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STRATIGRAPHIC RELATIONSHIPS AT THE JURASSIC–CRETACEOUS BOUNDARY IN EAST-CENTRAL NEW MEXICO

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Abstract—This paper addresses stratigraphic relationships at the Jurassic-Cretaceous boundary in the Tucumcari basin of east-central New Mexico. Where the Albian Tucumcari Shale (marine) overlies nonmarine units of the Jurassic Morrison Formation, the Jurassic-Cretaceous boundary is easily located. However, this contact becomes confused as Tucumcari shales lap out against the unconformity surface toward the north (paleo-landward), and are replaced by marginal marine and fluvial rocks of the Albian Mesa Rica Sandstone. We suggest that uppermost fluvial Morrison sandstones (Jackpile equivalents?) have erroneously been included within the Cretaceous Mesa Rica section. The Jurassic sandstones may be properly distinguished from the Mesa Rica by differences in lateral continuity, stratigraphic position, sandstone texture and mineralogy.

In addition to previously described stratigraphic units in the area, we recognize and informally name the Campana sandstone bed of the Tucumcari Shale. The Campana sandstone bed occupies a stratigraphic position between the Morrison unconformity surface and the overlying Albian marine transgressive surface, and occurs in discontinuous local exposures. This bed represents fluvial aggradation and estuarine inundation associated with base-level rise of the Tucumcari sea. Preservation of the Campana sandstone bed appears to be restricted to paleotopographic lows on the post-Jurassic depositional surface, where as much as two m of relief have thus far been documented. The most likely stratigraphic equivalent to the Campana sandstone bed is the basal sandstone of the Glencairn Formation in northeastern New Mexico.

INTRODUCTION

Recent field study in the Tucumcari basin and Bravo dome area of east-central New Mexico (Fig. 1) has revealed new observations concerning both the placement of the Jurassic-Cretaceous boundary in the area and the response of coastal sedimentation patterns to the incipient late Albian transgression. Our work suggests the "basal white sandstone," considered by Trauger et al. (1972) to be the basal unit of the Albian Mesa Rica Sandstone, is actually a series of widespread, but discontinuous, fluvial sandstones more properly belonging to the underlying Jurassic Morrison Formation (Jackpile equivalent?). In addition, we note the presence of a previously unrecognized unit that documents aggradation and infilling of topographic lows developed on the Morrison surface prior to marine inundation of the area during the Albian Tucumcari transgression. We consider this unit to be a basal sandstone bed of the Tucumcari Shale, here informally referred to as the Campana sandstone bed. Ongoing field documentation may justify its formal naming.

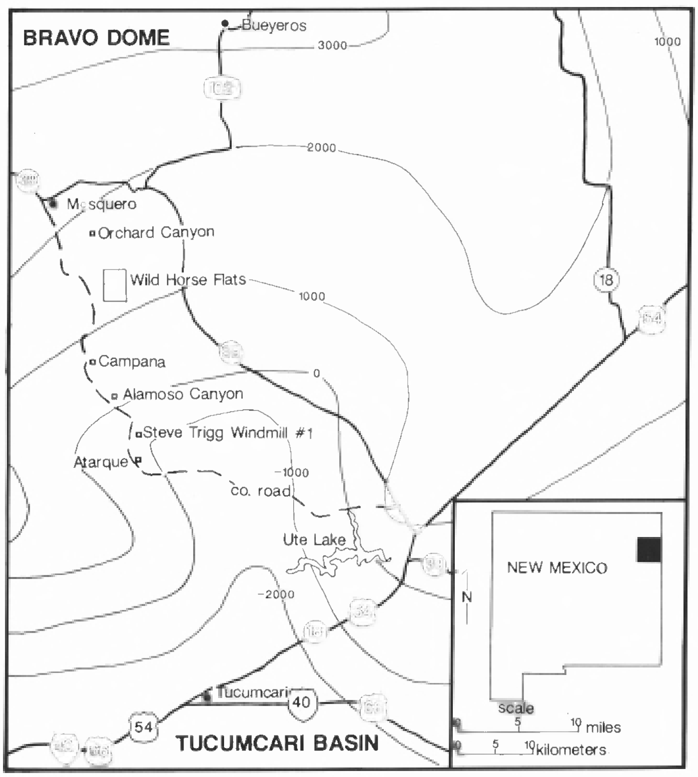

FIGURE 1. Location map of the study area including Precambrian basement structure contours of Suleiman and Keller (1985). Contour interval = 1,000 ft.

