經濟部中央地質調查所

# 地質專報

甲種第二十一號

## 新疆油田地質調查報告

（附圖版十四）

黃汲清　楊鍾健　程裕淇
周宗浚　卞美年　翁文波

中華民國三十六年二月
南京本所出版
（北平友聯中西印字館承印）

# GEOLOGICAL MEMOIRS

(Being the continuation of the Memoirs of the Geological Survey to be quoted as *Mem. Geol. Surv. China*)

SERIES A NUMBER 21

# REPORT ON GEOLOGICAL INVESTIGATION OF SOME OIL-FIELDS IN SINKIANG

(WITH 14 PLATES)

By

T. K. Huang, C. C. Young, Y. C. Cheng, T. C. Chow, M. N. Bien, and W. P. Weng

Published by

THE NATIONAL GEOLOGICAL SURVEY OF CHINA

under the Ministry of Economic Affairs

NANKING, FEBRUARY 1947

# REPORT ON GEOLOGICAL INVESTIGATION OF SOME OIL-FIELDS IN SINKIANG

With 14 Plates


Being partial report on scientific results of a field party consisting of:

T. K. Huang, Chief Geologist of the Geological Survey of China and Leader of the party

C. C. Young, Chief Paleontologist, Laboratory of Vertebrate Paleontology, Geological Survey of China

Y. C. Cheng, Chief Petrographer, Laboratory of Mineralogy and Petrography, Geological Survey of China

T. C. Chow, Topographer, Geological Survey of China

M. N. Bien, Geologist, Kansu Petroleum Administration

W. P. Weng, Geophysicist, Kansu Petroleum Administration



**Under the auspices of**

**the**

**NATIONAL RESOURCES COMMISSION**

October 1943

## CONTENTS

# REPORT ON GEOLOGICAL INVESTIGATION OF SOME OIL-FIELDS IN SINKIANG*

With 14 Plates

## (I) INTRODUCTION

*Aim of investigation.* The aim of our geological work in Sinkiang, as decided by Dr. W. H. Wong[1], Minister of Economic Affairs and concurrently Chairman of the National Resources Commission, was to make a more or less detailed study of the Tushantzu oil-field, Wusu[2], in the Northern Piedmont Belt of the Tienshan Mts., and to carry out a reconnaissance survey in the Southern Piedmont Belt of the same mountain system especially near Kucha[3] where oil is being "mined" with native methods, in order to locate one or more fields capable of being exploited on an industrial scale. Since coal, clay, limestone, etc. are also necessary for the establishment of an oil industry in a remote province of the country like Sinkiang, we investigated these deposits whenever they are or might be located in the neighbourhood of the possible oil-fields under consideration. Moreover, in accordance with a request of General Sheng Shih-Tsai[4], Chairman of the Provincial Government of Sinkiang (popularly known as Sheng Tupan), we investigated mineral deposits like copper, iron, gypsum and others, when these occur near the oil-fields. The present report deals with oil-fields and oil geology in general whereas mineral deposits other than oil are described in a separate report written in Chinese.

*Organization of field party.* The members of the field party were appointed by Dr. W. H. Wong and consist of:

T. K. Huang[5], Chief Geologist, Geological Survey of China,

---

* This report is written by T. K. Huang in September 1943.

1. 經濟部部長資源委員會主任委員翁文灝先生 2. 烏蘇獨山子油田 3. 庫車 4. 新疆邊防督辦兼主席盛世才將軍 5. 黃汲清

C. C. Young[1], Chief Paleontologist, Laboratory of Vertebrate Paleontology, Geological Survey of China,

Y. C. Cheng[2], Chief Petrographer, Laboratory of Mineralogy and Petrography, Geological Survey of China,

T. C. Chow[3], Topographer, Geological survey of China,

M. N. Bien[4], Geologist, Kansu Oil Administration (formerly Geologist, Geological Survey of China),

W. P. Weng[5], Geophysicist, Kansu Oil Administration.

T. K. Huang was chosen as leader of the party. It can be seen from this list that the six members cover a wide field of knowledge, and a field party like such, if well-prepared, well-equipped and well-organized, would be qualified to carry out a good deal of important geological exploration in Central Asia.

