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GEOLOGY OF NANCHANG, TANGYANG, AND YUAN-AN COALFIELDS, NORTHWESTERN HUPEH.

by

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(with 3 plates and 19 figures)

I. ITINERARY.

During the fall of 1928, Messrs. W. P. Shu, C. C. Yu and the writer were called to make a survey of the mineral resources of northwestern Hupeh on behalf of the Bureau of Reconstruction of that province. We reached Hsiangyang on the 28th October, and started our field work on the 29th. Our proposed trip was to start from Hsiangyang going westward to Lungchun, thence we were to turn southward to Nanchang, then again westward to Po-Kang and Chin-Feng-Chen. From Chin-Feng-Chen we would then go to Ku-Chen, Kwan-Hua, and Lau-Ho-Ko, and finally return to Hsiangyang where we started. After we had made a brief survey from Hsiangyang to Nanchang passing Wu-Chia-Chi, Lau-Kwan-Miao, we found however that our assigned area was too large for us to cover within the limited time of two months. It was then decided to split our party into two. Messrs. Shu and Yu formed the first party, and took up the area of I-Chen, Chin-Men, Chun-Chiang; while the writer was to survey the area stretching over the districts of Nanchang, Tangyang, Yuan-An and further to the west. After a survey of the coalfields of Yuan-An and Tangyang, the writer was prepared to go into the mountainous region to the west. Unfortunately a severe winter set in around that area. As it was impossible to carry on the field work with heavy snow storms reigning throughout the district the attempt to visit Po-Kang and Chin-Feng-Chen was abandoned. Thus only the Tungkung coalfield of Nanchang, the Kwan-In-Tse, the Miao-Chien, the Chieu-Tse-Shan, and the Shih-Ma-Chao coalfields of Tangyang were surveyed.

The actual time spent in the field was a little over two months, and the total distance traveled including all the side trips was about 3,000 li.

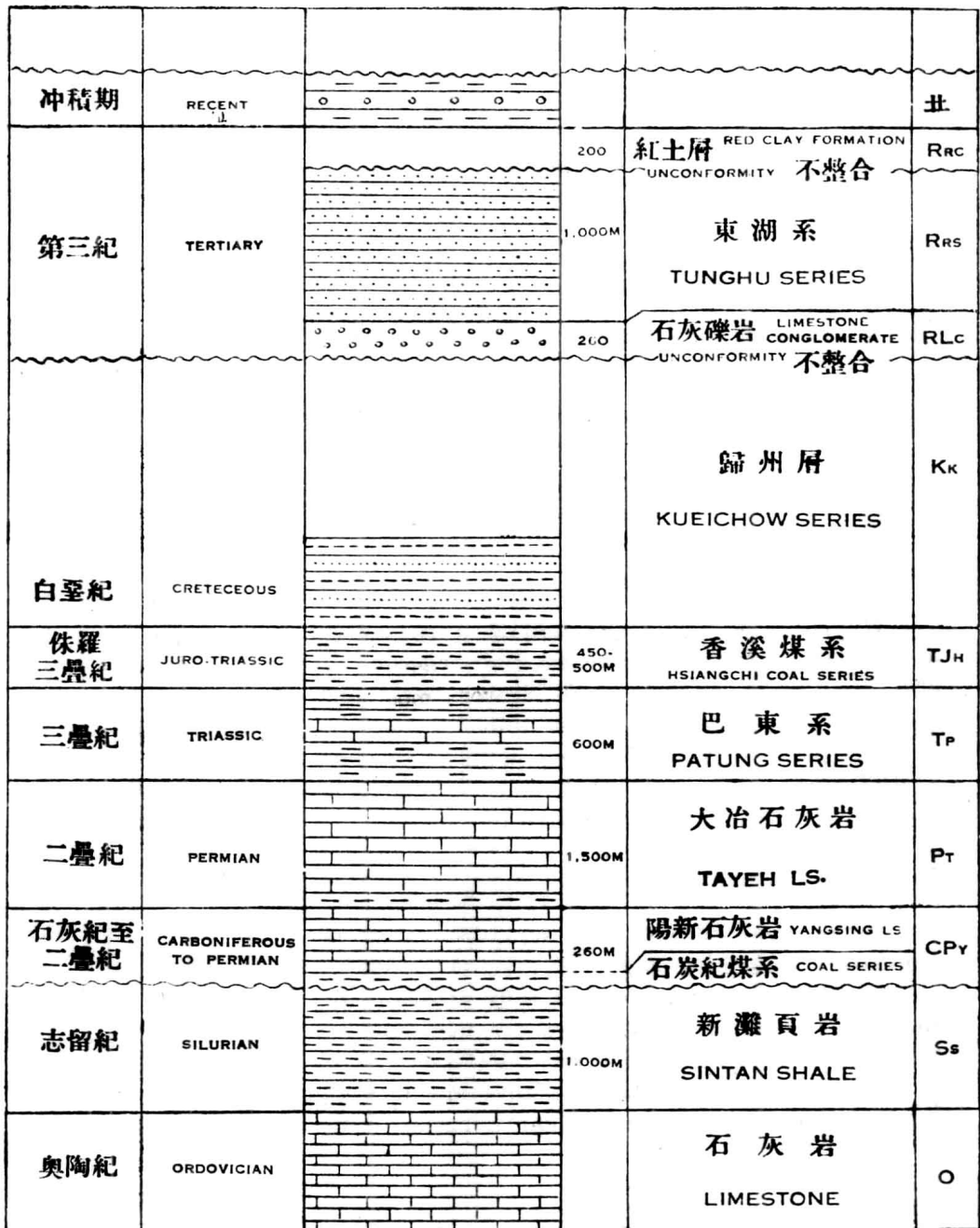
From the data recorded during the survey, one geological map and several sections are made, using the topographical sheets issued by the Hupeh Military Survey as a base. The areas to the north of Nanchang and within the district of Hsiangyang are only partly mapped.