The Lower Cretaceous section in the study area consists, in ascending stratigraphic order, of the Tucumcari Shale, the Mesa Rica Sandstone and the Pajarito Formation, which were earlier recognized as members of the Purgatoire Formation (Dobrovolny et al., 1946). Our stratigraphic nomenclature follows that of Griggs and Read (1959), who elevated these members to formational rank and abandoned use of the term Purgatoire Formation in northern New Mexico. Previous workers (Brand and Mattox, 1972; Gage and Asquith, 1977; Kisucky, 1987) demonstrated these units to be components of a fluvial-dominated deltaic system in which the Tucumcari Shale is prodeltaic, the Mesa Rica represents distal bar, distributary-mouth bar and distributary-channel belts, and the Pajarito records deposition on the delta plain. Throughout the area, either the Tucumcari Shale or the Mesa Rica Sandstone lies in unconformable contact on the Jurassic Morrison Formation. We believe the placement of this contact has been locally misinterpreted in east-central New Mexico, particularly where Morrison fluvial sandstones are directly overlain by Mesa Rica sandstones.

POSITION OF THE JURASSIC-CRETACEOUS BOUNDARY

In the vicinity of Atarque (Fig. 1), the Tucumcari Shale thins to a discontinuous pinchout (Fig. 2) marked landward by bioturbated sandstone (Trauger et al., 1972). Kisucky (1987) noted coincidence of this pinchout with basement structural features that define the boundary of the Tucumcari basin proper. Where present in the section, the Tucumcari Shale allows reliable placement of the Jurassic-Cretaceous boundary; however, this boundary becomes more subtle toward the north (paleo-landward) as the Tucumcari pinches out and the overlying Mesa Rica Sandstone changes from marine to fluvial.

Trauger et al. (1972) recognized a "basal white sandstone" of the Mesa Rica at Atarque that was separated from underlying white Morrison sandstones by the bioturbated Tucumcari surface; and Trauger et

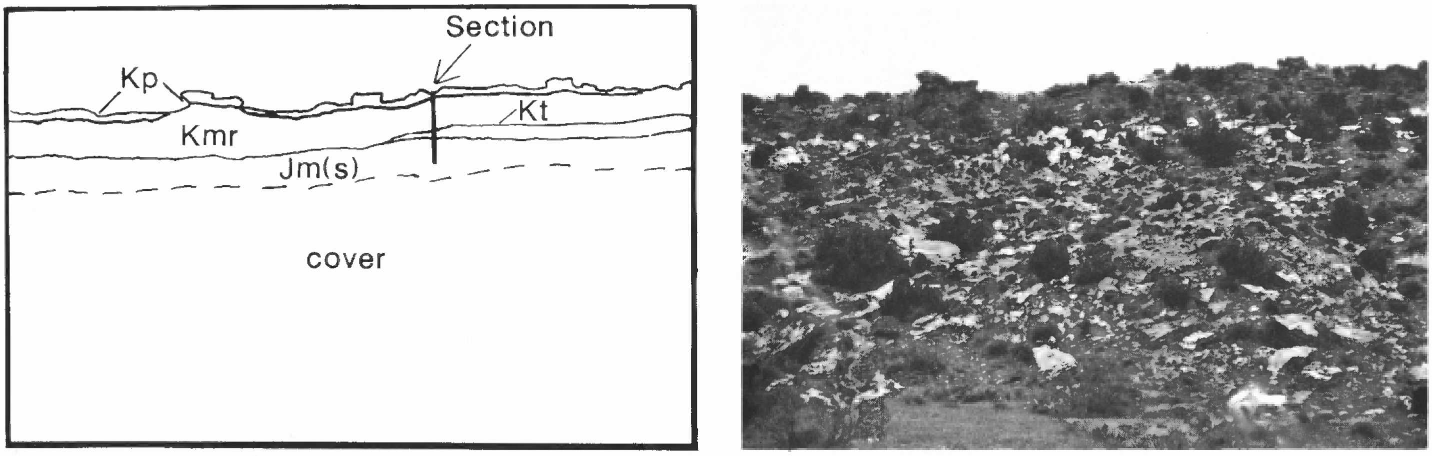

FIGURE 2. Photograph showing pinchout of the Tucumcari Shale (Kt) at Atarque. Other formations pictured include the Pajarito Formation (Kp), Mesa Rica Sandstone (Kmr) and Morrison Formation (sandstone) (Jm(s)).

