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UPPER CRETACEOUS DINOSAUR FOOTPRINTS FROM GRANT COUNTY, NEW MEXICO

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ABSTRACT—We describe two dinosaur trackways from the lower part of the Mancos Formation (Upper Cretaceous, upper Cenomanian) near Silver City in Grant County, southwestern New Mexico. These trackways consist of deeply-impressed footprints that include large imprints of the posterior metatarsals, which suggests walking in a wet substrate. They were made by relatively small theropod dinosaurs (estimated hip heights of 1-1.6 m). These are the only Late Cretaceous dinosaur tracks known from southwestern New Mexico.

INTRODUCTION

Dinosaur footprints of Early Cretaceous age are common in New Mexico, but Late Cretaceous footprints are only known from a few records (e.g., Hunt and Lucas, 1998; Lockley et al., 2000; Lucas et al., 2011). Thus, only a handful of Upper Cretaceous dinosaur footprint localities are known in the state, and all are from northwestern and west-central New Mexico (e.g., Wolberg et al., 1988; Heckert and Lucas, 1998; Hunt and Lucas, 2003; Lucas and Hunt, 2006; Lucas et al., 2011). Here, we add to this sparse record of Upper Cretaceous dinosaur footprints from a locality in southwestern New Mexico near Silver City in Grant County (Fig. 1).

GEOLOGICAL CONTEXT

The footprints documented here are from NMMNH locality 8286, which was discovered in the spring of 2007 by Ferguson while refining Cunningham's (1974) geologic map of the Silver City 7.5' quadrangle (Hildebrand et al., 2008) for the New Mexico Bureau of Geology (STATEMAP award # 06HQA0003). The tracks occur in an arroyo floor eroded into the lower Mancos Shale (=Colorado Shale or Formation of previous usage: Molenaar, 1983; Lucas et al., 2000). Structural complexity and the lack of continuous exposure between the outcrop and the base of the formation do not allow for precise measurement of stratigraphic position. An estimate of somewhere between 100 and 150 meters above the gradational contact with the Beartooth Quartzite can be made based on our knowledge of the local structure.

The track-bearing stratum is a 0.1-m-thick bed of olive-gray, argillaceous, fine-grained sandstone interbedded with shale, claystone, and siltstone. These strata are typical of a monotonous succession of Mancos Shale in the area that is at least 300 meters thick (Cunningham, 1974; Hildebrand et al., 2008). Sandstone beds, which constitute approximately 20% of the Mancos locally, are fine to medium grained, arkosic, and range up to 10 meters thick. Oyster shell packstones up to 20 cm thick occur elsewhere in the formation (Skotnicki and Ferguson, 2007; Hildebrand et al., 2008), but none have been identified in the area of the trackways.

The Mancos Shale is normally seafloor deposits of the Western Interior seaway, but some facies record shoal, beach and other paralic paleoenvironments. The underlying Beartooth Quartzite (10-40 m thick) is a pebbly shoreface sandstone that directly overlies Paleozoic carbonate strata (in this area the Mississippian-Pennsylvanian Lake Valley and Oswaldo limestones). The footprints are presumably of late Cenomanian age as they are stratigraphically low in the local section of the Mancos (Molenaar, 1983).

DESCRIPTION

The footprints at NMMNH locality 8286 are 11 tracks preserved in concave epirelief that comprise two nearly parallel trackways that head N12°W (Figs. 2-3). The tracks are deeply

