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New Mexico Geology, v. 5, n. 3 pp. 56-60, Print ISSN: 0196-948X, Online ISSN: 2837-6420.
https://doi.org/10.58799/NMG-v5n3.56

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Preliminary report on redefinition of Zuni Sandstone, west-central New Mexico

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Recent work by the New Mexico Bureau of Mines and Mineral Resources on the sequence of Upper Jurassic rocks in the Zuni Pueblo–Atarque area of west-central New Mexico has resulted in a redefinition of the Zuni Sandstone. Dutton (1885) originally described the Zuni as a series of sandstones and sandy shales lying between his Wingate Sandstone and his Cretaceous section (present Dakota Sandstone) in the area around the north and west sides of the Zuni Plateau (present Zuni uplift); he named this interval the Zuni sandstones. Dutton did recognize significant lateral variation in his new unit, especially between Zuni Pueblo and the Fort Wingate areas, but did not regard these variations as important (Fig. 1).

The lateral changes noted by Dutton in the Zuni sandstones were due in part to the fact that northward from Zuni Pueblo, where the sandstones are largely an eolian deposit, the upper part of the Zuni begins to intertongue with the lower members of the fluvial Morrison Formation. This intertonguing is what produced Dutton's colorful variegated beds in the Fort Wingate area. Of even greater importance, however, is Dutton's miscorrelation of the Wingate sandstone (Rock Point Member of the Wingate Sandstone of present usage) in the Zuni Pueblo area with the Entrada Sandstone (of present usage) in the Fort Wingate area. His correlation was based on the similarity in color of the two units and resulted in the inclusion of the Entrada Sandstone in the Zuni sandstones at Zuni Pueblo, but not in the Fort Wingate area. In this latter area, the base of the Zuni Sandstone was placed at the base of the Todilto Limestone and included the overlying Summerville, Bluff (or Cow Springs), and Morrison formations. At Zuni Pueblo, Dutton's Zuni sandstones consisted of the Entrada Sandstone and the overlying Cow Springs Sandstone, two largely eolian units separated by a notch or recess that is here considered to represent the Todilto Limestone interval. This recess was not noted by Dutton, but was alluded to by Darton (1910) as an "erosional break," and in some areas this recess was probably the basis for his division of the Zuni into upper and lower parts in a later publication (Darton, 1915). The Jurassic nomenclature of some of these early authors is shown and correlated in Fig. 2 and includes the work of Gregory (1917), who named the Todilto limestone, a unit whose presence or absence is critical to the redefinition of the Zuni Sandstone. The current stratigraphic divisions used by the U.S. Geological Survey in the southern San Juan Basin also are shown.