II. STRATIGRAPHY.

Age.	Formation.	Thickness.
9. Recent	Alluvium	
8. Tertiary	b. Red Clay Formation.....	200 m.
	—Unconformity—	
	a. Thin-Bedded Red Sandstone...	1000 m.
	Limestone Conglomerate.....	260 m.
	—Unconformity—	
7. Cretaceous	Kweichow Series	?
6. Juro-Triassic	Hsiangchi Coal Series.....	400-500 m.
5. Triassic	Patung Series	600 m.
4. Permian	Tayeh Limestone.....	1500 m.
3. Upper Carboniferous to Permian	Yangsing Limestone.....	260 m.
2. Lower Silurian	Sintan Shale	1000 m.
1. Ordovician	Limestones	?

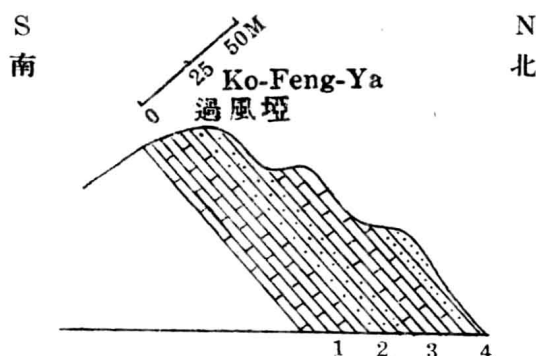
1. Ordovician Limestones.

Distribution. The distribution of the Ordovician formation in the area surveyed is not very extensive. Near Nanchang, in Chien-Tse-Ko, several fossils were found. They were mostly *Orthoceras* of Ordovician age. Here and there in the same locality some carbonaceous strata are found and the natives often worked them for coal. From Lungchun going southwestward, first we found the Permian and the Carboniferous limestones, then the coal series, then the Silurian shales which latter yielded the index fossil, *Encrinurus rex*. Below this formation, we met, at Wu-Chia-Chi, the Ordovician limestone sometimes cherty and sometimes interbedded with red clay layers or grey shales almost devoid of fossil. This limestone exhibits the same dip as the Silurian shales, i.e. northeast. From Wu-Chia-Chi to Nanchang, a part of this limestone has been eroded away being covered by a limestone conglomerate of Tertiary age. At Ko-Fen-Ya (Fig. 2), and Lau-Kwan-Miao, the Ordovician limestone contains some quartzitic layers. The same formation which crops out to the north of Hsiao-Chi-Tse are all very much weathered and fractured. Most of the strata give a brecciated appearance. Below this brecciated limestone there is a thin carbonaceous stratum about $1\frac{1}{2}$ meters thick. This material has been now and then worked by the natives for coal. The Ordovician limestone below the carbonaceous stratum is highly siliceous and dips northeast. It is well stratified; each stratum is about one meter in thickness. Locally it contains some cherts.



第一圖 南漳遠安當陽地質柱形圖

Fig. 1. Columnar Section of Nanchang, Yuan-an, Tang-yang Districts.



第二圖 吳家集東—過風壩奧陶紀岩石剖面圖
Fig. 2. Section of Ordovician Limestone at Ko-Feng-Ya.

- | | | |
|----|-----|------------|
| 4. | 石英岩 | Quartzite. |
| 3. | 石灰岩 | Limestone. |
| 2. | 石英岩 | Quartzite. |
| 1. | 石灰岩 | Limestone. |

Going westward to the district of Yuan-An, as one approaches the divide between Yuan-An and Ichang, a layer of argillaceous limestone of Ordovician age is found below the Sintan shale. Twenty-five meters lower from the contact between the Sintan shale above and the Ordovician limestone below, there is a very thin (about 3 inches thick) argillaceous layer which is nearly filled up with *Orthoceras sinensis* Foord. The largest attains a length of 4 to 5 feet. The area to the west of Hsiang-Yo-Pin and Ko-Chia-Ya was surveyed in 1924 by C. Y. Hsieh and Y. T. Chao of the Geological Survey.¹ The Ordovician limestones extend further west and south along the eastern limb of the Huangling Anticline.

Correlation. Basing on the fossil evidence of some Ordovician *Orthoceras* found in Chien-Tse-Ko, near Nanchang, and the position in the stratigraphical column that they underly the Sintan shale, the limestones that occur in discontinuous patches along Wu-Chia-Chi to Nanchang are denominated as Ordovician limestones. West of Yuan-An Hsien at Hsiang-Yo-Pin, an argillaceous limestone is found. *Orthoceras sinensis* Foord occurs abundantly in that horizon. This argillaceous limestone

¹ C. Y. Hsieh and Y. T. Chao: Geology of Ichang, Hsinshan, etc. Districts, W. Hupeh, Bull. Geol. Sur. of China, No. 7, Dec. 1925, pp. 13-76.

lies directly below the *Graptolite* shale of the Sintan series. The rock-character, the stratigraphical position, and the fossils found therein may well prove that this argillaceous limestone corresponds, in many respects, to the Neichiashan formation of the Gorge District² which is of the middle Ordovician age.

