The Middle Jurassic Summerville Formation, northern New Mexico--A reply to Anderson and Lucas, 1992

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The Middle Jurassic Summerville Formation, northern New Mexico—a reply to Anderson and Lucas, 1992

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Introduction

Recently, Anderson and Lucas (1992) indicated their displeasure with nomenclatural changes and correlations of some Jurassic lithostratigraphic units in northwestern New Mexico by objecting to: 1) the use of the names Wanakah Formation or Bell Ranch Formation in New Mexico, 2) the inclusion of the Todilto Limestone as a member of the Wanakah instead of a separate formation, 3) the name "Cow Springs" as applied to certain strata in the southwestern part of the San Juan Basin. In addition, they 1) did not recognize the utility of the Horse Mesa Member of the Wanakah and considered it superfluous, 2) considered all Jurassic eolian rocks above the Entrada Sandstone to be "homotaxial, and very likely correlative," 3) rejected the concept of the Tidwell Member of the Morrison Formation, and 4) believed that there is a concerted effort by current U.S. Geological Survey investigators to discredit the conclusions of previous workers. They stated (p. 87), "Since the earlier work . . . there has been a great deal of effort on the part of the U.S. Geological Survey investigators to disprove those original findings and provisional correlations, most of which we feel were valid." In summary, Anderson and Lucas (1992) believed that much of the preliminary work by USGS and other investigators in northwestern New Mexico was substantially correct, and that subsequent work is "without merit and tend[s] to stifle or inhibit regional correlations."

It is of considerable concern that the reports of Condon and Peterson (1986), Condon and Huffman (1988), Condon (1989a), and others, have troubled our New Mexico associates. However, Anderson and Lucas' (1992) article is replete with errors concerning Jurassic correlations and the motives of USGS researchers. The correlations presented in Anderson and Lucas (1992) are an over-simplification of the stratigraphic relations of Jurassic rocks in the eastern Colorado Plateau (Fig. 1). While it is true that not all Jurassic stratigraphic problems have been resolved satisfactorily, the stratigraphy of the eastern Colorado Plateau has been documented in much more detail than ever before, in contrast to what Anderson and Lucas (1992) would have the scientific community believe. Continuing work may warrant future modifications—but these changes would be adjustments to the stratigraphy already established by the authors noted above. Because the criticisms of Anderson and Lucas (1992) were so all-encompassing, it is not possible to respond to each detail in this report; the main points of disagreement are addressed herein.

Wanakah Formation

Anderson and Lucas (1992, p. 91) stated that, "Most importantly, Summerville has precedence, and the name Wanakah is occupied in New York State. Therefore, the name Wanakah should not be used to designate strata in Colorado." They cited Article 7(b) of the Stratigraphic Code (NACSN, 1983), which advises against duplication of names for stratigraphic units. They noted that the name Wanakah was first applied by Grabau (1917, p. 338, footnote) for a Devonian shale unit in western New York.

While it is true that the name Wanakah was used, albeit in a seven-word footnote ("Now designated the Wanakah shales by me"; Grabau, 1917), this is not an adequate definition of a new stratigraphic name today and was not adequate in 1917. There are stringent requirements for introducing formally named units in Article 3 of the current Code. These include designation of category and rank of unit; selection and derivation of name; specification of stratotype; description of unit; definition of boundaries; historical background; dimensions, shape, and other regional aspects; geologic age; correlations; and (optionally) genesis.

