

Waterborne Gravity Flows Buried Mongolian Dinosaurs

For more than 70 years, the red sandstones of the Upper Cretaceous Djadokhta Formation in the Gobi Desert of Mongolia have yielded abundant articulated skeletons of dinosaurs, lizards and mammals. The fossils at Bayn Dzak (Flaming Cliffs)— see Figure 1 (inset) — included the first well-documented dinosaur nests with eggs and the first known skeletons of *Protoceratops* and *Velociraptor*.

and even what was interpreted as a brooding dinosaur on a nest,³ plus the state and positions in which so many of the dinosaurs, lizards and mammals were found fossilised (taphonomic evidence), has easily convinced all investigators that these animals suffered a sudden death by rapid burial in sand. Large-scale cross-bedding in some of the associated sandstones has been interpreted as evidence of large dunes in a desert (aeolian) environment, and so the prevailing opinion has been that the animals were so well

Flood. And others have insisted that since these fossils represent dinosaurs that perished during the Flood, the palaeoenvironmental interpretation must be in error and the sands that buried these Mongolian dinosaurs must have been waterborne.

Who is right? The latest report from the continuing investigations at Ukhaa Tolgod gives some comfort to both sides of this debate. In a nutshell, Loope *et al.*⁹ are still convinced that the dinosaurs lived in a desert environment, but they document the evidence that they perished in episodic violent rain storms (flash floods), not wind/sand storms, and were thus buried by waterborne sand.

Figure 2 is a composite section of the rock strata exposed in the Ukhaa Tolgod area. Three sandstone facies are indicated — large-scale cross-stratified sandstone with fine structure (E-1), vaguely bedded sandstone with oriented concretionary sheets (E-2), and structureless sandstones lacking

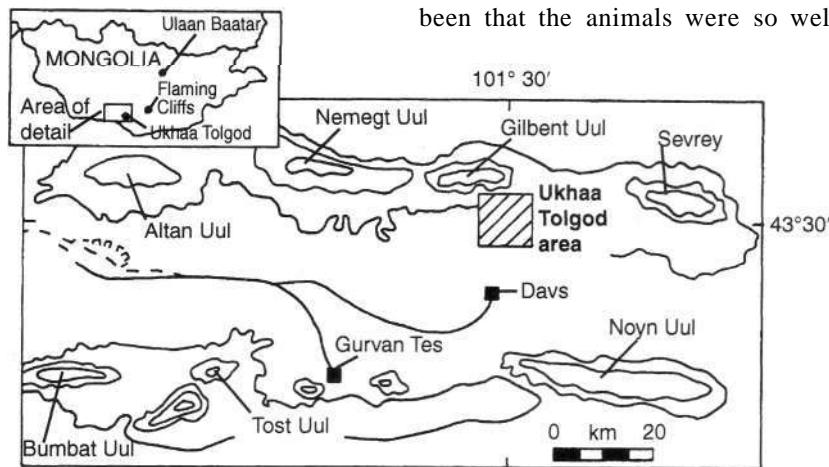


Figure 1. Map showing the locations of Bayn Dzak (Flaming Cliffs) and Ukhaa Tolgod in the Nemegt Basin, Mongolia.

In 1993 a new fossil locality was discovered in the Nemegt Basin, to the southwest of Bayn Dzak at Ukhaa Tolgod (see Figure 1).¹ This site has yielded an unmatched abundance of well-preserved vertebrate fossils, including more than 100 skeletons of theropod, ankylosaurian and protoceratopsian dinosaurs. Several specimens of the theropod *Mononykus* (once erroneously claimed to be a bird²) have also been found here, and the first known embryo of a theropod. More than 500 skulls (many with associated skeletons) of mammals, lizards and dinosaurs have been identified.

The discovery of so many articulated skeletons, dinosaur eggs,

preserved because they were buried in violent wind and sand storms.

It has been this locality, with its well-preserved dinosaurs, nests and eggs, and their interpreted demise in violent wind/sand storms in a desert environment, which has been a pivotal example in the debate amongst creationists over the Flood/post-Flood boundary in the geological record and exactly where dinosaur fossils fit in the Biblical framework of Earth history.⁴⁸ There is an obvious incongruity of a terrestrial desert environment during a global, and therefore marine, Flood. Therefore some argue that these fossilised dinosaurs and the sandstones enclosing them are therefore post-

