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GEOLOGY OF THE WU-AN, SHÊ HSIAN, LING HSIEN AND AN-YANG DISTRICTS, NORTHERN HONAN.

(Summary)

By C. C. Wang. 王竹泉

With 8 plates and 20 figures (in Chinese text)

GEOGRAPHICAL LOCATION.

This report deals with the geology of the four districts of Northern Honan situated approximately between latitude north 36°-37° and longitude east 113° 30′-114° 20′. The region lies west of the Peking-Hankow railway line and constitutes the eastern part of the Tai Hang mountain range which runs here in a direction from NNE to SSW.

The Tai Hang range[1] (太行山) passes on the west to the Shansi plateau and on the east in almost an abrupt way to the great coastal alluvial plain. As a broad structure, this range is an anticline the axial zone of which is constituted by older formations from the Archean gneiss to the Ordovician limestone with the Carboniferous and younger strata on the two limbs. The area of this survey made during the spring of 1925 is interesting as to show the detailed structure of the eastern limb of the broad Tai Hang anticline, and also for the important Carboniferous coal fields which exist along the eastern slope of the range.

The appended geological map is based on the topographical map on the scale of 1 to 100,000 and reduced to half of the original scale. While the contour lines are not always as accurate as could be desired, the map shows well the broad topographical feature enough to help the understanding of the general structure of the region.

STRATIGRAPHICAL SEQUENCE.

The sedimentary formations encountered in this region include from below upwards the following:

Archean gneiss:—There are two main areas, one on the NW of Wu-An district in the upper valley of Pei Ming Ho (北鳴河) river, the other on the west of Ling Hsien district in the axial range of Tai Hang Shan.

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1. Wang, C. C. An outline of the geological structure of Shansi. Bull. Geol. Soc. China, Vol. IV, No. 1, 1925, p. 89.

Algonkian quartzite (Sinian):—It unconformably overlies the Archean gneiss (text fig. 1) with a basal conglomerate, but conformably underlies the Cambrian formation as observable along the Ching Chang Ho (清漳河) valley south of Shê Hsien. Ripple marks are common on the bedding plane of the quartzite. Siliceous limestone is not observed.

Cambrian limestone:—At the base there is ordinarily 50-60 m of red shale, the main part consists of thick oolitic limestone rich in Trilobite fossils. This formation occurs generally in horizontal or gently inclined strata over large area in this mapped region especially along the two sources of the Chang Ho and west of the Nan Ming Ho (南銘河). It constitutes also the western part of Ku Shan (鼓山) in Wu An district.

Ordovician limestone:—This is a thick formation of over eight hundred meters. Actinoceras fossils have been observed in the eastern part of Ku Shan. Along a zone trending north to south on the west of Wu An, this limestone is intruded by a series of dioritic bodies.

Carboniferous and Permo-Carboniferous coal series:—This is the coal bearing formation which gives so much industrial importance to this region. There are several coal fields generally extending along a direction parallel to the main trend of the Tai Hang range. The main fields occur along the eastern main margin of the hilly limestone area constituting, broading considered, the monoclinal warp of the Tai Hang range down to the alluvial plain. From east to west and from north to south, we have first the Tzu Shan (紫山) field elongated in the NNE-SSW direction parallel to Ming Ho valley and extending along a distance of over twenty kilometers. The strata from Carboniferous up to Triassic gently dip to the east or toward the plain at about 20°-30°. On the west the Carboniferous field is limited by a strike fault named Tzu-Shan fault (Pl. II, fig. 2) bringing it in direct contact with the Triassic sandstone of Ming Ho valley.

The southern part of the Tzu Shan field develops into a series of minor foldings. From east to west, there are an anticline between Ta Ho Pu (大河鋪) and Kang Erh Cheng (康二城) and a syncline west of the latter village.

West of Ming Ho valley, Carboniferous crops out in a broader zone passing by Hui Lan (惠蘭) and Tien Tou (店頭). The strata regularly dip to the east at 10°-20°. They are however widely covered by the Tertiary conglomerate and the loess. In this field, NE of Hui Lan, is the Shun Cheng (順成) coal mine (Pl. II, fig. 2, Pl. VIII, fig. 4).