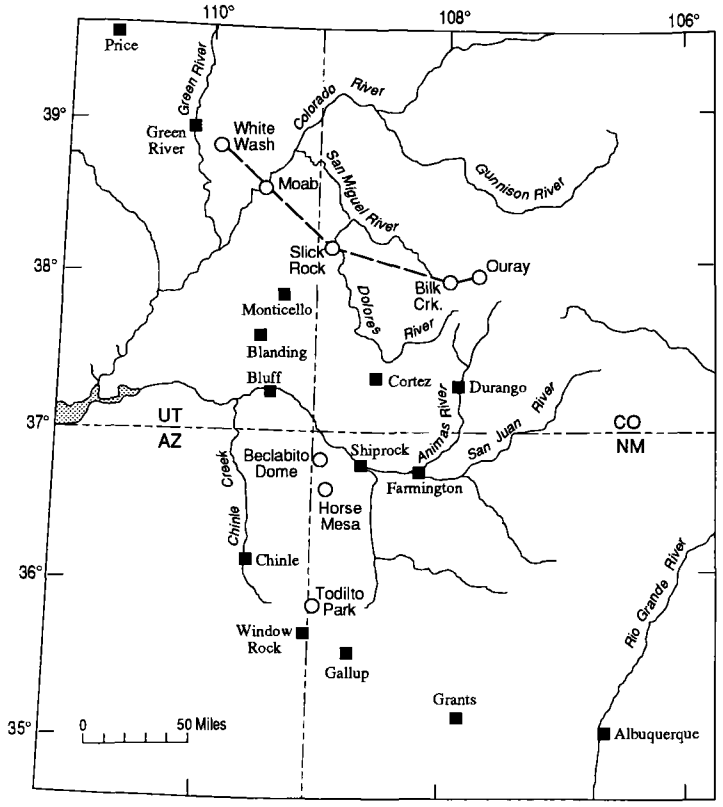

FIGURE 1—Location map of southeast Utah, southwest Colorado, and northwest New Mexico (modified from Anderson and Lucas, 1992).

Although Grabau cannot be held to current standards, he did have access to codified rules used for naming units for the USGS Geologic Atlas of the United States. Paragraph 3 of the Rules states, in part, "In every case the definition of a formation in the folio text should include a statement of the important facts which led to its discrimination and of the characteristics by which it may be identified in the field, whether by geologist or layman" (U.S. Geological Survey, 1903, p. 23). Grabau's casual mention of the name Wanakah in a footnote clearly did not meet the naming conventions of his contemporaries. Additionally, Article 7(c) of the current code notes that, ". . . priority alone does not justify displacing a well-established name . . ." The Wanakah of the eastern Colorado Plateau has been the subject of much more study than the New York unit. The rejection by Anderson and Lucas (1992) of the name Wanakah because it had been used previously by Grabau is specious.

The name Wanakah does not seem to have been used further until much later when Cooper (1930) formally introduced the Wanakah Member of the Ludlowville Formation into the geological literature. In the same year Burbank (1930) applied the name Wanakah Member of the Morrison Formation to rocks in southwestern Colorado. Burbank acknowledged Grabau's (1917) prior use of the term, but felt that the wide geographic and geologic separation would prevent confusion of the two units. One can only speculate that Burbank probably would have not used the term had he been aware of Cooper's work in New York. Because the units were both formally introduced in the same year, the name Wanakah does not have precedence in either New York or ☞

Colorado. Typical sections at or near the Wanakah mine were published by Burbank (1930) and O'Sullivan (1992) as well as by Anderson and Lucas (1992).

Since the appeal to the Code for rejection of the name Wanakah should be dismissed, what about rejection on stratigraphic grounds? This point involves three issues: 1) Recognition of two distinct units, based on lithology, in their respective type areas, 2) Correlation of the Wanakah with the type Summerville of the San Rafael Swell, and 3) Recognition of the Todilto Limestone Member of the Wanakah as a separate formation.

Anderson and Lucas (1992, p. 80) stated that, "The Wanakah Formation is another name for Summerville and associated strata in southwestern Colorado." This is incorrect because the Wanakah in southwestern Colorado consists of the Pony Express Limestone Member, the Bilk Creek Sandstone Member, and an upper unit variously called the marl member (Bush and others, 1959), upper member (Ridgley, 1989), or beds at Sawpit (O'Sullivan, 1992). Even considering only the part of the Wanakah above the basal limestone, the remaining part of the formation is lithologically distinct from the Summerville. The Wanakah consists largely of calcareous sandstone, whereas the type Summerville lacks significant amounts of sandstone.

