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New Mexico Geology, v. 15, n. 2 pp. 38-39, Print ISSN: 0196-948X, Online ISSN: 2837-6420.

<https://doi.org/10.58799/NMG-v15n2.38>

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## Zuni Sandstone and Acoma Tongue defined

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Seldom in the history of our science has a stratigraphic name been so badly mis-treated and misunderstood as the Zuni Sandstone. Ironically, it is a valid stratigraphic name and represents valid stratigraphic concepts. It lacks only a clear definition. Fortunately this can be provided with historical perspective, proper application of the requirements stated in the North American Stratigraphic Code (1983), and an understanding of the regional correlations of Middle Jurassic rocks.

The excellent exposures of light-colored eolian sandstones near Zuni Pueblo in west-central New Mexico were designated the "Zuni sandstones" by Dutton (1885). Dutton also had introduced the name Wingate sandstone for the underlying strata, which are well exposed near Fort Wingate, but when correlating between the two areas he inadvertently misplaced the Zuni-Wingate contact in the Zuni Pueblo section. He dropped this contact to the level that is currently recognized as the top of the Rock Point Member of the Chinle, and thus by error (probably based on color) he included in the "Zuni sandstones" strata that were recognized as Wingate 30 mi to the north. The actual contact is now known to be some 280 ft above the original placement, at an interval that has been designated by some authors as the "Todilto notch." One problem is, as Anderson (1983) discussed in a preliminary paper, that the "notch" is not recognizable everywhere; consequently, there are localities where the contact is problematic.

As is now well known, the U.S. Geological Survey (Baker et al., 1947) changed the name from Wingate to Entrada Sandstone. This tells us a number of things. First, we see that a perfectly valid and properly defined stratigraphic name can be willfully abandoned in the interest of regional correlations. This process is not necessarily bad because greater knowledge leads to progressive refinement of stratigraphic concepts, which in turn may expose excessive or superfluous nomenclature. Second, it tells us that the Entrada Sandstone is present near Zuni Pueblo, despite the locally problematic upper contact, and that two formations (Entrada and Zuni) occupy the  $\approx$ 500-ft-thick sandstone interval that lies between the Chinle Formation and the Dakota Sandstone. Last, it tells us that the authors who correlated

Entrada Sandstone into New Mexico and advocated the Wingate-to-Entrada name change (Baker et al., 1947) also recognized the lower San Rafael Group at Fort Wingate and near Zuni Pueblo.

The significance of this last point will be examined, but first the use of Cow Springs Sandstone must be explained. Owing to the lack of interest in the barren Jurassic rocks of the Zuni Indian Reservation the name Zuni Sandstone had languished for years as a vague stratigraphic concept. Perhaps this is why Harshbarger et al. (1951, 1957) felt at liberty to introduce their Arizona name, Cow Springs Sandstone, to designate the rocks that Dutton had named the "Zuni sandstones." The authors offered no explanation for how their name (or unit) related to the Zuni Sandstone, which added to the confusion. One of their colleagues at the U.S. Geological Survey, the venerable Carle H. Dane, protested the use of Cow Springs Sandstone in New Mexico in a 1956 memo to the Geologic Names Committee. In this memo Dane contended that use of the name Cow Springs Sandstone in New Mexico "curdles my gizzard." While it may be true that language can produce unusual reactions and maladies, perhaps the more pertinent point to be made here is that the rule of nomenclatural priority was not followed (Article 7,

Section c, North American Stratigraphic Code, 1983).

In deference to Harshbarger et al. (1957), they did provide insight on regional correlations. From their work others were able to ascertain that the Zuni Sandstone correlates with the Cow Springs Sandstone at Black Mesa, Arizona, and they did recognize the Entrada Sandstone below their "Cow Springs" at Zuni Pueblo. Thus, they acknowledged the presence of two formations in this 500-ft-thick sandstone interval, consistent with what is stated earlier in this paper. However, their (Harshbarger et al., 1957) failure to recognize Zuni as a local stratigraphic name was the second time in a decade that U.S. Geological Survey authors had, for relatively trivial reasons, sought to abandon valid nomenclature and install their own. And what two names more readily summon up the New Mexico landscape than Zuni and Wingate? The abandonment of the original concept of a Wingate Sandstone is accepted. Not so for the Zuni; it remains a valid name in New Mexico. The name Cow Springs was invalid and superfluous the day it was introduced to New Mexico, and it is not recognized by the New Mexico Bureau of Mines and Mineral Resources.

