

GEOLOGY OF KENKOU ON THE HUNAN-KWANGTUNG  
BORDER AND ITS BEARING TO THE OROGENY  
OF THE NANLING RANGES\*

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INTRODUCTION

In the winter of 1932 and the spring of 1933, the Nanling Mountain ranges covering the borders of Hunan, Kwangtung, Kwangsi and Kueichou were studied by the members of the National Research Institute of Geology, Nanking. These ranges lie between the Yangtze and Chükiang valleys running in the direction of E.NE.-W.SW.; but it is unexpected that the geological structure of the strata from Middle Devonian to Triassic in the region shows a main axis of the Nanling range. This very significant point was always born in mind throughout our journey.

In the end of our trip, we came to the Kenkou district on the border between Juyuanhsien, Kwangtung and Ichanghsien, Hunan. A geological sketch with an approximate scale of 1:50000 was made there. In order to make the structure clear, the deposits of the red clay and alluvium are omitted. As shown on the sketch map, the general strike of the Kenkou Series of Jurassic age differs to a notable extent from that of underlying Carboniferous-Permian Limestones. Such a condition may, of course, be brought about by tectonic disturbances which explain the uplift of the Nanling ranges.

After our Nanling trip, much new stratigraphic informations have been collected. In order to bring out the points clearly, it is necessary to sub-divide the geologic units of this region. The stratigraphy was revised and the new sub-divisions used in this paper will agree with the stratigraphic classification of the Nanling range to be published by the National Research Institute of Geology.

In 1929 and 1930 the Geological Survey of Kwangtung and Kwangsi published two papers<sup>1</sup> about the geology of Kenkou district and its vicinity.

\* Received for publication in December, 1933.

1. Annual Report of the Liang-Kwang Ti-Chih-Tiao-Cha-So, Vol. 2, Part 2, Page 24, and Vol. 3, Part 2, Pages 70-89.

Kouyatung coal field. They gave a brief account of the structure and the rocks underneath the Jurassic Series. At the same time, they published a Memoir<sup>1</sup> in which Dr. Chang Hsichih proved that those fossils coming from Kenkou coal pits belong to the Lower Jurassic. A list of forms has been given as follows:

*Teniopteris maclellandi* (?) Old. and Morr.

*Podozamites lanceolatus* (L. & H.)

*Ptilophyllum acutifolium* Morr.

*Pterophyllum nathorstii* Schenk

*Nilssonina* cf. *princeps* Old. and Morr.

#### TOPOGRAPHY

Kenkou is a small market-place about 600 m. north-northwest from the Hunan-Kwangtung border. The boundary line runs along the hill-range Maotzufeng, Pingshuila, Kuahsienp'ai and Patzuling in the N.60-70°E. direction. This range known locally as Kuahsienp'ai, extends 6 Km. east-northeastward and 15 Km. west-southwestward. It has a width about 1.5 Km. and a height about 500 m. above the river bed of Liaoshuiho which runs nearby.

On the northern side of the range, there is a flat plain with red clay and alluvial covering. About 1.8 Km. northwest of Kenkou, some small hills, known as Langpeishan and Chishanhsia, reach a height of about 100 m. On the west side of Chishanhsia, a range of hills about 200 m. in height runs along the south-southwest direction and crosses the river Chingshanhsia and thus makes the course of Liaoshuiho to diverge southwards. Farther northwest, the greater part of the area is covered with red clay and alluvium, and only a few isolated limestone hills, such as Niukuling, Laowangchung and those near Liyuanpao stand out here and there.

On the south-southwest side of the Kuahsienp'ai range, a valley lies along the Liaoshuiho in the southwest direction, beyond which there

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1. The Geological Survey of Kwangtung and Kwangsi, Palaeontological Memoirs, Vol. I, Part 2.

is a large area of high ground; such as Tienpingao and Houtzuchieng; these are two distinct and broad ranges of N.NE.-S.SW. trend with a height not lower than the Kuahsiemp'ai itself.

In this region, Liaoshuiho is the only river, that comes from the southwest near Shihwangchiao passes Chüchiachung turns northward at Lichiap'ai, and cuts a gorge through the Kuahsiemp'ai range. As soon as it reaches Kenkou it diverges its course northwestwards. Another gorge is found between the north of Chingshanhsia and south of Chishanhsia as the river flows west-northwestward. In the south of Liyuanpao another river joins up the Liaoshuiho and runs in a east-northeast direction to Pingshih, known as Wushui.