2. The Sintan Shale.

Distribution. Near Lungchun, Hsiangyang Hsien, the Sintan shale consists, in its upper part, of more than ten meters of rather compact greenish shale with *Encrinurus rex*, and in its lower part of some layers of fissile shale of various colors chiefly greenish yellow. Within this fissile shale there is another bed rich in *Encrinurus rex*. To the south of Nanchang near Hsiang-Hsuei-Tung, the same shale again occurs. This band of shale comes into direct contact with the Permian and the Carboniferous limestones at Kwan-In-Tang on the south and with the Ordovician limestones at Chien-Tse-Ko and Hsiao-Chi-Tse on the north.

Along Hsiang-Yo-Pin, the Sintan shale forms a continuous high ridge following its strike with a nearly vertical escarpment. Thus looking from a distance at the escarpment, it appears as a mighty city-wall. Here the upper part consists of compact greenish or yellow shale; the middle part consists of fissile shale of various colors; and the lower part is a dark grey to black shale containing abundant *Graptolites* which become even more abundant toward the bottom of the formation. The whole sequence is exposed from Hsiang-Yo-Pin to Huai-Hsu-Tien for about 8 *li*, locally folded into small and broad anticlines and synclines. Because of these gentle folds, it is difficult to estimate the real thickness of the whole formation, which probably amounts to 1,000 meters.

The lower part of the Sintan shale along Wu-Chia-Chi is covered by alluvium, and its contact with the Ordovician limestone below cannot be examined. About 4 *li* west of Hsiang-Yo-Pin, near a small bridge, there appears some argillaceous limestone (Ordovician) below the dark grey Sintan shale. The argillaceous content in the limestone decreases as one goes down from the top of the Ordovician limestone; some thirty meters lower pure limestone appears. This fact indicates that the transition from the Ordovician to the Sintan period is a gradual one. In the lower part of the Yangsing limestone near its contact with the Sintan shale, there is a

² J. S. Lee: *Geology of the Gorge District of the Yangtze, etc.*, Bull. of the Geol. Soc. of China, vol. III, No. 3-4, 1924, pp. 304-306. C. Y. Hsieh and Y. T. Chao: *op. cit.*, pp. 31-33.

coal series. This stratigraphical relation holds true in Lungchun and in Shih-Chiao-Pin. The coal series are often interbedded with layers of quartzite. This shows two periods of marine deposition intervened by a period of continental coal formation. Although there is no evident break between the Sintan Shale below and the Yangsing limestone above, the phenomenon of two marine phases interrupted by a continental one gives good ground for inferring a stratigraphical disconformity.

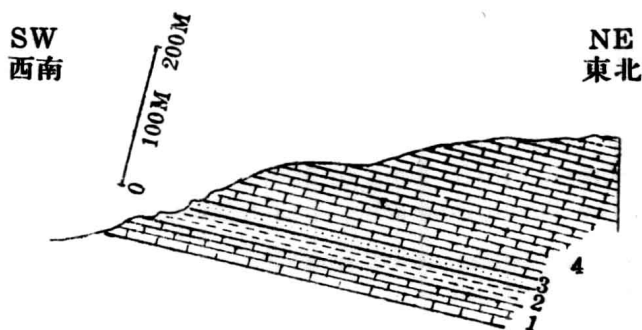
Correlation. Owing to the limited distribution of the Sintan shale in the area surveyed, no attempt is made to sub-divide the formation as is done by other writers.³ At Lungchun, two separate beds containing *Encrinurus rex* were found: one occurring in the compact greenish shale just below the Carboniferous coal series, while the other present in the yellow fissile shale about 40 to 50 meters from the top of the Sintan shale. *Encrinurus rex* may be considered as the index fossil of the Sintan shale. To the west of Hsiang-Yo-Pin, just above the Ordovician argillaceous limestone beds, abundant *Graptolites* were found in the dark grey to black shales. Following upward from this basal *Graptolite* shale there lies the greenish compact to fissile shale. Thus on the fossil evidence of *Encrinurus rex*, the upper limit of the Sintan shale is determined; and the basal part of the same formation is ascertained by the *Graptolite* bearing beds.

3. The Yangsing Limestone.

Distribution. Near Lungchun above the Carboniferous coal series, the Yangsing limestone is represented by a layer of massive coral limestone with abundant cherty inclusions. Its upper part consists of quartzite and limestone intercalations. The limestone at the top of the formation becomes highly siliceous causing the rock to show alternating white and grey bands. The white bands are usually calcareous and the grey ones siliceous. The middle part is composed of thin-bedded limestone interbedded with thin beds of quartzite and greenish shale. The quartz layers become thicker and thicker toward the upper part of the formation; some of them may reach a thickness of several feet. The lower part consists of limestone with abundant cherty inclusions and corals, and with a coal series at the base. The lower cherty limestone is about fifty meters thick, while the total thickness of the formation amounts to 260 meters.

