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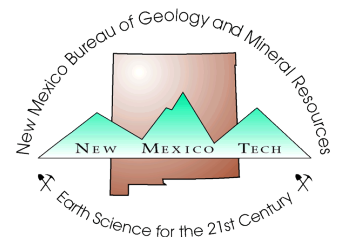
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Triassic stratigraphy and paleontology on the Fort Wingate quadrangle, west-central New Mexico

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Abstract

Triassic strata on the Fort Wingate quadrangle are nonmarine red beds assigned to the Moenkopi Formation and Chinle Group. The Middle Triassic Anton Chico Member of the Moenkopi Formation is as much as 20 m of dominantly grayish-red, trough-crossbedded micaceous litharenite that disconformably overlies the Middle Permian San Andres/Glorieta Formations and is disconformably overlain by the Upper Triassic Chinle Group. The Chinle Group is as thick as 350 m and consists of (ascending): mottled strata, Shinarump Formation, Blue-water Creek Formation, Blue Mesa, Sonsela, and Painted Desert Members of Petrified Forest Formation, and Owl Rock Formation. Fossil vertebrates from the Bluewater Creek Formation on quadrangle include *Buettneria*, *Desmatosuchus*, *Stagonolepis*, and a large phytosaur and indicate an Adamanian (latest Carnian) age for the formation. The Painted Desert Member is not fossiliferous locally but produces Revueltian (early mid-Norian) tetrapods elsewhere on the Colorado Plateau.

Introduction

The Fort Wingate 7¹/₂-min quadrangle lies in McKinley County, west-central New Mexico, about 20 km east of Gallup (Fig. 1). Triassic strata well exposed over approximately half the quadrangle are nonmarine, red-bed siliciclastics. They belong to the Moenkopi Formation (Middle Triassic) and the overlying Chinle Group (Upper Triassic). Detailed mapping and extensive studies of Triassic stratigraphy, paleontology, and sedimentation make the best-studied Triassic outcrops in west-central New Mexico those on the Fort Wingate quadrangle. We review the current understanding of Triassic stratigraphy and paleontology in this important outcrop area. NMMNH refers to the New Mexico Museum of Natural History and Science, Albuquerque, and UMMP refers to the University of Michigan Museum of Paleontology, Ann Arbor.

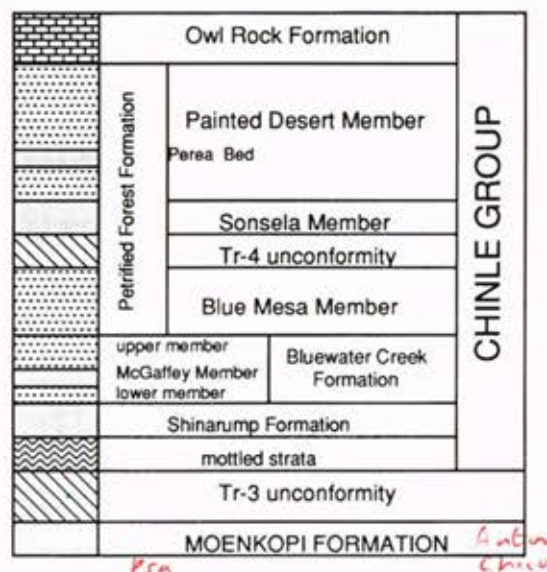


FIGURE 1—Location of the Fort Wingate 7¹/₂-min quadrangle, west-central New Mexico and summary of stratigraphic nomenclature used on the quadrangle.

Moenkopi Formation

The Moenkopi Formation is as thick as 20 m on the Fort Wingate quadrangle and is dominantly grayish-red, trough-crossbedded micaceous litharenite (Lucas and Hayden, 1989). It rests with marked disconformity on the underlying Middle Permian San Andres or Glorieta Formations and is overlain disconformably by the Chinle Group. Moenkopi strata are generally poorly exposed on the quadrangle. The thickest outcrop is just east of NM-400 in the NE¹/₄ sec. 20 (unsurveyed) T14N R16W (Figs. 2, 3).

No fossils are known from the Moenkopi Formation on the Fort Wingate quadrangle. However, fossil vertebrates, especially the capitosauroid amphibian *Eocyclotosaurus*, found elsewhere indicate a Middle Triassic (Anisian) age (Morales, 1987; Lucas and Hayden, 1989). Moenkopi strata on the Fort Wingate quadrangle be-

long to the Anton Chico Member of Lucas and Hunt (1987) and are correlative to the Holbrook Member of northeastern Arizona (Lucas and Hunt, 1993a).

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Chinle Group

Lucas (1993a, b) raised Gregory's (1917) Chinle Formation to group status, thereby elevating its members to formational rank and its beds to member rank. He thus modified Lucas and Hayden's (1989) Upper Triassic stratigraphy in west-central New Mexico (including the Fort Wingate quadrangle) to recognize four formational rank units (ascending): Shinarump, Bluewater Creek, Petrified Forest (includes the Blue Mesa, Sonsela, and Painted Desert Members) and Owl Rock Formations. Anderson and Lucas (1993) named the McGaffey Member of the Bluewater Creek Formation, and we formalize Cooley's (1957) term Perea Bed, thus completely establishing the formal nomenclature of Chinle Group strata employed here.

"Mottled strata" and Shinarump Formation

In the Fort Wingate quadrangle, the Chinle Group rests disconformably on the Moenkopi Formation. This disconformity is marked by silica-pebble conglomerate and quartzose sandstone of the Shinarump Formation and by biogenically and pedogenically modified siltstones, sandstones, and conglomerates that Stewart et al. (1972) termed the "mottled strata." Shinarump strata on the Fort Wingate quadrangle are best exposed in the NE $\frac{1}{4}$ sec. 20 (unsurveyed) T14N R16W where they consist of at least 4 m (12 ft) of yellowishgray, trough- and planar-crossbedded quartzose sandstone and silica-pebble (mostly quartzite and jasper) conglomerate (Fig. 3). Elsewhere on the quadrangle, the Shinarump Formation is considerably thinner and very discontinuous (lenticular) locally (Fig. 3). The thin and discontinuous Shinarump outcrops on the Fort Wingate quadrangle are near the depositional/erosional edge of the Shinarump outcrop belt.