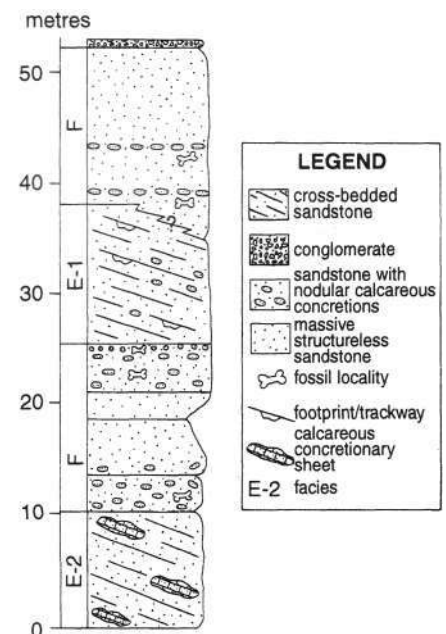


Figure 2. Composite stratigraphic section of the rock units exposed at Ukhaa Tolgod, Nemegt Basin, Mongolia.

oriented concretions (F). It should be noted that facies F contains all the fossils at Ukhaa Tolgod, including skeletons of *Oviraptor* preserved on nests of well-arranged eggs, along with perfectly articulated skeletons of dinosaurs, mammals and lizards. The same structureless sandstones contain some isolated or lenticular deposits of granules, pebbles and cobbles, and in some places are in apparent unconformable relationships to the other sandstone layers.

Loope *et al.*⁹ concur with the interpretation that the large-scale cross-stratified sandstones represent former desert sand dunes.¹⁰¹¹ They also believe they have identified large footprints/tracks, probably made by large dinosaurs such as ankylosaurs or *Protoceratops* climbing over the large dunes. Interestingly, the tracks 'are preferentially developed along distinct foresets, and may mark diastems [brief interruptions in sedimentation] between packages of rapidly accreted strata'.⁹ Loope *et al.* suggest that the vaguely bedded sandstone with oriented concretionary sheets also represents aeolian dune deposits, except that the accumulating sand was immobile for long periods of time (hence the blurring of internal structure).

However, what is of the utmost importance is that Loope *et al.* are adamant that the highly fossiliferous, structureless sandstones are non-aeolian. Indeed, they interpret these as alluvial fan deposits. The perfect articulation of the small lizard and mammal skeletons in these sandstones strongly suggests that their structureless nature is depositional. Thus Loope *et al.* concluded that rapid vertical accretion of structureless sand, sometimes with pebbles and cobbles, and accompanying *in situ* burial of large animals is much more likely to occur on sand fans during rain storms within a stabilised dune field than during wind storms in an active dune field. In short, catastrophic sediment gravity flows in flash floods caused by violent rain storms were responsible for virtually instantaneous burial of so

many large dinosaurs.

Talbot¹² had previously concluded that

'it is easier to imagine that the dinosaurs of southern Mongolia were hatching and raising their young in a moist, stabilized dune field than an active sand sea',

In any case, the carcasses of animals buried by migrating dunes in wind/sand storms would soon become exposed on the stoss (up-wind) sides of dunes as migration continued. Yet the well-preserved articulated skeletons of dinosaurs, lizards and mammals are clear evidence of rapid *in situ* permanent burial during rapid deposition of the enclosing sand.

So those creationists who are convinced that these dinosaurs died in a local catastrophe after the Flood will be reassured that the general palaeoenvironment is still interpreted as that of a desert with dunes, even if the mode of 'instant' burial of the dinosaurs has been reinterpreted as waterborne sediment gravity flows in violent rain storms. However, this reinterpretation of the mode of burial of these fossilised dinosaurs does highlight the fact that interpretations of the evidence do sometimes change when more field data becomes available. So can we be sure that the desert dunes palaeoenvironmental interpretation may yet have to be discarded if relevant new data indicate otherwise? After all, interpretations are still interpretations, not facts, or absolute proof of a former desert environment.

In any case, there is at least one remaining puzzle. What are 'nests of well-arranged eggs'⁹ doing **within** 'alluvial fan' sands washed in rapidly as gravity flows by violent rain storms (that is, flash floods)? Obviously, Loope and his fellow investigators are likely to suggest that the dinosaur mothers built 'nests' and laid the eggs in them between storms, oblivious to the dangers for them and their nests in the dry alluvial fans. However, this requires considerable elapsed time between flash floods, so where's the evidence in the sandstones of this

elapsed time? There is none, that is, no evidence of any former ground surfaces on which the nests were built, because Loope *et al.* describe the sandstones as 'structureless'.

At least we now all agree that the fossilised dinosaurs were catastrophically buried in waterborne sediment flows. As for the other interpretations, the dust may not yet have settled!

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