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新疆布尔津地区晚始新世哺乳动物化石的发现及其意义[1)]

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1995 年以来作者等人在新疆准噶尔盆地北缘乌伦古河地区开展了第三纪哺乳动物地层研究工作。在调查研究该区乌伦古河组地层同时(叶捷等,2001a, b),为搞清乌伦古河组的区域分布,我们在 1999 年和 2001 年先后两次前往布尔津地区考察了那里的"乌伦古河组"。在布尔津县城西北 14km 处额尔齐斯河北岸的一片新生代露头,长期被视为乌伦古河组,因而时代也被定为始新世至渐新世,但一直没有确凿的化石依据。1999 年我们首次在该套地层中采集到哺乳动物化石(99027 地点),2001 年再次在同一地点、同一层位采集到化石并实测了地层剖面。布尔津的该乌伦古河组地层可大致分为两段,下段为富含铁质的砂岩与泥岩互层,上段为浅灰绿色砂岩与杂色泥岩互层,整套地层的风化表面呈黄棕色。在乌伦古河组建组的乌伦古河流域,乌伦古河组则由一套浅灰绿色砂岩与棕灰色含砂泥岩构成,整套地层风化表面呈灰白色(叶捷等,2001a)。两个地区的乌伦古河组的岩性显然是不同的。野外追索证明,这两个地区的两套不同岩性的地层是两个不同沉积盆地的堆积物,这两个盆地在乌伦古湖附近(E87°12′)被一由古生代地层构成的山岭隔开。作为地质体,这两套地层间没有联系,不应当归为同一岩石地层单位。因此,布尔津地区的乌伦古河组名称应该更改。在地形图上,布尔津地区似乎位于现代广义的斋桑盆地中,因而必须与斋桑盆地中的相应地层做详细对比后才能对布尔津地区的该套地层冠名。

99027 地点的化石产自厚 1.2m 的黑色含锰质粉砂岩层(剖面第 21 层)中。化石材料都为奇蹄类零星牙齿,共 6 种,分属 4 个科:两栖犀科 *Cadurcodon* cf. *C. ardynensis*, Amynodontidae gen. et sp. indet., *Gigantamynodon giganteus*;跑犀科 Indricotheriinae gen. et sp. indet.;真犀科 Rhinocerotidae gen. et sp. indet. 和雷兽科 Brontotheriidae gen. et sp. indet.。该奇蹄类组合与我国云南的蔡家冲动物群、内蒙古的乌兰戈楚动物群和乌尔丁鄂博动物群、蒙古的 Gua-teg 和 Khoer-Dzan 动物群以及哈萨克斯坦的 Kusto 动物群中的奇蹄类构成相似。众所周知,由于同位素测年手段的应用,近来这些动物群的时代已由早渐新世更改为晚始新世,因此布尔津的奇蹄类组合及产化石地层的时代也应为晚始新世。布尔津地区晚始新

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世哺乳动物化石的发现不仅填补了新疆北部地区哺乳动物演化在该时段的空白,南、北地区大型奇蹄类构成的相似性还进一步表明,晚始新世时亚洲大陆南、北哺乳动物地理分区尚未形成。此外,在99027地点以北已发现一早渐新世哺乳动物群(99035地点),表明在布尔津地区可能有晚始新世/早渐新世哺乳动物地层界线的存在,提供了检验"蒙古重建"环境生物事件假说和解释欧洲"大间断"事件理论的可能性。

关键词 新疆布尔津,晚始新世,奇蹄类

中图法分类号 Q915.877

THE DISCOVERY OF LATE EOCENE MAMMAL FOSSILS FROM BURQIN OF XINJIANG

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Abstract The previously alleged "Ulunguhe Formation" in the Burqin region of Northern Xinjiang is lithologically different from the Ulunguhe Formation in its type-region, the Ulungur River area. The two regions are separated by a mountain of Paleozoic rocks. Therefore the sediments in two areas belong to different geological body respectively. The name "Ulunguhe Formation" should not be applied to the deposits in the Burqin region, for which, however, it is premature to name a new rock unit.