³ J. S. Lee: op. cit., pp. 306-309.
Hsieh and Chao: op. cit., pp. 33-46.

The same formation which crops out at Peng-Chia-Po (about 12 li west of Shih-Chiao-Pin, Fig. 3) is entirely made up of cherty limestone. The cherty inclusions are very abundant and uniformly distributed throughout the formation. At the base there is a layer of white quartzite about 10 or more meters in thickness. Below this quartzitic layer is the coal series about 30 meters thick, and consists chiefly of shaly strata. The average thickness of the coal seam is 18 inches. Beneath the coal series is a thin layer of crinoidal limestone. The boundary between the Yangsing and the Tayeh limestones is also marked by a coal series which is exposed at Liang-Ho-Ko, west of Yuan-An. But the coal from these measures is of very inferior quality. Along with the coal seam in the coal series, one often finds a layer of deep red material, chiefly consisting of hematite which commands a better price as pigment at Liang-Ho-Ko than the coal it contains.



第三圖 彭家坡附近剖面圖
Fig. 3. Section at Peng-Chia-Po.

4. 礫石石灰岩 — Cherty Limestone.
3. 石英岩 — Quartzite.
2. 煤系 — Coal Series.
1. 含海百合節灰岩 — Crinoidal Limestone.

General Character. This formation lies disconformably above the Sintan shale with its upper part containing some quartzitic layers and its middle and lower parts consisting of chiefly cherty limestone. Near its bottom there is a coal series which is often lenticular. The coal seam attains, in rare occasions, a thickness of two to three feet, as for instance that mined in Shih-Chiao-Pin, west of Yuan-An Hsien.

Correlation. The name, Yangsing limestone, was first applied by

Hsieh and Liu⁴ to a massive cherty limestone containing abundant brachiopods, corals, foraminifera, etc. in Yangsing, E. Hupeh. In a later publication, Hsieh and Chao⁵ correlated it with the lower part of the Wushan limestone in the Yangtze Gorge District. Since the Yangtze Gorge lies geographically farther west from the type locality, Yangsing, than the districts of Nanchang, Yuan-An and Tangyang, it is even more plausible to apply the name, Yangsing, to the limestone of the same character in the latter districts. This limestone, distributed in Nanchang and Yuan-An occurs directly above a coal series and below the thin-bedded Permian limestone. It is also cherty and contains abundant corals as described before. Therefore, from correlations done by previous writers and from the rock character and the stratigraphical position, the limestone at Lungchun, Shih-Chiao-Pin, etc. can justifiably be denominated by the name, Yangsing. Its stratigraphical position ought, then, to range from Upper Carboniferous to Lower Permian.

4. The Tayeh Limestone.

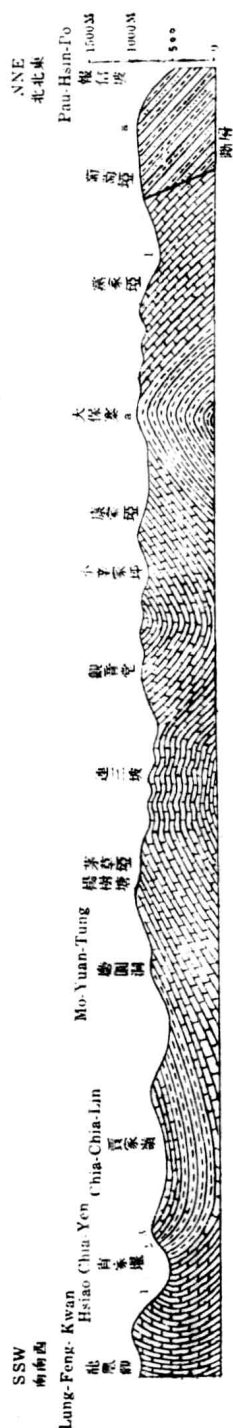
Distribution. The lithological character of this formation varies at different places. The total thickness is somewhere over 1,500 meters. The section from Kwan-In-Tang to Hsiao-Chia-Yen, mostly showing the upper part of the Tayeh limestone, is as follows:

G. Cellular and weathered limestone with veins of large calcite crystale	300 m.
F. Massive limestone with lenses of cherts.....	100 m.
E. Thin-bedded and slaty limestone.....	100 m.
D. Argillaceous limestone	30 m.
C. White massive limestone	50 m.
B. Red slaty limestone	80 m.
A. Massive limestone	?

From A lower down the limestone assumes a thin-bedded character still belonging to the Tayeh limestone (Fig. 4). This thin-bedded limestone is exposed from Kwan-In-Tang eastward to Lung-Fen-Kwan. To the west of Yang-Pin, not far from Men-Shan-Tung, and along Lo-Han-Yu, the same thin-bedded limestone is developed. Near Liang-Ho-Ko, there

⁴ C. Y. Hsieh and C. C. Liu: Outline of Geology and Ore Deposits of Hupeh, published by Hupeh Industrial Bureau, 1924.

⁵ Hsieh and Chao: op. cit., pp. 46-47.



