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SHORT COMMUNICATION

ASSIGNMENT OF *YAMACERATOPS DORNGOBIENSIS* AND ASSOCIATED REDBEDS AT SHINE US KHUDAG (EASTERN GOBI, DORNGOBI PROVINCE, MONGOLIA) TO THE REDESCRIBED JAVKHLANT FORMATION (UPPER CRETACEOUS)

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Assigning Central Asian nonmarine Cretaceous vertebrate fossils and their host rocks to lithostratigraphic units and establishing their sub-epochal ages can be challenging. Researchers frequently struggle with inconsistently applied locality and stratigraphic names, have to consider the impact of two distinct stratigraphic philosophies (Benton 2001a; Gladenkov, 2007), and often encounter additional challenges in working with manuscripts published in, or translated from, a variety of languages (e.g., Benton, 2001b). In addition to these challenges, chronostratigraphic data are rare due both to a lack of discovered rocks amenable to radiometric dating, and issues complicating paleomagnetic sampling in the Cretaceous (e.g., "Cretaceous Quiet Zone," Ogg et al., 2004). There are also inherent limitations in nonmarine biostratigraphic schemes and, in some cases, field areas may have complex stratigraphic architectures and depositional histories that are difficult to resolve without the aid of subsurface data (e.g., Graham et al., 2001; Johnson, 2004). Thus, although there have been significant advances in our knowledge about the ages and relationships of nonmarine Cretaceous vertebrate fossils and assemblages from southern Mongolia in the past 85 years, there remains much to learn and clarify.

During the 2007 field season, the Korea-Mongolia International Dinosaur Project (KMIDP) worked two weeks in the Eastern Gobi (Dorngobi Province, southwest of Sainshand) at three Upper Cretaceous localities: Shine Us Khudag, Khar Khutul, and Bayn Shiree (Fig. 1). Exposures of the 280 m thick, buff-colored Baynshiree Formation/Svita at each locality produce a rich assemblage of Cenomanian-Santonian vertebrate and invertebrate fossils, including dinosaurs (Vasil'ev et al., 1959; Martinson et al., 1969; Barsbold, 1972; Sochava, 1975; Martinson, 1982; Jerzykiewicz and Russell, 1991; Hicks et al., 1999; Ishii et al., 2000; Khand et al., 2000; Jerzykiewicz, 2001; Shuvalov, 2001; Graham et al., 2001). However, north of Shine Us Khudag and south-southwest of Khar Khutul, a 380 m thick succession of fossiliferous alluvial redbeds (here called the Shine Us Khudag redbeds) is broadly exposed ($\sim$50 km^2) and conformably overlies the Baynshiree Formation/Svita (Fig. 2). The Shine Us Khudag redbeds have variously been assigned to the Jibhalanta Suite, Javkhlant Formation, Baruungoyot Svita, Djadokhta Formation, and the "Barunbayan" (Table 1), and since 1969 have been regarded by most stratigraphers working in the area as having a Santonian-Campanian age (Martinson et al., 1969; Jerzykiewicz and Russell, 1991; Khand et al., 2000; Jerzykiewicz 2001; Shuvalov, 2001).

Locally abundant in the Shine Us Khudag redbeds are remains of the basal protoceratopsian dinosaur, *Yamaceratops dorngobiensis,* a taxon whose age, previously, had been assessed provisionally as late Early Cretaceous (Makovicky and Norell, 2006:3) based on an erroneous inference that the host strata occur stratigraphically below the Baynshiree Formation/Svita. Our review of GPS-derived locality data for the type and referred materials of *Yamaceratops dorngobiensis* confirms that they were collected from the Shine Us Khudag redbeds in a localized area of badlands called Khugenslavkhant (Makovicky and Norell, 2006; Fig. 1). Because the Shine Us Khudag redbeds conformably overlie the richly fossiliferous Upper Cretaceous Baynshiree Formation/Svita, and because geologists and biostratigraphers working in the Eastern Gobi have consistently shown the Baynshiree Formation/Svita and the Shine Us Khudag redbeds to be Late Cretaceous in age (Cenomanian-Campanian), we conclude that all known specimens of *Yamaceratops dorngobiensis* are also Late Cretaceous in age, not Early Cretaceous as previously suggested.