A perissodactyl assemblage was collected from the sediments of Burqin. It consists of exclusively perissodactyls, including *Cadurcodon* cf. *C. ardynensis*, *Gigantamynodon giganteus*, Amynodontidae gen. et sp. indet., Indricotheriinae gen. et sp. indet., Rhinocerotidae gen. et sp. indet., and Brontotheriidae gen. et sp. indet., and is comparable with the late Eocene mammal faunas of Asia, such as Caijiachong fauna of Yunnan, Ulangochu fauna and Urtyn Obo fauna from Nei Mongol of China, Guarteg and Khoer-Dzan fauna from Mongolia, and the Kusto fauna from Kazakhstan.

The discovery of the late Eocene mammals in North Xinjiang indicates that the terrestrial biogeographic division into south and north provinces in the Asian continent had not been achieved by the late Eocene.

Key words Burqin, Xinjiang, late Eocene, perissodactyls

Since 1995 the authors have been working on the Tertiary stratigraphy and faunas in the Ulungur River area of the north Junggar Basin, Xinjiang (Ye et al. 2001a). During the period of time we also investigated the Burqin area in 1999 and 2001. Mammal fossils were found in both years from sediments that were previously called "Ulunguhe Formation" on the north bank of the Irtysh River near the Burqin city (Fig. 1). The fossils were collected from two sections that are about 14km apart and represent two assemblages of different ages. One section generated fragmentary specimens of large perissodactyls (locality 99027), whereas the other produced better material of primarily small mammals (99035) (Fig. 1). By correlations with other Asian Tertiary faunas, the perissodactyl assemblage indicates the age of late Eocene, whereas the assemblage of small mammals is of early Oligocene age. In this study, we report only the rock section that yields the perissodactyl fossils, describe the fossils, and discuss their implications.

1 Lithological stratigraphy

The measured section is located on the north bank of the Irtysh River, 14km north of Burqin

