

ON THE MESOZOIC STRATIGRAPHY OF CHINA

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GENERAL STATEMENT ON THE DISTRIBUTION OF LAND AND SEA IN CHINA

One leading fact that distinguishes the Mesozoic from the Palæozoic Era in China is the great contrast in wide extent of lands and the withdrawal of the epicontinental seas from the Chinese basins. Such a change might be theoretically resulted from the enlargement of the Pacific Ocean by subsidence and widening and it is evidently resulted from the folding of the Palæozoic strata into mountain systems through the orogenic movement which occurred at the close of the Palæozoic. Between the mountain systems a great number of intermontane basins were formed in which continental type of sediments were accumulated.

In Mesozoic time the greater part of China was dry land, there existed only one way of marine invasion which is the Himalaya geosyncline on the Tibet border. From this invasion the marine sediments were deposited in the provinces of South China and in the Yangtze gorge provinces. But this phenomenon maintains only true in Early Mesozoic time and during the Upper Mesozoic the sea withdraw entirely from China. Since then no marine sediments were formed.

In China proper the Mesozoic strata of continental type are extensively developed, they consist chiefly of conglomerate, sandstone, shale and sometimes with thin layers of marl, clay and freshwater limestone. They contain frequently coal seams and plant remains.

In this paper more emphasis is paid on the Mesozoic formations of Kwangtung and Kwangsi which are not yet systematically studied. Now let me proceed to describe some known occurrences of Mesozoic formations in China and starting from Triassic.

I. THE TRIASSIC SYSTEM

The marine Triassic beds are found in Yangtze provinces such as Szechuan, Hupeh, Hunan, Kiangsu and Anhwei and in the provinces of South China, but their extent and character still remain to be determined. In South China the Triassic has been long reported from Yunnan, where both Lower and Middle Triassic are represented. The Ladinic is especially well developed, widely distributed and richly fossiliferous. According to Deprat the Triassic in the south-east of Yunnanfu consist of sandstone, marl, marly shale and thick series of limestone. The leading fossils are *Trachyceras fasiger* Mans., *T. costulatum* Mans., *Myophoria radiata* Loczy and *Myophoria elegans* Dunk, etc. In other part of Yunnan the Triassic beds are also found though they are not so well developed.

Recently Messrs. J. L. Hsu and T. I. Sun, geologists of the Geological Survey of Kwangtung and Kwangsi, discovered marine Triassic beds from south-western and western parts of Kwangsi in Pinghsiang (凭祥县), Lingyun (凌云) and Hsilin (西林) districts. In Pinghsiang district, the formation consists predominantly of shale, generally yellowish and greenish in color. Impure limestones interbedded with yellow and green shales are also abundant. The Triassic beds are generally disturbed, folded, intruded and overlain by rhyolite.

Fossils in the Triassic beds are rare. From the yellowish and greenish shale interbedded with impure limestone, several Pelecypods were found. According to the preliminary determination by the writer of this paper, the following species are identified:—

Myophoria goldfussi Alb.

Pecten sp. indef.

Lima sp. indef.

In Lingyün district the rocks of the Triassic beds are similar to those of Pinghsiang. From the greenish and yellowish shale many well preserved specimens of the genus *Daonella* were found. The rocks in Lingyün district is very richly fossiliferous.

According to the fossil content the Triassic beds in Kwangsi province is very probably Ladinic or in part Scythic. From the known evidences the

marine Triassic beds are very widespread in western part of Kwangsi near the border of Kweichow and Yunnan provinces.

In Yangtze gorge the Triassic beds were designated long years ago by Prof. C. Y. Hsieh and late Mr. Y. T. Chao as Patung series. The rocks of this series consist of purple, green and yellow shales with thin-bedded limestones. The total thickness is about 800 meters. The Patung Series lies disconformably upon the Tayeh Limestone, the latter forms the upper part of the Wushan Limestone of B. Willis.

In Szechuan the Triassic was named by the late Mr. Y. T. Chao as Feisienkuan shale for the lower part and Chaohua Limestone for the upper part of the system. It overlies disconformably upon the Omeishan basalt. The total thickness is about 850 meters. In western Kweichow the fossiliferous Triassic beds are rich in Ammonites as Trachyceras, Cladoceras etc.

In Kiangsu and Anhwei provinces the marine Triassic, designated as Chinglung Limestone, is wide-spread and well developed. The Chinglung Limestone lies disconformably over the Lungtan Coal Series and its thickness is variable.