In addition to *Yamaceratops dorngobiensis*, the KMIDP documented the presence in these redbeds of a soft-shelled turtle, and small nonavian theropod dinosaur skeletal remains and eggshell. Khand et al. (2000) noted the presence of ornithomimids. Most importantly, however, the Mongolian-American Expedition (MAE) working in and around Khugenslavkhant in 1991, 2002-2004 and 2006-2007 collected hundreds of vertebrate fossil specimens from the Shine Us Khudag redbeds, including the type and referred materials of *Yamaceratops dorngobiensis*, and the partial skulls and postcrania of two new eutherian mammals (Giallombardo and Novacek, 2006; Giallombardo, 2007). In addition to these published remains, MAE also collected multiple skeletons and skulls of a hypsilophodont dinosaur, several taxa of variously-sized theropod dinosaurs, turtles and lizards, additional specimens and taxa of mammals, and several types of dinosaur eggs and nests. One of the eggs includes the embryo of a protoceratopsian dinosaur (probably *Yamaceratops dornogobiensis*; Balanoff and Norell, 1996), and many of the dinosaur specimens are juveniles. Given this rich and distinctive fossil assemblage, we regard these Upper Cretaceous redbeds as a critical source of new paleobiogeographic, biostratigraphic, and paleoecologic data that will improve our understanding of the Upper Cretaceous geologic history of Central Asia.

Here, we review the details of the nomenclatural and age assignment history of the Shine Us Khudag redbeds, and present new lithostratigraphic and preliminary sedimentologic information that allows them to be formally assigned to the Javkhlant Formation. Our data more clearly establish and serve to redescribe the Javkhlant stratotype. We underscore that many of the basic sedimentologic descriptions and paleoenvironmental interpretations presented here are not substitutes for detailed

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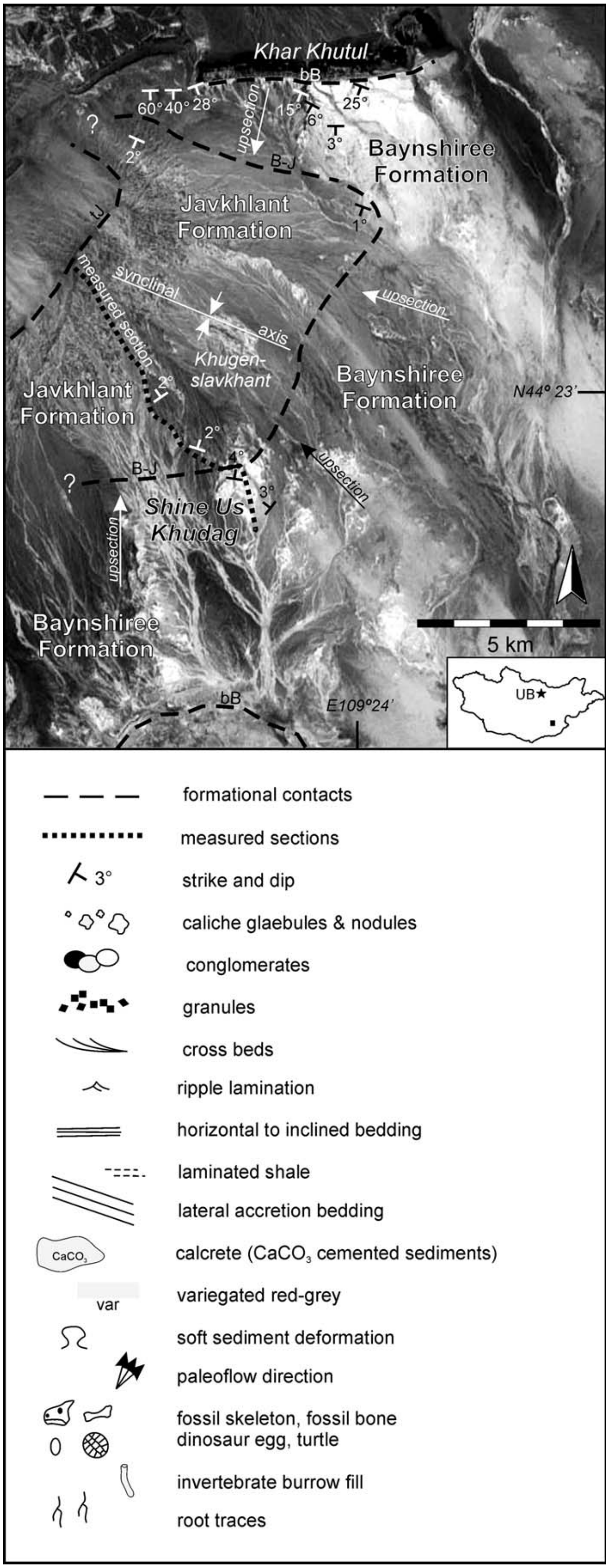

