**An Upper Jurassic theropod dinosaur from the Section 19 mine, Morrison Formation, Grants Uranium district**

Andrew B. Heckert, Justin A. Spielmann, Spencer G. Lucas, Richard Altenberg, and Daniel M. Russell  
2003, pp. 309-314. [https://doi.org/10.56577/FFC-54.309](https://doi.org/10.56577/FFC-54.309)

_in:_  
Geology of the Zuni Plateau, Lucas, Spencer G.; Semken, Steven C.; Berglof, William; Ulmer-Scholle, Dana; [eds.], New Mexico Geological Society 54th Annual Fall Field Conference Guidebook, 425 p.  
[https://doi.org/10.56577/FFC-54](https://doi.org/10.56577/FFC-54)

---

This is one of many related papers that were included in the 2003 NMGS Fall Field Conference Guidebook.

---

**Annual NMGS Fall Field Conference Guidebooks**

Every fall since 1950, the New Mexico Geological Society (NMGS) has held an annual Fall Field Conference that explores some region of New Mexico (or surrounding states). Always well attended, these conferences provide a guidebook to participants. Besides detailed road logs, the guidebooks contain many well written, edited, and peer-reviewed geoscience papers. These books have set the national standard for geologic guidebooks and are an essential geologic reference for anyone working in or around New Mexico.

**Free Downloads**

NMGS has decided to make peer-reviewed papers from our Fall Field Conference guidebooks available for free download. This is in keeping with our mission of promoting interest, research, and cooperation regarding geology in New Mexico. However, guidebook sales represent a significant proportion of our operating budget. Therefore, only *research papers* are available for download. *Road logs, mini-papers*, and other selected content are available only in print for recent guidebooks.

**Copyright Information**

Publications of the New Mexico Geological Society, printed and electronic, are protected by the copyright laws of the United States. No material from the NMGS website, or printed and electronic publications, may be reprinted or redistributed without NMGS permission. Contact us for permission to reprint portions of any of our publications.

One printed copy of any materials from the NMGS website or our print and electronic publications may be made for individual use without our permission. Teachers and students may make unlimited copies for educational use. Any other use of these materials requires explicit permission.
This page is intentionally left blank to maintain order of facing pages.
INTRODUCTION

Miners in the Grants uranium district doubtless encountered dinosaur bones relatively frequently, but very few of these discoveries were ever documented (Chenoweth, 1953; Smith, 1961) and even fewer were reposited in museums (Hunt and Lucas, 1993; Lucas et al., 1996). In this paper, we document fragmentary tooth-bearing dinosaur bones and associated teeth from the Morrison Formation Section 19 mine and discuss their biostratigraphic significance (Fig. 1). Throughout this paper, NMMNH refers to the New Mexico Museum of Natural History and Science, Albuquerque, and UMNH refers to the Utah Museum of Natural History, Salt Lake City.

PREVIOUS STUDIES

*Allosaurus* fossils in New Mexico are both rare and fragmentary. The first report of *Allosaurus* remains in New Mexico was from work during the summer of 1953, when W. L. Chenoweth and J. E. Self collected dinosaur remains from the Morrison Formation, near both Acoma and Suwanee Peak (Cibola County), that were later identified by E. H. Colbert to include *Allosaurus* (Smith, 1961). Rigby (1982) reported *Allosaurus* cf. *A. fragilis* teeth, which were found in 1978, from the Morrison Formation near San Ysidro, in Sandoval County and later identified by James Madsen. Isolated teeth and other bones of *Allosaurus* have been reported, but not documented, from Cibola and Quay counties (Lucas et al., 1985; Hunt and Lucas, 1993). Lucas et al. (1996) documented and included photographs of three *Allosaurus* teeth from the San Ysidro dinosaur quarry (NMMNH locality L-3283), also known as the *Camarasaurus* quarry, of Rigby (1982). Foster (2003) recently outlined all vertebrate records in the Morrison Formation of the Rocky Mountain region, including New Mexico, and identified *Allosaurus* remains at the Exeter site in Union County, in addition to the sites in Cibola, Sandoval and Quay Counties mentioned above. The theropod dinosaur from the Peterson quarry (NMMNH locality 3282) near Laguna, New Mexico (Williamson and Chure, 1996; Heckert et al., 2000) is an allosaurid, but is far larger than *Allosaurus* and, thus far, lacks cranial material, so is not comparable to the material we describe here.
PROVENANCE

