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## NOTE ON THE YUEHMENKOU SERIES IN THE WESTERN HILLS OF TAIYUAN, CENTRAL SHANSI

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### SUMMARY

In the consideration of the Permo-Carboniferous history of Eastern Asia, the Yuehmenkou series stands out as an unit of wide extent both stratigraphically and palaeontologically. The name Yuehmenkou series was first given by Dr. Norin in 1922 as a whole coal-bearing formation of Central Shansi, which was divided into two parts—a lower, the Taiyuan series, and an upper, the Shansi series. The type-locality of this formation is the Yuehmenkou, in the Western Hills of Taiyuan. The Taiyuan series is composed mainly of shale, variegated clay, sandstone, important coal seams and a few interstratified marine limestones. The same may be said to be the case in the Shansi series, but there seems to be only one layer of marine limestone, the Tungtayao Limestone, locally developed at the lower part of this series. The preliminary study of the palaeozoological remains contained in the marine beds of this formation, leads Prof. Grabau and Dr. Norin to consider its lower part, i. e., the Taiyuan series, as representing the transition from Viséan to Moscovian, without being as yet true Moscovian, and its upper, i. e., the Shansi series to be of Permo-Carboniferous age.

Later on, after going through careful researches of a number of fusulinids and brachiopods from the Taiyuan series in Central Shansi as well as from the equivalents in other parts of North China, Prof. J. S. Lee and the late Mr. Y. T. Chao, in a joint paper (1926), have pronounced that two distinct faunistical assemblages almost can be found everywhere in a complete section of the Taiyuan series. There is no overlap or transition for the leading forms of these two different faunas. The fauna of the lower part of the Taiyuan series is characterized by *Pseudostaffella sphaeroides* (Möller), *Fusulinella bocki* Möller and *Choristites mosquensis* Fischer, etc., being of Moscovian age, while that of the upper part of this series comprises a considerable number of well-developed species, such as, *Pseudoschwagerina princeps* (Ehrenb.), *Quasifusulina longissima* (Möller) and *Choristites parlovi* (Stuckenberg), etc., which are generally confined to the Upper Carboniferous or the so-called Uralian age. This palaeontological

evidence, taken in conjunction with the stratigraphical contributions, enable to suggest a new subdivision in the Taiyuan series. The lower part of the Taiyuan series is separated as an independent formation, the Penchi series, while the original name is kept for the upper part. The Penchi series is thus considered to be Middle Carboniferous or Moscovian, and the Taiyuan series, in the restricted sense, as Upper Carboniferous or "Uralian".

Owing to the scarcity or absence of marine fossils from the Shansi series, Le and Chao did not state any definite opinion about the age of this series. They are, however, disposed to place the Tungtayao Limestone of the type-area in the summit of the Taiyuan series, since a few brachiopods derived from this Limestone, exhibit a certain degree of affinity with those of the underlying series.

Later, in the important memoir of "The Upper Palaeozoic Plants from Central Shansi", in regard to the age of the Yuehmenkou series, Prof. Halle expressed nearly a similar opinion that on the evidence of fossil plants known from the Yuehmenkou series, both the lower part viz., the Taiyuan series (s.s.), and the upper part, viz., the Shansi series may be classed as Stephanian or under the wider designation Permo-Carboniferous.

Prof. Halle still has expressed the opinion that the Yuehmenkou series represents merely the Permo-Carboniferous deposits of N. China including the Taiyuan series (s.s.) in the lower part and the Shansi series (s.s.) in the upper; and the Penchi series, being of definitely a Middle Carboniferous age, seems to be taken as a separate formation. This definition is subsequently accepted by most geologists and palaeontologists, and particularly has been applied to a majority well-known literatures of palaeobotany.

It remains to consider that terms of the subdivisions of the Yuehmenkou series—the "Taiyuan series" and the "Shansi series"—have a much longer known history in the geological literatures than the "Yuehmenkou series". The words "Taiyuan" and "Shansi" were used in naming the rocks in question at least as early as 1882 (Richthofen's "Taiyang Schichten") and 1907 (Willis' "Shansi series") respectively. The primary conception of the "Taiyang Schichten" and the "Shansi series" is quite different either from the designations of Norin or from the current definitions being generally used.

Other reference to these terms, i. e., the Taiyuan series, the Shansi series and the Yuehmenkou series, is too extensive to review here; and the opinion of many authors is still by no means agreed upon the age of these series as well

as their boundary lines.

