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PERMIAN REFERENCE SECTION FOR SOUTHEASTERN ZUNI MOUNTAINS, CIBOLA COUNTY, NEW MEXICO

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Abstract—Rocks of Permian age form the flanks of the Zuni Mountains and are divided into the Abo, Yeso, Glorieta and San Andres formations. Despite extensive geologic mapping, no detailed stratigraphic sections for this sequence exist. Two stratigraphic sections for the southeastern Zuni Mountains were measured, correlated and combined to form a detailed composite section. This section correlates very well with two wells south of Gallo Peak and provides a good surface reference section for this region.

INTRODUCTION

Rocks of Permian age form cuestas, ridges and dip slopes around the flanks of the Zuni Mountains. These rocks are divided, in ascending order, into the Abo, Yeso, Glorieta and San Andres formations. Although these units have been extensively mapped by Smith (1954, 1958a, b) and Goddard (1966), no reference section has yet been established for the Permian strata in this region. The purpose of this paper is to present a surface reference section for the Abo, Yeso, and Glorieta and San Andres formations.

This paper is not directed toward resolving stratigraphic nomenclature and correlation problems between Arizona and New Mexico. However, possible solutions to nomenclature problems in central and western New Mexico will be suggested. Hopefully, these suggestions will lead to clarification and consolidation of terminology currently used in this region.

MEASURED SECTIONS

Two detailed sections were measured for this study. The first is at Gallo Peak in secs. 11, 12 and 14, T9N, R11W. The second is at the head of Zuni Canyon in sec. 8, T10N, R11W. Figure 1 shows the locations of the measured sections and wells used for correlation with these surface exposures. Figure 2 shows generalized lithologies measured at each location. The base of the section was assembled by reconnaissance of exposures near La Jara Spring in the NE¼, sec. 13, T10N, R12W. Detailed descriptions of strata listed in this paper are on open file at the New Mexico Bureau of Mines and Mineral Resources in both written and graphic form. Grain sizes are based on the AmStrat grain size card. Colors are from the Rock-Color Chart (Goddard et al., 1948).

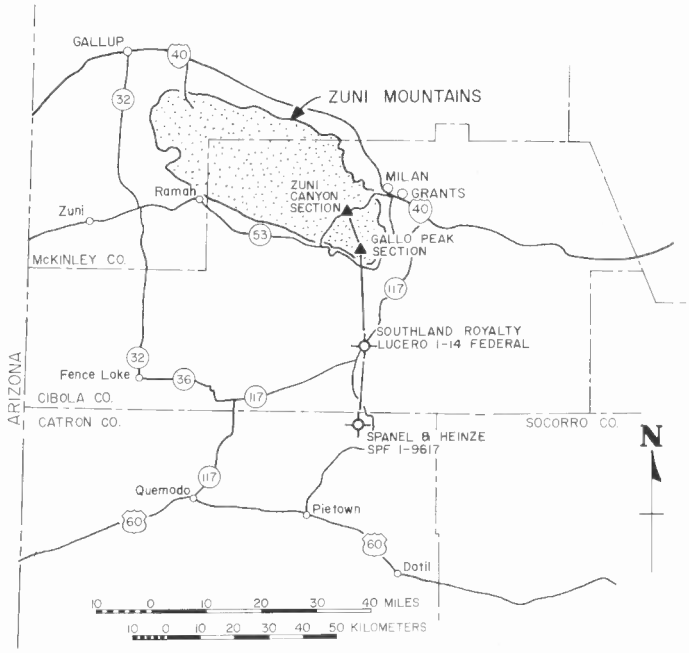

FIGURE 1. Map showing locations of measured sections and wells used for correlating sections into the subsurface.

ABO FORMATION

The Abo Formation was first described by Lee and Girty (1909) at Abo Pass, Valencia County, New Mexico. As in most of central New Mexico, it consists of interbedded mudstone, siltstone, sandstone and thin conglomerates. Near the base of the formation are scattered lenticular, massive-to-nodular limestones.

