

ON THE STRATIGRAPHY OF UPPER HUANGHO AND NANSHAN REGIONS*

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In the spring of 1934, Mr. T. F. Hou and the writer were instructed by the Geological Survey of China to explore the provinces of Kansu¹ and Ninghsia with a view to extending the geological map² of Suiyuan. They left Peiping on the 7th of May and arrived in Kansu on the 19th. A few days later they started for Yungteng (永登) with the specific object of studying stratigraphically and tectonically the eastern part of the Richthofen Range (See Fig. 1). They returned to Kaolan (皋蘭) from Chingtai (景泰). From Kaolan they proceeded northeastward to Chingyuan (靖遠), Haiyuan (海原) and Chungwei (中衛). Thence they went further northeast to Ninghsia taking a view of the Alashan which constitutes one of the most interesting territories in NW China. Going northward from the Alashan they reached Langshan and turned east to Pao-tou (包頭) at the beginning of October. In the spring of 1935, continuing the geological survey in Ninghsia and Kansu, Mr. T. C. Chow and the writer again made a reconnaissance in Kansu and Kukunor. Arriving at Sining (西寧) from Kaolan, they went through the Latsishan pass to reach Kueite (貴德) and turned west along the Hueichu river first up to Dabassunnor and then from Dabassunnor to Tulan (都蘭). A short excursion was also made to Hsiangjihha (香日哈), in the Tsaidam basin. From Hsiangjihha they moved northeastward to Kukunor and again eastward from Kukunor to Sining. From Sining they proceeded northward across the Tapanshan (Chingshihling) to Mongyuan (慶源) and visited the Tolaishan and the Richthofen Range. They returned eastward

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1 This has been partly published in Bull. Geol. Soc. China, Vol. XIV, No. 1, 1935.

2 It has been printed in Atlas for Mem. Geol. Surv. China, Ser. A, No. 12, 1934.

through Tsiuchuan (or Suchow) (酒泉), Changyeh (or Kanchow) (張掖) and Wüwei (or Liangchow) (武威) to Kaolan at the end of October. Thus the geological formations of the Upper Huangho and Nanshan regions became gradually better known.

The fossils collected during these trips have not yet been examined in detail. Only some¹ of the marine fossils have been provisionally studied by Messrs. C. C. Young and Y. S. Chi of the Geological Survey. The geological maps and sections are in preparation. This paper will give only a rough idea of the sequence of the important formations in the Upper Huangho and Nanshan regions.

In the territory studied, the geological formations are represented chiefly by the continental deposits but some of them are developed in marine facies. These formations are separated by several rather pronounced stratigraphical breaks. In descending order they are as follows:

Pleistocene	{ Loess	about 200 M
	{ Gravel	" 10 M
Pliocene	Kungho Series	" 500 M
Mio-Pliocene	Sining Series	" 1000 M
Eocene	Ssuk'ou Series	" 1000 M
Upper Cretaceous	Liyuankou Series	" 800 M
Lower Cretaceous	Hungkou sandstone	" 1000 M
Upper Jurassic	Yaochieh Series	" 200 M
Lower Jurassic	Lungfengshan Series	" 400 M
Permian-Triassic	Sitakou Series	" 1000 M
Upper Permian	Yaokou sandstone	" 900 M
Middle Permian	Taihuangkou Series	" 300 M
Lower Permian	Opo Series	" 300 M
Middle Carboni-ferous	Yanghukou Series	" 50 M
Lower Carboni-ferous	Cheuriukou Limestone	" 150 M

1 Aseptate Corals and Hybodus; Bull. Geol. Soc. China, Vol. XIV, No. 1 1935.

Devonian	Chingshihling Series	about 700 M
Devono-Silurian	Kulang Series	" 2000 M
Lower Palaeozoic?	Kaolan Series	