al. (1972) cautioned about local confusion of these two "white" sandstones. Our field work suggests that the two have been consistently confused in exposures lacking a clear Tucumcari Shale surface, even by the above authors and initially by ourselves. We now believe that most of the exposures of "basal white sandstone" described by Trauger et al. (1972) to the north of Atarque are, in fact, Morrison fluvial sandstones. White-weathering Morrison sandstone can be distinguished from the Mesa Rica by: (1) detailed landward correlation of the "Tucumcari" transgressive surface beyond the landward limits of shale deposition, (2) recognition at the top of the Morrison Formation of discontinuous sandstones interfingering with green mudrocks; and (3) petrologic differences between the dominantly feldspathic Morrison sandstones and the quartz-rich Mesa Rica sandstones.

The Tucumcari Shale and its equivalent landward-transgressive surface continue to mark the Jurassic-Cretaceous boundary in exposures north of the main shale pinchout at Atarque. Laterally discontinuous deposits of Albian marine shale that occur at Alamoso Canyon and Bueyeros (Fig. 1) are considered to be equivalent to the Tucumcari Shale at Atarque. Microfossil analysis (Table 1) of these discontinuous shales indicates marginal marine to open marine deposition.

The Bueyeros sample is interpreted to be a Tucumcari assemblage due primarily to the presence of *Trochammina* cf. *T. depressa*, *Haplophragmoides* sp., *Reophax* sp., *Verinuiloides* sp. and *Ammobaculites* sp., which typically occur in the nearshore Tucumcari Shale and Glencairn Formation to the north. The Alamoso Canyon sample contains a marine fauna, including the diagnostic *Trochammina* cf. *T. depressa;* however, the freshwater forms *Cypridea* (*?Cypridea*) sp. and *?Trapezoidella* sp. are also observed, suggesting a nearshore, mixed to brackish water environment. Presence of these Tucumcari Shale equivalents between the "basal white sandstone" and the overlying brown Mesa Rica sandstones at Bueyeros and Alamoso Canyon suggests that the "basal white sandstone" at these locations predates Albian transgression and belongs stratigraphically to the Morrison Formation.

TABLE 1. Microfossil data (see Fig. 1 for site locations).

Near Bueyeros NW 1/4, SW 1/4, sec. 7 T. 21 N, R. 32 E		Alamoso Canyon, Pablo Montoya Grant, Lat. 35, 32' 10" N Long. 103, 50' 50" E	
SPECIES	# of specimens	SPECIES	# of specimens
Haplophragmoides sp.	7	Trochammina cf T. depressa	17
Reophax sp.	1	? Ammobaculites sp.	6
? Verinuiloides sp.	1	Cypridea (? Cyridea) sp.	1
Ammobaculites sp.	1	? Trapezoidella sp.	1
Trochammina cf. T. depressa	1	Unidentified Ostracoda types 1, 2, and 3	22

We have traced the Tucumcari Shale northward into the landward-equivalent transgressive surface that separates Morrison fluvial sandstones and shales from overlying Mesa Rica marine sandstones. Northwest of Wild Horse Flats (Fig. 1), the transgressive surface is no longer identifiable; instead, fluvial Mesa Rica channels cut into the Morrison deposits. Where Cretaceous fluvial deposits are superimposed on Jurassic fluvial deposits (as occurs in excellent exposures of brown-over-white sandstones at Orchard Canyon; Figs. 3, 4), distinction of the Jurassic-Cretaceous boundary must be based solely upon geometric and lithologic characteristics of the sandstones.