In this district, with the exception of a small stream coming down from Chimuking and joining the Liaoshuiho at Lichiapai, there is no other water flow could be seen. This may be due to the previous limestone underneath.

#### STRATIGRAPHY

The older rock to be found in this area is undoubtedly the Kuhua Limestone of Upper Devonian as it underlies the Shihzuhsü Series of Tournaisian in the east of Liyuanpao, but they are confined in the northwest area of the Kuahsiemp'ai range. Other formations, such as Linwu Series of Viséan, Maping Limestone (Chuanshan Limestone) and Chihsia Limestone of Permian are also present; and they are exposed in the south side of the Kuahsiemp'ai range. No other younger formation has been noticed until Jurassic rock is reached. This Jurassic coal series, although well exposed, has its top part been faulted out. Owing to the tectonic disturbances it is impossible to make a section of their successions in detail. However, in each formation, we found more or less palæontological evidences, which are sufficient in identifying the strata.

These may be described as follows.

#### UPPER DEVONIAN

Kuhua Limestone:—On the west of Chishanhsia and Chingshanhsia, this limestone crops out as isolated hills, mostly covered by red clay, up to the east of Liyuanpao, and, hence westward, the Tournaisian Limestone is found resting upon the Kuhua Limestone.

On the southeast 1.5 Km. of Liyuanpao, there is a hill, known as Niukuling, composed of gray thin bedded limestone, which is sometimes so thin as several layers making an inch; and this gray limestone is partly interbedded with pink shaly limestone. It strikes N. to N.20°E. and dips 70-80° westward. Here fossils are rare, but *Cyathophyllum* cf. *lantenosi* Mansuy is noticed.

About 500 m. north of Changtieng, on the north bank of the Liaoshui river, the same thin bedded gray limestone with much calcite is exposed again on the road. It has a N.30°E. strike and a dip 75° northwestwards.

About 150 m. on the west of Chishanhsia, the exposed limestone has a laminated structure and red partings striking N.20-30°E. and dipping 60° westward. It is overthrust upon the Shihtzushü Limestone of Tournaisian in the vicinity of the Chishanhsia village. The thrust-escarpment stands in line with the limestone hill of Chingshanhsia in the northeast-southwest direction and is also composed of the same limestone.

The Upper Devonian limestone has a fairly uniform character throughout this area, although its thickness is unknown.

#### LOWER CARBONIFEROUS

Shitzuhsü Series (Tournaisian):—This series is distributed in two parts of the region; one is in the vicinities of Liyuanpao and Shihpalan, and the other in the district between Kenkou and Chishanhsia.

On the northern side of Liyuanpao village, there are two isolated hills composed entirely of the dark gray and thick bedded limestone which has been quarried for building purposes and in which many *Cystophrentis* sp. and *Caninia* sp. are found here and there. These fossils are also noticed in Shihpalan.

On the back hill of the Chishanhsia village, the Shihtzushü Limestone containing *Cystophrentis* sp. reappears and is thrust over by the Kuhua Limestone. Again, in Lanpeishan, northeast of the same village, the Tournaisian beds have been involved in strong folding, and overturned toward the south.

At about 500 m. S.80°E. from the back of the Paimaochow village, a limestone quarry shows that the Tournaisian Limestone thrusts on the Jurassic coal bearing series. Along the thrust line farther west-southwest, another limestone quarry situating about 1 Km. south of Niuhsiling, exhibits the exact contact of the thrust.

At last, in the southeast of Kenkou along the west bank of the Liao-shuiho just opposite the tavern in the main road, a block limestone is exposed at a distance about 40 metres from the outcrop of the Jurassic sandstone, and contains *Syringopora* sp.; it seems to belong to the Tournaisian.

As shown in the map, the area occupied by Shitzushü Limestone of Tournaisian is bound with two thrust-lines; one is overthrust by the Upper Devonian at Chishanhsia, and the other thrusting upon the Jurassic sandstone along Kenkou-Paimaochow line.

