斜角通常在二十度左右、有時近三十度、在長疃東北有成直立者、蓋局部變動也。第八區爲東窰溝煤田、地層傾向大致爲東南偏東及東北偏東、亦有斜向東南偏南北、斜角均在二三十度之間。第九區爲郭家寺煤田、地層傾向東南偏東及西北偏北、斜角約爲二三十度、間有成水平者。

凝灰礫岩層分佈雖廣、而地層傾斜、顯昧不定。有時礫岩暴露而成層狀、傾向易悉。有時岩流遍佈而爲塊形、斜向不明。在金家大梁北坡、地層傾向東南偏東、斜角約爲十度。其南坡地層亦多向東南傾斜、斜角由二十度至四十度、間有傾向正西者、斜角頗小、不逾十度。郭家寺東南地層傾向東北偏北、斜角爲七十度。至五家溝西礫

岩層傾向正南斜角四十五度。凝灰礫岩層傾斜顯著者、惟此數處、餘則概成塊狀、分辨匪易、然亦有略露層形而不可定其傾斜方向者。

本區域構造複雜、地層錯觸、實受斷層之影響。推其生成時期、多在中生代以後、或當第三紀之中葉。蓋中生代末期地層、常與元古代地層、成斷層接觸、其後於中生代末期也、殆無疑義。惟斷層交錯、顯昧有殊、有極明瞭一望而知者、有掩於黃土冲積層、難尋其端倪者。茲擇其涉及全部構造、而關係重要者、及其他顯著之小斷層、約略述之。

臥虎山一帶橫嶺北麓斷層、雖東西連續、而常被掩於黃土。西自橫嶺西端起、直向東趨、連亘幾三十里、東端匿於黃土之下。為一正斷層 (Normal Fault)、仰側為矽灰岩石英岩、間有片麻岩、俯側為矽灰岩、間有凝灰礫岩層中之斑岩。西部錯動甚大、東部頗小。故矽灰岩層多以斷層互相接觸也。

東葛峪以東斷層、或與前斷層本相連續、惟被掩於黃土、莫測究竟、故分言之。方向為東西、不甚延長、亦為一正斷層、仰側為片麻岩、俯側為矽灰岩、錯動不甚劇烈。

臥虎山一帶橫巔南麓斷層、驟視之矽灰岩層與凝灰礫岩層似成不整合之接觸、然就四周情形、及本區域全體構造觀察、極類斷層接觸。西起橫嶺西端、東盡於臥虎山之南、亦為正斷層、仰側為矽灰岩、俯側為凝灰礫岩層。錯動大小與橫嶺北麓斷層無甚懸殊。惟兩斷層之仰側、同為臥虎山橫嶺、又聯成地壘 (即凸起斷層 Horst)。

黑太山南麓斷層、與前斷層或本相接連、惟相距頗遠、故另述之。成東西方向。不甚延長。為正斷層仰側為矽灰

岩、俯側爲煤系及凝灰礫岩層中之斑岩。錯動劇烈。

黃陽山南麓斷層、分爲兩段、不相連續、一段自洋河岸起、蜿蜒至沈莊之北止、一段自郝家坡附近起、迤邐至水泉莊附近止。爲正斷層、仰側爲矽灰岩、俯側爲煤系及凝灰礫岩。錯動頗大。

黃陽山北麓斷層、自黃陰山西坡起、迤而東北、經黃陽山北麓、逾洋河、經元寶山之陰、止於烟筒山東坡、延長約三四十里。似爲一正斷層、而斷層面傾斜甚大幾成直立、仰側爲矽灰岩、俯側爲凝灰礫岩。錯動與前斷層不相軒輊、但兩斷層仰側同爲黃陽山、突出甚高又作成地壘（即凸起斷層）。

老鸛山東麓老東山南麓斷層、自老鸛山東北起、蜿蜒經老東山南麓、至坡地南山止、延長約二十里。爲正斷層、仰側爲矽灰岩、俯側爲凝灰礫岩。錯動大小與黃陽山北麓斷層相埒。但兩斷層俯側同爲凝灰礫岩、作成黃陽老東二山中間之谷、故兩斷層亦可聯稱爲槽狀斷層（Trough Fault）。

筆架山大南山北麓斷層、東起長疃附近、初沿桑乾河南岸至西窰溝、逾河、經郭家寺之南、西抵大羅山南坡、蜿蜒幾三十里。爲正斷層、仰側爲矽灰岩、俯側爲煤系及凝灰礫岩。錯動頗大。一部與老東山南麓斷層相對、又作成槽狀斷層、即桑乾河之谷也。

老鸛山北麓斷層、起於山之東北、向西南延長、至靳家梁之北、掩於浮土。爲正斷層、仰側爲矽灰岩、俯側爲凝灰礫岩。錯動劇烈。與老鸛山東麓斷層一部相對作成地壘（即凸起斷層）。

威叢山西麓斷層、起於姚家舖西南、至陽城附近止。爲正斷層、仰側爲矽灰岩、俯側爲凝灰礫岩。

胡家大山南麓斷層、不甚延長。仰側爲矽灰岩、俯側爲凝灰礫岩。

富貴山四周斷層、富貴山除山北一部與侵入岩接觸外、均爲斷層所限。仰側爲矽灰岩作成富貴山、俯側爲煤系及凝灰礫岩。

石崖山四周斷層、斷層圍繞全山。矽灰岩凸出而爲仰側、四周環以凝灰礫岩、均作爲俯側。

潭院至上水谷村附近斷層、起於潭院之南止於上水谷村東北。爲正斷層、仰側爲片麻岩、俯側爲矽灰岩。錯動不大。

上水谷村南斷層、斷層甚小、分截含鐵地層。錯動極微、上下錯動外、稍有平推錯動

鷄鳴山北麓斷層、不甚延長、錯動頗大。仰側爲矽灰岩、作成鷄鳴山、俯側爲煤系、即鷄鳴山煤田之所在也。

八寶山南坡斷層、其最重要者、爲分截矽灰岩寒武奧陶紀及煤系凝灰礫岩之斷層、延長約二十里。錯動劇烈。而斷層面傾斜頗大、似爲一逆斷層 (Reversed Fault)。煤田內斷層頗多、分隔煤田而爲三部者、有二小斷層、大致爲平推斷層 (Horizontal Fault)。其平安站煤系地層、與寒武紀頁岩、八寶山腰奧陶紀灰岩與煤系之間、均爲斷層接觸。

沙城以東、石河之北、焦家溝之南、均有斷層、分截片麻岩及矽灰岩。仰側均爲矽灰岩、俯側均爲片麻岩。殆皆爲逆斷層歟。

鑛產

本區域鑛產、煤鐵俱備、煤系屬中生代、煤層厚薄不一、數亦各處不同、大半爲無烟煤、質不甚佳、即有烟煤亦多不適於煉焦之用。鐵鑛除含於石英岩層內之赤鐵鑛外、尚有矽灰岩層內之赤鐵鑛、及煤系中之黃鐵鑛、其重

要鐵鑛、在宣化烟筒山一帶、即龍烟鐵鑛公司採辦之區、餘均鑛量極微、毫無價值、概不足以鐵鑛目之也。

(一) 煤田

煤系分佈雖廣、而產煤之區、率不綿延、非爲斷層所限、即上下不含煤部份特別發育、其中部含煤者、惟玉帶山、鷄鳴山、八寶山大尖山、黑太山、黃土灣、東窰溝、郭家寺、等煤田。就中以玉帶山鷄鳴山八寶山三煤田爲佳、煤層較厚。餘則面積既小、煤層又薄、開採不盛。僅以目覩耳食者拉雜述之。

玉帶山煤田　在京綏鐵路之西、其盛採部份、距下花園車站約八里。東起洋河西畔、經玉帶山南、迤西抵黃陽山麓。惟煤系暴露雖延長約十餘里、而產煤處僅在楡樹地青寺夏家溝紫坡窰等地、面積只十數方里也。

煤通常採者、計有三層第一層厚約一尺、第二層厚約五尺半、第三層厚約五尺、第二第三兩層相距甚近、只隔有黑色砂質頁岩一層厚自一寸至八寸不等。

煤分有烟煤無烟煤兩種、近玉帶山處、多爲無烟煤、距山遠處、多爲烟煤、愈遠烟煤愈多、至不見無烟煤之踪跡、但有烟煤亦不適於煉焦。

產煤區域、面積不逾十數方里、煤量自不能豐富。煤層雖有三層、可採者僅二三兩層、總厚約爲三公尺。煤層重要部份均在玉帶山附近、向南延長抵青寺而盡、計約一千八百公尺。楡樹地一帶、地層傾斜角度在三十度左右、沿層面向下採掘大抵不能過一千公尺。茲假定可採煤層之長爲一千八百公尺、寬爲一千公尺、厚爲三公尺、比重爲一・二。其煤量約爲六百四十餘萬噸。但舊日開採甚盛、煤層上部均已採掘殆盡。並以施工關係、不能盡數採出、假定以什之六爲可以採出之數、當爲三百八十餘萬噸也。

玉帶山一帶、舊日小窰甚多、均相繼歇業。今大事採辦者爲寶興煤鑛公司、在玉帶山西南楡樹地、距下花園車站約八里。呈請人周琳。前用土法開採、民國三年領照、鑛區三百十畝。資本銀二萬六千兩、由股份集成、共計百股。自開辦以來迄今將近十年、出煤方三年。開採第二第三兩煤層、煤分有烟無烟兩種、不能煉焦。開有竪坑一、深二百尺、口爲長方形、長九尺、寬七尺、爲出水之用、斜坑二、斜深至煤層約四百尺、至現採煤處約八九百尺、坑口高五尺、底寬五尺、頂寬三尺、坑內所留煤柱、方二十尺。支柱用楊柳木、徑二寸許、作成木架、每架用木三條、價約銅元二十枚、兩架相距約七寸。坑內裝運煤用布袋及條筐、布袋一個價約百二十枚銅元、使用一月、條筐兩個價十三枚銅元、使用半月。提水用升降機、水由坑內用條斗淘至竪坑底水池、灌入活底鐵筒提出之、鐵筒盛水約五百斤、條斗每個價十三枚、使用十日、機器全套價銀六千兩、由天津北洋勸業鐵工廠購買、馬力四十。坑內點燈用蔴油、一盞燈每日所用油價約值銅元十枚、最深處用安全燈、備有十盞。工人共計約三百餘人、均由鑛給食、採煤者五六十人、工價每人日得二十三枚至三十六枚銅元不等、採煤約六七百斤、水夫約百人、每人日得銅元十八枚、小工百餘人、機器匠十人、工錢按月計算、分九元十五元十七元三等。現日出煤約三十噸。在鑛場售賣每二十四斤銅元七枚。銷售由下花園車站運往張家口宣化等處。稅率出煤一噸、納銀一錢。

鷄鳴山煤田　在京綏鐵路之東、緊傍下花園車站、西起洋河東岸、南抵鷄鳴山北麓、向東延長約五里、北止於下花園之東北、雖面積不廣、然盡爲產煤部份、蓋煤系中部發育之區也。

煤層厚薄不等、層數亦多、除最薄者不計外、其主要煤層有三、第一層厚由二尺至七尺、第二層厚約四尺、第三層厚約八尺。

煤質灰分略多、硫質絕少、大致亦分有烟無烟兩種、而烟煤亦不能煉焦、茲將分析結果揭示如左。

地名	灰分	揮發分	炭分	水分	焦性
八畝地	一四・六	二六・〇六	五八・八〇	無	不煉焦
老莽剌	二七・五	二一・一五	四八・九五	二・四〇	不煉焦
蘭坡臭煤	二七・九	二四・一五	四五・五五	二・三〇	不煉焦

煤層傾斜角度甚大、往往幾成直立。故雖觸處有煤可採、而距地面稍深、即不易施工。茲假定三百公尺以上可用經濟的方法採掘、即作為可採煤層之寬。煤層走向、略成東西、至洋河近處、方向始變、故煤層之長、尙可踪跡、假定可採煤層之長為三千公尺。就通常開採之煤層而言、總厚約為十餘尺、今以四公尺為可採煤層之厚、煤之比重為一・二。其煤量約為四百三十餘萬噸。但因種種關係、不能盡數採出。而舊日曾經採掘、煤層已失其一部。假定什之六為可採煤量之數、當為二百六十萬噸也。

鷄鳴山一帶、舊日小窰林立、作輟靡常、人地屢易、今因受大鑛影響、閉辦者寥寥無幾、煤田內重要部份、概歸京張鐵路官鑛局採辦。鑛局在鷄鳴山北八畝地、距下花園車站約三里、自車站至鑛場、築有鐵路、復設小鐵道於鑛場井口至篩煤處之間。前清光緒末季、由京張鐵路局詳請直隸督轉咨商部立案、准予開採、並就鷄鳴山八畝地、收買舊洞、另開新井、先行試辦、所需經費、由路工經費項下墊撥、至宣統三年、郵傳部具奏歷辦情形、及聲敘用過辦鑛經費、計共用銀四十七萬餘兩、即作為該鑛資本、民國三年鑛務監督署成立、令知遵照新章註冊、

後經直隸財政廳繼續催辦、該礦以所領礦區面積過大、註册費頗鉅、迄今尙未履行、此民國七年以前之情形也。礦區面積計三十六方里、由地面開有豎坑一、深約四百尺、坑口方十二尺。提煤用捲揚機、捲輪徑約四尺、每小時提煤約二十噸。由井口下深二百尺處爲第一平巷、四百尺處爲第二平巷、內又開一豎坑、深約二百尺、直達第三平巷。坑口捲揚機一點鐘提煤十噸。採煤沿煤層走向進行、兼用長牆及房柱法、煤柱約五十方尺、東西坑道寬約六尺、高約七尺、上山挖煤坑道高寬各約三尺、下山挖煤坑道高寬各約六尺、坑道兩旁在壓力較大及水流下注之處、用石砌牆、餘則用楊柳木支柱。坑下運煤用容三分一噸之小車、提煤用絞籠高五尺寬二尺四寸、煤車由第三平巷出煤處用人力推至第二號豎坑底、至第二平巷、再用人力推至第一號豎坑底、提出地面豎坑之北、設有自動絞車附帶鋼製絞繩、煤車二十一個爲一組、四周以鋼繩套緊、適用重力斜坡自運法、重車下降空車上升、由小鐵道直達篩煤處、再裝入京張路火車、每車容煤三十噸。坑內工人約三百餘名、晝夜分爲三班、工價約洋三角五分、坑底出煤、有五號包工、出煤一噸、給予工價洋五角八分、其他工頭及木石瓦雜工等、工價類各有差、通風在大坑之旁挖有風道、口邊設有軸風扇一座、每分鐘抽風三萬立方尺。坑內採煤工人均用安全燈、排水在六百尺深處、設有直立抽水機一個、四百尺深處設有臥式大抽水機一座、各在豎坑底左近坑道之旁、設有地溝、水均由溝流入坑底水池、用抽水機上提、經六寸徑鐵管、送出地面、每日抽水二十小時、每分鐘抽水六噸。局內設有電報房、庫房、木工場、打鐵廠、機器房。鍋爐共有三個、爐面直徑七尺、長約三十尺、汽壓八十磅、每一鍋爐日燒煤五噸。產額每月不及五千噸。成本在二元以上、通常約二元四角左右。煤價每噸約三元四五角。銷售沿京張鐵路各車站、並可遠及天津保定、價各有差。稅率礦產稅每噸納銀一錢、運煤至天津

每噸繳納海關稅銀一錢、落地稅銀一錢、厘捐洋七八分。

八寶山煤田　在懷來縣新保安之東北、其南邊距新保安城約七八里。據八寶山之南坡、東西長約二十里、南北寬約二三里。煤系中部、觸處發育。故煤田所在、無往而不見有舊窰採掘之痕跡也。

煤層甚多、舊有七十二槽之稱。今所知者在東部有二十餘層、厚逾五尺者至四五層之多。在中部計有十餘層、皆甚薄、無逾三尺者。在西部亦有十餘層、惟有一層厚逾三尺。

煤質無烟煤多、中部稍有煙煤。據分析結果、大致可煉焦。惟面積狹小、出產不夥、煤灰分太多、稍有水分、灰之色澤率爲灰色、間有呈棕色者。

煤田爲斷層分隔爲東中西三部、東部煤層延長、厚度亦大、循跡計量、不下四千公尺、即作爲可採煤層之長、惟煤層傾斜過大、幾至直立、沿岸下採不能甚深、假定三百公尺以上之煤、可用經濟的方法採掘。煤層之厚逾五尺者、既有四五層之多、總厚計當不下二十尺、茲以六公尺爲可採煤層之厚度。煤之比重平均以一・二計。煤量約爲八百六十餘萬噸。除去已經採取及因種種關係不能採出者外、餘量尚不下五百萬噸也。

中部西部煤田皆面積狹小、煤層甚薄、即厚逾三尺者、亦不多覯、煤量頗微、不能大事採辦。充量估計、約不過數十萬噸耳。此外平安站附近亦有煤層、但厚只一二尺、且斷層甚多、交通不便、更無開採之價值矣。

煤田內小窰極多、統計約不下三四十處、然皆土人蒐集採挖、作輟無常、既無組織之可言、開採地點亦不一定、遇煤即挖、不預計長時採掘之方法、至洞深道遠、不利採取、便又遷往他處矣。

黃土灣煤田　在涿鹿縣西約二十里、面積較廣、惟開採不盛。在黃土灣附近有二小窰、煤層厚約三尺、爲無烟

煤、塊、末、皆有開採用斜坑沿地層斜向下掘。聞舊日在槐樹溝一帶、開採頗盛、煤層亦厚有厚至十餘尺者。但水勢浩大、土法採掘不易均繼續停工。

東窰溝煤田　在涿鹿縣西三十里、面積雖不甚廣闊。舊日開採頗盛、各處多見煤渣遺跡、惟今年小窰、全未興工。煤層及礦業情形、不甚明瞭。聞土人云、煤層厚薄地各不同、有一二尺者有三數尺者、煤爲無烟煤、末多塊少。

郭家寺煤田　在涿鹿縣西三十餘里、面積甚小東北爲侵入岩侵衝、東南爲矽灰岩阻絕。舊日小窰開採頗多、富貴山北坡及郭家寺北一帶、煤渣觸處堆積。今興工者惟小窰二處。採煤一層、厚只一二寸。爲無烟煤。土人春冬兩季採挖、夏秋停工。

大尖山煤田　在宣化東二十餘里、面積雖甚廣闊而開採不盛。西部大尖山附近、爲侵入岩衝撞、煤層多受彎曲。今歲惟在大尖山南坡及許家窰附近、有一二小窰掘挖。

黑太山煤田　在宣化東三十餘里、面積極小、長不及三里、寬僅二百餘公尺。沿黑太山南麓。北阻於斷層、地層多成直立。未見小窰採挖、煤層及礦業情形、均不明瞭。

（二）　鐵礦

本區域鐵礦、以種類言之、可分赤鐵礦及黃鐵礦兩種。赤鐵礦或夾於石英岩層內、或生於矽灰岩隙縫中。黃鐵礦每含於煤系下部、出產地點頗夥、然以質量言之、則多不足稱。宣化烟筒山一帶鐵礦而外、率無開採之價值也。

石英岩層內赤鐵礦　在宣化烟筒山發育特著、沿臥虎山一帶橫嶺北麓、暴露亦多。質既良佳、量又豐富、本區

域赤鐵鑛中、斯爲最上。宣屬南境潭院附近所見、質雖較佳、而鑛量殊微、不足與於鐵鑛之列。

烟筒山臥虎山一帶橫嶺北麓含鐵地層、東西延長約四十里、其間雖若隱若現、段落不接。然循層追索、每得其明晰現露之跡。橫嶺中間、復爲斷層分截、更劃鐵鑛暴露之區爲二帶。一爲地層原受剝蝕而浮露於地面、一爲地層斷折作爲仰側而隆出者也。玆由東而西、縷細述之。（以下摘譯安特生烟筒山鐵礦報告）。在前柳樹村之西五里許、始見鐵礦、山名三聖巔、爲石英岩組成、其南坡有鐵鑛露頭、因逼近斷層、層序錯亂、不能得一完全剖面。內有鐵鑛三層、尙約略可辨。其一厚約一公尺、復於溝底見有大塊鐵鑛、足證其層良佳、惟爲斷層隔斷、積量殊少希望。但斷層之仰側地層內、或尙含有良好鐵鑛、特埋沒於黃土之下、未能悉其究竟耳。沿層西向、至葛峪村南、有厚不及一公尺之鐵鑛。在葛峪村西南、復有鐵鑛一層、厚約〇・三五公尺、鑛質甚劣。再西至姚家溝東泡山一帶、鐵鑛露頭屢現、惟質頗劣、量似甚微。東泡山之西、即烟筒山鐵鑛、露出者厚驟增至二公尺、間有過之者。該鐵鑛中部最厚、層甚平、由此分向東北西三面、均漸次減薄、無從窺悉。由烟筒山而西、至黃土溝附近、有劣鐵鑛一層、然頗厚、在二公尺以上。黃土溝西北清河近旁、有一天然剖面、露出極顯、其最下層爲鰤狀鐵鑛、厚〇・一六公尺、上爲薄層石英岩、厚一・八〇公尺、再上爲鰤狀鐵鑛、厚約〇・三五公尺、頂上爲薄層石英岩、厚〇・一八公尺。此剖面之上、復有鰤狀鐵鑛一層、厚約〇・一五公尺。再西至陳家莊東南、有一剖面、最下層爲石英岩、厚一公尺、上部含有鐵質、上爲鐵鑛、厚〇・〇六公尺、再上爲頁岩及石英岩、厚一公尺、上復有鐵鑛一層、厚〇・二〇公尺、再上爲頁岩、厚〇・二公尺、上爲鰤狀鐵鑛、厚〇・七〇至〇・七五公尺、上又爲頁岩、厚一・一〇公尺、此鐵礦最西之露頭也。（參閱地質專報第二號中國鐵鑛誌）

總攬上述、前柳樹至陳家莊之間、鐵鑛露頭、通常約在一公尺左右、最薄者不下〇・三五公尺、惟烟筒山一帶、鑛層具厚至二公尺。此僅就露出者探測而言。其埋藏於地下、及含於斷層仰側地層者、尚有勘測之價值。至其質量如何、殊未可預言也。玆特就烟筒山鐵鑛、詳述其質量如次。

採取鑛樣化驗之法、力求準確、先擇適宜地點、就鐵鑛露頭掘鑿剖面多處、由上而下、依次鑿取相等之小塊、每一鑛層取鑛樣若干、壓碎混合、再行化驗、將同一鑛樣數種、反覆化驗、至得其極相近似之結果而後已。其鐵之成分、由百分之三十五至百分之五十八零七。平均數爲百分之四十八零七。鐵鑛中矽養二成分、常與鐵之成分成反比例、惟有時則不盡然、烟筒山鉄鑛內之矽養二成分由百分之四十三零七至百分之七零八、平均數爲百分之二十一零七。鐵鑛含硫甚少。磷分適度。其鉄礦比重、切實權定、最低者爲三・〇三、最高者爲三・七六、平均數爲三・三八。

鑛量估計、當依鑛質優劣鑛層厚薄而定、烟筒山鐵鑛佳處、皆在鑛區中部、再北似無開採價值、且有多處其下部鑛層較劣於上部、似未能同時開採、故將下部鑛層、暫棄置不取。今以鑛產厚在一公尺半以上、及成爲一厚層而含鐵尚富者、認爲有開採之價值。於是得可採鐵鑛兩區。一在北、面積較大、與烟筒山之斜坡相合。一在南、即山南斷層仰側之東部。平測之、大鑛區面積爲一百五十四萬平方公尺。小鑛區爲十七萬平方公尺。沿山之傾斜測之、大鑛區面積爲一百五十七萬平方公尺。小鑛區爲十八萬七千平方公尺。大鑛區內鐵鑛之平均總厚度爲二・二七公尺。小鑛區鐵鑛爲一・四二公尺。鐵鑛之平均比重爲三・三八、依法計算、則地平面上可採之鑛量、大鑛區每平方公尺、有七・六七噸、共計爲一千二百萬噸。小鑛區每平方公尺、有四・八〇噸、共計

為九十萬噸。兩項合計為一千二百九十萬噸。大鑛區內可採鐵鑛、含鐵成分平均為百分之四十九零二、計其所含之鐵量、當為五百九十萬噸。小鑛區平均為百分之五十三零四、計所含之鐵量、為四十八萬噸。合計為六百三十八萬噸。斯為地平面上可採鐵鑛量之準確最低數。如棄置之鑛層、將來或可開採、開採以後可延長至山之高處、則鑛量當不止此數也。然在地平面下、尚有許多鑛量可以採掘、如在烟筒山南小山之下、並向東西南三方延長、均可有良好鐵層。其小鑛區地平面下、亦當有佳鑛。因地層錯亂、必須詳細查勘、或施以鑽探。故地平面下埋藏之鑛量、現尚不能計算。然大約有五百萬至一千萬噸之譜。

宣化南境潭院附近有鐵鑛一層、厚二公尺有奇、品質優劣相間、大致可分三等、一為鲕狀佳鑛、二中等鑛石、三夾有石英質砂岩薄層者。第一等鑛石厚約半公尺、第二等厚約四・五公尺、第三等厚約一・二公尺。但鑛層頗不延長、離露頭數武、鐵質頓減、不堪稱鐵。至大房子水谷村南一帶及馬跑溝北山等處、惟見紅色粗砂岩、稍有鐵質、其附近散佈之碎鐵塊、亦有品質較優者。推其原因、蓋鐵鑛生成時、鐵質沉澱聚集、至不一律、有時鐵質極少、不能稱鑛、有時鐵質聚集而為較佳之鑛石也。