FIGURE 1. Locality map showing the distribution of the Baynshiree Formation and Shine Us Khudag redbeds (=Javkhlant Formation) at Shine Us Khudag. Satellite base-image downloaded from Google Earth (October, 2007). Rectangle in inset indicates location of field area south-southeast of Ulaanbaatar (UB), Mongolia. Strike and dip measurements indicate the presence of a broad, WNW-ESE oriented syncline southwest of Khar Khutul, and localized structural deformation associated with post-Cretaceous crustal movement in and around Khar Khutul (note steeply dipping strata south of Khar Khutul). Dashed lines indicate the known and inferred base of the Baynshiree Formation (bB), the Baynshiree and Javkhlant formational contact (B–J), and the erosional top of the Javkhlant Formation (tJ). Dotted line indicates location of Javkhlant Formation type section (Fig. 2) and Baynshiree Formation section (Fig. 3) examined by us. Place names in italics. Labeled latitude and longitude ticks are at the eastern and southern edge of image. "Khugen-slavkhant" is the general area where the type and referred materials of *Yamaceratops dorngobiensis* were collected. Bayn Shiree locality is 40 km east-southeast of Shine Us Khudag, and is not shown here. Symbol key is for all figures.

sedimentological and paleoenvironmental analyses of the Shine Us Khudag redbeds, which will be presented elsewhere.

We follow the spellings provided in Benton (2001b) for Mongolian locations and stratigraphic units, except in those cases where we quote original literature. However, following the most recent revision to the Russian Stratigraphic Code (see Gladenkov, 2007) and contra to recent trends (e.g., Benton 2001a), we do not use "Svita" (a chronostratigraphic term) and "Formation" (a lithostratigraphic term) interchangeably.

DESCRIPTION OF THE SHINE US KHUDAG REDBEDS

The preserved thickness of the Shine Us Khudag redbeds is 380 m (Fig. 2). The base of the unit is well exposed in the southern portion of the field area, where it rests conformably on the Bayn Shiree Formation (Fig. 2I). At the top of the section, the Shine Us Khudag redbeds are truncated by an angular unconformity overlain by Quaternary Gobi sediments. Throughout the field area, the Shine Us Khudag redbeds and the underlying Bayn Shiree Formation are structurally tilted in a variety of directions (Fig. 1), most likely as a result of the Late Mesozoic tectonic rift history of the area (cf. Graham et al. 2001; Meng et al., 2003; Johnson, 2004).

Although the Shine Us Khudag redbeds consist overwhelmingly of rooted and mottled paleosols, massive sandy mudrocks, and sheet-shaped-to-lenticular sandstones and conglomerates, we recognize a three-fold stratigraphic subdivision of the unit that reflects an upsection increase in both grain size and the relative abundance of coarse-grained versus fine-grained sediments and facies. We use this three-fold division to further organize our description of the Shine Us Khudag redbeds.

The lowest 110 meters of the Shine Us Khudag redbeds rest conformably on the light-tan colored sediments of the Baynshiree Formation. This lower interval is dominated by paleosols developed on mudstones comprising decimeter-thick couplets of deep red (10R 4/6; Rock-Color Chart Committee, 1995), clay-enriched horizons with slickensides and clay coatings, overlain by lighter red (10R 5/4-5YR 5/6), clay-impoverished and often well rooted horizons (Fig. 2G, H). Following Birkeland (1999), we tentatively interpret these mudstone couplets as ancient argilic (Bt) soil horizons overlain by ancient eluvial (E?) or surface (A) horizons. Interbedded with these paleosols are (1) decimeter-thick sheets of grey, fine-grained sandstone exhibiting root traces, finger-size invertebrate burrow fills, and soft-sediment deformation structures, (2) decimeter-thick deposits of massive, light red, sandy mudstone with very sparse assemblages of calcareous glaebules, interpreted here as immature caliches (Allen, 1986; Retallack, 1990), and (3) rare, 1-2 meter thick, lenticular sandstones with occasional granule to pebble strings, interpreted

