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Donald E. Owen and Diane K. Sparks

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SURFACE TO SUBSURFACE CORRELATION OF THE INTERTONGUED DAKOTA SANDSTONE–MANCOS SHALE (UPPER CRETACEOUS) IN THE ZUNI EMBAYMENT, NEW MEXICO

DONALD E. OWEN[1] and DIANE K. SPARKS[2]
[1]Department of Geology, Lamar University, Beaumont, Texas 77710; [2]Consulting Geologist, P.O. Box 7103, Beaumont, Texas 77726

Abstract—The correlation of the intertongued Dakota Sandstone and Mancos Shale members (Upper Cretaceous) from the southwestern part of the San Juan Basin southward across the Zuni embayment is described. Members of these units are correlated into the subsurface.

INTRODUCTION

This paper describes the correlation of the intertongued Dakota Sandstone and Mancos Shale members (Upper Cretaceous) from the southwestern part of the San Juan Basin southward across the Zuni embayment (Fig. 1). Both measured sections and well logs were used for correlation.

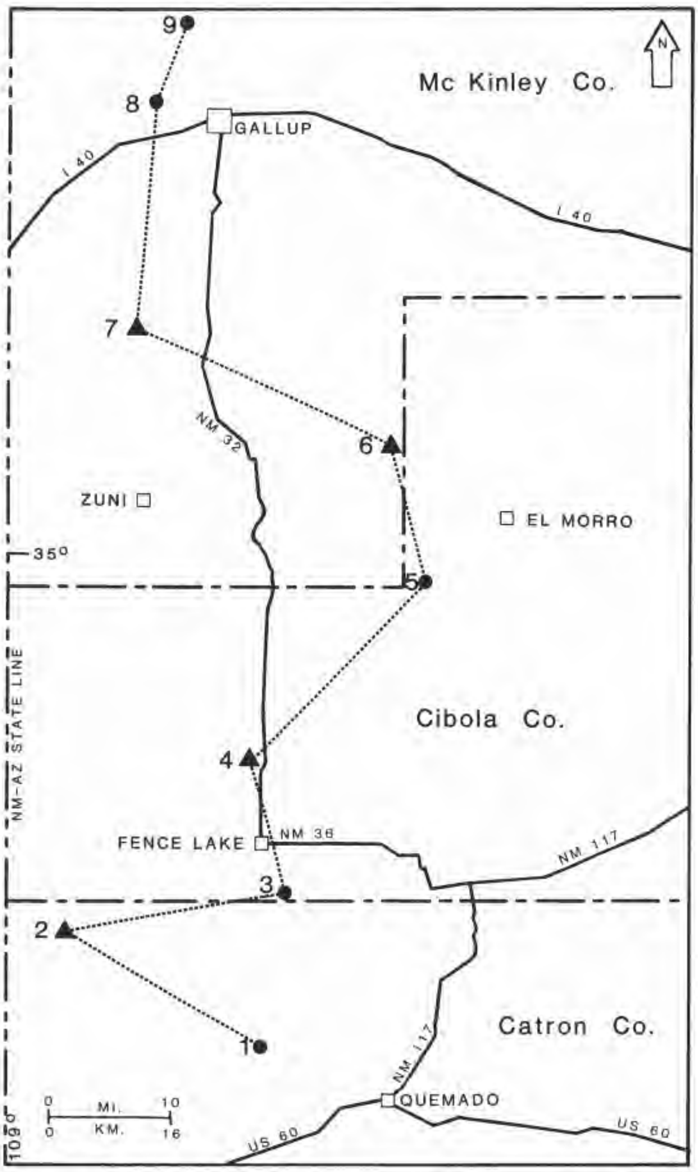

FIGURE 1. Location map of study area in western New Mexico. Line of cross section 1-9 (Fig. 2) indicated by dotted line. Numbers indicate localities of measured sections (triangles) and wells (cricles). See Table 1 for location data and names.