The mudstones are dark reddish brown, slightly calcareous and become silty up section. They are not well exposed and form brick-red

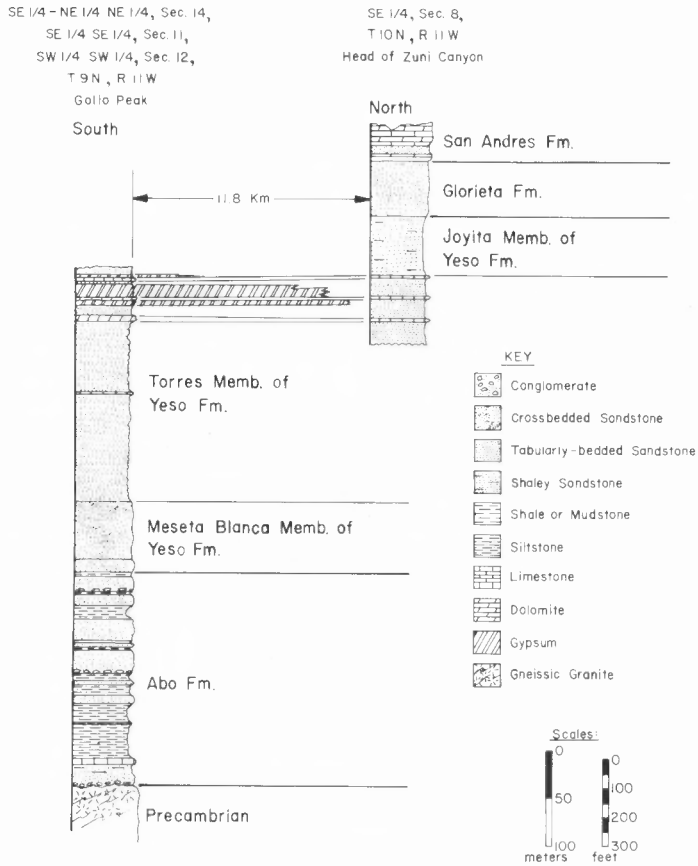

FIGURE 2. Measured sections of Permian rocks in the southeastern Zuni Mountains.

slopes in the walls of Bonita Canyon. The siltstones are dark reddish brown to grayish red, slightly micaceous with well sorted, angular, coarse silt to very fine sand-size quartz grains. They are well indurated, ripple cross laminated, calcareous and have scattered plant impressions preserved on parting and bedding surfaces. Bedding surfaces also display mud cracks, and scattered root casts(?). Locally, the tops of siltstone units are calcareous and nodular, representing possible paleosol horizons. Individual siltstone units tend to be laterally persistent over several hundred feet but are probably discontinuous over larger distances; faulting in this area makes determination of bed continuity very difficult.

The sandstones are grayish red, with well to moderately sorted, angular to subangular, coarse to very fine grains of quartz, orthoclase and muscovite. They are friable to moderately indurated, display upward-fining textures and are crossbedded to ripple cross laminated with asymmetric and lunate ripple marks. Sandstone units are medium to thick bedded, lenticular and display local slumping and lateral accretion surfaces. Bed tops and parting surfaces have mudcracks and locally abundant horizontal burrows.

The conglomerates are pale red to moderate reddish brown and consist of pebbles and granules of grayish red sandstone and dark reddish brown mudstone in a matrix of medium- to very fine-grained quartz sand. They are well indurated and laterally discontinuous, forming channels at the base of sandstone units or within mudstone sequences. Conglomerates are most numerous at the base of the section along the Abo-Precambrian contact and have a pinch-and-swell aspect (see Colpitts et al., 1989).

The limestones are medium to very light gray and range from thin, nodular carbonate mudstone and wackestone to massive bedded, fossiliferous wackestones and packstones (rare). These beds are broadly lenticular over approximately 0.5 to 1 km and vary between 0.3 to 6 m in thickness. They occur low in the section between 10 and 35 m above the base of the formation.

Several fossil organisms occur in the limestone at La Jara Spring. These include planispiral gastropods, brachiopod shell fragments and bryozoan shell fragments; no diagnostic fusulinids could be located. About 2.5 kg of sample were collected along the strike of this unit to check for fusulinids and/or conodonts. No results are available as yet. The age of this basal limestone and conglomerate sequence has been the subject of some controversy and discussion for several decades. Girty (in Darton, 1928) identified several brachiopods that can either be Wolfcampian or Virgilian in age. Cheetham (1951; in Kottlowski, 1960) suggested that bryozoans collected from these carbonates were Virgilian in age. An exact age for this sequence remains equivocal. Total thickness for the Abo Formation in the Zuni Mountains is 204 m (669 ft).