South of Tien Tou, the structure is complicated by some minor foldings and a long fault called here the Tientou fault (text fig. 7 Pl. II fig. 2). By this fault the Tientou field as the small syncline of Pa Tê Chen (八特鎮) is cut off from the Ho Tsun (和村) syncline. The latter extends southward into Tzu Hsien district (formerly known as Tze-Chow) of Chihli province the geology of which has been previously studied by Messrs. Y. T. Chao and C. C. Tien[1].

The Ho Tsun field is cut again by an important strike fault, the Ku Shan fault of an extension of over twenty kilometers and probably in continuation with the Tzu Shan fault. East of the Kushan fault (Pl. II fig. 2, Pl. VI fig. 1) abruptly rises the Ku Shan ranges of Cambro-Ordovician limestone. East of this range is another coal field dipping to the east. The coal field of Hsueh Tsun (薛村) is cut on the north by a transverse fault passing by near Hu Yu (胡峪) and extends on the south again into the Tzu Hsien coal field of Chihli province. The Carboniferous stratigraphy is essentially the same as that which has been already described.

South of Chang Ho, in the An Yang district, Carboniferous also occurs along a belt of approximately N-S trend passing by Tung Yeh (同冶) north to Kuan Tai (觀台) where is located the important Liu Ho Kou coal mine connected by a branch line to Feng Lo Chen (豐樂鎮) on the Peking-Hankow railway. The latter field has been surveyed in detail by Dr. V. K. Ting whose map and section are included in this report (text fig. 18 & 19). It has been also been studied by Messrs Chao and Tien who have collected many marine fossils. The stratigraphy as I have observed is given in Pl. III.

The upper part of the coal series containing the main coal seam called Ta Tan worked by the Liu Ho Kou mine has yielded some plant fossils including the new genus identified as Tingia by Dr. Halle[2] who considered it as of Permian age. Broadly speaking the Tung Yeh-Liu Ho Kou coal field also constitutes the monoclinal warping of the Tai Hang range down to the great plain. The eastern extension here is however much covered by the Tertiary conglomerate and the loess. This field extends north-ward across Chang Ho into the Pengcheng field of Tzu Hsien of Chihli province.

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1. Chao Y.T. and Tien C. C. On the stratigraphy of the Tze Chow (Tzu Hsien) and Liu Ho Kou coal fields. Bull. Geol. Surv. China, No. 6, 1924, p. 67 et sec. see geol. map.

2. Halle, T. G. A new genus of fossil plants from the Permian of China. Bull. Geol. Surv. China No. 7, 1925.

Besides these eastern fields, there are only a few small Carboniferous basins scattered in the limestone hills east of Ling Hsien, such as those of Ta Lien Chih (大連池) Chai Chu (窄曲) etc.

Permian shale and sandstone:—This is the formation immediately overlying the coal bearing series and consists of yellow, green shale and sandstone. Typical exposure is found in Tzu Shan and along a belt east of Ho Tsun (和村).

Triassic sandstone and shale:—The red color is predominant in this series which is thick of over 500 meters. Shale is predominant in the lower part, but sandstone gradually prevails upwards. Except where it is covered by Tertiary and Quaternary deposits, this formation usually constitutes the eastern margin of the rocky hills and gently dipping eastward to the plain. The division of Permian and Triassic is made according to the writer's experience in the geology of Shansi.

Tertiary conglomerate:—This formation unconformably overlies the Mesozoic or Palaeozoic strata. The pebbles mostly are come from the Sinian quartzite and vary in size from 1 or 2 inches to 4 or 5 inches. Some basalt pebbles or of other igneous rocks are also found. The conglomerate often forms hills of 40 to 50 meters above the ground and by weathering yield abundant loose gravel (Pl. V fig. 3) on the slope. An especially extensive area of this conglomerate occurs N. W. of An Yang between Chang Ho and Yuan Ho. The cement of the conglomerate is often constituted by a red argillaceous and fine sandy material. It generally dips to SE. The dip angle is steeper on the western part amounting to 16° (text fig. 5) and becomes very gentle 2-3° in the eastern part.

Quaternary Loess:—There are several loess basins in the area surveyed. The district cities are usually located in such basins, for instance Wu An, Shê Hsien and Ling Hsien. East of the Tung Yeh-Kuan Tai coal field and west of An Yang city is also an extensive loess area.