Lateral correlation in both outcrop exposures and on low altitude oblique photographs indicates the "basal white sandstone" to be discontinuous in both thickness and lateral extent. This geometry is similar to that of Morrison fluvial sandstones found lower in the Jurassic section; however, the relationship tends to be obscured by blocky slope cover derived from the overlying Mesa Rica Sandstone. Unlike the "basal white sandstone," brown Mesa Rica sandstones occur as a pervasive sheet with minor local variation in thickness. Figure 3 illustrates the difference in geometry between these two units; note especially the presence of Morrison mudrock between the two at the Campana section. Although only locally observed, this again suggests that the "basal white sandstone" properly belongs within the Jurassic Morrison Formation, rather than the Cretaceous Mesa Rica.

A final line of field evidence that helps distinguish the two sandstones is their mineralogic and textural character. Although not yet confirmed by thin-section analysis, hand-specimen and outcrop observations indicate that the Morrison sandstones (including the "basal white") are feldspathic with white, kaolinitic weathering as a common feature. Texturally, these are medium to fine grained and moderately sorted. In contrast, Mesa Rica sandstones are medium to coarse grained, well rounded, very clean quartzarenites containing local quartz-pebble conglomerates. The widespread nature of this upper Morrison Formation white sandstone invites tentative correlation with the Jackpile Member (Flesch, 1974) of the Morrison Formation in the San Juan Basin area. Further work will be necessary to confirm this relationship.

CAMPANA SANDSTONE BED OF THE TUCUMCARI SHALE

During landward correlation of the Tucumcari transgressive surface, it became apparent that a previously unrecognized sandstone is locally present between the Morrison "white sandstone" and the overlying Tucumcari Shale or the Mesa Rica Sandstone. We informally refer to this unit as the Campana sandstone bed of the Tucumcari Shale.

Highly localized exposures of the Campana bed occur at Alamoso Canyon and at Steve Trigg Windmill #1 (Figs. 1, 3). Mineralogically, these sandstones are indistinguishable from the Mesa Rica. At Alamoso Canyon the deposit consists of quartzarenitic sandstone with a high