A stratigraphic cross section (Fig. 2; Table 1) parallels part of the route of the 1989 New Mexico Geological Society Field Conference from near Gallup to near Quemado. Although the stratigraphy described in this paper is established on the surface, there has been little correlation of members into the subsurface. The main purpose of this paper is to demonstrate such correlation. The Zuni embayment is ideal for such a demonstration because wells have been drilled and logged in areas between Dakota-Mancos outcrops. Structure is the primary factor in controlling depth of the Dakota; surface relief is a secondary factor in determining where the Dakota is present.

STRATIGRAPHY

Stratigraphic nomenclature used in this paper is derived from San Juan Basin usage, mainly as described by Landis et al. (1973). Units recognized from top to bottom include the Mancos Shale, lower part (northern part of cross section) or Rio Salado Tongue (Hook et al., 1983, p. 24–27) (southern part of cross section) of the Mancos Shale, the Twowells Sandstone Tongue of the Dakota Sandstone, the Whitewater Arroyo Shale Tongue of the Mancos Shale, the Paguate Sandstone Tongue of the Dakota Sandstone, the Clay Mesa Shale Tongue of the Mancos Shale and the Dakota Sandstone, main body. The stratotypes of the Twowells Sandstone and Whitewater Arroyo Shale tongues (Owen, 1966) are located in the Zuni embayment (Fig. 2, at locality 7). The Mancos Shale, lower part includes the Greenhorn beds approximately 30 ft above the top of the Twowells. In the Zuni embayment, the Greenhorn consists of calcareous shale and calcarenite rather than limestone, and it is recognized mainly by fauna on outcrops and by a resistive zone on well logs. We prefer the name Greenhorn over Bridge Creek because the Greenhorn was first extended into the San Juan Basin area

TABLE 1. Location of wells and measured sections used in cross section (Fig. 2). Numbers refer to localities on index map (Fig. 1) and cross section (Fig. 2).

Locality	Location	Name
1.	12-02N-18W Catron Co.	Transocean No. 1 State-2111 TD 4275 ft.
2.	20-04N-20W & vicinity Catron Co.	Twentytwo Spring (Anderson, 1982)
3.	08-04N-17W Cibola Co.	Tiger No. 1 State-8 (Unit H) TD 4491 ft.
4.	12 & 13-06N-18W Cibola Co.	Mesita de Yeso (near Atarque)
5.	32-09N-15W Cibola Co.	Eidal No. 1 State 32 M TD 3110 ft.
6.	01-10N-16W Mc Kinley Co.	Ramah
7.	17-12N-19W Mc Kinley Co.	Two Wells (Owen, 1966)
8.	10-15N-19W Mc Kinley Co.	National No. 1 Gamerco TD 1919 ft.
9.	07-16N-18W Mc Kinley Co.	J. B. Tanner No. 1 Tanner TD 3158 ft.