Near Ho Tsun there is a conglomerate of limestone pebbles either lying at the base of the loess or interbedded with it. This is also observed east of Ku Shan.

IGNEOUS INTRUSION.

The region under survey is particularly interesting for the study of the dioritic intrusions and its metamorphic effects. The diorite of Tsu Shan[1] (磁山)

1. This name Tzu Shan means in Chinese "Magnetic hill" evidently so named because of the magnetic property of the iron ore. It is diferent from the other Tzu Shan east of Wu An city which means in Chinese "purple hill"!

or as some times also called Hung Shan (紅山) and its contact metamorphic iron ores have been already studied and described by several authors.[1] But Tzu Shan is simply one of the many intrusions of similar kind in this region.

As is shown by the geological map (Pl. I), the dioritic bodies occur mostly in the Ordovician limestone. Their out-crops have a clear tendency to follow the strike line of the limestone. The igneous rock when exposed is often still partly covered by remnants of limestone beds in horizontal or gently inclined position (text fig. 3 & 4, Pl. IV fig. 4. Pl. V fig. 1 & 2). The limestone is then often metamorphosed into marble.

Although the main intrusive bodies are in the Ordovician limestone, porphyritic apophyses or minor intrusions are sometimes found in the Permo-Carboniferous coal series (text fig. 16 & 17, Pl. VIII fig. 2) which is clearly metamorphosed. The age of intrusion must be therefore much later than the Ordovician, even much younger than the Permian.

The dioritic intrusions seem to have exerted much influence in determining different degree of metamorphism of the coal seams in the different coal fields. As a general rule, anthracite or anthracitic bitumnite predominates in all the coal fields in the region under survey except the fields of Ho Tsun and Hsueh Tsun south of Wu An district and the Kuan Tai coal field north west of An Yang district where there exists excellent bituminous coal. All these bituminous coal fields extend into the Tzu Hsien coal fields of Chihli province which are also the best bituminous coal fields in eastern North China. This distribution of anthracite and bitumite is easily explained by the distribution of the dioritic intrusions. The anthracite fields are intruded by or situated near the diorite while the bituminous fields are remarkably free of or comparatively further distant from such intrusion.

The relation of the Post-Palaeozoic diorite and the contact iron ores is well known, but by no means all the dioritic bodies produce iron ore even at the typical contact metamorphic zone. All the iron ore bearing bodies such as those of Kung Shan (鞏山), Shang chuan (上泉), Ching Ling Shih (青嶺寺), Hei Shih Po (黑石坡) and the well Known Tzu Shan (磁山) or Hungshan (紅山) are approximately situated on a same north-south line. Cutside of this zone dioritic intrusions are usually free of iron ore.

1. Tegengren F. K. The iron ore deposits and iron industry of China Mem. Geol. Surv. China. A 2 Vol. I, 1921-1923, pp. 174-179. Shu, W. P. Geological Survey of the Hung Shan intrusion, North China. Bull. Geol. Soc. China, Vol. III, No. 2, 1924, pp. 122-126.

STRUCTURAL GEOLOGY.

As can be seen from the W-E general sections (Pl. II), the strata from the Sinian quartzite up to the Triassic sandstone are generally but uniformly dipping to the east or south-east. There are only a few exceptions to this rule which are caused by local minor foldings such as have been mentioned when discussing the distribution of coal fields or by some local disturbance due probably to the igneous intrusion. As the diorite often tends to take a laccolithic form, the intruded limestone often dips away from the intrusive mass (Pl. II fig. 4). Broadly speaking therefore the eastern part of the Tai Hang range forms the eastern limb of a broad anticlinal structure. On the other hand, as the corresponding formations, say the Permo-Carboniferous occupy, on the western limb i.e. in eastern Shansi, a much higher level than on this eastern limb, the latter region may be also considered as constituting a monocline by which the Shansi plateau quickly passes to the Chihli-Honan plain.

Vertical faulting seems to be the main tectonic feature. It is by the Ling Hsien fault (Pl. II fig. 4, Pl. VI fig. 3) that the Tai Hang Shan proper (or the axial zone of the broad Tai Hang Shan) is abruptly elevated at four hundred meters above the the Ling Hsien basin. The Archean gneiss is brought by it in contact with the Ordovician limestone. This fault has an extension of above fifty kilometers in the mapped area and probably extends further southward. It is essentially a strike fault. The maximum vertical displacement is about six hundred meters.