In 1951 during a geological investigation of the gypsum ore and the coal field in the Western Hills of Taiyuan, the present writers, together with Messrs. Y. Y. Li, M. Hu and P. Y. Tien, etc. accomplished a much more detailed geological mapping work in an extensive area than has previously been done. In addition, considerable geological sections and palaeontological collections were made, though some of the fossil remains being fragmentary. One of the important stratigraphical successions measured by the present writers, and another much detailed stratigraphical records of a shaft of the Peichiachuang Coal Mine are shown in pl. II, figs. 1 & 2. The lithological character of the Yuehmenkou series of these two sections is by no means to differ greatly from that of Norin's type-section (cf. pl. II, fig. 3). For fossils found by the present writers from different horizons in the section of pl. II, fig. 1, as marked by the field number ST222, ST2075.....ST2069 etc., the reader is referred to the Chinese text p. 204.

On the evidence afforded by the sections of pl. II, and with regard to stratigraphical and palaeontological relations throughout the Western Hills of Taiyuan and to certain well-established facts of the corresponding deposits in other parts of N. China, some tentative conclusions can be drawn as to the boundary of these series as well as their geological age.

(1) **The conception of the Yuehmenkou series:** This series comprising the two subdivisions, the Taiyuan series and the Shansi series, must be properly defined to represent only the main coal formation of a Permo-Carboniferous or Sphenian-Permian age of N. China, while its underlying rocks of a Middle Carboniferous age have long been customary indicated under the name Penchi series as a separate formation. Since the distinction of the fauna and the flora as well between these two formations is readily recognized everywhere, it would seem therefore to be no more including the Penchi series in the Yuehmenkou series.

(2) **The lower boundary of the Taiyuan series:** The lower boundary of the Taiyuan series has been chosen by the present writers at the base of the Chinszu Sandstone complex (cf. pl. II, fig. 1). It differs considerably from that proposed by Lee and Chao in 1926. The supposed base-line of this series in Central Shansi, as indicated by Lee and Chao in the "Columnar section of Palaeozoic coal-bearing series in different parts of N. China" is at the floor of Norin's coal seam III, and this coal seam is immediately succeeded by a bluish grey limestone (the Miaokou Limestone) generally no less than 2 m. in thickness. As

shown in the section in pl. II, fig. 1, the plant-bearing beds ST2104 and ST2139, yielding some diagnostic forms of Upper Carboniferous or Stephanian age, such as, *Neuropteris pseudovata*, Gothan & Sze, *Alethopteris* cf. *strictnervis* J. & G., etc. occur certainly in lower horizons than the line as Læ and Chao advocated. Besides, the plant-bearing bed ST2139 is most probably corresponding to Norin's plant-bed 1 which is situated at the middle part of the Chinszu Sandstone complex. The lower limit of the Taiyuan series is thus suggested to be at the base of the Chinszu Sandstone complex. This is also supported by the fact that from a lenticular limestone embedding in a shaly bed not far from the top of the Chinszu Sandstone complex, at the vicinity of Minsientsun, a fusulinid identified as *Triticites* sp. has been found by the writers. This trustworthy genus is hitherto only known from the Upper Carboniferous to Lower Permian.

(3) **The boundary line between the Taiyuan series and the Shansi series:** The boundary line under consideration seems much desirable to be placed at the base of the Peitsakou sandstone. This rests upon the following evidence: (a) The Tungtayao Limestone should be, as Norin originally proposed, located in the Shansi series, in spite of slightly conflicting ideas of some authors that they attempt to make it as a cap-rock of the Taiyuan series. During the investigations of recent years, marine beds supposed to belong to the Shansi series, perhaps at least partly corresponding to the Tungtayao Limestone, have also been discovered in the Fengfeng coal field, SW Hopi and in the Linshih coal field, S. Shansi, etc.. (b) The original distinguishable line between the Taiyuan series and the Shansi series of Norin's type-section, is drawn only at a few feet below the base of the Peitsakou Sandstone through a set of shaly beds, with bottom-conglomerate of iron-impregnated limestone and ore-concretions. But the so-called bottom-conglomerate as well as the whole set of shaly beds is only locally developed. It is thus not sufficient well for designation as a critical line. (c) The Peitsakou sandstone is the thickest (generally more than 10 m.), and most constant homogeneous sandstone consisting chiefly of white quartz sands, and occasionally embedded gravel-layers with pebbles up to the size of an egg. This sandstone probably occurs everywhere and usually forms dominant cliff being readily recognisable. A disconformity separating it from the underlying deposits may also be traced at most places in the south part of the Western Hills. It is most convenient for the present to take the Peitsakou sandstone as a basal sandstone of the Shansi series.