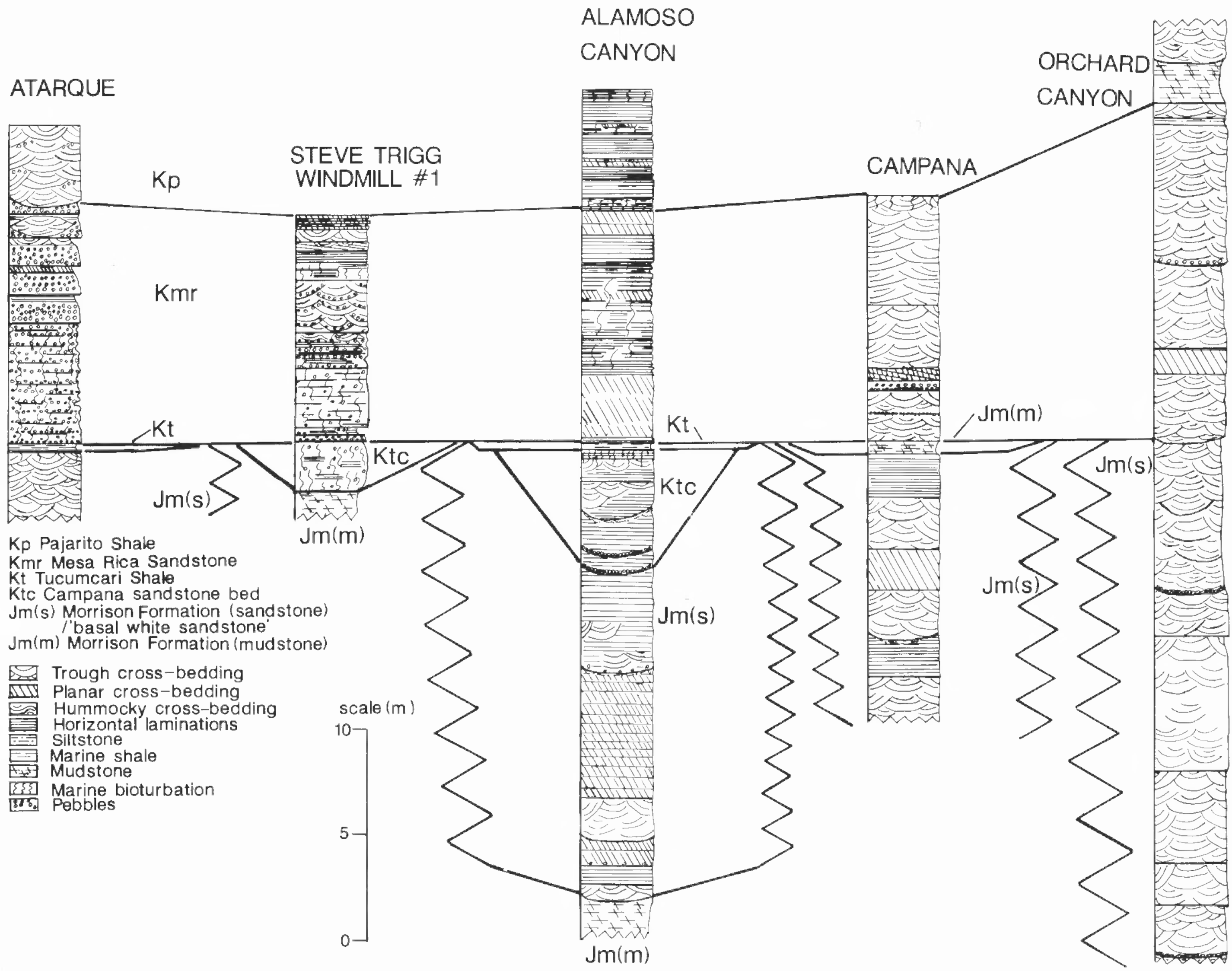

FIGURE 3. Measured sections and lateral correlation relationships in the study area (see Figure 1 for section locations).

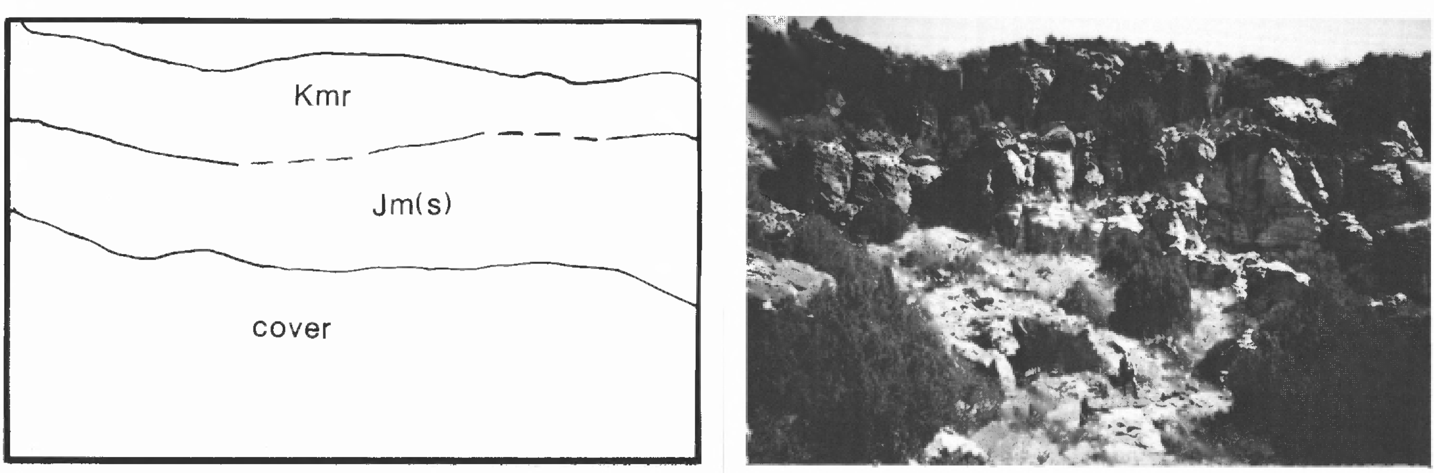

FIGURE 4. Photograph showing fluvial Mesa Rica sandstones (brown) overlying fluvial Morrison sandstones (white) in Orchard Canyon near Mosquero. Photo taken approximately 0.25 mi north of measured section at Orchard Canyon (Figs. 1, 3).

