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PRE-GRANEROS CRETACEOUS STRATIGRAPHY OF NORTHEASTERN NEW MEXICO

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INTRODUCTION

Late Albian and early Cenomanian strata are widely exposed in eastern Colorado, central Kansas and western Texas. In New Mexico, equivalent strata are exposed in the northeastern and east-central as well as north-central and northwestern (e.g., Chama and San Juan Basins) parts of the state. In the northeastern and east-central parts of the state, pre-Graneros Cretaceous strata are well exposed in the Cimarron River valley and the Canadian River valley (Fig. 1), although in the latter much of the Cretaceous and Tertiary beds have been removed by erosion revealing the underlying Jurassic and, particularly, Triassic beds. Along the resultant escarpments (Canadian escarpment in the north and the Llano Estacado in the south), good sections of the Cretaceous are found. Hydrocarbon- and water-well logs are quite common in this region, but logging in many cases starts only below the base of the Cretaceous, thus limiting the opportunity for subsurface correlation of the Cretaceous in this region.

In spite of relatively good exposures of the Cretaceous, identification and correlation of these strata have remained rather unclear and problematical. In particular, the nature of the relationship of the Dakota Sandstone with the Mesa Rica, and the correlation of these units with strata outside this region, are unclear. The strata of this region consist of the Tucumcari Shale, restricted to the southern and eastern parts of east-central New Mexico, overlain directly by the Mesa Rica Sandstone which forms prominent scarps encircling mesas throughout the Tucumcari basin, in turn overlain by the Pajarito Shale. To the north and northwest of the Tucumcari basin, the Dakota Sandstone appears to occupy a position homotaxial with the Mesa Rica Sandstone and the Pajarito Shale beneath the Graneros Shale, marking the initiation of the Mancos transgression into this region during the Cenomanian. The Tucumcari Shale, Mesa Rica Sandstone and Pajarito Shale belong within the Purgatoire Group.

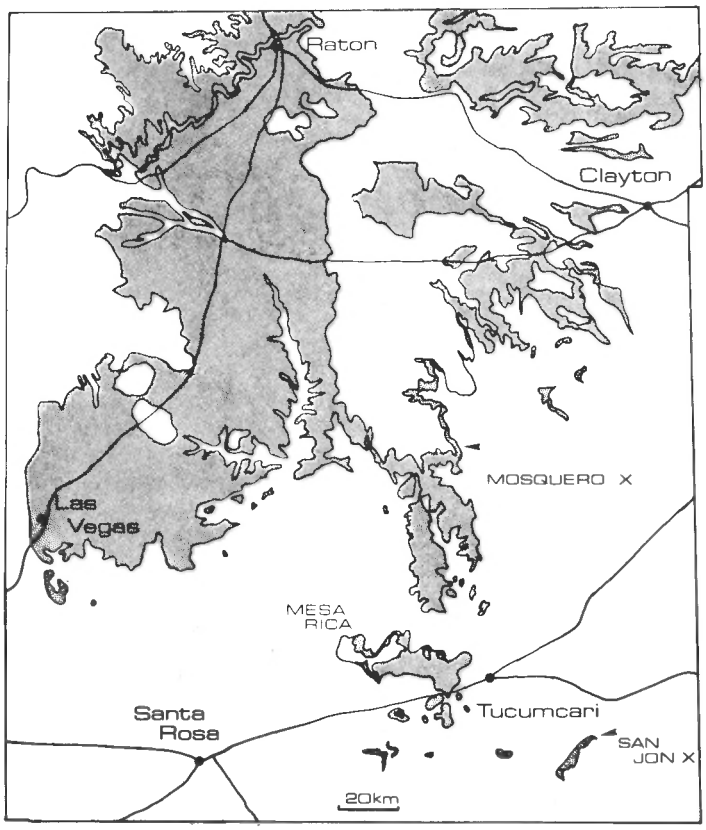

FIGURE 1. Outcrops of Cretaceous (Tucumcari Shale–Graneros Shale) rocks in northeastern New Mexico. Mosquero X and San Jon X refer to stratigraphic sections mentioned in the text. Adapted from New Mexico Geological Society (1982).