*Important events during our geological investigation.* Four members of the party (Huang, Young, Cheng, Chow) left Pehpei[6] in a great hurry on Oct. 29, 1942, and flew from Chengtu to Tihua (Urumchi)[7] in which city they arrived on Nov. 13. Bien and Weng were already in Tihua, having arrived one week earlier. After necessary preparations and arrangements with the Provincial Government, the whole party, together with a party of 5 engineers[8], left Tihua on Nov. 28 and arrived at Tushantzu in the evening. Owing to repeated conferences and friendly talks with Soviet engineers and geologists in charge of the Tushantzu Oil Refinery[9], we did not start actual field work until Dec. 3 after which date snow fell several times and toward the end of December snow was knee-deep on the hill slopes and the out-door temperature at noon was around $-14°$ C. It can easily be imagined that under such conditions topographic surveying and even fossil-collecting work were almost impossible. But since the work was to be done we somehow

1. 楊鍾健 2. 程裕淇 3. 周宗浚 4. 卞美年 5. 翁文波 6. 北碚 7. 迪化(烏魯木齊)
8. The "Mission to Tushantzu" was composed of two parties: one party of geologists and another one of engineers of which Kuo Ko-Chuan (郭可詮) was the leader, Chin Hsi-Ken (靳錫庚), Lung Hsien-Lieh (龍顯烈), Hsu Hung-Pin (許鴻賓) and Na Jen-Chien (那伋千) being members.
9. During these conferences we asked the Soviet authorities to supply us with geological and drilling records kept by the Tushantzu Oil Refinery (獨山子煉油廠). They at first promised to do this but later flatly refused.

contrived to finish our field work on Dec. 31, and returned to Tihua on Jan. 18[1]. Since the Chinese New Year was approaching, it was clear that we should not start field work in South Sinkiang until the New Year was over. After fully three weeks' stay in the provincial capital, we left for South Sinkiang on Feb. 11 and arrived at Kucha on Feb. 16. The party then consisted of Huang, Young, Cheng and Chow, Bien and Weng having being ordered to go back to Kansu. For more than 2 weeks we were fully occupied with geological mapping in the Kan[2] area, north of Kucha, while one week was spent in route reconnaissance between Kan and Qaraqoul[3], a hamlet situated at the foot of the high Tienshan ranges. Having completed our field work in the Kucha area on Mar. 24, it appeared clear that the nature of the Kan oil-field is not at all encouraging and further exploration in the Southern Piedmont Belt seemed necessary. Consequently we started for Aqsu[4] on Mar. 28 and found ourselves again busy with detailed surveying work in the Taqlaq[5] area, north of Wensu[6], where oil seepages have been known for a long time. Two weeks' hard work completed the survey and on Apr. 23, we left Aqsu for Tihua. We did not go further west to Kashgar[7] and Yarkand[8] though we know well that oil seepages occur in these districts; geological explorations in regions near the Pamirs and the Kuenlun[9], to be certainly interesting, would require at least 6 months of field work, and for this we were not prepared and moreover the party was not so organized. Consequently we considered our mission as completed and flew back home on May 10.

It may be of interest to make some simple calculations on the efficiency of our field work, as follows:

| | |
|---|---|
| Days away from the Geological Survey (Oct. 29—May 13) ..... | 197 |
| Days spent in Tihua. ..... | 43 |
| Days spent in travelling ..... | 42 |
| Days out for field work ..... | 112 |
| Days for taking rest and for office work ..... (during field work) | 41 |

1. Days in January were extremely cold and we spent most of these cold days indoors in plotting a mining claim map and in drawing up a short report thereon.
2. 綢嚴 3. 喀拉庫爾 4. 阿克蘇 5. 塔克拉克 6. 溫宿 7. 喀什 8. 莎車 9. 帕米爾及崑崙山

Days for actual field work ..... 71
Field work efficiency[1] ..... 36%

*Method of Work*. Our method of work was a rather special one, one which cannot be generally adopted for explorations in Central Asia. Usually, geologists making reconnaissances in Sinkiang like to have a big caravan, with many camels and donkeys loaded with all sorts of provisions. Such kind of arrangement is, in many respects, a convenience, but in some respects it is a hindrance too. Since our time available was very short, we did not contemplate the organization of caravans but used motor trucks for all major transportations. Thanks to Sheng Tupan, motor trucks were put at our disposal not only in the Northern Piedmont Belt but also in South Sinkiang, and one will be surprised to know that many of the foot-hill regions of both the Northern and Southern Piedmont Belt of the Tienshan are carrossable and in some cases loaded trucks can go as high as 2200 m above sea-level. Moreover, since we did not go far into the Tienshan proper, we did not use yurts, nor even tents (tents were used only once near Aqsu). Experience shows us that most efficient field work, not only in reconnaissance but also in detailed mapping, can be done by the combined application of motor trucks and horses. Horse-riding is a great advantage both in flat countries and hilly regions; in the Taqlaq area horse-riding enabled us to complete a detailed map (Plate XIII) in 12 days which would require a full month otherwise. For future geological reconnaissance work in the Tienshan-foot-hills, therefore, we highly recommend a combination of horses and motor trucks[2].