Continental Triassic especially the Rhätic, seems rather wide-spread in China. Owing to its similarity of the rock characters, it is very difficult to be distinguished from the Lower Jurassic, the Liassic. One fact remains to be true, that is, the coal seams of the Triassic beds are mostly not workable and of no economic value. The lower part of the Hsiangchi Series is generally held as Rhätic. The plant-bearing beds of the Hweili district in Szechuan are generally regarded as Rhätic. Recently Messrs. Y. L. Chi and C. H. P'an subdivided the Shuangt'ien series from the Mentoukou Coal series of the Western Hills and regarded it as Lower Triassic.

In Kwangtung and Kwangsi there is no definite Triassic of continental type.

Summarizing from the known facts we can see that the marine Triassic of China exhibit more or less the same characters in different localities. It consists of a series of shales generally of purple, green or yellow in color with a series of thin-bedded limestones. In general it overlies the Permian beds disconformably and its thickness is variable in different localities. In age

it ranges from Lower to Middle Triassic, rarely also Upper Triassic, while the most well developed and wide-spread one is Ladinic.

II. THE JURASSIC SYSTEM

The marine Jurassic is rarely represented in China proper, though it has been long reported from the Tibet border, Himalaya and Indo-China. The only known Jurassic beds in China proper are found in western Yunnan in the region of Luchiang or Salwen river. Reed studied the fossil collections of that region and regarded them as of Bathonian age.

In south-eastern China, the Liassic fossiliferous beds have been found from the Tolo Channel, not far from Hongkong, where the *Ammonites Hongkongites hongkogensis* Buckman were collected and the formation was named as Tolo-channel Formation.

Recently Mr. T. H. Ting, member of the Sino-Swedish expedition discovered fossiliferous Jurassic beds from western Sinkiang in the Kashgar region, but the result has not yet been published.

Continental beds of Jurassic age are wide-spread in all parts of China showing practically the same lithological characters. They consist of a series of shale, sandstone, black carbonaceous clay-shale, conglomerates and arkosic sandstones of various colors. Coal seams are frequently present, though sometimes unimportant and not workable. Plant remains are not seldom. Among the Jurassic beds the Liassic is most wide-spread and well developed.

In North China many productive coal fields are of Liassic age. The Tatung Coal Formation in Shansi, the Shensi coal series and the Mentoukou coal series of Hopei etc. belong all to this age. In Yangtze gorge the upper part of Hsiangchi series is also of Liassic.

In Kwangtung the Liassic beds are widely distributed almost throughout the whole province. The Hsiaoping Series first designated by Dr. A. Heim after the name of a Station on the Yueh-Han Railway line, consists of a series of black carbonaceous clay-shales, gray or yellow micaceous sandstones and white arkosic sandstones. Several coal seams of inferior nature and many fossiliferous layers were found in this series

The fossils of the Hsiaoping series are mainly plant remains and fresh-water Crustaceans (Astheria). The plants identified are the following:

Pterophyllum æquale Brongn.

Pterophyllum multilineatum Shir.

Podozamites lanceolatus (L. & H.).

Podozamites shenki Heer

Cladophlebis? denticulata (Brongn.).

Taniopteris sp.

Judging from the fossil contents, the Hsiaoping series is undoubtedly of Liassic age.

Along the Canton-Kuilung railway in the neighbourhood of the stations Changmoutou (樟木頭), Tutang (土塘) Ch'angping (常平) and Hungli (橫瀝), the Jurassic beds are also wide-spread; they can be subdivided roughly into two parts: the lower part consists of conglomerate, white coarse sandstone and yellow sandstone, while the upper part fine sandstone, pink or gray clay-shales and clays. The lower part is strongly metamorphosed while the upper part is rather soft and less metamorphosed. The Jurassic beds are strongly disturbed, being affected by foldings and igneous intrusions.

No fossils were found from the above regions, but at Tungkuan district where the same beds extended, many plant fossils were collected. They are of the same type as those contained in the Hsiaoping series.

Besides the above mentioned localities, there are many other occurrences in Kwangtung province, which for simplicity sake will not be mentioned here.

III. THE CRETACEOUS SYSTEM

In China proper the marine Cretaceous rocks are entirely unknown till to present, though the Cretaceous rocks of continental type are rather wide-spread. They are the deposits of intermontane basins. The rock consist mainly of conglomerate, sandstone, shales and sometimes thin layers of marl and clay. They are generally red or pinkish red or green in color. They contain in general a rich amount of iron oxides showing that they have probably been deposited under an arid climate.

The Cretaceous beds are sometimes rich in organic remains, especially fishes (*Lycoptera*), insects, plants and also bones of reptiles.