PURGATOIRE GROUP

The Purgatoire Group lies along the western part of the southern High Plains of Colorado, with the type area in Otero County, southern Colorado, and was extended into northeastern New Mexico by Stanton (1905). Dobrovolny et al. (1946) divided this pre-Dakota Purgatoire into three members: Tucumcari Shale, Mesa Rica Sandstone and Pajarito Shale, naming the latter two in the process, but not designating stratotypes for them except for noting their prominence on Mesa Rica (Fig. 1). The Tucumcari Shale was defined by Cummins (1892) for the Tucumcari Mountain section. In proposing these members, Dobrovolny et al. reduced the Purgatoire from a group to a formation. Griggs and Read (1959) rejected this classification since it based the formation on age rather than mappability (or lithology); they proposed formational status for Dobrovolny's et al. members and raised the Purgatoire to a group.

Since it will be argued that the Mesa Rica Sandstone, the Pajarito Shale and the Dakota are homotaxial (Fig. 2), these units cannot belong to the Purgatoire Group (since by definition this is a pre-Dakota unit). Scott (1970) correlated the Tucumcari Shale with the Glencairn Member of the Purgatoire Formation (thereby rejecting Griggs and Read's classification) of southern Colorado, but, since the name Tucumcari Shale has precedence over the Glencairn Member (Cummins, 1892, versus Findlay, 1916), a case could be made for extending the Tucumcari Shale into Colorado. However, it is more practical to retain the local names for the Tucumcari basin only.

TUCUMCARI SHALE

This unit is the basal member of the Purgatoire Formation (using current definitions) and represents the initial Cretaceous transgression of the sea from the southeast (Texas and the Gulf of Mexico) during the late Albian (T5: Kauffman, 1979). It overlies the Jurassic Morrison Formation with an unconformity marked by a thin conglomerate in the Tucumcari Shale, which represents a large part of the Early Cretaceous. The rich fauna in this shale is characteristic of the late Albian (Duck Creek) of Texas and includes *Texigryphaea tucumcarii*, *Trigonia* sp., *Protocardia texana* and *Mortoniceras* (= *Pervinquieria*) *equidistans* (Table 1). The characteristic lithology is a dark-gray shale interbedded with thin sandstone bands with a thick, bioturbated, fossiliferous, coarse sandstone at the top (about 3 m at the San Jon section) representing the maximum extent of transgression. This unit has been placed in the overlying Mesa Rica Sandstone by Griggs and Read (1959), Brand and Mattox (1972), Jacka and Brand (1972) and Gage and Asquith (1977) because of lithological similarity with the Mesa Rica, but the fauna from this sandstone is characteristic of the underlying shale, not of the barren Mesa Rica. Scott (1974) presented a detailed paleoecological analysis of this shale and determined an oscillating (but generally transgressive) sequence by identifying faunal associations of the upper, middle and lower shoreface and open bay/marine environments.

Scott (1970, fig. 2) indicated that the Tucumcari Shale is equivalent to the Kiowa Shale to the east and the Glencairn Member of the Pur-