The Shinarump Formation is exposed widely across the Colorado Plateau and is typically much thicker and more laterally continuous than on the Fort Wingate quadrangle (Stewart et al., 1972). In southeastern Utah and northeastern Arizona, economically significant uranium oxide deposits were mined in the Shinarump Formation. Fossil plants and regional correlation indicate the Shinarump is of Late Triassic (late Carnian: Tuvanian, about 225 Ma) age (Lucas, 1993b).

The thickest "mottled strata" section in western New Mexico is on the Fort Wingate quadrangle, where these strata reach their maximum thickness of about 22 m (Figs. 3, 4A). Here, they consist of sandy siltstone, sandstone, and conglomerate that are mottled grayish purple and grayish red purple. Orange secondary gypsum nodules are locally abundant in the mot

ted strata, particularly in sec. 9 (unsurveyed) T14N R16W. Numerous large-diameter cylindrical burrows (Fig. 4A) in the mottled strata were misidentified by Dubiel et al. (1987) as lungfish burrows (McAllister, 1988) and have been reidentified by Hasiotis and Mitchell (1989) as crayfish burrows. Mottled strata represent a weathering profile (cumulative pedon) developed in Moenkopi strata. Therefore, they postdate early Anisian and probably are of Late Triassic (Carnian) age. They are widely distributed at the base of the Chinle Group on the Colorado Plateau, and are also locally present in other parts of New Mexico, west Texas, western Oklahoma, Colorado, and Wyoming (Stewart et al., 1972; Lucas, 1993b).

In the SW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 9 (unsurveyed) T14N R16W the mottled strata are disconformably overlain by the Shinarump Formation (Fig. 3). This relationship has been observed elsewhere on the Colorado Plateau (Stewart et al., 1972; Lucas and Heckert, 1994). This indicates that the mottled Data accumulated as paleosols developed on the Tr-3 erosional surface (Pipiringos and O'Sullivan, 1978). Shinarump Formation deposits record the late Carnian infilling of scour surfaces and paleovalleys that preceded the onset of deposition of subsequent Chinle Group units (Lucas and Huber, 1994; Lucas, 1995).

Bluewater Creek Formation

Lucas and Hayden (1989) introduced the term Bluewater Creek Member of Chinle Formation for as much as 60 m of red-bed sandstone, siltstone, and mudstone that overlie the Shinarump /mottled strata in west-central New Mexico. This unit is widely exposed on the Fort Wingate quadrangle, especially on the army depot (Fig. 2). Previously, it was informally termed the "lower red member" of the Chinle Formation (Cooley, 1957, 1959; Akers et al., 1958; Stewart et al., 1972). Some workers (Ash, 1967, 1969, 1978, 1989; Repenning et al., 1969; Shomaker, 1971; Dubiel et al., 1993) applied the term Monitor Butte Member to these strata, even though they are lithologically dissimilar to the type section of the Monitor Butte in San Juan County, Utah where this unit is dominantly greenish-gray, smectitic claystone and clayey fine-grained sandstone (Stewart, 1957; Stewart et al., 1972). We prefer to recognize a lithologically distinct Bluewater Creek Formation on the Fort Wingate quadrangle and throughout west-central New Mexico (Lucas and Hayden, 1989; Lucas and Hunt, 1993a; Lucas and Heckert, 1994; Heckert and Lucas, 1996).

On the Fort Wingate quadrangle, the lower part of the Bluewater Creek Formation includes a 1.5-m-thick lenticular bed of carbonaceous shale that crops

out intermittently over several tens of acres. Ash (1978) termed these beds the "Ciniza Lake Beds." Because this unit is so thin and of such limited areal extent, we follow Lucas and Hayden (1989) in abandoning the term Ciniza Lake Beds. We note also that Anderson et al. (in press) were unable to map this unit at the 1:24,000 scale of the Fort Wingate 7 $\frac{1}{2}$ -min quadrangle. Immediately below these strata are steeply dipping sandstones of the lower Bluewater Creek Formation that Ash (1978) interpreted as syndepositional slumping that produced an angular unconformity within the Bluewater Creek Formation. Anderson et al. (1989) and Lucas and Hunt (1993a) questioned this conclusion, arguing that the apparent angular unconformity represents Quaternary slumping and/or Laramide-related deformation. However, at least some of these beds represent syndepositional deformation, as Dubiel et al. (1993) documented well (Fig. 4B).

