



## *Stratigraphy of the outcropping Permian rocks around the San Juan Basin*

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STRATIGRAPHY  
OF THE OUTCROPPING PERMIAN ROCKS  
AROUND THE SAN JUAN BASIN

By Charles B. Read

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Introduction

This resume of Permian stratigraphy as it is shown in the belts of outcropping strata on the margins of the San Juan Basin is based on field observations by the writer and his colleagues. All areas discussed have been examined and the stratigraphy in the Lucero and Nacimiento areas has been reported in detail by the U. S. Geological Survey. This summary is restricted to the outcrop areas because deep wells in the San Juan Basin that penetrate the Permian rocks are few and fail to add substantially to our information on the distribution and relationships of the strata.

Stratigraphy

The rocks that crop out in the Zuni and Lucero Uplifts have been differentiated into three formations, which, in ascending order, are the Abo formation of Permian (?) age, and the Yeso and San Andres formations of Permian age. The Abo formation is a sequence of brown arkosic or quartzose sandstone and siltstone that exhibits irregular bedding. In the Lucero Uplift, which lies southeast of the San Juan Basin, the formation rests with apparent conformity on the Red Tanks member of the Madera limestone of late Pennsylvanian age. In the Zuni Uplift the Abo locally rests on a few feet of impure limestone and coarse clastics of problematical age, which in turn lie on pre-Cambrian rocks. Elsewhere in the uplift the Abo formation is in direct contact with the pre-Cambrian. In the Sierra Nacimiento the Abo formation rests on Upper Pennsylvanian strata over large areas (Wood and Northrop 1946). Locally, however, it lies directly on the pre-Cambrian rocks.

The Yeso formation overlies the Abo formation with a sharp but apparently even basal contact in both the Lucero Uplift (Kelley and Wood 1946) and the southern part of the Zuni Uplift. Two members have been recognized: a lower massive or thick-bedded and cross-bedded quartzose sandstone and an overlying sequence of fine-grained sandstone, siltstone, gypsum, and dense limestone beds. In the Sierra Nacimiento south of the latitude of Cuba the Yeso formation consists of a basal massive ledge of cross-bedded quartzose sandstone that is overlain by even-bedded fine-grained sandstone and siltstone. Two or three thin beds of dense lime-

stone commonly occur in the upper part of the formation.

Both in the Lucero Uplift and in the Sierra Nacimiento the name Meseta Blanca sandstone member has been applied to the basal cross-bedded sandstone of the Yeso formation. The overlying sequence of fine-grained sandstone, siltstone, and evaporite in the Lucero Uplift has been designated the Los Vallos member of the Yeso formation (Kelley and Wood 1946). For its approximate correlative in the Sierra Nacimiento the name San Ysidro member has been used.

The San Andres formation conformably succeeds the Yeso formation and in the Lucero and Zuni Uplifts consists of the Glorieta sandstone member and the upper limestone member. In the Sierra Nacimiento the Glorieta sandstone member is conspicuous as far north as La Ventana. However, the upper limestone member is absent except in a small area in the extreme southern part of the range.

In the uplifts along the Arizona-New Mexico line Permian strata are broadly exposed. In this outcrop belt the Arizona nomenclature has been used. In the southern part of the Defiance Uplift, which lies a short distance west and northwest of Gallup, New Mexico, a massive quartzose sandstone is believed to be equivalent to the Glorieta sandstone member of the San Andres formation and the Coconino sandstone of the Mogollon Rim, Arizona. This ledge is the upper member of the DeChelly sandstone of some authors. It conformably overlies a sequence of even-bedded fine-grained brown sandstone and siltstone that contains two thin limestone ledges referred to the Supai formation by some authors. Although the base of this sequence is not exposed, drill holes indicate that it rests on pre-Cambrian rocks.

Northward along the Defiance Uplift, several tongues of sedimentary wedges of massive brown or gray sandstone appear in the so-called Supai formation. These thicken and finally merge in the Coconino sandstone to form a great wall of sandstone ledges that is referred to as the DeChelly sandstone. In the northern part of the uplift, in consequence, the DeChelly sandstone overlies undifferentiated red or brown beds of the so-called Supai formation. These are equivalent to only the lower part of the Supai formation farther south. Locally the Supai formation is known to rest on the pre-Cambrian, as at Bonito Canyon near Ft. Defiance, Arizona.