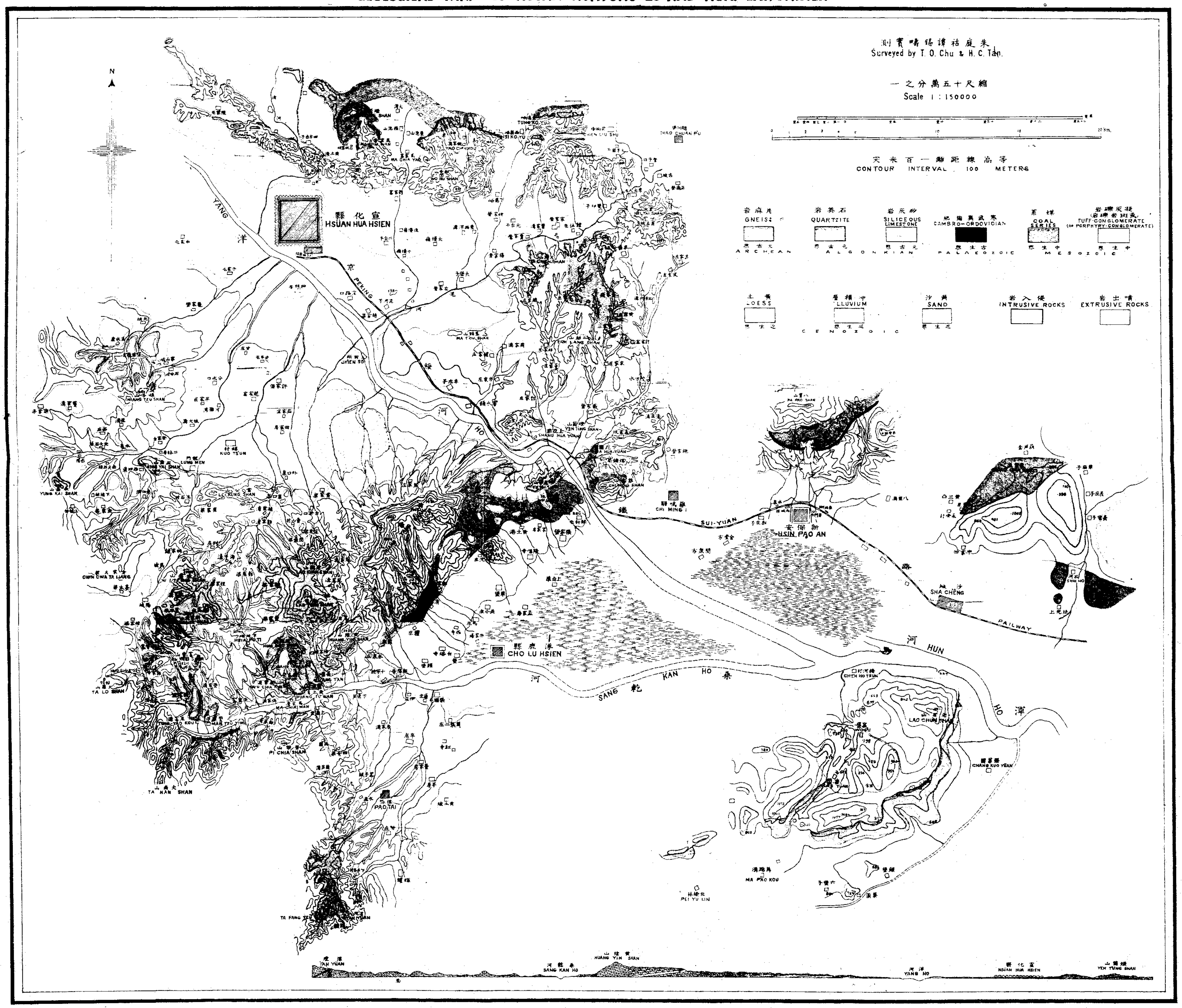
矽灰岩層內赤鐵鑛　露出顯著者、一在下坡地南溝中、含於矽灰岩隙縫內、狀不規則、厚薄不等、最厚處不及一尺、且不延長、過露頭即渺、但鑛質頗佳。一在郭家寺南溝中、亦夾於矽灰岩層隙中、礦石頗薄、但質亦較佳。此類鐵鑛生成、大抵由含鐵之溶液滲經灰岩、其鐵質沉澱於灰岩隙縫中也。

煤系中黃鐵鑛　大致在煤系下部、西窰溝王家樓一帶盛產之、黃陽山南麓煤田、亦間有露出者、頗尠、均在距地面數尺以下。據云厚薄不等、最厚者達半尺。土人採挖、沿地層斜向掘洞採出、用以燒硫。王家樓西窰溝均設

有鑛局、即燒硫處也。其法用無底瓦罐、下接盆、上覆蓋、裝鑛石燃火後、鑛中硫質蒸汽入盆、凝結成爲純硫、再熔煉之、作爲硫磚。王家樓礦局、曾用西人所傳鐵製圓釜燒煉法、不驗而罷、斯亦不知其所以然而誤仿之者也。

直隸宣化涿鹿懷來地質圖

GEOLOGICAL MAP OF HSÜAN-HUA, CHO-LU AND HUAI-LAI, CHIHLI.



宣化一帶古火山之研究

王恒升

引言

環太平洋之濱、火山星列、中國居其西而無所見焉。故火山之見於前人記載也甚鮮。邇來中國地質日見發達、古生代之地層測勘殆盡、中生代之研究漸已啟端。於侏羅煤系之上嘗見一火山岩層、種類龐雜、有流紋粗面安山以及火山礫岩凝灰岩諸岩石。分佈廣袤、東起奉天、西徂山西、南始吳越、北達內蒙。雖斷續無定、而縱橫所及、幾可二三百萬方里。誠我國中生代火成岩地質史上之一大觀也。宣化位於直隸之西北隅、有火山遺跡之一區也。(Pl. I) 京綏鐵路經過之、交通便利、富產煤鐵。中西人士往蒞調查者自龐丕理氏 Pumpelly 以降(註一)頗不乏人。惟或偏於地質、或注意鑛產、其於火山岩石之研究、類皆簡略。前歲孟冬升奉本所翁所長之命專勘察其地之火山岩、以補前人所未竟。前後凡二次、需時約兩旬。火山岩凡分二類、一屬於酸性者、岩漿膠定、當噴發之際、流動滯緩、噴結所致、輒為高山 (Pl. II, AA')。一偏於基性者、岩漿流動、橫溢地表、平凝如鋪 (Pl. II, AA')。而各層有時更相重疊、先後之序可尋。按其次序、考其成分、自局部言之、其岩漿係由基性而漸富於酸性。自全體言之、則由酸性而遞轉於基性。似地殼內部岩漿之變遷、受一定之物理及化學動力所支配、故循一定之程序。誠岩石學上所不可忽之事實也。

本區概況

本篇之作特重岩石。調查所及、多限於宣化之東南兩隅。自宣化西行經張家口至漢諾壩一帶、雖亦曾略勘查、乃燕京大學巴爾博教授 Prof. Barbour 已先詳測、將有專論。故僅記其岩石。至本區中地層之次序、岩層之構

造、前篇譚君論述已詳、本篇所及、不過略道其大概、爲參證之資耳。

(甲)地層　本區地層凡分八系：

(一)太古界片麻岩　爲本區最古且最下之地層、露出於北部。東起白廟、西抵宣化城北之四方台子、(Pl. I) 斷續相連。在四方台子之南、受斷層之影響、更露出於清水河之西岸。石色淺紅、間有深色條帶、深淡相間、示片麻岩之特徵。淡色條帶富長石及石英、深色帶中多角閃石及黑雲母。全體變質甚烈、然少顯著之層序、無過量之矽鋁養化物、似原由火成岩變質而成也。結晶疎鬆、頗易崩解、故多組成低嶺。偉晶花岡岩脈侵織其間、含巨片雲母。

(二)震旦紀石英岩及矽質灰岩　不整合於片麻岩之上、分上下兩部、下部爲石英岩層、含鱗狀鐵鑛、露出於宣化城北之煙筒山。上部爲矽質灰岩、岩色淺灰、富含矽質、時成燧石及矽質薄層、爲本系灰岩之特徵。岩質堅韌、侵蝕綦難、故在本區之內、或突出地表、成最高之山峯。(黃陰山)或孤峯屹立、獨樹崢嶸。(鷄鳴山)露出地分南北二帶、在北者西起陳家莊、東抵黑大山。在南者東起新保安之北山、西南抵黃陰山。其他如石崖山、威叢山、皆爲斷碎之露頭。全系總厚不下一千公尺。

(三)奧陶紀灰岩　露出於八寶山之南麓、石色深黑、成分較純、堪資燒灰、客冬之役、曾覓得Archaeocyathus 一碎片、爲下奧陶紀之化石。與震旦紀灰岩成斷層之接觸。

(四)下侏羅紀煤系　本系地層露出於武家溝、玉帶山、鷄鳴山、黑大山、大尖山、崔家莊諸處。下部多紅綠及黑色頁岩、黑色頁岩中含黃鐵鑛、富者可以製硫。(王家樓及玉帶山之西麓)上部以砂岩爲多。

煤層或夾於砂岩之間、或夾於砂岩與頁岩之間、分烟煤及半無烟煤兩種。據天興煤鑛(在武家溝)鑽探之結果、謂煤可採者凡五層。全系厚約六百公尺、不整合於震旦灰岩之上。前在學中旅行、於鷄鳴山官鑛之黑色頁岩中、曾尋得 Anomozamites sp., Thyrsopteris sp., Dicksonia sp , Pdozamites sp., 諸化石、約與北京西山之門頭溝煤系同時、蓋屬於下侏羅紀者也。

(五)上侏羅紀安山礫岩層　露出於武家溝玉帶山一帶、下部以礫岩、安山礫岩、凝灰岩爲多、時間安山岩流。在武家溝本系地層與門頭溝煤系地層成不整合之接觸。(Pl.II, BB')在玉帶山之東麓以礫岩層與門頭溝煤系成平行不整合之接觸。其礫岩子石多矽質灰岩、石英岩、砂岩及安山岩。安山礫岩層內之子石富安山岩、間有矽質灰岩及石英岩、大者直徑可四五公分、雜亂無序、與砂礫細粉相攙合。其爲火山噴發所堆積、蓋無疑義也。

是役也在玉帶山南麓之凝灰岩及礫岩之間、曾尋得植物化石、經ヰ粗略檢定、有左列六種：

(1) Cladophlebis denticulata	繁衍期自上三疊紀至下白堊紀尤以上侏羅紀爲多、
(2) Macrotæniopteris cf. richthofeni	侏羅紀
(3) Neocalamites sp.	三疊紀
(4) Ctenis sp.	自上三疊紀至侏羅紀
(5) Podozamites sp.	自上三疊紀至侏羅紀
(6) Fossil wood.	上侏羅紀

似爲上侏羅紀之產物、或與北京西山之髫髻山系相當。惟在西山髫髻山系之下有一九龍砂礫岩層、厚自六百至八百五十公尺。九龍系之下始爲門頭溝煤系。今在宣化一域安山礫岩層逕覆於下侏羅煤系之上、九龍系地層不見。其或未經沉積、或曾經沉積又被侵蝕。故煤系生成之後、當有一侵蝕期也。在該期之中地層波皺、波皺之極、地殼內部失却平衡、火成岩之活動寖假而盛、噴出地表、遂成火山。然當時較老之地層已被摺皺、故武家溝之安山礫岩層不整合於煤系之上。

(六)白堊紀粗面火山岩系　整合於安山礫岩層之上。下部富紅砂岩、礫岩、及粗面岩層。上部富流紋岩、紅砂岩、及礫岩。分佈較廣、西起滴水崖、東至李家粱、南始海子溝、北達大尖山 (Pl. I)。或有一部仍爲上侏羅紀之地層、但因無化石之確證、且二者又難以區分、故仍歸併於此。著者於前冬(一九二六)伴拉軻教授 Prof. A. Lacroix 赴神威台壩在萬全縣城西方之紅紗岩中、採得骨化石碎片、似爬虫類之遺骸、卜克教授 Prof. Berkey 歸之於下白堊紀。(註二) 該層與粗面岩層之上部相當、故疑粗面岩之噴出屬諸白堊紀、

(七)黃土　色黃質粘、乏層序、被水侵蝕、多成壁立深溝、與太古界片麻岩、震旦灰岩、安山礫岩、悉爲不整合之接觸、分佈自麥嶺至許家窰一帶、其他如戴家營、螂村、上坡地諸處亦甚發達。厚者可達二十公尺、所含化石以蝸屬 Helix 爲多及他種腹足類、蓋正當更新期初期之乾燥氣候而漸次遞積者也。

(八)沖積層及再生黃土層　爲本區地層之最新者、凡黃土之被水沖徙而再沉澱、及河谷之沖積層悉屬之。前者與原生黃土殊難區別、惟時含碎石之扁豆狀層而已。後者以流砂散石爲多、分佈於山谷

河牀。在十字坡一帶、該沖積層高出現在之河底約二十公尺、似在最近期中本區地面猶有隆升之徵也。

(乙)構造　自大體論之、本區爲一不對稱之向斜層、其北部黑大山之震旦灰岩、及大尖山至麥嶺一帶之侏羅煤系、當向斜層之北翼。南翼在桑乾河以南、而出乎本區之外。洋河兩岸殆逼近其中軸。該向斜層復經斷陷、故其中部震旦之灰岩突出。(黃陽山)斷層之大者有二、其縱斷距皆不下千餘公尺。

(一)黃陽山走向斷層　西南起自侯家坡、東北抵於烟筒山、西爲俯側、東爲仰側、以此斷陷、使火山礫岩層與震旦灰岩相接觸。斷層面陡立。縱斷距至少在一千公尺以上。

(二)雞鳴山逆斷層　西起玉帶山之東麓、至雞鳴山而顯著、孤峯矗起、壁立如削。鷄鳴山之東受侵入岩之影響、及鷄鳴驛河之侵蝕而中斷。逾鷄鳴驛河復突出屹立、綿亘不絕、以抵於平安站。斷層面沿鷄鳴山之西北麓向東延展、斷層面南爲仰側、北爲俯側、以逆衝之故、致震旦灰岩覆於侏羅煤系之上。觀其衝動之方向、知當時動力係自南而北者。該斷層西隔黃陽山走向斷層不及三公里、二者皆爲本區之主要斷層、其生成均在安山礫岩之後、似屬同一時期。或實爲同一斷層、在黃陽山一帶波皺之力較小、斷層面陡立、因以成走向斷層。迨至鷄鳴山波皺之力大、斷層面倒斜、遂成逆斷層歟。其他如八寶山南麓之二小斷層、老鸛山西麓斷層、石崖山斷層、率密邇兩大斷層、爲局部之構造、或卽兩大斷層斷陷之餘波也。

斷層之年代　在本區之內、最新地層受斷層之影響者、爲白堊紀之火山礫岩層、故斷層之年代至早當

在白堊紀之後。白堊紀以後中國主要地動期學者率歸諸漸新統。漸新統之地動尤以多斷層著聞、然則本區斷層之發生或在漸新統與中新統之間歟。

火山岩與侵入岩之分佈及其性質

在本區域之內、火山岩之重要者凡四、侵入岩之重要者亦凡四。安山岩、粗面岩、流紋岩、玄武岩、屬於火山岩者也。娘子山石英斑岩、八寶山長石斑岩、趙家莊正長岩、玉帶山輝長岩屬於侵入岩類者也。其他如侵入岩牆、岩層、因地而生。或與主要之侵入岩有關係、或與火山岩有關係。然因其地位之不同、故其各個性質亦隨之而差異。茲續述如左：

（甲）噴出岩或火山岩類、

（一）安山岩　露頭凡三處、（一）分佈於武家溝至安家溝一帶者、覆於安山礫岩層之上。石色或棕灰或微紅。斑晶甚顯、多中性長石及鈣鈉長石、或單生、或雙晶、或成環帶狀 Zonal晶形細長方正。(Pl. III, A) 晶基爲玻璃質、充塡於各斑晶之間、示安山岩構造之特徵。暗色鑛物 Mafic mineral爲雲母、輝石、及磁鐵鑛。雲母常風化爲磁鐵鑛及石英。(二)露出於雷公山腰者、(插圖一見英文篇)位於粗面岩之下、玄武岩之上、厚約四十公尺。石色黝黑、下部密緻、上多氣孔、氣孔多爲方解石及石英所塡充。斑晶富中性長石及鈣鈉長石、成細長方形平行排列、爲岩漿流動之結果。晶基半爲玻璃質、半爲結晶質、含細粒磁鐵鑛。暗色鑛物多角閃石及淡色輝石。角閃石被風化爲綠泥石 (Pl. IV, A)。(三)露出於郭家莊之東者、夾於安山礫岩及凝灰岩之中間、厚約二十公尺。(Pl. II, CC') 岩色深灰、富具氣孔、

多數孔內爲方解石(Pl. III, D)所塡塞、間有瑪璃質。結晶情況隨地而異、近邊際者斑晶少、體勻淨、間有細長長石、交錯其間、(Pl. III, C)岩石因以顯斑駁之狀。位於內部者斑晶顯著、(Pl. III, B)多中性長石、中含晶基、當爲急遽結晶使然。晶基分玻璃質及結晶質。結晶質含針狀長石、玻璃質富具鐵粒。

雷公山之角閃安山岩與郭家莊之安山岩流皆視武家溝之雲母安山岩稍新。與之共生之火山安山礫岩率富安山岩子石、其岩石之性質與安山岩相若、惟風化之程度較高。(Pl. IV, B)

(二)粗面岩　露出之區亦凡三處。(一)位於雷公山之頂者、在安山岩層之上、厚約三十公尺、以薄層紅土與安山岩相間。石色或淺灰、或微紅、下部密緻、呈岩漿流動時之遺紋。上部富氣孔、爲瑪瑙質所塡充、瑪瑙分白紅兩種、重疊相列、(Pl. VIII, D)美麗可觀。全體斑晶顯著、以玻璃長石及正長石爲多、玻璃長石晶瑩透澈、顯熔蝕之痕、(Pl. IV, C)酷似水晶。正長石風化較劇、晶面污垢、形如塵玷。晶基含平行排列之針狀長石及磁鐵鑛、磁鐵鑛風化呈赤色、晶基爲之浸染作紅色。(二)露出於窪前後莊附近者、分佈於自窪前後莊至北坡一帶。位於一粗輝綠岩之上、其性質大致與雷公山者相彷彿、惟气孔較多、气孔多長圓形、排列一致、似爲當時岩漿流動引曳之結果。(三)露出於張家口附近者、分佈於張垣東西北三面之高山。石色或淺灰、或微紅、間含暗色扁豆層、气孔甚多、孔內爲矽質所塡充。斑晶顯著、多玻璃長石及鈉長石。晶基爲玻璃質、風化甚烈。(Pl. IV, D)

其他如馬頭山及定方水之長石斑岩侵入岩層、其岩石之性質與(一)(二)相彷彿、惟缺少玻璃長

石。蓋淵源殆同、惟後者未噴出地面耳。

雷公山粗面岩位於安山岩之上、故粗面岩之噴發後於安山岩。安山岩之噴發在上侏羅紀、粗面岩或在白堊紀之初。張家口西賜兒山麓粗面岩之下、有粗面岩礫岩一層、爲噴發所堆積。故粗面岩噴溢之前、亦有一度之爆發、但其岩漿所含气體較多、流動容易、及溢出地表、多成平台橫嶺、與流紋岩之凝結成高山者迥異也。

(三)流紋岩　分佈於娘子山至永蓋山一帶。岩質堅密、風解甚難、故突出地表、形如錐尖。石色微紅、斑晶不著、偶見石英而已。晶基爲玻璃質、有顯著之流痕、(Pl. V, C) 其下面爲一流紋礫岩層、所含子石多流紋岩及黑曜岩。黑曜岩之大者直經可達一公尺、色黑質細、斑晶甚少、間有正長石及黑雲母。晶基爲玻璃質、含棒狀雛晶。分層而列、呈條帶狀紋。

其他如宣化城北之四方台子、張家口西之桑市及莘莘菴諸處均有零碎流紋岩、惟皆富具气孔、斑晶較著、斑晶以長石及石英爲多。長石風化不甚劇、或單晶、或雙晶、劈開明顯。石英熔蝕、輪邊圓滑、且帶裂紋。其晶基全爲玻璃質、流痕甚顯。(Pl. V, B)

在娘子山、流紋岩逕覆於粗面岩之上。(Pl. II, AA) 張家口西方桑市附近、流紋岩與粗面岩上面之礫岩層及凝灰岩更相間疊、故流紋岩之噴發當後於粗面岩。因其岩漿膠定、噴出地面、多凝結爲高山。

(四)玄武岩　分佈於張家口西漢諾壩及神威台壩一帶。位於南天門礫岩層之上。石色黝黑、有气孔、儲

集形如海綿、堪稱浮石者。有密緻堅實、含橄欖石結核者。斑晶顯著、以白色橄欖石及淡紫色輝石爲多。長石爲鈣鈉長石、多雙晶。晶基半玻璃質、半結晶質。結晶質含橄欖石及磁鐵鑛小粒。(Pl. VI, C) 安特生博士 Dr. J. G. Andersson (註三) 謂其噴發在漸新統、岩漿因偏基性而流動、橫溢地表、滑平如舖。

(乙)侵入岩類、

(一)娘子山石英斑岩火山頸　露出於宣化西南二十里之娘子山、爲娘子山之極峯。四周爲流紋岩所圍繞、二者無顯著之分界、融合如一體、故知其爲流紋岩之噴出口。石色灰綠、近流紋岩處漸變紅色。斑晶有長石及石英、長石爲正長石及斜長石兩種。石英外形圓轉無稜角、時有缺口、晶基侵入之。(Pl. V, A) 其四周有一石英帶、與斑晶成光性之連續 Optical Continuity、在交插聶氏三稜鏡下、清晰可辨、此當與斑晶之如何生成息息相關者。試舉二說以明之：(一) 斑晶迅速結晶說、主之者爲克勞氏 Cross、(註四) 皮爾蓀氏 Pirsson、(註五) 伊鼎氏 Iddings (註六) 諸人。克勞氏嘗研究考勞拉斗 Colorado 省石英安山岩及閃長岩之際、謂其內之斑晶有生成於岩漿衝動停止以後之徵象。皮爾蓀氏更例舉斑岩斑晶結晶不能過早之確證。伊鼎氏於研究克蘭道盆地 Crandal Basin 火山岩石之後、謂『凡斑岩中之斑晶大抵爲其成分各歸子迅速結晶之結果。其生成雖略先於晶基之凝固、但非結晶之後、久懸於熔岩之中者。』升 於研究本區安山岩之際、見斑晶嘗含晶基、其斑晶之分佈、又與其所處之地位有關係。似其結晶之時期在熔岩噴出之後、與三氏所說頗相符合。使

該石英斑岩內之石英斑晶爲迅速結晶之結果、其四周之石英可視爲岩漿內石英分子凝聚之餘波、因與斑晶物理狀況相同、故光性相連續也。（二）斑晶先生成說、昔日攻岩石學者咸謂斑晶生成於岩漿運動之前、故斑晶之結晶爲一時期、而晶基之結晶又爲一時期。斑晶之所以時有熔蝕之遺痕者、即因其結晶過早、迨岩漿侵入於地殼之上部、壓力減小、融度低減所致也。該石英斑晶旣顯熔蝕之痕跡、亦可視爲結晶先成之徵象、其四周之石英帶或即爲復被熔解之石英。其與斑晶之光性能相連續者、因受斑晶分子之感觸耳。蓋與石英岩中之石英粒嘗爲次生石英所包圍、其光性相連續者、之理正相同也。斑岩中之暗色鑛物爲角閃石、黑雲母、及磁鐵鑛。三者者常相聚於一處。副鑛物有磷灰石、及風信子石。晶基爲長石及石英所組成。

（二）八寶山長石斑岩　露出於八寶山一帶、爲八寶山之極峯。侵入於煤系及火山礫岩層之間、色淡棕、斑晶多長石及雲母片、長石以正長石爲多。接近邊際、結晶漸細、石英增多、雲母減少。晶基爲結晶質、含剩餘石英。副鑛物有燐灰石、及磁鐵鑛。以岩石之性質論似與粗面岩有生成之關係也。

玉帶山之腰際、亦見一長石斑岩層侵入於安山礫岩之上。斑晶多正長石、間有黑雲母。晶基半爲結晶質、半爲玻璃質、含長石細粒、或爲八寶山長石斑岩之分枝。

（三）趙家莊輝石正長岩　在趙家莊之北、侵入於侏羅煤系中。石色黑白相間、晶粒勻細。暗色鑛物與淡色鑛物量幾相若、淡色鑛物爲長石、多正長石及鈉長石、暗色鑛物富綠色輝石、角閃石、及磁鐵鑛。角閃石風化變爲綠泥石。副鑛物有磷灰石、多成細柱狀、間有大者。

沿玉帶山東北麓之煤系中、亦見一正長岩侵入岩層。岩石之性質與上述之輝石正長岩頗相似、惟磷灰石較少、而輝石增多耳。

大尖山石英斑岩露出於大尖山南麓、與輝石正長岩相距甚邇、侵入於煤系之中。石色淺白、斑晶有石英及長石、（正長石及斜長石均有）偶含失色雲母片。石英斑晶四邊圓滑、具蠶食缺口、被晶基侵入示顯著之熔蝕現象。(Pl. VI, C)、晶基全爲結晶質、爲長石及石英所組成、因密邇輝石正長岩、或生成上爲同源耳。

(四)玉帶山輝長岩　露出於玉帶山之東麓、侵入於侏羅煤系之內。石色黝黑、石質堅韌、風解之後、岩面如球殼剝裂。自此分出之岩牆岩層甚多、其著者如八寶山南麓及鷄鳴山南麓煤系之侵入岩層、雷公山安山岩下之侵入岩層、馬頭山及滴水崖正長斑岩下之侵入岩層皆是也。其鑛物成分大致與輝長岩相同、(Pl. VI, D) 惟結晶較細。輝長岩中之斑晶以鈣鈉長石爲多、間有中性長石、多成雙晶、有橫斷裂紋。暗色鑛物爲雲母、紅色輝石、雲母多風化爲綠泥石、間有揷入長石晶內者。輝石結晶常圍裹長石成輝綠岩組織 Ophitic Structure、(Pl. VII, A) 副鑛物有鈦鐵鑛。

玉帶山之輝長岩內有一正長岩脉、寬五尺許、而結晶甚粗、似爲剩餘岩漿所結成、其主要鑛物爲玻璃長石、雲母、及綠色輝石。(Pl. VII, B) 副鑛物爲磷灰石及磁鐵鑛、磷灰石多成針柱狀、有生於長石晶體之內者。

在滴水崖輝長岩之分枝（粗輝綠岩）曾侵入於紅砂岩層、在粗面岩之下、其年代似較粗面岩爲

新。大抵粗面岩噴發之後至漸新統、基性岩始活動。漸新統玄武岩之輝石帶紅色。今玉帶山之輝長岩輝石亦帶紅色。似有同源之徵象。然則該輝長岩之年代或亦屬漸新統歟。

(五)黃土港玄武岩　侵入於煤系之內成岩牆。石色黝黑、有气孔、孔內爲方解石所塡充。斑晶以長方斜長石(中性長石)爲多、平行排列。(Pl. VII, C, D) 晶基富鐵質、不透明、針狀長石作輻射狀。暗色鑛物爲雲母風化變爲綠泥石。

