

SOME CORRELATIONS BETWEEN THE GEOLOGY OF CHINA PROPER AND THE GEOLOGY OF MONGOLIA.*

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During the summer of 1930 we had, thanks to the Central Asiatic Expedition led by Dr. R.C. Andrews, a splendid opportunity for studying the geological formations of SE. Gobi, along the Kalgan-Urga trail, South and East from Iren Dabasu. As a result of those observations, it seems that the following views can be tentatively presented, concerning the correlations between the Geology of China Proper (as built up by the National Geological Survey) and the Geology of Mongolia (as understood by Prof. Berkey and Morris in their epoch-making work "The Geology of Mongolia"***).

1. *The Geological Age of the Mongolian Batholite*

As discovered and emphasized by Berkey and Morris, the chief feature of the old Gobi floor consists of a series of thick slates and sandstones (admitting a few limestone intercalations), "the Khangai series", invaded by a huge granitic intrusion, "the Mongolian Batholite". Provisionally, and with some hesitation, Berkey and Morris have referred the whole Khangai series to the Sinian: and, consequently, they consider the Mongolian Batholite as a pre-Palaeozoic intrusion, this interpretation being rather in opposition with the conditions met, not only in the Khingan and in the Western Hills of Peking, but also in the Tsing Ling and in S. China (where the late granites are of a post-Jurassic age).

From our last observations, on the contrary, it seems clear that (in the SE. Gobi at least) the Khangai series, possibly Sinian*** in its lower horizons, extends at least so high as to the uppermost Palaeozoic (it includes

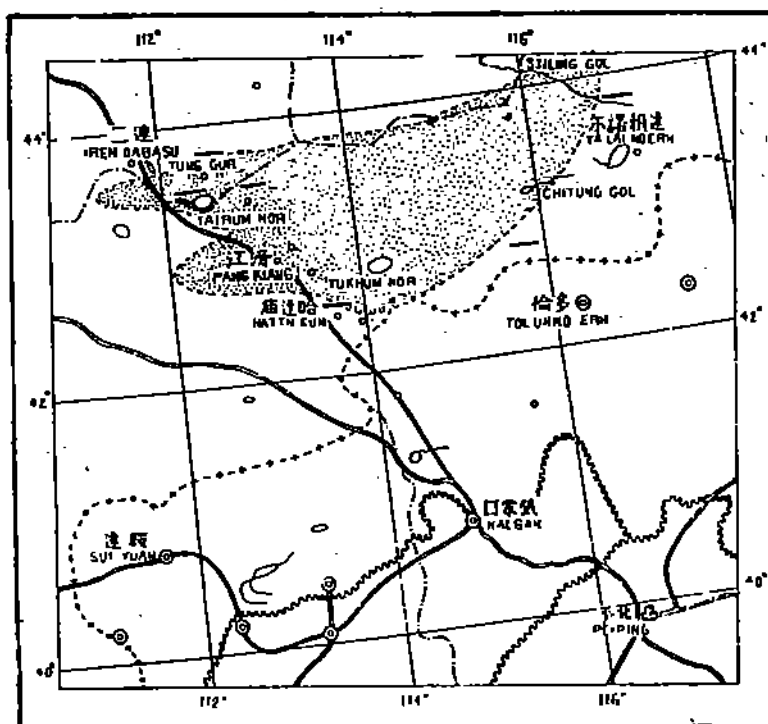
* Read at the general meeting of July 30, 1930, manuscript received on August 26, 1930.

** Charles P. Berkey and Frederick K. Morris, *Geology of Mongolia*, *Natural History of Central Asia*, Vol. II, 1927

*** Possibly Sinian remains are represented, near Hattin Sum, by patches of quartzites and siliceous slates, isolated in the intrusive granites and diorites.

perhaps some Mesozoic terms), so that the intrusive Mongolian Batholite has to be held as post-Palaeozoic, just as it is the case for the other recent granites in China.