For more detailed surveying work we used one theodolite of Zeiss-2 model and another one of Soviet make. Chow used to plot rod-readings by theodolite at home whereas Huang preferred the American telescopic alidade and the plane-table, which enabled him to complete the map of Taqlaq (Plate XIII). Other instruments included one Lufft aneroid barometer and Brunton compasses. Weng did some magnetic surveying with a small magnetometer of his own design (using Breithaupt compass), and his results will be reported separately.

---

1. The ratio, days for actual field work divided by days away from the Survey, expressed in percentage, is field work efficiency.

2. Ford motor trucks are good; Dodge trucks are much better; Soviet trucks are of less value whereas Soviet tires are usually the cause of trouble. Good horses can be had from the local Police and usually the horses of the Uigur villagers are not bad.

Division and co-operation of work were not always easy among members of the party, especially when their scientific interest is widely different and when each member might have practised a different routine and field method. It is thus clear, the task of the leader must have been a very hard one. Usually, when coming to a new region, all members of the party reconnoitered together for a couple of days, then division of work began: Chow took charge of topographic surveying and became instrument man, with Cheng, Bien or (and) Huang acting as rodmen or helping him in calculations[1]; Huang with Cheng or Bien started to study the stratigraphy in detail and at the same time noting down structural peculiarities; Young went out alone or with Bien to collect fossils whereas Weng rode away for his self-planned reconnaissance. At occasions side trips were taken, for example, from Tushantzu to Chersum and from Tushantzu to Anchihai, when only some of the party took part, others remaining at headquarters. In the Kucha area side reconnaissances were made by Huang, together with Young and Cheng, while Chow remained at Kan for topographic surveying.

*Acknowledgments.* To us Chinese geologists, Sinkiang is a new country and it was the first time that the Central Government dispatched geologists to carry out explorations in the largest province of China. It can thus be seen that the accomplishment of our task was not easy and was only possible through the wise and careful direction and supervision of Dr. W. H. Wong. General Sheng Shih-Tsai realized perfectly well the aim of our work, received us with great courtesy and favoured us, at all times and in all ways, with very valuable assistance. We take this occasion to tender our cordial thanks to Minister Wong and Sheng Tupan. Mr. C. C. Chien[2], Vice-Chairman of the National Resources Commission, taking great interest in our work, frequently gave us valuable instructions. General Mao Pang-Chu[3], Commander of the Chinese Air Force, Mr. Sun Yueh-Chih[4], General Manager of the Kansu Petroleum Administration and Mr. Hsieh Shu-Ying[5], Director of Szechuan and Sikang Copper Administration, rendered valuable help in transportation and other facilities. Director Li[6], Director Peng[7], Director Sheng[8], General Wang[9], Chief of Staff, and General Sung[10], Chief of

1. In the Taqlaq area, Chow first laid out a traverse with theodolite while Huang did the topographic surveying with Cheng helping him in a number of days.

2. 資源委員會錢副主任委員 3. 空軍總指揮毛邦初將軍 4. 甘肅油礦局總經理孫越崎 5. 川康銅業管理處長謝樹英 6. 建設廳李廳長 7. 財政廳彭廳長 8. 新疆運輸局盛局長 9. 汪參謀長 10. 宋副官長