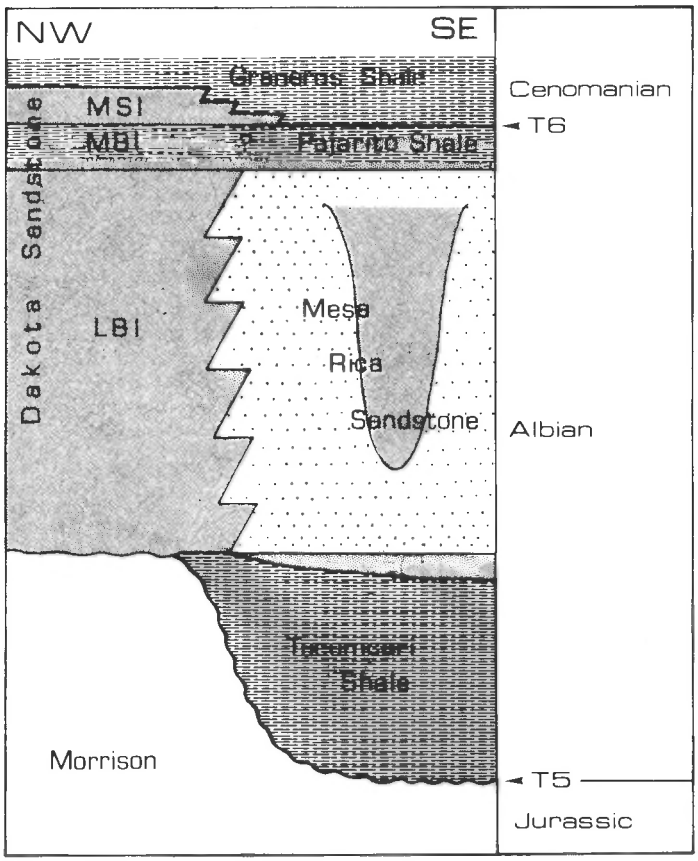

FIGURE 2. A schematic stratigraphy of the Cretaceous of northeastern New Mexico showing the proposed relations between the Morrison Formation (Jurassic), Tucumcari Shale (with upper sand bed), Dakota Sandstone (LBI = lower-braided-alluvial interval, MBI = meander-belt interval, MSI = marine-sand interval), Mesa Rica Sandstone (shoreface/delta-front facies, and channel facies) and the Graneros Shale. Transgressions T5 and T6 follow Kauffman (1979). Unit thicknesses are representative and not to scale.

gatoire Formation in southern Colorado based on the zone-fossil *Inoceramus bellvuensis*. The overlying Mesa Rica Sandstone prograded over this unit during the latest Albian as the "Tucumcari sea" regressed east and southeast, marking the end of this marine incursion (R5: Kauffman, 1979).

MESA RICA SANDSTONE

This unit is a thick, lobate sandstone body exhibiting a variety of sedimentary structures clearly associated with a deltaic system. Fossils are not known except for an ichnofauna of *Rhizocorallium* and *Ophiomorpha*. Detailed sedimentological analyses of the Mesa Rica by Gage and Asquith (1977) revealed that the lower part of this unit represents a lower-shoreface (delta) environment, while the upper part represents a more estuarine facies; i.e., the sequence follows a progressively shallower environment typical in a prograding-delta system. Lateral variation is apparent owing to the positioning of the various submarine channels leading from the delta. This lower unit is regarded by Scott (1970, 1974) as belonging to the Tucumcari Shale.

The Mesa Rica Sandstone is a local stratigraphic name for a sand body thought for a long time to have been restricted to the Tucumcari basin and with uncertain temporal equivalents outside the basin. Bullard (1928), Mankin (1958), Brand and Mattox (1972) and Jacka and Brand (1972) believe that this unit is equivalent to the Cheyenne Sandstone, and thus is older than the Dakota Sandstone, based on apparent lithological similarity and rather tenuous direct correlation. However, since the Tucumcari Shale is equivalent to the Kiowa, which overlies the Cheyenne, the Mesa Rica, overlying the Tucumcari, cannot be equivalent to the Cheyenne. Scott (1970) and, though more cautiously, Gage and Asquith (1977) suggest that the Mesa Rica is correlative with the Dakota Sandstone, particularly with the lower-braided-alluvial interval, which commonly occurs farther to the north and northwest. This correlation is based on the general pattern of the fluvio-deltaic system of the Dakota and Mesa Rica Sandstones (using isopach and current direction patterns as well as general lithological resemblance). As Scott (1970) points out, the Graneros Shale overlies both units, which indicates that either they are homotaxial, or the Dakota pinches out in the Tucumcari basin and there is no Mesa Rica equivalent outside of the basin.