The fossils described here were recovered from the under-
ground workings of the Section 19 mine, T14N, R9W, Cibola
County, New Mexico, by the junior authors (R. A. and D.M.R.)
during mining operations in 1977 (Fig. 1). One of the authors
(R.A.) brought some of these fossils to the NMMNH and tracked
down his supervisor at the time (D.M.R.), who has loaned the
others to the NMMNH for purposes of this study. The fossils
were discovered after blasting an access drift in waste rock in
stope 4303. At the time, mine operations were in the “Westwater
Canyon Member” of the Morrison Formation, and matrix still
encrusting some of the fossils is a yellowish gray (5Y7/2 of God-
dard et al., 1984), fine-grained, subrounded, moderately poorly
sorted sublitharenite.

Following Anderson and Lucas (1995, 1996, 1998), we only
recognize three members of the Morrison Formation in the
Grants uranium district. These are, in ascending order, the Salt
Wash, Brushy Basin, and Jackpile members (Fig. 1). The “West-
water Canyon” Member of economic usage (Gregory, 1938) is
clearly synonymous with the Salt Wash Member (Anderson and
Lucas, 1996, 1998). Vertebrate fossils from the Morrison Forma-
tion occur almost exclusively in the Brushy Basin Member both
in New Mexico (Hunt and Lucas, 1993; Lucas et al, 1996; Lucas
and Heckert, 2000) and across its outcrop belt in the western U.S.
(e.g., Carpenter, 1998; Turner and Peterson, 1999; Foster, 2003).
Salt Wash Member dinosaurs are all but unknown in New Mexico
(Hunt and Lucas, 1993; Lucas et al. 1996) and limited to just a
few generically identifiable records across the Morrison Forma-
tion as a whole (e.g., Gillette, 1996; Foster, 2003).

DESCRIPTION

Due to the unusual circumstances of discovery and collection,
the specimen we describe here is somewhat fragmentary (Figs.
2-3). Furthermore, it is apparent that the specimen was disarticu-
lated prior to burial, as the largest block includes a right maxilla
and a right dentary, rotated 180 degrees relative to each other
(Fig. 2A-D). The specimen (NMMNH P-38975 for fossils in the
NMMNH) consists of: a right dentary, with interdental plate, that
preserves the first to seventh tooth position and a single tooth in
position one (Figs. 2A, D-E, 3); a right dentary fragment with a
single tooth and a replacement tooth; a right dentary fragment
with a single replacement tooth; another maxillary fragment with
two replacement teeth; a third maxillary fragment with a single
replacement tooth; three right maxillary teeth (two illustrated in
Fig. 2F-G), two left maxillary teeth (Fig. 2F-G); a single right
dentary tooth; two left dentary teeth; two right maxillary tooth
fragments; three left maxillary tooth fragments; two right denta-
ry tooth fragments; and twelve indeterminate tooth fragments.
Oddly, the dentary is conjoined in the same block with a right
maxillary fragment that has been rotated 180 degrees from its
initial position. This maxillary fragment has five preserved tooth
positions, three of which bear fully erupted teeth, and a replace-
ment tooth (Figs. 2B-D, 3B-C). There is no duplication of unique
elements, and all of the fossils were found together in a small area
that the uranium miners took to be a single skull. Therefore, even
though the bones were obviously somewhat disarticulated, there
is no reason to assume that there is more than one individual or
taxon preserved as NMMNH P-38975.