The Ho Tsun fault, the Ku Shan fault and the Tzu Shan fault as have been already mentioned in connection with the coal fields are of the similar nature as the Ling Hsien fault so far as they are strike faults with notable vertical throw. It is likely that the Tzu Shan fault and the Ku shan fault are continuous one to another and should be considered as only one fault which has then a total extension of over fifty kilometers.

In the north-western part of the mapped region, the strata tend to strike NE-SW instead of NNE-SSW. The main faults take also the same direction. Such is the case with the Shê Hsieh fault (Pl. II fig. 3) extending over thirty kilometers.

All the strike faults above mentioned have their upthrow side on the east or south-east and down throw-side on the west or north west. The Ling Hsien fault constitutes the only exception to this rule with its upthrow on the west. In other

words, in the majority of cases the effects of the vertical faulting is often a counter balance to the dip of the strata due to the folding.

There are also a number of transverse or oblique faults such as those passing by Hu Yu, Kuan Fang etc. which cut across the strike of the strata.

As to the date of the folding, it is only possible to say, within the limit of evidence in this region, that it is post-Triassic and pre-Tertiary. The faulting is of a younger age which is also testified by the young topographical feature of the fault scarps and the river valleys.

PHYSIOGRAPHY.

The topographical development of the region referred to may be summarized under two stages:— 1 feature of youth with elevations and canyons, 2. aspect of advanced maturity with low ridges and wide valleys. The former corresponds to the Fenho stage of Bailey Willis in Shansi while the latter to his Tanghsien stage.

The mature surface is well represented by the gentle hills between the Lin Hsien loess basin in the west and the An Yang plain in the east. These hills scarcely exceed 200m in height above the adjacent flat valleys which are thick covered by loess. They are constituted mostly by the Ordovician limestone, though occasionally by the diorite. Another area of mature topography is recognized along the Nan Ming Ho below Yang Yi Chên (陽邑鎮) in the Wu An district.

The feature of youth consists of a tectonic topography partly determined by fault and partly characterized warping. The mountains of Tai Hang Shan, Ku Shan, Han Shan and Shih Shan are thought to be fault-scarps, (plate VI fig. 1,3) of which the relief varies from 250 m. to 400 m. The name Tai Hang Shan is here employed only in a restricted sense-that is, it simply denotes the scarp of Lin Hsien fault west of Lin Hsien Basin. This basin and those of Wu An and Shê Hsien are all regarded as down-warps or the downthrows of the faults. The Lin Hsien basin samewhat rectangular in form has a breadth from 10 to 15 li and a length of more than 30 li. The warping of the youth stage is typically shown by the canyons of the Chang Ho (Pl. VII fig. 3 & 4) in Shê Hsien and Lin Hsien, and by those of the Pei Ming Ho above Chi Chêng Chên (Pl. IV, fig. 3) and of the Nan Ming Ho above Kuan Tao.

As to the development of streams, the Nan Ming Ho represents an interesting case of diversion. As shown on the map, its NW-SE course is rapidly changed into a SW-NE one in the east of Pa Tê Chên where it is confluent with a brook coming from the south. Such brook flows in its upper course through Ho Tsun

along an old abandoned broad river valley and its divide with the headwaters of the Fu Yang Ho (滏陽河) at Ping Chêng in the Tzu Hsien district of Chihli is not only gentle and insignificant in relief but entirely constituted by loess. All the facts mentioned seem to indicate that the Nan Ming Ho once flowed along the west foot of Ku Shan through Ho Tsun to Ping Chêng in connecting with the Fu Yang Ho and was only diverted to the present course by an upwarp near Ho Tsun. Another case of brook diversion is observed in Ku Shan east of Sien Chuang (仙莊), Wu An. Here a brook flows in E-W tread. Its upper course well exhibits a wide valley of mature topography (Pl. VII fig. 1) while its lower course enters a deep canyon of youth (Pl. VI fig. 4), though it pursues its way entirely in the Cambro-Ordovician limestone. Such a curious change on the form of channel may be interpreted in two ways: 1. The referred brook originally flowing to the east reverses west by its profund headerosion. 2. In the lower course of the brook is established an upwarp in which it is strong enough to maintain its course. That either of these cases is more probable still needs further precise investigation in future. The same circumstance also occurs on the tributary of the Nan Ming Ho near Mu Liang Tien S.W. of the Wu An city.