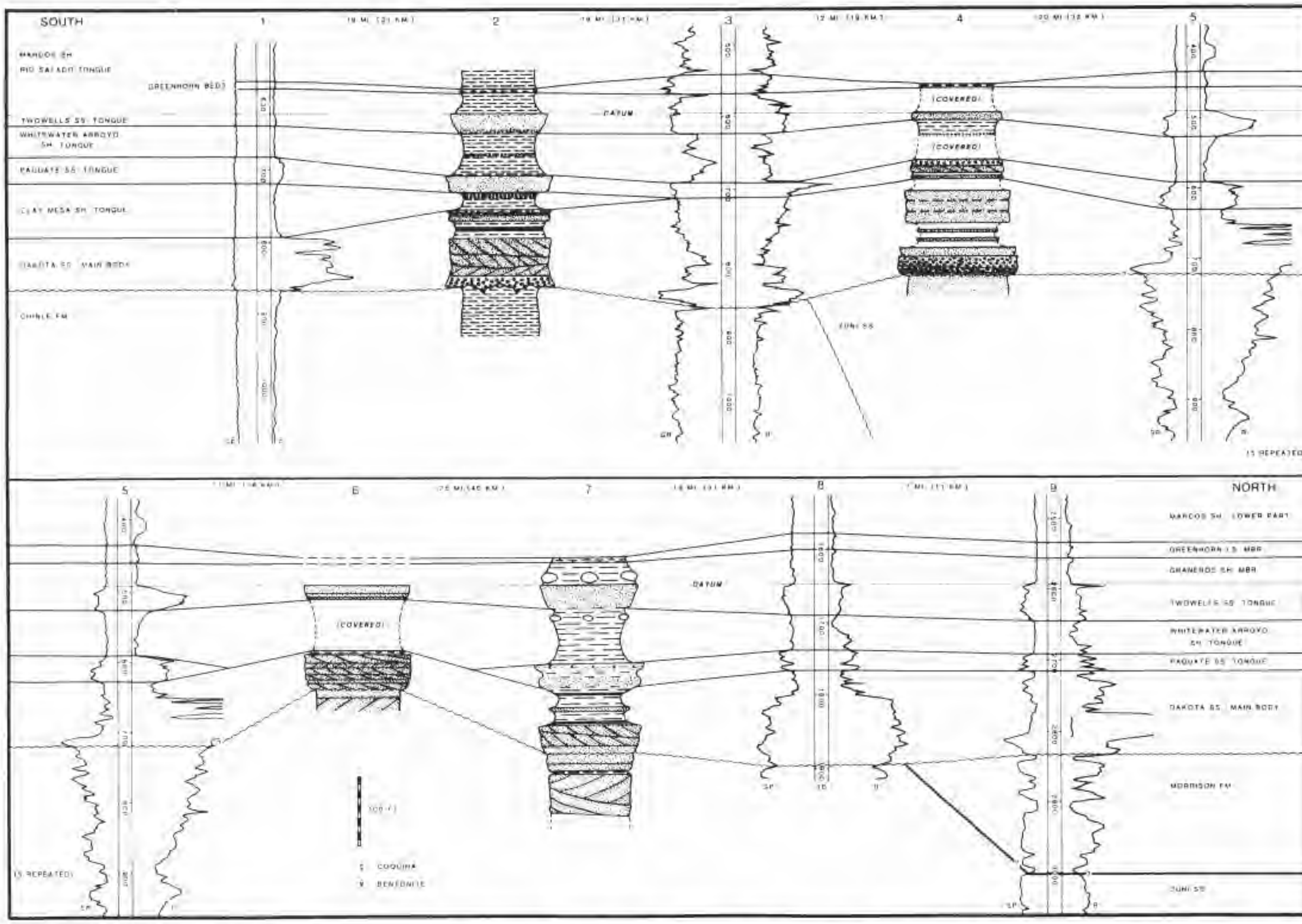

FIGURE 2. South-to-north stratigraphic cross section of Dakota Sandstone and Mancos Shale members. See Figure 1 for line of cross section and Table 1 for location data and names. SP is spontaneous potential; GR is gamma ray; R is resistivity. All depths in ft. Locality 5 log repeated at right end of upper panel and left end of lower panel.