YESO FORMATION

The Yeso Formation was named by Lee and Girty (1909) for exposures near Mesa del Yeso near Socorro, New Mexico. In the Zuni Mountains, the Yeso consists of four general subdivisions: a basal crossbedded, orange-red sandstone sequence; a red, tabularly bedded sandstone sequence; an alternating carbonate-gypsum-sandstone sequence and an upper, red brown, shaley sandstone sequence. The basal crossbedded sequence was named the Meseta Blanca Member by Wood and Northrop (1946) for the sequence observed in the Nacimiento Mountains. The remaining three units were assigned to the San Ysidro Member. Results of this study suggest that the tabular-bedded sandstone and the carbonate-gypsum-sandstone sequence can be assigned to the Torres Member of the Yeso Formation on the basis of lithology, grain size and subsurface correlations southward (Fig. 3) and eastward into the Socorro region. The upper shaly sandstone sequence can be correlated with the Joyita Member on the basis of color and grain-size distributions as well as stratigraphic position; this sequence is identical to the Joyita Member described in the Socorro region.

Meseta Blanca Member

The Meseta Blanca Member is moderate reddish orange and consists of a very well sorted, angular to subangular, very fine quartz grains. The lower 17 m (56 ft) consists of a massive, locally crossbedded and bioturbated, very fine-grained sandstone. The upper 61 m (201 ft) of the unit consists of an extensively crossbedded, very fine-grained sandstone. Crossbed foresets dip southeastward, although several sets dip to the northwest.

The Meseta Blanca is gradational with the underlying Abo Formation; the contact was selected at the change from alternating dark reddish brown mudstones and grayish red sandstones to more orange colors and increased textural maturity. The upper contact was placed at the change from dominantly crossbedded sandstones to tabularly-bedded sandstones that characterize the Torres Member in this area. The Meseta Blanca Member is 78 m (257 ft) thick.

Torres Member

The Torres Member consists of two sequences in the Zuni Mountains: 192 m (630 ft) of tabular-bedded sandstone and 48 m (158 ft) of alternating carbonate, gypsum and sandstone.

Tabular-bedded sandstone sequence

Mapped as the "second member of the Yeso Formation" by Smith et al. (1958a, b), this sequence consists of moderate reddish orange to pale reddish brown, fine to very fine-grained, very well to moderately sorted, subangular to angular quartz sand. Beds are thickly laminated to thickly bedded and have small dark reddish brown, micaceous rip-up clasts on parting surfaces; cement is generally calcite. Bed surfaces also contain occasional halite casts, twig(?) impressions and asymmetric ripple marks. About 115 m (376 ft) above the base of the Torres is a thin (0.3 m) dolomite bed. It is laterally persistent but could not be identified near Zuni Canyon.

Carbonate-gypsum-sandstone sequence

Mapped as the "Limestone Member of the Yeso Formation" by Smith et al. (1958a, b), it was applied by them as a regional stratigraphic marker. In the Gallo Peak area, it consists of two lower dolomites and an upper limestone separated by interbedded sandstone and thick gypsum units. The basal dolomite is pale yellowish gray to grayish brown, calcareous, oolitic, thin to thick bedded and has extensive scour structures at the base. Near the top of this bed, the oolites decrease in abundance, and molds and pseudomorphs after swallow-tail selenite appear along the bedding planes.

The second dolomite is brownish black, fetid and slightly calcareous. Near the base, calcite pseudomorphs after halite are scattered along the bedding planes. Near the top of this bed is a fossil-rich layer with conispiral gastropods, bivalves, brachiopods(?) and scaphopods all represented. Within this layer are relic gypsum rosettes that were probably once anhydrite. These rosettes occur at irregular intervals along the outcrop. The upper limestone is light brownish gray to light gray and is very leached and vuggy. This grades upward to a nodular to wavey-bedded, light gray limestone.

The gypsums in this sequence are very light gray to white, laminated and very fine-crystalline. They underlie and overlie the second and third carbonates of the sequence. These gypsum beds persist northward to the head of Zuni Canyon and pinch out near the north edge of sec. 21, T10N, R11W, about 2.4 km (1.5 mi) south of the Zuni Canyon section (Fig. 2).

The sandstones are moderate reddish brown to yellowish gray and pale red, and consist of very fine to fine, well sorted, angular quartz grains. They are very friable and poorly exposed due to gypsum washing down from overlying gypsum beds. Thickness of the Torres Member in the Zuni Mountains is about 240 m (788 ft).

