ON THE DISCOVERY OF THE GRAPTOLOITE-SHALE FROM LIENTAN, YUNAN DISTRICT IN KWANGTUNG PROVINCE AND ITS STRATIGRAPHIC CORRELATIONS

By Hsicheh Chiang (張景熙)
(Geological Department, Sun Yatsen University, Canton)

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I. INTRODUCTION

During the years of 1869-1870 von Richthofen first studied the geology of Kwangtung province. His journey was, however, only confined to a traverse route along the North River from Sandun, Chichiang to Hunan province. The geology of the West River districts was quite unknown to him, he did not go so far to those districts. After von Richthofen, in the years of 1911-1916

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some Japanese geographers of the Tokyo Geographical Society visited many places of the western, eastern and northern parts of Kwangtung province. Judging from the maps, those traverses were very rapidly made and the geological observations were, in many places, not accurate. In recent years the geologists of the Geological Survey of Kwangtung and Kwantung have done a great deal of special geological and paleontological studies. The stratigraphy of the lower Paleozoic formations offers, however, a very hard problem to the geologists on account of the strong disturbance, the high metamorphism of the rocks and the lacking of paleontological evidences. For in the exact correlation of the lower Paleozoic rocks, the lithological characters alone can hardly be relied upon, criteria must be looked for from stratigraphical relations, and, first of all, reliable paleontological evidences.

II. THE OCCURRENCE OF THE GRAFTOLITE-SHALE FROM LIEN TAN IN WEST RIVER DISTRICT

During the summer vacation in 1931 a senior student, Mr. Chu-chia-kwei (賀家樞) of the geological department in Sun Yat-sen University in Canton, made some geological excursions at the neighbourhood of his native country. From Lien Tan in Yitun district he found several pieces of black shale containing Graftolites. At the beginning of the fall term Mr. Chiu showed me those specimens which he collected from the field. This is the first discovery of Lower Paleozoic fossils in South China and will be of great help for attracting the very puzzling problems in the stratigraphy of the lower Paleozoic formations in Kwangtung province.

On the middle of November Dr. Kuei-si and the writer made a geological excursion in the West River districts with students of the three higher classes. We took the occasion to visit the fossil locality and to make a closer examination of it. From this trip we collected many well preserved specimens of Graftolites. In spring time Mr. J. L. Hsu, the geologist of the Geological Survey of Kwangtung and Kwantung, and the writer of this paper with one assistant and

several students visited this fossil locality again. This short paper was written by the author, based upon the excursions and from the fossils collected.

III. BRIEF ACCOUNT ON THE GEOLOGICAL CONDITIONS OF THE GRAPTOLITE-SHALE FROM LIENTAN

The Graptolite-bearing strata were first discovered from the Westou hill or Wentouhan (西患) near by the bus station of Lientan. A new section cut at the stone quarry was found on the hill. The strata of the formation are very clearly visible. Lithologically, they are here essentially argillaceous or carbonaceous shales. The shales are generally strongly metamorphosed and have become slate-like. They are originally grey or black in color and when strongly weathered they become gradually yellowish or brownish. The rocks are rather hard and brittle. The lower part of the strata is in general thin-bedded, while the upper part of it is thick-bedded. In the described district the strata strike in a general north-easterly and south-westerly direction; they dip to the south-east about 35°-40°. The known thickness here is about 25 to 30 meters. The base of the strata is not exposed. Palaeontologically, this series of strata are very rich in organisms. But the only known fossils found till present belong to Graptolites.

IV. A PRELIMINARY REPORT ON THE DETERMINABLE FOSSILS FROM THE LIENTAN GRAPTOLITE-SHALE

The collected fossils from this shale series are only Graptolites. Besides Retiolites, they all belong to the Monograptus type. Monograptus luriculatus (Barr.) and Monograptus solens (Crinitz) are the leading forms among the collected fossils. Monograptus elegans (Nicholson) and Monograptus calli (Barr.) are also very common. Monograptus gregarius Lapw., are only found from the lower part of the series. Besides the just mentioned forms, there are several other indeterminable Monograptolites. They belong perhaps to some new species. Taking as a whole, the fossils from the Lientan Graptolite-shale formation are exceedingly numerous in individuals but rare in species. A preliminary list of the identified species will be given as follows:
Diplagnostus (Orthagnostus) sp.
Rerolleites geminispinus Barr. var. spinosa Chang (var. nov.)
Monagnostus sp.
Monagnostus spiralis (Gemîtz)
Monagnostus exigus (Nicholson)
Monagnostus hollii (Barr.)
Monagnostus horticulatus (Barr.)
Monagnostus grossus Layw.