COAL RESOURCES.

There are seven coal fields in the visited region and most of them are being worked by native mines. A summarized table is given as below:—

Coal field	Total thickness of workable coal seams.	Probable reserves	Mines	Daily output of respective mines.
Tsu-shan field	7 m.	764,400,000 tons	Chung-Hsing mine.	6 tons
			Ting-Shêng mine.	4 „
			Ta-cheng mine.	
			Ho-chung mine.	
Tientou-Hutian field.	7 m.	691,801,200 tons	Ta Hsing mine.	20 „
			Shun-Chêng mine.	50 „
Ho-Ts'un field.	5 m.	71,500,000 tons	Small pits.	80 „
Hsieh-Yuan field.	5 m.	181,518,000 tons	Only one pit.	10 „
Tung-Yeh field.	3 m.	171,567,200 tons	Liu Ho Kou mines.	4 „
Ta-Lien-Chi'h field.	4 m.	28,600,000 tons	Ta-mien mine.	1500-2000 tons
Tsai-Chu field.			Small pits.	

In the Tsu-shan coal field 16 coal seams thicker than 2 ft. each are said to be present after the experience of the native miners at Chou Chuang south of the

Wu An city, while in the Tung Yeh field 8 seams are observed as shown in the plate III. Of all the mines worked in the region under survey, the Liu Ho Kou coal mine is the greatest with a yearly output of 500,000 tons during 1923. The analysis of the coal taken from this mine according to Mr. Chang Ching Kuang's report is as follows :—

Volatile matter	Fixed carbon	Ash	Moisture	Sulphur	Calorif. power.
19.82	67.63	2.14	1.11	0.65	7502.

GEOLOGY OF SOUTHWESTERN CHEKIANG*

(With 1 map and 5 figures)

by

C. C. LIU and Y. T. CHAO

(Summary)

INTRODUCTION

The area surveyed is located between Latitude 28° 30′ to 30° and Longitude 118° 30′ to 120°, including the districts, Tung-Lu (桐廬), Kien-Teh (建德), Lan-Chi (蘭谿), Tang-Chi (湯溪), Lung-Yu (龍游), Chu-Hsien (衢縣), Kiang-Shan (江山), Chang-Shan (常山), Kai-Hua (開化), Sui-An (遂安), Chun-An (淳安), and a part of Feng-Shui (分水), Yu-Chian (於潛), and Fu-Yang (富陽). We left Peking in September 1926, and returned at the end of Decemoer. The actual working days amounted to a little less than three months.

This part of Chekiang is a mountainous country, with all the principal ranges trending in a N. E.-S. W. direction, this latter being also the structural axis of the underlying rocks. The central part is occupied by a high range to which various local names have been applied in different localities. For simplicity, we propose to call it the Wei-Ling range (幔嶺). This range commences from the Western Lake of Han-Chow and extends southwestward into the Kiangsi province. It is formed mainly by the Silurian quartzite and sandstones, rising to a height generally above 1,000 meters. The structure is, broadly speaking, a syncline. Southeast of the principal tributaries of the Chian-Tang river on the eastern and southern border of our area surveyed, is the famous range, Hsian-Hsia-Ling (仙霞嶺) which is made up entirely by the thick sheet lava of Cretaceous age. Because of its massive character, it also builds up lofty mountains generally above 1,000 meters.

For the drainage system in S. W. Chekiang, it is referred to the map attached at the end of this paper.

STRATIGRAPHY

In this part of Chekiang the sheet lava, which once covered the whole province, was largely eroded away during recent geological times, and hence the underlying sedimentary series are exposed to the surface. The Palæozoic rocks, however, are complexly folded and repeatedly faulted. Further more, they are not

*During absence of C. C. Liu, this paper was compiled by Y. T. Chao.

infrequently covered with Cretaceous deposits disposed in the form of separate basins, or else still buried under the remnants of lava flows. All these facts increased greatly our perplexity in the study of the order of succession.