Joyita Member

Mapped as the "Upper Member of the Yeso Formation" by Smith et al. (1958a, b), the Joyita is moderate red to pale reddish brown and consists of fine, very well sorted, subround to round quartz grains. It is moderately indurated, has mudstone rip-up clasts and calcite cement. It forms the bright dusky red interval below the Glorieta Formation and is intertongued with it at both sections. In the Zuni Mountains it is 61 m (201 ft) thick. It is correlated with the Joyita Member of the Yeso

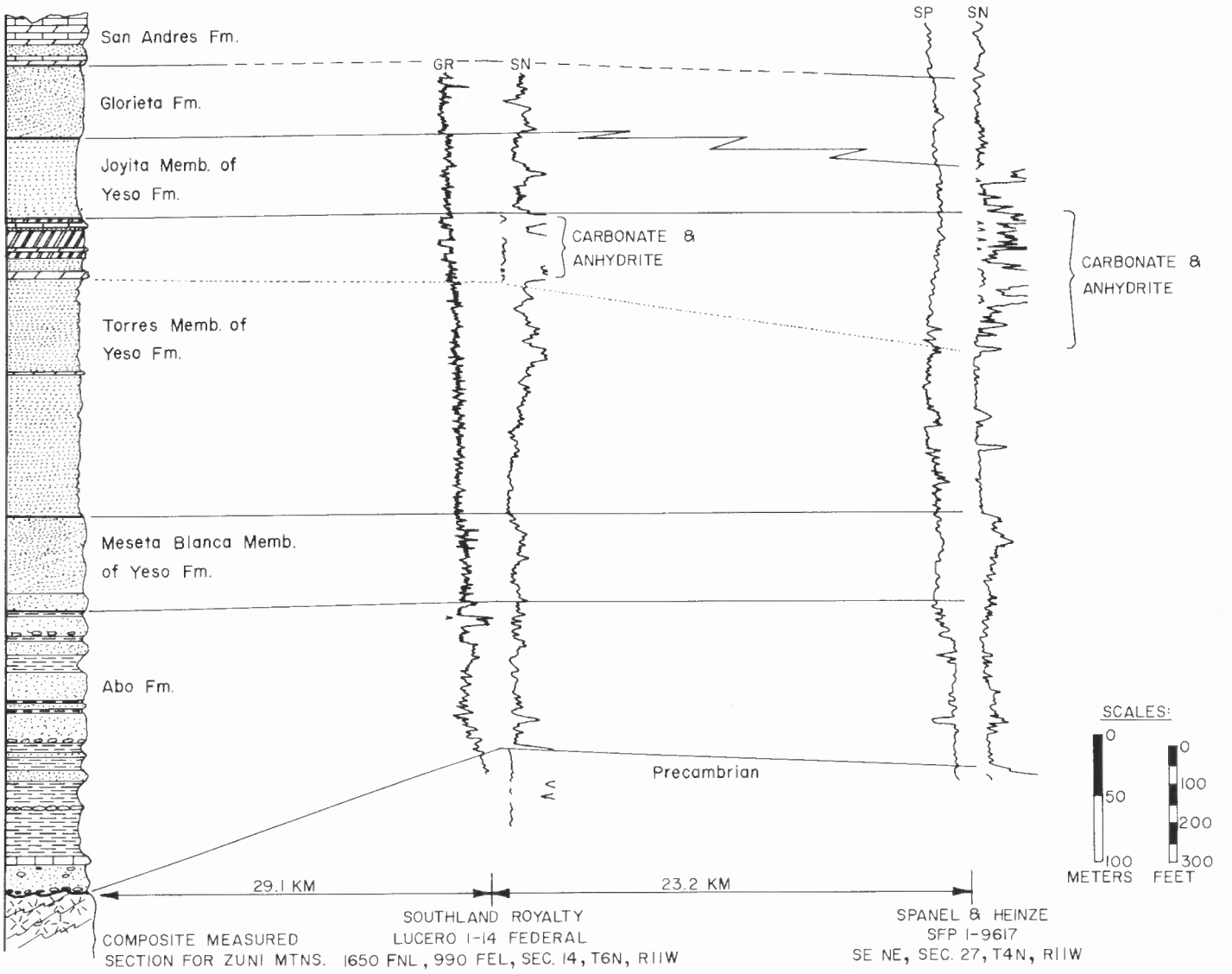

FIGURE 3. Correlations between the composite stratigraphic section for the Zuni Mountains and wireline logs from two wells south of the Zuni Mountains.

Formation on the basis of lithology and petrographic characteristics as well as color and its relationship with the overlying Glorieta Formation (the Joyita also intertongues with the Glorieta Formation in the Socorro region).

GLORIETA FORMATION

The Glorieta Formation forms bold, white cliffs in the Zuni Mountains immediately above the bright reds of the underlying Yeso Formation. It is very pale orange to grayish pink and consists of medium, subrounded to rounded, very well sorted quartz grains. It is friable, thick to massive bedded, and the upper part has tabular crossbed sets 0.18 to 0.36 m (0.6 to 1.2 ft) thick. It is 60 m (197 ft) thick and is gradational with the underlying Joyita Member of the Yeso Formation, intertonguing with it. The Glorieta also intertongues with the overlying San Andres Formation.