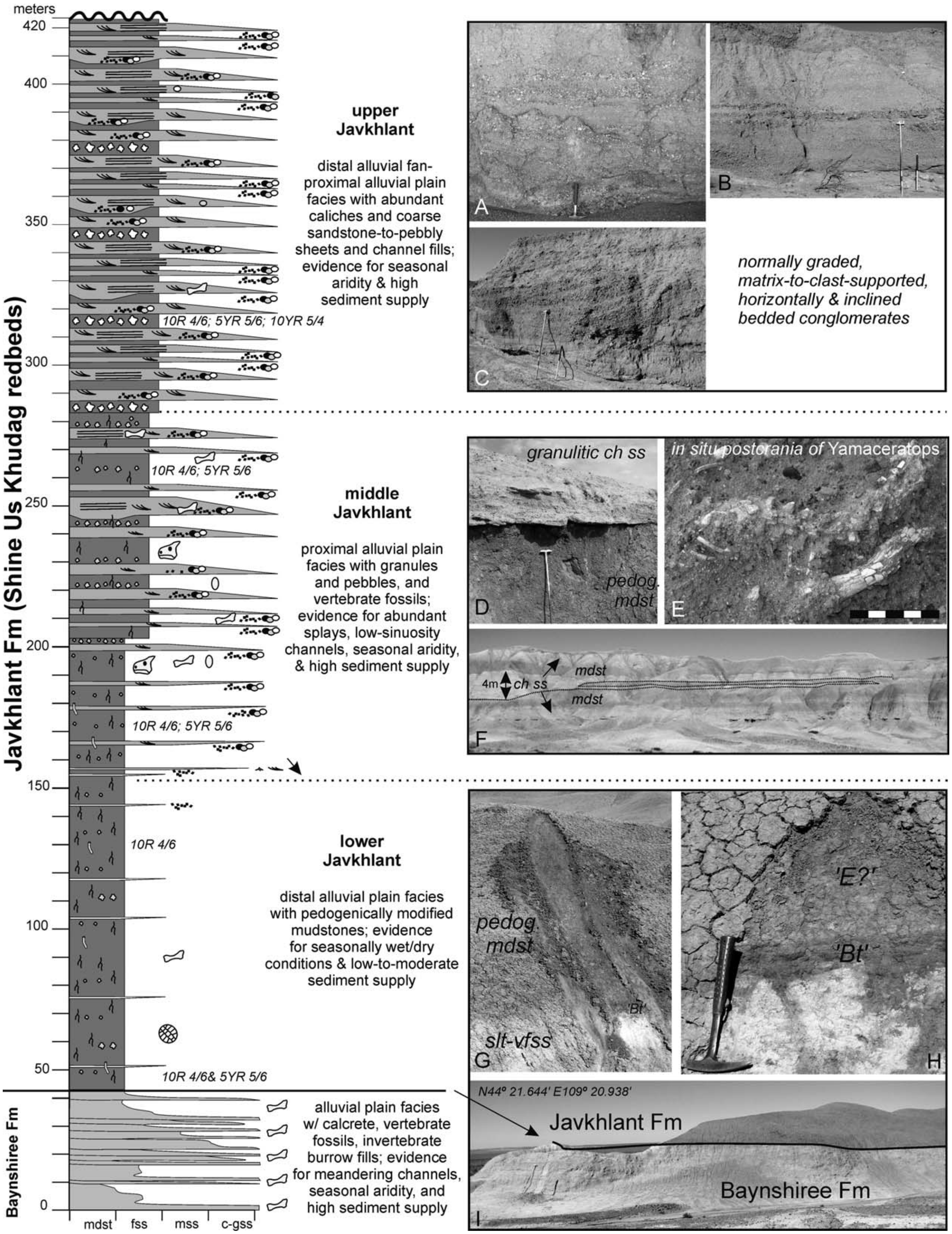

FIGURE 2. Measured section through the uppermost 43 m of the Baynshiree Formation and the preserved stratigraphic extent of the Shine Us Khudag redbeds (=Javkhlant Formation type section; 380 m) at Shine Us Khudag (see Fig. 1 for location). The section is divided into three units that, in combination, reflect an up-section increase in grain size and an increase in the proportions of coarse-grained sediments. Photographs A-I illustrate common facies types and fossils in each unit. Jacob's staff is 1.5 m long; ice pick is 75 cm long; geology hammer is 35 cm long. Scale bar in 'E' is 5 cm. **Abbreviations**: **mdst**, mudstone; **fss**, fine grained sandstone; **mss**, medium grained sandstone; **c-gss**, coarse grained to granulitic sandstone; **ch ss**, paleochannel sandstone; **pedog mdst**, pedogenically modified mudstone; **slt-vfss**, siltstone-to-very fine grained sandstone; '**E?**' and '**Bt**,' paleosol horizons (see text). Latitude-longitude designation in 'I' indicates location of exposed formational contact. Alpha-numerics (e.g., 10R 4/6) indicate rock color (see text). See Figure 1 for symbol key.

TABLE 1. Historical nomenclature and age assignments for the Shine Us Khudag redbeds.

Reference	Stratigraphic nomenclature	Age assignment
Martinson et al. (1969 [English translation])	Jibhalant Suite	Santonian-Campanian?
Martinson et al. (1982)	Baruungoyot Svita	Upper Senonian (Coniacian-Maastrichtian)
Jerzykiewicz and Russell (1991)	Djadokhta Formation	Mid Campanian - ?
Khand et al. (2000)	Javkhlant Formation	Santonian-Campanian
Shuvalov (2001)	Baruungoyot Svita	Santonian-Campanian
Graham et al. (2001)	“Barunbayan”	Upper Senonian? (Coniacian-Maastrichtian)
Eberth et al. (this paper)	Javkhlant Formation	Late Cretaceous (?Santonian-Campanian)

as paleochannel fills and splays (Leeder, 1999). Vertebrate fossils are fragmentary and rare. The predominance of alluvial paleosols (including immature caliches) and other mudrocks relative to paleochannel deposits suggests high accommodation (Catuneanu, 2003) and the presence of alluvial plain surfaces that were frequently exposed long enough (>10s-1000s of years) to allow for caliche and other paleosol formation (Allen, 1986; Retallack, 1990).