Since Chekiang is situated on the lower entrance of the Yangtze Valley, the expectation of finding the same order of succession as in the other provinces of Central China seems to be not altogether purely a matter of conjecture even without going into the field. In this journey, this was fully confirmed, nearly all of the fossiliferous horizons in Hupeh and other provinces of the Lower Yangtze having been found at their expected positions. It must be noted, however, that the Palæozoic seas entered the Yangtze Valley from the west. Hence, the succession is most complete in Western Hupeh, becoming incomplete in some horizons, or else changing to a shore-facies towards the eastern sections.

The base of the Palæozoic is not exposed in the districts surveyed, the oldest rock being doubtfully considered as the Cambrian. The top of the Palæozoic ends with the mid-Permian coal series. A large part of the Mesozoic is entirely wanting. Upon the folded and faulted Palæozoic platform lie Cretaceous deposits which are then followed by the lava sheet of enormous thickness. The widespread Tertiary Red Sandstone series in Central China forms an elongated basin within which the Chukiang river has carved its meandering courses.

In descending order the following formations appear in succession (fig. 1):

10. Chukiang red beds ..... Early Tertiary

Unconformity

9. Rhyolite sheet lava
8. Kienteh formation ..... Cretaceous

Unconformity

7. Lihsien coal series
6. Feilaifeng limestone ..... Permian

Disconformity

5. Chienlikang sandstone
4. Fengchu shale ..... Silurian
3. Yenwashan formation
2. Yinchufu series ..... Ordovician
1. Taoshuiwu formation ..... Cambrian?

I. Taoshuiwu Formation: This formation is typically developed at Tao-Shui-Wu (倒水塢) in the vicinity of Lin-Chia (林家), Yu-Chien-Hsien. It lies immediately below the black shales at the base of the Yinchufu series, and is composed mainly of compact, dark-colored sandstones and conglomerates.