The south flank of the San Juan Mountains constitutes the northern margin of the San Juan Basin. Permian strata are exposed intermittently and consist of red or brown arkosic or quartzose strata that are referred to the Cutler formation. No further differentiation appears possible in this area.

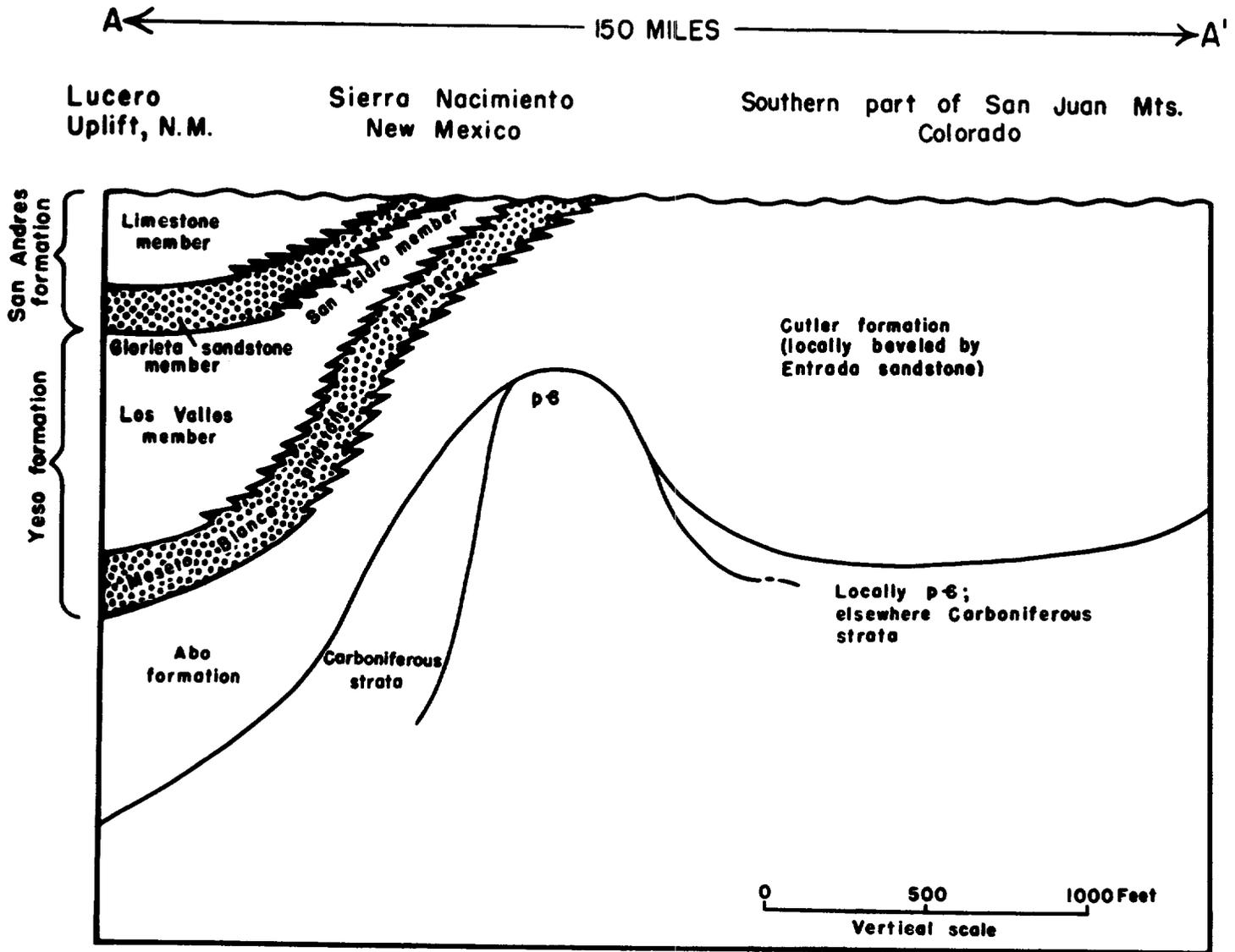


FIGURE 1. DIAGRAM SHOWING RELATIONSHIPS OF PERMIAN ROCKS IN PARTS OF THE LUCERO UPLIFT, NEW MEXICO, THE SIERRA NACIMIENTO UPLIFT, NEW MEXICO, AND THE SAN JUAN MOUNTAINS, COLORADO

Traced southward the Cutler formation changes by lateral gradations into the DeChelly sandstone and so-called Supai formation in Arizona and into the Abo, Yeso, and San Andres formations in New Mexico. Similar lateral gradations have been observed westward from the San Juan Mountains and into Utah.