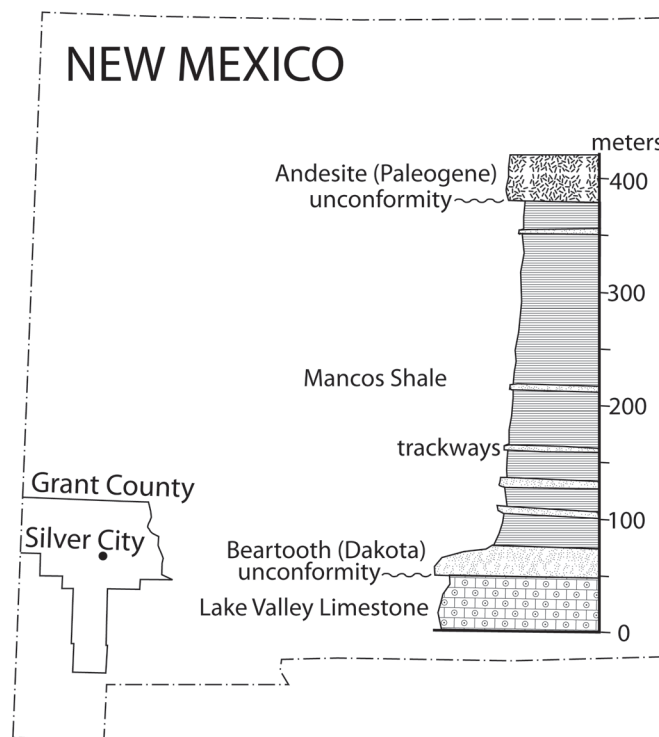


FIGURE 1. Index map and stratigraphic diagram showing location of dinosaur trackways in Grant County.