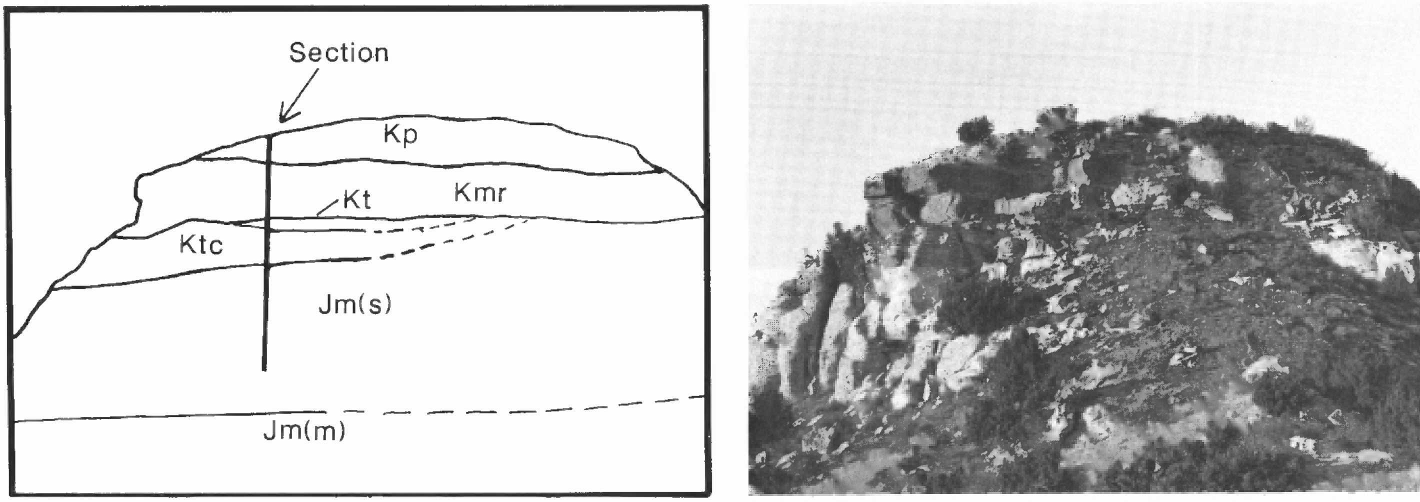

FIGURE 5. Photograph at Alamoso Canyon section showing Campana bed of the Tucumcari Shale (Ktc) within channel scour on Morrison sandstone (Jm(s)) and underneath Mesa Rica Sandstone (Kmr). Abbreviations as in Figure 3.

quartz-pebble content; it erosively overlies feldspathic Morrison sandstones (Fig. 5). The bed underlies the thin, localized deposit of Tucumcari Shale described earlier. Internally, the unit contains scour surfaces overlain by thin pebble conglomerates and trough-crossbedded and horizontal-laminated sandstones. We interpret the Campana bed to have been deposited under fluvial aggradation conditions in response to base-level rise during inundation of the Tucumcari sea. Intense bioturbation occurs at the top of this unit, near the contact with the Tucumcari Shale, indicating increasing marine influence during the final stages of channel backfilling.

At Steve Trigg Windmill #1, the Campana bed is a quartzarenite with low pebble content and intense bioturbation. Physical sedimentary structures are almost entirely obliterated by bioturbation, indicating considerable marine influence and/or slow sedimentation rates during deposition. Here, the sandstones clearly onlap a paleo-topographic low on the Morrison, and they are overlain by a surface directly correlated into the Tucumcari Shale pinchout at Atarque. The Tucumcari Shale is not present at this section, and the Campana bed is separated from the overlying marine Mesa Rica Sandstone by this transgressive surface. We interpret the Campana bed at this location to have been deposited under estuarine conditions, as a local topographic low (maximum relief approximately two m) as the Jurassic surface was inundated by the rising Albian sea.