#### Paleogeography

At the beginning of Wolfcamp time a series of generally north- or northwest-trending active positive elements which are sometimes referred to as

the Ancestral Rocky Mountains lay in parts of northern and central New Mexico (See Fig. 3). The westernmost of these positive elements was adjacent to the present San Juan Basin and flanked it on the northeastern and eastern margins. At least two masses have been recognized---a very large feature or group of features that is called the Uncompahgre axis and a smaller one that is called the Penasco axis. These positive elements were the principal sources of clastic materials that accumulated in the San Juan Basin as well as in the intermontane basins.

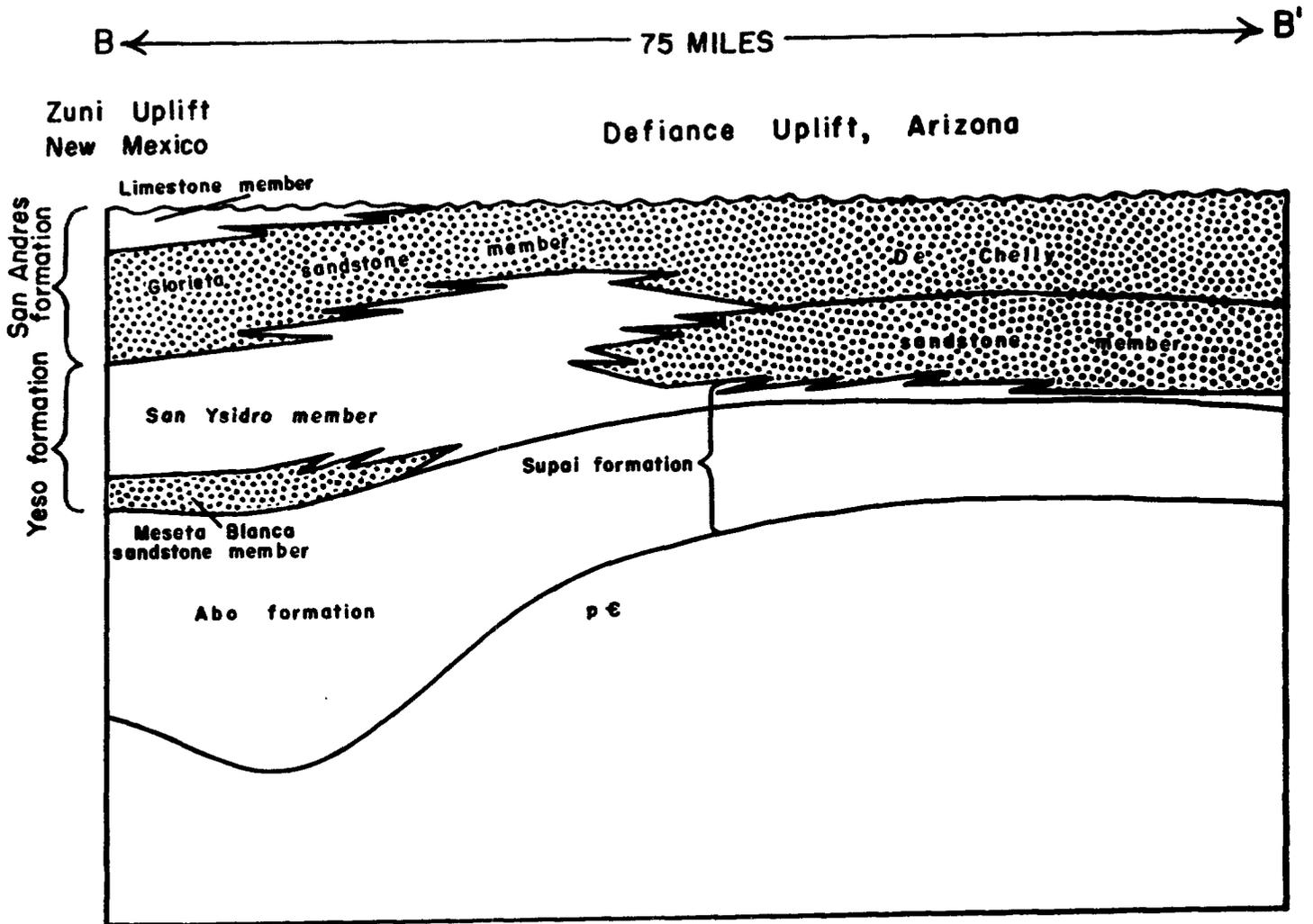


FIGURE 2. DIAGRAM SHOWING RELATIONSHIPS OF PERMIAN ROCKS IN PARTS OF THE ZUNI UPLIFT, NEW MEXICO, AND THE DEFIANCE UPLIFT, ARIZONA

0 500 1000 Feet  
Vertical scale

Along the New Mexico-Arizona line there were two stable geanticlines---the Zuni and Defiance arches. Although these locally contributed clastics to the adjacent basins they appear to have been generally inactive and therefore minor sources of materials.

These two types of positive elements---the active Ancestral Rocky Mountains on the east and north and the stable but inactive elements on the west---flanked the ancestral San Juan Basin on three sides. To the south lay the early Permian sea. Into the old San Juan Basin arkose, graywacke, and quartzose sandstone derived from the Ancestral Rocky Mountains were deposited under

dominantly floodplain and delta conditions. This continental phase of basin filling was the final episode in a cycle of geosynclinal sedimentation that commenced in Pennsylvanian time and terminated in early to middle Permian time. This termination was a result of geanticlinal maturity and subsequent burial of the positive elements by clastics derived from areas still farther to the north.

After the time of geanticlinal maturity and old-age broad downwarping movements occurred. These permitted the northward transgression of seas that had prior to that time been restricted to areas south of the San Juan Basin.