The Kaolan Series consists of well bedded gneiss with interbedded mica-schist and occasional marble, all being of sedimentary origin. This series of rock has been invaded and soaked by the reddish or grey biotite-granite. Exposures of this group are seen near Kaolan, Luotu (樂都), Huangyuan (皇源), Tulan etc. The age of this series is still a question. In south Shensi there occurs a group of crystalline rocks, with granite-gneiss and mica-schist interbedded with bands of marble. The age of these rocks was thought by Y. T. Chao¹ & T. K. Huang to be Wutaian by comparing their lithological character with the metamorphic series in the Yangtze valley. In Suiyuan there is another series of ancient rocks, mainly gneiss, schist and marble, which unconformably underlies the Wutai system. This series has been considered by C. C. Sun² as a type intermediate between the Taishan and Wutai systems. Petrographically the Kaolan Series, therefore, is surely comparable with the groups of crystalline rocks in the provinces mentioned above. The Kaolan Series is not a true stratigraphical unit. It, in some cases, passes imperceptibly into the Kulang series whose age ranges from Devonian to Silurian. It is possible that the Kaolan Series is one part of the Kulang Series in a strongly metamorphosed state.³

*The Kulang Series*⁴ occurs in Kulang (古浪), Tulan, and Yungteng districts and is often associated with the Kaolan Series as stated above. The

- 1 Y. T. Chao & T. K. Huang, *Geology of the Tainlingshan and Szechuan*, Mem. Geol. Surv. China, Ser. A, No. 9, 1931.
- 2 *Geology of Suiyuan and SW. Chahar*, Mem. Geol. Surv. China, Ser. A, No. 12, 1934.
- 3 Formerly the Kaolan Series was thought to be of Archæan age in Bull. Geol. Soc. China, Vol. XIV, No. 1.
- 4 During his survey of Kansu (1880), the Australian geologist, L. von Loczy was struck by the frequent presence of a very thick graywacke and phyllite formation intercalated by a few marine limestone layers. To this series, extensively occurring in Nanshan, the name of Nanshan sandstein was given, and it was considered to be Wutaian, or partly early Palæozoic.

total thickness is estimated at about 2000 meters. Dark green graywackes and phyllites predominate. Thin limestones are intercalated in it, chiefly in its upper part. The limestone beds yield tabulate corals (*Pachypora*, *Favosites* etc.), which are, according to Mr. Y. S. Chi, of Devonian age. If this is true the upper part of the series is Devonian, and the lower part may be considered to be Silurian or still older.¹

The Chingshihling Series: Upon the Kulang Series lies conformably the younger Chingshihling series of purely continental origin. A tolerably complete and continuous sequence of this series, consisting of alternating beds of green and red slates and graywackes in the lower part and massive, green and red graywackes and conglomerates with slaty intercalations in the upper part, has been observed at Chingshihling and in the Richthofen Range which latter is separated from the former by the Tatungho valley. The series, being underlain by the Kulang Series as mentioned above and being followed, with a hiatus, by the Chouniukou Limestone of Lower Carboniferous age, is surely not older than Devonian and younger than early Carboniferous. It is probably upper Devonian in age.

The Chouniukou Limestone: At Chouniukou (臭牛灣), (on the NE slope of the Richthofen Range) the limestone is blue or grey in colour and fine in texture, frequently intercalated with grey and black shales. From the limestone fossils were collected by Prof. P. L. Yuan², indicating a Visean age.

Twelve years later (1892), V. A. Obrutchev paid a visit to the said province and got a collection of Devonian fauna (*Spirifer anossofi*, *Sp. elegans*, *Rhynchonella aliensis* etc.) from the Nanshan Sandstein in the Western Richthofen Range.

In 1934-35, in the course of a journey across the upper Huangho and Nanshan regions, the writer noticed the same series from which the Devonian fossils were also found in the eastern Richthofen Range. He is of the opinion that this series, in fact, may be divided into two geological units, one being of marine origin, which is named Kulang Series, and the other, purely continental Chingshihling Series.

- ¹ Detailed descriptions of this are to be found in Bull. Geol. Soc. China, Vol. XIV, No. 1, 1935.
- ² P. L. Yuan, Carboniferous Stratigraphy of NW. Kansu, Bull. Geol. Soc. China, Vol. 4, No. 1, 1925.