Genetically, the Campana sandstone bed of the Tucumcari Shale is very similar to the Mesa Rica Sandstone in that both were deposited along the margin of the Tucumcari sea, and both were receiving similar sediment input. The Campana bed was deposited as fluvial and marginal marine systems aggraded in response to a relative rise in sea level, in a fashion similar to that postulated by Weimer (1984) for related Western Interior Cretaceous deposits. The Mesa Rica prograded seaward into the Tucumcari basin in response to subsequent relative sea-level fall. The sandstones are typically separated from one another by a thin tongue of Tucumcari Shale; however, this relationship ceases to exist in the landward direction where the Campana sandstone bed and the Mesa Rica Sandstone merge.

Preservation of the Campana sandstone bed appears restricted to local paleo-topographic lows on the Morrison surface. We expect that continued field work will reveal more occurrences of this basal bed and will further highlight the character of topographic relief on the post-Jurassic land surface.

A probable stratigraphic equivalent to the Campana bed is the basal sandstone member of the Glencairn Formation of northern Union County, New Mexico, which is believed (Long, 1966) to have originated at approximately the same time, under similar rising base-level conditions. Because the Campana bed lies between the Jurassic Morrison Formation and Albian Mesa Rica Sandstone, the Lytle Sandstone may also be considered as a potential equivalent; however, we do not support this correlation at the present time. There are no data at present to suggest that highly localized fluvial and estuarine sandstones of the Campana bed were related to the extensive Lytle fluvial system of southern Colorado. Neither is there evidence that Lytle deposition (Long, 1966) occurred in direct response to transgression of the Skull Creek (Tucumcari-equivalent) sea, as seems apparent for the Campana bed.

CONCLUSIONS

Results of this study have profound implications for the local position of the Jurassic-Cretaceous boundary in east-central New Mexico. We believe that Jurassic Morrison Formation sandstones (Jackpile equivalents?) have been confused in the field and in the literature with the overlying Cretaceous section. This observation has important ramifications for studies involving construction and interpretation of Lower Cretaceous isopachs that may have erroneously included these sandstones.

In addition to the previously recognized stratigraphic units in the study area, a previously unrecognized basal sandstone bed of the Tucumcari Shale is described. The Campana sandstone bed records the infilling of post-Morrison topography in response to transgression of the Tucumcari sea. As such, it provides an opportunity to document the recorded influence of base-level rise upon adjacent nonmarine and marginal marine depositional systems in east-central New Mexico.

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REFERENCES

Brand, J. P. and Mattox, R. B., 1972, Pre-Dakota Cretaceous formations of northwestern Texas and northeastern New Mexico: New Mexico Geological Society, Guidebook 23, pp. 98–104.

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

Flesch, G. A., 1974, Stratigraphy and sedimentology of the Morrison Formation (Jurassic), Ojito Springs Quadrangle, Sandoval County, New Mexico: New Mexico Geological Society, Guidebook 25, pp. 185–196.

Gage, J. E. and Asquith, G. B., 1977, Sedimentology of Mesa Rica Sandstone in the Tucumcari basin, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Circular 57, 14 pp.

Kisucky, M. J., 1987, Sedimentology, stratigraphy, and paleogeography of the Lower Cretaceous Mesa Rica delta system, Tucumcari basin, east-central New Mexico [M.S. thesis]: Albuquerque, University of New Mexico, 186 pp.

Griggs, R. L. and Read, C. B., 1959, Revisions in stratigraphic nomenclature in Tucumcari-Sabinoso area, northeastern New Mexico: American Association of Petroleum Geologists Bulletin, v. 43, pp. 2003–2004.