The middle 130 meters of the Shine Us Khudag redbeds package consists of lenticular and sheet-shaped, coarse-grained deposits (Fig. 2F) that increase in abundance upsection. Both contain muddy-to-pebbly sandstones, are decimeters to a meter or more thick, contain strings and ‘scour’ fills of pebble-size volcanic, metamorphic, and sedimentary-rock clasts, including reworked caliche glaebules and nodules (Fig. 2D), as well as fragments, elements and skeletons of vertebrate fossils, mostly dinosaurs (Fig. 2E). The lenticular deposits are further characterized by local occurrences of CaCO3-cemented, meso- to large-scale trough cross-bed sets, and frequently can be traced laterally into flat-based sandy sheets (‘wings’) that thin laterally and pinch out within 10s to 100s of meters of the associated lenticular body (Fig. 2F). Based on these geometries and architectures, relatively coarse sediment compositions, indications of unidirectional flow, and the presence of terrestrial vertebrate fossils, we interpret these coarse grained sediments as representing deposits of alluvial channels, splays, and, possibly, sheet floods (Reineck and Singh, 1980; Leeder, 1999).

In this same middle interval, fine grained facies are dominated by decimeter-thick tabular beds of massive, sandy, red-brown mudrock (5YR5/6; Fig. 2D) similar to those present in the lowest portion of the stratigraphic succession. These exhibit root horizons, mottled-to-variegated bases and tops, decimeter-thick intervals of light-grey colored caliche glaebules and nodules, and yield fragmentary to completely articulated vertebrate fossils. The variegated mudstones likely represent overbank facies that experienced variations in water table position and subaerial exposure in a seasonally-arid setting (Allen, 1986; Retallack, 1990; Eberth and Miall, 1991; Therrien and Fastovsky, 2000). In the upper one-half of this interval, paleochannel fills are up to 4 meters thick and 30 m wide, and ratios of coarse grained versus fine grained deposits approach 1:3. Most of the vertebrate fossils seen by us and collected by MAE (see Introduction) occur preferentially, but patchily, in this middle interval (Fig. 2E).

In the uppermost 140 m of the Shine Us Khudag redbeds, conglomeratic sheets and lenticular paleochannel deposits continue to increase in abundance relative to tabular mudstone deposits, becoming dominant by a ratio of 2:1 in the uppermost exposures (Fig. 2A–C). In addition to commonly occurring glaebular to nodular caliches, like those encountered in the lower 240 m of the section, we occasionally observed decimeter-thick massively cemented, laterally-extensive white calcareous deposits (some locally truncated by conglomeratic paleochannel fills) that we interpret as very mature to hardpan caliches (Allen, 1986; Eberth and Miall, 1991). In this interval, red-brown (5YR5/6) poorly-sorted and flat based, massive, sandy-to-pebbly mudrocks and sandstones with coarse sand grain and pebble ‘float’ are quite common. These deposits most likely indicate a history of debris flow (Nemec and Steel, 1984; Major, 2000; Eberth et al., 2006). Vertebrate fossils are rare, however, occurring as well-worn bone fragments in the paleochannel fills.

PALEOENVIRONMENTAL CHANGE UPWARD THROUGH THE SHINE US KHUDAG REDBEDS

The gradual upsection increase in grain size and increased proportions of coarse-grained sediments, in combination with the likely occurrence of debris flow deposits higher in section in the Shine Us Khudag redbeds suggest that, through time in this area, an alluvial plain depositional system was replaced by a prograding alluvial-fan system. In addition, the upsection increase in caliche maturity (glaebular horizons dominating in the lowest 110 m and nodular to hard pan horizons dominating in the uppermost 140 m) suggests that, through time, seasonal periods of aridity may have become more intense, prolonged, or both. Given that rates of sediment supply and accumulation typically increase from an alluvial plain setting up-dip into an alluvial fan setting (Leeder, 1999), the increased maturity of caliches upsection through the Shine Us Khudag redbeds is more suggestive of an increase in the intensity of seasonal aridity rather than an increase in the temporal duration between major depositional events (an alternative means of increasing caliche maturity; Eberth and Miall, 1991; Retallack, 1990). Unlike Upper Cretaceous redbeds units to the west (see below), there are no indicators of eolian depositional environments anywhere in the section.