The fossil list includes *Productus giganteus* Martin var. *Maximus* M'Coy, *Spirifer striatus* Mart., *Orthoteles crenistria* Phillips, *Leptaena analoga* Phillips, *Schizophoria resupinata* Martin, *Lithostrotion portlocki* etc. The formation is also well developed in Yehniukou (野牛溝), Chingyangkou (青羊溝), Opokou (俄博溝), Kuankou (關溝) etc. (in the western Richthofen Range) where it consists of thick bedded, fine textured greyish blue limestone (sometimes interstratified with black shale) with more or less rounded nodules of black flint. Through the whole formation fossils are abundant¹. The same limestone in Chingshihling, Wenposaishihchiashan etc. is almost wholly metamorphosed and is converted into crystalline, sometimes silicified greyish white limestone which only yields very poorly preserved fossils.

In the Alashan, Niushoushan etc. a greyish black, thick and thin bedded limestone, sometimes with more or less irregular layers of chert, underlies the Opo Series of Lower Permian age. Both on a stratigraphic and lithologic basis, this limestone seems to be equivalent to the Chouniukou Limestone.

The Yanghukou Series: The Series lies immediately above the Chouniukou Limestone or above the Chingshihling Series and is followed by the Opo Series of Lower Permian age. It measures at about 50 meters. The lower part of the series, exposed in Yanghukou (in N. slope of the Richthofen Range), consists of sandstones and thin beds of shale. In the upper part, dark grey shale predominates, containing beds of limestone which yields the typical Penchi fauna.

At Lichiachuan (李家泉), Mokou (墨溝), Yaokou (窯溝) and Hungshanyao (紅山窯) (on the N. slope of the Richthofen Range), the series is again composed of shales and sandstones with layers of richly fossiliferous, grey or yellow limestone.

At Chouniukou, according to Prof. P. L. Yuan, the lower part of the series comprises greenish grey, micaceous, thin bedded sandstone with fossil plants. This is followed by fossiliferous shale and limestone carrying a middle Carboniferous fauna. Here the Opo Series, however, is not observed.

¹ From this limestone, T. C. Chow & the writer got a large collection of fossil.

The Opo Series: Lying disconformably on the Yanghukou Series, the Chouniukou limestone, the Chingshihling Series or the Kulang Series is the Opo Series which is observed in the Alashan, Niushowshan, Holishan, Tolai-shan, the Richthofen Range and the Alexander Range. In this series, comparatively coarse-grained sandstone and sandy or argillaceous shale with workable coal-seams occur frequently in alternation with beds of marine limestone. They probably are of late Palæozoic age. Among the marine fossils, there occur some forms of brachiopods and fusulinids, which appear to indicate both the Taiyuan Series and the Shansi Series that are well developed in northeastern China and recently considered by paleontologists to be better classified as Lower Permian.

The Taihuangkou Series: The Opo Series is conformably overlain by the Taihuangkou Series which is well developed in the Nanshan region, but becomes very thin in the upper Huangho territory. The prevailing rocks are here dark green sandstone and shale which sometimes contain workable coal-seams or else are somewhat bituminous. As considered by G. Bexell¹, this series corresponds to the Shihhōtsu Series of Shansi, probably belonging to the Middle Permian age. From certain horizons of the formation, plant-fossils were collected by Bexell in the Richthofen Range. According to Dr. T. G. Halle they are: *Annularia stellata* (Schloth) Wood, *Sphenophyllum emarginatum* Brongn, *Sphenopteris pseudogermanica* Halle, *Pecopteris* cf. *orientalis* (Schenk) Pot., *Callipteris* sp.; *Alethopteris Norinii* Halle, *Neuropteris pseudorata* Gethan & Sze, *Protoblechnum wongii* Halle, *Lepidodendron oculus felis* (Abbado) Zeill., *Walchia* cf. *hypnoides* Brongn, *Cordaites* sp., etc. From the same place the writer made another collection of the same flora.