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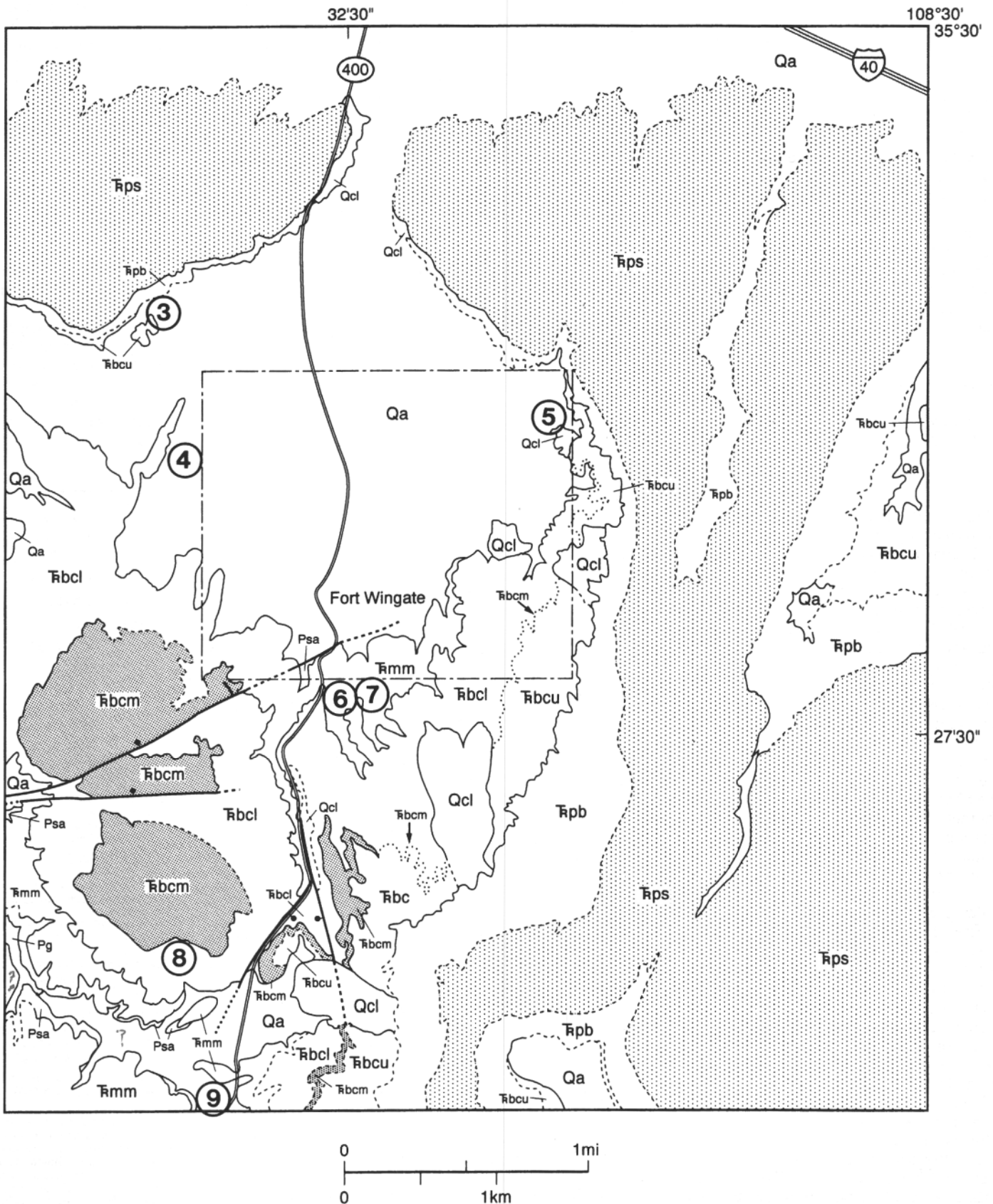


FIGURE 2—Geologic map of the northeastern part of the Fort Wingate 1:24,000 quadrangle. **Psa**, Permian San Andres Formation; **Pg**, Permian Glorieta Sandstone; **Trmm**, Triassic Moenkopi Formation and mottled strata and Shinarump Formation of Chinle Group (undivided); **Trbc**, Triassic Bluewater Creek Formation of Chinle Group divided into lower (**Trbcl**), McGaffey (**Trbcm**), and upper (**Trbcu**) members; **Trp**, Triassic Petrified Forest Formation of Chinle Group, divided into Blue Mesa (**Trpb**) and Sonsela (**Trps**) Members; **Qa**, Quaternary alluvium; **Qcl**, Quaternary colluvium. Numbers in circles locate sections in Fig. 3.