該岩牆復露出於王家樓左右及八寶山之南麓。在八寶山爲侵入岩層。

(六)武家溝粗輝綠岩　侵入於武家溝之煤系中。石色黝黑、斑晶顯著、以角閃石、長石及輝石爲多。長石多鈣鈉長石、輝石間有成雙晶者、以(100)面爲雙晶面。角閃石多風化爲炭酸鑛物、晶基半結晶質、半玻璃質含針柱狀長石、及磁鐵鑛。(Pl. VIII, A)

(七)殷家莊雲母玢岩　露出於殷家莊之東南、侵入於火山礫岩層及砂岩層之內。石色淺綠、主要鑛物多中性長石及黑雲母、兼富磁鐵鑛、雲母多風化爲綠泥石。

定方水之東有一玢岩岩層、侵入於紅砂岩內。其鑛物成分與該岩牆酷似、惟風化較輕。(Pl. VIII, B)

(八)郭家灣橄欖石玢岩　露出於郭家灣河之東岸。凡二層、中隔薄層紅土。石色深灰、含氣水孔、內爲瑪瑙質所浸塡。長石以鈣鈉長石及中性長石爲多、成長方形、平行排列。暗色鑛物爲輝石及橄欖石、橄欖石風化爲紅色之伊鼎石。Iddingsite (Pl. VIII, C)

玆按其年代之先後、生成之關係、簡列一表、以明其相互之關係。

種類＼時期	上侏羅紀	下白堊紀？		漸新統
		（甲）	（乙）	
噴出岩類	武家溝雲母安山岩 玉帶山安山礫岩 雷公山角閃安山岩 郭家莊安山岩	張家口粗面岩 窪前後莊粗面岩 雷公山粗面岩	娘子山流紋岩 四方台子流紋岩 苹平庵流紋岩 土井子黑曜岩 娘子山流紋礫岩	漢諾壩玄武岩
侵入岩類		馬頭山長石斑岩 玉帶山長石斑岩 八寶山長石斑岩 ?	娘子山石英斑岩 永蓋山石英斑岩 大尖山石英斑岩 ?	玉帶山輝綠岩 雷公山輝綠岩 窪前後莊輝綠岩 馬頭山輝綠岩 八寶山南輝綠岩 ?黃土港玄武岩 武家溝粗輝綠岩
深造岩類		趙家莊正長岩 ?玉帶山正長岩		玉帶山輝長岩

由此觀之、本區之火成岩雖種類龐雜、分佈凌亂、然使詳其年代之先後、察其生成之關係、綜合類分、其岩漿之變遷亦似有一定之方向也者。試統論之、本區當上侏羅紀之際、地殼波皺、火山噴發、唯時岩漿稍偏基性、故有武家溝之雲母安山岩、玉帶山安山礫岩、郭家莊及雷公山之安山岩。安山岩噴發之後、地殼變動暫歸平穩、氣候轉於乾燥、安山岩層上之紅土及砂礫層因於累積焉。迨迄白堊紀、火山復熾、凡張家口、窪前後莊子、雷公山諸處之粗面岩、皆於是時生成。其昇起而未達地表者、成侵入岩類、如八寶山、玉帶山之長石斑岩、趙家莊、玉帶山之正長岩、其顯著者也。粗面岩噴發宏富、分佈廣遠、與安山岩相較、不啻倍蓰、誠中國一最盛之火山期也。繼粗面之後、爲流紋岩、成娘子山、四方台、萃華庵諸處之酸性火山岩。流紋岩噴發之後、火山又熄、侵蝕堆積同時並進、因是有南天門系礫岩及砂岩之生成。自是經中上白堊紀、始新統以迄漸新統、殆少火成岩之活動。迄漸新統、地殼又起變動、以多斷層著稱、隨斷層而起者有漢諾壩一帶玄武岩流之橫溢、間有侵入岩層。自上侏羅紀至白堊紀火山噴發、始爲安山岩流、繼爲粗面岩流、終爲流紋岩流、其變化自基性而漸趨於酸性。及漸新統岩漿逆轉、復有玄武岩之基性岩流。使以上侏羅及白堊紀之連續火山噴發爲一期、而以漸新統之玄武岩另爲一期、則岩漿之變化乃自酸性而遞轉入基性。舊日火山呈此種現象者甚多、如意之璠臺萊利 Pantelleria (註七)美之高林山 Higlawood Mountain (註八) 其最著者也。邇者法教士德日進氏P. Teeilhard (註九)在達賴湖Dalai-noor 畔調查火山噴發之次序、更與宣化所述者相同。(左表)

	達賚湖左右 （德日進）	宣化附近 （巴博教授及著者）
白堊紀	玄武岩	……玄武岩
	流紋火山礫岩及流紋岩礫岩	……南天門礫岩層
	流紋狀流紋岩 微晶花岡岩及流紋岩	……流紋岩及石英斑岩
	頁岩及流紋凝灰岩	……？……粗面岩
		紅土及礫岩層
上侏羅紀	安山岩流礫岩與褐炭 安山火山礫岩層 安山岩系	……安山岩流 角閃安山岩流 火山礫岩及凝灰岩 雲母安山岩及火山礫岩
下侏羅紀		門頭溝煤系

然則此現象乃普遍的、非偶然的、其或與地殼之變動有關、（自上侏羅紀至白堊紀地殼變動以波皺著、漸新統以斷陷著）抑或為岩漿自身變化之結果。是誠岩石學上一重要之問題而不可忽者也。

化學成分

研究岩石、鑛物與化學成分原相並重。不明鑛物之組合、雖知化學成分之意義。不辨化學成分之差異、難得鑛物成分組合之由來、其他如研究岩石生成互相之關係、岩石鈣鹼性之分類、及最近伊鼎氏之完全根據化學成分分類、則更舍研究化學成分而無從著手者也。研究我國岩石學者除二三外人之外、率多趨重於鑛物之記述、化學成分尚有所未遑。本篇之作、本所所長翁先生對於化學成分多所鼓勵、惟幷因羈於他事、僅分析二種、一為輝石玄武岩、一為角閃安山岩、合燕京大學高君分析張家口之流紋岩（或粗面岩）凡為三種。其成分及按伊鼎氏之新分類法皆見於英文篇內、茲不復贅。至其化學成分與世界他處之異同、擬俟分析略多、再總而詳論之。

註一 Geol. Research in China, Monglolia and Japan, Smithsonian Contr., 1866, 第二〇二頁

註二 Nat. Hist. XXIV, 第一六一頁

註三 中國北部之新生界，地質專報甲種第三號第一〇三頁，第一五二頁

註四 The Laccolitic Mountain Groups of Colorado, Utah and Arrizona, 14th Ann. Rept. U. S. Geol. Survey, 1895, 第二二九頁

註五 Rocks and Rock Minerals, Pirsson, 第一五七頁; Eleventh Ann. Meeting, Geol. Soc. Am.

註六　The Dissected Volcano of Crandal Basin, Wyoming, Geology of the Yellowstone National Park, Part II, 1899, 第二六六―二六八頁

註七　The Volcanoes & Rocks of Pantelleria, The Journal of Geology Vol. XXII, 1914, 第二五―二七頁

註八　Petrography and Geology of the Igneous Rocks of the Highwood Mountains, Montana, 第二〇一頁

註九　Étude Géol. Sur la Région du Dalai-noor, Mém. Soc. Géol. France, No. 7, 第七―五三頁

BULLETIN

OF

THE GEOLOGICAL SURVEY OF CHINA

NUMBER 10. JANUARY 1928.

CONTENTS

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GEOLOGY OF THE TA CHING SHAN RANGE AND ITS COAL FIELDS

(Summary)

By C. C. WANG.

With 4 plates and 31 figs. (in Chinese text).

INTRODUCTION

Ta Ching Shan (大青山) sometimes also spelled Ta Tsing Shan means in Chinese the great blue mountain and is the name of the mountain range stretching in a E-W direction on the north of the Kuei Hua alluvial plain. The old name of the range was Yin Shan or In Shan (陰山) which is often used in more extension. The first geological notice on this region was due to Armand David[1] who crossed a part of the range in 1866. In 1915 Dr. W. H. Wong[2] made a reconnaissance map on the whole range and broadly marked out the distribution of the coal fields. Geological work was of course much more difficult at that time when the Ta Tung-Suiyuan and Suiyuan-Paotou railway was not yet built.

The structure of the Ta Ching Shan range is complicated by a number of faults and thrusts. In his first impression, Dr. Wong attributed most of the dislocations to vertical movement; but he later realized the importance of the orogenic character in this range and it was for the express purpose of ascertaining the exact nature of the mountain structure besides studying some local coal fields, that the author of this paper was instructed to resurvey this region in the autumn of 1925. I had the advantage of using as basis an excellent new topographical map on the scale of 1:100,000 by the local military survey office. The result of my study completely confirms the importance of horizontal movement in this mountain which constitues a most important region in the tectonics of North China.

STRATIGRAPHY.

The sedimentary strata in the Ta Ching Shan range may be distinguished into six main formations as below:—

Wutai system:—This is the oldest formation in the referred region and very similar in lithologic character with the Wutai system as named by Bailey Willis in

1. Journal d'un voyage en Mongolie fait en 1866.
2. Report on the geology of Suiyuan. Bull. Geol. Surv. China No. 1. 1918.

the Wu Tai district of Shansi. It is therefore of Proterozoic or pre-Cambrian age. It is composed of two main parts, the lower one consisting of gneiss and crystalline schists widely distributed between the coal field and the Kueihua basin, and the upper one built up of marble and quartzite. The Pre-Cambrian marble is chiefly exposed along the southern margin of Ta Ching Shan. Some specimens of the marble have been analysed by Mr. H. T. Lee[1] and proved to be all rich in magnesia. Strata of the Wutai system as a general rule show distinct bedding, dipping to S or SE. But there are numerous local disturbances; anticlinal folding is visible in several sections (See figs. 7 and 9). The magnesian marble is unconformable with the gneiss and schists (fig. 14).

Permo-Carboniferous coal series;:—Lying unconformably on the Wutai system is the Permo-Carboniferous coal bearing series composed of quartz conglomerate, sandstone, shale and coal seams at a total thickness of about 100 m. only (fig. 1). In comparing with the corresponding coal series of Shansi which is more than 300 m. thick and contains several marine limestones at its lower part, not only the thickness in the referred region is here greatly reduced but the marine horizons are totally absent; this may prove that the Carboniferous sea of Shansi has never invaded the vicinity of Ta Ching Shan which probably only occupied the northern margin of the Shansi Permo-Carboniferous swamp. Conglomerate is prevailing in this series.

This coal series mainly occurs in the western part of the Ta-Ching Shan north of the Sa La Chi (Saratsi) district. It is found in narrow strips either on the southern margin of the Mesozoic coal field as at Chung Pao Ko Su (中保圪素), Shih Siang Yao Tzu (石匠窰子) and Tung Sheng Mao (童盛茂) (fig. 2) or limited on bcth sides by thrust faults as at Sa ko Yao Tzu (沙鍋窰子), Nao Pao Kou (腦包溝) etc. (See figs. 2, 3, 9). The strata usually dip to S but often in reversed position. A rich fossil flora was collected at Ku Man Yin Tien (谷滿銀店) (fig. 9) near Nao Pao Kou (腦包溝), yielding the following fossil plants upon a preliminary examination:

Neuropteris flexuosa Brongniart, *Pecopteris arborescens* Schloth, *Sphenophyllum oblongifolium*, *Sphenophyllum thoni* Żeil, *Annularia brevifolia* Brongniart, *Sphenopteris sp.*, *Cordaites sp.*

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1. On the magnesian content of the Pre-Cambrian marble in North China Bull. Geol. Soc. China Vol. V. No. 1, pp. 83-84.

Permo-Triassic and Triassic red shale and sandstone:—This series rests conformably on the Permo-Carboniferous coal series with a basal quartz conglomerate in the western part of Ta Ching Shan as can be observed in the vicinity of Tung Sheng Mao (Fig. 4), or unconformably directly upon the Wutai system in the eastern part as at Wen Chia Yao (溫家窰) N. of Kuei Hua Cheng (歸化城) (Fig. 5). In the middle part of Ta Ching Shan this formation is wide spreaded with reversed strata dipping to S and limited on the south by an important overthrust (Fig. 6). The main rocks are red conglomerate and sandstone alternating with shale at a total thickness from 400 m. to 600 m. No fossils have been found. It is identified as of Permo-Triassic and Triassic age merely by comparing its lithologic character with the Red Series in Shansi and Shensi.[1]

Lower Jurassic coal series:—This coal series is built up of green shale, sandstone, conglomerate and coal seams Its total thickness is about 400 m. In the vicinity of Kang Pao Kou (康包溝) (Fig. 4), its basal quartz conglomerate seems to show a conformable contact with the Triassic sediments. At Ta Kou (大溝) the coal series also contains a thin bed of limestone about 2 or 3 feet thick and on the north of San Tao Pa (三道壩) the number of limestone increases to 6 or 7 horizons with badly preserved fossil-fish. This fresh-water fossil is discovered for the first time in the lower Jurassic coal series in North China. At Wu Ta Kou (五達溝), Yang Ko Leng (楊圪塄) and on the northwest of Shih Kuai Tzu (石拐子), numerous plant fossils have been collected enough to confirm the age of the coal series. The following list is the result of a preliminary examination:

At Wu Ta Kou, ***Cladophlebis sp.***

At Yang Ko Leng, ***Podozamites lanceolatus*** Heer, ***Asplenium whitbyense*** Heer, ***Cladophlebis sp.***, and ***Coniopteris sp.*** etc.

At Shih Kuai Tzu, ***Cladophlebis cf. acutangula, Baiera sp.***, and ***Czekanowskia rigida*** Heer. etc.

This series has its full development in the western part of Ta Ching Shan in a broad gently dipping syncline (fig 3) although limited on both sides N and S by thrust faults. Eastwards from Shih Kuai Tzu also called Shih Kuai Chen (石拐鎮) (a well known center of coal mines at NE of Pao Tou) the strata of this series become more and more steeply inclined until reversed so that its outcrop constitutes a narrower band between the Permo-Triassic on the south and Upper

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1. C. C. Wang: Explanation to the 1:1,000,000 Geol. Map of China, Taiyuan-Yulin sheet, 1926.

Jurassic shale on the north and continues so to the east until interrupted by faulting and granitic intrusion. East of the granitic intrusion, it forms small fields dislocated by faults. Finally it occurs in an isolated basin at Pa Kou Tzu (壩口子), north of Kuei Hua Cheng.

Middle and Upper Jurassic red shale and sandstone:—The lower Jurassic coal series is succeeded by a series of red shale and sandstone probably of Middle and Upper Jurassic age. No distinct disconformity is observed between their contact (fig. 2 and 6). The sediment consists chiefly of red conglomerate with sandstone and red shale as exposed from E to W in Shui Mo Kou (水磨溝) (Fig. 12), Hei Niu Kou (黑牛溝) (Fig. 7), Chu Erh Kou (珠爾溝), Tung Kou (東溝) and Hsi Kou (西溝), while on the north of Shih Kuai Tzu at Hsiao Pa Tzu (小壩子), Te Sheng Kou (得勝溝) and Hu Tung Tu (胡洞兎), the violet or red shale and sandstone more prevail. The total thickness can not be precisely estimated though it is likely more than 500 m. This series of sediments is easily distinguished by its predominant red green color from the underlying Lower Jurassic coal series. Up to present no fossil has been discovered in it. But by comparing its lithologic character and stratigraphic position with the fossiliferous Lower Jurassic coal series in North Shensi, its age can be assigned to Middle and Upper Jurassic.

Quaternary alluvium and peat deposit. The alluvium is composed of redeposited loess, sand and gravel mostly exposed in the Kueihua basin, while the peat deposit occurs as depressed wet grass ground on the southwest of the Tai Ke Mu (台格木) station of the Suiyuan-Paotou railway (Fig. 13) and on the southeast of Tao Tzu Hao (討子號) station. Fresh water mollusk shells are often found from the peat.

Granite intrusion:—Granite occurs between Wan Chia Kou (萬家溝) and Hsi Kou (西溝). In Hsi Kou the Middle and Upper Jurassic rocks are metamorphosed by granite so as to become quartzite and slate. Hence, the age of intrusion is at least post-Jurassic.

Andesite dyke:—It is intruded into the Permo-Triassic sediments SW of the Pa Kou Tzu (壩口子) basin.

STRUCTURAL GEOLOGY.

As already mentioned, there is a distinct unconformity between the Upper Wutai marble and the Lower Wutai gneiss and schist. Another important unconformity separates the Wutai system from all the overlying sediments ranging from Permo-Carboniferous to Upper Jurassic in age which form structurally one and the same unit being folded and thrusted all together at a same period. No younger rocks other than the quaternary deposit are known in the region under study.

The effects of the post-Jurassic deformations being more important for the elucidation of the mountain structure, the coal fields will be only studied here. We can proceed by separately treating the three main types of structure: folding, thrusting and faulting.

Folding:—Proceeding from east to west, we have first a synclinal basin with the centre approximately at Pa Kou Tzu (Fig. 5) north of Kuei-Hua Cheng. It is broken on the south by the great vertical fault of a later age to which is due the abrupt rising of the Ta Ching Shan range.

From Shui Mo Kou (fig. 12), (NE of Pi Ko Chi station), westward cross Hei Niu Kou and Chu Erh Kou to Hsi Kou, N of Cha Su Chi station, the Mesozoic strata develop in a sucession of anticlinal and synclinal foldings (fig. 7 and 12) of E-W trend. The folds are often unsymmetrical with the axis inclined toward the north so that the northern limb of an anticline generally dips more steeply than its southern one. This structure is clearly shown in the section near Sze Tao Ho Tzu (fig. 12). The folding is however often complicated by faulting as is the case in the Hei Niu Kou section (fig. 7). In the seetion of Tung Kou and Hsi Kou, southward dip largely prevails often at a gentle angle.

West of the granitic intrusion, from Pai Shih Tou Kou (白石頭溝) (fig. 6) westward across Mai Ta Kou (麥達溝) north of the Mai Ta Chao station, to Shui Ching Kou (水晶溝) (fig. 2), north of the Sa La Chi station, the Mesozoic beds tend to form a syncline on the north, as can be observed north of I Chien Shang (以前賞) (fig. 12), which deepens and broadens westward. The strata forming the south limb of the I Chien Shang syncline are strongly compressed from the south so that they first become vertical and then overturned to dip southward instead of northward. Thus along a distance of about 40 kilometers, from Pai Shih Tou Kou to the west of Shui Ching Kou, the strata from the Permo-Triassic up to a part of the Lower Jurassic coal series are completely overturned, dipping to the south at angles varying from 30° to 40°. This overturn of the strata is followed on the south by the important overthrust from south northward which the author proposes to call Paishihtoukou overthrust (fig. 2 and 6). On the north side the above mentioned syncline is complicated by local minor folds and usually also cut by faults or thrusts.

Further west the Mesozoic basin is both on the north and south sides, cut by faults or thrusts so that the Triassic red shale and sandstone and the Lower Jurassic coal series are only preserved (fig. 3 and 4). The latter series containing the main workable seams constitute a valuable coal basin in the vicinity of Shih Kuai Tzu (fig. 3).

Thrusting: The main Mesozoic field of Ta Ching Shan is limited by two important overthrusts which bring the Wutai system in direct contact with the Triassic or the Upper Jurassic formation. The one on the north is called the ***Yin shan*** **(陰山)** ***overthrust.*** It runs from near A Ta Kou, NE of Paotou, eastward across Hu Tung Tu, Hou Tsiao Pa Tzu and Lao Tao Kou (老道溝) to Shui Mo Kou, north of Ping Chou Hai railway station, along a total distance of about 200 li. The general trend is east-west nearly parallel to the prevailing strike of the sedimentary strata. Several explanations of this extensive fault line seem possible at the first thought. First it may be easily taken for a normal fault with great vertical throw bringing the Pre-Cambrian in level with the Jurassic beds. Second, it may appear as an overthrust from north southward thrusting the Pre-Cambrian Wutai system from the north over the Jurassic beds on the south. Both suppositions have some likeness when one only looks upon the geological map. Field study at several points both on the east and west of the dislocation (fig. 7 and 12) shew to the author however definite evidence in favor of a third explanation, viz., that is an overthrust directed from south to north with the Jurassic beds thrown over the Wutai system. Such relation is actually observed north of Lao Tao Kou (fig. 7) and of Szu Tao Ho Tzu (fig. 12). The Yinshan thrust therefore seems to the author to be one of the whole system of north-ward thrustings so characteristically prevailing in the Ta Ching Shan region. It is possible however that the thrust plane of the Yinshan dislocation is sometimes so steep as to be nearly vertical so that it actually becomes a normal fault in certain sections along its very long course.

The ***Paishihtoukou*** thrust is only in extension second to the Yin Shan thrust. This name is given to the overthrust which brings the Wutai system over the Permo-Triassic and Triassic beds on the south of the main Mesozoic field.

It extends from Chien Teng Chang (前燈場) (fig. 2) on the west through Chung Pao Ko Su to Pai Shih Tou Kou (Fig. 6) on the east of a length of about 60 li. This overthrust is easily recognised by its bringing Wu Tai system from south to north over the Permo-Triassic strata. The generation of the overthrust seems to be intimately related with the overturning of the latter. As shown in geological map, the eastern end of the mentioned overthrust possibly goes further east through the contact between the granite and the Permo-Triassic strata directly north-eastward to Lao Tao Kou (fig. 7) close to the Yinshan fault on the north. If so considered, the Paishihtoukou thrust forms a continuous thrust line of about 100 li. The eastern extension of the Paishihtoukou thrust is followed on the south by another overthrust which brings the Jurassic beds northward in direct contact with the Wutai marble. (Fig. 7). This is called ***Mamihata thrust***. The pre-Cambrian marble north of Ma Mi Ha Ta (馬密哈達) is therefore brought by two overthrusts on the north and south so as to be included amidst the Jurassic beds.

Further south, pre-Cambrian (Proterozoic) quartzite and marble appear again on the south of the Permo-Triassic and Triassic formation NW of Pi Ko Chi station. That the thrust plane is a flat one by which the Wutai formation rests above the Permo-Triassic red beds is well shown by the outcrop of the latter near Hei Niu Kau Kou as the marble has been there eroded away. The thrust is named ***Tzulaoshan*** **(雌老山)** ***overthrust*** from the name of a conspicuous hill NW of Pi Ko Chi station. The Tzulaoshan overthrust seems to be coutinuous westward with the ***Kucheng thrust*** N.W. of Cha Su Chi station by which the pre-Cambrian marble is also brought northward over the Permo-Triassic red shale (fig. 17). However, south of the marble of Ku Cheng (fig. 17) there appears again the red shale which is probably brought about by another thrust. The red shale on the south dips northward at exactly right angle with the marble dipping southward.

Instead of narrow belts of pre-Cambrian marble among the permo-Mesozoic sediments as we have just explained in the eastern part of Ta Ching Shan, there occur in the western part of Ta Ching Shan a number of narrow east-west belts of Permo-Camboniferous or Mesozoic strata suddenly appearing in the midst of pre-Cambrian gneiss or schist (fig. 3 and 9). The Permo-Mesozoic strata in such narrow belts are generally strongly compressed. In certain cases, as south of Kuan Tien Tzu (fig. 9 and 10) it is obvious that the gneiss has been thrusted from south northward over the Jurassic sandstone. It is therefore of great probablity that these belts of Kuan Tien Tze (Fig. 9, 10) and Ku Man Yin Tien (Fig. 9) are all limited on both north and south sides by parallel northward overthrusts.

As a conclusion, the region of Ta Ching Shan is characterized by the abundance of main overthrusts and sharp folds in conspicuous distinction to the area of shansi which is especially marked by numerous simple broad folds. All the axes of folds and the lines of overthrusts generally run from east to west not only parallel to one another but also parallel to the general strike of the formations in the Ta Ching Shan range. From the phenomena of the overthrusts by which one part of strata is often thrown northwards upon another and from the unsymmetrical folds with their axial planes pushed northward, the direction of the compressing force to which are due these deformations was evidently from south to north. The southward overturning of the strata in the whole area between Pai Shih Tou Kou and Lao Wo Pu may be also taken as a strong evidence in favour of the northward direction of the compression force.

The thrusts seem to grow in importance and regularity from south northward and it seems that they have been produced in successive order (although in a same orogenic period) from south to north so that the thrusts on the south are often produced earlier and cut by the more northern ones. Thus the Mamihata thrust is apparently cut by the Paishihtoukou thrust which seems to be in its turn cut by the Yinshan thrust.

Besides the major structure as above outlined, there are many beautiful local exposures of the thrusting of strata such as shown by the figures 8B, 15, 17, 18, 19 and 20. All these observations tend to confirm the northward direction of the thrusting force.

As to the date of the folding and thrusting, it is only possible to say in the Ta Ching Shan region that they were produced at a period of post Jurassic, since the youngest strata thus deformed are upper Jurassic and there is no younger formation except the quaternary. However by extending the conclusion from the tectonic history of Shansi[1], we may think that the main orogenic movement was produced during the middle Cretaceous time.

The main direction of the Mesozoic orogenic movement in Ta Ching Shan and its neighboring regions.

In order to discuss the relation between the orogenic characters in Ta Ching Shan and those in its neighboring regions including the ranges in Shansi and north Honan on the southeast, Tsin Ling (秦嶺) on the south, and Ho Lan Shan (賀蘭山), Lang Shan (郎山) and Ula Shan (烏拉嶺) on the west, the latter regions should be first briefly summarized as follows:

1. C. C. Wang, Explanation to Geol. Map of China, Taiyuan-Yulin sheet p. 36.

The orogenic features in Shansi and north Honan have already been described by the author in his previous publications[1]; from these descriptions it can be easily deduced that the direction of the orogenic force is generally from NW to SE or to E by S, since the axes of the principal folds, such as the Lu Liang and Tai Hang anticlince etc (fig. 21), often appear to bend with the convex side toward SE and the southeastern limbs of these anticlines frequently dip more steeply than their corresponding north-western ones. This assumption is strongly supported by Bailey Willis' observation[2] of the overthrusts in northern Shansi and Western Chihli which are also directed from NW to SE.

Willis[3] have also made it very clear that in the Tsin Ling range the folding and thrusting are directed from N to S. According to T'an the Tsinling folding is also late Mesozoic.