The Yaokou Sandstone: Proceeding upward the Taihuangkou Series in the Nanshan region becomes so pure that the bituminous beds are very scarce. However, toward the top intercalations of red sandstone appear more and more numerous, and by gradual transition the rock becomes a coarse-grained reddish sandstone for which the writer proposed the name of *Yaokou Sandstone*. Going

1 G. Bexell, On the Stratigraphy of the plant-bearing deposits of late Palæozoic and Mesozoic age in the Nanshan Region, *Geognæiska Annaler*, 1935.

eastward, the sandstone becomes more fine-grained, usually with intercalations of shale.

As no fossils have been found in the formation, its exact age can not be asserted. It may be either the upper portion of the Taihuangkou Series, also of middle Permian age, or of upper Permian age.

The Sitakou Series: Continually overlying the Yaokou sandstone is the Sitakou Series, about 1000 meters in thickness. It consists of green sandstone and shale usually with intercalations of red beds. The plant-bearing beds are not frequently observed. In the western Richthofen Range, in the lower part of the series, Bexell found *Phyllothea deliquacens* Zal., *Callipteris* sp., *linopteris sibirica* Zal., *Brongniartites salicifolius* Zal., *Rhipidopteris ginkgooides* Schmalh, etc. According to Dr. Halle¹, these forms seem to be late Permian in character. Thus the higher beds may be assumed to correspond to the lower and upper Triassic.

The Lungfengshan Series: In the Upper Huangho region, the Sitakou Series is often succeeded by another coal series, the Lungfengshan Series, in which fine or coarse-grained greenish grey sandstone and grey or black shale, as a rule, predominate, with coal seams from 1 ft. to 15 ft. in thickness. From the formation the writer has found Lower Jurassic plant fossils² at Lungfengshan (龍鳳山), Shihkoupu (石溝堡), Sitakou (西大溝) etc. In the Nanshan region the same series occurs not infrequently, conformably overlying the Sitakou Series. At Chienlikouting (千里溝頂), Peitapan (北大坂) and Hsiaoshihmenkou (小石門溝), Wuweihsien (武威縣), it is composed of greenish grey sandstone with beds of black shale and coal seams. The shale is highly carbonaceous and yields some plant-remains including *Cladophlebis* sp., *Hausmannia* cf. *ussuriensis* Kryzhtofovich, *Ginkgo* cf. *lepida* Heer, *Podzamites lanceolatus* (L. & H.) etc.

1 T. G. Halle. On the distribution of the late Palæozoic floras in Asia, *Geograsciska Annaler*, 1935.

2 T. F. Hou & C. C. Sun, A Geological Section NW of Lanchow, *Bull. Geol. Soc. China*, Vol. XIV, No. 1.

The Yaochieh Series: In the Nanshan region, the deposition of the Jurassic sediments was followed by a period of violent orogenic movement and subsequent wide-spread denudation when the great part of the Jurassic sediments was removed. At Yaochieh (饒街), Tiehmeikou (鐵麥溝), Hungkou (紅溝), the Permian or Permo-Triassic beds are unconformably overlain by probably upper Jurassic strata for which the writer proposes the name of Yaochieh Series. Petrographically, this series may be subdivided into two parts. The upper part is formed of fine-grained red sandstone with intercalated shale which bears poorly preserved *Podozamites lanceolatus*. The lower part mainly consists of dark paper-shale with coal seams and earthy limestone nodules in which fragmentary remains of shark¹ of Mesozoic age have been found.

The Hungkou sandstone: This occurs in Hungkou (in the western Richthofen Range), Tiehmeikou, Yehniukou, Akanchenkou, Talapaikou, etc.; and rests either disconformably upon the Yaochieh Series or unconformably overlies formations ranging from Devonian to Lower Jurassic in age. The total thickness is estimated at about 1000 meters. Cross-bedded red sandstones predominate. Conglomeratic sandstone is usually intercalated in it. This formation shows characters of the Cretaceous red sandstones on the Shensi-Kansu border and is, in all probability, Cretaceous in age.