as a lithostratigraphic unit (Dane, 1948). Hook and Cobban (1981, p. 6) preferred to use Bridge Creek because of age equivalence and lithologic similarity to the Bridge Creek Limestone Member of the Greenhorn of its type area in southeastern Colorado; however, age has no part in the definition of a lithostratigraphic unit. The Whitewater Arroyo and Clay Mesa tongues consist of gray, offshore marine shales with bentonites, some of which may be correlated between localities. Some of the bentonites are thick enough to be recognized on well logs as a thin, very low-resistivity zone. For example, the bentonite in the Whitewater Arroyo at localities 2 and 4 probably correlates with the low resistivity zone at a depth of 645 ft at locality 3. The Twowells and Paguate tongues are bioturbated, fine-grained, coarsening-upward sandstones with traces of glauconite and local oyster–coquina beds. They were deposited mainly as regressive shoreface sands. Dakota Sandstone, main body refers to the complex of primarily nonmarine sandstones and conglomerates and lesser amounts of nonmarine shales with local thin coal beds in the lower part of the Dakota. The main body is fluvial and deltaic with a westerly source. The Dakota-Mancos section above the main body is all marine. Eastward into the San Juan Basin, the Dakota main body is gradually replaced by the marine Cubero Tongue and Oak Canyon Member of the Dakota (Landis et al., 1973).

A low-angle, basal Dakota unconformity truncates three units underlying the Dakota main body along the cross section. From north to south the units truncated are: the Morrison Formation (Upper Jurassic), the Zuni Sandstone (Upper Jurassic) and the Chinle Formation (Upper Triassic) (Fig. 2).

DISCUSSION

Correlation was made from the southwestern San Juan Basin in the north, where the base of the Dakota is approximately 2830 ft deep, into the Zuni embayment in the south, where the Dakota locally crops out. Four measured sections and five well logs were used. Localities 8 and 9 at the northern end of the cross section (Fig. 2) are tied into a larger study of about 650 well logs and 65 measured sections throughout the San Juan Basin (Owen et al., 1988).

The top of the Twowells was used as datum because it is present at all localities on the cross section (Fig. 2). The Greenhorn would be a useful datum also, but it is not present at locality 6 due to recent erosion. Greenhorn thicknesses appear greater in the subsurface than on the surface (Fig. 2), because some of the resistive calcareous shale is not seen on the surface due to leaching and poor exposure.

Subsurface correlations were based mainly on resistivity (R) and, to a lesser extent, on spontaneous potential (SP) and gamma ray (GR) curves. SP curves are not well developed on most logs; only one log has a GR curve. The Dakota commonly is an aquifer in this area, and no commercial hydrocarbons have been found in it. Most of the hydrocarbon test wells were drilled for deeper objectives.

The Paguate Sandstone has been generally recognized in the area of the southern part of the cross section (Fig. 2) by Hook et al. (1980), West (1984) and Anderson (1987). The Paguate is not present at locality 6. The Paguate-Dakota main body contact is very lobate, and locality 6 is in one of the lobes of main body protruding eastward. We differ from Landis et al. (1973), Hook et al. (1980) and West (1984) in that we do recognize Paguate in the area north of locality 6 (Fig. 2) as a marine sandstone that onlaps directly on nonmarine Dakota main body from the east without significant thickness of intervening marine shale (Clay Mesa Tongue equivalent). Landis et al. (1973) were reluctant to recognize Paugate in the Gallup area because of the lack of underlying marine shale, although they noted that marine fossils occur in the upper part of their Dakota main body (our Paguate). Recognition of the Paguate in this area is based on its lithology and fauna on outcrops between Gallup and Zuni (Fig. 1) and on correlation of well logs from the San Juan Basin northeast of Gallup. We have used the name Clay Mesa Shale Tongue in the southern part of the cross section (Fig. 2), and the Clay Mesa is present in most of the San Juan Basin.

The Dakota main body is characterized by its lithologic variability, containing conglomerates, sandstones, carbonaceous shales and local coals. Thickness varies more than overlying units, too. The basal Encinal Canyon Member of the Dakota (Aubrey, 1988) is not present in the study area except at El Morro (Fig. 1), 7 mi east of the line of cross section.

The unconformity at the base of the Dakota is difficult to place in the subsurface, especially where the contact is sandstone on sandstone (for example, locality 5, Dakota, main body on Zuni). This contact is easily recognized on outcrop by distinct color and grain-size differences.