V. ON SOME OTHER OCCURRENCES OF THE SILURIAN
GRAPTOLITE-BEARING STRATA IN CHINA

Before coming to the determination of the stratigraphic position of the
Liectau Graptolite-Shale, it is of necessity to get a short review of the known
occurrences of the Graptolite-bearing strata of the Silurian age recognized in
China and then make a correlation of them. As we have already known that
the Graptolite-bearing strata of the Silurian age occur only from Central and
South China and entirely unknown from North China. In Central China they
are very widely distributed. We may state them briefly in the following:

1. The Graptolite-Shale from Lungshan near Nanking, Kiangsu prov-
ence.

Dr. Frech\(^1\) described several species of Graptolites, which were col-
clected by von Richthofen from Lungshan. The following species have been
identified:

1. Climagnostus scalaris (Hin.)
2. Linagnostus nilsoni Barr.
3. Diplagnostus sp.
4. Rerolleites? sp.

Afterwards Mr. Weiman Hau collected also a great number of
Graptolites perhaps from the same locality recorded by Frech. The following
species have been identified:

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Climacograptus scalaris (His.) var. normalis Lapw.
Climacograptus tenuis Elles et Wood
Climacograptus mediae Torquikt
Glyptograptus inexactus Elles et Wood
Monograptus incommodus Torquikt

Judging from the Graptolite fauna, the age of the Graptolite-Shale from Lungshan is of Lower Llandovery and can be correlated with the lower horizon of the Shihtien Graptolite-Shale from West Yunnan.

2. The Graptolite-Shale from Shihtien, West Yunnan.

The Silurian Graptolite-bearing strata are represented at Shihtien in West Yunnan by two horizons. They are different both in lithologic characters of the rocks and from the fauna content. The lower horizon consists of tough black carbonaceous and finely micaceous shales or slates rather course in grain and less flaggy than the higher horizon. The Graptolite species identified by Miss Elles comprise the following:

Monograptus incommodus Torquikt
Monograptus regularis Torquikt
Monograptus tenuis? Portl.
Climacograptus rectangularis McCoy.
Climacograptus tenuis Elles et Wood.
Climacograptus sp.
Mesograptus modestus Lapw.

The higher horizon consists of a rough fine grained greenish gray or pinkish flaggy slate:

The following Graptolite species from these beds have been identified:
Monograptus sedgwicki Portl.
Monograptus lebeformi McCoy.
Monograptus tenuis Portl.
Monograptus leptipterus Lapw.
Monograptus atticus Jones

Monographus joculans Lapw.
Monographus gennantis Barn.
Glyphoporus serratus Elles et Wood
Glyphoporus incertus Elles et Wood
Climacographus scalaris Hsi.
Climacographus tamausi Elles et Wood
Glediograptus perlatus Nich.
Monographus magnus Lapw.

The above mentioned species indicate Lower Llandovery age and belong to the base of the zone Monographus sedgwicki.

3. The Sintan Shale from Yangtze Gorge.

The well known Sintan shale, designated by Willis and Blackwelder from the classic region of the Yangtze Gorge, has been assigned as Siluro-Devonian age. It was based only upon the stratigraphic position and no conclusive index fossils were found. In 1924 Prof. Lee and Mr. Y. T. Chao discovered in the gorge district a black Graptolite shale, which was designated by Prof. Lee as Lungna Shale after the river Lungna-chi (龍男溪) on the east side of Sintan. The upper part of the series which lies above the Lungna Shale was designated as Sintan Shale.

In 1925 Messrs. Hsieh and Chao divided again the Sintan Series into three distinct horizons; namely 1. the Shunan formation, 2. the Lofaping Series and 3. the Lungna Shale.