In Shantung the Cretaceous beds are widely distributed in the basins of Laiyang, Chaohsien and Menyin. The rocks consist mainly of conglomerates, sandstones and shales. Well preserved *Lycoptera* fishes, insects and plants were collected. Reptile bones are also found from the Lower Cretaceous beds.

In other provinces of North China such as Jehol, Kansu, etc, Cretaceous beds with *Lycoptera* fish are also found. In Yangtze gorge the Kweichow Series belongs to Cretaceous while in Szechuan the Red Beds of the red basin are especially famous. The Chiente series and the Rhyolite lava sheet of Chekiang provinces belong to Upper Cretaceous.

In South China especially in Hunan, Kwangtung and Kwangsi the Red Beds are very wide-spread. The rocks are on the whole rather similar in character consisting of conglomerate, sandstone, shale and sometimes thin layers of marl and clay. Layers of salts and gypsum are often found. The color of the rock is in general red or pinkish red.

Mr. C. C. Tien has subdivided the Red Beds of Hunan into two parts: the Heng Yang series for the lower part and the Tan Shih series for the upper part. The former belongs to Eocene while the latter Cretaceous.

In Kwangtung and Kwangsi the basal part of the Red Beds consist of conglomerate with boulders of quartzite, granite and other igneous rocks. (In northern part of Kwangtung the conglomerate composed fully of limestone pebbles.) They contain also red sandstone and clay in intercalation. The upper part of the Red Beds consists of massive, coarse sandstone, red clay, and sometimes thin layers of marl. The total thickness of the Red Beds is about 1,000 meters.

The Red Beds lie nearly horizontal or they show only a little warping. Intense folding has never been seen in both Kwangtung and Kwangsi provinces.

Correlation Table of Mesozoic Beds in South China

Locality System	Yunnan	Kwangtung & Kwangsi	Hunan	Hubei	Szechuan	Chekiang Kiangsu & Anhwei	Fukien	Western Hills Peiping of	Shansi & Shensi	Shantung	Kansu & Sinkiang	Suiyuan & Mongolia
Cretaceous		Red Beds	Tanahilt. Red Beds & Hsiang- lun Red Beds	Kweichow Series	Red Beds of the Red Basin.	Rhyolite Lava Flow Chientsa series	Wuyi Formation	Tunglankou Formation Green Rhyolite Tungling Formation Tiaooh	Red or green sands & shales	Wangshih Formation Mengyin series with fish & reptile bones etc.	Wusunpu Formation with Lycopoda fish.	Irendabaan Formation Djadochta Formation Ondaisair Formation Oahih Formation with Dinosaur bones etc.
Jurassic	Beds of Ba- thonian in Lu-Chiang River region with Terebra- tula, Rhynchon- ella etc.	Hsiao-ping series with plant remains and Eosheria Fo-ho Channel Formation with ammonites	Hsiang- chi coal series	Upper part of Hsiang- chi series	Hsiangchi series (Mienhsien series Tsihshu'u series and Suchiaho series)	Conti- nental beds with Coal series	Lian Coal Series	Fichi shan series Churlung- shan series Mentoukou Series	Tatung coal Formation Shensi coal series	Santai series Fangra coal series		Conglo- merate, Sandstone with coal seams
Triassic	Sandstone, marl, marly shale and thick series of lime- stone with Trachyceras Myophoria, Avicula etc.	Pingertuan Formation with Myophoria, Pecten etc. in Western Kwangsi	Thin- bedded limestone & yellow shale	Lower part of Hsiang- chi series Pahung series with Spiriferina	Chaohua limestone (Chialing limestone) Faisienkuan series	Chinglung limestone		Shuangtuan Series Hungmiao- ling series? (Permian- Triassic)	Shihchien- feng series	Haikunlun series Quartzite & Sandstones	Theronor- pha Beds of Sinkiang	

IV. THE OROGENIC MOVEMENT AND THE IGNEOUS ACTIVITIES IN MESOZOIC ERA

In general the Triassic and the Jurassic beds suffered more disturbances than that of the Cretaceous. The Yenshan Movement with its accompanied igneous activities has rendered the Early Mesozoic beds to be strongly folded, tilted, and sometimes strongly metamorphosed. Such features have been seen in all parts of China. In Kwangtung and Kwangsi provinces both Triassic and Jurassic of either marine or continental origin suffer very intense orogenic and igneous disturbances.

The Cretaceous beds, on the other hand, lie in general horizontal or dip very slightly. They show only a gentle warping, while strong foldings have been very seldom seen. Whoever has made geological travelling through Hunan, Kwangtung and Kwangsi provinces, will well remember the immense deposit of the Red Beds showing slight inclination toward the periphery of the inland basins. So far as I have observed, no igneous intrusion has been found in the Cretaceous beds.