SAN ANDRES FORMATION

Named by Lee and Girty (1909) for exposures in the San Andres Mountains, the San Andres Formation consists of three informal members in the Zuni Mountains (Smith, 1954; Smith et al., 1958a, b): a lower calcareous dolomite unit about 9 m (30 ft) thick, a middle crossbedded sandstone unit about 6 m (20 ft) thick and an upper dolomitic limestone to calcareous dolomite unit about 30 m (100 ft) thick. All three units are easily recognizable throughout the southeastern Zuni Mountains.

The calcareous dolomites are medium brownish gray to light gray, locally cherty and are fossiliferous in the upper unit. They form distinctive olive gray-weathering cliffs above the Glorieta. The middle sandstone unit is very pale orange to grayish pink and consists of medium, very well sorted, subrounded to rounded quartz grains. This unit is thin to thick bedded with crossbeds that are similar to those found in the underlying Glorieta Formation. This sandstone unit represents a tongue of the Glorieta Formation, a common occurrence in central New Mexico. The upper surface of the San Andres Formation is a major erosional unconformity. Smith (1954) reports finding sinkholes and karst features filled with detritus from the overlying Triassic. Because the top of the section is eroded, no similar features were observed at either of the measured section locations.

SUBSURFACE CORRELATIONS

As part of a larger project covering the distribution and characteristics of Permian strata in central New Mexico, two wells due south of the Gallo Peak section were used to establish a preliminary subsurface correlation (Fig. 3). The first well is the Southland Royalty, Lucero 1-14 Federal located 1650 FNL, 990 FEL, sec. 14, T6N, R11W. This location is within sight of Gallo Peak and provides an excellent com-

parison point for the composite section. Although the top of the Glorieta was not evident on the correlation logs, the detailed logs confirm the top shown in Figure 3. All other units are easily distinguishable, and the correlation is "hung" on the top of the carbonate-gypsum-sandstone sequence described earlier. Three interesting characteristics developed as a result of this correlation: first, the gypsums are anhydrite in the subsurface and are easily distinguishable as a carbonate-anhydrite sequence (sandstone is not readily discernible at the scale of Figure 3); second, the thin dolomite observed in the Gallo Peak Torres section correlates with a high resistivity zone on the short normal curve; and third, the short normal displays a "bowl-shaped" signature that is characteristic of the Meseta Blanca Member on shallow resistivity and sonic logs elsewhere in central New Mexico. The top of the "bowl shape" is also used to mark the top of the Meseta Blanca in this paper (Fig. 3); scout reports and completion cards for these wells call this the top of the Abo Formation. Other interesting features include the significant thinning of the Abo Formation. This suggests that the Southland Royalty well was drilled on the Paleozoic Zuni uplift. In addition, a high resistivity zone 20 m (66 ft) above the base of the Abo suggests the presence of a carbonate bed similar to those found in the Zuni Mountains.

The second well is the Spanel and Heinze, Santa Fe Pacific 1-9617 located in the SE¼ NE¼, sec. 27, T4N, R11W. It lies 23.2 km (14.4 mi) south of the Southland Royalty Lucero well. Important features in this well include thinning of the Joyita Member of the Yeso Formation with attendant thickening of the Glorieta Formation, significant thickening of the carbonate-anhydrite interval down to the level of the thin dolomite in the Zuni Torres section, appearance of at least one thin carbonate between the base of the carbonate-anhydrite sequence and the top of the Meseta Blanca Member, the characteristic "bowl shape" on the short normal curve indicating presence of Meseta Blanca and a slight thickening of the Abo Formation.

CONCLUSIONS

Detailed measurements and descriptions of Permian strata in the Zuni Mountains serve two useful purposes: first, they provide geologists working in this area with a place where they can "see the rocks" on the surface and become familiar with the section; and second, they demonstrate that the composite section developed from these data serves as a useful reference for subsurface correlations in areas adjoining the eastern and southeastern Zuni Mountains. Additional surface sections to the northwest near Cottonwood Canyon and McGaffey Lake should aid further studies by providing data points for tying the sections presented in this study together with measured sections and well-log data in eastern Arizona. This composite section will also provide a reference point for subsurface correlations to the east and southeast across the Acoma basin into the Socorro region where tectonic activity has disrupted the Permian section.

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