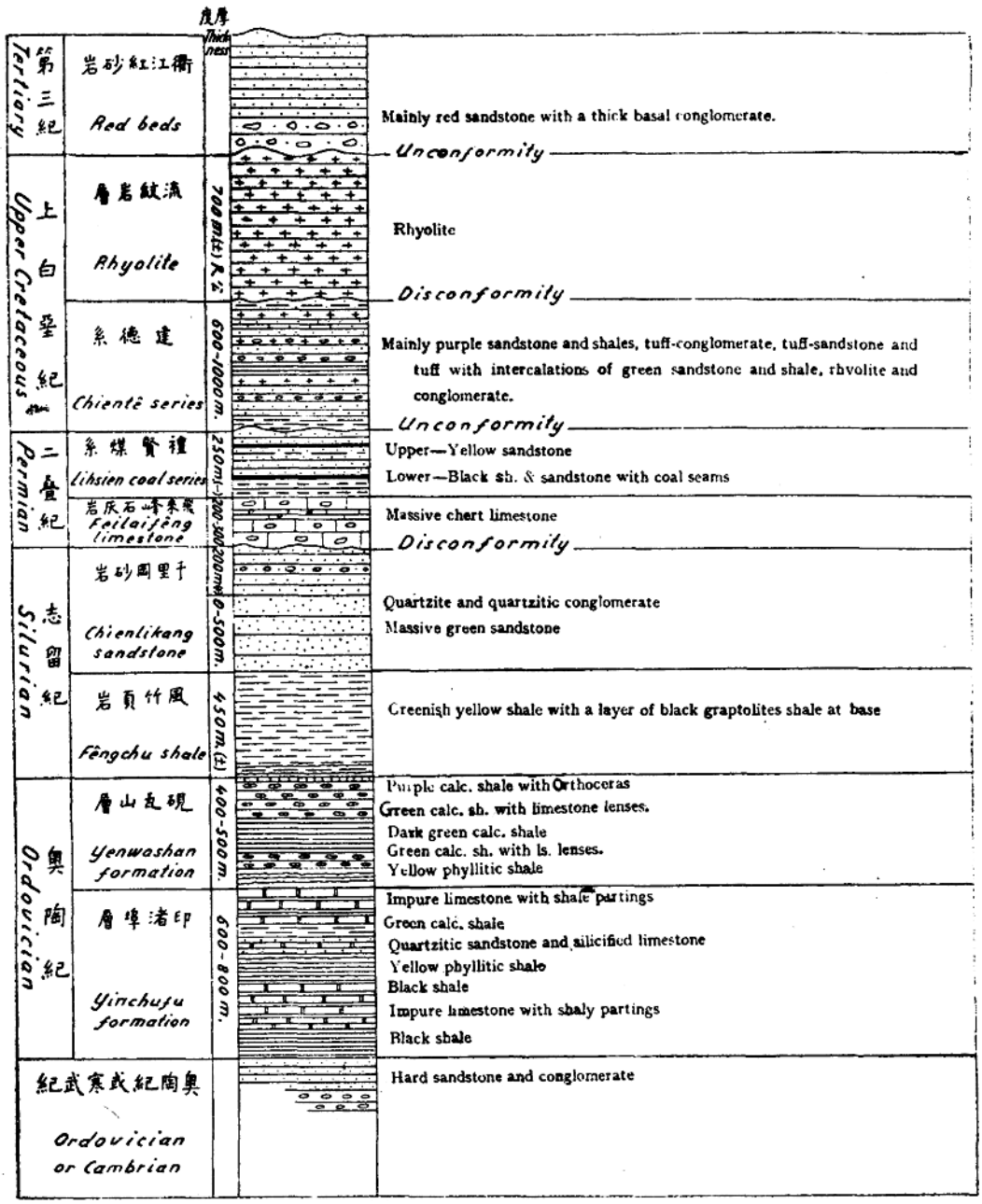


Fig. 1. Generalized columnar section of Southwestern Chekiang.

第一圖. 浙江西南部地層柱形圖.

In the area surveyed, a series of dark sandstones and conglomerates also crops out at Fu-Ho (浮河) in the northeast part of Chang-Shan. From its stratigraphic position and lithological characters, it appears to belong to the this formation.

II. YINCHUFU SERIES: The series may be conveniently divided into three parts and amounts to a thickness of not less than 1,000 meters. From a shale bed at the middle part of the series, a Graptolite fauna has been obtained.

The lower division of the series is mainly earthy limestones, with a division of black, bituminous shale in the basal part. The black shale is well laminated, and contains occasionally thin bands of limestones which disappear within no great distance. When fresh, it is black and frequently oily in lustre. After long exposure

Fig. 2. Profile section along Hsin-An-Kiang from Chun-An-Hsien to Wei-Ping.
第二圖. 淳安至威坪沿新安江印渚埠系剖面圖(地質圖

1-7. Yinchufu formation 印渚埠系. 1. Black shale. 2. Impure limestone with shale shale. 5. Silicified limestone and quartzite. 6. Greenish thin bedded hornstone with laminations. shales. 9. Kienteh formation 建德系. 10. Rhyolite 流紋岩. 11. Alluvium.

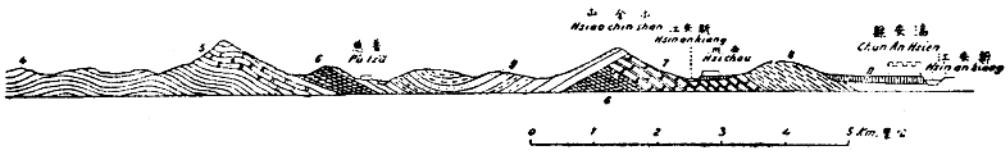
to the agency of weathering, however, the bituminous matter disappears by oxidation, and the shale changes to a pale yellowish and whitish tint. Powders of the fresh rock are combustible in fire, hence the name "Shimai" or "stone-coal" given it by the natives. It can be used for burning lime. Thus all along the outcrop of this black shale series, lime pits exist in great numbers. This black shale series presents a striking similarity to the Utica shale of North America, both belonging to the same geological period and changing laterally to a limestone series. It is to be noted, however, that the Utica shale has been the mother rock of petroleum deposit. But the black shale series at the base of the Yinchufu formation has so far not been known to furnish petroleum.

The limestone above the black shale is thin bedded and impure, containing brownish earthy bands at close intervals. The distance between these earthy bands ranges from a few inches to one or two feet. The earthy layers are often weathered out upon the surface, imparting it a very characteristic banded appearance.

The total thickness of the black shales and limestones, included in the lower division of the Yinchufu series, is more than 400 meters.