TABLE 1. A faunal list of the Tucumcari Shale. From Brand and Mattox (1972) and Scott (1970, 1974).

Arctica sp.	Inoceramus bellvuensis
Botula sp.	Lingula subspatulata
Breviarca angulata	Lima sp.
Breviarca subovata	Lopha quadriplicata
Breviarca habita	Mortoniceras equidistans
Caprina sp.	Neithea occidentalis
Cliona sp.	Neocrassina semicostata
Corbula crassicostata	Ostrea subovata
Corbula smolanensis	Oxytropidoceridae
Cragnities (aff. serratescens)	Pecten sp.
Crassatellina oblonga	Pinna comancheana
Cribratina texana	Plicatula sp.
Cyrimeria sp.	Protocardia multistriata
Drepanochilus sp.	Protocardia texanii
Eopachydiscus cf. laevicaniculatum	Scabritrigonia emoryi
Exogyra texana	Serpula sp.
Flaventia sp.	Syncyclonema inconspicus
Gryphea corrugata	Tapes belviderensis
Gryphea tucumcarii	Turritella seriatum
Gryphea marcoui	Unio sp.

PAJARITO SHALE

The Pajarito Shale overlies the Mesa Rica conformably and consists of a relatively thin sequence of light-gray shale and frequent interbedded sandstone. Plant debris and woody fragments are quite common, but the only recorded fossil is *Lopha quadriplicata* (Dobrovolny et al, 1946), although no specimens or published illustrations are known to me. This taxon does indicate at least a Duck Creek (late Albian) age for the Pajarito Shale, thus negating correlation with the Cheyenne Sandstone. Gage and Asquith (1977) indicate that the Mesa Rica and the Pajarito show lateral interfingering, the latter representing a delta-plain facies resembling the meander-belt member of the Dakota Sandstone. The Pajarito Shale grades into the Graneros Shale (see Dobrovolny et al., 1946: sec. 34, T8N, R32E, and stratigraphic section 10).

DAKOTA SANDSTONE

Following Jacka and Brand (1972) and Gilbert and Asquith (1976), the Dakota Sandstone is clearly divisible into three units: lower-braided-alluvial interval, meander-belt interval and marine-sand interval. The Dakota is normally mapped in the northern and northwestern parts of northeastern New Mexico where these three units can be traced with little difficulty (from Las Vegas to Clayton). The prominent non-marine lower-braided-alluvial interval is typically composed of a thick sequence of trough crossbedded sandstone (0.1–0.5 m thick) and conglomeratic beds (especially in the northwest) generally trending east or southeast and representing a braided-alluvial plain leading to the Mesa Rica delta(s) (Gage and Asquith, 1977). No fossils are known from this Dakota interval except rare occurrences of the trace fossil *Planolites* (Bejnar and Lessard, 1976).

The meander-belt interval represents an interchannel delta-plain facies (Gage and Asquith, 1977), typically being a thin shale with frequently interbedded sandstones of minor distributary channels exhibiting trough crossbedding and occasional ripple marks. Plant debris and palynomorphs are abundant in the shaley horizons, and root casts and dinosaur footprints are noted from the sandstones. The dinosaur footprints have been found near Fort Union, north of Las Vegas (Bejnar and Lessard, 1976) and at Clayton Lake, although the exact stratigraphic position of these finds is uncertain. What appears to be a bounce trace of an ammonite was recently found in a shale in this unit at the Mosquero section, which may throw some doubt on the interpretation of its facies, but this item is regarded as exceptional for the time being.