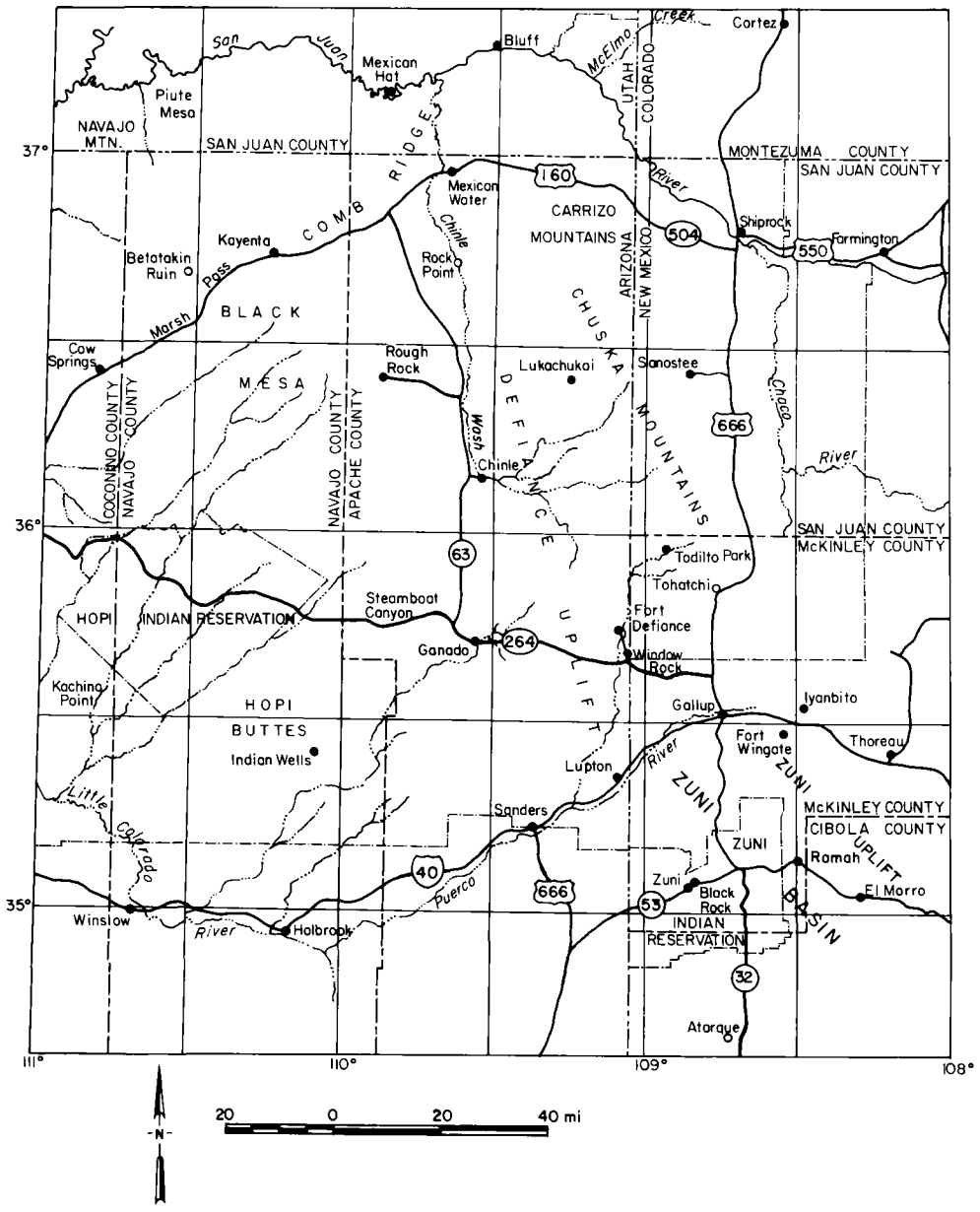

FIGURE 1—Index map of study area (modified from Harshbarger, Repenning, and Irwin, 1957).

The modern stratigraphic framework in the Zuni Pueblo area was established by Harshbarger, Repenning, and Jackson (1951) and Harshbarger, Repenning, and Irwin (1957), who traced both the Entrada Sandstone and the whitish, highly crossbedded Cow Springs Sandstone (type locality at Cow Springs, Arizona; Fig. 1) into the Lupton–Zuni Pueblo area from the "Navajo country." They observed that southward from Lupton into the Zuni Pueblo–Black Rock area (Fig. 1) distinguishing the Entrada and the Cow Springs as separate lithologic units became increasingly difficult. Curiously enough they never made reference to the notch or recess (or horizontal truncation plane of Wright and Dickey, 1979), even though they specified a 359-ft-thick section of the upper sandy member of the Entrada as being present in the Black Rock area. Their work pointed out that, whether recognizable as two separate units everywhere or not, the Zuni sandstones of Dutton included the Entrada Sandstone at Zuni Pueblo. Harshbarger, Repenning, and Jackson (1951) and Harshbarger, Repenning, and Irwin (1957), however, did not formally address the matter of correlating their Cow Springs–Entrada interval with Dutton's Zuni sandstones as Dutton's locality was outside their study area. Had they merely stated that the Zuni sandstones of Dutton seem to be

composed of the undivided equivalents of the Cow Springs and Entrada Sandstones in this area, much of the later misunderstanding and misuse of the term Zuni Sandstone would have been avoided. Such a statement would have at once precluded the use of the name Zuni in those areas northward of the Zuni Basin where the presence of the Todilto Limestone and the Summerville Formation splits Dutton's Zuni sandstones into its component parts—the Entrada and Cow Springs Sandstones. The term Zuni would have had no application wherever the Todilto–Summerville units were recognizable.