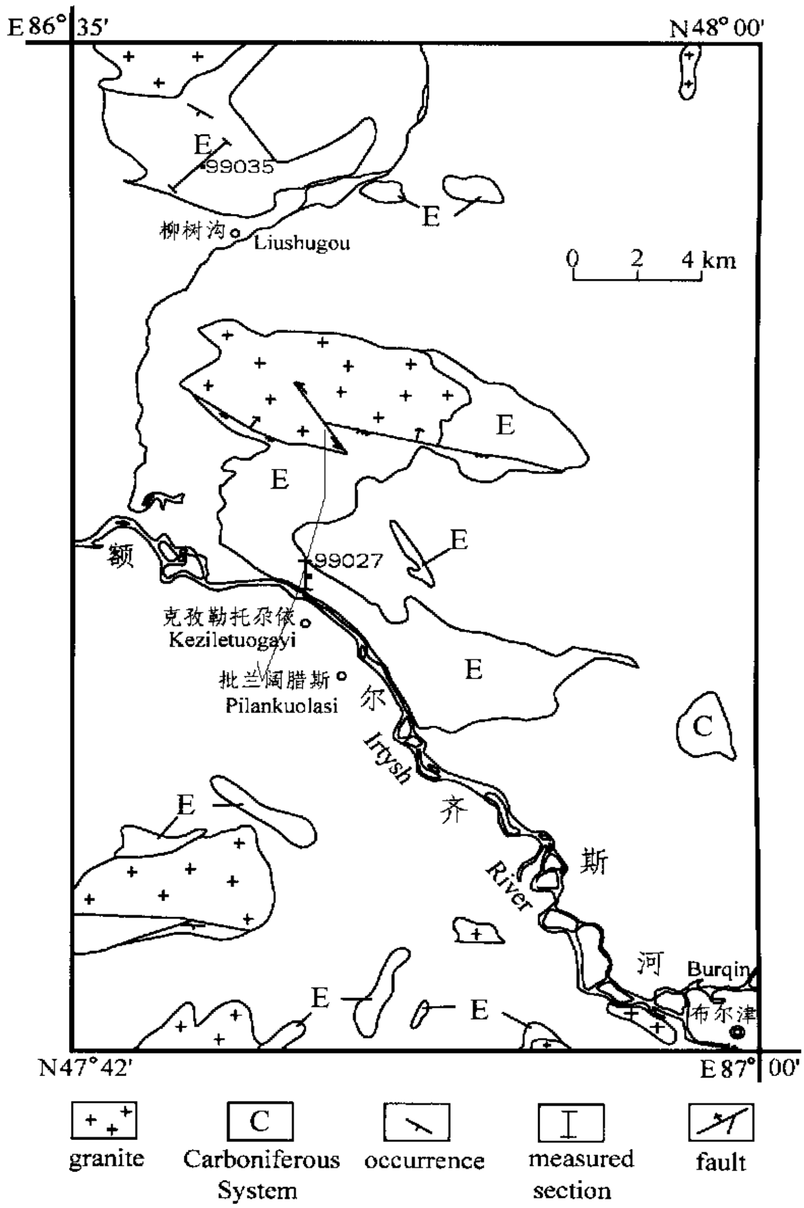

Fig. 1　The sketch geological map of northwestern part of Burqin, Xingjiang showing the location of the measured sections

city (N47°50.416′, E86°40.837′). The lithology from top downwards is as below:

Grayish white conglomerates

unconformity

28. Grayish green mudstone　2m

27. Variegated mudstone, dominantly grayish green with yellow spots, and becoming red with weathering　1.5m

26.	Yellow medium and fine sandstone	6m
25.	Grayish green muddy siltstone	3m
24.	Reddish brown mudstone	3m
23.	Yellowish green coarse micaceous quartz sandstone with dark particles observable on fracture surface and with oblique-bedding in the middle part of this layer	3.5m
22.	Variegated mudstone	2.8m
21.	Black manganese siltstone, yielding mammal fossils	1.2m
20.	Variegated mudstone, lithologically as layer 27	2.5m
19.	Grayish green medium and fine sandstone	8.0m
18.	Rusty yellow fine muddy sandstone	1.2m
17.	Light grayish green medium and coarse quartz sandstone	1.8m
16.	Light brown fine muddy sandstone	1.5m
15.	Light grayish green medium micaceous sandstone with oblique bedding	3m
14.	Rusty yellow coarse pebbly quartz sandstone	1.5m
13.	Grayish white muddy siltstone with earthy yellow weathering surface	1.5m
12.	Yellow medium sandstone	3.5m
11.	Brown ferruginous fine quartz conglomerates	4m
10.	Grayish white siltstone grading upwards into fine sandstone	1.6m
9.	Light earthy yellow muddy fine sandstone with cross-bedding	2.4m
8.	Grayish white ferruginous coarse or conglomeratic coarse quartz sandstone, frequently with discontinuous ferruginous sandstone bands containing nodular iron-manganese crust which are 1～2cm in thickness	3m
7.	Grayish white muddy fine quartz sandstone containing micaceous, with discontinuous brown striae of ferruginous sediments, occasionally small muddy gravel. Grading upwards into medium sandstone with oblique-bedding	3.4m
6.	Blue-gray mudstone with earthy yellow weathering surface	2.6m
5.	Light grayish green sandy mudstone with light red weathering surface	6m
4.	Yellow fine sandstone with oblique-bedding	4.5m
3.	Light yellow siltstone with microstratification, feeling unctuous	1.5m
2.	Dark purple ferruginous pelitic sandstone	0.3m
1.	Grayish yellow mudstone intercalated with grayish white siltstone and fine sandstone. Mudstone is 2～5m thick, blocky structure; siltstone is 1.5～5m thick with irregular chalybeate fine sand veinlet nearly vertical to the layer surface. Brownish red after being weathered, only 30.7m exposed	

The deposits in the section reported here can be divided into two parts: The lower part (1～11 layers) consists of alternate layers of ferruginous sandstone and mudstone, and the upper part is made of alternate layers of light grayish green sandstone and variegated mudstone. The weathered surface of the entire set of sediments looks yellowish brown. These deposits were previously considered to be "Ulunguhe Formation" by the local geological mapping team. Comparing the beds from Burqin region with those from Ulungur River areas, we found the sediments from the two areas are lithologically different. The typical Ulunguhe Fm. in the Ulungur river region is a set of light grayish green sandstone and brownish gray sandy mudstone, as a whole, grayish white in color on weathered surface (Ye et al., 2001a). We traced the rocks along the Irtysh River and found Paleozoic rocks near Ulungur lake at about E87°12′ which makes up a natural barrier separating two deposit basins. The typical Ulunguhe Fm. sediments exist only in the east basin, and the deposits in Burqin region are accumulated in the west Basin (Burqin Basin). They are different geological bodies. Therefore the name Ulunguhe Fm. should not be used for the deposits of the Burqin Basin. Geographically Burqin is adjacent to the modern Zaisan Basin. Whether they were connected together in the relevant geological time remains a problem to be solved. It is premature to establish a new rock unit for the sediments described here before further investigation is carried on, particularly in correlation with the Tertiary beds of the Zaisan Basin, Kazakhstan.