The uppermost unit of the Dakota, the marine-sand interval, represents a transgressive-shoreline sand (T6: Kauffman, 1979) on the delta-plain facies and contains a rich littoral/sublittoral ichnofauna of *Ophiomorpha, Skolithos, Arenicolites, Rhizocorallium, Planoides, Thalassinoides,* and *Corophinoides* (Bejnar and Lessard, 1976; Gage and Asquith, 1977). Wood-fragment casts and other plant debris are occasionally found in this unit.

RELATIONSHIPS OF THE CRETACEOUS STRATA

The Tucumcari Shale is clearly the oldest Cretaceous unit in this region, representing the initial marine transgression into this region during the late Albian. The relationship between the overlying Mesa Rica Sandstone and the Dakota Sandstone has tentatively been thought of during the past 15 years as homotaxial (Scott, 1970; Gilbert and Asquith, 1976; Gage and Asquith, 1977). The Bonita fault zone south of Tucumcari exposes some 85 m of Graneros Shale lying directly on the Pajarito Shale and containing a thin limestone that may be correlative with the Greenhorn Limestone (Dobrovolny et al., 1946). The Graneros overlies the Dakota Sandstone in the northernmost part of the state (Baldwin and Muehlberger, 1959) and in all other regions of the Western Interior (Gilbert and Asquith, 1976; Witzke et al., 1983). The same overlying Graneros would indicate, though does not prove, that the Dakota and Mesa Rica are homotaxial. The lower-braided-alluvial intervals of the Dakota and the Mesa Rica are, respectively, fluvial and deltaic deposits showing conforming patterns of current directions, and are thus thought to be stratigraphically equivalent (Gilbert and Asquith, 1976). Furthermore, since the Mesa Rica Sandstone is deltaic, there must be a feeder fluvial system supplying the sediment, and the Dakota Sandstone clearly acts as a sediment source. There is no other fluvial-sand body between the Jurassic Morrison and the Dakota. The mapped lateral facies transition between the Mesa Rica and the Dakota has not been defined clearly other than along a broad arc running around the northern rim of the Tucumcari basin (Gilbert and Asquith, 1976, fig. 17). Mesa Rica to the northwest of Tucumcari is probably a critical area, although the nature of such a transition would be gradational and thus difficult to identify.

The nature of the Mesa Rica–Dakota (lower-braided-alluvial interval) fluvio-deltaic system is shown in Figure 3 using published stratigraphic sections. Since there is a degree of variation between the interpretation of authors on the measurements of these sections, I have tried to remeasure them myself, although I have not been able to remeasure all of these. Inevitably, there is a degree of error involved, but this should not affect the overall pattern too greatly. The pattern that emerges is of a fluvially dominated delta with a major channel running east and another running south and southeast, with distributary channels leading from the latter. There appears to be an additional channel in the Las Vegas area. The Mesa Rica Sandstone occupies the delta-front and submarine-channel facies, whereas the lower-braided-alluvial interval occupies the delta-plain channel. Baltz (1965) and Jacka and Brand (1972) indicated that the provenance of the delta sediments was from the San Luis and Apishapa uplifts in what is now southern Colorado and north-central New Mexico, a model confirmed by Gilbert and Asquith (1976). Because of the prograding nature of the delta, the Pajarito and the meander-belt interval of the Dakota eventually covered the channel and delta-front facies. The marine-sand interval of the Dakota appears to have no equivalent in the Tucumcari basin.