The significance of the lower San Rafael Group is that it is a sequence that repre-

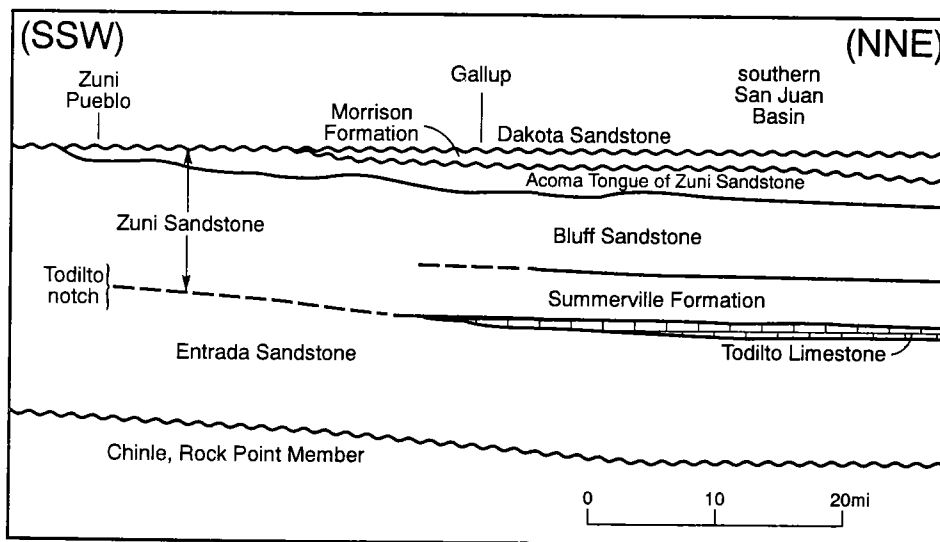


FIGURE 1—Diagrammatic stratigraphic cross section from Zuni Pueblo to southern San Juan Basin showing relationship of Todilto-Summerville-Bluff to Zuni Sandstone and stratigraphic position of the Acoma Tongue of the Zuni.

sents a transgression and highstand during Middle Jurassic (Callovian) time, a time of rather extreme aridity in western North America. The highstand is recorded by the Todilto Formation (limestone and gypsum) deposited in a paralic salina associated with, and at the southern end of, the Curtis-Sundance seaway. The southern margin of the basin of Todilto deposition-precipitation was just north of Zuni Pueblo (the area central to this discussion; Fig. 1). However, the local stratigraphic relationships are clear; thicknesses and lithologies do not vary significantly southward to Zuni, and the "Todilto notch" helps define the highstand. Thus, the "notch" not only represents the break between lower and upper San Rafael Group but also the attendant change from a transgressive facies tract to a regressive facies tract.

The regressive sequence comprising the upper San Rafael Group has been well defined in Utah where for the most part it overlies the Curtis Formation. The base of the regressive sequence consists of thinly bedded, gypsiferous sandstone, siltstone, and mudstone and represents deposition on an arid coastal plain-sabkha having short-lived, broad, shallow lakes and periodic influx of fine-grained eolian sand. These strata were designated the Summerville Formation by Gilluly and Reeside (1928) and in part overlap the Curtis in age. Summerville strata thin considerably southeastward through the Four Corners area; however, this thinly bedded, distinctive unit is recognizable into the San Juan Basin of New Mexico where it overlies the Todilto. The Todilto thus occupies a stratigraphic position similar to the Curtis (Anderson and Lucas, 1992). The Todilto and overlying regressive sequence (Summerville, etc.) recently have been assigned to the Wanakah Formation (Condon and Peterson, 1986). The objections to use of Wanakah for these strata were discussed by Anderson and Lucas (1992) and include the fact that Wanakah has been used since 1917 to designate Devonian strata in New York State.

