NOTES ON THE HIATUS BETWEEN THE ICHANG LIMESTONE AND NEICHIA FORMATION.§

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The Neichia formation as well as the Ichang limestone are widely distributed in Southern and Central China. Between them there exists a remarkable hiatus which should be noticed.

In Kueichou province the succession of the Ordovician beds are well shown at Wulip'o (五里坡), Meit'anhsien (湄潭縣). According to Mr. T. K. Huang, the uppermost beds of the Ichang limestone containing *Cameroceras færstei* Yü[1] etc. are overlain by the greenish shales in which the typical form *Phyllograptus wulipoensis* Yü was found. Just above this lies the limestone bed, which consists of *Lesueurilla meitanensis* Yü, *Eccyliopterus sinensis* (Frech), *Cameroceras tenuiseptum* var. *ellipticum* Yü. This bed is in turn succeeded by the *Yangtzeella poloi* bed, and then by the *Orthoceras* limestone which forms the top of the Neichia formation. According to the previous geological observation, the beds included between the Ichang limestone below and the Silurian black shale above were regarded as a unit, the Neichia formation of Middle Ordovician. But by the discovery of *Phyllograptus* we now know that the Ichang limestone was still overlain by some shales of Lower Ordovician in some places. Here a new name "Meitan shale" as suggested by Prof. A. W. Grabau has been applied to the *Phyllograptus* shale in separating it from the overlying Middle Ordovician shale beds. Nevertheless, I am still quite doubtful how far the Lower Ordovician fauna extends upward. It is only provisional to regard the *Lesueurilla* bed, which immediately overlies the Meitan shale, as the basal part of the Neichia formation. Mr. Y. L. Wang, who has accompanied Dr. V. K. Ting to travel over a wide area in southwestern China, told me that in Kueichou province the maximum thickness of the *Orthoceras* limestone measures 80-100 m, while that of the beds between the *Orthoceras* lime-

§ Manuscript received Oct. 1932.

1. All the forms mentioned in this paper have been determined by the author, and the description will be published in the Palaeontologia Sinica.

stone and the Ichang limestone reaches 180-200 m. As the geologists have not separated out the Meitan shale in the field, its actual thickness is not yet clear.

In Hupeh province Prof. J. S. Lee has reported[1] that the Neichia formation is estimated at 110 m. in thickness in Yangtze Gorges. This formation is mainly composed of an intercalation of a green calcareous shale and slabby brownish-yellow or light grey argillaceous limestone crowded with *Yangtzeela (Tripecia) poloi* etc. being capped with a dense grey Pagoda limestone of only a few meters thick. So far neither *Phyllograptus* shale nor *Lesueurilla* bed has been found there. Further northward at Taihungshan (太紅山), Nanchanghsien (南漳縣) in the same province, the Neichia formation consists of yellowish green shales, 25 m. thick at the lower part, and the *Orthoceras* limestone of 60-80 m. in thickness at the upper[2]. In the middle part of the shale bed, *Didymograptus murchisoni* var. *geminus* (Hisinger) has been found in association with many trilobites[3] such as *Asaphus gigas* var. *hupeiensis*, *Taihungshania shui*, *Bathyurus minor*, *Taihungshania brevica*, *Bronteus* sp., while the form *Yangtzeella poloi* is wholly absent.

In Kiangsu province Messrs. S. Chu and C. Li have made a detail section at Lunshan (嶐 山). According to their observation the Silurian shales lie upon the greyish green argillaceous limestone about 15 m. thick, in which *Vaginoceras neichianense* Yü and *Vaginoceras uniforme* Yü were found. This limestone rests directly upon the red siliceous limestone attaining a thickness of about 10 m. Not far below this bed, *Cameroceras hupehense* Yü was collected from the thick-bedded grey limestone. As based on the fossil determination, the fossiliferous beds at Lunshan undoubtedly represents the *Orthoceras* limestone and Ichang limestone of Hupeh respectively. Mr. S. Chu thought that the boundary between the *Orthoceras* limestone of the Neichia formation and Ichang limestone would be drawn at the base of the red siliceous limestone. As the Ichang limestone in Hupeh as well as the other localities contains much more