第四圖 龍鳳崗至報信坡剖面圖
 Fig. 4. Section from Lung-Feng-Kwan to Pan-Hsin-Po.
 2. & 3. 巴東系 Patung Series.
 1. 二疊紀與石炭紀灰岩 Permian and Carboniferous Limestones.
 a. 志留紀頁岩 Sinton Shale.

lies, in the middle part of the Tayeh limestone, a few fossiliferous beds containing crinoid joints, imperfect brachiopod shells, etc. Lower down approaching a shale series, some ostracods (?) were found on the northern bank of a small stream where a paper mill is located.

Towards the top of this formation which directly underlies the Patung series, the rock becomes very cellular in structure as if it had been exposed for a long period of weathering before the deposition of the Patung series. Most of the lime content was dissolved, and some redeposited in situ. The rocks are spongy in appearance, and full of solution holes which are lined with small calcite crystals. Part of the lime in solution was carried further down and deposited in cracks and fault-fissures as calcite veins with its crystal as long as one foot. These two properties of the upper part of the Tayeh limestone—(1) cellular structure with calcite crystals lining the cavities, (2) calcite veins with crystals of fairly large size—are the spectacular points of the formation at its contact with the Patung series.

Correlation. The Tayeh limestone is correlated in the same way as the Yangsing limestone,⁶ and needs no further discussion except that it is separated from the Yangsing limestone below sometimes by a coal series, and the main feature of the entire formation is its thin-beddedness.

5. The Patung Series.

Distribution. This is the most widely distributed formation in the area surveyed. It first appears at Hsiao-Chia-Yen, forming the Hsiao-Chia-Yen basin. It then occurs at Lo-Pin, Tungkung, around the

⁶ Hsieh and Liu: op. cit.; Hsieh and Chao: op. cit., pp. 46-53.

Hsiangchi coal series, Hsin Chien-Si and Hsia-Ko. In the southwestern part of the area surveyed, it is distributed along the synclinal basin from Yang-Pin to Yuan-An whence flows the present Chu River. The section at Tungkung showing the entire Patung series as follows:

- E. Purple shale 134 m.
- D. Yellow shale and thin beds of limestone intercalations. . 41 m.

NOTE:—From the top of these intercalations down about two meters, there is a thin bed of limestone which is capped by a thin sheet of yellow shale and consists of three layers: all rich in crinoidal joints, especially the upper and the lower layers. The thickness of this thin bed of limestone is about 60 centimeters.

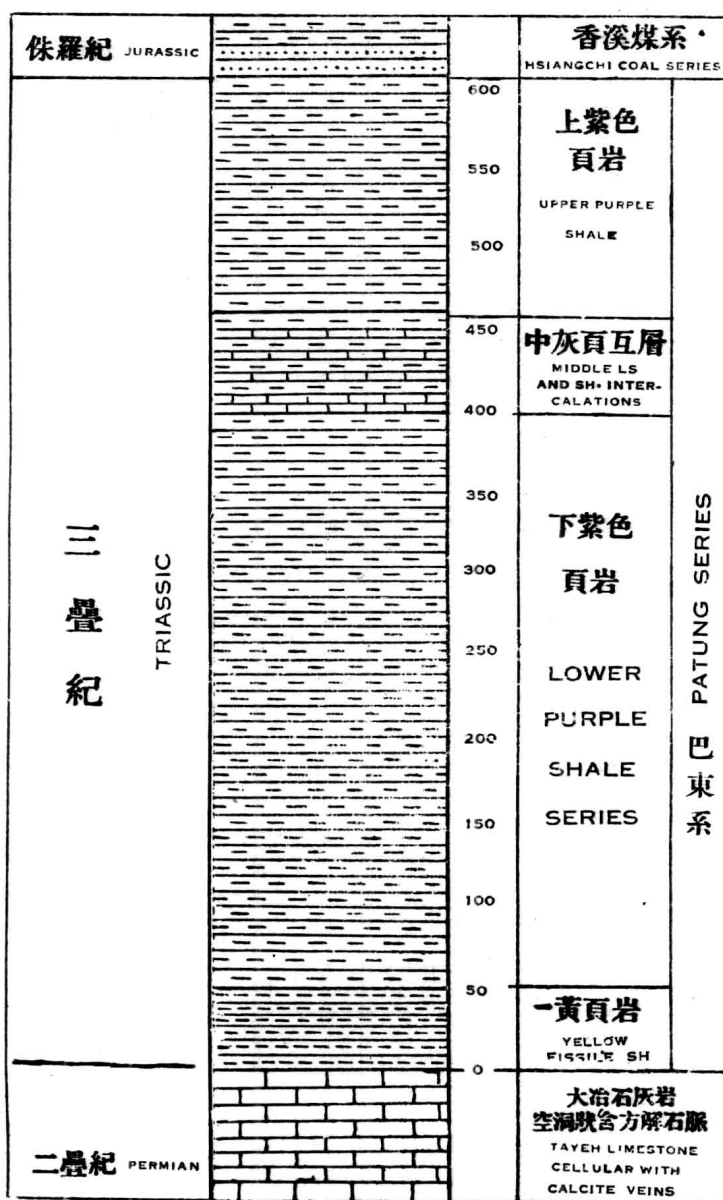
- C. Limestone 24 m.
- B. Purple shale 350 m.
- A. Yellow shale 50 m.

(See also Fig. 5, 6 and 7).