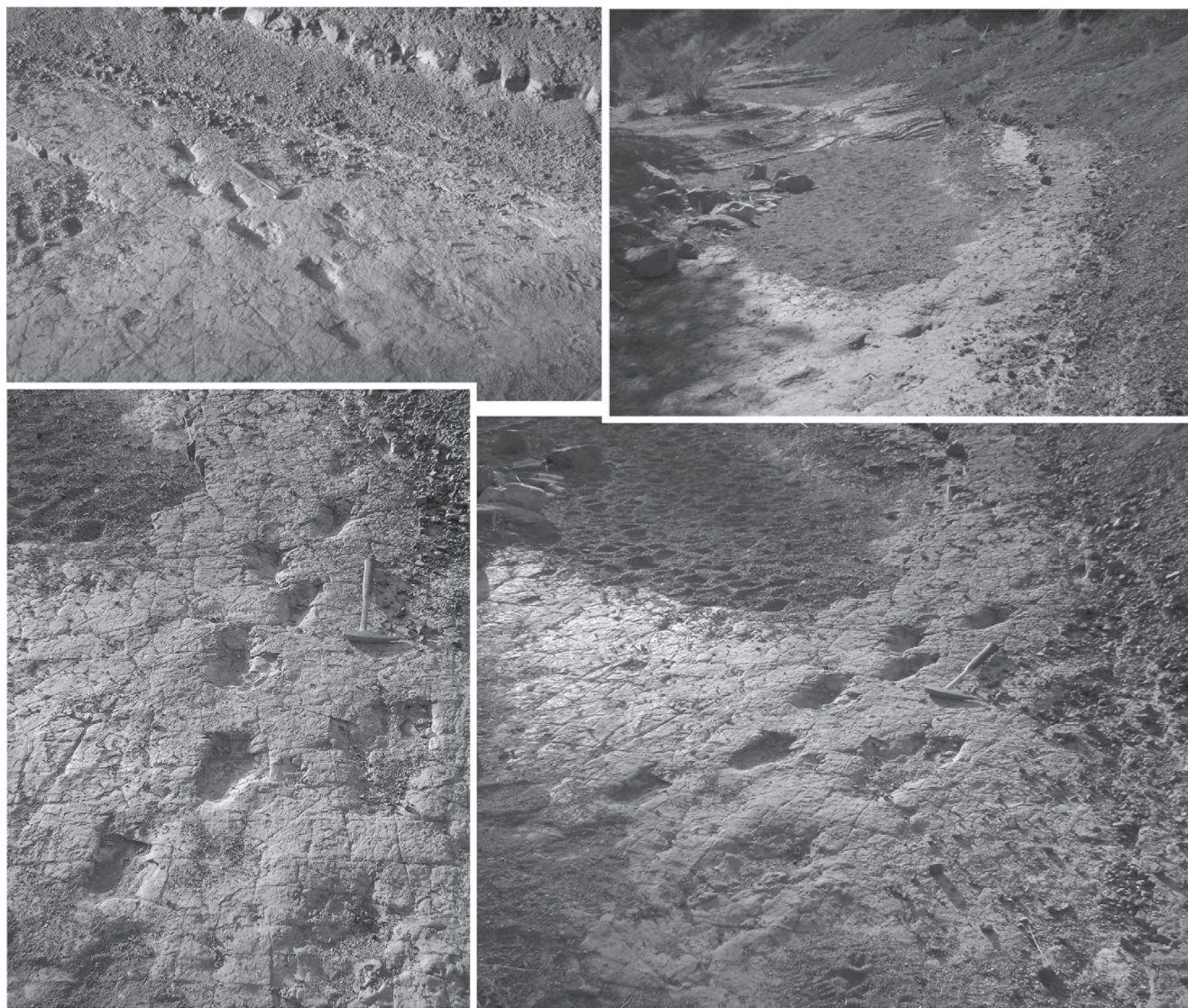


FIGURE 2. Photographs of the trackways at NMMNH locality 8286 from various angles.

incised (4-5 cm deep) and are mostly elongate, ovoid to triangular impressions. They are clearly poorly-preserved undertracks.

The longer trackway (trackway A in Figure 3) consists of eight footprints, and the shorter trackway (trackway B in Figure 3) consists of three footprints. In trackway A, footprint lengths range from 180 to 300 mm, and widths (at the anterior end of each footprint) range from 110 to 140 mm. All the footprints are shaped like obtuse triangles with the short side at the anterior end (Fig. 3B). Most display three digit imprints at their anterior ends. These digits appear as short, pointed and well separated imprints, but the footprints are dominated by the imprint of the “heel” and posteriorly-directed metatarsal impression. The posterior end of the footprints is narrow and pointed to slightly rounded.

All of the footprints are similar to each other, and there are no closely-spaced manus-pes pairs. Therefore, we conclude that trackway A was made by a biped. If we use the estimate of hip

height as four times footprint length (Alexander, 1976; Thulborn, 1990), that biped had a hip height of about 1.2 m. Stride length in the trackway varies between 550 to 750 mm, because in the middle of the trackway there is an evident “stutter” step where the stride is much shorter for two strides (in Figure 3, from Lb to Lc and Rc to Rd). The trackway width is narrow (~ 150 mm), and the pace angulation is ~ 120°.

Trackway B consists of three footprints that are 350-420 mm long and 160-250 mm wide. They appear to be a short trackway segment with a pace of ~ 600 mm if “a” and “b” are successive pes imprints, or 1300 mm if “a” and “c” are successive footprints (Fig. 3). Two of the footprints are similar to those of trackway A in being elongate, obtuse triangles, but footprint a is broader and more rounded than the other two. We also interpret trackway B as the trackway of a biped and estimate its hip height to be as much as 1600 mm.