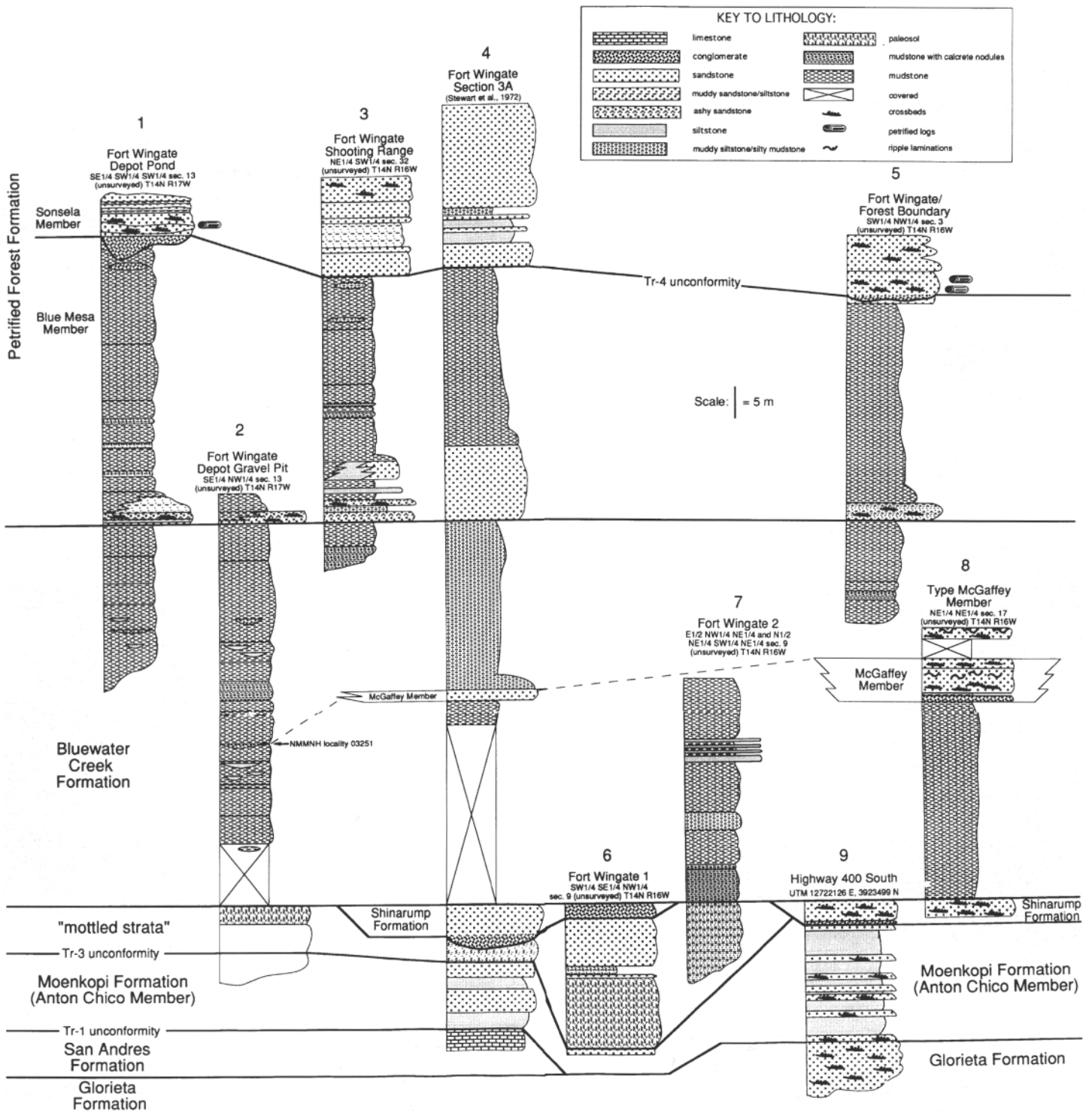
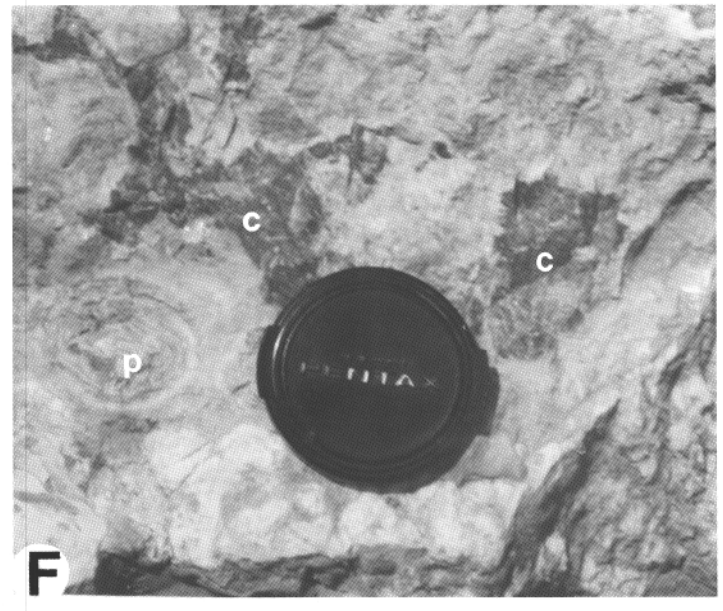
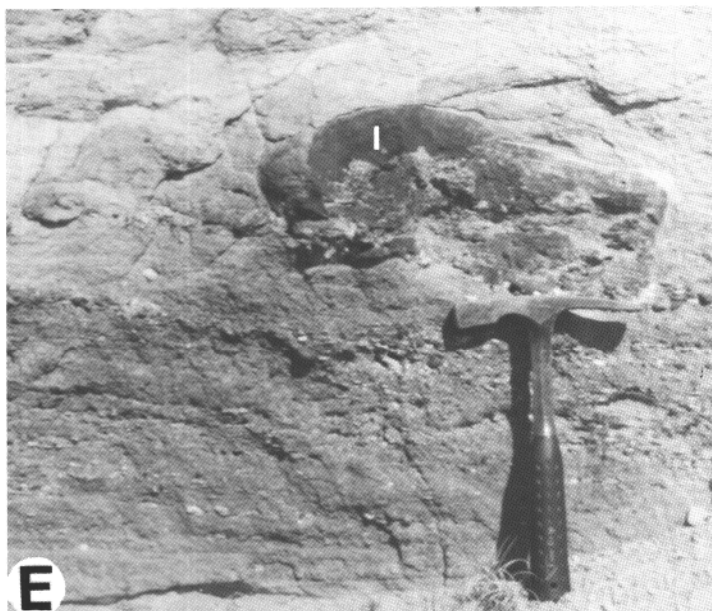
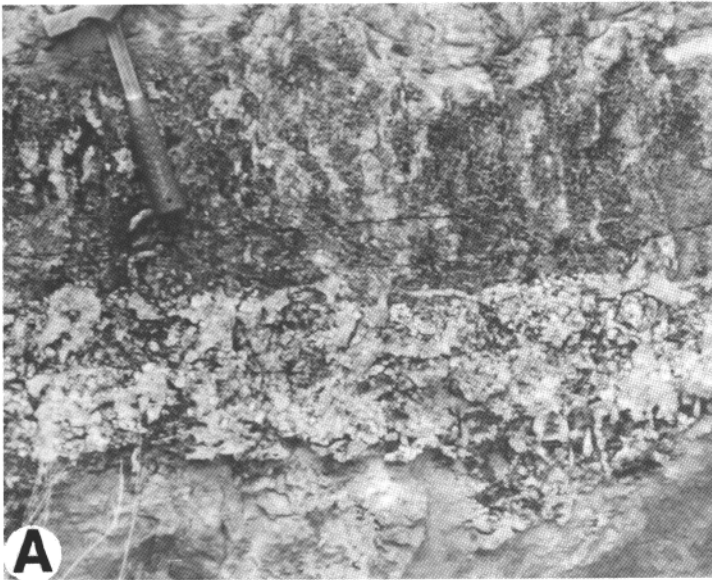


FIGURE 3—Measured stratigraphic sections of the Moenkopi Formation and lower part of the Chinle Group on the Fort Wingate 7½-min quadrangle. See Fig. 2 for locations of most sections.