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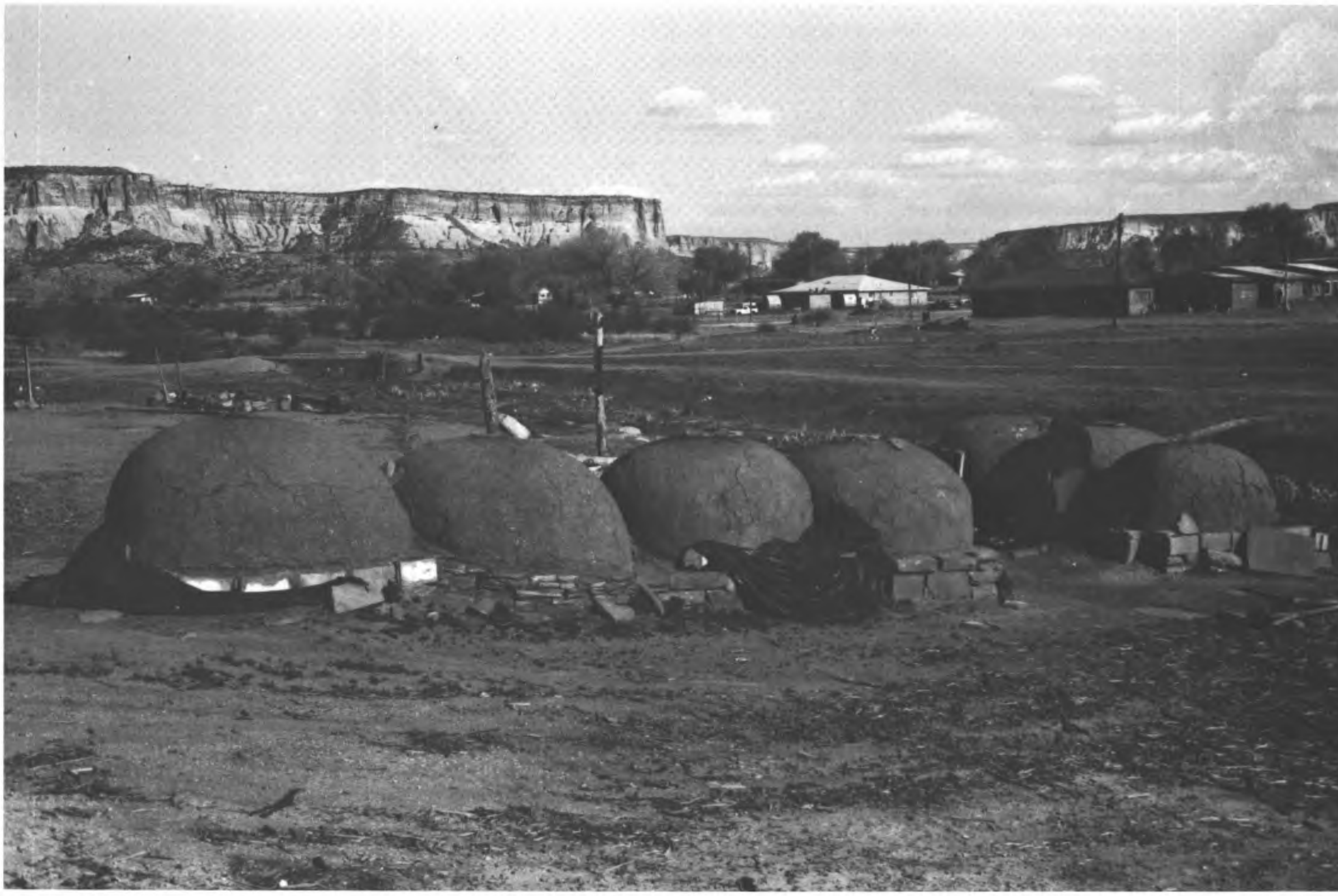

Outdoor ovens (hornos), used primarily for bread, Zuni, New Mexico. Photo by O. J. Anderson.