No such clarification was forthcoming. In 1956, however, word reached C. H. Dane of the impending U.S. Geological Survey publication by Harshbarger, Repenning, and Irwin in which the Cow Springs Sandstone would be recognized as far east as Zuni–Black Rock. Dane responded with the following memorandum reprinted here with the permission of the U.S. Geological Survey:

March 8, 1956
TO: Geologic Names Committee
FROM: Carle H. Dane
SUBJECT: Reinstatement of Zuni sandstone

All of the strata between the Wingate (now Entrada) and Dakota sandstones were mapped by Dutton (1885, Mt. Taylor and the Zuni Plateau, U.S.G.S. 6th Annl. Rept. p. 137). The basal 2 to 25 feet above the Wingate (now Entrada), where it was thin bedded limestone, was called by Gregory the Todilto formation and the overlying lower part of the sandstone unit was erroneously called Navajo by Gregory (1917, Geology of the Navajo country). The Todilto is not present in the western and southern parts of the Gallup–Zuni Basin. Baker, Dane, and Reeside (1936) recognized Gregory's miscorrelation of Dutton's Zuni sandstone with the Navajo and correctly assigned the bulk of the Zuni to their Morrison formation as a sandstone facies of the formation (see Figure 14, p. 51, Professional Paper 183), but they included the Todilto limestone as a member of the Morrison. The history is rather fully documented on pp. 43–44 of the Baker, Dane, and Reeside report. The comparable sandstone facies in the Black Mesa area of Arizona was later called Cow Springs sandstone by Harshbarger. Subsequently it became clear that the Baker, Dane, Reeside report "Morrison sandstone facies" included equivalents of the upper part of the San Rafael group of which certainly the Todilto limestone, the Summerville, and the Bluff sandstone (if that is now included in the San Rafael group, and I believe it is) are representatives. Therefore, it is clear that the only proper procedure is to restore Zuni sandstone in Dutton's original usage. If the stratigraphic relationships had been fully understood, it would have been highly appropriate for Harshbarger to use Zuni for what he termed Cow Springs sandstone in the Black Mesa area. In my opinion, this should have been done but there are, of course, arguments in favor of a local Arizona name. Once it was done, however, there was no good reason why Cow Springs