The two most diagnostic elements are the maxilla and dentary
fragment that are in the same block. As of this writing, this part
of the specimen is still in the possession of Russell. As preserved,
the large dentary fragment measures 137 mm long, 49 mm high,
and 30 mm wide, and the maxilla fragment measures 102 mm
long, 60 mm high, and 22 mm wide. The single tooth in the
dentary is in the anteriormost (first) position, and is recurved,
serrated and lacks longitudinal grooves. The maxilla fragment
preserves three consecutive, nearly complete teeth. These teeth
are recurved, serrated and laterally compressed. The serrations
on these teeth are fine, with a denticle density of 2-3/mm. The lateral
(external) surface of the maxilla is heavily ornamented, with both
the typical line of nutrient foramina and a more unusual pattern
of faintly radial, deeply incised grooves.

The fragmentary nature of these specimens prevents us from
assigning them to the typical Morrison Formation taxon Allosau-
rus on a cladistic basis. Numerous phylogenetic analyses have
been conducted on theropod dinosaurs (e.g., Holtz, 1994, 2000),
but when discussing synapomorphies of the Allosauridae or
Allosaurus specifically, they refer solely to postcranial material
for these taxa. Accordingly, we rely on comparison to Allosaurus
(Madsen, 1976) and Ceratosaurus (Madsen and Welles, 2000),
and therefore assign this specimen to the Allosauridae based on
features of the conjoined right dentary and right maxilla. The
only other reasonably common large theropod present during this
time interval is Ceratosaurus. This specimen is not Ceratosaurus
based on two main characters. First, there is no lingual groove on
the first tooth of the dentary, a diagnostic feature of Ceratosaurus
(Madsen and Welles, 2000, fig. 11). Second, the nutrient foramina
on the maxilla are present directly above the maxillary teeth (Fig.
2B-C, 3B), as in Allosaurus (Madsen, 1976, pl. 1), not slightly
above the maxillary teeth and with an associated groove, as in
Ceratosaurus (Madsen and Welles, 2000, pl. 10). The specimen
has several other characteristics that are typical, if not diagnostic,
of the Allosauridae. These include a foramen below the Meck-
elian groove and directly under the fourth tooth position of the
dentary (Figs. 2A, 3A) as seen in Allosaurus (Madsen, 1976,
pl. 9, fig 10). The dentary’s shape is more or less linear (Figs.
2A, 3A). It is not the angled dentary seen in other theropods of
the time, although of large Morrison Formation theropods, only
Allosaurus, Ceratosaurus, Marshosaurus and Torvosaurus are
known from cranial material (Molnar, 1990; Molnar et al., 1990;
Britt, 1991; Madsen and Welles, 2000). Of these theropods, the
preserved material most closely resembles Allosaurus and is
clearly not Ceratosaurus. D. Chure (pers. comm., 2003) also
agrees that the Salt Wash fossils we document here are not refer-
able to Marshosaurus or Torvosaurus. The medial symphysis on
the dentary (Fig. 2A, 3A) is angular and similar in appearance to
Allosaurus (Madsen, 1976, pl. 9, fig. d).

We compiled data (Table 1) on the crown height, fore-aft basal
length, and fore and aft denticle density, following Farlow et al.
(1991) and Carr and Williamson (2000), for the teeth from the
Section 19 mine specimen, known *Allosaurus* teeth specimens on loan from the UMNH, and other *Allosaurus* teeth specimens in the NMMNH. The table shows that the Section 19 mine specimen bears similar denticle density numbers to those of the *Allosaurus* specimens from both UMNH and NMMNH; namely, that their fore and aft denticle densities are equal or nearly equal. This is obviously an extremely preliminary analysis. Most work on theropod tooth variation has focused on Cretaceous theropods (e.g., Farlow et al., 1991; Carr and Williamson, 2000; Sankey, 2002). However, the densities we document here are slightly finer than the 2/mm we measured for *Ceratosaurus* from Madsen and Welles (2000, fig. 2).
The Section 19 mine theropod fossils, from the Salt Wash Member, are some of the oldest Morrison theropods known. Radioisotopic ages and microfossils from the Tidwell Member of the upper Summerville Formation, which underlies the Morrison Formation throughout New Mexico, suggest that it is of Oxfordian age (Peterson et al. 1993; Shudack et al., 1998). Magnetostratigraphy and radioisotopic ages indicate that the upper part of the Morrison Formation may be as young as Tithonian and locally, it may even range into the earliest Cretaceous. The Morrison Formation thus may encompass part of Oxfordian time, and all of Kimmeridgian and Tithonian time (Fig. 1), which is at least 10 million years on any recently published numerical time scale.