HISTORICAL NOMENCLATURE AND AGE ASSIGNMENTS OF THE SHINE US KHUDAG REDBEDS

Historically, the nomenclature and age assignments of the Shine Us Khudag redbeds have been inconsistent. Originally, the redbeds were erroneously assigned to the Paleogene by Vasil’ev et al. (1959) and Sochava (1975). In contrast, Martinson et al. (1969) observed that they conformably overlie the Baynshiree Svita and assigned them to a new stratigraphic unit – the Javkhlant Svita – whose age was assessed as “Santonian-Campanian?” With the exception of Khand et al. (2000), use of the term “Javkhlant” for these beds has found little favor with subsequent stratigraphers, and was apparently abandoned even by Martinson (see his 1982 monograph on the Upper Cretaceous molluscs of Mongolia). Instead, for the next quarter century, the redbeds package was directly or indirectly assigned to the Baruungoyot Svita (Martinson, 1982; Shuvalov, 2001), the Djadokhta Formation (Jerzykiewicz and Russell, 1991; Jerzykiewicz, 2001), and the “Barunbayan” (Graham et al., 2001; Meng et al., 2003). We review and evaluate these assignments below (Table 1).

Assignment to the “Barunbayan” by Graham et al. (2001) and Meng et al. (2003) is the least well-supported, and can be discarded from further consideration for the following reasons. The terms Baruunbayan Svita and “Barun-Bayan” Formation have long standing previous uses, and consistently refer to late Early Cretaceous sediments and fossils in the Trans-Altai Gobi region to the west (e.g., Shuvalov, 1982; 2001; Yamamoto et al., 1993;

Samoilov and Benjamini, 1996; Khand et al., 2000). Neither Graham et al. (2001) nor Meng et al. (2003) cite the origin of the term “Barunbayan,” provide explanations for its relatively new use as an Upper Cretaceous stratigraphic unit, indicate its stratigraphic rank, or indicate the location of a type section.

There is broad consensus in all published stratigraphic schemes addressing Upper Cretaceous strata in southern Mongolia that a package of Upper Cretaceous nonmarine strata, which are predominantly red (but see Dashzeveg et al., 2005), occurs stratigraphically between the Baynshiree and Nemegt formations/svitas, crops out in kilometer-scale patches across the region, and extends south into northern and northwestern China. However, this unit is variously named, subdivided, and dated. Within the context of the Svita concept (O’Rourke, J.E., 1976; Benton, 2001; Gladenkov, 2007) the redbeds are consistently referred to as the Baruungoyot Svita (Shuvalov and Stankevich, 1977; Shuvalov, 2001:268). The type section for this extensive chronostratigraphic unit is the thick Upper Cretaceous mixed alluvial-eolian redbeds succession exposed at Khulsan (Western Gobi, Nemegt Basin), which was described by Gradzinski and Jerzykiewicz (1974) and assigned, by them, to the “Barun Goyot” Formation. As described by Shuvalov (2001), the Baruungoyot Svita embraces all redbeds units thought to include strata of Santonian-Campanian age (e.g., Djadokhta, Baruungoyot, Bayn Zag, Javkhlant) and, thus, encompasses a broad variety of lithologies and paleoenvironments (e.g., alluvial fan, alluvial plain, channels, calcareous and non-calcareous paleosols, eolian dune, interdune, lakes/ponds, wetlands, etc.).

Whereas application of the term Baruungoyot Svita for redbeds across southern Mongolia remains technically correct within the chronostratigraphic context of the Svita concept, from a lithostratigraphic perspective, the term clearly reflects an extreme oversimplification of the lithologic, sedimentologic, facies, and source area complexity and variation that characterizes the preserved redbeds fill in Late Cretaceous sub-basins across southern Mongolia (e.g., Fastovsky et al., 1997; Khand et al., 2000; Graham et al., 2001; Dashzeveg et al., 2005; Dingus et al., 2008). From the perspective of lithology, sedimentology, facies, facies assemblages, stratigraphic architecture, and fossil content, the redbeds at Shine Us Khudag do not match well with the sediments of the Baruungoyot Svita or the “Barun Goyot” Formation (Table 2). On this basis, ongoing assignment to Baruungoyot (Formation or Svita) is not recommended here.