FIGURE 4—Photographs of selected outcrops of Chinle Group strata on the Fort Wingate quadrangle. **A**, "Mottled strata" in the SW¼ SE¼ NW¼ sec. 9 (unsurveyed) T14N R16W; note extensive bioturbation. **B**, Flat-lying conglomerate (2) overlying steeply dipping sandstones (1) in lower Bluewater Creek Formation near "Lake Ciniza." These beds are evidence of

syndepositional slumping during the Late Triassic. **C**, Section of the bench-forming McGaffey Member (2) and underlying red beds of the lower member of the Bluewater Creek Formation (1) in NE¼ NE¼ sec. 17 (unsurveyed) T14N R16W. **D**, Exposures of the upper Bluewater Creek Formation (1) and the Blue Mesa (2) and Sonsela (3) Members of the

Petrified Forest Formation near the small-arms firing range on the Fort Wingate Army Depot (section 3 in Fig. 3). **E**, Close-up of petrified log (1) in conglomeratic sandstone of the Sonsela Member. **F**, Close-up of pedogeestones of the Owl Rock Formation. Note the pisolitic texture (p) and brecciated chert (c).



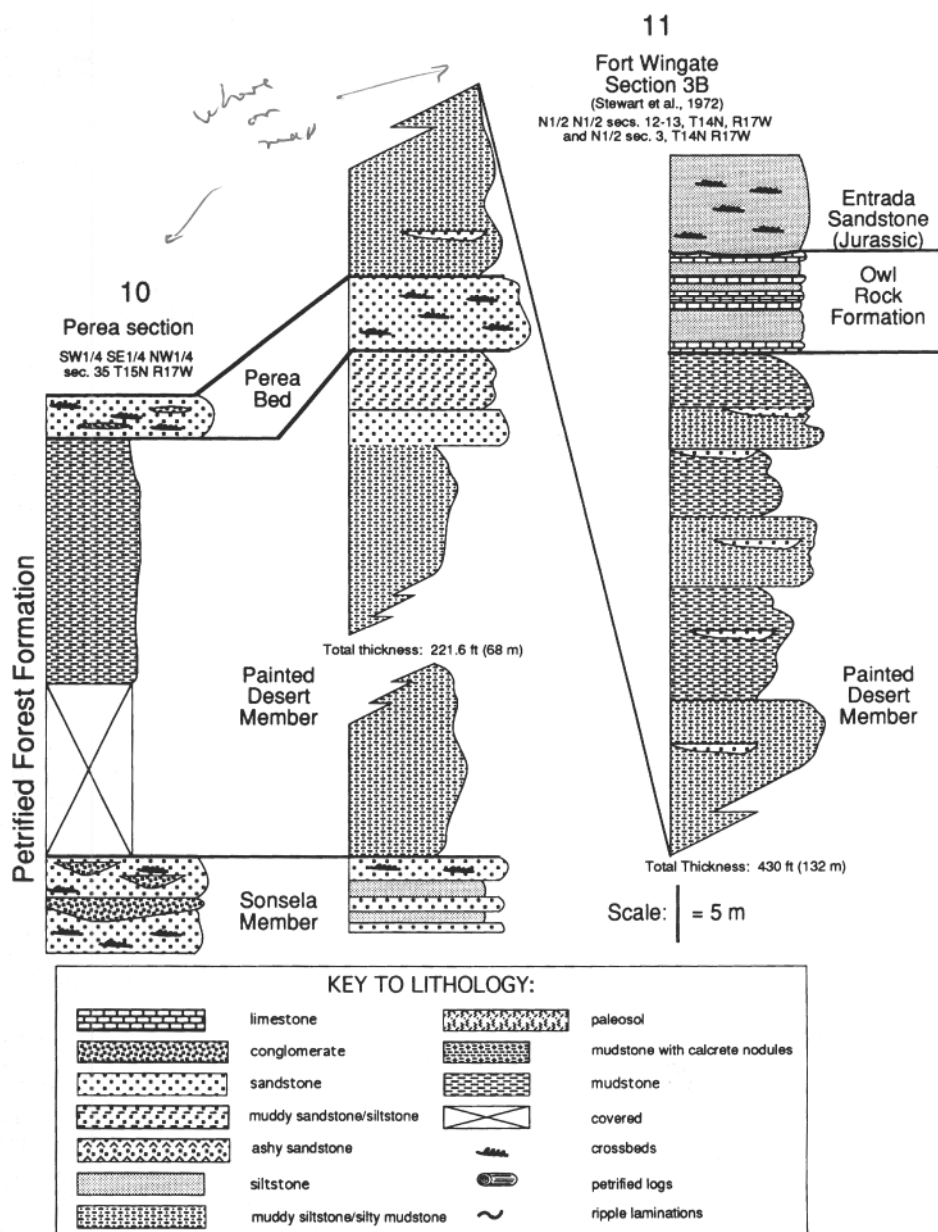


FIGURE 5—Measured stratigraphic sections of the upper part of the Chinle Group on the Fort Wingate quadrangle

Throughout most of the Fort Wingate quadrangle, the Bluewater Creek Formation can be divided into three members (Figs. 1, 3, 4C). The lower member is as much as 36 m of red-bed mudstones and thin sandstones. The overlying McGaffey Member, which has its type section on the quadrangle, is as much as 12 m of ledge- and bench-forming ripple-laminated sandstones (Anderson and Lucas, 1993). It forms a prominent marker bed throughout the quadrangle and can be recognized as far east as the Lucero uplift in Cibola County (Lucas and Heckert, 1994). The upper member is red-bed mudstones as thick as 30 m. The McGaffey Member pinches out locally; for example, it is absent from our Fort Wingate Gravel Pit Section (Fig. 3).

Fossil plants from the lower part of the Bluewater Creek Formation on the Fort Wingate quadrangle belong to Ash's (1980) *Dinophyton* floral zone of late Carnian age. Fossil tetrapods from the Bluewater Creek Formation, especially the phytosaur *Rutiodon*, the aetosaurs *Desmatosuchus* and *Stagonolepis*, and the large metoposaurid amphibian *Buettneria*, indicate an Adamanian age, which is latest Carnian (Lucas, 1993b; see discussion below).