A sandstone marker bed in the Wanakah near Bluff, Utah—the bed at Butler Wash—and the lower member of the Wanakah merge northward into the Entrada Sandstone (O'Sullivan, 1980b). The middle member of the Wanakah also grades northward into the Entrada in east-central Utah (O'Sullivan and Pierce, 1983). These relations indicate that few, if any, strata previously called Summerville in the San Juan Basin can be traced into the type Summerville. The sections of Anderson and Lucas (1992, p. 82) are too widely spaced and do not show the bed at Butler Wash in the area where it was defined. They thus incorrectly simplify the correlations from northwest New Mexico to the Moab area.

A comparison of the stratigraphy of McKnight (1940, p. 90) (Fig. 2) with Anderson and Lucas (1992, p. 82) (Fig. 3) is illuminating. McKnight used an unconformity (currently recognized as the J-3 unconformity) at the top of the main body of the Entrada Sandstone as a datum. At Dellenbaugh Butte, (Fig. 2) the Curtis and Summerville Formations are both present above the Entrada. At White Wash, McKnight recognized only the Summerville above the Entrada, but the Curtis, which is a gray marine unit, was interpreted to grade laterally into the beds called the lower Summerville (McKnight, 1940, p. 98). However, the assignment of strata immediately above the Entrada to the Summerville at this locality only was made on the basis of the change from dominantly greenish-gray strata to dominantly red strata. Anderson and Lucas (1992, Fig. 5A) showed a distinct two-part division of the Summerville at this locality. Marker beds traced around the White Wash area establish the stratigraphic position of the contact between the Curtis (i.e., lower Summerville of McKnight) and the Summerville (O'Sullivan, 1980a). Thus, instead of assigning the whole interval between the Entrada and Morrison to the Summerville at White Wash, the lower, lighter-colored part of the section is considered a landward facies of the Curtis.

McKnight's next section to the southeast at Tenmile Wash (Fig. 2) shows the Moab Tongue of the Entrada grading laterally westward into the lower Summerville of McKnight (Curtis equivalent). The Summerville Formation extends to the southeast stratigraphically above the Moab Tongue. The relations shown by Anderson and Lucas (1992) are essentially the same as those shown by McKnight in the area of White Wash (Fig. 3). What they failed to show is that their Summerville Formation at Whitewash [sic] is equivalent to both the Curtis and Summerville Formations at a locality farther west at Dellenbaugh Butte.

Anderson and Lucas (1992) correlated the Moab Tongue of the Entrada with the lower Summerville of McKnight and thus with rocks equivalent to the Curtis. O'Sullivan (1980a) showed this much more clearly, based on detailed correlations of marker beds. Additionally, Anderson and Lucas (1992) showed the Todilto Limestone below the datum at the base of the Moab Tongue, indicating that the limestone is equivalent to the upper part of the Entrada, not to the Curtis. The unit labelled Summerville in areas to the southeast of Moab (Fig. 3) consists of Entrada, Curtis, and Summerville equivalents, and therefore cannot be called Summerville. The name used by O'Sullivan (1980b) and O'Sullivan and Pierce (1983) for these rocks is Wanakah Formation. It can be demonstrated, through subsurface log correlation, that the Wanakah of southwest Colorado and southeast Utah is the unit previously called Summerville in the San Juan Basin. Although the name Summerville is "entrenched" in New Mexico, it is incorrectly entrenched. Geologic observations should be the basis for regional correlations, not entrenchment.

Todilto Limestone

The Todilto Limestone was defined by Gregory (1917) for exposures in Todilto Park on the west side of the San Juan Basin. The equivalent "Pony Express [Limestone] beds," along with the overlying sandstone bed and shale beds, were included by Burbank (1930, p. 175) in the Wanakah near Ouray, Colo. The sand-

