

THE TREMADOCIAN IN SOUTH ANHUI*

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For a long time I have been doubtful of the age of a nearly homogeneous group of greenish shales which was repeatedly found to lie below the Ningkuo Shale, a graptolite-bearing shale of Arenigian age, so familiar and widely distributed in N. Kiangsi, S. Anhui and S. W. Chekiang. Wherever we met the Ningkuo Shale in these provinces, we met the underlying greenish shales too.

In the years 1931-32, while collecting graptolites from the Ningkuo Shale at Huloasu (胡樂司), S. Anhui¹, both Mr. Y. Y. Lee and I observed that below the graptolite-bearing Ningkuo Shale there is a considerable thickness of shales from which we failed to find any kind of fossils except one or two indeterminable fragments of trilobites. In the winter of 1934, while studying the so-called Yinchupu Series² at Yüchien (於潛), W. Chekiang, I again noticed that the same shales lie below the yellowish, phyllitic *Phyllograptus* shale (equivalent of the Ningkuo Shale) in the middle part of the Yinchupu Series. A similar case was also observed by Mr. Lee at Wuning (武寧), N. Kiangsi³, where the Arenigian graptolite shale is underlain by the greenish calcareous shales with a few trilobite fragments.

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- 1 S. C. Hsü: Graptolites of Lower Yangtze Valley, Monograph of National Research Institute of Geology, Academia Sinica, Ser. A, Vol. IV, 1934, p. 4.
- 2 For Yinchupu Series, see C. C. Liu & Y. T. Chao, Geology of S. W. Chekiang, Bull. Geol. Surv. China, No. 9, 1927, pp. 14-17.
- 3 Y. Y. Lee: Geology of the Neighbouring Districts of Suishui, N. Kiangsi, Contributions from the National Research Institute of Geology, Academia Sinica, 1933, No. 3, p. 43.

In the winter of 1935, for the purpose of studying the lower Palaeozoic formations in South Anhui, Mr. Lee and I went to Tanchiachiao (譚家橋), a small town about 15 kilometers to the south of the city of Taiping District (太平縣). Here, at the low hills near the town, we again met already the familiar rocks, i.e., the Ningkuo Shale containing the typical Arenigian graptolites and that group of shales lying below it and furnishing, as former experience shows, no fossils except some poorly preserved fragments of trilobite. This time, however, we made up our mind to make a thorough search for trilobites from these shales with a view to get some knowledge about their geological age. One evening, while we were nearly disappointed after a long search in vain and were just on the point of leaving the spot,—a certain spot on the southern slope of a small hill called Lo-to-pei-pao (駱駝背寶) or "The Camel Carrying Precious Stones", about $\frac{1}{2}$ km. to the northeast of the town—one stroke of the hammer, however, brought us a beautifully preserved multi-ramous graptolite on the surface of a slab. The new excitement made us to commence our work anew, and several more pieces of graptolites were obtained. In addition to these, some specimens of trilobites were also found from the same horizon. The graptolites, as well as the trilobites, were later found to belong to a single species. These are *Clonograptus tenellus* var. *callavei* Lapworth¹ and *Asaphus ovatus* Sheng².

The graptolite is known to be characteristic of the Shinarump shales of Great Britain, while the trilobite is a species newly established by Mr. Sheng and has been first collected by him from the shale below the Arenigian graptolite beds in the Yinchupu Series. It is no wonder that *Asaphus* comes from the same horizon with *Clonograptus*, since the former may appear as early as in the Tremadocian time though it is characteristic of the Ordovician. Thus the two fossils in association tell us definitely that we are dealing with a Tremadocian formation.

The formation has a thickness of about 230 meters. It is entirely composed of more or less calcareous, slabby and fissile shales generally yellowish

1 Elles & Wood: Monograph of British Graptolites, Part II, 1902, p. 84.

2 S. F. Sheng: Lower Ordovician Trilobite Fauna of Chekiang, Palaeont. Sinica, Ser. B, Vol. III, Fasc. 1, 1934, p. 9.

green or bluish gray in color. In its upper part, however, there are purple shales alternating with greenish ones. Its basal part becomes more calcareous and darker in color. To distinguish it from the Ningkuo Shale lying above, I propose the name Tanchiachiao Shale for this group of shales which, in fact, differ very little from one another in lithologic characters and form a rather homogeneous unit. The best outcrop of the upper part (beds 3-7 in the following list) of the Tanchiachiao Shale and the overlying Ningkuo Shale is found at Lo-to-pei-pao, a small hill mentioned above, whereas the lower part (beds 1-2) of the Tanchiachiao Shale and the underlying impure limestones are best exposed at the highway near Shangchangyuan (上长源), a village about 4 km. to the north of Tanchiachiao. By combining the two sections at the two localities a probably complete succession of the beds of the Tanchiachiao Shale may be obtained. This is shown as follows:

Arenigian, Ningkuo Shale:

Blue and yellowish brown shale containing *Phyllograptus*, *Tetragraptus* and *Didymograptus*, etc.

Tremadocian, Tanchiachiao Shale:

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| 7. Greenish shale without fossil | 10 m. |
| 6. Yellowish green shale containing <i>Clonograptus</i> and <i>Asaphus</i> | 6 m. |
| 5. Greenish blue shale containing limestone nodules | 2 m. |
| 4. Greenish gray, fine, calcareous shale containing <i>Asaphus</i> and traces of <i>Clonograptus</i> | 7 m. |
| 3. Purplish red, soft, clayey shales alternating with greenish calcareous ones, containing <i>Asaphus ovatus</i> Sheng | 59 m. |
| 2. Bluish gray to greenish gray, slightly calcareous shale, easily weathered to clay, containing very sparingly small forms of <i>Asaphus</i> | 121 m. |
| 1. Bluish gray to dark gray, finely laminated shaly limestone | 33 m. |

Disconformity

Sinian (?), impure limestones:

Thin-bedded limestones alternating with thick-bedded ones, containing carbonaceous shales especially in the lower part. 500 m.

The section begins with a series of dark gray limestones with black carbonaceous shales in its lower part. Most of the limestones are thin-bedded and containing impure, argillaceous bands at close intervals. In these respects they are similar to the limestone in the lower part of the Yinchupu Series of western Chekiang. The limestone series is correlated with the Töngying Limestone of the Yangtze Gorge by Messrs. Lee¹ and Yü². It is disconformably overlain by the Tanchiachiao Shale which is in turn conformably overlain by the Ningkuo Shale.

The finding of the Tremadocian fauna in the Tanchiachiao Shale in South Anhui show us that the shale which furnishes *Asaphus ovatus* Sheng in the Yinchupu Series of western Chekiang should, on both palæontological and stratigraphical grounds, also belong to Tremadocian. Rocks of the same age probably also occur in Wuning, N. Kiangsi, since, as mentioned above, from the shale below the *Tetragraptus* beds (Arenigian) at Wuning, several trilobite fragments suggestive of the genus *Asaphus* were collected by Mr. Lee. Future discoveries might testify that the Tremadocian has a distribution in Central China much wider than what we know now.

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- 1 Y. Y. Lee: Sinian Glaciation in the Lower Yangtze Valley (published in this Volume).
 - 2 T. Y. Yü: Sinian Stratigraphy of the Yangtze Valley (Manuscript to be published in this bulletin).