Petrified Forest Formation

Most of the thickness of Triassic section exposed on the Fort Wingate quadrangle belongs to the Petrified Forest Formation,

divided into the (ascending) Blue Mesa, Sonsela, and Painted Desert Members (Fig. 1). The base of the Blue Mesa Member is a grayish-white, low-angle trough-crossbedded, muddy micaceous sandstone above Bluewater Creek Formation red beds of mudstone and siltstone (Figs. 3, 4D). The dramatic contrast in lithology and color provides an easily mapped contact between the Bluewater Creek and Petrified Forest Formations (Figs. 2, 4D). Strata of the Blue Mesa Member on the Fort Wingate quadrangle are as thick as 43 m and mostly purple and greenish-gray smectitic mudstone. No generically determinate fossils are known from the Blue Mesa Member on the Fort Wingate quadrangle, but in the Petrified Forest National Park and the St. Johns area of Arizona, the Blue Mesa Member yields megafossil plants, palynomorphs, and tetrapods of Adamanian (latest Carnian) age (Lucas, 1993b).

The Sonsela Member disconformably overlies the Blue Mesa Member and forms the prominent cuestas that flank NM-400 north of the village of Fort Wingate (Fig. 2). The Sonsela is as much as 24 m of light-gray to yellowish-brown, fine-grained to conglomeratic, crossbedded sandstone with locally abundant fossil logs (Figs. 3, 4E, 5). Poorly preserved unionid bivalves (Lucas and Hayden, 1989, fig. 9F-I) are also known from the Sonsela Member on the quadrangle. The basal contact of the Sonsela is characterized by changes in lithology from underlying Blue Mesa Member mudstones to Sonsela conglomerate and sandstone. Scour-and-fill and stratigraphic relief characterize this contact. Regional stratigraphic relationships indicate the base of the Sonsela Member is an unconformity of basin-wide extent termed the Tr-4 unconformity (Heckert and Lucas, 1996). This unconformity approximates the Carnian-Norian boundary (Lucas, 1993b).

The Painted Desert Member is poorly exposed on the Fort Wingate quadrangle north of the Sonsela cuesta and is as thick as 180 m. It consists mostly of reddish-brown and grayish-red, smectitic mudstone with minor beds of resistant, laminated or crossbedded, micaceous litharenite. A laterally continuous sandstone that crops out as a persistent bench over the northern part of the quadrangle was named the Perea Sandstone Bed by Cooley (1957) in a University of Arizona master's thesis; a paper was never published, so later workers have not used Cooley's term. In contrast to Ash's (1978) Ciniza Lake Beds, this unit is indeed mappable at the 1:24,000 scale (Anderson et al., in press). Therefore, we designate unit 12 of Stewart et al.'s (1972, p. 190) NM-3b section as the type section of the Perea Bed. There, in the NW 1/4 NW 1/4 sec. 3 (unsurveyed) T14N R17W, they measured 7 m of very fine to fine-grained, subangular, moderately sorted quartzarenite (Fig. 5).

These sandstones are yellowish gray, light greenish gray, and light olive gray and contain minor conglomerates. Bedforms range from horizontally laminated to low-angle trough- and planar-crossbedded.

We measured 4 m of fine- to medium-grained laminar- to low-angle crossbedded, pale-red sandstones of the Perea Bed in the SW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 35 (unsurveyed), where this sandstone defends a low cuesta that is laterally continuous with the type section. Here, the Perea Bed is locally conglomeratic, with conglomerate clasts consisting of mudstone rip-ups and intraformational calccrete nodules. No extraformational clasts were observed.

Stewart et al. (1972, p. 188) noted a single indeterminate bone while measuring the section; otherwise, no fossils are known from the Painted Desert Member on the Fort Wingate quadrangle. However, the lower part of this unit produces an extensive vertebrate fauna of Revueltian (early Norian) age in the Petrified Forest National Park, Arizona (Long and Murry, 1995; Hunt and Lucas, 1995).

Owl Rock Formation

The youngest Chinle Group unit exposed on the Fort Wingate quadrangle is the Owl Rock Formation. Here, at the base of "the Hogback" along the western margin of the quadrangle it is as thick as 22 m and consists of laterally persistent beds of pale-red and pale reddish-brown calcareous siltstone, thin-bedded sandy siltstone, and light greenish gray limestone and nodular limestone (Figs. 4F, 5).

Blakey and Gubitosa (1983) and Dubiel (1989a, b) concluded that deposition of the Owl Rock Formation took place in an extensive lake. However, Lucas and Anderson (1993) argued that Owl Rock limestones on the Fort Wingate quadrangle are stage III to stage VI calcrites and thus are not of lacustrine origin. No fossils are known from the Owl Rock Formation on the Fort Wingate quadrangle, but fossil vertebrates from the unit in Arizona indicate a Revueltian (Norian) age (Lucas, 1993b).

Paleontology

Mehl et al. (1916) first described fossils from the Triassic strata near Fort Wingate, although Darton (1910, p. 46) earlier mentioned indeterminate bone fragments from this region. The material described by Mehl et al. (1916) was derived entirely from the Bluewater Creek Formation and included an aetosaur pelvis they named *Acompsosaurus wingatensis* and a partial phytosaur snout attributed to *Paleorhinus* sp. Unfortunately, this material is now lost. Camp (1930) also briefly mentioned indeterminate postcrania of metoposaurids and phytosaurs from the Fort Wingate area.

Ash (1967, 1969) reported on various megafossil plants from the Fort Wingate area and noted briefly the presence of an amphibian and a phytosaur in the lower units of the Chinle. Various authors made the next significant contribution to Fort Wingate area paleontology in Ash's (1978) volume *Geology, paleontology, and paleoecology of a Late Triassic lake, western New Mexico*. There, Ash described a large paleoflora. Numerous conchostracans were named *Cyzicus (Lioestheria) wingatella* by Tasch (in Ash, 1978). Isolated fish scales were attributed to the coelacanth *Chinlea* by Ash (1978), who also illustrated abundant vertebrate coprolites.