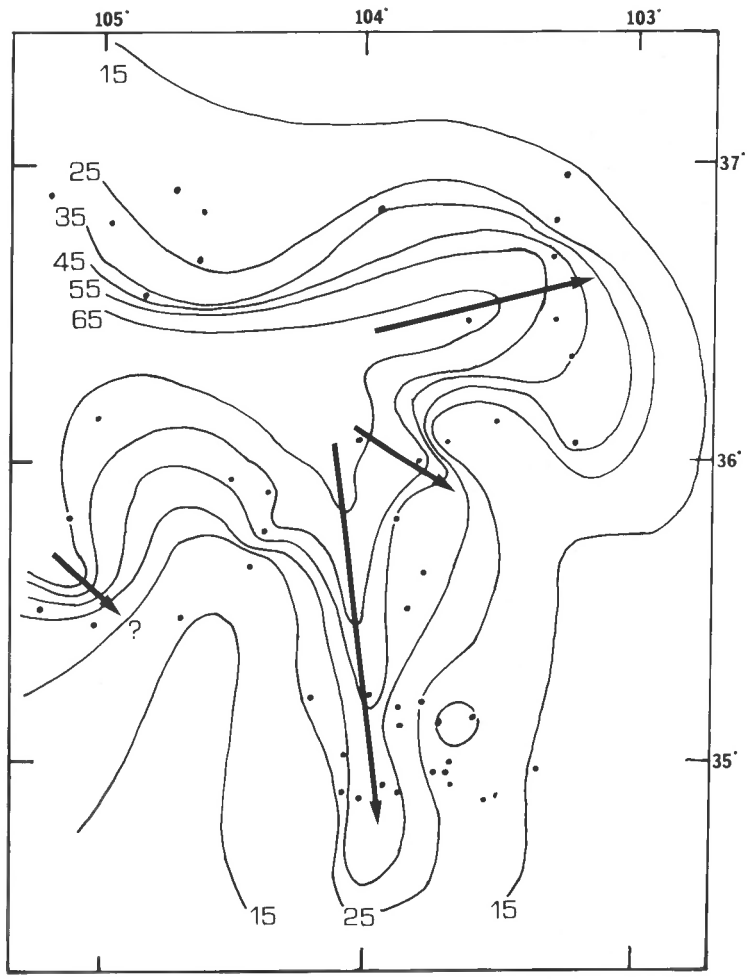

FIGURE 3. Isopach map of the lower-braided-alluvial interval of the Dakota Sandstone and the Mesa Rica Sandstone in northeastern New Mexico showing delta lobes. Arrows indicate possible channels (thicknesses in m). Data from sections in Baldwin and Muehlberger (1959), Dobrovolny et al. (1946), Gage and Asquith (1977), Gilbert and Asquith (1976), Mankin (1958) and Scott (1970).

Wanek (1962) preferred to use the name Mesa Rica for both the Mesa Rica and the lower-braided interval of the Dakota, at least in the area he mapped to the northwest of Tucumcari, and reserved the name Dakota in this region for what is here regarded as the marine-sand interval. This agrees with the idea presented here of equivalency of the Mesa Rica and Dakota as defined in this paper, but Wanek's definitions do raise the question of what is the Dakota in northeastern New Mexico in relation to other areas, particularly Colorado. Clearly, the transgressive (T6: Kauffman, 1979) nature of the marine-sand interval is characteristic of the Dakota in other parts of the Western Interior, while the underlying fluvio-deltaic complex of the lower-braided interval–Mesa Rica is related to the regression of the Aptian seaway (T5: Kauffman, 1979). The correlation of the Dakota outside New Mexico is, however, beyond the scope of this paper.

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REFERENCES

Baldwin, B. and Muehlberger, W. R., 1959, Geological studies of Union County, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 63, 171 pp.

Baltz, E. H., 1965, Stratigraphy and history of the Raton Basin, and notes on

the San Luis Basin, Colorado–New Mexico: American Association of Petroleum Geologists, Bulletin, v. 49, pp. 2041–2075.

Bejnar, D. C. and Lessard, R. H., 1976, Paleocurrents and depositional environments of the Dakota Group, San Miguel and Mora Counties, New Mexico: New Mexico Geological Society, Guidebook 27, pp. 157–163.

Brand, J. P. and Mattox, R. B., 1972, Pre-Dakota Cretaceous formations of northwestern Texas and northeastern New Mexico: New Mexico Geological Society, Guidebook 27, pp. 98–104.