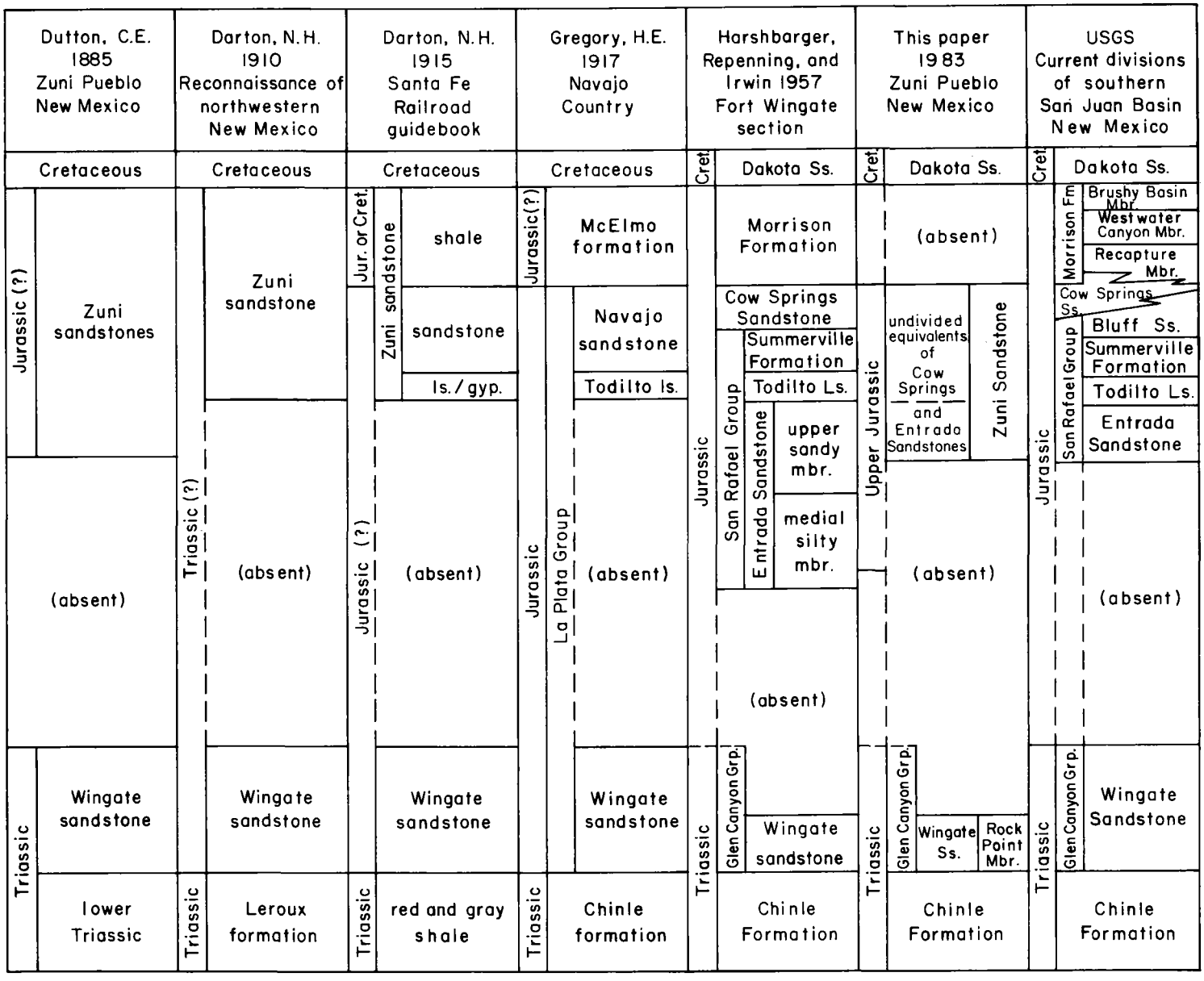

FIGURE 2—Evolution and correlation of Jurassic nomenclature used in the study area.

should have been permitted to jump east of the Defiance uplif[t] into the Arizona–New Mexico border area; and there is certainly no justification for crowhopping Cow Springs into the Acoma Basin farther east. (I might add that the thought of replacing an elegant name like Zuni by the tawdry commonplace Cow Springs curdles my gizzard. Imagine the Enchanted Mesa, the fabulous El Morro, "Acoma, the Sky City", and all the other beautiful rocks of the Land of Enchantment composed of the Cow Springs sandstone. Heaven forbid!) On the New Mexico Geologic Map, I propose to use Zuni sandstone in the Gallup–Zuni and Acoma basins. The abandonment of the name was based on a misunderstanding of correlation. It should be restored.

Carle H. Dane

The memorandum, which was never circulated, obviously did little to clarify the problem. Dane had earlier (*in* Baker, Dane, and Reeside, 1936) recommended abandoning the name Zuni, and now he was proposing that Harshbarger's Cow Springs was equivalent to Dutton's Zuni sandstones, when in fact it was equivalent to only the upper part of the Zuni. On the basis of this supposed equivalency, Dane recommended restoring the name Zuni for use throughout the Zuni, Acoma, and southern San Juan Basins and adjacent parts of Arizona regardless of whether or not the Todilto or Summerville Formations were present in the local section.

As per his memo, Dane did restore the name Zuni for use in the Zuni–Acoma area of New Mexico, but an official notification of the restoration was not circulated by the U.S. Geological Survey. Official notification came ostensibly through Keroher and others (1966) who updated the lexicon of geologic names. The lexicon, however, contained no definition or redefinition of the Zuni Sandstone, nor did the New Mexico state geologic map (Dane and Bachman, 1965) contain any definition or redefinition.