Plant fossils identified by Ash (1978, p. 21) include "leaves, leafy shoots, stems, spores, [and] pollen." He distinguished 27 plant taxa, the most common of which are *Dinophyton* (a gymnosperm), *Neocalamites* (pith casts), and the palynomorphs *Pityosporites* and *Klausipollenites*. Almost all plant fossils recovered from the Chinle Group on the Fort Wingate quadrangle are from Ash's "Ciniza Lake Beds" low in the Bluewater Creek Formation. The only other plant fossils known from the quadrangle are the abundant petrified logs of the genus *Araucarioxylon* that weather out of the Sonsela Member throughout the region.

Hunt and Lucas (1989, 1993) reviewed the vertebrate paleontology of the Fort Wingate area in a pair of summary articles. In 1989, they noted the presence of another coelacanth in addition to *Chinlea* after reviewing the material published by Ash (1978). We concur with Hunt and Lucas (1989) and Lucas and Hayden (1989) that the phytosaur fossil Mehl et al. (1916) identified as *Paleorhinus* is generically indeterminate. Hunt and Lucas (1989) concurred with Lucas and Hayden (1989) that the lost *Acompsosaurus* specimen probably pertains to the aetosaur *Stagonolepis robertsoni*. However, Hunt and Lucas (1993) recanted and instead reasigned the *Acompsosaurus* specimen to cf. *Desmatosuchus*. We concur with the earlier decision of Hunt and Lucas (1989) and refer the *Acompsosaurus* material to *Stagonolepis*, a conclusion reached independently by Long and Murry (1995). *Stagonolepis* is an index taxon of the Adamanian land-vertebrate faunachron of Lucas and Hunt (1993b) and suggests that the Bluewater Creek Formation is of latest Carnian age.

As part of a master's thesis at the University of New Mexico, Heckert (1997) explored the paleontology and stratigraphy of the lower Chinle Group in west-central New Mexico. Heckert described material from a variety of new NMMNH localities; the most productive on the Fort Wingate quadrangle is NMMNH L-03251. This locality has produced numerous specimens of *Buettneria* sp., phytosaurs, *Desmatosuchus* sp., *Stagonolepis?* sp., a dicynodont, and other unidentified reptiles. Other localities on the quadrangle

have produced *Buettneria* sp. and assorted phytosaur postcrania.

The NMMNH locality L-03251 is in a heavily cemented intraformational conglomerate (Fig. 3). This horizon is approximately two-thirds of the way up from the base of the Bluewater Creek Formation, at a level roughly homotaxial with the McGaffey Member, which is not present in this area. At NMMNH L-03251, bones are found loose on the surface over an 800-m² area, with some additional bone found in the conglomerate. The conglomerate is composed principally of reworked calccrete nodules, representing avulsion and redeposition of nearby floodplain deposits, including perhaps the preserved tetrapod material. Here we illustrate typical fossils from NMMNH locality L-03251, including metoposaurid skull fragments and postcrania, a partial ilium and pubis of the aetosaur *Desmatosuchus* sp. and a lateral spike that also pertains to *Desmatosuchus* sp. (Fig. 6).

Fossils NMMNH P-18326 and 18311 (Fig. 6C–D) are interclavicle fragments that belong to the Metoposauridae because of their deep, regular, waffle-iron-like pitting. Hunt (1993) revised the Metoposauridae, noting that among the large metoposaurids, *Buettneria* exhibits more pitting and fewer radial ridge-and-groove features over its clavicles and interclavicles than *Metoposaurus*. For this reason, we identify NMMNH P-18326 and P-18311 as *Buettneria* cf. *B. perfecta*.

The skull fragment, NMMNH P-18312 (Fig. 6A–B), also clearly represents a metoposaurid. Generic distinction of metoposaurid taxa is based principally on the position of the lachrymal relative to the orbit and the development of the otic notch region of the posterior of the skull (Hunt, 1993). Neither of these is preserved in NMMNH P-18312, but *Metoposaurus* and *Buettneria* are the only large metoposaurid taxa known from the Chinle Group. Of these, *Metoposaurus bakeri* is much rarer, known only from slightly older strata in Texas. Therefore, we tentatively identify NMMNH P-18312 as cf. *Buettneria* sp.

Specimen NMMNH P-18308 (Fig. 6F) represents a partial right ilium and pubis of *Desmatosuchus* sp. Although Case (1922) illustrated excellent and nearly complete material of *Desmatosuchus*, Long and Murry (1995) were the first to publish photographs of the ilia of this nearly ubiquitous lower Chinle taxon. Specimen NMMNH P-18308 is very similar to UMMP 7322 (Long and Murry, 1995, fig. 91). Although the anterior process of the iliac blade is missing in the NMMNH specimen, the intact posterior process is triangular in lateral view with a transversely thickened dorsal margin. The posterior process is almost entirely posterior