As developed near Yuan-An, this formation shows a different lithological character from that of Tungkung. In the former place, the middle calcareous layers (C and D) are thickened, and become more purely calcareous; while the shaly layers diminish with the tendency to form a continuous limestone series totaling about 150 meters thick. Often the limestone alone crops out as a continuous ridge with its foothills on both sides covered with purple shales. This is eminently the case in the In-Tse Shan, Yuan-An, and in the hills near Fu-Chia-Ho, Lo-Han-Yu, etc. According to Hsieh and Chao,⁷ the Patung series attains a thickness of 800 meters in the vicinity of Patung. The limestone in the series is about 300 meters thick. "In the Hsiang-chi valley 25 li east of Tze-Kuei Hsien, the Patung series is mostly absent. Only at one place on the left bank of the Hsiangchi river below Pei-Ma-Tan, did we see a little outcrop of purple shales lying beneath the coal series. . . . This irregularity in the distribution of the Patung series may be interpreted in two ways. (1) the Patung series was only sparingly deposited along the Hsiangchi valley. . . . (2) The Patung series was deposited in the Hsiangchi valley same as in Patung Hsien but was again mostly eroded away before the deposition of the Hsiangchi coal series. . . . At any rate, the break at the base of the Patung series seems to be widespread, while that on the top is only local though the latter may be very profound along the Hsiangchi valley." ⁸ The break at the base of the Patung series as mentioned by Hsieh and Chao agrees

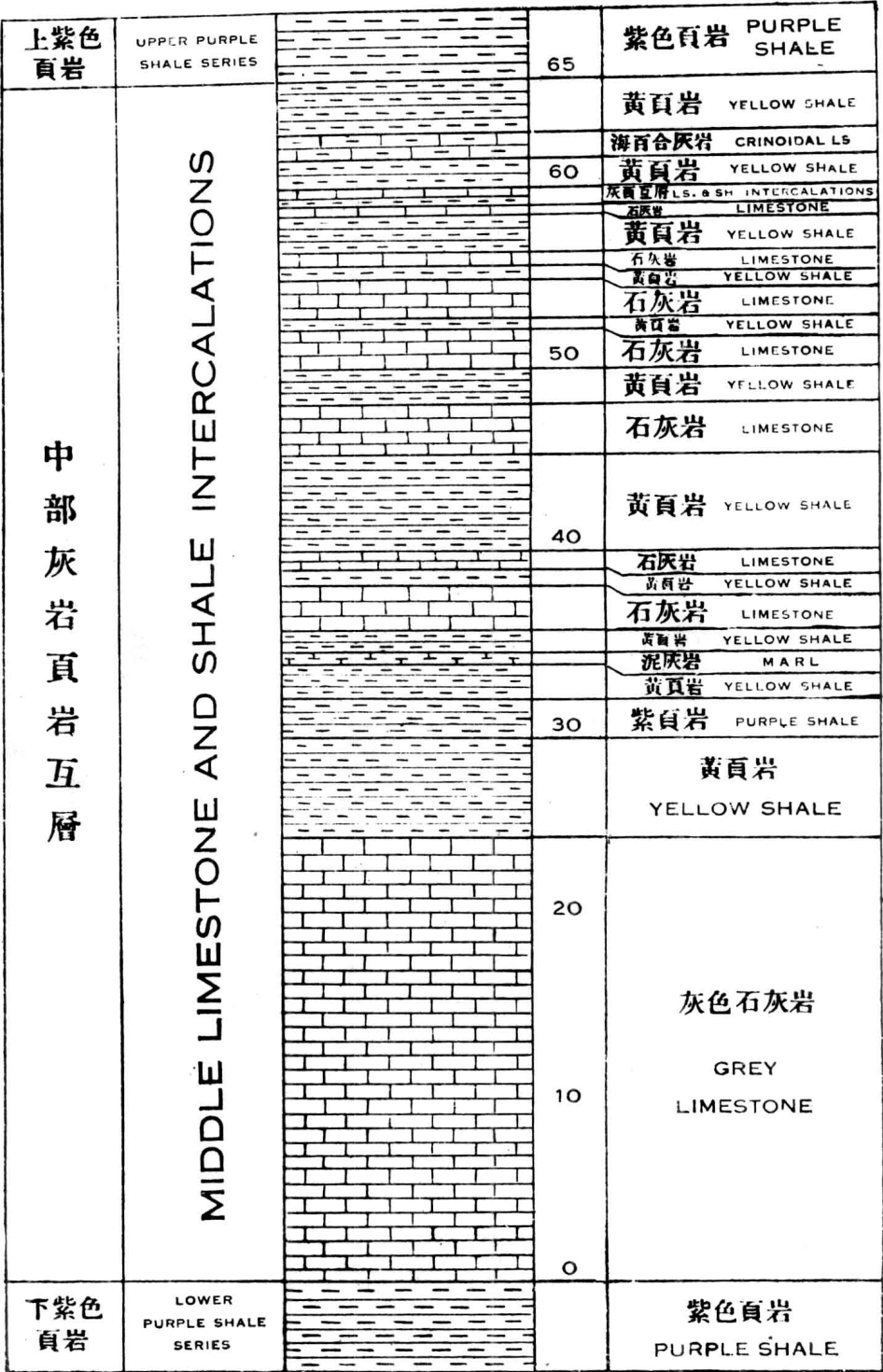
⁷ Hsieh and Chao: op. cit., pp. 53-56.