The direction of the orogenic force in Ho Lan Shan (or Ala Shan) has been studied in 1921 by Dr. W. H. Wong and confirmed to be from W to E and, though his observation is not yet published, the following description kindly communicated by him may suffice for the present purpose:—

The geology of Ala Shan was first surveyed by Obroutchef who has already recognised the existence of a great eastward overthrust, but he mistook the Sinian limestone for Carboniferous and his memoir did not give any section indicating the thrusted structure. In 1921, Dr. Wong has visited the main valley leading from the Yellow River plain to Fu Ma Fu, the chief residence of Ala Shan, i. e. the Su Wei Kou valley, where the geological structure of Ho Lan Shan is very well exposed. On the summit of the hills is the thick limestone (fig. 22) very similar in lithologic character to the Nankou limestone. Under this limestone sometimes occurs a quartzite with ripple marks and rain prints; such character is also typical of the lower part of the Nankou formation (Sinian). There seems therefore little doubt on its geological age which should belong to the Sinian of Grabau or the neo-Proterozoic of Willis. Below this are deeply deformed and metamorphosed Carboniferous strata in whith however some well preserved plant fossils as *Calamites sp.* and *Lepidodendron sp.* etc., have been found. Figure 22 shows a generalized outline of the structural feature which is in reality much more complicated. Sometimes stratification can not be easily distinguished from schistosity, and this distinction is

1. C. C. Wang: Explanation to the Geol. Map of China, Taiyuan-Yulin sheet 1926; and geol. of Wu An, She Hsien, Ling Hsien & An Yang districts, N. Honan, Bull. Geol. Surv. China No. 9. 1927
2. Willis: Research in China, Vol. I, part I, p. 124-162, 1907.
3. , op. cit. p. 299-317,
4. H. C. Tan: Mesozoic formations in S. E. Honan etc. Bull. Geol. Soc. China, Vol. 4, No. 3-4 p. 252-253.

often only possible where schist and sandstone are alternatively interbedded as shown in Fig. 23. There is no doubt as to the existence of the great overthrust first recognized by Obrutchef, which brought the Sinian limestone from west eastward above the Carboniferous. The thrust is the more important as the limestone is now recognized to be of much older age than assumed. This great thrust extended no doubt much further earthward so that all the Carboniferous now exposed on the eastern slope of Ho Lan Shan was entirely covered once by the Sinian limestone as is testified by the large blocs of this rock widely scattered over the plain. The eastward direction of the orogenic force is also shown by the close foldings and thrustings as well as the inclination of strata within the Carboniferous (fig. 22 & 23).

N.E. of Ho Lan Shan on the east side of the Yellow River rise two mountains called Arbous Ula and Yinze Shan, the geological structure of which was first described by P. Teilhard de Chardin [1] as constituted by two anticlines separated by a synclinal basin (fig. 24). Both of the anticlines are inclined eastward.. This evidently indicates the folding force was directed towards the northeast.

The geology of Lang Shan (or Scheiten Ula) and Ula Shan both situated north of the great elbow of the Yellow River, on the west of Ta Ching Shan and northeast of Arbous Ula is yet imperfectly known; but all the previous geological writers including P. Teilhard [1] (fig. 25) believe the existence of southward movement in these ranges. Such direction of the orogenic movement would be difficult to under stand when correlated with the northward direction as observed by the author in Ta Ching Shan, since these western ranges above referred to apparently constitute adjoining chains of the same system as Ta Ching Shan trending nearly E-W.

However in examining more closely Teilhard's section (reproduced in fig. 25), it seems to the author that as the pre-Cambrian strata in Ula Shan uniformly dip to the south, the orogenic force is more probably directed northward rather than southward. The assumption of a southword movement can be therefore only based on the section observed on the southern foot of Lang Shan (fig. 25). This is however a partial section of a much larger chain. Dr. W. H. Wong who has visited the same region on his way to Kansu in 1921 kindly communicated to me a comparatively more complete section at the same locality (fig. 26). From this

1. Teilhard: Observations geologiques sur la bordure occidentale et meridionale de l'Ordos, Bull. Soc. Geol. de France, 4 series, tome XXIV, p. 49 et 402, 1924; and on the geology of the northern, western and southern borders of the Ordos, China. Bull. Geol. Soc. China, Vol. III, No. 1, 1924.

section it seems that the dislocation between the Wutai and the Sinian systems may be as well explained by a northward movement, there is in any case no definite evidence as to the prevailence of the southward movement. West of Wulan Hutung (烏蘭忽洞 the same as Oula Houtong in Teilhard's section) are the hills north of Ta Shei Tai (大佘太) the strata of which are also strongly deformed (fig. 27) according to Dr. Wong. The direction of the folding seems to clearly indicate, there at least, also a north-ward movement.

Thus, after carefully considering all the available field evidence, it seems well established that the orogenic movement which affected all the strata from the pre-Cambrian to the Upper Jurassic is, prevailingly at least, directed from south northward in all the adjoining chains of Lang Shan (Sheiten Ula), Ula Shan and Ta Ching Shan. This seems to be the conclusion from the field observation independent from all theoretical considerations.

All the previous authors writing on the tectonics of this part of China seem to have been much influenced by the theoretic consideration of Ordos as "*avant-pays*" of the orogenic force which came from W and N all against it. In fact, all the folded ranges under discussion just surround the Ordos and north Shensi plateau where strata remain horizontal or very little folded. To explain this phenomenon, it may be assumed that the eastward orogenic stress of Ala Shan, when it came partly through Arbous Ula to the Ordos and north Shensi plateau particularly resistant to the folding, had made the plateau a kind of centre from which it spreaded and proceeded toward N, E and S respectively on a semi-elliptical front as indicated in fig. 21. Ta Ching Shan, Lang Shan and Ula Shan all lying on one end of the major axis of the imagined ellipsis and Tsin Ling on the other have suffered particularly violent compression, and hence numerous large overthrusts and sharp folds have been produced. Shansi and north Honan on one end of the minor axis of the ellipsis have only been gently compressed so as to produce simple broad folds.

If reconstructed in imagination and in a much simplified way, all the regions under discussion might, as a whole, be represented by a great broad and shallow tabular syncline; indeed, such type of syncline is very commonly observed in Shansi, as Ning Wu syncline etc.. The Ordos and north Shensi plateau just occupies the axial or central zone of the assumed tabular syncline; Ta Ching Shan, Lang Shan on one side and Tsin Ling on the other respectively form its north and south borders; and Ala Shan on one side and Lu Liang Shan, Ho Shan and Tai

Hang Shan etc. on the other constitute its west and east limbs. But the tangential stress applied to the great tabular syncline should be originated from the west.

In the above explanation, a difficult problem would arise as how to account for the structural condition east of Suiyuan or SE of Ta Ching Shan. If the explanation is correct, the strata there should strike in a NW-SE direction so as to connect the Ta Ching Shan northward orogenic stress on one side and the Shansi southeastward one on the other in forming an arc front. Such seems not to be the case although the geology in the referred region has not yet been thoroughly surveyed. On the other hand, there is one notable fact worthy of attention, that is, between Ta Ching Shan on one side and the Ordos plateau and the Kuei Hua Basin on the other there exists a great normal fault called the Ta Chang Shan fault. Consequently the north Shensi syncline[1] has no north limb constituted by southward dipping late Palaeozoic or early Mesozoic strata as there should be theoretically. The exact termination of the fault east of Suiyuan has not yet been investigated but it probably extends further. Therefore, even if there did exist originally strata with NW-SE strike in the region, they might have been partly cut away or deformed otherwise by the later dislocation.

Likewise, since the relation of the regional folding betwcen Ala Shan and Lung Shan and further between Lung Shan and Tsin Ling are all obscure at present, it is obviously very difficult to arrive at any definite conclusion on the correlation of the orogenic directions SW of the North Shensi region (fig. 21). However, as the folding of Lung Shan has been assumed by Dr. W. H. Wong[2] to be much younger in age and probably belongs to Middle or later Tertiary, it does not fall into the scope of the present discussion which only concerns the folding and thrusting produced during the late Mesozoic time. As far as this orogenic period is concerned, the author has attempted to outline the orogenic feature of each and all of the ranges mumbered 1 to 11 in the text figure 21 and tried to explain their mutual relation in the face of the new observations now available.

Faulting:- Besides the thrust-faults above described, there are in the Ta Ching Shan region a number of other faults which are mostly of the "strike or oblique type."

Of course, it may not always be easy to distinguish between a thrust or a normal fault without careful observation in the field. Thus the Shih Kuai fault

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1. C. C. Wang: explanation to the Geol. Map of China, Taiyuan-Yulin sheet, p. 28.
2. W. H. Wong: Crustal movements and igneous activities in East China since Mesozoic time. Bull. Geol. Soc. China Vol. 6 No. 1, 1927.

which limits the Shih Kuai coal field on the south, may appear as an overthrust from south to north at the first glance at the geological map. However the field evidence (fig. 3 & 28) makes it more probabe a vertical fault with the upthrow on the south and down-thow on the north. Yet the possiblity may not be entirely lacking that it is still the western extension of the Paishihtoukou thrust locally dressed here.

Several other faults have been observed in the vicinity of Ta Kou and Chien Siao Pa Tzu on the west of the granite and Hsi Kou and Hei Niu Kou (fig. 7) on the east of the intrusion. These are generally oblique to the strike of the strata and extend often over pretty long distance from 10 to 20 li. But the displacements are within the Permo-Mesozoic beds.

The Mesozoie belt of Kuan Tien Tzu (fig. 9) and Chung Ti Yao Tzu (種地窰子) (fig. 10) is separated from the corresponding belt of Men Tou Kou (fig. 3) by a dip fault with the down throw side on the west. This may be however also explained by a horizontal shift.

Finally the whole Ta Ching Shan range is separated from the Kuei Hua plain by a great normal fault or a system of normal faults broadly from east to west. The fault scarp is well shown by the abrupt elevation of the Ta Ching Shan range with an almost straight front. The length of the fault line is about 240 li between Kuei Hua and Pao Tou and probably extended farther east of the former city with a vertical displacement of at leart several hundred metres. It cuts across the Pa Kou Tzu syncline and the Tzulaoshan-Kucheng overthrust. This will be called the Ta Ching Shan fault.

As a general rule. the faults cut across the folds and the thrusts and thus appear to be younger in age. In the absence of stratigraphic data in the Ta Ching Shan region for setting an upper limit to their age, we can only indirectly infer from physiographic evidence and comparison with the faults of Shansi [1] which have been assigned to Pleistocene and also mostly belong to strike or oblique type. This seems especially true of the Ta Ching Shan fault as already deseribed.

PHYSIOGRAPHY.

The topography in the vicinity of Ta Ching Shan may be represented by two different stages: (1) a stage of maturity corresponding to the Tanghsien stage

1. C. C. Wang; Explanation to the Geol. Map of China, Taiyuan-Yulin Sheet p. 37.

of Bailey Willis[1] in Chihli and Shansi and (2) that of youth to the Fenho stage of Willis and the Huangho stage of the author.[2]

The principal areas consist of the Kuei Hua basin and the Ta Shing Sh. range. The former is drained chiefly by the river Ta Hei Ho, a tributary of the Yellow River, and forms an alluvial plain triangular in shape surrounded by the abrupt scarp of Ta Ching Shan on the north and by rather gentle hills on the south and southeast. Its longest diameter from east to west is about 300 li while its width from south to north about 150 li. The surface of the basin is usually a little undulated at an average altitude of about 1100 m. above sea level and is entirely covered by alluvial deposits. The main cause of its generation seems due to its forming a depressed downthrow of the Tachingshan fault.

Generally speaking, the actual feature of Ta Ching Shan is a plateau uplifted by the Ta-Ching-Shan fault and deeply dissected by transverse consequent valleys coming down to the plain. It may be again distinguished into two longitudinal portions, south and north, each of which presents a distinct topography. The ***southern portion*** is situated between the coal field of I Chien Shang, San Tao Pa and Lao Wo Pu and the Kuei Hua basin. All the principal valleys in this portion show the feature of deep canyons of the Fenho stage, such as Pai Shih Tou Kou, Shui Ching Kou (fig. 4) and Pa Tu Kou etc., running in a universal N-S direction nearly forming right angles with the direction of the main ridges and cutting across the strike of the strata. Near the mouth of Wan Chia Kou (NE of Tao Tzu Hao Station) as shown in fig. 29, and north of the mouth of Pai Shih Tou Kou as shown in fig. 30, there is evidently development of the valley in two stages: (A) the canyon of the Fenho stage and (B) the V-shapeh gully of the Huangho stage cut on the bottom of the canyon. The ***northern portion*** is on the north of the coal field of I Chien Shang, San Tao Pa and Lao Wo Pu with its principal valleys generally trending from east to west, therefore often paralled to the strike of the strata and of the chief adjacent ridges. These E-W valleys are mostly shallow and broad while the ridges among them are generally gentle and low with a surviving relief within 100 m. All these features certainly correspond to the mature topography of the Tanghsien stage.

Sometimes the longitudinal mature valleys of the northern area are cut across by the N-S youthful ones originated from the south and progressing northward.

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1. Willis; Research in China, Vol. 1, part 1, 1907.
2. C. C. Wang: op. cit p. 40.

The reason of the distribution of the physiographic features above mentioned is easy to understand. After the late Mesozoic orogenic movement, the mountains were eroded to yield a mature topography. The Tachingshan faulting and warping are of geologically recent production. The mature plateau of Ta Ching Shan was then uplifted so that the vertical cutting progresses from south to north and the N-S consequent valleys are lengthening themselves onward and eventually capturing the older E-W mature valleys. More recent revival of the Ta Ching Shan uplift causes the formation of the small gullies of the Huangho stage.

The whole tectonic and physiographic history can be broadly summarized as follows:

Cretaceous: Lateral compression, folding and thrusting;

Tertiary: Erosion to maturity, Tanghsien stage;

Quaternary: Tachingshan fault and uplift, vertical erosion, Fenho stage;

Late Quaternary or Recent: Revival of uplift and vertical erosion, Huangho stage.

COAL RESOURCES.

Though the coal-bearing region north of the Kuei Hua Basin is, as a whole, commonly called Tachingshan coal field, it actually contains two coal series different in age, Permo-Carboniferous and Lower Jurassic. There may be again distinguished into seven subordinate coal fields according to their distribution.

1. *The Pakoutzu* (壩口子) *coal field:* This is about 20 li north of Kuei Hua Cheng and built up only of the lower part of the Lower Jurassic coal series. No good coal seams have been discovored and those formerly operated by native pits are merely from a few inches to one foot thick and of semibituminous quality.

2. *The Heiniukou* (黑牛溝) *coal field:* About 10 li N.W. of the Pi Ko Chi station, coal occurs in the Lower Jurassic series. The worked coal seam is semibituminous in quality and commonly 1 or 2 ft. in thickness. Only three pits exist during the writer's visit with little output. The probable coal reserve seems not to be more than 2,900,000 tons, if the average thickness of the coal seam is taken as half meter down to a vertical depth of 500 m.

3. *The Liushuwan* (柳樹灣) *coal field:* This field is situated north of Cha Su Chi Station and also consists of Lower Jurassic coal series. There are two coal

seams to be worked; one is about 1 ft. thick and the other 2 to 4 ft. The coal is anthracite and its analysis is shown as below.–

Moisture	Volatile matter	Coke	Fixed Carbon	Ash	Color of ash
1.46	3.44	95.10	79.86	15.24	Yellow

Nature of coal	caloric power
Coking	7046

If one meter is taken as the average total thickness of the coal seams, the coal reserve is about 11,700,000 tons. An annual coal production of 5,000 tons from native pits has been reported.

4. *The Shihkuai* (石拐) *coal field:* This is the largest and most important coal field in Ta Ching Shan extending from Ta Kou westward through I Chien Shang, Liu Tao Pa and Lao Wo Pu to Shih Kuai Chen at a total length of about 120 li. The coal series belongs to Lower Jurassic. The coal seam worked at Ta Kou, Liu Tao Pa and Chung Lao Wo Pu is about 4 ft. thick, while in the vicinity of Shih Kuai Chen there are 7 workable coal seams, two of which are being worked during the writer's visit, respectively 3 ft. and 6 ft. thick (fig. 31). As to the quality of the coal, both anthracite and bituminous coal exist with the valley of Mai Ta Kou as boundary of separation. East of Mai Ta Kou, (麥達溝) between Liu Tao Pa and Ta Kou, all the coal is anthracite. Samples taken from I Chien Shang have yielded the following analyses.

Moisture	Vol. matter	Coke	F. Carbon	Ash	Color of ash
1.40	4.80	93.80	84.26	9.54	Reddish

Nature of coke	Caloric power
non-coking	7350

West of Mai Ta Kou, in Hu Lu Ssu Tai and Shih Kuai Chen, the coal is all bituminous, coking and chiefly in lumps; the analysis of samples from Shih Kuai Chen is as the following :–

Moist.	Vol. matter	Coke	F. Carbon	Ash	Color of ash
1.44	33.02	65.54	56.62	8.92	brown

Nature of coke	Sulphur	Caloric power
coking	0.0127	7751

The existence of anthracite east of Mai Ta Kou is, as Dr. Wong has already pointed out, probably due to the metamorphosing influence of the granitic intrusion.

If the average total thickness of the coal seams between Ta Kou and Chung Lao Wo Pu is taken as 1.5 m. and that in Shih Kuai Chen and west of Chung Lao Wo Pu as 3 m., the coal field should have a reserve of 20,300,000 tons of anthyracite and of 85,800,000 tons of bituminous coal. The coal is all worked by native method and the largest mine is called Mo Nan (漠南) coal mining company situated at Shih Kuai Chen. From rough estimates the annual coal production of anthracite is about 18,000 tons and that of bituminous coal about 47,000 tons.

5. *The Tung Sheng Mao* (董盛茂) *coal field:* This field is constituted by Permo-Carboniferous coal series. One coal seam is observed at Ma Ti Wan Tzu south of Tung Sheng Mao and its thickness is about 6 m. The coal is bituminous and coking; the analysis of a sample from Ta Tan Hao is as follows:–

Moist.	Vol. matter	Coke	F. Carbon	Ash	Color of ash
1.16	22.68	76.16	66.54	9.62	Yellowish

Nature of coke	Sulphur	Galoric power
Coking	0.0162	7685

Taking 3 m. as average thickness of the coal seam, the reserve is calculated at 37,800,000 tons. The field is little worked with an annual coal output of not more than 2,000 tons.

6. *The Yangkoleng* (楊圪塄) *coal field:* South of the Tungshengmao coal field is that of Yangkoleng. It consists of both Permo-Carboniferous and Lower Jurassic coal series and therefore may be subivided into three parts as the following table:–

	Geol. Ages	Average thickness of coal seam	Probable reserve	Annual output.
East part	Permo-Carb.	2 m.	4,500,000 tons	1,000 tons
Middle „	Lower Jurassie	1.5 m.	5,800,000 „	6,000 „
West „	Permo-Carb.	1 m.	1,600,000 „	1,000 „

The coal is all bituminous, but only that of the Lower Jurassic coal series is coking. The most important mining place is in the vicinity of Yang Ko Leng.

7. *The Kuantientze* (寬店子) *coal field:* This is situated south of the Yangkoleng coal field and composed of the Lower Jurassic coal seires. There are three coal seams worked at Kuan Tien Tze; the upper one is about 2 ft. thick, the middle 1 ft. and the lower 3 ft. Two meters being taken as the average total thickness of

the coal seams, the reserve is about 24,000,000 tons with an annual coal production of not more than 3,000 tons. The coal is all bituminous and coking.

Conclusion: The total coal reserve in the above mentioned 7 coal fields includes 32,000,000 tons of anthracite and 165,000,000 tons of bituminous coal; or according to the geological age the Permo-Carboniferous coal series contains 44,000,000 tons of coal and the Lower Jurassic coal series 153,000,000 tons. As to the total annual coal production, it only amounts to 23,000 tons of anthracite and 60,000 tons of bituminous coal at the time of the author's visit. The former is chiefly mined in the vicinity of Ta Kou, while the latter is mainly from around Shih Kuai Chen. At the pit mouth, the average price of coal is about $2.8 a ton. The coal is transported by mules, donkeys or carts to the cities or larger villages in the Kueihua basin, and is mainly consumed by the Suiyuan-Paotou Railway.

PEAT BEPOSITS

The main peat deposit occurs SW of the Tai Ko Mu station and extends from NE to SW over 12 kilometers. The known width is about one kilometer, Thickness of peat is 1-3 feet. The peat contains 64 % vol. mat. and only 16 % fixed carbon.Reserve is about 11,000,000 tons.

Another area occurs SE of the Tao Tze Hao station. A third area is in the vicinity of Erh Tao Ho Tzu, E of the above named station.


綏遠大青山煤田地質圖
THE COAL FIELD OF TA-CH'ING-SHAN, SUIYÜAN.
民國十四年秋王竹泉測
Surveyed By C. C. Wang, 1925.
等高線距離五十公尺
Contour interval : 50 m.
高度標点以平均海面為準悉用公尺記數
Height in metres above sea-level.
縮尺十萬分之一
Scale 1 : 100,000
2500 0 2500 5000 m.
5 0 5 10 Li
本平面圖上剖面圖之號數與報告中圖號相同
The number of the sections on the map corresponding to that of the text figures.
花崗岩 GRANITE
元古界 PROTEROZOIC
五台系 WUTAI SYSTEM
石炭二疊紀 PERMO-CARBONIFEROUS
下煤系 LOWER COAL SERIES
二疊三疊及三疊紀 PERMO-TRIASSIC & TRIASSIC
紅色頁岩及砂岩 RED SHALE & SANDSTONE
下侏羅紀 LOWER JURASSIC
上煤系 UPPER COAL SERIES
中侏羅紀及上侏羅紀 MIDDLE? & UPPER JURASSIC
紅色頁岩及砂岩 RED SHALE & SANDSTONE
第四紀 QUATERNARY
泥炭層 PEAT DEPOSIT
冲積層 ALLUVIUM
安山岩 ANDESITE

第二版至第四版照片說明 Explanation to the Plates II IV.

第二版 甲. 五達溝內韓同會村南結晶片岩之片理.

Plate II. A. View of the bedded structure of crystalline schist S of Han Tung Hui in the valley of Wu Ta Kou.

乙. 薩縣同盛茂村南石炭二疊紀煤系與元古界石英岩間之不整合.

B. View of unconformity between the Permo-Carboniferous coal series and the Proterozoic quartzite S of the village of Tung Sheng Mao.

丙. 萬家溝內之花崗岩露頭及小瀑布.

C. Outcrop of granite in Wan Chia Kou with a small waterfall.

第三版 甲. 巴兎溝內康包溝附近下侏羅紀煤系之底層礫岩與三疊紀紅色沙頁岩之接合.

Plate III. A. Apparent conformity between the basal conglomerate of lower Jurassic coal series and the Triassic red shale and sandstone near Kang Pao Kou in the valley of Pa Tu Kou.

乙. 水磨溝內四道河子北之上侏羅紀礫岩層.

B. Outcrop of Upper Jurassic conglomerate N of Ssu Tao Ho Tzu in the valley of Shui Mo Kou.

丙. 黑牛溝內烏蘭板申村北之馬密哈達逆掩摺斷(上侏羅紀紅色頁岩與砂岩一部逆覆于元古界大理岩上).

C. View of Mamihata overthrust with a part of Upper Jurassic red shale thrusted over Proterozoic marble N of Wu lan Pan Shen in the valley of Hei Niu Kou.

第四版 甲. 水晶溝村北之深峽谷形.

Plate IV. A. View of the canyon feature N of the village of Shui Ching Kou.

乙. 石拐鎮附近東官窰用土法燒焦炭之景.

B. View of burning coke with native method near Shih Kuai Chen.

丙. 台格木車站西南產泥炭廠將泥炭疊于坑旁令日晒乾之景.

C. View of drying peat lumps dug out from neighboring pits SW of the Tai Ko Mu station.

甲 A

乙 B

丙 C

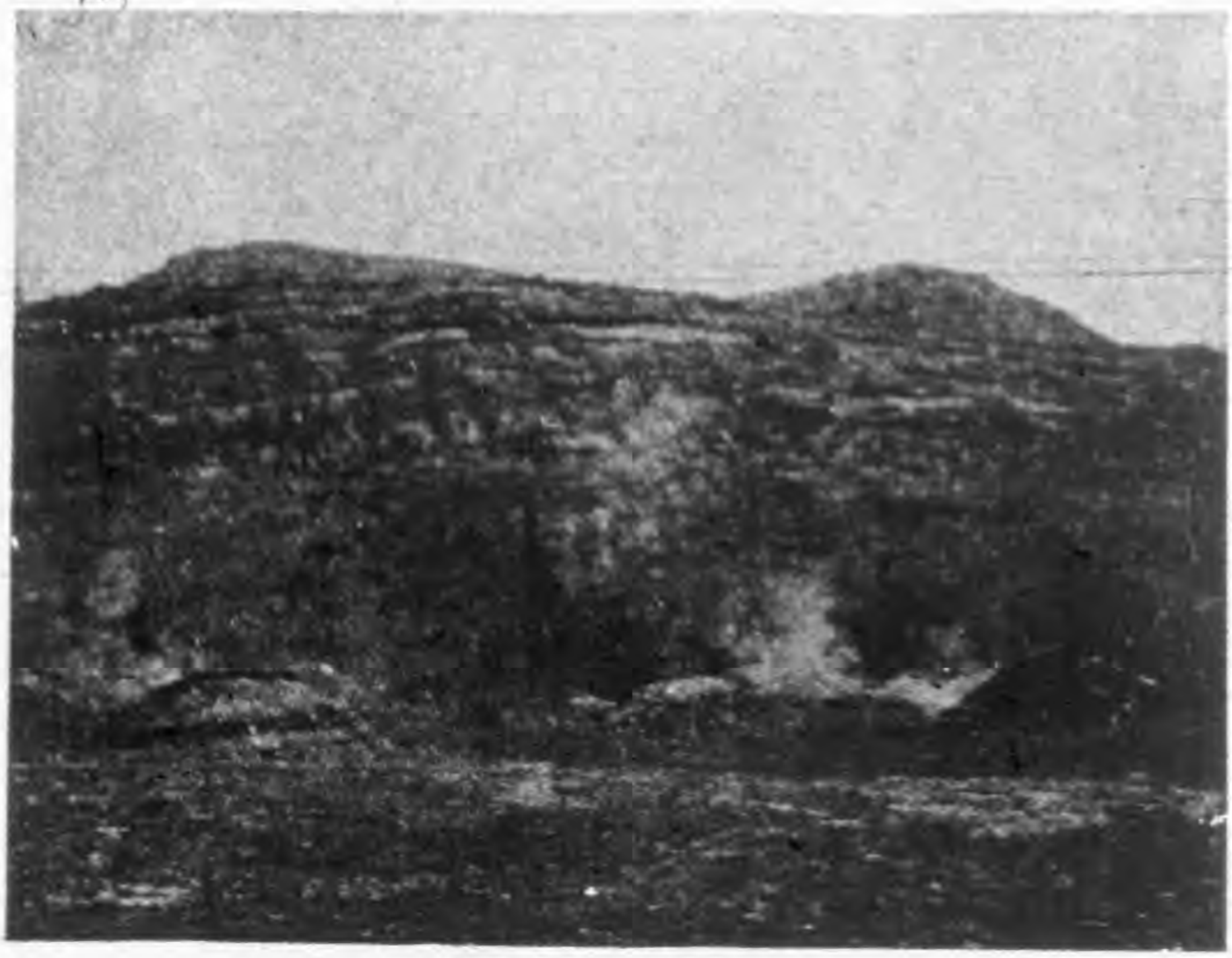
甲 A

乙 B

丙 C

甲 A

丙 C



乙 B

GEOLOGY OF HSUAN HUA, CHO LU AND HUAI LAI DISTRICTS, N. W. CHIHLI.