From the Lungna Shale the lower part of the Sintan Series a Graptolite fauna has been obtained. According to the provisional determination of Dr. A. W. Grunau the following species have been identified:

Petalographus palmae Barnardo
Monographus sedgwicki Portland

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<tr>
<th>Zone Divisions</th>
<th>Leading Fossils</th>
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<tr>
<td>Terebratula</td>
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<td>Monograptus spicatus</td>
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<td>Monograptus spicatus</td>
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<td>Zone of Monograptus turricularis</td>
<td>Monograptus exigius</td>
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<td>Monograptus halli</td>
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<td>Monograptus turricularis</td>
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<td>Zone of Monograptus gregarius</td>
<td>Monograptus gregarius and other</td>
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<td></td>
<td>indeterminable fossils</td>
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VII. CONCLUSION

Based upon the field observations and the fossils identified in this paper, it would be well justified to establish a new geological formation the "Lienan Formation". The age of this formation is Lower Silurian. The lower part of the Lienan formation can be correlated with the Llandovery Beds, and the upper part of it, with the Gallo-Taranon Shales of western Europe. This formation is the only richly fossiliferous beds of the Lower Palaeozoic formations so far known from Kwangtung province. The Lienan formation is probably equivalent to a part of the Lungsian series \(^1\) of T. O. Chu, but its exact relation is not yet clear.

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1. The Lungsian series was first designated by Mr. Chu Tingyo from Kwei Htien, Kwangsi province. According to him the age of the Lungsian series is from Cambrian to Silurian. Not a single fossil has been found. Annual Report Geol. Surv. of Kwangtung & Kwangsi. Vol. 1, 1927-1928, pp. 6-8.
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Monograptus sedgwicki Postland
Monograptus regularis Tomquist
Monograptus diniagui Carrières
Glyptograptus incertus Elles et Wood
Diplograptus (Cephalograptus) cometa Geinitz

From the collections of 1925 by Messrs. Hsieh and Chao the following species have been identified by Dr. Grabau and Dr. Y. C. Sun: 1

Petalograptus palmatus Barr.
Monograptus cremaster Lapw.
Monograptus marri Pern.
Mesograptus choui Sun
Diplograptus sp.
Chlamidograptus haichi Sun
Chlamidograptus cf. scalaris His.
Cephalograptus cometa (Geinitz)

Besides the Graptolite fauna, fossils of Anthozoa, Brachiopoda, Cephalopoda, Trilobita and Crinoid stems have also been found from the upper fossiliferous horizons of the Li-Ien Shale. From the Lojaping series and the Shanmoe formation a very rich fauna has also been found; but fossils of Graptolites are entirely absent.

Judging from the faunal content, the Li-Ien Shale of the Sintan series indicate an Early Upper Llandovery age.

4. The Graptolite-bearing strata from SW. Chekiang.

From southwestern Chekiang Messrs. Liu and Chao 2 discovered in 1927 Graptolite-shales of both Ordovician and Silurian age. They designated those of Ordovician age as Yinchu formation (印慈礁層) and Yenwasshan formation (雁褰山層) and those of Silurian age as Fengchu Shale series (風竹頁岩系). From both formations of Ordovician age a very rich Graptolite fauna has been

obtained. They are quite distinct from the Silurian Graptolites and therefore out of our present discussion.

From the Fenqiu Shale Series only fragments of Graptolites belonging probably to the genera Monograptus and Climacograptus, have been obtained.

Besides the above mentioned Silurian Graptolite-bearing strata in China, there are several other occurrences such as the Graptolites from Taishan (T'ai Shan), a new locality discovered by Mr. J. L. Hsu, from Liupanshan in east Kansu by geologists of the National Geological Survey in Peking and those from Anhwei province by the geologists of the National Research Institute of Geology in Shanghai. But these materials are not yet determined and described.

VI. AGE AND CORRELATION OF THE LIENTAN GRAPTOLITE-SHALE

After a review of the occurrences of the Silurian Graptolite-bearing strata and the different faunal characters from different localities in China, it is now easier to make a correlation with the Lientan Graptolite-Shale in Yunnan district.

All of the Graptolite fauna from Lientan are of Silurian age. The total absence of the Genus Climacograptus, the presence of Monograptus turricolatus Barr., and above all, the abundance of Monograptus spiralis (Cebinus) indicate that the Lientan Graptolite-shale is a higher horizon than those occurrences of Yangtze Gorge and those of Shihlien, in west Yunnan. It is much higher than the Graptolite-shale of Lungshan in Kiangsu province. According to the stratigraphic succession and the identified fossils (see faunal list in the foregoing pages) of the Lientan Graptolite-shale, three zones may be distinguished: namely 1. Zone of Monograptus gregarius, 2. Zone of Monograptus turricolatus, and 3. Zone of Monograptus spiralis.

That means, the lower part of the Lientan Graptolite-shale can be correlated with the Llandovery and the upper part of it, with the Gala-Taraman Shales of western Europe. The leading fossils of the different horizons may be noted as follows:

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1. Y. C. Sun; op. cit.