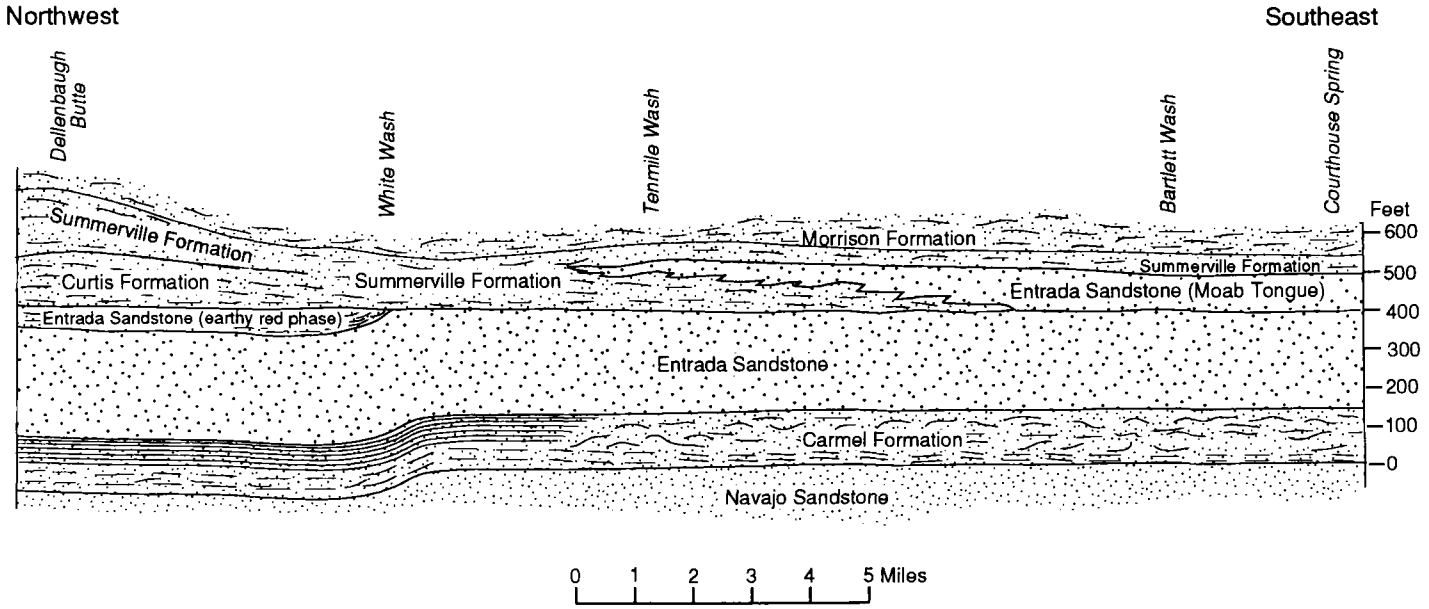

FIGURE 2—Diagram showing stratigraphic relations of the San Rafael Group northwest of Moab, Utah (from McKnight, 1940).

stone bed subsequently has been assigned to the Bilk Creek Sandstone Member of the Wanakah (Goldman and Spencer, 1941). When Condon and Huffman (1988) extended the name Wanakah into northwestern New Mexico and northeastern Arizona, it was prudent to maintain the same base of the formation from one area to the other, at the base of the limestone member. A principal reference section for the Wanakah was established at Horse Mesa, Arizona and New Mexico, where three members of the Wanakah are present: the Todilto Limestone Member at the base, the Beclabito Member, and the Horse Mesa Member.

Anderson and Lucas (1992, p. 81) argued against inclusion of the Todilto as a member of the Wanakah. They cited the thickness (locally over 150 ft) and areal extent (33,000 mi^2) of the unit as reasons for continuing its status as a formation. They also stated that, ". . . [it] has been recognized as [a formation] since the name was introduced by Gregory (1917)."

The North American Stratigraphic Code, Article 24(d) states that, "Thickness is not a determining parameter in dividing a rock succession into formations. . ." Article 25(a) of the code states that, "Even if all members of a formation are locally mappable, it does not follow that they should be raised to formational rank, because proliferation of formation names may obscure rather than clarify relations with other areas." Moreover, Harshbarger and others (1957, p. 38) and Woodward (1987, p. 34) correctly pointed out that the Todilto has been assigned to various units as both a formation and as a member since it was originally defined. Condon and Huffman (1988) emphasized regional stratigraphic relations rather than stressing local differences. The Code states that formations are fundamental units in lithostratigraphic classification. Condon and Huffman (1988) therefore correlated the formation-rank Wanakah over the eastern Colorado Plateau while using local names such as Todilto and Pony Express as members of the Wanakah.