(Summary)

BY H. C. T'AN. 譚錫疇

(With one Plate)

As explained by the author himself in the introduction, he had no time to pay special attention to the igneous rocks in this area which have however great scientific interest. A supplementary study was later made by Mr. H. S. Wang whose paper is published in this same bulletin immediately following the present one.

W. H. Wong

INTRODUCTION.

In the autumn of 1918, the writer in coorperation with Dr. J. G. Andersson and Mr. T. O. Chu made a geological survey in the districts of Hsuan Hua, Cho Lu and Huai Lai in N. W. Chihli with the special purpose of prospecting the important iron ores known to occur in this region and looking for pure limestone and coking coal for the then proposed metallurgic work. Dr. Andersson made a detailed survey on the Yen T'ung Shan iron ore deposits and studied the geology in the vicinity of Hsin Pao An in the Huai Lai district, Mr. Chu surveyed the part, east and north of the river Yang Ho, including the mountains, Yen T'ung Shan, Wo Hu Shan, Hei T'ai Shan, Ta Chien Shan, Chi Ming Shan and Yuan Pao Shan while the writer worked in the part, west and south of Yang Ho, including the hills, Huang Yang Shan, Huang Yin Shan, Lao Tung Shan, Lao Huan Shan, Pi Chia Shan, Chin Chia Ta Liang and Niang Tzu Shan and the plain through which the river Sang Kan Ho passes. This paper contains only the summary of the generalgeology of the region; some points here touched remain still unsettled and need be restudied in future for only one part of whole area treated in the paper was surveyed personally by the writer while materials for the remaining parts were only verbally communicated by Dr. Andersson and Mr. Chu. The details on the iron ores have been already embodied in a special memoir on the iron ore deposits and iron industry of China by Mr. F. R. Tegengren.

TOPOGRAPHY

The region here in question is situated in the northwestern part of Chihli, through which the Peking-Suiyuan Railway Passes. The larger part of this area belongs to the Hsuan Hua district and the remainder to the Cho Lu and Huai Lai districts. The lowest point in this region is about 500 meters above sea level. About two-thirds of the surveyed area are hilly and one-third is occupied by plains.

Most of the elevations occur in the southern part of this region among which the highest one is Huang Yang Shan, extending from the western bank of the river Yang Ho, westward to meet other mountains, with an altitude of 1,666 meters above sea level.

The main streams are Yang Ho and Sang Kan Ho which have their sources in Shansi, flowing with many tributaries east-and southeastward and uniting to form one river named Hun Ho in the southeastern part of the mapped area.

Generally speaking, there are two plains which are separated by hills from one another. The first plain is surrounded by the Huang Yang Shan, Lai Kung Shan, Niang Tzu Shan, Ta Chien Shan, Hei T'ai Shan, Wo Hu Shan and Yen T'ung Shan and has an area of about 350 square kilometers. It is extensively covered by the loess ranging from several meters to 30 meters in thickness; beneath this cover the rock foundation probably consists of the tuff-conglomerate formation as will be later treated. The part, north of Huang Yang Shan is however covered by loose sands; this area of about 15 square kilometers is entirely denuded of vegatation. The second plain occurs along the lower courses of the rivers Sang Kan Ho and Yang Ho (or Hun Ho), including the land between Pa Pao Shan and Lao Chun Shan and east of Huang Yang Shan and Pi Chia Shan, with an area approximately equal to the plain first mentioned; it is entirely covered by loess and alluvium.

STRATIGRAPHY.

The stratigraphic sequence in this region is, in general, the same as the prevailing type in northern China. The special feature is that the mesozoic coal series seem to directly overly the Pre-Cambrian or Proterozoic siliceous limestone,§ and the whole system of Palaeozoic and lower Mesozoic is entirely missing except one small area at Pa Pao Shan where Cambrian strata have been hypothetically identified.

Archæan: This formation consists chiefly of gneiss and occasionally amphibolites with intrusions of granite and pegmatite, the gneiss being often pegmatitic with coarse schistosity and large crystals of minerals. It occurs in the southernmost and northernmost parts of this area, especially along the northern foot of Yen T'ung Shan and Wo Hu Shan, the southern slope of Lao Chun Shan and in the vicinities of T'an Yuan, Shang Shui Ku, Chiao Chia Kou and Shih Ho.

§ Sinian limestone according to the terminology lately adopted on the suggestion by Dr. A. W. Grabau. Bailey Willis' nomenclature is followed in this paper prepared in 1919.

Quartzite Formation: This formation rests unconformably upon the Archæan gneiss and belongs to the lower part of the Neo-Proterozoic (Grabau's Sinian) and comprises largely quartzite, quartzitic sandstone and slate, with shales and thin-bedded limestone, and iron ore beds. The quartzite is mostly white in colour and compact in character, and becomes in some parts white coarse sandstone. Along the northern slope of the range including Yen T'ung Shan and Wo Hu Shan and at Hei T'ai Shan it contains quartzitic slate, quartzitic sandstone with ripple-marks, iron ore beds and black slate. Along the southern slope of Lao Chun Shan and in the vicinities of T'an Yuan and Ta Fang Tzu it is not well developed and consists of red coarse sandstone, darkbrown and green shales with several thin beds of limestone, white quartzite and lenticular poor iron ore beds. The thickness of this formation is greatly variable, in the northern part of this area it amounts to not less than 200 meters but in the southern part the total thickness is estimated at only about 50 meters.

Siliceous Limestone (Sinian Limestone): This formation may be referred to the upper Neo-Proterozoic. It consists of typical siliceous limestone and quartzite and shales in the lower part, the siliceous matter forming nodules, lenticules and even layers. This limestone often constitutes high mountains and is well developed in the southern and northernmost parts of this area. At Yen T'ung Shan, Wo Hu Shan and Hei T'ai Shan the lower part of this formation comprises siliceous limestone and quartzitic in part green in colour, and the upper part contains siliceous limestone with chert nodules and layers. In the southern part this formation consists of thin-bedded limestone with or without siliceous matter and containing green shale in the lower part, and of thick-bedded limestone with or without siliceous matter, occasionally including hematite masses. Owing to the incomplete exposure of this formation the total thickness can not be estimated, but so far as can be judged from the surveyed area, it seems to be not less than 1,000 meters.

Cambro-Ordovician Formations: These formations were not visited by the writer, according to an unpublished report of Prof. Wang Lieh Cambro-Ordovician strata are said to occur along the southern slope of Pa Pao Shan and consist of black and red shales and pure limestone of about 6-7 meters in thickness; the former may be regarded as belonging to the Cambrian and the latter to the Ordovician. But it may be questioned whether the black shale is not the uppermost part of the siliceous limestone and the pure limestone seems too thin for representing Ordovician limestone usually so well developed in other parts of northern China.

Jurassic Coal Series: This series is in fault contact with the underlying formations. The basal beds are either concealed beneath the surface covering or cut away by the faults, and these exposed and left may be petrographically divided into three parts; the lower part consists chiefly of brown, dark, green and violet thin shales, without coal seams but with calcareous lenticules arranged along the bedding plane and pyrite utilized for preparing sulphur; the middle part comprises dark and greenish shaly sandstone, black shale, red clayey shale, brown and green shale and thin-bedded sandstone, conglomeratic sandstone, conglomerate with limestone pebbles, thin-bedded siliceous limestone, greenish sandstone, quartzitic sandstone with pyrite, white-gray and reddish coarse sandstone and conglomerate, and yellowish loose sandstone, including workable coal seams. The upper part contains violet and green shales and sandstones, without coal seams. It is well developed in various coal fields in this area. One part of this series was faulted away, so that the real thickness can not be known, but estimates based on the remaining parts give a thickness of about 300 meters to the lower part and 200 meters the middle part. The upper part being greatly variable and undeterminable.

Tuff-conglomerate: Upon the coal series disconformably or perhaps unconformably rests a complex of sedimentary and volcanic rocks. This group may be called Tuff-conglomerate or Porphyry-conglomerate. It may be divided again into two parts; the lower part embraces brown, red, green and violet tuff-conglomerate and tuff with red sandstone and thin-bedded shale; the upper part consists chiefly of brown, red and green tuff and tuff-conglomerate interbedded with brown, purple and green stratified or massive and porphyritic or homogeneous lava flows with which the obsidian is occasionally associated. The pebbles contained in the tuff-conglomerate are made mostly of various igneous rocks and also quartzite, limestone and gneiss. This formation occupies about one half of this area, either forming the foundation of the plains or constituting hills and mountains often with conspicuous cliffs. One part of this formation was eroded and faulted away, so that the real thickness is unestimable, the remaining and exposed part amounts to more than 500 meters. Owing to the lack of fossils the horizon of this formation can not be precisely determined, according to the superposition and petrographic characters it may correlate the tuff-conglomerate and lava formations which I have described later from Shantung§ and of the lower Cretaceous age.

Superficial Deposits: The loess and alluvium are wide-spread here and there between the mountains and streams. The loess is a yellow clay formation, exhibiting typical vertical cleavage with a thickness varying from several meters to about 30 m. Land shells and fossil bones are occasionally found. North of Huang Yang Shan there occurs an area of loose sand several feet thick.

§ H. C. T'an. New research on the Mesozoic and Early Tertiary Geology in Shantung. Bull. Geol. Surv. China No. 5, p. 2

THE ANCIENT VOLCANOES OF HSUAN-HUA (宣化) THEIR ROCK TYPES AND GEOLOGICAL AGE.

By H. S. WANG. 王恆升

With 8 plates and 2 figures.

INTRODUCTION.

Volcanic rocks of Mesozoic and Tertiary age are widely distributed in Eastern China. But only a few regions have been studied into details as to the petrographical characters and the exact mode of occurrence of these volcanic formations. They have been often vaguely mapped under such names as prophyry or simply volcanic rocks which may suffice for the reconnaissance work but need more precision for the real understanding of the complete geological history of the country.

The occurrence of volcanic rocks in Hsüan-hua and its adjoining regions has been noticed since the early geological work by Pumpelly[1] and von Richthofen[2]. More recently it has been broadly mapped by my colleagues, Messrs. H. C. T'an and T. O. Chu. It was for the purpose of specially studying these igneous rocks which were not made out clear enough that the author was instructed to resurvey this region.

In consequence, two trips were successively made, one in the winter of 1926 and the other in the spring of 1927, each during about ten days. Two short visits were also paid to the region north of Kalgan[3] where volcanic formation are also beautifully developed.

As a result of these field studies and the subsequent petrographic work carried out in the laboratory of the Survey, it has been possible to establish a clear sequence of the volcanic eruptions in this regions during the Mesozoic and Tertiary time. The successive lava flows petrographically and chemically studied reveal themselves as a beautiful example of gradual variation in the magmatic composition.

1. R. Pumpelly, Geographical Research in China, Mongolia and Japan, Smithsonian Contri., 1866, p. 202.
2. F. v. Richthofen, China Vol. II, pp. 339.
3. The geology and petrography of the Kalgan is being studied in details by Prof. Barbour of the Yenching University. During my last visit, I had the pleasure of accompanying a number of senior geologists and petrographers including Prof. Lacroix, Teilhard, Barbour and Dr. Wong. I have been especially benefitted by explanation given by Prof. Barbour, during this short excursion.

GENERAL GEOLOGY OF THE REGION.

North of the latitude of Peking, there are a great number of regions where volcanic rocks are widely spread as shown in the small map inserted in the Plate I. The Hsüan-hua region lies south of Kalgan and is more or less continuous with the latter region as far as the volcanic phenomena are concerned. Some of the material erupted was most probably derived from one and the same general source, while others represented a connected series of eruptions.

As is shown on the revised map (Pl. I), a high and massive range of limestone forms the northern rim at the eastern part of the Hsüan-hua region and stretches from Shang-hua-yüan (上花園) to Huang-yin-shan (黃陰山) along the south-eastern border of the region under study. This is the Sinian limestone which is often contaminated by silica and not infrequently contains cherty or flinty laminæ and lenticules. As this siliceous limestone is mostly resistant to weathering, it often constitutes the highest and nearly inaccessible elevations within the area studied.

Along the western bank of Ch'ing-shui-ho (清水河), which runs from the north of Hsüan-hua city, underlying the Sinian limestone outcrops the Archæan gneiss not very far from the northern mouth of the valley. In this very gneiss, we found pegmatite veins with large fleshy feldspar crystals and large biotite plates. About 5 li northward from this place, the gneiss replaces the Sinian limestone for the northern border and extends more or less continuously to Pai-miao (白廟) where occurs a hot spring along a fault-fissure.

At Pa-pao-shan (八寶山), above the Sinian strata we found a pure limestone of lower Ordovician age, which has been broadly included by Messrs. T'an and Chu within the Cambro-Ordovician. The new revision rests on the evidence of a fragmental *Archaeocyathus* found by the author. As this limestone is not well-developed in this region, we not infrequently found that the Jurassic coal series, including the volcanic ejactamenta, directly overlies the Sinian strata.

Though the hiatus between the Jurassic and the Sinian formation is of great magnitude, yet the latter is only disconformably overlain by the former, namely the Jurassic coal series with coal seams. The coal is largely anthracitic, and according to the boring of the Tien-hsing coal mine (天興煤礦), there are at least five coal seams which are workable. Buff sandstones intercalate with the coal seams, and occassionally with black shales. Toward the lower part, black shales predominate, and are locally, for example, at Wang-chia-lo (王家樓), so rich in pyrite that they are mined, in a primitive way, for extracting sulphur.

At Wu-chia-kou (武家溝), and Yü-tai-shan (玉帶山), the coal series is, in turn, directly overlain by the extrusives with a layer of agglomerate at the base. At Wu-chia-kou, the agglomerate unconformably overlies the coal series, indicating that prior to the ejection of the lava, there had been an orogenic movement by which the coal series was folded. After or accompanying the folding, erosion was effective, disclosing the older strata, such as the Sinian and Archæan by removing their respective superformations. Upon this eroded surface, the volcanic tuff, agglomerate were deposited accompanied occassionally by lava streams.

Having sketched the general features of this region, we may now take up the geology of the volcanic rocks. They had been reduced to a considerable extent by erosion and not only were their original forms destroyed but were also isolated here and there from their original distribution.

So far as can be deduced from the volcanic relics of this region, there occurred two main kinds of rocks, the acid and the basic. The former, being comparable to Stromboli, constitutes a high dome, the latter forms not infrequently a typical mesa-topography (See Fig. AA, Pl. II). The two types, mentioned, are so contrasting with each other that they can hardly be confused even at a great distance, for example, at Hsüan-hua station (宣化車站).

THE EARLY ANDESITE AND ANDESITIC AGGLOMERATE.

Within the area considered, this is by far the best developed among all the volcanic rocks, but it is also now ruptured at various places. At Wu-chia-kou (武家溝), it unconformably overlies the lower Jurassic coal series with a layer of agglomerate about 20 meters thick at its base (Pl. II, Fig. 2). From this village, it extends continuously westward to An-chia-kou (安家溝) where the andesite is preponderant, and northward through Hsin-chuang-tz (辛莊子), K'ou-chia-kou (寇家溝), Yin-chia-chuang (殷家莊) to Yü-tai-shan and crossing the Yang-ho river (洋河) through Kuo-chia-chuang (郭家莊) to Chao-chia-chuang (趙家莊), where the tuff and agglomerate, occassionaly intercalated with red clay and sandstone, become predominant. Only about the vicinity of Kuo-chia-chuang we found another seam of vesicular andesitic lava which is strongly prophyritic with phenocrysts of feldspars. From Kuo-chia-chuang both eastward and westward, the agglomerate extends about 90 kilometers to the eastern bank of Nie-ho river (泥河)

and 13 kilometers to Li-chia-liang (李家梁) respectively, forming the low hills north of the Peking-Sui-yüan railway line. Tectonically, it only overlies the lower coal series concordantly throughout this zone but at Yü-tai-shan there occurs between the two, a layer of conglomerate the pebbles of which consist mostly of quartzite, siliceous limestone and sandstone indicating the true unconformable relation.

In the basal agglomerate, the boulders are largely andesite, quartzite and siliceous limestone either angular or subangular. They are set disorderly in a fine matrix, and seem to be unaffected by any further transportation since their deposition. Though they are occassionally overlapped by the andesitic lava, yet it is sufficient to show that prior to or accompanying the andesitic eruption, there was a violent explosion which resulted in the deposition of these pyroclastic rocks.

THE HORNBLENDE ANDESITE AND THE TRACHYTE.

As shown on the accompanying map (Pl. I), an elongated body of extrusives is exposed at Lei-kung-shan (雷公山), south of Kou-ts'uen (郭村). This is the hornblende andesite which is overlain by a seam of trachyte and underlain by an augite basalt, with a layer of red clay between (See fig. 1). Observations at other localities lead to the conclusion that the augite basalt is in all probability intrusive in origin and younger than the remaining two seams which are most likely two lava flows in successive eruption.

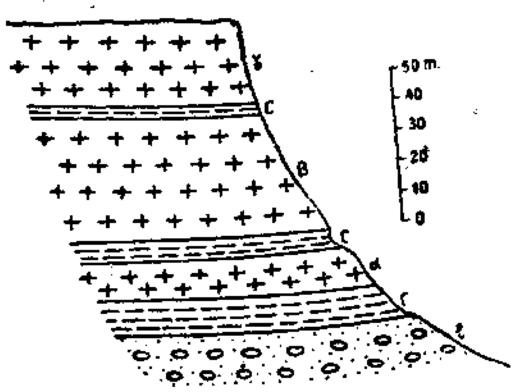


Fig. 1. Section of Lei-kung-shan: b, agglomerate; c, red clay; α, augite basalt; β, hornbende andesite; γ, trachyte.

The contact of the two lava sheets with their respective underlying red clay is usually uniform and smooth. The interest of such a contact lies in the fact that it required a dry surface when the lava was poured out and that this assumed condition is remarkably coincident with the arid climate as revealed by the red color of the accompanying beds.

It must be remarked here that the above mentioned sequence is by no means constant everywhere. Along the eastern bank of the river near Li-kou-chuan (犁口泉), the trachyte directly overlies the augite basalt, while in the vicinity of Lung-men (龍門), it caps a layer of agglomerate; at Ti-shui-yai (滴水崖), Ma-tou-shan (馬頭山), it is again underlain by the augite basalt with or without a layer of red clay between.

The trachyte is rather vesicular on the upper surface but usually fairly dense toward the middle and the lower part. When the vesicles are scattered throughout the whole body, they tend to increase in size towards the lower part, reaching occassionally a man's fist or even larger. Beautiful agate and drusy quartz fill them as amygdules. It often constitutes a mesa-topography, which is quite distinct from the other extrusives.

As shown by fig. 1, the augite basalt is underlain by a layer of agglomerate which is well developed near Shih-yai-shan (石崖山) where it intercalates with red clay and conglomerate (Fig. 2). This is the "tuff-conglomerate" of Mr. T'an including the lava sheets. So far as only the extrusives are considered, the designation of tuff-conglomerate may convey a misconception about the distribution as well as the magnitude of the ancient volcanoes under discussion, the author, then, attempts to differentiate them on the map with a particular sign.

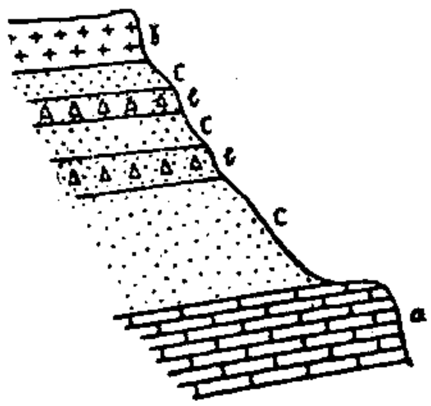


Fig. 2. Section near Shih-yai-shan. a, Sinian Ls.; b, agglomerate; c, red clay; r, trachyte.

THE RHYOLITE AND THE TRACHYTE OF THE HSÜAN-HUA REGION AND OF KALGAN.

The rhyolite is best exposed about the vicinity of Niang-tze-shan (娘子山), surrounding an intrusive neck. Other localities where it occurs are Sĕ-fang-tai (四方台) north of Hsüan-hua, Tsai-shih (柴市), Tsui-ping-an (翠平菴), and the western hills of the old Wan-chuan city (舊萬全城).

At Niang-tze-shan, the rhyolite intergrades imperceptibly with the volcanic neck. The same relation is more clearly revealed at Yüng-kai-shan (永蓋山), where occur at least three different rocks which can hardly be separated by any distinct line.

Near the intrusive neck the rhyolite becomes fairly coarse, porphyritic and of a greenish color; farther away it turns to a pinkish hue, possessing occassionally a fine fluidal structure and abundant angular fragments, some of which are xenocrystic, and some are the same as the main body.

Toward the base, we find volcanic tuff and agglomerate on the western side of Chai shan-pŏ (寨山坡). In the agglomerate, the boulders are largely obsidian and are often of a considerable size. Perhaps there are no other facts which reveal the violence of the volcanic explosion better than those large boulders just mentioned. Near the pyroclastic rocks, we found some perlites with typical botryoidal structure, indicating that they were exuded not far from the crater. The intrusive neck, mentioned above, may be of such an origin.

The hills about Kalgan are largely composed of reddish trachyte which is occassionally rather vesicular, the vesicles being filled by quartz. Dark laminations are locally found intercalating in the main body, for example, at Yü-shan or Fish Hill (魚山), east of Kalgan. It is capped by red sandstone, tuff and conglomerate (Nan-tien-men (南天門) series of Barbour) into which the rhyolite has intruded. This shows that the trachyte is undoubtedly older than the rhyolite a fact already observed at Niang-tze-shan where the rhyolite has broken throug the trachytes duing explosion. However, since it is well-developed here, namely a Kalgan, we must expect later to locate another crater in this locality.

THE OLIVINE BASALT OF HAN-JŌ-PA (漢諾壩)

This is the best developed among all the volcanic rocks described. At Han-jō-pa, it directly overlies the Shan-fang-pu (膳房堡) gravel, and constitutes a typical plateau which is quite contrasting with the rough surface of its underlying gravel bed. It is usually very dense, of a dark color, and occassionally with vesicular bands, the vesicles being mostly filled by calcite. Patches or nodules of olivine are not infrequently observed megascopically in the compact variety.

THE INTRUSIONS.

So far as the author's field data of this district reveal, there are only four major intrusive bodies, namely the Niang-tze-shan quartz prophyry, the Pa-pao-shan feldspar prophyry, the syenitic intrusion near Chao-chia-chuang (趙家莊) and the gabbro of Yü-tai-shan, with minor dykes, sills, such as at Wu-chia-kou, Yin-chia-chuang, Yü-tai-shan, Lei-kung-shan, Chi-ming-shan (雞鳴山) and Ma-tou-shan, etc. However, they are rather irregular in distribution and not abundant enough to serve to locate the crater as in Highwood Mountains[1] and Crandal Basin[2].

1. L. V. Pirsson, Petrography and Geology of the igneous Rocks of Highwood Mountains, Montana, Geol. Surv. U.S. S.B.D. No. 237, 1905, Pl. III, pp. 31-32.
2. I. P. Iddings, The Dissicted Volcano of Crandal Basin, Wyoming, Monogr. Geol. Surv. U.S., Vol. XXXII, Part II, 1899, Pl. XXVII, p. 216.

As already remarked, the quartz porphyry of Nian-tze-shan is a volcanic neck which has broken through the trachyte during explosion. The feldspar porphyry of Pa-pao-shan and the syenitic intrusion near Chao-chia-chuang have intruded both into the coal series and the andesitic agglomerate. (Pl. II, Fig. BB' CC'). Since the agglomerate contains no pebbles of them, it seems very likely that the agglomerate is older than both, and that they are in all probability affiliated with the trachyte described before.

The gabbro occurs at the eastern foot of Yü-tai-shan in the coal series. Not infrequently, it sends off off-shoots as sills and dykes in its vicinity.

PETROGRAPHIC DESCRIPTION.

The biotite andesite (Pl. III, fig. A). It occurs essentially in the vicinity of An-chia-kou where it overlies a layer of agglomerate in which the boulders often show a greenish tint. When fresh, it is pinkish in color and porphyritic in texture. Uuder the microscope, it consists of innumerable small feldspar-laths, either simple or twinned and a residuum of reddish glass, giving a typical andesitic structure. Judging from the extinction angle, the feldspars are largely andesine and labradorite, and when they occur as phenocrysts, they are either zonal or twinned. Biotite, magnetite and greenish augite are both present, the biotite not infrequently altering to magnetite and quartz granules.

The andesite and the hornblende andesite. The former is found on the eastern side of Kou-chia-chuang where it intercalates in the tuff and agglomerate. It is usually very vesicular, strongly porphyritic with exceedingly large tabular feldspar crystals (Pl. III, fig. B) and rarely fine and dense. When fine, the acicular feldspars, interlacing together (Pl. III, fig. C) impart the rock a spotted appearance. The vesicles are filled with calcite and agate (Pl. III, fig. D).

The feldspars are usually lath-shaped, twinned, and more or less parallel in arrangement, indicating the original flow-character. They give an extinction angle of 20°-25° on sections at right angle to (010) and are therefore andesine. When they occur as phenocrysts, they not infrequently enclose the groundmass as inclusions. The groundmass is partly glassy and partly crystalline with feldspathic microlites. The glassy base is generally rich in iron granules, and is, therefore, opaque in transmitted light.