The marine deposits that resulted from this transgression and associated lesser fluctuations are the Yeso and San Andres formations. It may be deduced from the distribution of these deposits that the northernmost limit of the strand line of this sea lay at about 36° north latitude along the east margin of the present San Juan Basin and trended northward toward the point of junction of New Mexico, Arizona, Colorado, and Utah. Northeast of this line the marine Yeso and San Andres formations grade rapidly into the subaerial and subaqueous floodplain and delta deposits of the Cutler type. The great tangentially cross-bedded sandstone of the Meseta Blanca, Glorieta, Coconino, and DeChelly types are interpreted as migrating beach and bar deposits, some of which are transgressive and

others regressive. It is probable that the positions and migrations of such bars and beaches were controlling factors in the distribution of evaporites in the southern part of the San Juan Basin during parts of Yeso and San Andres time.

To the writer's knowledge there is no record of Permian sedimentation in the area after the deposition of the San Andres formation. In fact, the full record of San Andres deposition is not preserved, owing to the presence of a profound pre-Upper Triassic hiatus and resultant disconformity. The depth of erosion of this irregular plane is problematical, but it is markedly irregular and locally has a relief of at least 100 feet.

NOMENCLATURE OF PERMIAN FORMATIONS

Provincial Series, West Texas (for comparison)	Lucero Uplift, N. M.	Zuni Uplift, N. M.	Sierra Nacimiento, N. M.	Defiance Uplift, Ariz.	San Juan Mts., Colo.
Ochoa					
Guadalupe					
Leonard	San Andres formation Limestone member Glorieta sandstone member	San Andres formation Limestone member Glorieta sandstone member	San Andres formation Limestone member Glorieta sandstone member	Upper member  Lower member	Cutler formation
	Yeso formation Los Vallos member Meseta Blanca sandstone member	Yeso formation Los Vallos member Meseta Blanca sandstone member	Yeso formation San Ysidro member Meseta Blanca sandstone member		
Wolfcamp	Abo formation	Abo formation	Abo formation	Supai formation of some authors	Rico formation (locally)
	Pennsylvanian	Pennsylvanian locally Pre-Cambrian elsewhere	Pennsylvanian Locally pre-Cambrian	Pre-Cambrian	Hermosa formation