Eolianites overlying the Entrada Sandstone

In the San Juan Basin and surrounding areas, five units are recognized above the Entrada Sandstone that are all or partially eolian in origin: the Cow Springs Sandstone, the Horse Mesa Member of the Wanakah, the Bluff and equivalent Junction Creek Sandstones, and the Recapture Member of the Morrison Formation. An additional unit recognized by some geologists, the Zuni Sandstone, includes both the Entrada and Cow Springs Sandstones. The Cow Springs Sandstone, Horse Mesa Member, and lower part of the Junction Creek Sandstone are correlative and represent eolian deposition marginal to sabkha deposits of the underlying and laterally equivalent Beclabito Member of the Wanakah. The Bluff Sandstone, upper part of the Junction Creek Sandstone, and part of the Recapture Member are also correlative, but they are stratigraphically above the Cow Springs Sandstone and Horse Mesa Member of the Wanakah (Condon and Peterson, 1986). Anderson and Lucas (1992, p. 91) lumped all of these units into the Zuni Sandstone and the Bluff Sandstone, which they incorrectly correlated to the southern part of the San Juan Basin.

Cow Springs Sandstone

Harshbarger and others (1957) concluded that the Cow Springs Sandstone was deposited on the south side of a large basin in which equivalent formations of the San Rafael Group were deposited to the north. The sandstone is correlated, and the name carried, from the type locality in the Black Mesa Basin into the southwestern San Juan Basin based on lithology, mode of origin, stratigraphic position at the top of the Entrada Sandstone, and relation to the Beclabito Member of the Wanakah Formation. O'Sullivan (1978) showed the Wanakah grading laterally into the Cow Springs in the Black Mesa Basin in a manner similar to that shown by Condon and Peterson (1986) in the San Juan Basin. The correlation of the Bluff Sandstone of southeast Utah with the Cow Springs, as shown by Anderson and Lucas (1992, Fig. 2C) is incorrect, as first shown by Wright and Becker (1951) and later shown by Condon (1989b). The Bluff Sandstone overlies strata partly equivalent to the Cow Springs Sandstone in the type area of the Bluff in southeast Utah. The assertion by Anderson and Lucas (1992, p. 91) that the Cow Springs was shown by Peterson (1988) as a "pre-Todilto" unit in the Black Mesa area is also incorrect. The Todilto is not present in the Black Mesa area, and it wasn't discussed by Peterson (1988).

Horse Mesa Member of the Wanakah Formation

As used by Condon and Huffman (1988), the Horse Mesa Member is the same unit described as: 1) the upper sandy member of the Summerville by Harshbarger and others (1957), 2) member A of the Bluff and Junction Creek Sandstones by Craig and Cadigan (1958), 3) the Bluff Sandstone by Thaden and Ostling (1967), 4) the brown-buff sandstone by Silver (1948), and 5) the Bluff Sand- ☞