⁸ Hsieh and Chao: op. cit. pp. 53-54.

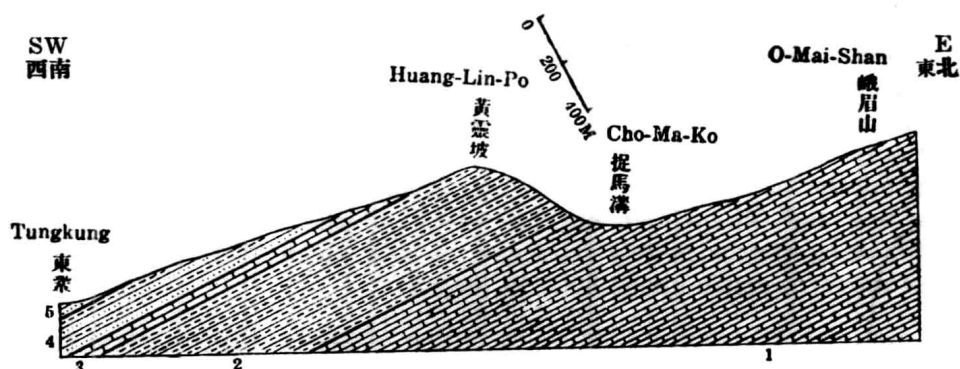


第五圖 東壘一帶巴東系柱形圖

Fig. 5. Columnar Section of the Patung Series around Tungkung.



第六圖 巴東系中部在東壘一帶柱形圖
Fig. 6. Columnar Section of Middle Patung Series around Tungkung.



第七圖 東羣迄峨眉山剖面圖

Fig. 7. Section from Tungkung to O-Mai-Shan.

5. 香溪煤系 — Hsiangchi Coal Series.
 2, 3 & 4. 巴東系 — Patung Series.
 1. 二疊石灰岩 — Permian Limestone

with the observation of the writer that the top of the Tayeh limestone often appears very much weathered and earthy. But the discontinuity at the top of the Patung series has not been observed in the area surveyed. Its total thickness and that of the limestone member are slightly different at various places. In Patung,⁹ the total thickness amounts to 800 meters, and the middle limestone member has a thickness of 300 meters. In the western part of the area surveyed, as in the vicinity of Yuan-An (Fig. 13), the thickness of the middle limestone member thins down to 150 meters. Going westward to Tungkung and Hsiao-Chia-Yen, the middle limestone becomes even thinner, to about 60 meters thick, and the total thickness of the series thins down to 600 meters.

This series is capped on the top conformably by the green sandstone of the Hsiangchi coal series and followed at the base disconformably by the weathered limestone of the Tayeh formation.

Correlation. The correlation of this formation in the area surveyed with that at its type locality, Patung, is entirely based on its lithological character and stratigraphical relation. In Patung,¹⁰ this formation likewise disconformably overlies the Tayeh limestone, and is characterized by a tripartite division, namely, two thick series of purple shale forming its upper and lower parts with a thin-bedded limestone in between.

⁹ Hsieh and Chao: op. cit. p. 56.

¹⁰ Idem.

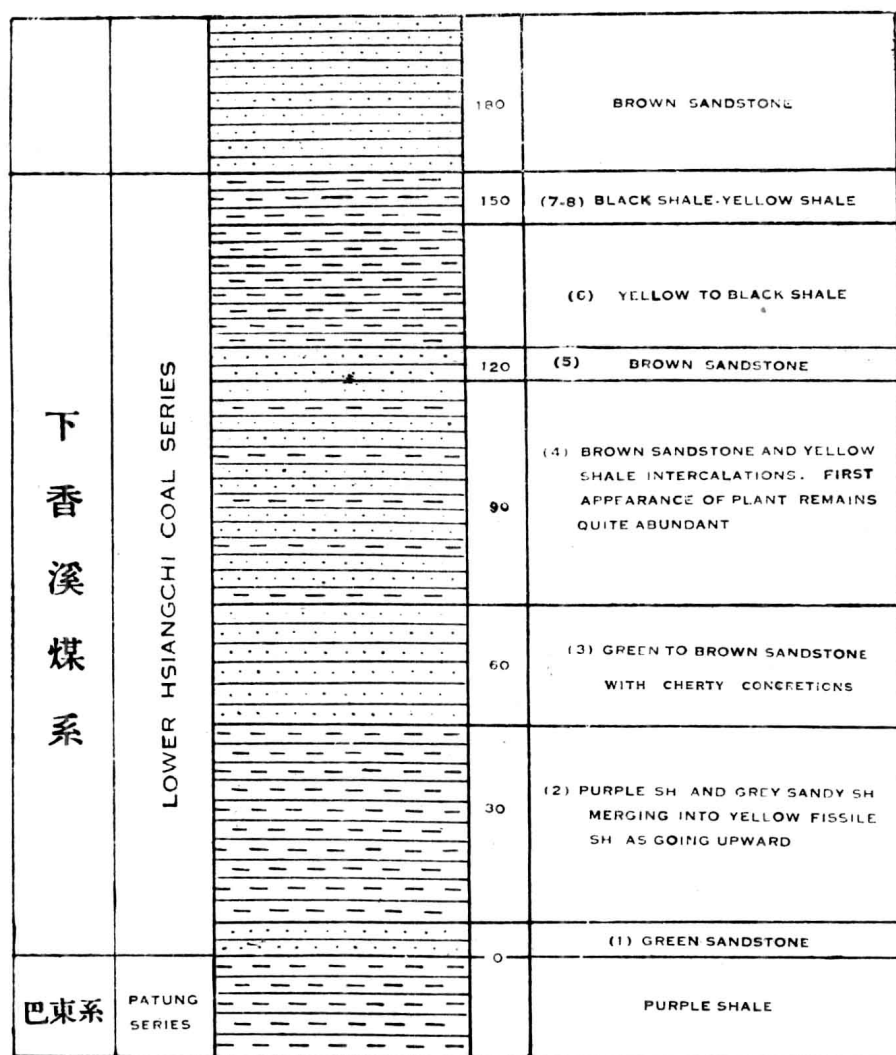
6. The Hsiangchi Coal Series.