2　Brief desciption of the mammalian fossils

Amynodontidae Scott et Osborn ,1883

Cadurcodon **cf.** C. ardynensis **(Osborn ,1923)**

(Fig. 2)

Specimens　Two upper right canines ,V 13094. 1～2 ;one right and one left lower canine , V 13094. 3～4 ;upper part (top part) of a right lower canine ,V 13094. 5 ;two complete left p3 ,V 13094. 6～7 ; one complete left p4 ,V 13094. 8 ; a fragmentary right p4 ,V 13094. 9 ; a fragmentary left upper molar ,V 13094. 10.

The upper canine (C1) is robust ,curved posteriorly and is elliptical in cross-section. A weak ridge is on the posterior surface of the tooth. The tooth part labial to the ridge is wider than the part lingual to the ridge. The big smooth wear facet faces anteriorly and truncates the tooth obliquely (V 13094. 1) . V 13094. 1 is 27mm wide and 31mm long at the base ;V 13094. 2 is 23mm wide ,30mm long at the base.

The lower canine (c1) is slightly curved posteriorly. It is triangular in cross section with a sharp anterior ridge and two posterior ridges. The surface between the two posterior ridges is wide , depressed and longitudinally extended. The labial surface of the tooth is more or less flat and the lingual surface convex. V 13094. 3 is fresh and measured 51mm high ,25. 5mm wide and 33mm long at the base.

Lower premolar (p3) : triangular in occlusal view. The labial wall is flat. The protoconid is developed and connected with the metaconid ,forming a short transverse ridge. The hypolophid is low and wide ; the cingulum around the tooth is developed. The tooth has single root with a vertical groove on the inner side. V 13094. 6 is 23mm long and 20mm wide ,V 13094. 7 is 25. 6mm long and 26mm wide.

p4 : Trapezoid in occlusal view. The labial wall is more or less flat , but with a weak vertical groove in between the anterior and posterior lophs. The paralophid is slender , the metalophid is thick , the hypolophid is low and is the widest loph of the tooth ; the cingulum around the tooth is developed. V 13094. 8 is 34. 1mm long and 32mm wide.

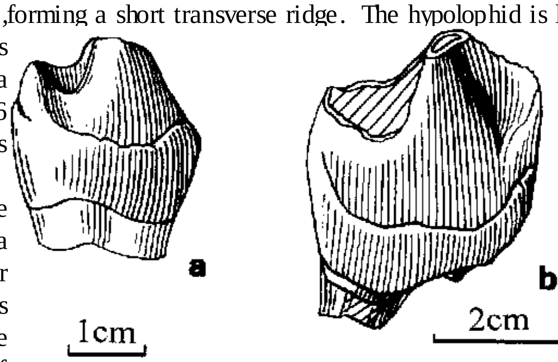

Fig. 2　*Cadurcodon* cf. *C. ardynensis*
a. Left p3 , V 13094. 7 ; b. Left p4 ,V 13094. 9.
Both are lingual view

The described teeth are similar to those of *Cadurcodon ardynensis* (A. M. 19154 ,A. M. 20441) from the Ardyn Obo Formation of Mongolia (Osborn ,1924) and the p3 (V 13094. 6～7) and p4 (V 13094. 8) resemble the p3 and p4 (1397 - 3) of *Cadurcodon ardynensis* from Solonkeur of Mongolia (Gromova ,1958) in morphology but with larger size.

Amynodontidae gen. et sp. indet.

The only specimen available is a fragmentary left lower canine ,V 13097 , damaged on the lower part. The preserved part is 71. 5mm high , larger and much higher than that of *Cadurcodon ardynensis*. It possesses characters typical for amynodontids : triangular pyramid in shape with flat labial face , convex lingual face and slightly concave posterior face. It is referred to an open nomenclature (nomenclatura aperta) for lack of comparative material.