1. Bull. Geol. Soc. China, Vol. III, No. 3-4, pp. 354, and 370.
2. Mem. Inst. Geol. No. 8, Nat. Resear. Inst. China p. 46.
3. The trilobites have been described by Y. C. Sun in "Ordovician trilobites of Central and Southern China", Palaeontologia Sinica, Ser. B, Vol. VII, Fasc. 1.

flinty concretions as it comes nearer to the top it is more likely that the red siliceous limestone at Lunshan represents the top of the Ichang limestone.

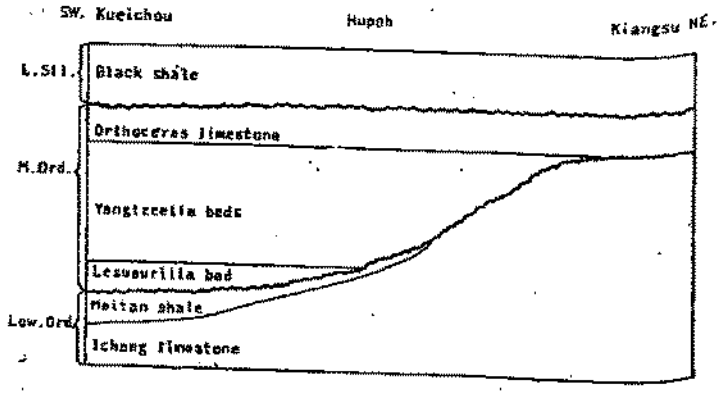
From the above mentioned facts we have recoguized the following points:

1. At Wulip'o, Meitanhsien, Kueichou, the *Yangtzeella* beds are underlain by the *Lesueurilla* bed, and next by the Meitan shale containing the typical Lower Ordovician form *Phyllograptus*, which rests directly upon the *Cameroceras* bed of the Ichang limestone. But in the Yangtze Gorges neither the *Phyllograptus* bed nor the *Lesueurilla* bed has ever been found, and the Ichang limestone is immediately overlain by the *Yangtzeella* (*Triplecia*) beds. In Kiangsu province even the *Yangtzeella* bed is absent, and the uppermost bed of Neichia formation, the *Orthoceras* limestone, is directly in contact with the Ichang limestone.
2. The shale beds, which form the lower part of the Neichia formation, measure slightly less than 180-200 m.[1] in thickness in Kueichou. In Hupeh province they are about 100 m. thick in Yangtze Gorges, and only 25 m. thick further north at Nanchanghsien. In Kiangsu they are almost wholly absent.
3. The lower part of the Neichia formation is composed of an intercalation of shales and limestones from Kueichou northeast to the Yangtze Gorges, but becomes wholly shales at further north of Hupeh province.

These points just mentioned would suggest that in the Ordovician period the sea water advanced from southwest to northeast, and there exists a great hiatus at the end of the Lower Ordovician. After the deposition of the Ichang limestone the sea water began to withdraw southwestward. When the land was emerging along the Yangtze Valley, the Meitan shale was deposited in the further south region. During the opening of the Middle Ordovician the sea water swingingly advanced again towards the land. The deposits, of course,

1. This thickness includes the Meitan shale at the base. As the thickness of the Meitan shale is uncertain, the lower part of the Neichia formation, therefore, must be less than this measurement in thickness.

accumulated thicker, as the place comes nearer to the origin of the ocean. At the end of this epoch the sea water spread over a much wider area. Even in Chekiang province the *Orthoceras* limestone was also deposited at the top layer of the Yenwashan formation.[1] Before the deposition of Silurian black shale the land emerged again, and the *Orthoceras* limestone had been suffering much erosion; so that its thickness is quite variable at the different localities. These phenomena will be illustrated by the following diagram.



1. C. C. Liu & Y. T. Chao: Geology of south-western Chekiang, Bull. Geol. Surv. China, No. 9, 1927, p. 18.