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CONTENTS

DISCOVERY OF CRETACEOUS AND OLDER TERTIARY STRATA IN MONGOLIA[1]

THE American Museum of Natural History announces,[1] under date of May 3, 1922, that strata of Cretaceous age, overlain by two distinct Tertiary formations, have been discovered in the Gobi region of southeastern Mongolia.

They were found on the outbound trip from Kalgan to Urga at a point about 260 miles northwest of Kalgan. Strata of Cretaceous age are wholly unknown in Eastern Asia, as far as the writers of the present communication are aware, and because of the apparent importance of the find, it was decided to leave the geologists in camp at this place while the rest of the party moved on. Accordingly Messrs. Berkey, Granger and Morris spent a week in additional inspection of the ground and furnish the notes for this memorandum.

Obretcheff, the Russian geologist, who gives an account of a reconnaissance trip over this same route from Ude to Kalgan, describes sedimentary beds at many places, always referring to them as representatives of the Gobi formation. His only age determination, however, was made on the basis of a few fragments of *Rhinoceros,* found at the escarpment five miles south of Iren. These remains were judged by Eduard Suess, to whom they were referred, to indicate an age not earlier than the Miocene. The Tertiary age of the rest of the occurrences mentioned by him seems to have been taken for granted and apparently that is in general correct, but it is evident that the Gobi formation can not properly include strata of both Tertiary and Cretaceous ages.

[1] Abstract: "Discovery of Cretaceous and Older Tertiary Strata in Mongolia," Walter Granger and Charles P. Berkey. American Museum *Novitates,* No. 42, 7 pp. 1 fig., August 7, 1922.

It is clear also that the term Gobi formation or Gobi series is properly applied to the Tertiary beds instead of to those of Cretaceous age.

The best exposures of this underlying Cretaceous formation are in the vicinity of the small salt marsh Iren Dabasu, where a total thickness of about 150 feet of nearly horizontal strata is judged to be of this age. Tertiary beds not older than the Miocene lie on top of the Cretaceous strata and are best exposed about five miles south of Iren. Twenty miles farther south early Tertiary beds were found in essentially the same relation.

The finding of this upper Cretaceous formation makes a new designation necessary. For this purpose nothing seems to be as appropriate as the name of this locality. We therefore propose the term "Iren Dabasu formation" for these beds.

Remains in all three beds are fragmentary, decidedly so in the Houldjin gravels, but they are of unusual interest apparently and we have taken everything which has any character.

Dinosaurs are represented in the Iren Dabasu beds by one complete tibia, ends of femora and humeri, presacral and caudal centra, many good foot bones, including claws of fore and hind feet, portions of a small carnivorous dinosaur skull with two or three teeth, and two teeth of a predentate, as well as two portions of jaw with the alveoli of some teeth, also predentate. Remains of the small *Ornithomimus*-like creature are particularly abundant and the last day at Iren Dabasu we picked up probably fifty good foot bones and centra from two or three knolls. We could find no teeth of the little fellow though—wonder if he was edentate like *Struthiomimus?* The Cretaceous exposures are very limited so far as we could see but may, of course, outcrop in other basins to the east or west of the road. We did not have time to extend our work in either direction. The outcrops we did see will stand a more careful going over.

The Houldjin gravels are exposed as a rather thin capping to a low bench of Cretaceous which we followed for several miles. Things are badly broken up here—even such massive bones as the heads of femora and humeri were usually cracked into several pieces before deposition. There is one fine bone—a calcaneum of the big beast which would be a match for the astragalus of *Baluchitherium*[2] (?). I can think of nothing else to which it might belong. It is as long as the great *Megatherium* calcaneum from Long Branch, N. J., but is not edentate. A head of a femur is the size of one's head and other limb bone ends correspond. Some enormous rhinoceros teeth (broken) may belong with this animal. Smaller teeth are surely *Rhinoceros.* We did not explore the full length of the exposure and there are possibilities in excavation at one or two points of the bluff where we did explore.