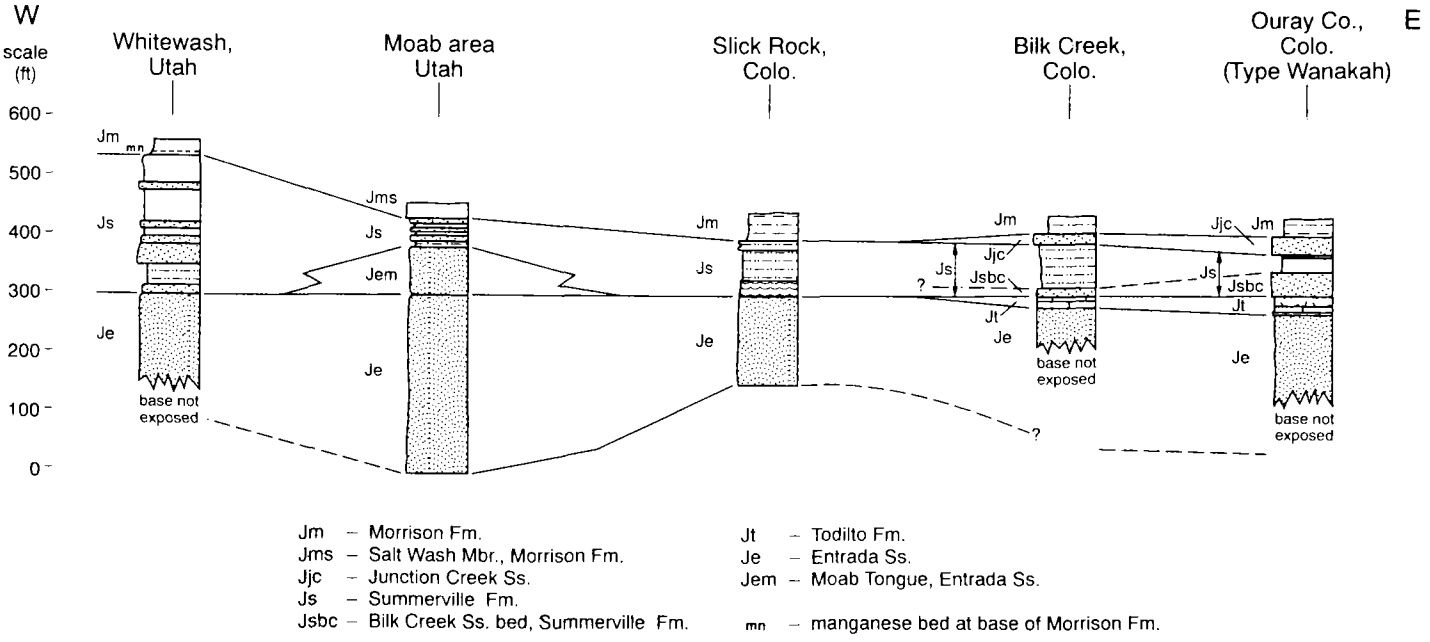

FIGURE 3—Diagram showing stratigraphic relations of the San Rafael Group from northwest of Moab, Utah to Ouray, Colorado (from Fig. 2D of Anderson and Lucas, 1992). Location of line of section is shown on Figure 1.

stone by Maxwell (1982). Condon and Huffman (1988) and Condon (1989a) distinguished the Horse Mesa from the partially equivalent Cow Springs Sandstone on the basis of subtle, but important, differences in composition and transport directions. Although described as a "fluviatile sandstone" by Maxwell (1982), the Horse Mesa actually represents a period of widespread eolian activity at the close of deposition of the San Rafael Group. There are critical differences between the Horse Mesa and the eolian rocks in the Bluff, Junction Creek, and the Recapture Member that warrant recognition of the Horse Mesa as a separate unit. The Horse Mesa and Cow Springs are stratigraphically below, lithologically different from, and genetically unrelated to those overlying eolian strata. Anderson and Lucas' (1992) contention that the Horse Mesa is superfluous is erroneous, because recognition of the Horse Mesa documents an important event in the depositional history of the San Rafael Group.

Bluff and Junction Creek Sandstones

The Bluff and Junction Creek Sandstones represent a large dune field in the Four Corners area and in southwestern Colorado. Anderson and Lucas (1992, p. 80) contended that the Bluff Sandstone contains a fluvial facies, but offered no documentation for that interpretation. The most distinctive characteristic of the Bluff and Junction Creek is very large scale, tabular crossbed sets that indicate eolian transport to the east and northeast. The assertion of Anderson and Lucas (1992, p. 87) that the Bluff extends southward in the subsurface is incorrect. Detailed measured sections along the western basin margin (Condon, 1989b) and subsurface studies (Blakey and others, 1988; S. M. Condon and A. C. Huffman, Jr., unpubl. data) indicate that the Bluff cannot be traced to the southern San Juan Basin.