This more satisfactory view is supported by some very decisive facts (cf. the map, text-fig; 1):



a) In two places (near Hattin Sum, 40 miles SE. from Pang Kiang, surely, and near the Tairum Nor, SE. from Iren Dabasu, most probably), traces of fossil wood have been collected in Late Palaeozoic (or even Early Mesozoic) conglomerates or silicified clays belonging to the top of the Khangai series. In both places, the wood-bearing horizons overlie closely the Upper-Palaeozoic limestone (s. below), and, in Hattin Sum, they are directly intruded by the granitic rock.

b) North of Tung Gur (near Bolok-In-Sumu), in the very middle of a thick series of Khangai slates (intruded itself by granite) a bed of limestone, metamorphosed along its borders, has yielded well preserved Crinoids and Corals. The same kind of limestone (identical by its lithological characters

with the Upper Palaeozoic Crinoid-limestone of Dalai Nor, Linn-Si, Hailar, Harbin and Kirin)* has been recognised by us in several places between Hattn Sum and Iren Dabasu, always incorporated in the Khangai series. Generally the beds, moderately thick (never more than a few meters) are strongly crushed and marmorized. Nevertheless, for two localities at least (in addition of the case of Bolok-In-Sumu above mentioned), we think that a microscopical study will prove the presence of Crinoid fragments in the formation, this presence being strongly suggested by a first examination in the field.

Of course, the post-Palaeozoic age of the Mongolian Batholite, if admitted, does not exclude the possibility of some shifting or migration of the eruptive zone towards the East and the South during the Mesozoic times. As a result of such a migration, the recent granites and acid porphyries could be pre-Jurassic in the Central Gobi, and post-Jurassic in the Khingan and in the Western Hills**. But, in any way, a fundamental identity (in age, succession, association and lithological characters) between the post-Palaeozoic granites, diorites, rhyolites and andesites is perfectly striking all over N. China and Mongolia, from Kalgan to Hailar across the Gobi, and from Peking to Heilungkiang along the Pacific ranges.

2. *Extension and localisation of the Pliocene in SE. Gobi*

In 1928, the Central Asiatic Expedition has discovered SE. from Iren Dabasu, near the Tairum Nor, a large sedimentary basin filled with Pliocene lake-deposits (Tung Gur formation, or *Platybelodon* beds); and the geologist

* And probably of Jisu Honguer (Permian), cf. Berkey and Morris, loc. cit., p.181 etc.

** The difficulty for solving this question is due to the fact that the characteristic Jurassic Plant-bearing beds, so widely extended over N. China (Shensi, Shansi, Hopei, Jehol, Manchuria) are absent, or scarcely recognisable, in the Central Gobi.

The problem, however, can probably be settled by a further survey of the eastern Gobi border, between the Djalai Nor (Hailar) and the Dalai Nor (Dolonnor). In this area, an older post-Palaeozoic granitic mass (the "Habotou granite") is intruded, f.i. near Linn Si and along the Tsijing gol, by dykes of a younger granite ("the Linn Si granite"); and traces of Plant-bearing Jurassic (?) beds occur occasionally, f.i. between the Tsijing gol and the Sjiling gol, and close to the Djalai Nor (cf. Tellhard de Chardin, *Etude géologique sur la région du Dalai Nor*, Mém. de la Soc. Géol. de France, n. 7, 1926.).

of the Expedition, Mr. L. Erskine Spock has already suggested* the view that those fossiliferous deposits, as well as the barren Pang Kiang formation of Berkey and Morris (loc. cit., 1927) and the Dalai Nor "White beds" of Teilhard (loc. cit., 1926), belong to a same big Pliocene formation covering the whole SE. Gobi. Further explorations made, this year, around the Tairum Nor and near the Tukhum Nor** (60 miles ESE. from Pang Kiang), helped by a personal knowledge of the Dalai Nor's basin, allow us to give a new support and more distinctness to this assumption.

In spite of the fact that, on account of the sands, we were not able to reach, from the Pang Kiang area, the Dalai Nor region, it seems fairly sure, now, that, for the whole SE. corner of the Gobi (SE. from the line Iren Dabasu-Dalai Nor), the history of the sedimentation, during the post-Oligocene times, is the same, and may be reconstructed in the following way:

A. *Ante-Pliocene times*. As a result of a very strong erosion, the old Gobi floor is practically everywhere exposed and re-excavated.