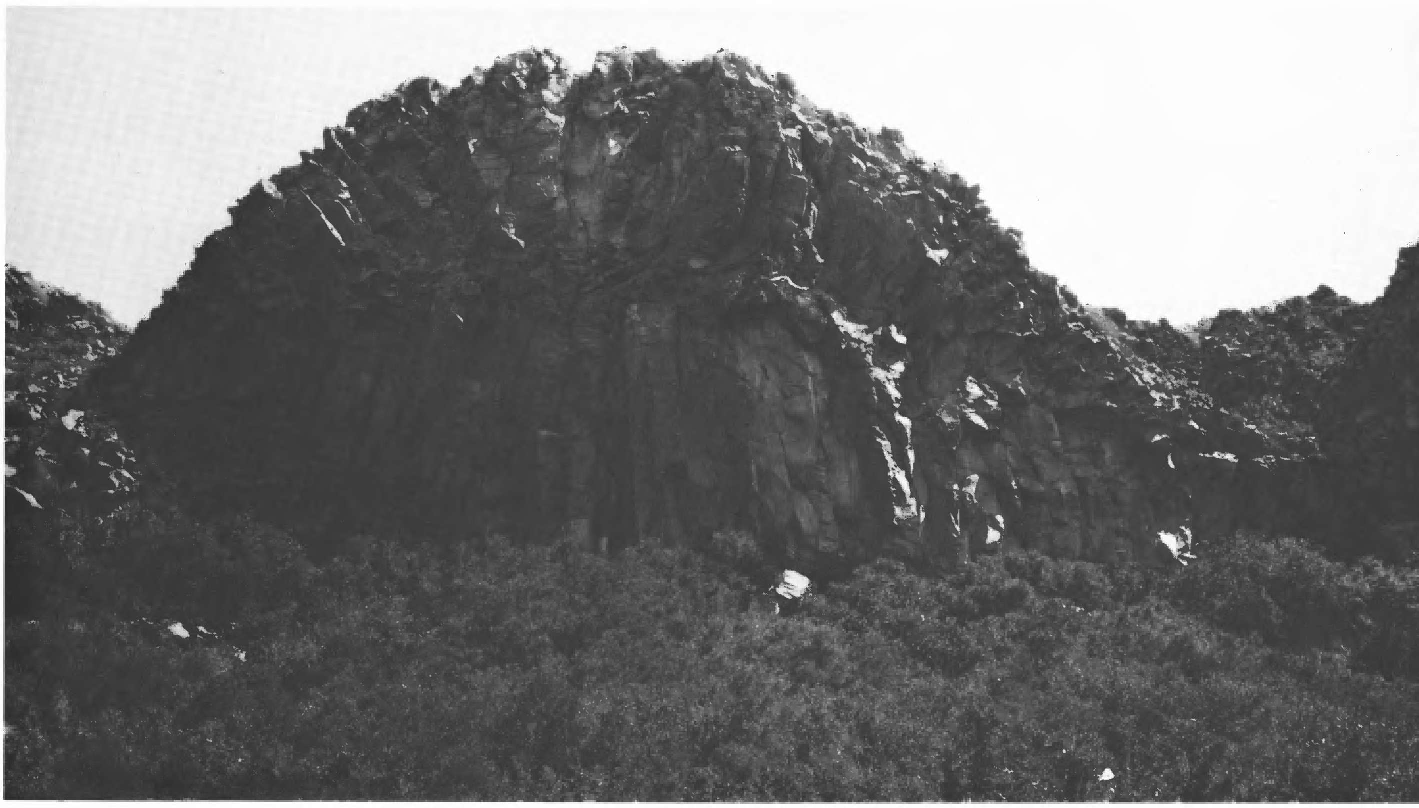
Long, C. S., 1966, Basal Cretaceous strata, southeastern Colorado [Ph.D. dissertation]: Boulder, University of Colorado, 479 pp.

Suleiman, A. S. and Keller, G. R., 1985, A geophysical study of basement structure in northeastern New Mexico: New Mexico Geological Society, Guidebook 36, pp. 153–160.

Trauger, F. D., 1972, Ground water in east-central New Mexico: New Mexico Geological Society, Guidebook 23, pp. 201–207.

Trauger, F. D., Mankin, C. J. and Brand, J. P., 1972, Road log first day: Tucumcari, Mosquero and San Jon country: New Mexico Geological Society, Guidebook 23, pp. 12–45.

Weimer, R. J., 1984, Relation of unconformities, tectonics and sea-level changes, Cretaceous of Western Interior, U.S.A.; *in* Schlee, J. S., ed., Interregional unconformities and hydrocarbon accumulation: American Association of Petroleum Geologists, Memoir 36, pp. 7–36.



Columnar basalt at west end of Johnson Mesa, Colfax County, New Mexico. Photograph by W. T. Lee circa 1900–1910, courtesy of the U.S. Geological Survey and R. Eveleth, NMBMMR.