Linwu Series (Viséan):—This series is found in two localities, one of which is the southwest area of Lichiap'ai on the west side of the river where the dark gray limestone with cherty nodules crops out along the path-way near the east side of a small village (Shetsun) and contains *Productus edelburgensis* and *Lithostrosion* cf. *portlocki* E. & H. They are undoubtedly Viséan fauna. This limestone extends continuously to the foot of the northern hill and dives underneath the Jurassic basal conglomerate. Owing to the limit of the outcrop, the structure of the limestone is somewhat obscure. Following the way a little farther northwest, some sandstone and black shales crop out with a N.20-30°E. strike and a dip 40-45° northwestward. It may represent the top sandstone and shale of the Linwu Series, and it may be noted that this is usually the case in the Nanling range. Undoubtedly the limestone containing *Productus* is successively underlying them.

On the east hill of Fengmukang, there is another locality for Linwu Series. It is composed of a dark gray limestone with a N.20°E. strike and a dip 30-40° northwestward and has been so distorted that one may easily mistake the numerous joints and flexures for bedding planes. Some Viséan forms are present. On the west-northwest side of this limestone range, a series of coal bearing shales and sandstone form a valley which runs side by side with the range itself, and both extend south-southwest toward Tienpingao. Along this valley many

old coal pits and dumps are present, and these indicate the top part of Viséan and are overlain by the lower Permian limestone on the west-northwest.

#### LOWER PERMIAN

**Mapping Limestone (Chuangshan Limestone):**—The lower part of this limestone consists of a crystallized, partly silicified, hard and blackish limestone, the upper part consists of fine, white and massive limestone containing a great deal of *Fusulina*.

On the northwest of Shihwangchiao and west of the quarry near Tangtsun, the white massive *Fusulina* limestone is exposed well under the Chihsia Limestone; in the former *Schwagerina princeps* occurs. This form denotes the Chuanshan Limestone of Lower Permian. Again, walking from Shetsun westwards, after passing the top sandstone and shale of Viséan, the massive, black, fractured and silicified limestone appears at once. As soon as Tangtsun is reached, the white massive limestone containing *Schellwienia parvula* (Schellwien), *Schellwienia longissima* (Möller) crops out here and there.

From Lichiap'ai to Fengmukang, a distance not more than 600 m., both the black crystallized and white massive limestones of the Mapping Series are exposed on the way. Another locality for this limestone is situated about 500 m. north of Fengmukang. It contains *Schellwienia simplex* Schellwien, *Schwagerina princeps* Ehrenberg and is much foliated. This limestone continuously crops out to the south of Fengmukang and rests on the top of the Linwu Series on the east.

#### MIDDLE PERMIAN

**Chihsia Formation:**—This is well exposed in Shihwangchiao near Chuchiach'ung, and chiefly consists of dark gray limestone with cherty nodules. It rests on the Mapping Limestone on the west. *Tetrapora* sp. and *Michelinia* sp. are abundant. Farther north-northeast in a quarry near Tangtsun the same limestone is exposed with a N.20°E. strike and a dip 35° southeastward. It undoubtedly rests on the Mapping Limestone on the west side, but the exposure between the quarry and the Mapping Limestone near Tangtsun is somewhat obscure.



4. Whitish gray sandstone interbedded with a little shale, mostly covered. 50 m.
3. Chiefly black shales intercalated with a few sandstone beds containing two coal seams, the top one about 1 m. thick, and the other 2 m. thick. In the black shales many plant fossils are found. 40 m.
2. White fine and thin bedded sandstone. 10 m.
1. Dark gray to red conglomerates consisting of limestone pebbles, but in the basal part some large block of limestone about 2 metres in diameter containing Viséan fossils being noticeable. In the upper part light brown sandstone pebbles about 3 cm.-6 cm. in diameter. They are cemented with calcareous material. 40-70 m.

u. Unconformity

Cl. The Linwu Limestone (Viséan).

The total thickness of Kenkou Series ranges from 340 to 370 metres. It is an elongated and narrow uplift range along the N.60-70°E. - S.60-70°W. direction, from 1.5 Km. to 2.5 Km. in width and 60 Km. in length. The accompanying sketch only represents a portion of it. The plant fossils found in this series have been identified by Dr. H. C. Sze as follows:

*Equisetites* sp.