Gigantamynodon giganteus **Xu, 1961**
(Fig. 3)

A damaged right upper canine, V 13095.1; a damaged right m1/m2, V 13095.2 and 3 damaged m3, V 13095.3～5.

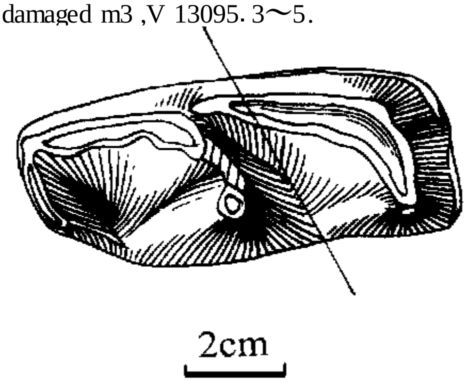

Fig. 3 *Gigantamynodon giganteus* m3, pieced together from two specimens: The anterior part of V 13095.4 and the posterior part of V 13095.5

The upper canine (V 13095.1) is damaged in the top and base parts. It is robust, curved posteriorly, expanded from top to the base rapidly and with elliptical cross section. Specimen V 13095.2 is a damaged right m2 or m1, remaining only the posterior part with deep talonidbasin and developed cingulum. It is 43mm wide. A concaved posterior contact facet with m2 or m3 is present. Specimen V 13095.4 and V 13095.5 is the anterior part of a right m3 and the posterior part of a left m3 respectively. They came probably from one individual, judging from the same degree of wear. The m3 is probably rectangular in occlusal view with flat labial wall. The paralophid is low and widens downwards. The metaconid and entoconid are developed. The metalophid extends postero-internally, forming an angle of 65° with the labial wall. The talonid is long with rather deep talonidbasin. The cingulum around the tooth is distinct. The tooth is estimated 80mm long and 41mm wide.

Though damaged all the specimens characterize the *Gigantamynodon giganteus*. They resemble the specimens described by Xu (1961) from the type locality (Qujing, Yunnan) in 1) especially large size; 2) m1 and m2 having rather deep depression on the posterior wall, which is caused as Xu guessed by strong mutual squeeze between the cheek teeth; 3) the morphology and size of m3.

Hyracodontidae Cope, 1879
Indricotheriinae gen. et sp. indet.
(Fig. 4)

The only specimen is the left first lower incisor, V 13096. It resembles the corresponding tooth from Luoping, Yunnan (Chiu, 1962) in morphology but is smaller than the latter and displays subtle differences from the latter. Usually indricotheres lower incisors are situated at the front end of the lower jaw and extended forwards. The described i1 is worn at the top and its lower border curves upwards. Two ridges extended from the top to the base are present on the dorsal surface, the mesial one is higher than the distal one. The single tooth root is laterally flattened and slightly concave mesially. The tooth is 32.8mm wide and 29mm long at the base. This i1 differs from the Luoping specimen in 1) lack of the knobs at the base of lingual surface; 2) having contact facet on both mesial and distal side, which indicates the probable presence of at least one more incisor (or ? canine) and thus characterizes early indricotheres.

Rhinocerotidae gen. et sp. indet.

Among the fragmentary teeth only three specimens provide indicative information.

1) The nearly complete right M1 ?, V 13098.1 is medium high with long metacone and a crista on the ectoloph. It is 38mm wide.

2) The anterior part of a slightly worn M1 ? V 13098.2. The paracone, parastyle and the anterior cingulum are developed. An incipient antecrochet is present. The protoloph is 36.5mm wide (labial-lingual).

3) The anterior part of a left lower molar V 13098.3. The cingulum is developed and the metalophid

is 21mm wide.

Based on the presence of a crista and an antecrochet on M1 ?,these specimens may be temporarily referred to Rhinocerotidae.

Brontotheriidae gen. et sp. indet.

A damaged right lower molar ,V 13099 , with only metaconid and talonid ,the labial part of the latter is broken off. The metaconid is well-developed. The talonid is widely opened and about 34mm long.