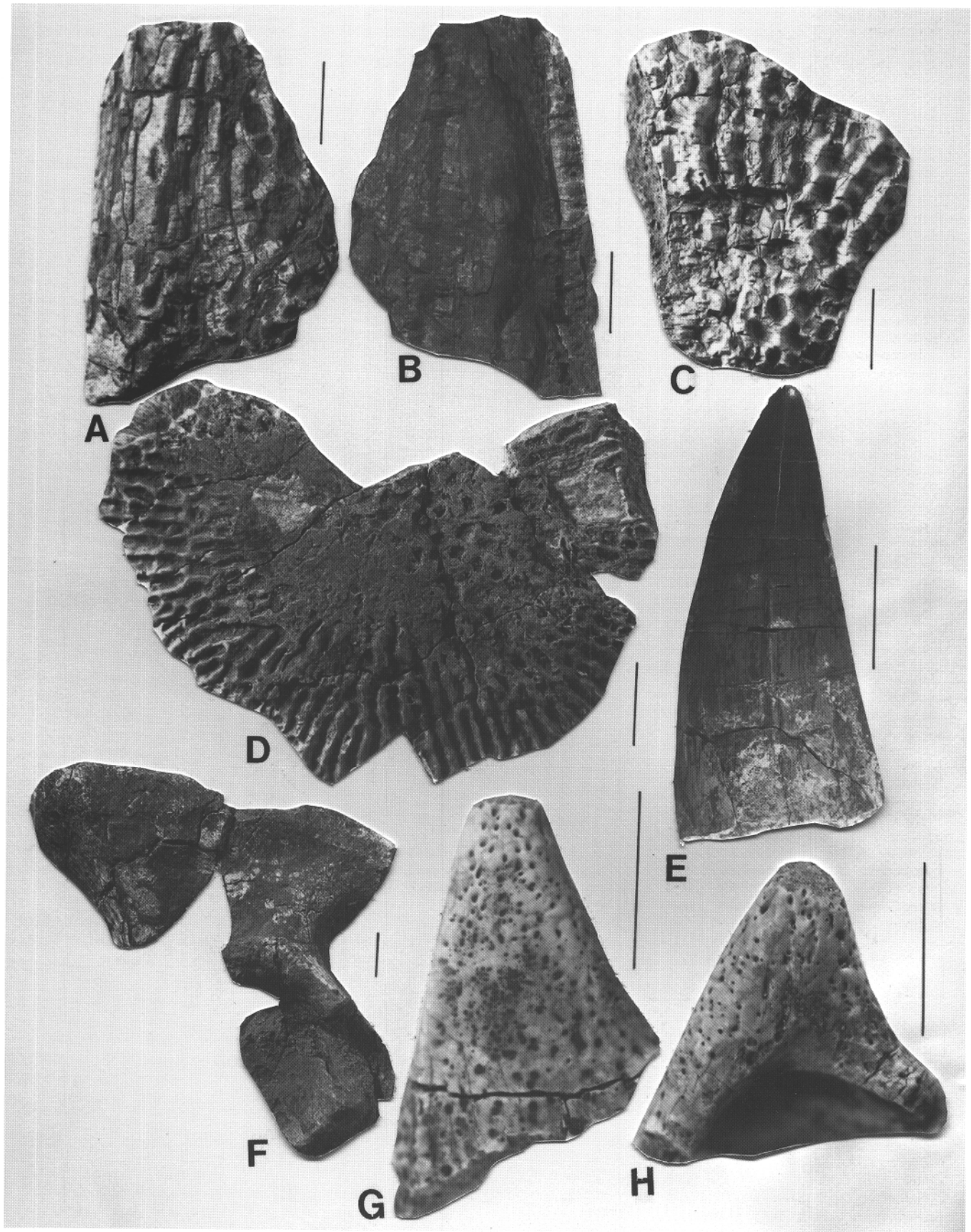


FIGURE 6—Selected Late Triassic (late Carnian) tetrapod fossils from the Bluewater Creek Formation, Fort Wingate 7½-min quadrangle (A–D, F–H) and nearby (E). A–B, NMMNH P-18312, skull fragment of the temnospondyl amphibian cf. *Buettneria* sp. in dorsal (A) and ventral (B) views. C, NMMNH P-18326, interclavicle fragment of *Buettneria* cf. *B. perfecta* in ventral view. D, NMMNH P-18311, interclavicle of a juvenile *Buettneria* cf. *B. perfecta* in ventral view. E, NMMNH P-18306, a large caniniform tooth of a phytosaur, in labial view. F, NMMNH P-18308, right ilium and pubis of the aetosaur *Desmatosuchus* sp. in lateral view. G–H, NMMNH P-18293, right lateral scute of *Desmatosuchus* sp. in dorsal (G) and posterior (H) views. All specimens are from NMMNH locality L-03251 except E, which is from NMMNH L-03254. Scale bars = 2 cm.

to the ischial process. The acetabulum is deep with a well-developed brevis fossa. The pubis is badly damaged and incomplete but still well fused to the ilium. The puboiliac articulation is transversely broad, approximately 2½ times wider than dorso-ventrally tall. In these features, NMMNH P-18308 fits well the criteria for *Desmotosuchus* and is distinct from *Stagonolepis*, which has a posterior process of the ilium that is quadrilateral in lateral view and possesses a more robust anterior iliac process than could have existed on NMMNH P-18308 (Long and Murry, figs. 79-80, pp. 86-87). Similarly, a variety of characters also prevent us from assigning this ilium to any of the other Chinle aetosaurs, including *Longosuchus*, *Typothorax*, and *Paratypothorax* (Long and Murry, 1995).

We also collected a lateral spike, complete except for part of both the dorsal and lateral flange, from NMMNH L-03251 (Fig. 6G-H). This specimen, NMMNH P18293, is typical of *Desmotosuchus* lateral scutes (Case, 1922; Long and Ballew, 1985; Long and Murry, 1995; Heckert et al., 1996). This scute is strongly flexed, with dorsal and lateral flanges meeting at an approximate right angle. A posteriorly recurved spike projects laterally from the scute and is round with a slightly concave posterior margin. Pitting in the scute surface is faint and randomly distributed. This specimen represents a right lateral scute of *Desmotosuchus* sp., probably from posterior to the forelimb. *Desmotosuchus* may have the longest temporal range of any aetosaur, as it is known from sediments of early late Carnian to early midNorian age (Lucas, 1993b; Lucas and Hunt, 1993b).

Other vertebrate fossils collected from NMMNH L-03251 include isolated post-crania of a dicynodont, phytosaurs, aetosaurs, and metoposaurs, reptile skull fragments, phytosaur teeth, and numerous metoposaur skull fragments. The presence of a very large phytosaur tooth (Fig. 6C) in the Bluewater Creek Formation in the Ciniza quadrangle, immediately east of the Fort Wingate quadrangle, suggests that large, heterodont phytosaurs were present in the Bluewater Creek Formation. One fragmentary dorsal centrum, NMMNH P-18328, is strongly constricted, quadrilateral in cross-section, and strongly keeled along the ventral surface. In these features it resembles *Stagonolepis* as described by Walker (1961) and Long and Murry (1995). *Stagonolepis* is an index taxon of the Adamanian land vertebrate faunachron and suggests a latest Carnian age for the Bluewater Creek Formation.

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