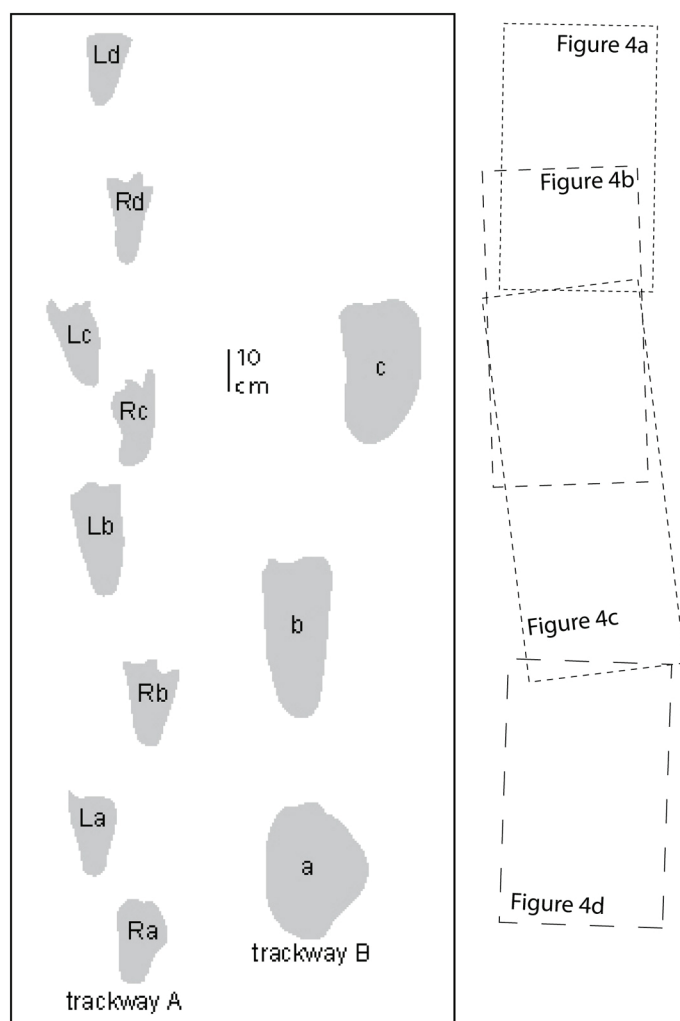


FIGURE 3. Map of the dinosaur trackways in the Mancos Formation near Silver City, New Mexico, showing location of stereophotographs in Figure 4.

DISCUSSION

We identify the footprints described here as those of theropod dinosaurs in which the posterior imprint of the metatarsal is very extensively impressed (see Lockley et al., 2006 for documentation of similar, but larger theropod footprints from the Cretaceous of northeastern New Mexico). The three forward-pointing digits (digits 2-4) of the Grant County footprints are only seen at the anterior end of the footprints as short and thin imprints. Thus, the majority of the footprint surface area was made by the “heel” and the metatarsal.

This kind of theropod undertrack was well documented by Gatesy et al. (1999, 2005) based on Triassic examples as tracks that were deeply impressed in a wet substrate. Kuban (1989) illustrates similar Cretaceous examples. On less wet substrates, theropod footprints are typically tridactyl, consisting of the long,

thin and pointed imprints of digits 2-4 with little or no imprint of the “heel” or the metatarsal (e.g., Thulborn, 1990). However, when theropods walked on relatively wet substrates their feet sank into the substrate so that a large part of the footprint made encompasses the “heel” and a long, posteriorly-directed metatarsal imprint (see especially Gatesy et al., 1999, figs. 2-3). The tracks in trackway A described here are readily interpreted as this kind of extramorphological variant of theropod dinosaur footprints.

The larger trackway B is also readily interpreted as consisting of the same kind of extramorphological variant of theropod footprints. If so, footprint “a” in trackway B may more closely approximate a characteristic theropod footprint (lacking an obvious metatarsal imprint), though it is so indistinct that we hesitate to further interpret it.

Because of their poor preservation and extramorphology, we make no ichnotaxonomic assignment of the Grant County footprints other than to attribute them to a theropod trackmaker. However, M. G. Lockley (written commun., 2012) has noted that they do somewhat resemble the footprints of segnosaurs (cf. Sennikov, 2006). They do indicate that during the late Cenomanian theropods with hip heights of about 1-1.5 m were walking the shorelines of the Mancos seaway in what is now southwestern New Mexico. They also indicate the likelihood that more dinosaur footprints may be found in the Mancos Formation of Grant County.