Lieutenants, of the Provincial Government of Sinkiang, supplied us with all kinds of valuable information and helped us in many ways. Director Wen[1] and Police Chief Wang[2] of Tushantzu Oil Refinery, Governor Liu[3] and Police Chief Meng[4] of Aqsu, Magistrate Wang[5] of Wensu, Magistrate Han[6] and Police Chief Chang[7] of Kucha and many other local authorities in Sinkiang were our hosts and honoured us with greatest courtesy during our stay in the respective districts. To all these gentlemen our cordial thanks are due. We also like to express our deep gratitude to Dr. C. Y. Lee[8], Director of the Geological Survey of China, who, from the beginning, showed great sympathy in our work and, during the drawing up of the reports, rendered every kind of facility. It is also fitting at this place to express our indebtedness to the draftsmen, typists and librarians of the Survey, whose valuable service made it possible to complete the present report within such a short time. Finally, we have pleasure to mention our high admiration for Mr. Kuo Ko-Chuan, leader of the engineers' party, and his associates, with whom we co-operated so well during those unforgettable hours at Tushantzu; and for our Chinese, Uigur, and naturalized Russian assistants and servants, without whose service the accomplishment of our task could hardly have been possible.

## (II) GENERAL APERCU OF THE GEOLOGY OF SINKIANG

*Natural Geographic Divisions.* The province of Sinkiang comprises three mighty mountain systems and two great inland basins, which, named in the order from south to north, are:

The Kuenlun System, generally 4000 m above sea-level
The Tarim Basin, around 1000 m above sea-level
The Tienshan System, generally 2000 m above sea-level
The Basin of Dzungaria, below 1000 m and above 200 m above sea-level
The Altai System, generally 1000-2000 m above sea-level

The Kuenlun is the highest mountain system of Sinkiang and is among the highest in the world. It is a latitudinal system, with a distinct curvature convex toward the south, *i.e.*, toward the Tibetan plateau. Toward the northwest it merges into a bundle of mountain ranges, popularly known as the Pamirs, or, the

1. 獨山子煉油廠文廠長 2. 警察局王局長 3. 阿克蘇劉行政長 4. 警察局孟局長 5. 溫宿縣王縣長 6. 庫車縣韓縣長 7. 警察局張局長 8. 中央地質調查所李所長

"roof of the world". North of the Pamirs is the Tienshan, which, like the Kuenlun, is latitudinal and is the most important system of Sinkiang. It divides the province into two unequal parts: the southern, bigger part is the Tarim Basin, or, as the Chinese call it, Tienshan Nanlu[1]; the northern, smaller part is the Basin of Dzungaria, or, Tienshan Peilu[2]. The Tienshan, quite unlike the Kuenlun, consists of a complicated virgation of parallel and subparallel chains, extending from the Qarliq-tagh, east of Hami, to beyond the Sino-Soviet frontier, disappearing in the Turanian lowland. Intermontane basins and depressions are numerous (Plate II), the most significant ones are: the Basin of Fergana, the Narin Basin, the Depression of Issiq Kol, the Ili Basin[3], the Depression of Bagrash Kol[4], the Depression of Turfan[5]. The last-named lies to the south of the Bogdo Ula[6] and is both the lowest and one of the hottest places of China.

The Tarim Basin, forming the "heart of Central Asia", is a unique geographic province. Being surrounded on all sides by high ranges except in the east, the Basin receives practically no rainfall at all and became, since time immemorial, a true desert. Its drainage is radial and a typically inland one. Rivers taking their sources from the snow-fields and glaciers in the Kuenlun and Tienshan, run down the mountain slopes and largely disappear in piedmont gravel beds. Only a few of them are able to cross the "gobis" and drifting sands: these are the Khotan Darya[7], the Yarkand Darya[9] from the Kuenlun, the Aqsu[9], the Muzart[10], the Konche[11] from the Tienshan. All these rivers, except the Konche, become confluent in the lower regions of the Basin, which lie nearer to the Tienshan, to form the famous Tarim[12].

The Basin of Dzungaria, being situated north of the barrier range of Tienshan, receives more rainfall and is largely a steppe rather than desert; this explains the dominance of this part of the country by Qasaq (Kasak) and Mongolian nomadic tribes. From the Kirgiz Steppes the Basin is separated by a group of hills, termed by Obrutschew "Grenz-Dsungarei" of which the Tarbagatai[13] forms the main range whereas the Altai Mountains, running NW-SE, serve as the natural boundary between Dzungaria and Outer Mongolia. North of the Basin of Dzun-

1. 天山南路 2. 天山北路 3. 伊犁盆地 4. 博斯騰泊窪地 5. 吐魯番窪地 6. 博格多山
7. 和闐河 8. 葉爾羌河 9. 阿克蘇河 10. 穆素爾河(下游爲渭干河) 11. 孔雀河 12. 塔里木河 13. 塔爾巴哈台山

garia and south of the Altai lies the basin of Tulta (Chenghuassu)[1] which belongs to the drainage system of the Irtysh[2].