Overlying the Summerville are local to regional eolianites that have been given a variety of names, including Bluff, Junction Creek, Zuni, yellow sandstone, and, most recently, Horse Mesa Member of the Wanakah. Bluff Sandstone has been the name accepted for many years by mappers in New Mexico; Junction Creek Sandstone is used in Colorado. But the point is that the Summerville and Bluff units that overlie the Todilto constitute a progressive refinement of the stratigraphic interval that was the original Zuni Sandstone. In fact, south of the Todilto pinchout the Summerville-Bluff grade into the main body of the Zuni Sandstone. If nomenclature changes involving the downgrading of Todilto-Summerville-Bluff to member ranks were necessary here, most certainly Zuni would be the logical

choice for the umbrella formation. But Zuni was not chosen; nor is any modification in nomenclature necessary.

#### Acoma Tongue of the Zuni Sandstone

A change in the bedform at the top of the Bluff Sandstone can be recognized across the southern San Juan Basin. The change is relatively abrupt and includes crossbed type, scale and magnitude of crossbeds, crossbed-dip direction, and a slight increase in grain size. This contrast with the underlying facies of the Bluff can be recognized at Mesa Gigante, Mesita, Seama Mesa, Acoma, Haystack Mountain north of Grants, Church Rock where there is a definite change in lithology at the break, and near Zuni Pueblo. At the Seama Mesa-Acoma localities, Maxwell (1976, 1979) referred to the upper, boldly crossbedded unit as the Zuni Sandstone. With the recognition of this unit at the top of the "main body" of the Zuni Sandstone near Zuni Pueblo, it has become necessary to regard Maxwell's Zuni as merely a tongue of the larger unit, and thus Anderson and Lucas (1992) proposed the name Acoma Tongue of the Zuni. This bedform change and the recognition of its regional extent have permitted reconciliation and proper correlation of Maxwell's (1976) Zuni Sandstone with the original Zuni Sandstone at Zuni Pueblo. This uncertainty admittedly had been a hindrance to the use of the name Zuni. Moreover, the designation of this change in bedform as an "unrecognized time boundary" (Condon and Peterson, 1986) at the base of the Morrison Formation is without merit and is here rejected. The Acoma Tongue of the Zuni is described as quartzose, commonly having frosted grains, and generally eolian in origin. As such this part of the section has been recognized as pre-Morrison since Goldman and Spencer's (1941) work.

In some areas the Acoma Tongue contains or grades into strata that exhibit some fluvial influence. Such an area is north of Thoreau. However, reconnaissance work and one measured section indicate that 66-70% of the section at Thoreau is of eolian origin. The eolian sands are of the pre-Morrison type; the interdunal and fluvial facies are siltstone, silty sandstone, and mudstone that exhibit dark, oxidized colors such as maroon, purple, and grayish red. These colors bleed down over the lighter-colored rocks, and the thickness of the interdunal and fluvial facies is exaggerated. The section thus superficially resembles the strata that are called Recapture Member of the Morrison Formation in Utah. The type Recapture, however, is considered to be dominantly fluvial in origin and is somewhat coarser grained than the section at Thoreau. It is therefore suggested that the Thoreau section, as much as 212 ft thick, be included as the upper part of the Zuni Sandstone, with a local name of member (tongue) rank if neces-

sary, to acknowledge the facies contrast with the Acoma Tongue.

Considerably upsection in the Zuni Sandstone at Thoreau and at Haystack Mountain some coarse-grained sandstones are present that might represent facies transitional to the overlying Morrison Formation. The base of the Morrison Formation in the southern San Juan Basin is herein considered to be the regionally traceable scoured surface at the base of what has been called the Westwater Canyon Member of the Morrison. Anderson et al. (1993) assert that the Westwater Canyon Member cannot be correlated from the type area in Utah into the San Juan Basin, and thus the Prewitt Member (from Smith, 1954) may be a more appropriate name for the basal Morrison unit.

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