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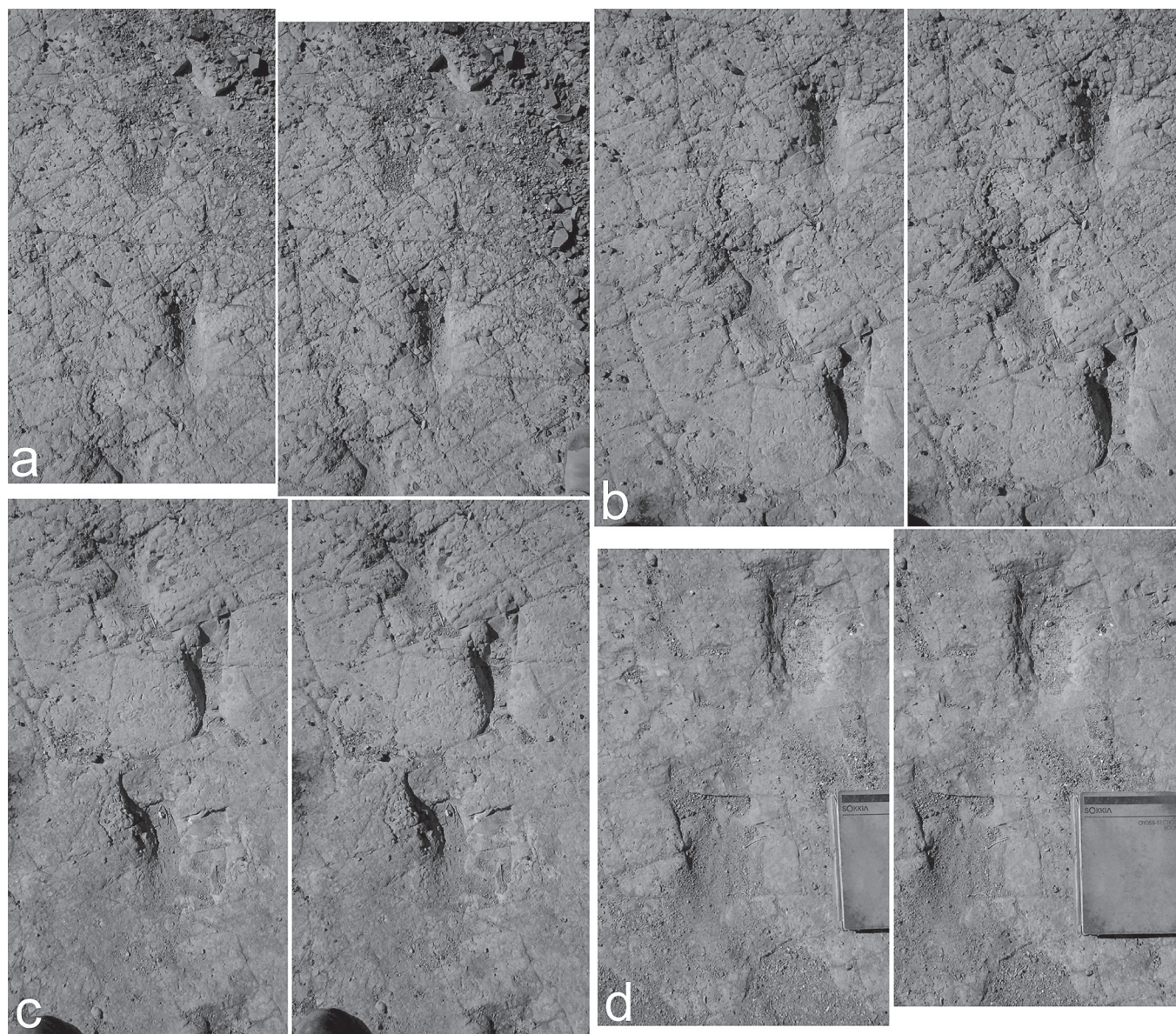


FIGURE 4 Four stereo pairs (a, b, c, d) of trackway A. See Figure 3 for location of the photo pairs.

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