Subsequent to the publication of the state geologic map and the lexicon (Keroher and others, 1966), various investigators began referring to the Zuni as the equivalent of one of their mapped units. One of the earliest such usages was by Thaden, Merrin, and Raup (1967) and Thaden, Santos, and Raup (1967) who mapped a 300–340-ft-thick fine-grained crossbedded sandstone between the Summerville Formation and the Recapture Member of the Morrison Formation as the yellow sandstone in the Thoreau, New Mexico, area. They stated that the yellow sandstone interval had been called Bluff or Zuni by some workers and that it may be a tongue of the Cow Springs Sandstone. Diagrammatically they indicated an intertonguing relationship between the Bluff and the yellow sandstone, with a tongue of the Cow Springs coming in from the west, and all units overlain by the Recapture Member. The Bluff and the yellow sandstone interval can be traced all the way, with minor color changes, to the Fort Wingate–Gallup area where Harshbarger, Repenning, and Irwin (1957) described the section as Cow Springs overlain by and intertonguing with the Recapture Member.

Green and Pierson (1977) used the terms Cow Springs and Bluff in their San Juan Basin nomenclature chart and stated that where the two are recognized separately, the contact between them is considered to be intertonguing and arbitrary. Green (1975) had earlier discussed paleodepositional units in upper Jurassic rocks of the southern San Juan Basin and included the Bluff in his Cow Springs Sandstone with an unconformity in the upper part. Lupe (1981) described the relationship of the lower part of the Morrison to the Bluff and Cow Springs as a lateral facies change; he considered the Recapture Shale Member of the Morrison to have gone from a fluvial to an eolian facies southward.

Maxwell (1976), working in the area east of Grants, was the earliest to map the undefined Zuni Sandstone following publication of the state geologic map (Dane and Bachman, 1965). Maxwell was able to distinguish a light-colored eolian crossbedded sandstone from the underlying Bluff Sandstone in the northern half of the Acoma Pueblo quadrangle; he designated this upper sandstone the Zuni. He considered the Bluff to be a fluviatile deposit at this locality and the presence of numerous sandstone pipes within it helps distinguish it from the Zuni (of Maxwell); southward the Bluff and Zuni merge into a single unit. He noted that the Zuni is unconformably overlain by the Brushy Basin Member with a fossil soil zone at the contact. Thus the Brushy Basin does not grade southward into eolian sandstone at this locality, as had been described at other localities (Silver, 1948) but rather has cut out part of and therefore is younger than the underlying eolian sandstone. This interpretation is consistent with the observation by most workers that only the lower members of the Morrison intertongue with the eolian facies southward. By Brushy Basin time, mostly shale was being deposited and the sand supply for the eolian deposits to the south was interrupted. The Brushy Basin shale overlapped the Zuni (of Maxwell) as Morrison deposition came to a close. A short distance to the south of Maxwell's area the Brushy Basin member has been beveled off by pre-Dakota erosion of gently northward-dipping strata and the Dakota Sandstone rests on the Zuni Sandstone of Maxwell (see also Maxwell, 1982).

Mapping by Anderson (1982) in the Atarque area (Fig. 1) initially recognized the Cow Springs Sandstone, but this work had to be revised with the realization that the Cow Springs Sandstone did not include the lower Entrada part of the section which is now considered to be present in the area; the unit is now recognized as the redefined Zuni Sandstone, described below.

In view of the present confusion surrounding the usage of the name Zuni and the obvious need for a modern definition, the present author is recommending the following: while it is recognized that the in-field distinction between the two largely eolian units—the Entrada and the Cow Springs Sandstones—will be difficult and not always practical, the name Zuni Sandstone shall be applied to the undivided equivalents of the Entrada Sandstone and the Cow Springs Sandstone where they rest in contact south of the Todilto–Summerville pinchouts in the Zuni Basin and eastward as appropriate into the Acoma Basin. This usage corresponds to the original use of the term Zuni in this area only. Northward and eastward the Cow Springs Sandstone rests on younger San Rafael formations, the Summerville and the Bluff, and is more easily distinguished from them, although problems are found locally in recognizing the Bluff and Cow Springs as separate units. In the San Juan Basin and the Acoma sag, the usage of the name Cow Springs Sandstone ought to continue in the sense of Thaden, Merrin, and Raup (1967), Thaden, Santos, and Raup (1967), Green (1975), Green and Pierson (1977), and Lupe (1981).