B. *Lower Pliocene (Pontian) times*. Extensive deposition, on the Gobi floor, of generally dark red clays (barren in Pang Kiang, fossiliferous in the Tukhum Nor and near the Dalai Nor).

C. *Upper Pontian (or Middle Pliocene?) times*. Over the eroded (Tairum Nor), or even faulted (Dalai Nor), surface of the Red Pontian clays, large lakes, fed by inland streams, are gradually filled by generally white sands, clays and characteristical lacustrine limestone (*Ostracod limestone*)***: Tung Gur formation, White Beds of the Dalai Nor, Ertemte sands?****.

* L. Erskine Spock. Pliocene Beds of the Iren Gobi. American Mus. Novitates, n. 394, 1929.

** This Tukhum Nor is not the same as the Tukhum Nor, West from Iren Dabasu, taken by Morris for the type locality of an Eocene formation.

*** A very similar Ostracod-limestone occurs, as isolated patches, in S. Ordos, i. e. near Cheu Tchoeize (over the Pontian?) and near Hoa Ma Tcheu (over the Cretaceous). Cf. Teilhard and Licent, Etudes géologiques sur la bordure méridionale de l'Ordos. Bull. Soc. Géol. de France, ser. 4, t. XXIV, p. 66 and 70, 1924.

**** On account of a fundamental similarity in the fauna, and even, sometimes, in the facies (the upper layers of the Tung Gur formation are generally red), the distinction between the sediments belonging to the Phases B and C is not always easily recognisable. To the cases of unconformity and disconformity reported above in the text may be added the fact that the two series are frequently overlapping. F. i. the Tung Gur beds are missing over the Red Pontian beds, North of the Tairum Nor and possibly in the Pang Kiang area (unless they are represented by the top of the Pang Kiang deposits); and, on another hand, the Red Pontian beds are not found below the White under-basaltic beds (Tung Gur formation) along the Sjiling gol (cf. Teilhard, 1926.)

Phases A and B are easily recognisable in N. China. On the contrary the Phase C seems so far to be special to the Gobi (the correspondent deposits have to be searched amongst the lower horizons of the so called Reddish Clays of Shansi) -It is noteworthy that the Tung Gur formation is exceedingly similar, by its sedimentary facies, to the Nihowan lake-deposits (Sanmenian), and contains (cf. Spock, 1929, p.5) a number of small thick *Unionidae* which may prove to be the direct ancestors of the *Lamprotula* so characteristic of the Sanmenian deposits of N. China.

The distinct and exclusive localisation of thick Pliocene sediments in the SE. corner of the Gobi is probably not due to some selective post-Pliocene erosion by which the Pliocene deposits would have been destroyed in the more NW. area of the Mongolian Plateau, and preserved in this particular place. But it suggests that, since the beginning of the Pliocene times already, the Central part of the Gobi was under desertic conditions (erosion stronger than deposition), which did not prevail in the SE. Mongolia before the Sanmenian times.

3. The late Cenozoic Stages.

The Tung Gur formation is the last thick sedimentary series met in the Gobi. At the end of the Pliocene times, we find that the *Lamprotula* lakes have already migrated down to the Sangkan Ho and Hoang Ho basins. And, as a probable consequence of a further extension of the Gobi desertic area, dissection begins to be much stronger than deposition even in the SE. corner of the Mongolian Plateau. Over this area, the Sanmenian and Loessic (Middle Pleistocene) times are chiefly represented by erosional features.

To the Sanmenian we ascribe tentatively the formation of the "Gobi erosion plane" of Berkey and Morris, and the deposition, over the slightly dissected plane, of a distinct sheet of stratified sands and gravels[(sometimes 4-5 meters thick, and sometimes taken in hard conglomerate, f.i. near Pang Kiang and the North of the Tairum Nor *

To the ante-Loessic erosion (*Ching Shui stage* of Barbour) has to be attributed the final excavation of the chief depressions actually met over the Mongolian Plateau (a first outline of those depressions was probably shaped by the Sanmenian erosion, or *Fenho stage* of Barbour). As a definite proof of

* The "early Pleistocene" age of the Gobi plane in this area has been recognised by Spock (loc. cit., p.8).

the ante-Loessic age of the Gobi depressions we can afford the fact that *Rhinoceros tichorhinus* occurs in the 10-12 meters thick sandy deposits which line the border of those depressions near Hattin Sum. Just as in the Dalai Nor and the Djalai Nor areas, distinct Middle Pleistocene high terraces are seen along the Tukhum Nor, the Tairum Nor and other minor lakes, over the whole surveyed area.