Jerzykiewicz and Russell (1991) and Jerzykiewicz (2001) proposed the existence of two superposed redbeds units across southern Mongolia — a lower Djadokhta Formation overlain by the “Barun Goyot” Formation — and inferred that this stratigraphic superposition reflects paleoclimatic change across Central Asia during the Late Cretaceous. In their proposal, an older Djadokhta Formation (type section at Bayn Zag, Central Gobi) is characterized by more arid paleoenvironments relative to a younger, and slightly more mesic, “Barun Goyot” Formation (type section at Khulsan, Western Gobi). As in the case of the Baruungoyot Svita, these two formations were thought to include all Upper Cretaceous redbeds strata across the Gobi region of southern Mongolia (Jerzykiewicz, 2001:fig. 15.3). Jerzykiewicz and Russell (1991) and Jerzykiewicz (2001) extended these two formations into the Eastern Gobi on the basis of a statement in Sochava (1975), who reported calcareous concretions and dinosaur remains at the base of the Shine Us Khudag redbeds (see Martinson, 1982:fig.3). Jerzykiewicz and Russell (1991) and Jerzykiewicz (2001) interpreted this report of calcareous concretions as supporting their hypothesis for a shift towards more arid climates upwards across the Baynshiree-redbeds conformity and, accordingly, included the Shine Us Khudag redbeds in the Djadokhta Formation, a unit that is characterized by eolian and semi-arid facies in its type area and elsewhere (Berkey and Morris, 1927; Gradzinski et al., 1968; Lefeld, 1971; Gradzinski et al., 1977; Eberth, 1993; Jerzykiewicz et al., 1993; Dashzeveg et al., 2005). Although Gao and Norell (2000) challenged the faunal basis for the interpretation of stratigraphic superposition of the Djadokhta and “Barun Goyot” formations, and, to date, there are no known localities that expose the contact between these two units, the proposal that the Shine Us Khudag redbeds are assignable to the Djadokhta Formation is still outstanding and, thus, must be addressed.

Our measured section (Fig. 2) and examination of the Baynshiree Formation-Shine Us Khudag redbeds transition demonstrates that there is no evidence, in our field area, for the extreme paleoclimatic shift described by Jerzykiewicz and Russell (1991) and Jerzykiewicz (2001). In fact, as described here, the lowest 110 m of the Shine Us Khudag redbeds are notable for the rarity of caliche nodules and the absence of caliche hard pans (Fig. 2). Instead, the climatic conditions reflected in these lower strata appear to have been the least arid during the time represented by the entire redbeds section. There is, however, an erosionally resistant, 20-meter thick zone of $CaCO_3$-rich

TABLE 2. Geological comparison of Upper Cretaceous redbeds in southern Mongolia and northern China.

Javkhlant Formation, Eastern Gobi (this paper)	Alluvial plain facies and alluvial fan facies. Three fold stratigraphic division through 380 m showing (1) a lower mudstone-dominated unit (110 m) with stacked paleosols, and caliche glaebules, (2) a middle unit (130 m) comprising channel/sheet sandstones (<4 m thick), pedogenically modified mudstones, caliche nodules, and patchy occurrences of vertebrate fossils, and (3) an upper unit (140 m) dominated by granulitic to pebbly sandstone. Upsection increase in abundance and maturity of caliches, and thickness and proportion of coarse grained facies. Stratigraphic pattern suggests that an alluvial plain system was replaced by a prograding alluvial fan system in a seasonally wet-and-dry setting that became increasingly more arid through time.
Baruungoyot Svita (Shuvalov, 2001); “Barun Goyot” Formation, Western Gobi (Gradzinski and Jerzykiewicz, 1974; Jerzykiewicz, 2001)	Continental sandy redbeds comprising eolian dune and interdune deposits, with interbedded deposits of ephemeral streams, channels, and ponds. Reworked caliches dominate over in-situ caliches. Upsection transition from eolian dune dominated succession to alluvial-paludal dominated succession. Hot and semi-arid paleoclimate throughout.
Djadokhta Formation, Western and Central Gobi, and northern China (Eberth, 1993; Jerzykiewicz, 2001; Dashzeveg et al., 2005)	Continental sandy redbeds comprising eolian dune and interdune deposits, with interbedded deposits of ephemeral streams, channels, and ponds. Mass sediment flows (sourced from eolian dunes) locally present. In-situ and fluvially reworked caliches present. Two subunits recognized by Dashzeveg et al. (2005) are differentiated primarily on the basis of color, and are separated from one another by a planar bedded, mudstone-dominated interval. Hot and semi-arid paleoclimate throughout.

sediments near the top of the Baynshiree Formation at Shine Us Khudag (Fig. 3), which is rich in dinosaur fossils. This zone may have been misidentified by Sochava (1975) as belonging to the overlying redbeds succession. This proposed misidentification is supported by our observation that dinosaur fossils are extremely rare in the lower 110 meters of the overlying Shine Us Khudag redbeds.

Many other lithologic, sedimentologic, facies, and facies architecture differences preclude assignment of the Shine Us Khudag redbeds to the Djadokhta Formation (Table 2). Most important among these is the interpretation that the Shine Us Khudag redbeds represent deposition in alluvial to alluvial fan settings, whereas the Djadohkta Formation is interpreted as representing deposition in eolian, eolian interdune, and alluvial fan settings (Eberth, 1993; Jerzykiewicz et al., 1993; Fastovsky et al., 1997; Dashzeveg et al., 2005).

Finally, we also note that although a detailed description of the vertebrate fauna from the Shine Us Khudag redbeds fauna is not yet available, reports from MAE of a new genus of ceratopsian dinosaur, a new hypsilophodont dinosaur, and at least two new mammal taxa from these redbeds (see above) suggest that the Shine Us Khudag fauna is quite different from those known from the Djadokhta or "Barun Goyot" formations (cf. Jerzykiewicz and Russell, 1991).