*Cladophlebis denticulata* Brongniart

*Dictyophyllum nathorsti* Zeiller

*Pterophyllum aequale* Brongniart

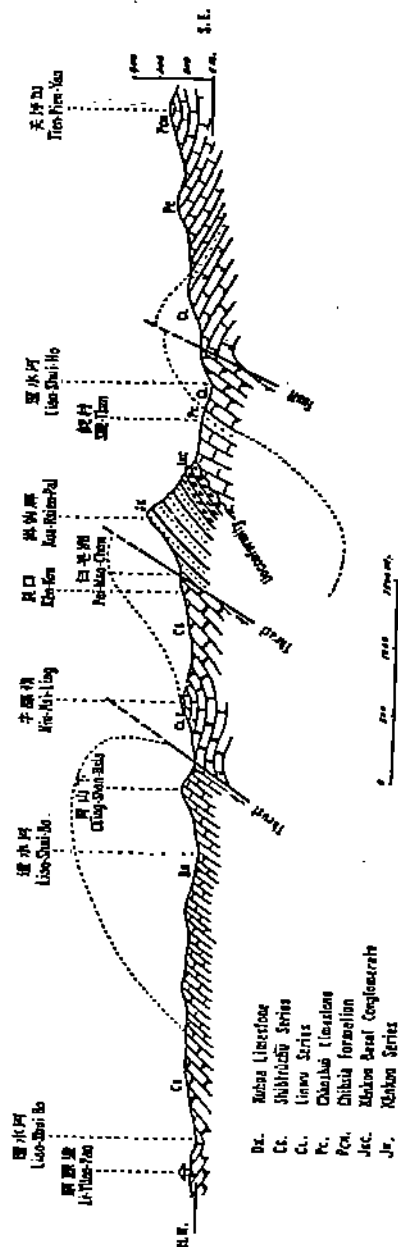
*Podozamites lanceolatus* (L. & H.) Braw

these species probably belong to (Rhät)—Lias.

Other younger formations as red clay and alluvium are present in the comparatively lower part of the region; but they are of no importance.



II. Section of the Kenkou District



### UNCONFORMITY

The folds of the Carboniferous-Permian strata are distributed on the south east region of the Kuahsiemp'ai range with a N.20°E. strike. But the Kenkou series of Jurassic age ranges along the N. 60-70°E. direction and dips 30-50° northwestward. The discordant angle between the two strikes is at least 40 degrees. The basal conglomerate of the Kenkou Series resting on the variation of Carboniferous-Permian formations could be accurately located along the northern line of Shetsun and Tangtsun.

It is thus evident that, the Jurassic rocks rest unconformably on an erosion surface of a series of folds of Carboniferous Permian strata; the accompanying sketch is almost self-explanatory.

### STRUCTURE

Folding:—On the northwest area of the Kuahsiemp'ai range, there are two synclines occurring in the Tournaisian Limestone; one is at the northeastern hill of Li-yuanpao and the other at Lanpeishan 1.5 Km. north of Kenkou. On the southeast area of the range, the Carboniferous-Permian beds folding into a series of anticlines

and synclines along the north-northeast direction underlies unconformably the Kenkou Series, which ranges in the east-northeast directions.

1. The Liyuanpao Syncline—It is well exposed at the northeastern hill of Liyuanpao village, and the limestone here belongs to the Shihhtzuhsü Series. The synclinal axis runs N.10-20°E. with both limbs dipping very gently towards the centre.

2. The Langpeishan Anticline—Langpeishan, being an isolated limestone hill and surrounded by red clay, shows that the Tournaisian beds are involved in an anticline which is overturned toward the southeast with the axis running N.20°E. and passing across Chishanhsia in the south-west.

3. The Southwestern Fengmukang Syncline—In the vicinity of Fengmukang, the Linwu Series of Lower Carboniferous and the Maping Limestone of Lower Permian with a coal bearing shale and sandstone between them have a N.20°E. strike and a dip 30-40° northwestwards. It forms the east limb of this syncline. Again, about 700 m. east of Lichiap'ai, the Maping Limestone is exposed on the road with the Chihhsia Limestone on its top which extends farther east. It forms the west limb of this syncline. Consequently the synclinal axis runs in a N.20°E. direction.

4. The Lichiap'ai Anticline—Near Shetsun, southwest of Lichiap'ai, the Linwu Series strikes N.20°E. and 45° northwestwards with the Maping Limestone on the dipping side forming the northwest limb of this anticline. Again, the Maping Limestone appears in the east of Lichiapai forming the southeast limb of it; and the Linwu Series in Lichiap'ai is undoubtedly itself the axial part of the anticline, its direction being also N.20°E.

5. The Quarry Syncline—From Tangtsun westwards no outcrop could be seen until the quarry is reached where the Chihhsia Limestone shows a dip 35° southeastward and a N.20°E. strike, which agrees with the axis of folding. The Maping Limestone reappears in the farther east of the quarry, the west limb of the syncline is complete.

