

GEOLOGICAL NOTES FROM KANSU

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Age of the Kueite Series: In my paper "Essays on the Cenozoic of Northern China" I have mentioned a fossil find which was made by Dr. Wong Wen-hao and Mr. C. Y. Hsieh in the "Red beds" of Ku Yuan Hsien, E. Kansu. These were shells and opercula of a small gastropod which I thought to be identical with a species found in the Eocene beds of Yuan Chu Hsien of S. Shansi. From this comparison I concluded that the beds in question were of Eocene age and that very likely part of the Kueite series of Lozcy was to be included under the same heading.

This interpretation was based upon the assumption that there occur in the Kueite basin two Tertiary series, an upper one containing the Pliocene fossils found by Lozcy and a lower series presumed to be Eocene and correlated with the Kuyuan beds.

My observations in Kansu during my journey there 1923-24 have shown me the fallacy of my interpretation and the complete correctness of the statements given by Lozcy. At the same time my observations have revealed a period of young block-faulting in Kansu which proves that the tectonic development of that area is widely different from that of northeastern China.

In the Kueite basin I found in many places the same fresh water mollusks as collected by Lozcy, and these finds were in some cases made deep down in the splendid sections.

Mammals were found by me in two places in the Kueite basin: in one locality together with the usual fresh water Mollusks numerous fragments of a rodent and in another locality, also deep down in the series, Artiodactyla and Carnivora of types which I can mark without doubt as belonging to the younger Tertiary.

Our finds near Sining were still more conclusive. In two places we found here numerous remains of mammal, among which a Mastodon is by far the most common, proving beyond doubt that the beds in question belong to the younger Tertiary.

In Nien Pe Hsien (碾伯縣) we found numerous fresh water shells, among which a species identical with or at any rate closely resembling the Ku Yuan gastropod.

At Hsien Shui Ho in Ping Fan Hsien (平番縣), 120 li from Lanchow, the Mastodon fauna was again encountered in typical red beds which are here rather strongly dislocated.

The exact age of this formation cannot be definitely ascertained before the numerous fossils collected by us have been determined. However, already from the indications given above it seems beyond doubt that the red beds of the Kueite basin as well as all the way from Sining to Lanchow belong to the Younger Tertiary, most probably Pliocene and that Lozcy's term Kueite formation ought to be upheld for this series.

As to the relationship of the Kuyuan beds, first studied by Mr. Hsieh, to the Red beds of Kueite, Sining and Lanchow, I can for the present only state that the similarity to these beds is very striking. A revision of the Ku Yuan fossils will be needed in order to settle this question.

Post-Kueite block faulting: In most places the Kueite beds are horizontal or nearly so, but locally strong disturbances are encountered. A splendid section which proves beyond any doubt that the present position of the Kueite beds is not due to the deposition in preexisting valleys, but to big faults, is found at the Huang Ho, some 40 li above Kueite city at a place named Lung Yang Hsia. Strong disturbances within the Kueite beds are also visible in the eastern part of the Kueite basin on the north side of the river.

In fact, it soon becomes evident that the Hsia (峽) topography, which is such a characteristic feature of this area, is due to the block-faulting. The Hsia is the Chinese term for narrows where the river (there are several Hsias in the Sining Ho between Sining and the outlet in the Huang Ho) cuts through a barrier of old resistant rocks (granite, limestone etc). It is easy to prove that the Hsias are horsts through which the river has cut a "durchbruch thal" and that the lowlands, where the river has cut broad open valleys in the soft Kueite beds, are sunken areas.

Whether there is also real folding in the Kueite series is more difficult to say. Locally sharp folds are seen, but they are of small extent and might be only a secondary phenomenon accompanying the block-faulting. This period of tectonic movements is evidently of very young Tertiary age and no parallel to it is, as far as my experience goes, known from northeastern China.

Cretaceous beds of Liu P'an Shan (六盤山): In Mr Hsieh's section from Sze Kou Tze, north of Ku Yuan city, which is reproduced in my paper on the Cenozoic of N. China, page 144, there is marked a series C, which was interpreted by Mr. Hsieh as of Palaeozoic age. It is a formation consisting mainly of very soft grey, easily crumbling shale with interbedded layers of oolitic limestone. We met this series not far from Ping Liang and followed it through Wa Ting into the southern part of Ku Yuan Hsien. North of Ku Yuan city we met it again in Mr. Hsieh's section and in many outcrops west of his locality. To judge from specimens brought by one of my men, it forms the crest of Liu P'an Shan, where this mountain range is crossed by the cart-road between Ping Liang and Lan Chow.

We were fortunate to find fossils in this shaly series in several places. They are fragments of plants, mussels and a large sized *Estheria* (according to Dr. Grabau's determination) as well as various insects. The fossils, which according to Dr. Grabau mostly represent new species, have not yet been closely studied, but there is hardly any doubt that they are of young Mesozoic age and very likely approximately corresponding in age to the Cretaceous faunas and floras from Shantung, recently described by Dr. Grabau and Mr. Chow.

Age of Liu P'an Shan: It is very noticeable that the crest of the Liu P'an Shan range consists of this easily eroded shale series. The steep sides of this range exhibit large outcrops of this crumbling rock which is so quickly disintegrating that over large areas no vegetation has been able to develop.

This fact, that almost everywhere in this area the highest ridges are formed of this easily eroded rock, must be marked as something quite exceptional and can only be interpreted as proving that Liu P'an Shan is a mountain *in the making*. In this connection it is interesting to note that the

maximum intensity of the 1920 earthquake was round the northern end of Liu P'an Shan. It is tempting to assume that this strong manifestation of seismic activity is closely connected with the apparent immaturity of Liu P'an Shan. Also from other parts of Kansu I have observations indicating that the tectonic movements, which I have marked above as post-Kusite, have continued as late as after the formation of the gravel—conglomerate which nearly everywhere underlies the loess.

Marine Lower Carboniferous at the western end of Kokonor: To the north of the river which from west flows to the westernmost part of Kokonor I noticed beds of crystalline, partly oolitic limestone containing among other fossils a small *Spirifer* or allied genus. According to Dr. Grabau's kind communication the beds can fairly safely be marked as lower Carboniferous.

The above notes on some new features of the geology of Kansu are by force quite summary, as my field notes from the 1923 campaign are not available to me when writing this paper. At a later occasion I will deal with these problems in full detail.