The type locality of the redefined Zuni Sandstone is Taaiyalone Mesa (Dowa Ya-

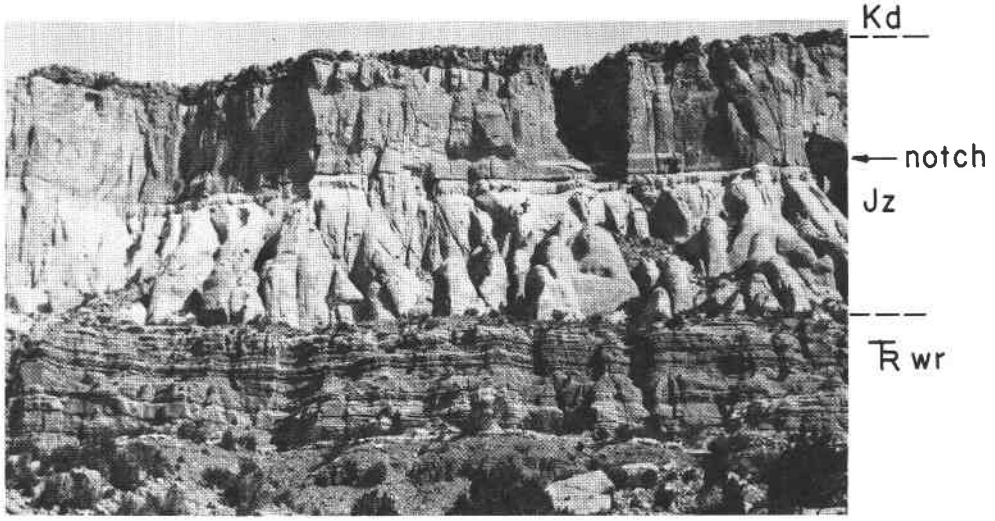

FIGURE 3—Type locality of Zuni Sandstone at south end of Taaiyalone Mesa, Black Rock, New Mexico; **Rwr,** Rock Point Member of Wingate Sandstone; **Jz,** Zuni Sandstone; **Kd,** Dakota Sandstone. Note medial color change and notch in Jz.

lanne on the Zuni 7½-min sheet) in sec. 36 T. 10 N., R. 19 W. and sec. 1 T. 9 N., R. 19 W. (Fig. 3). Here the Zuni is estimated at 500 ft in thickness with the notch or recess representing the Todilto interval near the middle. A 2–4-inch-thick grayish-red (5 R 4/2) very fine grained silty sandstone occupies the notch, but there is little or no relief at this horizon and little to distinguish the lower and upper sandstones. Generally the lower one is very light gray and slightly coarser grained and better sorted than the upper, although both are, for the most part, upper very fine to lower fine grained. The upper one is grayish pink (5 R 8/2) weathering to pale red (5 R 6/2). Locally vertical grooves, 4–6 ft in height, are present below the notch.

A more detailed account of the problems in correlating Jurassic rocks of west-central New Mexico with those elsewhere on the Colorado Plateau has been prepared as New Mexico Bureau of Mines and Mineral Resources Open-file Report 174. It includes a regional correlation diagram and a measured section at the proposed type locality of the Zuni Sandstone and is available through the NMBMMR publications office, Socorro, NM, 87801.

ACKNOWLEDGMENTS—The writer wishes to express his appreciation to Charles Maxwell, Stephen C. Hook, David W. Love, and Don Wolberg for their helpful discussion and critical reading of the manuscript. Thanks also are due the Pueblo of Zuni for kindly granting permission to collect samples at and photograph the important outcrop localities.