Distribution. The Hsiangchi coal series is distributed along the margin of a synclinal basin in the central part of the area surveyed. This basin corresponds nearly to the central part of the Tanyang Syncline. The areal distribution of this series extends up to Tungkung and Lo-Chia-Wen on the north, Kwan-In-Tse and Kwan-Miao-Pin on the east, Shih-Ma-Chao and Miao-Chien on the west, and the Chieu-Tse-Shan on the south, being approximately from east to west about 30-40 *li* in width, and from north to south about 80 *li* in length.

General Character. This formation consists chiefly of shale and sandstone intercalations. Sandstones are of green, white, brown and yellow colors; and the shales are of yellow, brown, grey, to black colors. The thin-bedded sandstones and shales contain abundant plant remains. The whole series is predominantly a sandstone series. Most of the coal seams occur near the upper two hundred meters, and the coal produced is mostly anthracite. The total thickness of the coal series is about 450 to 500 meters.

The lower part of this series consists of the following sequence of strata:—

- | | |
|---|-------|
| 8. Yellow shale | 7 m. |
| 7. Black shale | 3 m. |
| 6. Yellow to black shale | 27 m. |
| 5. Brownish yellow sandstone | 6 m. |
| 4. Brown sandstone and Yellow shale intercalations, sandstone predominant | 46 m. |
| Its upper part is of thin-bedded sandstone and yellow, grey to black fissile shale. Plant remains first appear in this horizon, when examining in an ascending order. | |
| 3. Green to brown sandstone with a thin layer of black shale in between | 25 m. |
| The yellow shale usually contains elliptical concretions, the shells of which are composed of chert and the nuclei of loose yellow to red sand-grains. This feature is typical in the lower part of the Hsiangchi coal series and can be used as a criterion in the field for identification. | |
| 2. Purple shale and very sandy shale merging into a yellow fissile shale | 41 m. |
| 1. The lowest, a layer of greenish compact sandstone | 8 m. |



第八圖 下香溪煤系與巴東系接觸處岩層柱形圖

Fig. 8. Columnar Section of the Lower Hsiangchi Coal Series near its Contact with the Patung Series.

The rocks succeeding 8 upward are mostly brown sandstone with intercalated yellow or black shales, while those below 1 are purple shales of the Patung series. (Fig. 8).

The entire Hsiangchi coal series can be divided according to its lithological character into three parts as follows:

3. Interbedded sandstones and shales.....150 m.
Sandstones predominate. The shales vary in color from green, brown, yellow to black. The color of the sandstone varies from grey to yellow. There are three coal seams seen in this division, and are mined at Wei-Chia-Wen, Mei-Tse-Ya, etc. The entire division is scattered with plant remains especially the top part.
2. The sandstone division100 m.
In this division, thick-bedded sandstone predominates. Thin-bedded sandstones and shales occur occasionally. A coal seam belonging to this division is mined at Chow-Chia-Wen, about 4 *li* south of Tungkung. The sandstones are very easily weathered to loose sand grains such as those exposed near Hsin-Chia-Ya.
1. The shale division150-200 m.
Variegated shales dominate this division, but they are now and then intercalated with greyish white or brown sandstones. In the middle part of this division (Fig. 9) there occurs a coal seam being mined in Pi-Chia-Wen near Tungkung.

Correlation. Pending the precise determination of the numerous plant remains, this formation is tentatively correlated with the Hsiangchi coal series of the Gorge District.

7. The Kweichow Series.

Directly above the Hsiangchi coal series, there appears a series of green sandstone and purple shale intercalations. The series is very well developed at the type locality, Kweichow, whence the name was derived.¹¹ In the area surveyed this series is sparingly distributed. It is only exposed in the Kwan-Miao-Pin Syncline, which is situated from north to south between Liang-Ho-Ko and Yu-Chi-Ho, and from east to west between Kwan-Miao-Pin and Kwan-In-Tse. Thus only a part of the series is seen. From the limited observations, it appears to consist chiefly of green sandstones and purple shales. Thickness is not determined, and the contact between the Hsiangchi coal series and the Kweichow series does not appear unconformable.

¹¹ J. S. Lee: op. cit. pp. 313-315.
Hsieh and Chao: op. cit. pp. 63-66.