The middle division of the formation is composed of sandstones and shales, amounting to a thickness of 300-400 meters. The basal part is again a bed of black shale, often weathered to a yellowish tint. Above this comes a sequence of yellow shales of a silky lustre and phyllitic appearance. Towards the upper part, the yellow shales become gradually greenish grey in color and at the same time merge into calcareous shales. The upper part of this division is marked by a thick bed of calcareous sandstone.

The upper division of the Yinchufu formation consists mainly of impure limestones with alternating earthy bands. The lithological characters are the same as those of the limestones in the lower part of the formation. Thickness approximately 300 meters.



(Section line II in map).

内 剖 面 線 II).

partings. 3. Phyllitic shale. 4. Yellowish and reddish phyllitic shale and green calcareous 7. Impure limestone with shale partings. 8. Yenwashan formation 硯瓦山系 : green calcareous

The line extending from Feng-Shui, through Chun-An, Sui-An, Kai-Hua, southwestward into the Kiangsi province coincides approximately with the contact line between the Yinchufu series and the Yenwashan formation. From this westward to the boundary between Anhui and Chekiang, the Yinchufu series is extensively developed. The strata dip generally towards the southeast, and hence the black shale series at the basal part of the formation is chiefly exposed at the western border of the province.

From Kai-Hua westward to Pai-Sha-Kuan (白沙關), the beds are variously tilted and are thus not suitable for stratigraphic investigation. They have also been appreciably altered by metamorphism, as is shown by the great abundance of cubic crystals of pyrite in the sandy layers of the formation. On the route leading from Kai-Hua to Ma-Chen (馬金), the upper limestone is preceded by a thick bed of brecciatic conglomerate, containing angular fragments of hard shales and fine sandstones. Below it is a thick quartzite with intercalations of sandy limestones. The sandy limestones are yellowish green in color, and characterized by beautiful colored laminations. These conglomerate and quartzite have also been found in

Kuo-Tsun (郭村), west of Sui-An, but so far they have not been observed further north. From Chun-An westward along the Hsinan-Kiang through Wei-Ping to Chieh-Kou (街口) of Anhui, the Yinchufu series is also exposed (Fig. 2). The succession, however, is obscured by the occurrence of a small basin of the Kienteh formation and remnant of the sheet lava. The black shales at the basal part of the formation, on the other hand, are well developed from Wei-Ping to the border region between Anhui and Chekiang, and there they are extensively mined by the natives for burning lime. Finally the series is best exposed at Yinchufu, the type locality from which place the order of succession stated before is obtained.

From Chang-Kou (場口) of the Fu-Yang district southwestward through Chi-Hsia-Chen (芝夏鎮) of Tung-Lu, Yang-Chi (洋溪) of Kien-Teh, Hsia-Ma-Chiao (下馬橋) of Shou-Chang, Tai-Yen-Tou (玳瑁頭) of Chu-Hsien, to Fan-Tsun (芳村) of Chang-Shan is another zone where the lower part of the Yinchufu series is exposed. Here the formation has a general dip towards the northwest. It is faulted against the Chianlikang sandstone on the northwest, and is buried either underneath the rhyolite sheet lava or the Kienteh formation on the southeast. The prevailing rock-types are impure limestones and black shales, the same as those exposed at Wei-Ping. Hence all along this zone, the black shales are again mined in various places for burning lime.

At Chu-Ko-Chen (諸葛鎮) in the north part of Lan-Chi and at Shi-Fu (石佛) of Lung-Yu, there are also isolated hills made up by impure limestones and black shales, these latter being again mined for lime manufacturing. They are in fault contact with the Silurian Chianlikang sandstone on the north, and buried underneath the basal conglomerate of the Chukiang red beds on the south. As shown by the lithological characters, they correspond most probably to the lower part of the Yinchufu series. But when their position is taken into consideration, they represent more likely the remnant left by the same fault as at Yen-Wa-Shan (硯瓦山) on the border region between Kiang-Shan and Chang-Shan. About 2 li northeast of Shi-Fu, there is a division of yellowish shales with a layer of black shale cropping out besides a temple. The beds are vertically tilted, and are separated from the anticlinal hill of the impure limestones and black shales by rice field. Hence the relation between them needs further careful investigation. From the data available at present, it appears extremely probable that these yellowish shales correspond to those just above the impure limestones at the lower part of the Yinchufu series. From the black shale layer intercalated within the yellow shales, a rich Graptolite fauna has been obtained, which according to the preliminary