JERZYKIEWICZ, T., Geological Survey of Canada, Calgary, Canada, P. J. CURRIE, P. A. JOHNSTON and E. H. KOSTER, Tyrrell Museum of Paleontology, Drumheller, Alberta, Canada, and R. GRADZINSKI, Polish Academy of Sciences, Krakow, Poland

Upper Cretaceous Dinosaur-Bearing Eolianites in the Mongolian Basin

An eolian origin for the Djadokhta Formation, which yielded the first discovered nests of unquestionable dinosaur eggs, was postulated during the Central Asiatic Expedition of the American Museum of Natural History (Berkey and Morris, 1927). Since that time, controversial opinions have been published about the depositional environment of the Upper Cretaceous dinosaur-bearing formations (the Djadokhta, the Barun Goyot and the Nemegt formations) of the Mongolian Basin. Notwithstanding evidence of dunes in the Djadokhta Formation (Lefeld, 1971), and dunes intertongued with widespread interdune sediments in the Barun Goyot Formation (Gradzinski and Jerzykiewicz, 1974), the basin is still being interpreted as a large inland lake (Verzilin, 1982).

During the 1988 "Dinosaur Project" expedition to the Chinese part of the Mongolian Basin (Bayan Manduhu locality), a rich vertebrate fauna and numerous nests of dinosaur eggs were discovered in well exposed eolianites of the Djadokhta Formation.

The dunes consist of large scale tabular-or wedge-planar sets of cross-strata. The foreset dip directions span 170° (mean angular deviation of dip direction is 44°). This, along with bioturbation by rootlets is indicative of parabolic and/or blowout dunes that were stabilized by vegetation and moisture. Interdune deposits are of two main types: (1) structureless and/or faintly bedded, poorly sorted sandstones containing numerous calcareous concretions and angular pebbles with frosted and pitted surfaces (dry facies); and (2) alternating sandstones and mudstones showing water-laid structures (wet facies). The former, resulting mainly from the transformation of dunes by primary (dust and sandstorms) and secondary (pedogenesis) processes, form the bulk of the Formation. The latter, deposited in intermittent ponds and ephemeral streams are particularly well developed in the upper part of the Djadokhta Formation.

The dry interdune deposits yielded most of the fossils. Many dinosaur skeletons were found where faintly cross-bedded sets interfinger with structureless sandstone. A mass grave of six skeletons of juvenile ankylosaurids (Pinacosaurus) was found in sandstone with traces of cross-stratification, some 200 m downwind of well preserved dunes. Another site yielded a group of five Protoceratops. They may have been buried by a sand storm. Similar examples of trapped and rapidly buried dinosaurs were found in eolianites of the Djadokhta Formation at Toogreeg by the Polish-Mongolian Expedition in 1971.

Djadokhta eolianites are commonly modified by pedogenic processes and bioturbation. Numerous caliche paleosol profiles (glaebular paleosol, rhizocretions, petrocalcitic horizons) were found in the Bayan Manduhu sections. Some have thick and laterally extensive petrocalcitic horizons representing mature caliche paleosols diagnostic of semiarid environment. Other profiles are incomplete due to syndepositional erosion. As a result, redeposited caliche debris, including rhizocretions and fragments of the hardpan occur as channel lag in the interdune deposits. Caliche paleosols analogous to those from Bayan Manduhu occur in the Djadokhta Formation at Byan Dzak where they have been erroneously interpreted as lacustrine precipitates (Lefeld, 1971). Endogenic traces are abundant and include: (1) rhizoliths, (2) Ancorichnus-like inclined meniscate shafts, and (3) Teichnus-like tabular or coiled retrusive spreiten. Although the Djadokhta Formation contains little or no carbonaceous material, the spreiten indicate that the sediment originally contained sufficient organic material to support deposit feeding invertebrates. Excavations of recent dunes in the Bayan Manduhu area revealed abundant organic laminae rich in wind blow organic detritus, especially disintegrated camel dung, and substantial bioturbation by tenebrionid beetle larvae, which fed on the detritus. By analogy, the disintegrated dung of Protoceratops, the principal vertebrate herbivore in the Djadokhta fauna may have provided the trophic base for the invertebrate tracemakers.

The semiarid environment supported only small to medium-sized vertebrates. Isolated bones and teeth of large dinosaurs (ornithopods, sauropods and theropods) are extremely rare, and may represent transient individuals. Lizard and mammals probably fed on xerophytic vegetation and on insects. Protoceratops and Pinacosaurus were the most common herbivorous dinosaurs and grew to about 3.5 mm. Three species of small theropods were found and probably survived by eating insects, lizards, mammals, carrion, juvenile dinosaurs and possible eggs. The low faunal diversity as a good indicator of the stressed environment, and this is consistent with the sedimentological interpretation.

The Mongolian Basin during the deposition of Djadokhta strata was an internally drained intermontane basin. The semiarid climate resulted in caliche paleosol profiles and the development of dunes. They decrease toward the top of the Formation, gradually giving way to water-laid deposits in the upper Djadokhta Formation and the Barun Goyot Formation. This shift is probably due to the development of a permanent drainage pattern characterized by large, high sinuosity, meandering rivers, which deposited the strata fo the Nemegt Formation in the Maastrichtian (Gradziński, 1969).

REFERENCES

Berkey, C. P. and F. K. Morris, 1927, Geology of Mongolia, Natural History of Central Asia, Vol. II, The American Museum of Natural History, New York, 475 p.

Gradziński, R., 1969, Sedimentation of dinosaur-bearing Upper Cretaceous deposits of the Nemegt Basin, Gobi Desert. In: Results of the Polish-Mongolian Palaeontological Expeditions—Part II, Edited by Z. Kielan-Jaworowska, Paleontolgia Polonica, 21, p. 147-229.

Gradziński, R., and Jerzykiewicz, 1974, Dinosaur- and mammal-bearing aeolian and associated deposits of the Upper Cretazceous in the Gobi Desert, Mongolia, Sedimentary Geology, 12, p. 249-278.

Lefeld, J., 1971, Geology of the Djadakhto Formation at Bayn Dzak (Mongolia). In: Results of the Polish-Mongolian Paleontological Expeditions—Part III, Edited by Z. Kielan-Jaworowska, Palaeontologia Polonica, 25, p. 101-127.

Verzilin, N. N., 1982, Paleolimnologiczeskoe znaczenie teksturnych osobiennostiej verchnemelovych otlozenij Mongolii. In Mezozoiskie ozernye basseiny Mongolii. Edited by G. G. Martinson, Nauka, Leningrad, p. 81-100.

28TH INTERNATIONAL GEOLOGICAL CONGRESS, ABSTRACTS.
VOL. 2, P. 2-123. 1989
MEETING: JULY 9-19, 1989, WASHINGTON D.C.