Thrusts and Fault:—There are two over-thrusts in the north of the Kuahsienp'ai range, one occurring in the west of Chishanhsia and the other in the south of Kenkou.

1. Chishanhsia Thrust:—At the northwest of the Chishanhsia village, the Shihtzuhsu Limestone has a N.70-80°E. strike and a dip 30° northwestward and 50° southeastward, and thus a local anticline is formed; the Kuhua Limestone with a N.10-20°E. strike and a dip 70° northwestward thrusts on the northwest side of the anticline. Along the fault-line, a spring comes out by the side of the village, and affords the water supply for its inhabitants. This fault-escarpment follows the strike of the Kuhua Limestone and stands out 100 m. above the alluvial plain in the N.30°E. direction, it extends southwestward across Chingshanhsia and continues up to Patzuling where the topography seems to be much disturbed by it.

2. The Kenkou Thrust:—The limestone in the northeast of the range of Kenkou Series belongs to the Shihtzuhsu Series with a N.60-70°E. strike and a dip towards northwest, both being in agreement with those of the Kenkou Series underneath. Consequently the thrust-line also runs the same direction.

The exact spots for seeing the fault-line can be located in three places.

First, as one walks along the west bank of the river opposite the Kenkou toward southeast, about 40 metres before reaching the Kenkou Sandstone, the Shihtzuhsu Limestone of Tournaisian exposes along the bank with a N.60-70°E. strike and a dip 45° northwestward, after passing 40 metres distance, the Kenkou Sandstone appears at Taifei tavern with the same strike and dip. Although the covered space is 40 metres in length, but there could exist nothing else but a thrust.

Secondly, about 500 m. up the slope from the Paimaochow village in the S.80°E. direction a limestone quarry reveals the Tournaisian Limestone with a N.70°E. strike and a northwest dip. Immediately below the limestone, the Jurassic coal pit is dug out amongst the sandstones, which have a local strike N.70°E. and a dip 55-70° northeastward.

Finally at about 1 Km. from S.20°E. of Niuhsiling, another limestone quarry shows the exact position where the gray thick-bedded Shihtzuhsu Limestone is faulted up against the Kenkou Sandstone.

3. The Maotzufeng Fault:—The Maotzufeng hill is composed of Kenkou coal bearing sandstone with a N.60°E. strike and a northwest dip, but immediately south, the Maping Limestone with a N.20°E. strike and a northwest dip seems to be faulted up against the sandstone. This fault-line extends southwest along the Liaoshui valley in Chuchiach'ung with a downthrow side on the northwest which is in a reverse order with the thrusts described before.

#### CONCLUSIONS

(1) Kenkou Movement:—The Carboniferous-Permian strata on the southeastern side of Kuahsienp'ai range have been folded along the N.20°E. direction, which agrees with the tectonic structure of the later Palæozoic and early Mesozoic rocks in the Nanling ranges. The Kenkou Series, on the other hand, is exposed along the Kuahsienp'ai range itself with a N.60-70°E. strike, which also agrees with the direction along which the Nanling Mountain range has been lifted up. So far as it goes, there must be an unconformity between the Jurassic and the Permian sediments.

The foregoing evidences show that the unconformity and the tectonic structure of Jurassic rocks clearly indicate that before the Jurassic was deposited, the region had been uplifted, folded and subjected to a long continued erosion, which probably took place in the period between the Triassic and Jurassic just as the Chinglung Limestone of the Triassic age rests conformably or disconformably on the Permian rocks elsewhere, as, for instance, in the vicinities of Ichanghsien and Chenchowhsien, and which gave rise to the most marked break in the Mesozoic formations. It is believed that this movement extends throughout the whole area of the Nanling ranges.

We propose to call this movement, which preceded the Jurassic transgression, the Kenkou Movement. Comparing with the development in the lower Yangtze valley, this movement seems to correspond to the unconformity between the Jurassic and Triassic rock in Chihsiashan,<sup>1</sup> about 15 Km. east from Nanking. A disconformity existing between the Jurassic and the purple red sandstone of Triassic was noticed by Mr. C. Li<sup>2</sup> in Hupei. Therefore it is very probable that the Kenkou Movement exists throughout southeastern China.

1. "Geology of Nanking Hills" will soon be published by the Institute of Geology, Nanking.

2. Memoir of the Institute of Geology, Nanking No. IV, p. 25.