Despite its apparent long duration, the Morrison Formation vertebrate fauna appears to be a single chronofauna that changed little during the timespan of Morrison deposition. Recognizing this, Lucas (1993) introduced the term Comobluffian land-vertebrate faunachron to refer to the interval of Late Jurassic time characterized by the Morrison Formation chronofauna. Attempts at biostratigraphic subdivision of the Comobluffian either lack a foundation in lithostratigraphy (e.g., Bakker et al., 1990; Carpenter, 1998) or are based on questionable lithostratigraphic principles (Turner and Peterson, 1999; refuted by Trujillo, 2002).

For example, Carpenter (1998) proposed two Morrison biozones based on the stratigraphic distribution of vertebrates in the Garden Park Paleontological Resource Area of Colorado (Fig. 4). The lower Haplocanthosaurus biozone is essentially from the Salt Wash Member, whereas the upper Camarasaurus biozone is from the Brushy Basin Member. The lack of general utility of Carpenter’s (1998) biozones is demonstrated by the fact that Camarasaurus is found in the Tidwell Member of the Summerville Formation (Hunt and Lucas, 1993; Lucas et al., 1996).

**FIGURE 3.** Interpretative sketches of *Allosaurus* from Section 19 mine. A. right dentary in lingual view with right maxilla in the background. B. right maxilla in lateral view with right dentary in background. C. right dentary in dorsal view, right maxilla in ventral view. All scale bars equal 2 cm. Abbreviations: d = dentary, f = foramen, idp = interdental plates, m = maxilla, mg = Meckelian groove, ms = medial symphysis, mt = maxillary teeth, nf = nutrient foramina.

**FIGURE 4.** Stratigraphic distribution of vertebrate taxa from the Morrison Formation in the Garden Park Paleontological Resource Area in Colorado (based on data in Carpenter, 1998). The gray shaded box indicates the *Haplocanthosaurus* biozone of Carpenter, which is succeeded by his *Camarasaurus* biozone.
and in the Salt Wash Member of the Morrison Formation as well (Ikejiri, 2002), so it has a much longer stratigraphic distribution than its limited record at Garden Park.

**CONCLUSIONS**

Identifiable dinosaur fossils from the uranium mines in the Morrison Formation are rare, and few, if any, were reposited in museums. The specimen described here, albeit fragmentary, is sufficiently complete to identify as *cf. Allosaurus*. Indeed, this turns out to be one of the oldest records of the genus, as almost all other records of *Allosaurus* are from the overlying Brushy Basin Member of the Morrison Formation (Foster, 2003). We hope that articles such as this spur others with similar fossils in their possession to bring them to our attention. The data from fossils such as these is invaluable, but lost to science as long as these specimens remain hidden in private hands. For example, this specimen is the stratigraphically oldest record from New Mexico, but was unknown to science until a chance encounter between two of the authors brought it to light.

**ACKNOWLEDGMENTS**

Kate Zeigler, Adrian Hunt, and Dan Chure reviewed an earlier draft of this manuscript and improved it with their comments. Scott Sampson of the UMNH allowed us to borrow *Allosaurus* specimens for comparative purposes.

**REFERENCES**


Britt, B.B., 1991, The theropods of the Dry Mesa Quarry (Morrison Formation), with emphasis on the osteology of *Torvosaurus tanneri*: Brigham Young