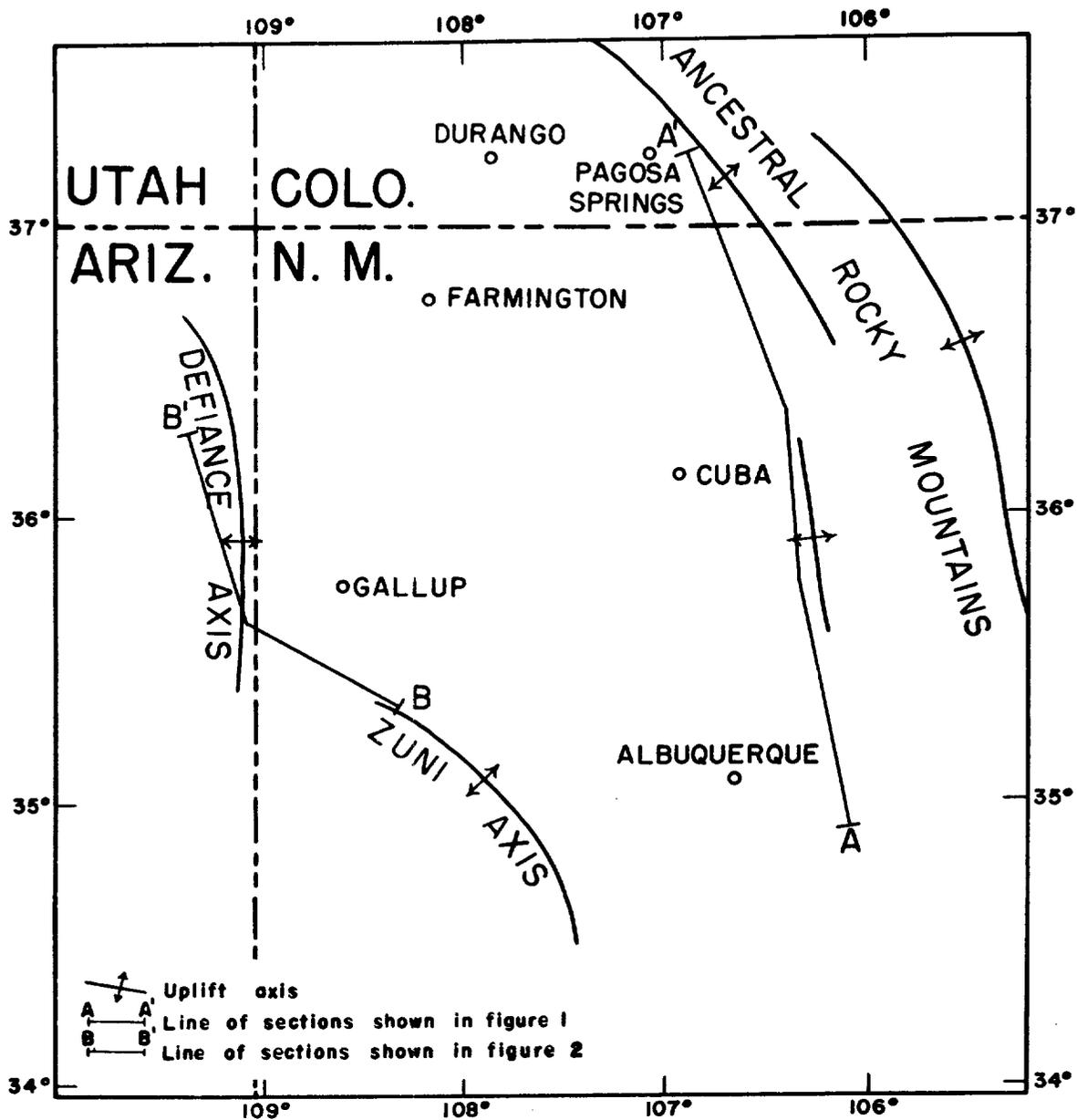


FIGURE 3. MAP OF NORTHWESTERN NEW MEXICO SHOWING POSITIONS OF LOWER PERMIAN POSITIVE AXES

Selected References

- Kelley, V. C. and Wood, G. H. (1946) Lucero uplift, Valencia, Socorro, and Bernalillo Counties, New Mexico: U. S. Geol. Survey Oil and Gas Invest. Prelim. Map 47.
- Wood, G. H. and Northrop, S. A. (1946) Geology of the Nacimiento and San Pedro Mountains and adjacent plateaus: U. S. Geol. Survey Oil and Gas Invest. Prelim. Map 57.