The hornblende andesite at Lei-kung-shan is a greenish dark rock, amygdaloidal with calcite and quartz filling the vesicles. In thin sections, it has a typical trachytic structure, consisting in a parallel arrangement of lath-shaped feldspars recalling the hyalopilitic structure of Rosenbusch. The feldspars possess an extinction angle of 20°-28° on sections at right angles to (010), and, therefore, vary from andesine to labradorite. Mafic minerals are largely hornblende, magnetite and colorless augite, the hornblende being mostly altered to greenish chlorite. The groundmass is partly crystalline partly glassy with abundant granules of magnetite (Pl. IV, fig. A)

As these two andesitic lava sheets intercalate in the tuff and the red clay above the basal agglomerate, it seems very likely that they were comparatively younger than the biotite andesite described above. That a sill which appears very similar to them, especially that of Kou-chia-chuang, has been found intruding into the agglomerate at Yü-tai-shan proves this assumption.

Their associated tuff and agglomerate. Four slides have been prepared from the pebbles collected; one was picked up from the pebbly bed of Yin-chia-chuang. It is of a dark color with phenocrysts of feldspars and hornblende (Pl. IV, fig. B) the latter being completely weathered to chlorite and quartz, and only its original form being preserved by a darkish border. The groundmass is partly glassy, partly crystalline with microlites of feldspar, apatite, magnetite and secondary calcite.

The other two slides were prepared from the pebbles of Yü-tai-shan. One of these is of a reddish color, closely resembling the biotite andesite of An-chia-kou, and the other is similar to the andesite of Kuo-chia-chuang. The fourth was prepared from the pebbles of Yen-tung-shan (煙筒山) and looks very much like its associated andesite.

From the above described characters, it seems very likely that these pebbles were nothing else but fragments resulting from the volcanic explosion and some of them were, therefore, volcanic bombs. As they were compactly set in a fine matrix, they not infrequently appear in the vertical inaccessible cliff.

The trachyte. This is a reddish rock which has a porphyritic structure with phenocrysts of orthoclase and sanidine. Occassionally the latter is strongly corroded, giving the appearance of quartz from which it is distinguished by its a negative optical character (Pl. IV, fig. C). The groundmass consists of microlites of feldspars more or less trachytically arranged and abundant iron granules. When weathered, the latter often imparts to the groundmass a reddish color, and obscures the original texture; and the orthoclase phenocrysts give an earthy surface. It is occassionally rather vesicular, secondary quartz filling the vesicles and when the vesicles increase to a fairly large size ,the drusary quartz crystals are often enclosed by the agate which not infrequently shows beautifully banded colors (Pl. VIII, fig, D).

It is suitable to state here, that the trachyte or better still the feldspar porphyry of Ma-tou-shan, and of the eastern hill of Ting-fang-shui (定方水) are not extrusive lava sheets but intrusive sills (Pl. II, Fig. CC'). However, that they are affiliated with the trachyte is undoubtedly revealed by both their topographical feature as well as their petrographical character. The only difference is that they contain no sanidine, but only orthoclase.

The trachyte of Kalgan is essentially the same as that of Lei-kung-shan, but is often more weathered and porous. Agate is absent in this variety while vesicles filled with quartz are abundant (Pl. IV, fig. D).

The rhyolite of Niang-tze-shan and of other localities and its associated quartz porphyry. As implied by the name quartz porphyry, it possesses phenocrysts of quartz and feldspar, the latter including orthoclase as well as plagioclase. The quartz often shows a resorbed roundish border with inlet of the groundmass (Pl. V, fig. A). The groundmass, being holocrystalline, consists of feldspar and quartz granules. Mafic minerals are hornblende and biotite, which are not infrequently associated with zircon, apatite and magnetite.

It is worthy of notice, here, that the roundish border of the phenocryst quartz is by no means as smooth as most of the common corroded crystals, but is saw-tooth-like in appearance, clearing around itself a zone of groundmass, in which the quartz granules are optically continuous with the phenocrystic quartz. This can be best seen under crossed nicols, and, when properly oriented, it appears in a bright zone as an illuminated border about a dazzling flame.

There are two explanations about this singular feature. First we may suppose that this was effected by mere resorption. In other words, the phenocrysts, quartz, had already crystallized out when the groundmass was still molten. After the magma, including the phenocrysts, intruded into the upper layer, the pressure being relieved, the quartz underwent refusion. As most of the sand grains in sandstone have an optically continuous zone of secondary quartz, the phenocrysts, in question, developed around themselves such a zone of the refused quartz.

However, there is still another explanation. Cross[1] has called attention, in Colorada, to the fact that certain large crystals of orthoclase in dacite porphyries and in granular diorite appeared to have crystallized after the magma of their rocks have been erupted and had come to rest; Pirsson[2] pointed out evidence of the relative late growth of phenocrysts in many porpnyritic rocks; Iddings,[3] in his conclusion of studying the "Dissected Volcanoes" of Crandal Basin, Wyoming, remarked that the phenocrysts of porphyritic rocks were "the result of crystallizatior which has taken place very shortly before the final solidification or crystallization of the whole rock mass, and that they are comparatively rapid growth and are not minerals that have existed within the molten magma for any considerable length of time prior to its solidification" By analogy, we may suppose the phenocryst, quartz, in this case, as formed by a more or less simultaneous crystallization with the groundmass. In this way, the fissure-like quartz surrounding it may be explained as the old passage ways through which the phenocryst quartz derived its constituent from the still liquid magma

The rhyolite of Niang-tze-shan is generally dense in texture and non-porphyritic, except occassionally with phenocrysts of quartz. This is quite different from those at other localities, for instance as Tsuei-ping-an and Tsai-shih near Kalgan, and Sĕ-fang-tai north of the Hsüan-hua city. At the latter localities, it is often porous and porphyritic with phenocrysts of orthoclase and quartz. Under the microscope, the orthoclase is fresh, either carlsbad-twinned or simple, and with observable cleavage. The quartz often shows roundish border and cracks from the margin. The reddish groundmass is wholly glassy, and in it, primary fluxional structure which usually curves around the phenocrystic quartz or feldspars, if present, is noticeable (Pl. V, fig. B, C).

Its associated tuff and agglomerate. The former is usually light brown in color and fairly compact. Phenocrysts are largely broken crystals of orthoclase, quartz, and few magnetite, indicating the trituration during the explosion. The groundmass consists partly of quartz granules and feldspar crystallites and partly of glass.

Most of the boulders in this agglomerate are obsidians. In thin section, the obsidian consists of a glassy base, with marked fluidal structure and occas-

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1. Laccolitic Mountain Groups of Colorado, Utah and Arrizona, Fourteenth Ann. Rept., U.S. Geol. Surv., 1895, p. 229.
2. Eleventh Ann. meeting, Geol. Soc., Am.
3. loc. cit., p.p. 266-268.

sionally including abundant incipient crystals or, better, belonites, arranged in zones, imparting to the groundmass a banded structure. Phenocrysts are mostly orthoclase, sanidine and quartz with accessories of ilmenite, apatite (Pl. V, fig. D; Pl. VI, fig. A).

The olivine basalt of Han-jö-pa. Under the microscope, it is fairly porphyritic with phenocrysts of colorless olivine, magnetite grains and purplish augite. The feldspars are largely twinned labradorite and the groundmass is partly glassy and party crystalline with granules of olivine and augite (Pl. VI, fig. B).

The feldspar porphyry of Pa-pao-shan. It is strongly porphyritic with phenocrysts of feldspar and biotite flakes. Toward the margin, the texture decreases in coarseness, showing the cooling endomorphic action. The feldspars are largely orthoclase weathered into an earthy appearance. The groundmass is generally holocrystalline, with residual quartz and feldspar. Apatite occurs either in the groundmass or as inclusions in the biotite or associated with the magnetite.

It is worth noticing here, that in the marginal facies, the quartz seems to increase, while the biotite decreases; and when this structure is well-developed, it deserves the name of granophyric micro-granite.

The augite syenite of Chao-chia-chuang. It is medium grained, of a light dark color and consists of mafic minerals and feldspars in nearly equal amounts; mafic minerals are mostly prismatic hornblende, greenish augite and magnetite, the former not infrequently altering to chlorite; feldspars are orthoclase with little albite, both being strongly weathered. Fairly large crystals of apatite occur as the accessories which usually crystallized together with the hornblende and magnetite. and occassionally as slender prisms enclosed in the feldspars.

Along the southern bank of the Yang-ho river, near Hsia-hua-yüan (下花園), occurs a syenitic sill in the coal series. Petrographically, it differs very little from the augite syenite just described, except that in this specimen, the accessory mineral apatite becomes less in amount while the augite increases. In another slides, both identifiable hornblende and biotite are present.

At Ta-chian-shan (大尖山) farther northward from Chao-chia-chuang, occurs a dyke of quartz porphyry. Being light colored and porphyritic, it contains only few flakes of leached biotite; quartz and feldspar (including orthoclase and plagioclase) occur as the phenocrysts. the former, namely quartz, showing not infrequently a smooth roundish corroded border, with inlets of the groundmass.

The groundmass is holocrystalline, consisting essentially of quartz and feldspar granules (Pl. VI, fig. C).

On the southern bank, just opposite to Han-lin-chuang (韓林莊) this very porphyritic dyke intruded again into the agglomerate. As it has a decidedly different feature from the quartz porphyry of Niang-tze-shan it may or may not be a differentiated body of the syenite.

The gabbro intusion of Yü-tai-shan. Is a dark-colored rock of medium grain and, when weathered, shows the typical ball-structure. In thin sections, it is more or less porphyritic, the phenocrysts being labradorite with transverse cracks and twinned; not infrequently biotite flakes intrude into them, simulating, the appearance of inclusions. The small feldspars, judging from their extinction angle, are largely andesine. Mafic minerals include biotite, purplish augite and ilmenite, with little residual quartz. The biotite not infrequently alters to chlorite. Ophitic structure, in which augite encloses the feldspars is fairly well-developed (Pl. VI, fig. D).

When it occurs as sills, for example, as at Lei-kung-shan, Ti-shui-yai, Ma-to-shan, Yü-tai-shan, Chi-ming-shan etc., the texture becomes so fine that it deserves the name of augite dolerite (Pl. VII, fig. A). However, the constituent minerals are essentially the same as those in the gabbro and there is no doubt about that they were derived from the latter, namely the gabbro.

At Yü-tai-shan, there was found a dyke about one foot or more thick, in the gabbro. Its texture is fairly coarse with feldspar and biotite as the essential constituents. The interesting feature about this dvke is that some of the feldspars prove to be sanidine with abundant acicular inclusions, probably apatite. Mafic minerals are greenish augite and magnetite (Pl. VII, fig. B). It is highly probable that this minor intrusion was found from the residual magma of the gabbro, and was therefore contemporaneous to it.

The porphyry sill of Yü-tai-shan: About in the middle of Yü-tai-shan, occurs a sill of a light colored rock which consists essentially of orthoclase as the phenocrysts. Biotite occurs in flakes, and occasionally as inclusions in the feldspars. The groundmass is partly glassy and partly crystalline with feldspar granules. According to its mineral constituent, it is a proper feldspar porphyry, and is most probably an off-shoot of the Ta-pao-shan porphyry.

The dolerite or basaltic dyke of Huang-tu-kong (黃土港). On the north-western side of Huang-tu-kong, occurs a dyke in the coal series. It is dark in color and amygdaloidal with calcite filling the amygdules. Under the microscope, lath-shaped feldspars (largely andesine) are more or less parallely arranged in a darkish opaque base, in which minute microlitic feldspar occasionally radially arranged, and greenish chloritic grains probably altered from the biotite are fairly abundant (Pl. VII, fig. C, D).

It was again found at the southern side of Wang-chia-lo and the southern foot of Pa-pao-shan. Here, it keeps its usual petrographical appearance, but, in its mode of occurence, it is a concordant intrusion, namely a sill.

The augite dolerite dyke of Wu-chia-kou. It occurs in the coal field of Wu-chia-kou and is generally of a dark color and strongly porphyritic with phenocrysts of hornblende, feldspar, and augite. The augite is usually fresh and occassionally twinned on (100) plane, while the hornblende is frequently weathered to carbonate. Judging from the extinction angle, measured from the twinning plane, the feldspars are largely labradorite. The groundmaas is partly glassy and partly crystalline with microlites of feldspars and abundant grains of magnetite. (Pl. VIII, fig. A).

The biotite porphyrite of Yin-chia-chuang. It intruded into the agglomerate at the vicinity of Yin-chia-chuang, and usually shows a greenish color. In thin section, most of the biotite have altered to chlorite and the lath-shaped feldspars, giving an extinction angle of 16° on sections perpendicular to (010), are andesine. Besides this, magnetite grains are also abundant.

On the eastern side of Ting-fang-shui, there occurs a sill in the agglomerate. Mineralogically, it contains the same biotite and andesine as that just described, but is more fresh and porphyritic with phenocrysts of feldspars and biotite (Pl. VIII, fig. B).

The olivine ~~porphyrite sill~~ of Kuo-chia-wan (郭家灣). Along the eastern bank of Kuo-chia-wan, there occur two sills in the red clay. Both are of a greyish dark color and contain vesicles filled with agate. Under the microscope, the feldspars are trachytically arranged and have an extinction angle from 20°-28° (measured from the twinning plane). Mafic minerals are magnetite, colorless augite and olivine. The latter, namely olivine, often alters to red iddingsite which is a common product of olivine when exposed to atmosphere (Pl. VIII, fig. C).

From these descriptions, it seems very likely that some of these rocks, described, are undoubtedly affiliated with one another, their different forms being the result of crystallization at different conditions. The augite dolerite of Lei-kung-shan, Ma-tou-shan, Chi-min-shan, etc. are obviously off-shoots of the augite gabbro at Yü-tai-shan. If the syenitic dyke in the gabbro of Yü-tai-shan has, as previously assumed, resulted from the residual magma of the gabbro, there are reasons to believe that the augite syenite of Yü-tai-shan in the coal series, and that occurring near Chao-chia-chuang, are differentiated bodies from the same magma. Moreover, the feldspar porphyry of Pa-pao-shan, Ma-tou-shan, may be a hypabyssal modification of the extrusive trachyte, at Lei-kung-shan and Kalgan, and the rhyolite of Niang-tze-shan, etc. is derived from the quartz porphyry.

CHEMICAL COMPOSITION.

In order to accertain the composition of the rocks above described, the author has effected two chemical analyses of basalt and andesite respectively. A trachyte of the Kalgan region has been analysed by Mr. T. C. Ko of Yenching University. The direct results of the three analyses are given below:—

	Augite basalt Ti-shui-yai (滴水崖) Hsüan-hua	Hornblende andesite Kou-chuan (口泉) Hsüan-hua	Trachyte or Rhyolite Kalgan
SiO_2	45.47	55.03	65.65
Al_2O_3	17.34	19.05	17.44
Fe_2O_3	8.13	8.01	2.11
FeO	5.81	1.37	0.92
MgO	8.34	2.66	
CaO	9.59	6.81	1.31
Na_2O	3.63	3.89	5.70
K_2O	1.53	3.24	5.13
TiO_2	n.d.	n.d.	
P_2O_5	n.d.	0.86	
Moisture			0.74

Their "normal" composition calcalated from the above data is as follow:—

1. The augite basalt.

Standard minerals	Percentage	
Or. (orthoclase)	4.9	32.7
Ab. (albite)	8.8	
An. (Anorthite)	14.7	
Ne. (Nepheline)	4.3	
Di. (Diopside)	9.1	66.4
Ol. (Olivine)	50.9	
Mt. (Magnetite)	6.4	
Total	101.1	

Class, $\frac{Sal}{Fem.} = \frac{32.7}{66.4} = 0.49 =$ IV, dofemic.

Order, $\frac{P+O}{M} = \frac{9.1+50.9}{6.4} = \frac{60}{6.4} = 9.4 = 1$, perpolic.

Section of order, $\frac{P}{O} = \frac{9.1}{50.9} = 0.18 = 4$, domolic.

Section of rangs, $\frac{MgO+FeO}{CaO'} = \frac{209+81}{75} = 3.8 = 2$, domiric.

Subrang, $\frac{MgO}{FeO} = \frac{209}{81} = 2.5 = 1\text{-}2$, premagnesic.

Grad, $\frac{L}{F} = \frac{4.3}{4.9+8.8+14.7} = \frac{4.3}{28.4} = 0.15 = 4\text{-}5\text{-}6$, perfelic.

Subgrad, $\frac{K_2O'+Na_2O'}{CaO'} = \frac{16+58}{96} = 0.77 = 3$, alkali calcic.

2. The hornblende andesite.

Standard minerals	Percentage	
Q. (quartz)	0.5	77.8
Or. (orthoclase)	18.1	
Ab. (albite)	30.3	
An. (anorthite)	24.4	
Di. (diopside)	1.0	21.4
Hy. (hypersthene)	5.9	
Mt. (magnetite)	4.2	
Hm. (Hæmatite)	4.7	
Ap. (Apatite)	5.6	
Total	99.2	

Class, $\frac{Sal}{Fem} = \frac{77.8}{21.4} = 3.6 =$ II, dosalic.

Order, $\frac{Q}{F} = \frac{5}{72.8}$ $0.07 = 5$, perfelic.

Rang, $\frac{K'_2O+Na_2O'}{CaO'} = \frac{95}{92} = 1.03 = 3$, alkali calcic.

Subrang, $\frac{K_2O'}{Na_2O'} = \frac{34}{61} = 0.53 = 4$, dosodic.

3. The trachyte.

Standard minerals	Percentage	
Q. (quartz)	10.41	96.34
Or. (orthoclase)	30.40	
Ab. (albite)	48.90	
An. (anorthite)	6.40	
C. (corundum)	0.23	
Mt. (magnetite)	3.05	
Total	99.39	

Class, $\frac{\text{Sal}}{\text{Fem}} = \frac{96.34}{3.05} = 31.4 = \text{I}$, persalic.

Order, $\frac{\text{Q}}{\text{F}} = \frac{10.40}{85.20}\ 0.12 = 5$, perfelic.

Rang, $\frac{K_2O' + Na_2O'}{CaO'} = \frac{146}{25}\ 5.81 = 2$, domalkalic.

Subrang, $\frac{K_2O'}{Na_2O'} = \frac{54}{92} = 0.59 = 4$, dosodic.

THE GEOLOGICAL AGE OF THE ERUPTIONS

Perhaps there is no division in the Chinese geological succession, the age of which is so disputable as these igneous rocks under discussion. Pumpelly,[1] having noticed some porphyry pebbles in the basal conglomerate at Chai-tang (齋堂), believed the existence of a Pre-Jurassic igneous activity. Dr. Wong,[2] in studying the igneous rocks of Western Hills, concluded that the igneous action prolonged through the whole Jurassic period, beginning with a granitic intrusion. Recently, not very long after Dr. J. G. Andersson[3] correlated the gravel beds north and northwest of Wan-chuan city (萬全城) with the Tiao-chi-shan formation which has been considered by Mr. Yih[4] and Prof. Barbour[5] as Upper Jurassic, Mr. T'an[6] discovered some identifiable Cretaceous fossils underlying his tuff conglomerate in Shantung and revised them as Cretaceous.

1. Loc. cit., p. 19.
2. Loc. cit., pp. 49-51.
3. Loc. cit., p. 101.
4. Loc. cit., pp. 30-31.
5. Loc. cit., p. 165.
6. Loc. cit., pp. 155-156.

The author in his trip, has collected some plant fossils in the basal part of the agglomerate on the southern slope of Yü-tai-shan. Although recent work in other regions tends to show the unreliability of plant remains for accurate correaltion over wide areas, yet some of the plant fossils of this collection are so rich that they can hardly be overlooked, especially as the age of their overlying volcanic formations are still disputable. The following list is a brief summary resulting from a preliminary study made on them with their respective geological range.

1. *Cladophlebis denticulata*, ranging from Rhætic to Wealden; according to Seward, chiefly characteristic of the upper Jurassic.
2. *Macro-tæniopteris c. f. richthofeni;* Jurassic.
3. *Ctenis* sp., from Rhætic to Jurassic.
4. *Neocalamites* sp., from Rhætic to Liassic.
5. Fossil wood. Chiefly characteristic of Upper Jurassic as in the Purbeck beds of England.

From the above table, it seems very likely, to assign to the fossiliferous bed, in question, an upper Jurassic age. Consequently, of these igneous rocks, one part at least, probably the andesite, belongs to upper Jurassic, while the remainder may be Cretaceous. However, as they are more or less continuous in sequence, there are reasons to believe that they were poured out by a prolonged igneous activity opened near the close of the Jurassic period.

Considering the extrusive of this region, it began with outpourings of biotite andesite accompanied by pyroclastic products. Following this volcanic eruption, was a quiescent period, during which the red clay, sandstone, and occassionally andesitic lava flows were deposited.

Then another active period was revived, resulting in the hornblende andesite and trachyte. This was followed, not very long after, by the quartz porphyry and rhyolite of Niang-tze-shan, completing one cycle.

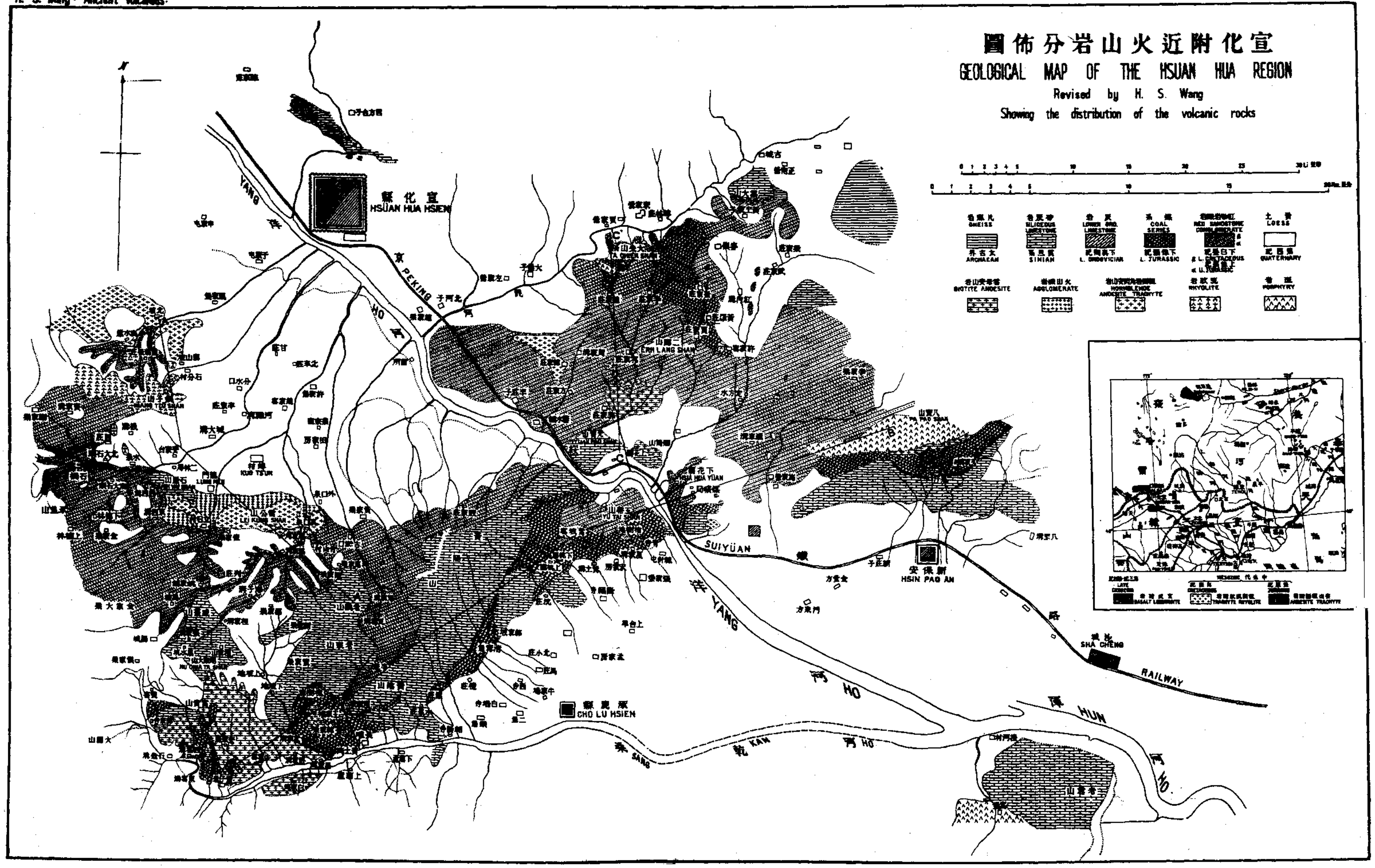
Following the first cycle, came another quiescent period which was recorded by the heavy bed of the Nan-tien-men (南天門) series. Since then, no volcanic activity, so far as is now known, took place, until in the Oligocene, or even later, was erupted the famous heavy flow of the olivine basalt.

Granting the order of events just described, we have now a beautiful example, demonstrating the actual variation of the magma erupted. Within one cycle, it declined in basicity, but increased when the two cycles are taken together.