The Irdin Manha beds offer the greatest opportunity for future work. Mammalian remains are abundant though fragmentary and we examined less than two miles of a line of exposures extending many miles both east and west of the trail. A small lophiodont (*Helaletes*-like) is most abundant and we got numerous teeth besides two maxillæ (one with premaxilla and orbital region) and a few lower jaws, also numerous foot bones, limb bones and vertebræ. Next in abundance is a perissodactyl, looking much like our late Eocene titanotheres. We have several premolars, many incomplete molars and one lower jaw with p_3—m_3 in fair condition. Other forms are curiously rare, a creodont lower jaw and an artiodactyl astragalus or two being the only things noted. Trionychids are common and we saw a complete though badly broken carapace which we were hurrying to get to our car before a storm overtook us the last day we were there. We made three trips down from Iren Dabasu camp but could not do more as our food was getting short and we had to join the rest of the party here.

In the vicinity of the small salt lake Iren Dabasu, the Cretaceous beds lie immediately on the slate floor of the basin and between this base and the first determinable beds of later age, in this case late Tertiary, about 150 feet of strata are exposed. The bottom members are dominantly sands and sandstones, prevailingly thin-bedded, some of which are strongly

[2] A gigantic perissodactyl described by C. Forster Cooper from Baluchistan.

cross-bedded and well cemented. The middle members become finer grained, more mixed with clay and more variable in color. The upper beds are dominantly clays and sandy clays and very fine sands, varying in color from white to dark red and drab and yellowish green. No less than twenty distinct beds or layers can thus be distinguished, all of which are regarded as belonging to a single geologic formation.

Only the lower members of this "Iren Dabasu" formation have been found to be fossiliferous. The list includes:

1. Predentate dinosaurs, probably of the bipedal type.
2. Carnivorous dinosaurs of at least two genera, the smaller one being of the *Ornithomimus* type.
3. Crocodiles.
4. Turtles of the *Trionyx* type.
5. A few pelecypod shells.

The geologic column for the Iren Dabasu basin therefore is essentially as in the following table:

Recent	Uplift and Erosion			
	Peneplanation			
Tertiary	Miocene or Later: Upper barren sands; Rhinoceros gravels	25′+ 5′	The Houldjin Formation	The Gobi Series
	Oligocene or Eocene: Upper barren sandstones; The Lophiodont bed	25′+ 4′	The Irdin Manha Formation	
	Physical and Faunal Break			
Cretaceous	Upper barren members, chiefly clays, marls and fine sands	90′	The Iren Dabasu Formation	
	Lower or Dinosaur beds, chiefly sands and sandstones	60′		
	Great unconformity			
Pre-Cretaceous	The old-rock floor, chiefly slates, limestones and igneous rocks			Probably The Nank'on Series

THE HOULDJIN BEDS (MIDDLE TERTIARY)

For the late Tertiary beds found five miles farther south and belonging to the Gobi Series of Obretcheff we propose the term "Houldjin Beds," taken from the local name of the upland formed by these beds. They are characterized by the following fossil content:

1. A rhinocerid.
2. A large carnivore.
3. An artiodactyl of the size of a Virginia deer.
4. An enormous mammal, probably a perissodactyl and possibly related to or identical with *Baluchitherium*, discovered by Forster Cooper in Baluchistan.
5. A tortoise of large size.

There is a sharp physical change immediately below this formation and only the coarse sandy conglomeratic member at the very base has been found to be fossiliferous. The fossil remains are unusually fragmentary.

IRDIN MANHA FORMATION (EARLY TERTIARY)

For the early Tertiary beds found twenty-five miles farther south, also assumed properly to belong to Obretcheff's Gobi Series, we propose to use the term "Irdin Manha formation." It appears to lie immediately on Cretaceous beds, the Iren Dabasu formation, and again there is a sharp change in type of rock. The beds are cross-bedded sandstones, limy sands and pebbly sandstones. Only the lower member has been found to be fossil-bearing. It is characterized by the following forms: (1) Small Lophiodonta of at least two species in great abundance; (2) A perissodactyl about the size of the Upper Eocene titanotheres and possibly related to this family; (3) A small artiodactyl; (4) A small creodont; (5) An abundance of turtles of both the hard-shelled and soft-shelled groups; (6) Teleost fishes.

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