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USGS

TOPOGRAPHIC MAPS—NEW (scale 1:24,000)

	yr	lat	long	contour (ft)
*Animas	77–82	31°52′30″	108°45′	10
*Animas Peak	77–82	31°30′	108°45′	40
*Animas Peak NE	77–82	31°37′30″	108°45′	20
*Antelope Pass	77–82	31°52′30″	108°52′30″	40 20
*Beacon Hill	77–82	31°52′30″	108°37′30″	20
*Big Hatch Peak	77–82	31°37′30″	108°22′30″	10 40
*Black Point	77–82	31°22′30″	108°52′30″	10 40
*Carrizozo East	75–82	33°37′30″	105°45′	20
*Cedarville	75–81	34°15′	105°37′30″	10
*Center Peak	77–82	31°30′	108°37′30″	40
*Clanton Draw	77–82	31°30′	108°52′30″	20
*Doyle Peak	77–82	31°45′	108°15′	20
*Duoro	75–81	34°22′30″	104°52′30″	10
*Fitzpatricks	77–82	31°22′30″	108°45′	40 10
*Foster Lake	75–82	32°37′30″	106°7′30″	10 50
*Gillespie Mountain	77–82	31°37′30″	108°37′30″	40
*Godfrey Peak	75–82	33°22′30″	105°52′30″	40
*Hachita Peak	77–82	31°45′	108°22′30″	40 20
*Hatchet Ranch	77–82	31°37′30″	108°15′	40 20
*Hilo Peak	77–82	31°22′30″	108°30′	20 10
*Horse Mountain	77–82	31°30′	108°30′	20
*Lake Lucero NE	75–82	32°37′30″	106°15′	10 50
*Lone Mountain	74–82	33°45′	105°45′	20
*Mescalero	75–82	33°7′30″	105°45′	40
*Mockingbird Gap SE	75–82	33°30′	106°15′	40
*Mount Baldy	77–82	31°37′30″	108°52′30″	40
*Pierce Peak	77–82	31°22′30″	108°15′	40
*Playas Lake North	77–82	31°52′30″	108°30′	10
*Playas Lake South	77–82	31°45′	108°30′	10
*Red Canyon	75–82	33°37′30″	106°7′30″	20 5
*San Antonio SE	75–82	33°45′	106°45′	10 5
*Sentinel Butte	77–82	31°22′30″	108°22′30″	40 20
*Sheridan Canyon	77–82	31°30′	108°15′	40
*Sierra Blanca Peak	75–82	33°15′	105°45′	80
*Tank Mountain	77–82	31°45′	108°45′	20
*Tularosa NE	75–82	33°7′30″	106°	10
*U Bar Ridge	77–82	31°30′	108°22′30″	10 40
*Walnut Wells NE	77–82	31°37′30″	108°30′	10
*Whitemire Pass	77–82	31°45′	108°37′30″	40
*Wrye Peak	74–82	33°52′30″	106°15′	20

REVISED TOPOGRAPHIC MAPS (scale 1:24,000)

	yr	yr (rev)	lat	long	contour (ft)
*Acme	62	79–82	33°30′	104°15′	10 5
*Antelope Lookout Mesa	70	78–82	35°45′	108°7′30″	20 10
*Candy Mesa	68	79–82	34°30′	104°	10
*Conejo Creek West	67	79–82	34°7′30″	104°22′30″	10
*Cooley Lake	67	79–82	34°	104°7′30″	10
*Cooper Ranch	66	79–82	34°30′	104°30′	20
*Deep Well	67	79–82	33°37′30″	104°45′	10
*Deering Place	67	79–82	33°52′30″	104°15′	10 5
*Dunlap Sill	67	79–82	33°52′30″	104°30′	10
*Eighteenmile Hill	67	79–82	34°7′30″	104°7′30″	10
*Eightmile Draw	62	79–82	33°37′30″	104°15′	10 5
*El Morro Mesa	66	79–82	34°15′	104°37′30″	10
*Elkins	67	79–82	33°37′30″	104°	10
*Fort Stanton	63	79–82	33°22′30″	105°30′	40 20
*Fort Sumner East	68	79–82	34°22′30″	104°7′30″	10
*Glenrio	68	81–82	35°7′30″	103°	10
*Haystack Butte	67	79–82	33°45′	104°7′30″	10
*La Espia Peak	67	79–82	34°	104°15′	10 5