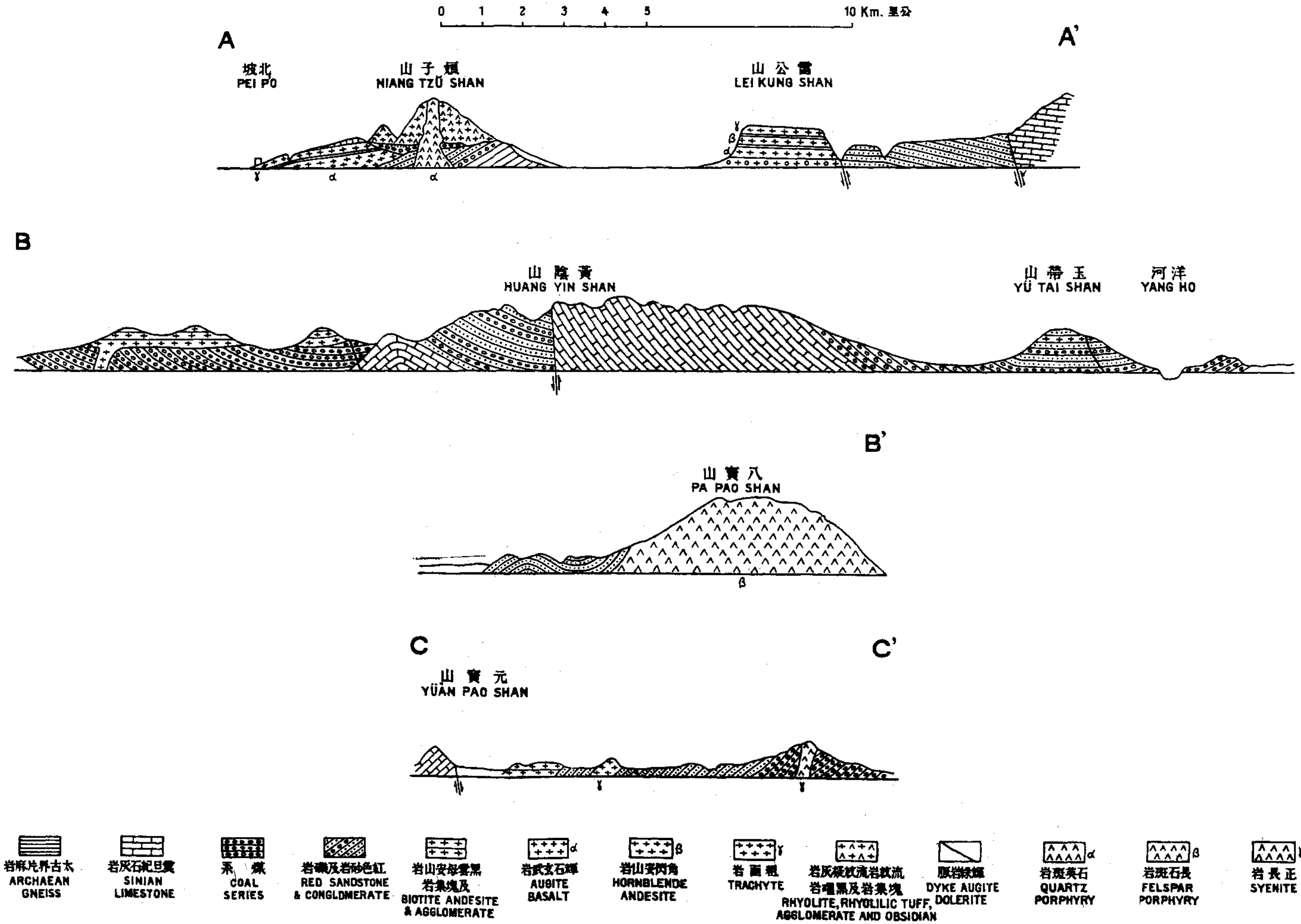
It is remarkable to note that this independent observation is coincident with those of Pantelleria, High-wood, as described by Washington[1] and Pirsson[2] respectively, and the recent research of P. Teilhard[3] in Dalai-noor. The following table is given for comparison of the igneous rocks in this region discussed, with those in Dalai-noor according to Teilhard.

Dalai-noor Region By P. Teilhard.	Hsüan-hua and Kalgan Region By Prof. Barbour in Kalgan and the author in Hsüan-hua.
Basalt	Basalt.
Brèches et conglomérate rhyolitiques	Shan-fang-pu series Nantien men series
Rhyolite fluidal Microgranite et rhyolite non fluidal	Rhyolite and quartz porphyry
Schistes tendres intercale avec des cinders rhyolitiques.	Red sandstone and conglomerate
Coulées d'andésite, lignites et grès. Brèches andesitiques	Trachyte Red clay and conglomerate Hornblende andesite, tuff & agglomerate
Formations andesitiques diverses	Biotite andesite and agglomerate
	Men-tou-kou coal series.

1. The Volcanoes and Rocks of Pantelleria, Journ. Geol., Vol. XXII, 1914, pp. 22-25.
2. Loc. cit. pp. 199-201.
3. Étude Géologique Sur la région du Dalai-noor, Mém., Soc. Géol. de France, N.S., No. 7, 1926, pp. 1-58.


宣化附近火山岩分佈圖
GEOLOGICAL MAP OF THE HSUAN HUA REGION
Revised by H. S. Wang
Showing the distribution of the volcanic rocks
GNEISS
ARCHAEAN
SINIAN
L. ORDOVICIAN
COAL SERIES
L. JURASSIC
LOESS
QUATERNARY
BIOTITE ANDESITE
AGGLOMERATE
HORNBLENDE ANDESITE TRACHYTE
RHYOLITE
PORPHYRY
宣化縣
HSÜAN HUA HSIEN
YANG HO
PEKING
SUIYÜAN
RAILWAY
新保安
HSIN PAO AN
SHA CHENG
涿鹿縣
CHO LU HSIEN
HUN HO
SANG KAN HO

宣化附近火成岩區域剖面圖
Sections of the Volcanic Rocks in the Hsuan Hua Region.



EXPLANATION OF PLATE III.

PLATE III.

Fig. A.— Biotite Andesite, Wu-chia-kou (武家溝).

Minerals: Phenocrysts, labradorite and biotite; groundmass glassy.

Fig. B.— Andesite, Kuo-chia-chuang (郭家莊).

Minerals: Phenocrystic andesine including the groundmass as inclusions; glassy groundmass with microlites of feldspars.

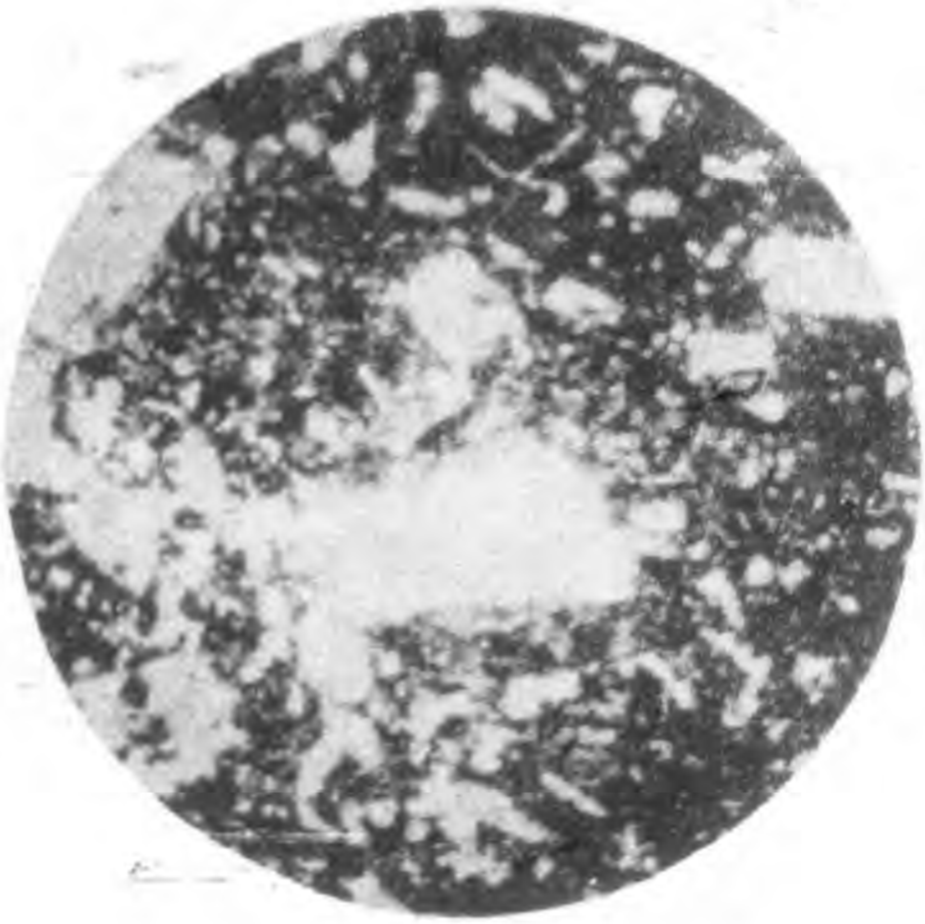
Fig. C.— Andesite, Kuo-chia-chuang (郭家莊)

Minerals: Lath-shaped feldspars interlacing together; groundmass with microlites of feldspars.

Fig. D.— Amygdaloidal Andesite, Kuo-chia-chuang (郭家莊).

Non-porphyritic and vesicular, the vesicles being filled by calcite (light)

Fig. A.

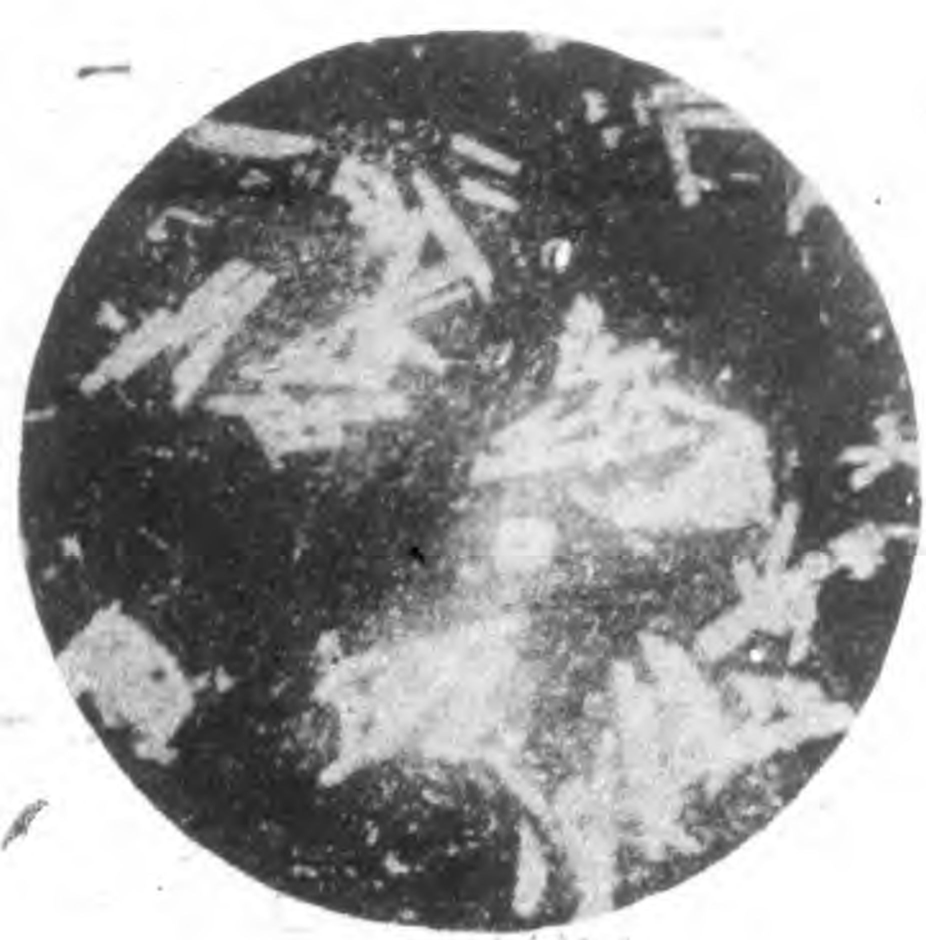


× 16

Fig. B.

× 13,5

Fig. C.



× 13,5

Fig. D.

× 1,35

EXPLANATION OF PLATE IV.

PLATE IV

Fig. A.— Hornblende Andesite, Lei-kung-shan (雷公山).

Minerals: Microlitic feldspars trachytically arranged, as resulted from the flowing movement of the magma; groundmass hypocrystalline.

Fig. B.— Hornblende Andesite, Yin-chia-chuang (殷家莊).

Minerals: Phenocrysts of feldspars and hornblende; the latter often weathered to chlorite and quartz, surrounded by a darkish border.

Fig. C.— Trachyte, Lei-kung-shan (雷公山).

Minerals: Phenocrysts of sanidine more or less corroded.

Fig. D.— Trachyte, Kalgan (張家口).

Minerals: Phenocrysts, orthoclase and sanidine.

Fig. A.

× 13,5

Fig. B.

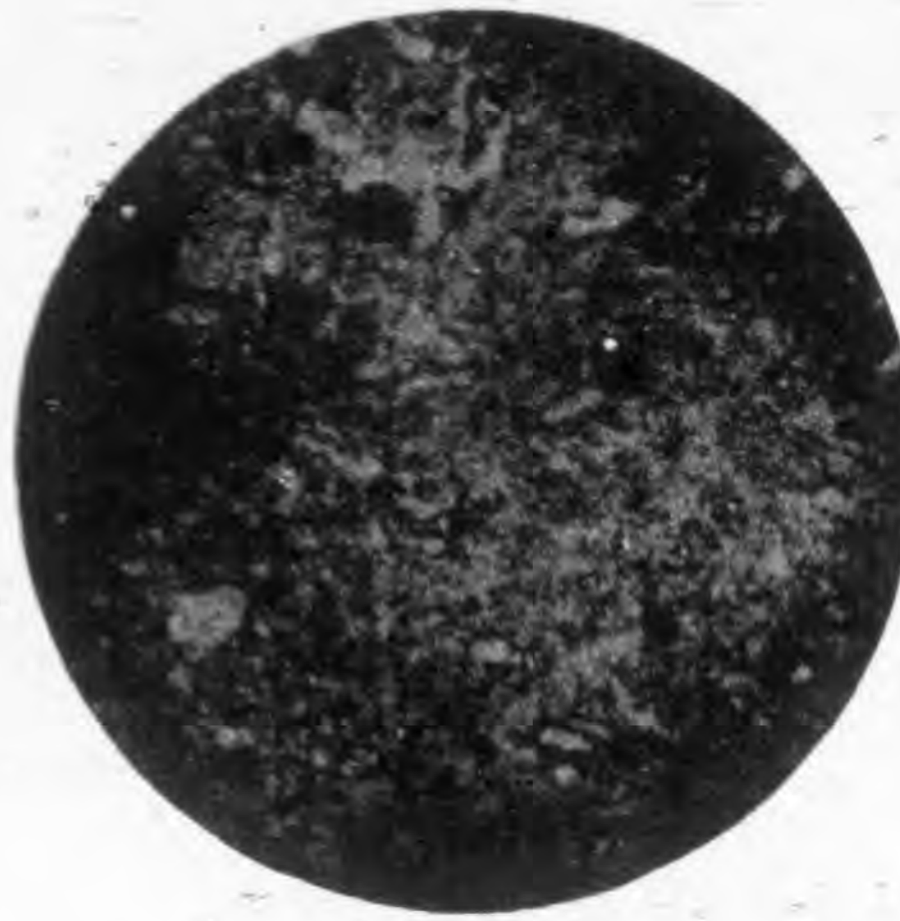


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Fig. C.

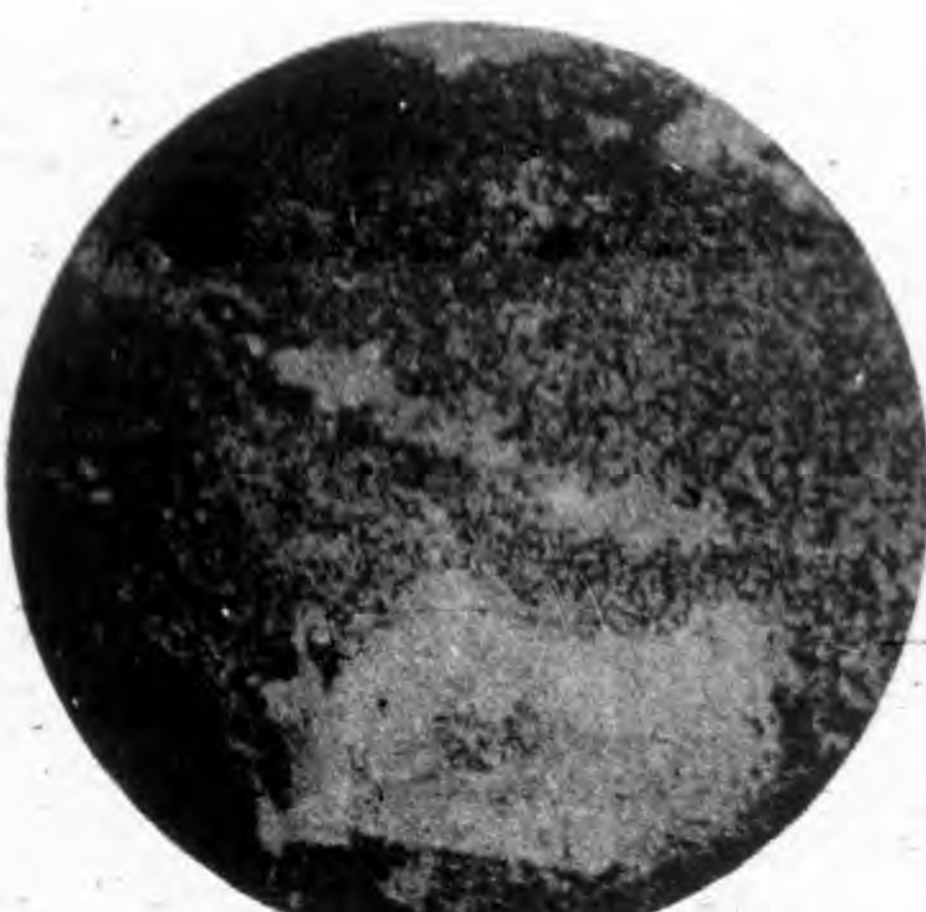

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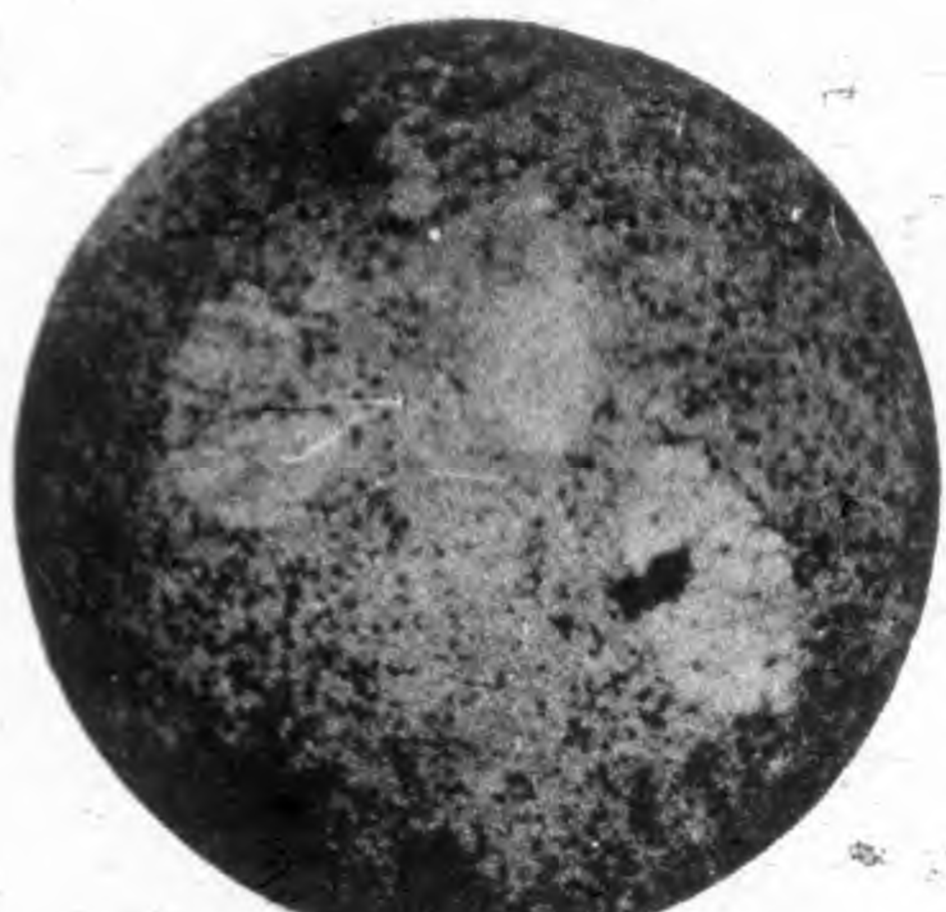
Fig. D.



× 16

EXPLANATION OF PLATE V.

PLATE V.

Fig. A.— Quartz Porphyry, Niang-tze-shan (娘子山).

Minerals: Phenocrystic quartz corroded and cracked, groundmass holocrystalline.

Fig. B.— Rhyolite, Sê-fang-tai (四方台).

Minerals: Phenocrysts of quartz and orthoclase; groundmass largely porous, glassy and fluidal, the fluxional bands curving around the phenocrysts which crystallized out prior to the cessation of the flowing movement of the magma.

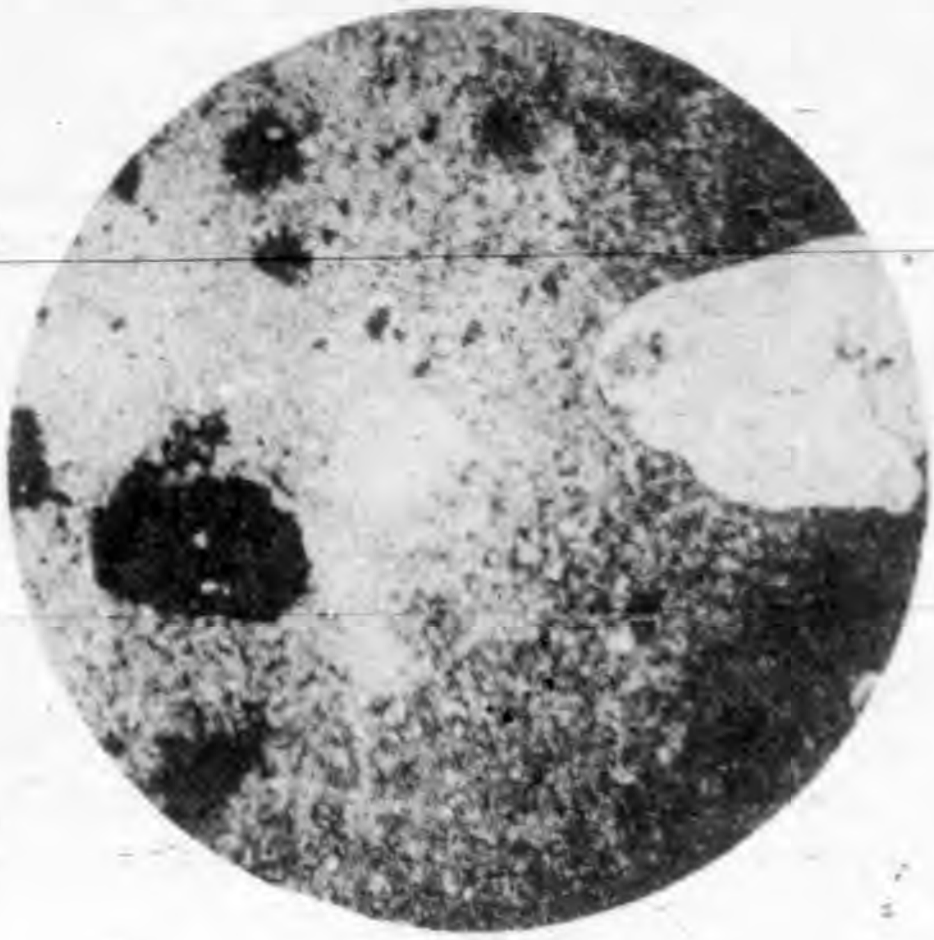
Fig C.— Rhyolite, Yüng-kai-shan (永蓋山).

Minerals: Phenocrystic quartz and xenocrystic fragments; groundmass glassy and fluxional.

Fig. D.— Obsidian (trachytic), T'u-tsing-tze (土井子).

Minerals: Sanidine phenocrysts, around which the fluxional structure of the groundmass undulates; groundmass glassy and perlitically cracked.

Fig. A.

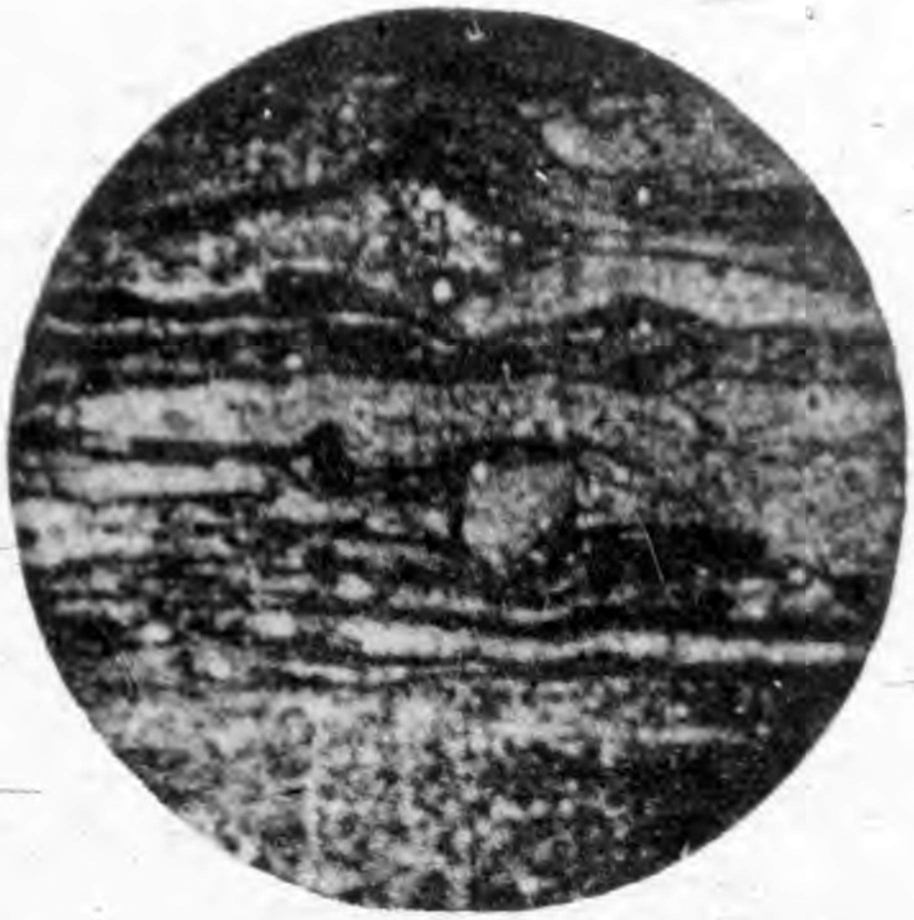


× 16

Fig. B.

× 13,5

Fig. C.



× 13,5

Fig. D.

× 13,5

EXPLANATION OF PLATE VI.

PLATE VI

Fig. A.— Obsidian (rhyolitic), Kalgan (張家口).

Minerals: Phenocrystic quartz and sanidine; groundmass fluidal.

Fig. B.— Olivine Basalt, Han-jo-pa (漢諾壩).