ASSIGNMENT OF THE SHINE US KHUDAG REDBEDS TO THE JAVKHLANT FORMATION

Considering all of the preceding information about the Shine Us Khudag redbeds, we support Martinson et al. (1969) and Khand et al. (2000) in their assignments of these redbeds to a discrete stratigraphic unit, the Javkhlant. We concur as well that the regional geographic extent of Javkhlant is limited to the eastern Gobi, and that the type section of the Javkhlant should comprise the Shine Us Khudag section ("southwest of Hara Hutul Ula," Martinson et al, 1969:108). However, unlike Martinson et al. (1969) and other stratigraphers who have assessed the Javkhlant within the Svita "concept" (e.g., Shuvalov, 2001), we recommend that the lithostratigraphic term, Javkhlant Formation, be used henceforth in reference to the Shine Us Khudag redbeds and their regional lithostratigraphic equivalents (cf., Khand et al. 2000). Although Khand et al. (2000) referred the redbeds to the Javkhlant Formation they provided no lithostratigraphic data, measured sections or photographs, only citing Martinson et al. (1969) as the basis for their assignment. In this context, and in line with the formal requirements outlined by North American Commission on Stratigraphic Nomenclature (2005), we propose that the measured section, photographs and descriptions of the Shine Us Khudag redbeds provided here serve as a formal redescription of the Javkhlant Formation.

Based on extensive local and regional biostratigraphic data from the underlying Baynshiree Formation/Svita in the Eastern Gobi (summarized in Jerzykiewicz and Russell, 1991; Jerzykiewicz, 2001; Sochava, 2001), we accept that the rocks and fossils of the Javkhlant Formation at Shine Us Khudag are Late Cretaceous in age (Table 1). However, in the absence of independent chronostratigraphic data from these beds, we can only tentatively accept the previously proposed biostratigraphically derived Santonian-Campanian age range for this formation at Shine Us Khudag. For the time being, the exact stratigraphic

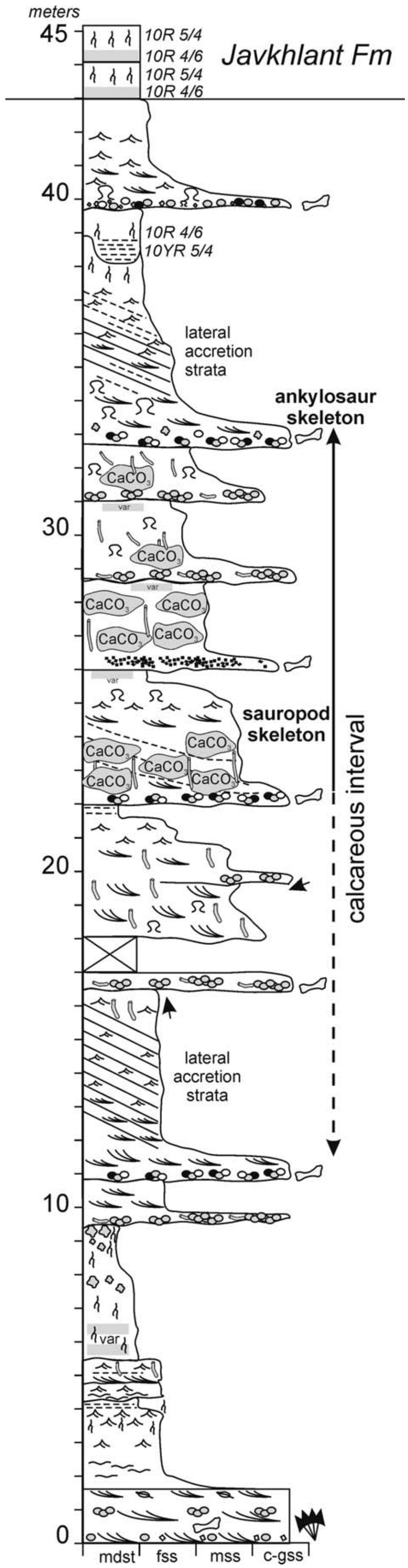

FIGURE 3. Measured section through the uppermost 43 m of the 280 meter thick Baynshiree Formation at Shine Us Khudag. A prominent and erosionally resistant interval with localized calcareous cement near the top of the formation is indicated by the solid/dashed vertical line. Dashed portion of the line indicates relatively less calcareous cement than the solid portion. This section is rich in the remains of fossil vertebrates. See Figure 1 for symbol key.

and chronostratigraphic relationships of the Javkhlant Formation with the Djadokhta and "Barun Goyot" Formations to the west remain unresolved.

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