Bullard, F. M., 1928, Lower Cretaceous of western Oklahoma, a study of the outlying areas of Lower Cretaceous in Oklahoma and adjacent states: Oklahoma Geological Survey, Bulletin 47, 116 pp.

Cobban, W. A., 1985, The Lower Cretaceous ammonite *Schloenbachia loensis* Conrad var. *equidistans* Cragin: U.S. Geological Survey, Bulletin 1641-A, 4 pp.

Cobban, W. A. and Reeside, J. B., Jr., 1952, Correlation of the Cretaceous formations of the United States: Geological Society of America, Bulletin, v. 63, pp. 1011–1045.

Cummins, W. F., 1892, Report on the geography, topography, and geology of the Llano Estacado or Staked Plains and notes on the country west of the plains: Texas Geological Survey, Third Annual Report, pp. 127–223.

Dobrovolny, E., Bates, R. L. and Summerson, C. H., 1946, Geology of northwestern Quay County, New Mexico: U.S. Geological Survey, Oil and Gas Investigations, Map OM-62 (2 sheets).

Findlay, G. L., 1916, Description of the Colorado Springs Quadrangle, Colorado: U.S. Geological Survey, Atlas, Folio 203, 17 pp.

Gage, J. P. and Asquith, G. B., 1977, Sedimentology of Mesa Rica Sandstone in Tucumcari basin, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Circular 157, 14 pp.

Gilbert, J. L. and Asquith, G. B., 1976, Sedimentology of braided alluvial interval of Dakota Sandstone, north-eastern New Mexico: New Mexico Bureau of Mines and Mineral Resources, Circular 150, 16 pp.

Griggs, R. L. and Read, C. G., 1959, Revisions in stratigraphic nomenclature in Tucumcari–Sabinoso area, northeastern New Mexico: American Association of Petroleum Geologists, Bulletin, v. 43, pp. 2003–2007.

Jacka, A. D. and Brand, J. P., 1972, An analysis of Dakota Sandstone in the vicinity of Las Vegas, New Mexico, and eastward to the Canadian River valley: New Mexico Geological Society, Guidebook 27, pp. 105–107.

Kauffman, E. G., 1979, Cretaceous; *in* Treatise on Invertebrate Paleontology, Introduction (Part A), pp. A418–A487.

Mankin, C. J., 1958, Stratigraphy and sedimentary petrology of Jurassic and pre-Graneros Cretaceous rocks, northeastern New Mexico [Ph.D. thesis]: Austin, University of Texas, 231 pp.

New Mexico Geological Society, 1982, New Mexico geological highway map.

Scott, R. W., 1970, Stratigraphy and sedimentary environments of Lower Cretaceous rocks, southern Western Interior: American Association of Petroleum Geologists, Bulletin, v. 54, pp. 1225–1244.

Scott, R. W., 1974, Bay and shoreface benthic communities in the Lower Cretaceous: Lethaia, v. 7, pp. 315–330.

Stanton, T. W., 1905, The Morrison Formation and its relations with the Comanche Series and Dakota Formation: Journal of Geology, v. 13, pp. 657–669.

Stovall, J. W., 1943, Stratigraphy of the Cimarron Valley (Mesozoic rocks); *in* Schoff, S. L., ed., Geology and groundwater resources of Cimarron County, Oklahoma: Oklahoma Geological Survey, Bulletin 64, pp. 43–100.

Wanek, A. E., 1962, Reconnaissance geologic map of parts of Harding, San Miguel, and Mora Counties, New Mexico: U.S. Geological Survey, Oil and Gas Investigations, Map OM-208 (1 sheet).

Witzke, B. J., Ludvigson, G. A., Poppe, J. R. and Raven, R. L., 1983, Cretaceous paleogeography along the eastern margin of the Western Interior seaway, Iowa, southern Minnesota, and eastern Nebraska and South Dakota; *in* Mesozoic paleogeography of the west-central United States: Denver, S.E.P.M., Rocky Mountain Section, pp. 225–254.