Minerals: Microlitic feldspars, olivine and augite; glassy groundmass.

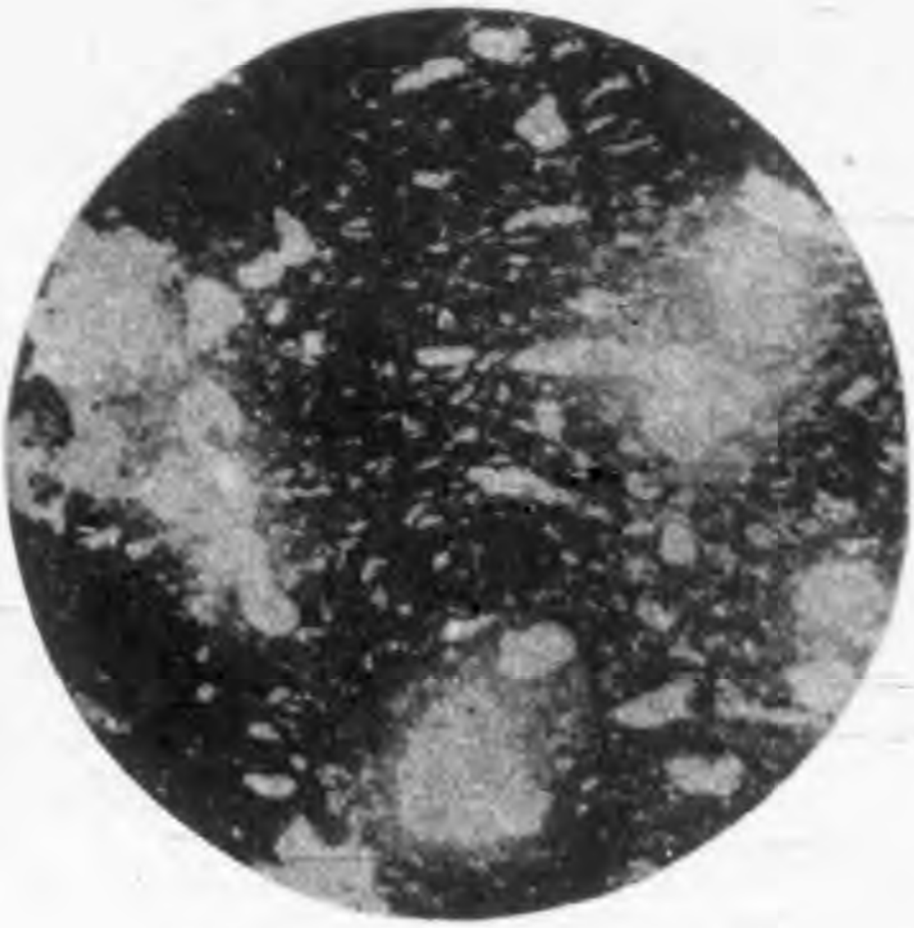
Fig. C.— Quartz Porphyry, Ta-tsian-shan (大尖山).

Minerals: Corroded quartz engulfed by the groundmass; groundmass holocrystalline.

Fig. D.— Augite gabbro, Yü-tai-shan (玉帶山).

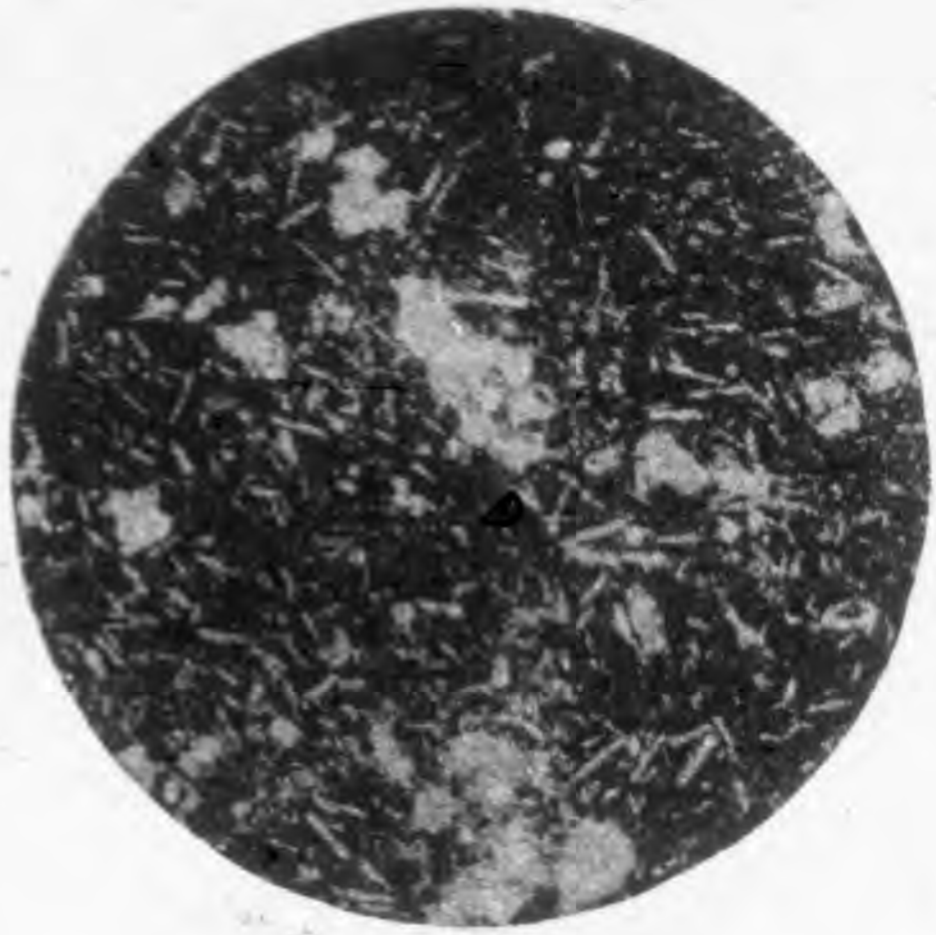
Minerals: Feldspars (labradorite) with abundant inclusions; mafic minerals being augite and biotite.

Fig. A.



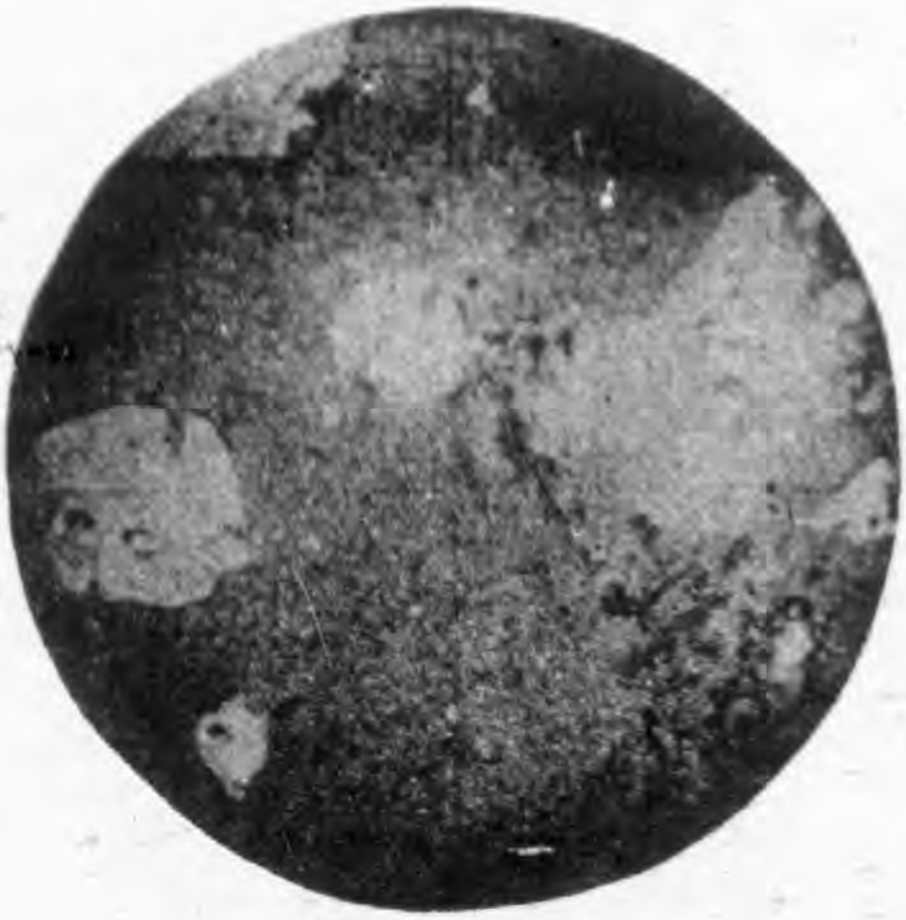
× 13,5

Fig. B.



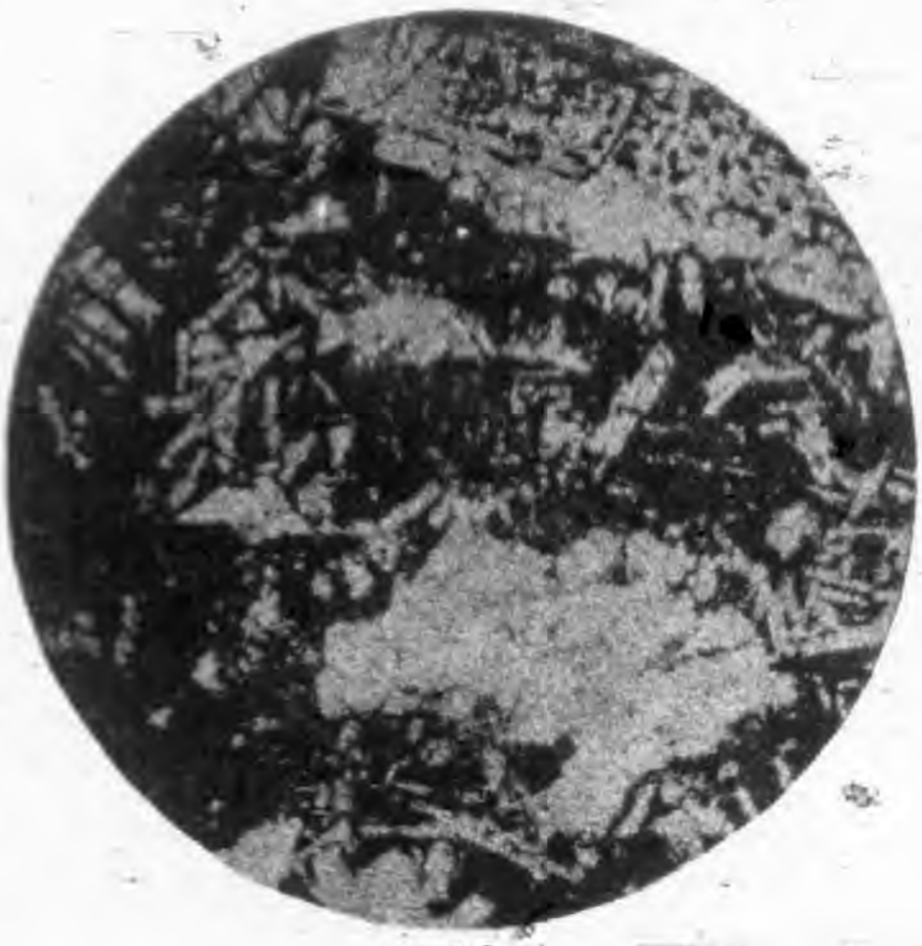
× 13,5

Fig. C.



× 13.5

Fig. D.



× 13,5

EXPLANATION OF PLATE VII.

PLATES VII

Fig. A.— Augite Dolerite, Li-k'ou-chuan (裡口泉).

Minerals: Microlitic feldspars (light) and augite (faint dark); the augite frequently encloses the feldspars, giving an ophitic structure; black, ilmenite.

Fig. B.— Syenite, Yü-tai-shan (玉帶山).

Minerals: Sanidine, orthoclase, biotite and augite.

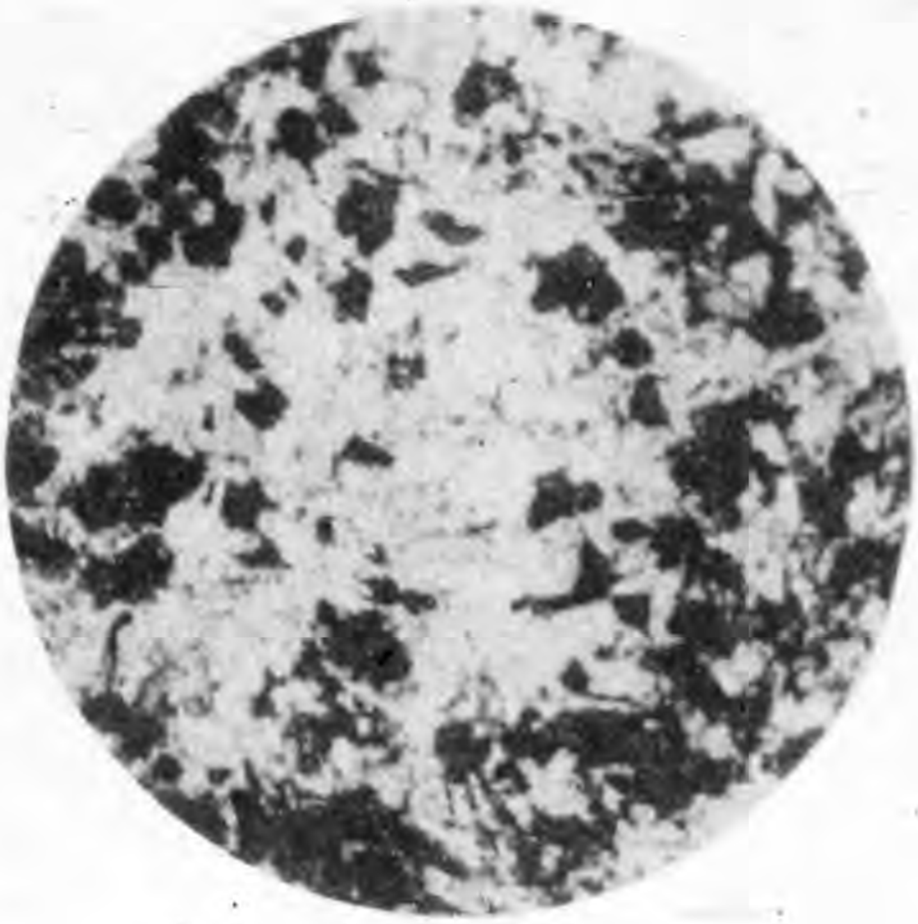
Fig. C.— Basalt, Huang-tu-kong (黃土港).

Minerals: Parallelly arranged, lath-shaped feldspars and radially arranged feldspar microlites, the former crystallized out before the cessation of the flowing movement of the magma.

Fig. D.— Basalt, Wu-chia-kou (武家溝).

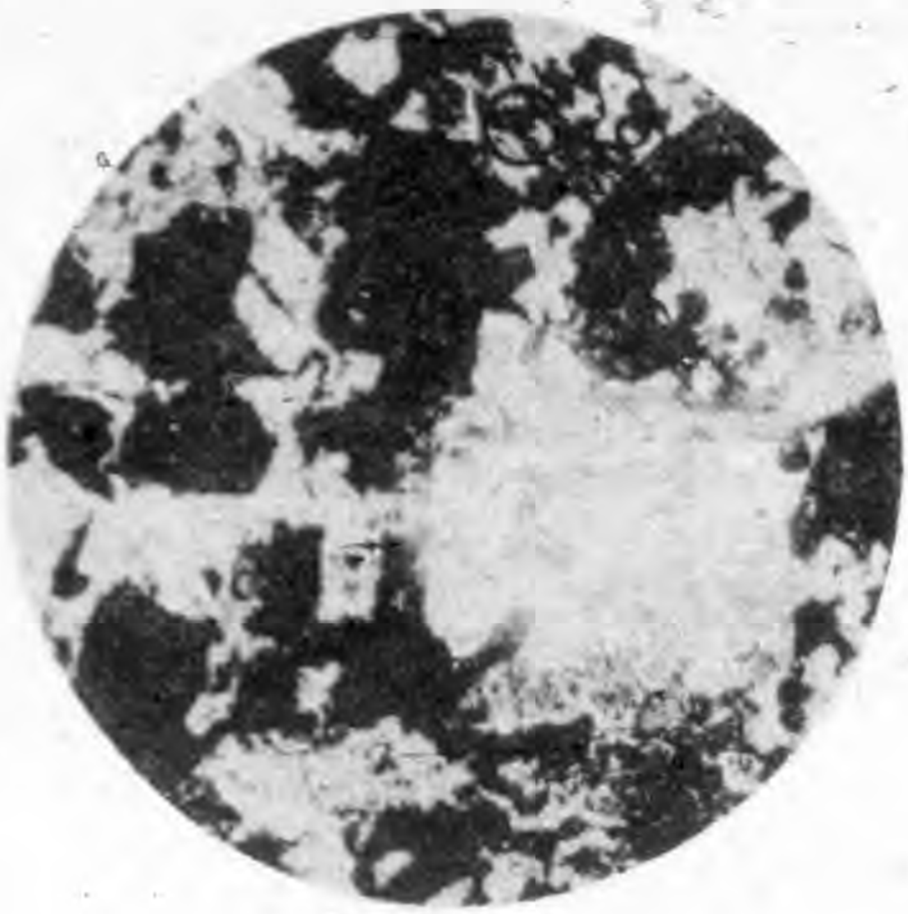
Minerals: Lath-shaped feldspars parallelly arranged; augite (faint light) and glassy base.

Fig. A.



× 16

Fig. B.



× 13,5

Fig. C.

× 13,5

Fig. D.

× 13,5

EXPLANATION OF PLATE VIII.

PLATE VIII

Fig. A.— Augite Dolerite, Wu-chia-kou (武家溝).

Minerals: Phenocrysts, feldspar and augite; groundmass cryptocrystalline with magnetite grains.

Fig. B.— Biotite Porphyrite, Ting-fang-shui (定方水).

Minerals: Phenocrysts of plagioclase (light) and biotite (dark).

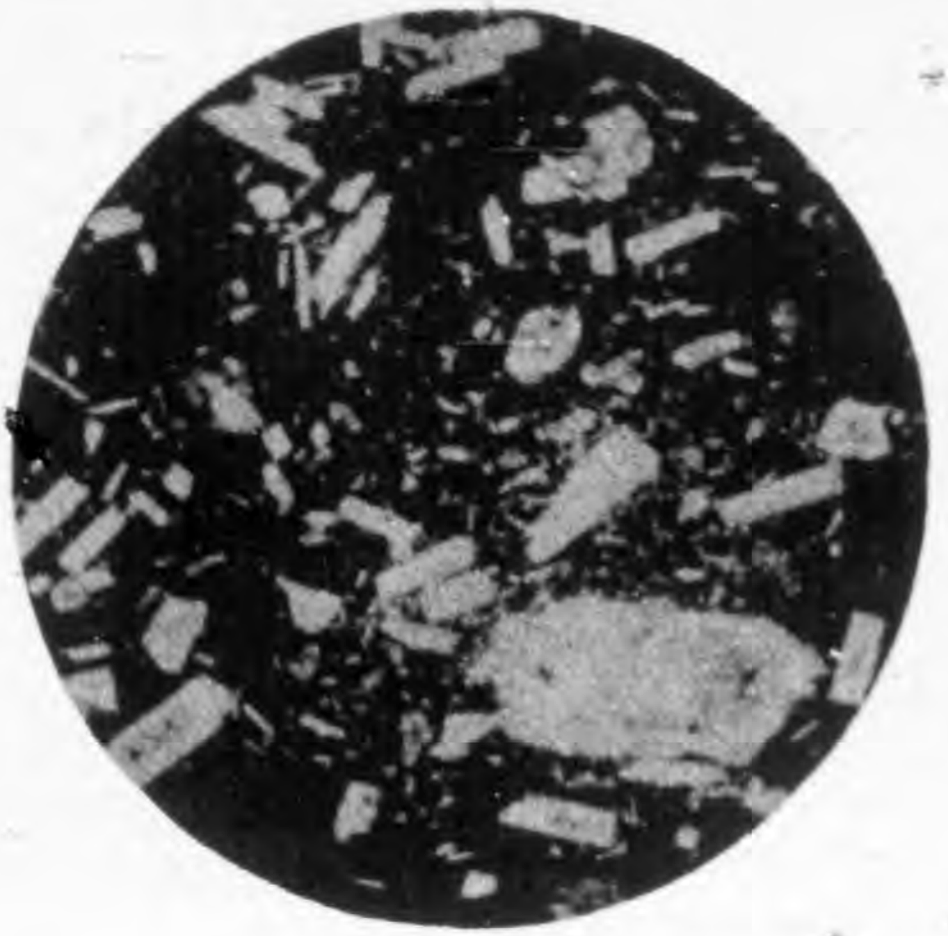
Fig. C.— Olivine Porphyrite, Kuo-chia-wan (郭家灣).

Minerals: Lath-shaped feldspars trachytically arranged; colorless augite and olivine.

Fig. D.— Agate, Wa-tsian-ho-chuang (窪前後莊).

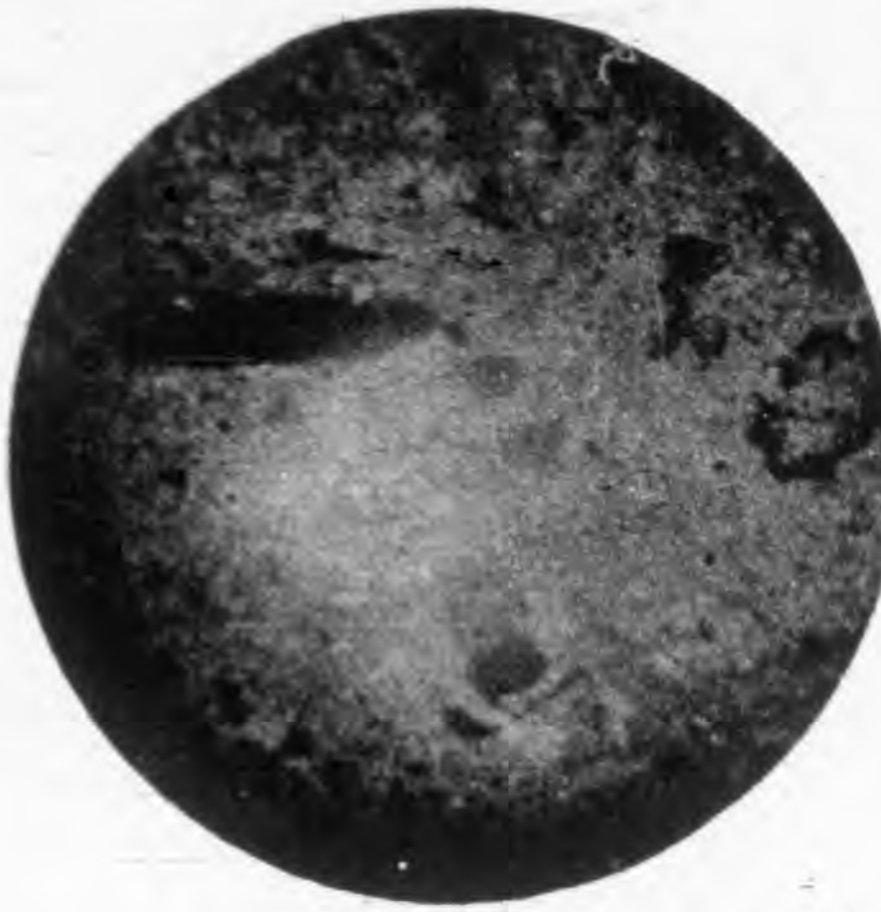
Allotriomorphic and fibrous quartz (Nicols crossed).

Fig. A.



× 16

Fig. B.

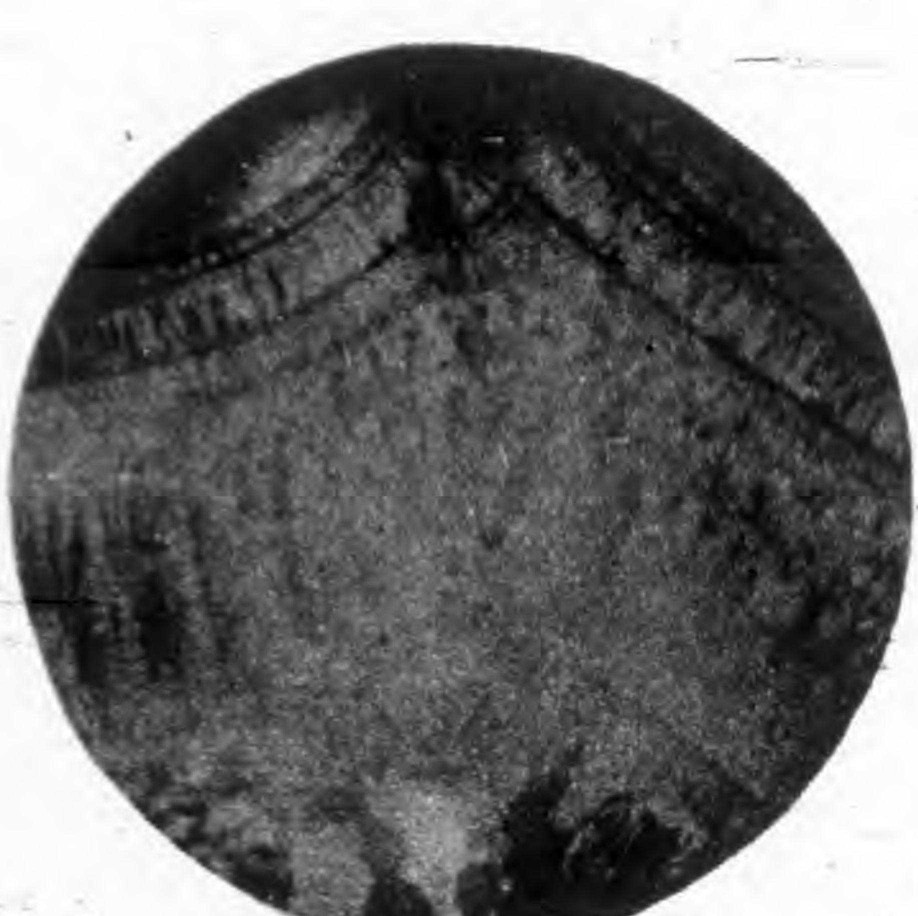


× 13,5

Fig. C.

× 16

Fig. D.



× 13,5