Human activity in the Tarim Basin is mainly agricultural, but owing to lack of rainfall cultivation is more or less confined to belts of oases along the foothills of the Tienshan and the Kuenlun. The population is Uigur. In the steppes of Dzungaria a nomadic life is led by Mongols and Qasaqs, but a narrow zone of cultivation occupied by Chinese, Tungans and Uigurs, is found along the northern foot of the Tienshan. Within the Tienshan system itself, two prosperous centres of cultivation are found in the Ili Basin and in the Depression of Turfan.

*General Tectonic History.* The most important tectonic element of Sinkiang is undoubtedly the Tarim mass or Serindia, which since Pre-Cambrian times has been consolidated and became inert during successive cycles of orogenesis. During the greater part of Paleozoic times the Tienshan geosyncline lay to the north of Serindia whereas to its south was the Kuenlun geosyncline. These two major geosynclines were connected toward the west in the region of the present Pamirs; in the east they were, at intervals, possibly also confluent in western Kansu. Marine deposition went on *pari passu* in these geosynclines with continental and delta sediments along and near the shore-line of Serindia, which then appeared as a huge island supplying clastic sediments to the bordering geosynclines. The Variscan revolution folded these geosynclinal deposits into mountains while the sea entirely withdrew toward the west near the end of Paleozoic, only to return to Kashgaria and the western Kuenlun in Eocene times. It can thus be seen that, the Tarim Basin, though differing somewhat in nature and extent from the present one, already existed early in Mesozoic times, being flanked by high mountains of the Paleo-Kuenlun and Paleo-Tienshan.

The Tienshan is a major tectonic element. It is undoubtedly a Variscan mountain but its present form is the outcome of Tertiary orogenesis. In Triassic and Jurassic times the high Paleo-Tienshan was gradually worn down and became, perhaps in Cretaceous times, a peneplain. Toward the end of Cretaceous and in Tertiary times, these worn-down mountains were rejuvenated through the Alpine cycle of orogenesis which continued into the early Quaternary. Thus, in the sense of Stille, the Paleo-Tienshan is an Alpino-type mountain whereas the modern

1. 承化寺現名阿山 2. 額爾濟斯河

Tienshan,, though refolded during the Alpine cycle, is a mountain of Germano-type; or, as Argand [1]* puts it, the Paleo-Tienshan belongs to the "plis geo-synclinaux" and the modern Tienshan to the "plis de fond". Alpino-type of folds, however, occur in the Mesozoic and Tertiary formations in the Northern and Southern Piedmont Belts to be dealt with more in detail later on. It is significant to note that similar tectonic history is recorded in the Kuenlun.

The nature of the Basin of Dzungaria, being less explored, is not clear. From purely geotectonic considerations we suggest that the Basin of Dzungaria, similar to Serindia, is formed of a consolidated mass of Pre-Cambrian or at least Pre-Caledonian rocks. Thus the relation of Dzungaria to the Tienshan can be parallelled with the relation of the Tarim Basin to the same mountain system. It is probable, however, that Tertiary and perhaps also Mesozoic (including the Jurassic) formations extend from the Tienshan to the Altai and Tarbagatai, across the entire Basin in flat-lying or gently folded belts, and in this respect the Basin will be of great significance to petroleum geology.

*Outline of the Structure of the Tienshan.* The Tienshan, as our map shows (Plate II), consists of bundles of high ranges formed of metamorphic and sub-metamorphic Paleozoic rocks and granitic intrusions with intermontane basins and depressions filled with Mesozoic and Tertiary deposits. For the sake of convenience we tabulate the characteristics of the Tienshan as follows:

(1) The existence of parallel to sub-parallel Variscan ranges, which owe their orographic expression to Alpine folding.

(2) These ranges generally strike E-W but, since most of them are in the form of curves, WNW and ENE strikes are frequently met with.

(3) These curves, with a few exceptions, are generally convex to the south, toward the Tarim Basin.

(4) The Tienshan System is narrowest near longitude 84°, *i. e.*, along a line from Wusu to Bugur[1]. It widens out both eastward and westward and appears widest at longitude 76° (longitude of Kashgar).