On the whole, the compared series of the physiographical Upper Cenozoic stages in N. China and SE. Mongolia can be provisionally and tentatively understood as reported in the Table I, at the end of the present paper.

Possible Traces of Palaeolithic Industry in Central Gobi

In a small Nor, excavated N. of Tung Gur, in some Upper Cretaceous beds over which extends a 3-4 meters thick (and well consolidated) Middle Pleistocene gravel, we collected on the soil a series of stone implements belonging perhaps to a Palaeolithic age. The best specimens are:

a) A remarkably fine and large scratcher in quartzite, very strongly worn.

b) A much worn "percuteur" or envil in quartzite, astonishingly similar to (but a little smaller than) the Palaeolithic envil collected by us in 1929, in the Loessic terraces of the Chungar river (Eastern Ordos)*.

c) A probably artificially broken rhyolitic boulder. This specimen, if it is really an artefact, would establish the Palaeolithic age of the industry, because it was collected (mixed with several older boulders) just on the foot of the small cliff capped by the Pleistocene gravels, and is still bearing a small patch of the cement which consolidates the lower boulder bed of these gravels.

* See P. Teilhard de Chardin and C. C. Young. Preliminary Observations on pre-Loessic and post-Pontian formations in W. Shansi and N. Shensi, Appendix III. Mem. Geol. Surv. of China, n. 3, 1930.

TABLE I
PHYSIOGRAPHICAL STAGES IN N. CHINA AND GOBI
(ARRANGED BY P. TEILHARD DE CHARDIN
AND C. C. YOUNG, JULY 1930)

Stages		N. China	Gobi (Central, and NE.)
Cycle A (Pontian,	Tangshien..	Strong erosion exposing the ancient floor (a folded Mesozoic rocks, and older).	Id. (N. and NW from Iren Dabasu, the erosion seems to have been lighter, or even absent: on account of already desertic conditions in this area?)
	Pao-te	Deposition of the Red Clays. (<i>Hipparion richthofeni</i>).	Id. (The Red Clays are not found N. and NW. from Iren Dabasu).
Cycle B (Upper Pontian?)	X	First erosion of the Red Clay?	Erosion of the Red Pontian Clays (and local faulting, v. z. near the Dalai Nor).
	Y	Deposition of the older Reddish Clays of Shansi, N. Shensi? "Ostracod-limestone" of S.W. ordos?	Deposition of the big lake deposits: Tung Gur formation (<i>Platybelodon</i> beds) White Beds of the Dalai Nor)..... (-Pre-" <i>Lamprotula</i> beds").
Cycle C. (Sanmenian) (Gunz-Mindel?)	Fenho	Strong erosion.	Formation of the "Gobi erosional plane" (of Berkeley), and first outlines of the actual depressions.
	Sanmen	Thick deposition: Lake deposits (Shangkai-ho) <i>Lamprotula</i> beds, Reddish Clays (chiefly at the end of the stage....)	Upper-gravels (over the "Gobi plane"). The light material of desintegration, blown out by the wind, forms the Chinese Reddish Clay?
Cycle C.	Chou-Kou-Tien	?
Cycle D (Middle Pleistocene "Loessic") (Risswurm?)	Ching-shui ..	Erosion	Final excavation of the chief actual depressions met on the Mongolian Plateau.
	Malan	Deposition of the "Loessic" sediments (gravels, sand, loess).	(Most of the desintegrated material blown over China)-Sandy "loess" with <i>Rhinoceros tichorhinus</i> (South of Pang-Kiang);-lower gravels of the Gobi,-Noor terraces..... Extension maximum of the Noor
	Panchiao (and modern)	Erosion	Erosion (A maximum extension of the sand-dunes seems to have occurred in the Neolithic times, in Mongolia and Manchuria. These dunes are already fixed).