The Liyankou Series: At Liyankou (梨園溝), SW. of Changyeh, the Hungkou red sandstone is succeeded by a transition zone of green and red sediments. These transition beds are finally replaced by green sandstone and shale, sometimes containing bluish grey earthy limestone layers. This series is very probably equivalent to the formation from which P. L. Yuan has found Cretaceous fossils² in the Liupanshan region of E. Kansu.

The Ssukou Series: In 1921, C. Y. Hsieh found, at Ssukoutzu N. of Kuyuan, a thick sedimentary series conformably overlying a series of grey shale

1 C. C. Young, On a Dorsal Fin-spine of *Hypodus*. Bull. Geol. Soc. China, Vol. XIV, No. 1.

2 P. L. Yuan, Geological notes on eastern Kansu. Bull. Geol. Soc. China, Vol. IV, No. 1.

and oolitic limestone¹ (probably equivalent to Liyuankou Series of the writer), which is composed of shale and sandstone alternately bedded and with limestone beds and gypsum. The limestone has yielded shells and opercula of a small gastropod, which up to present have not yet been examined by specialists.

The same series was recently discovered by the writer at Shihhsienkou (石峡口), a little northwest of Ssukoutzu. Here the lower part of the series is built up by conglomerate and sandstone. In the middle part, red and green clay-shale predominates, containing gypsum and occasional limestone layers. In the upper part there occurs red sandstone, alternating with clay-shale, which latter unconformably underlies the Sining Series of Miocene-Pliocene age (see below).

The age of the formation in question was thought by J. G. Andersson² to be Miocene-Pliocene. However, from the indications given above it seems beyond doubt that the series belongs to the older Tertiary, very probably Eocene.

*The Sining Series*³: In the region of Sining, Kueite, Kaolan and Shihhsiakou, there occurs a red series lying unconformably upon the Ssukou formation and older strata. It consists chiefly of soft red sandstone and clay, sometimes with thin beds of green sediments intercalated with layers of gypsum and rock salt, Chilisalt peter being not infrequently interbedded in it. In the regions of Sining and Kueite, J. G. Andersson found numerous mammalian bones among which a *Mastodon* is very common, showing more probably that the red beds under consideration belong to Miocene-Pliocene.

The Kungho Series: In the territory from Kueite to Kungho there occurs a formation of reddish fine clay merging upward into yellow sand with layers of gravel, yielding fresh water shells possibly of late Pliocene age. This

- 1 C. Y. Hsieh, Preliminary Notes on the Topography and Geology of Northern Kansu, Science, Vol. 9, No. 10 1934 (in Chinese) and Geological Notes from Kansu. Bull. Geol. Soc. China, Vol. IV, No. 1, 1925.
- 2 J. G. Andersson, Geological Notes from Kansu. Bull. Geol. Soc. China, Vol. IV, No. 1.
- 3 L. Loczy first saw the red beds in Upper Huangho region, he named it the Kueite Series, in view of its typical development in Kueite basin, which almost includes both the Sining Series and the Kungho Series in this paper.

series of strata was apparently not affected by any deformation of profound character. In the vicinity of Kueite it horizontally overlies the folded Sining Series.

The Gravel: In central Kansu, where the base of the Loess is exposed, it is marked by a gravel deposit of some 10 m. in thickness. The pebbles of the gravel, all of rounded shape, consist almost entirely of metamorphic rocks. Though no fossils have been found the age of the gravel is thought to be lower Pleistocene for it occupies the same stratigraphical position as the Sanmen Gravel of the lower Huangho region.

The Loess: The loess is well-developed in the territory traversed. It is frequently found in valleys, forming cliffs and terraces, and showing the characteristic columnar jointing. From Chingyuan to Kaolan and from Kaolan to Kulang the loess forms a continuous plateau with incised canyons showing the rock floor of older formations.