---

* Figures in brackets refer to number of work listed in References at end of volume.

1. 輪台

(5) The widening out toward the Soviet Union is due to the occurrence of bifurcations in the central Tienshan.

(6) The intermontane basins generally are latitudinal troughs or depressions. The principal ones were originated already in Mesozoic times while others came into existence in Tertiary times.

(7) The Tienshan ranges are "Blockgebirge", being mostly one-sided thrust blocks, thus giving rise sometimes to high-angled "Schuppenstruktur". Horsts and grabens are not common.

(8) A narrow but persistent belt of low hills composed of post-Variscan sediments occur both along the northern and southern foot of the Tienshan. These are respectively termed the Northern and Southern Piedmont Belt.

(9) Both the Northern and Southern Piedmont Belts are well-defined from the main Tienshan by major, high-angle thrusts, pushing away from the Tienshan toward Dzungaria and the Tarim Basin.

(10) Most of the thrust faults, which gave rise to the "Blockgebirge" and the structural troughs, are post-Jurassic; many of them are post-Tertiary.

Geographers used to speak of the eastern, the central and the western Tienshan. Such a subdivision however appears to be quite arbitrary and is geologically non-existent. On the other hand, a subdivision into the Northern, the Central and the Southern Tienshan is a convenient one both geologically and orographically. Hereafter when we speak of the three parts of the Tienshan, we always bear in mind the following definitions:

*The Northern Tienshan* includes those parts of the Tienshan which lie to the north of the Ili Basin and the Depression of Turfan (and the Depression of Shona nor).

*The Central Tienshan* includes those parts of the Tienshan which lie to the south of the Ili Basin and the Depression of Turfan and to the north of the Narin Basin and the Depression of Khaidu Gol[1]-Bagrash kol.

*The Southern Tienshan* includes those parts of the Tienshan which lie to the south of the Narin Basin and the Depression of Khaidu Gol-Bagrash kol.

---

1. 開都河

The Northern Tienshan consists of three (or perhaps more) main ranges arranged *en échelon*. The longest is the Borokhoro-Irankharbut range which begins in Qasaqstan, extends eastward toward Sairam Nor, thence runs ESE, forming the southern limit of the Basin of Dzungaria. In the Borokhoro the range is low but in the main Irankharbut some of the peaks exceed 4000 m, bearing snow fields. Toward the east the range seems to merge into the Chirgostau south of Dabancheng[1] but this needs verification. Other geologists used to combine the Irankharbut with the Chol-tagh. East of Tihua lies the unique range of Bogdo Ula, which is separated from the Irankharbut by the graben of Dabancheng with its Mesozoic and Tertiary deposits. The Bogdo Ula is undoubtedly a horst, bounded on both sides by high-angle thrusts and plonging rather rapidly from the high peaks of Bogdo (6500 m) toward Chichitsao[2], SE of Tihua. Northwest of Tihua there is a high, isolated hill called Yaomoshan[3] which appears to be an anticline in Carboniferous and Permian rocks and which extends eastward to Hungshanssu[4] and into the city itself. This Yaomoshan anticline, as it might be termed, is separated from the Bogdo horst by a syncline in Jurassic coal series. East of Chikoching[5] there occurs the easternmost range of the Tienshan, the mountains of Barkul and the Qarliq-tagh. These latter are presumably similar in structure to the Bogdo Ula and might also be separated from it by a graben at Chikoching, which, together with the graben of Dabancheng, offers easy passage across the formidable Tienshan. Between the Northern Tienshan and the Basin of Dzungaria lies the narrow Northern Piedmont Belt, whose width is generally around 30 Km. This belt is found immediately south of the main caravan route (now highway) and north of the major thrust faults. Continental deposits, piedmont, fluviatile and lacustrine, ranging in age from the Permo-Triassic up to Quaternary, occur extensively in this belt, generally with the Mesozoics nearer to the high mountains and as a rule moderately folded and tilted. Immediately south of the Wusu-Manass line there occurs a series of prominent hills running parallel to the highway and being separated from the main piedmont hills by flat and open stretches of gobi gravels. These hills are found to be anticlinal ranges formed of Tertiary and early Quaternary deposits and are of great significance in petroleum geology. We shall call them the *fore-ranges* of the Northern Tienshan.

---

1. 達板城 2. 芨芨槽或芨芨草 3. 妖魔山 4. 紅山寺 5. 七角井