(4) **The stratigraphical relation between the Shansi series and the Lower Shihhotze**

**series:** An examination of Norin's papers dealing with the boundary line between the Shansi series and the Lower Shihhotze series, shows that the features recognised in the Western Hills of Taiyuan region are no good agreement with the facts that seen in the Eastern Hills. As shown in the classical section of the Yuehmenkou, Western Hills, there is no sharp division between these two series, and furthermore Norin has held the Lotopo Sandstone, in a certain sense, to be a transitional bed from the Shansi series to the Lower Shihhotze series; whereas in the Eastern Hills the case being considered as that owing to almost the entire part of the Shansi series is often missing, one unconformity is supposed existing between the Shansi series and the Lower Shihhotze series, though this hiatus is originally assumed to be a disconformity in Norin's contribution of 1922. Since then no further important information about this subject has been added for a long time. It was in the spring of 1951 that Mr. T. C. Tseng has stressed the importance of local features in believing that the unconformity between these two series might be representing a late phase of the Variscian in N. China. More recently, Mr. W. T. Chang, on the contrary, points out that the Lower Shihhotze series, in most cases, is conformably overlying on the Shansi series in N. China.

As a result of an extensive search of the stratigraphical section in the Western Hills, and through a careful study of a fairly large number of the critical accounts of N. China, the present writers are of the opinion that it seems safe to regard the stratigraphical relation between the Shansi series and the Lower Shihhotze series as a disconformable contact, though it is in reality uneasily perceptible in some places. However, this disconformity has been detected by many geologists in a vast area of N. China and it occurs commonly in the south part of the Western Hills and in the Eastern Hills of Taiyuan. Unconformity between them might also be observed in very restricted areas of this region. But there is no adequate reason to believe that these local features merit to describe as an orogenic disturbance.

(5) **On the age of the Taiyuan series and the Shansi series:** On account of the preceding remarks as to the age of the Taiyuan series, the present writers see no deviation from the conclusion advanced by Profs. Lee and Halle, etc.. But, on the age of the Shansi series, they are quite prepared to agree with Profs. Sze and Huang that the Shansi series in N. China perhaps can be correlated with the Chilsia limestone in S. China, being of a Lower Permian age. As discussed at some length in the Chinese text, on the one hand there is no

decisive evidence that the fauna gathered from the Tungtayao Limestone is quite sufficient to prove an Upper Carboniferous age; on the other hand, the flora of the Shansi series, though particularly meagre in the type-area, from the equivalents in other parts of N. China recalls a much greater resemblance to that of the Lower Shihhotze series or Lower Permian elements. The most important forms of the equivalents, as proclaimed by Stockman and Mathieu from the lower part of the Chaokochwang series in Kaiping basin, E. Hope, and by H.H. Lee from the Shansi series of southeastern Shansi, are as follows:

*Sphenophyllum thonii* Mahr

*Pecopteris arcuata* Halle

*Taeniopteris multinervis* Weiss

*Taeniopteris nystroemii* Halle

*Tingia carbonica* (Schenk)

*Emplectopteridium alatum* Kaw. etc.

Most of these species occur very commonly in the Shihhotze series in Central Shansi, as well as in other parts of N. China. The presence of *Taeniopteris multinervis*, *Sphenophyllum thonii* and *Emplectopteridium alatum* is notable. The first two are generally regarded as most characteristic elements of Lower Permian, while the last one, i. e., the monotypic plant *Emplect. alatum*, excepting the new finding in SE Shansi, is heretofore only known from the upper part (bed-D) of the Jido series, Korea. The upper part of Jido series which contains also important coal seams, is held by many authors to be corresponding to the Lower Shihhotze series of Central Shansi of a Lower Permian age. Accordingly, it would seem better to assign the Shansi series in the type-area to be also Lower Permian. But no final solution can be hoped for until more palaeontological evidence is available about this series. And the most promising line of inquiry seems to be the fusulinids of the Tungtayao Limestone, and possibly also through a thorough study of the Upper Palaeozoic plants widely distributed in N. China.

The Yuehmenkou series as a whole is thus representing Permo-Carboniferous or else forming a connecting link between the Stephanian and Lower Permian.