3 Discussion and conclusion

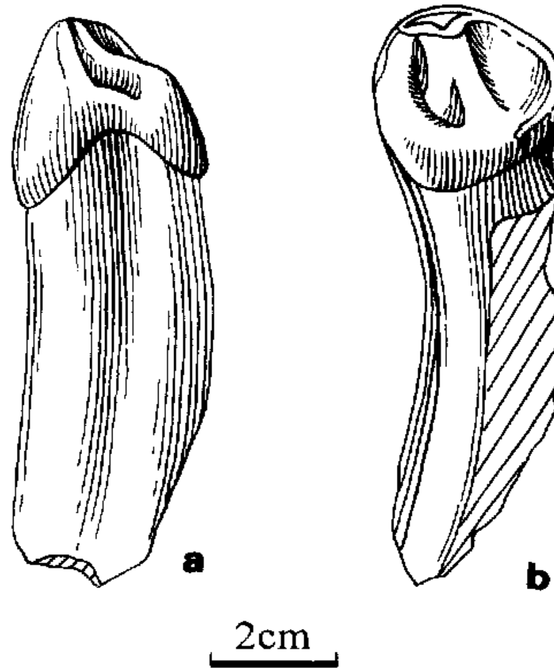

Fig. 4 Indricotheriinae gen. et sp. indet. ,V 13096
a. lateral view ;b. dorsal view

All the fossils from Burqin beds are perissodactyls. This perissodactyl assemblage is comparable with those from Caijiachong fauna of Yunnan , Ulangochu fauna and Urtyn Obo fauna of Nei Mongol (Li and Ting ,1983) , Gua-teg and Khoer-Dzan faunas from Mongolia (Russell and Zhai , 1987) , and Kusto fauna from Kazakhstan (Emry et al. , 1998) . Based on mammal faunas from 10 localities of Asia Savage and Russell (1983) listed 82 species of the then Asian“Early Oligocene”mammal fauna. Among them there are 42 species of perissodactyls :15 brontotheres ,10 amynodonts ,8 hyracodonts and 3 rhinocerotids. The perissodactyls obviously occupied a predominant position among the macromammal world during that time. Because the North American mammal stage Chadronian has been shifted from early Oligocene to late Eocene as a result of new isotopic dating data (Swisher and Prothero ,1990 ;Berggren and Prothero ,1992) , corresponding Asian “early Oligocene”mammal faunas were also compressed down to the late Eocene (Mckenna , 1995 ; Tong et al ,1995 ;Wang ,1997 ;Meng and McKenna ,1998) .

Comparison of the late Eocene mammal faunas with those of older and younger ages shows that the late Eocene is the latest period when the perissodactyls were prosperous in Asia. Specifically , during this period of time , brontotheres remained abundant and became extinct at the Eocene-Oligocene boundary. Amynodonts continued to be diversified and specialized during late Eocene ,and decline within early Oligocene. Indricotheres appeared in the late Eocene , and diverged in the Oligocene. Early rhinocerotoids began to radiate in the late Eocene and gradually replaced the hyracodonts in the Oligocene. This pattern is clearly reflected by the composition of the Burqin fauna. The amynodont *Cadurcodon* cf. *C. ardynensis* shows high-crowned tooth and reduced premolars ,and *Gigantamynodon giganteus* is large and has lower molar with flat labial surface and more obliquely extended lophids. The only recovered specimen (i1) of indricotheres characterizes the early indricotheres , such as the incisor from Luoping , Yunnan (Chiu , 1962) . The two fragmentary upper molars with incipient crista and antecrochet and the lower molar with developed cingula indicate the probable presence of early rhinocerotoids. By correlation with those late Eocene faunas of Asia ,and morphological comparison of specimens of related taxa ,the Burqin perissodactyl assemblage is undoubtedly of the late Eocene age. This is the first record of late Eocene mammal fauna in the Northern Xinjiang. Because of its similarity of faunal composition to those of southern and eastern areas of Asia , the Burqin assemblage further confirms that the biogeographic division of the south and north faunal provinces in Asian continent had not been formed in the late Eocene. In addition, the composition of the Burqin fauna is also consistent with the "Mongolian Remodelling" (Meng and McKenna, 1998), in which Eocene faunas of central Asia are dominated by large perissodactyls, whereas the Oligocene faunas are represented primarily by small mammals. The transition of the terrestrial faunas probably reflects the change of global climates across the Eocene-Oligocene boundary. Future study of the Oligocene mammal assemblage found in nearby section (locality 99035) will provide additional evidence to testing of the "Mongolian Remodelling".

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