Anderson and Lucas (1992, p. 89) implied that an unconformity was recognized by Condon and Huffman (1988) at Tsitah Wash, Arizona, where the Bluff overlies truncated beds of the Horse Mesa Member. This is not true. Condon and Huffman (1988) did not discuss the cause of the folding in the Beclabito and Horse Mesa Members, but based on observations at many localities in southeast Utah and northeast Arizona believe that the folds are due to syndepositional slumping. Corken (1979, p. 17) noted similar thickness variations in the unit recognized as the Horse Mesa in northwestern New Mexico. He attributed the thickness variations to, ". . . pre-Morrison low-amplitude folding and subsequent planation." However, he did not specify the cause of the folding in that area.

Recapture Member

Anderson and Lucas (1992, p. 88) disputed the presence of any eolian rocks in the Morrison Formation. In doing so they dismissed the observations and conclusions of Craig and others (1955), Harshbarger and others (1957), Freeman and Hilpert (1956), Moench and Schlee (1967), Saucier (1967), Corken (1979), Huffman and others (1980), and Thaden (1990), all of whom described eolian rocks in the Morrison of the San Juan Basin. Eolian rocks in the Morrison have also been described in Arizona (Peterson, 1988), Colorado (Rowley and others, 1979), Wyoming (Uhlir, 1986; Weed and Vondra, 1987), and South Dakota (Szigeti and Fox, 1981).

The observed interbedding of eolian rocks with the Morrison resulted in a conceptual model that portrayed the Morrison and all of the San Rafael Group grading southward into a thick eolian "sandpile." Saucier (1967) was the first author to recognize both fluvial and eolian facies within the Recapture Member, and he did not describe the eolian facies as a tongue of the Cow Springs Sandstone. He recognized that the eolian facies was a part of the same depositional system that in other places deposited fluvial strata of the Recapture. Saucier's interpretations were generally unheeded by subsequent mappers working along the southern basin margin.

Corken (1979) described eolian rocks within the lower part of the Recapture Member and even within the upper part of the Salt Wash Member of the Morrison in the northwestern part of the San Juan Basin. Thaden (1990) mapped eolian strata within the Recapture in the Todilto Park area and other localities along the western side of the basin. Condon (1985) described interbedded fluvial and eolian beds in the Recapture in the Lupton area. In the Church Rock area, northeast of Gallup, eolian strata occupy nearly the entire Recapture interval (Saucier, 1967).

In all of these localities, one characteristic feature distinguishes the eolian beds of the Recapture—the presence of very large scale crossbed sets with transport directions to the east-northeast. On the basis of the documented occurrences of eolian rocks within the Recapture, and also on the basis of interbedding of the Recapture with eolian rocks displaying very large scale crossbedding in the Laguna area (Freeman and Hilpert, 1956, p. 314; Moench and Schlee, 1967, p. 17), Condon (1989a) extended the concept of an eolian facies of the Recapture to the Acoma Sag area. This facies was previously called the white sandstone member of the Morrison Formation by Silver (1948), the upper part of the Bluff Sandstone by Moench and Schlee (1967), and the Zuni Sandstone by Maxwell (1982). Anderson and Lucas (1992, Fig. 2) referred to the unit as the Acoma Tongue of the Zuni Sandstone. The eolian strata in the Recapture are coeval with the Bluff and Junction Creek Sandstones of the northern San Juan Basin. Where this facies is in contact with the underlying Cow Springs Sandstone at Lupton or Horse Mesa Member in the Acoma Sag, the contact is commonly sharp, but it is not interpreted as an unconformity.

The documented presence of eolian rocks in the lower part of the Morrison Formation, both in the San Juan Basin and in other areas of the Western Interior, indicates that Anderson and Lucas (1992) were mistaken in assuming that the Morrison consists of only fluvial rocks. The lithology and transport directions of the eolian facies of the Recapture indicate the similarity of this facies to the Bluff and Junction Creek Sandstones, but interbedded fluvial strata led Condon and Peterson (1986) and Condon (1989a) to assign the entire interval to the Recapture.

Zuni Sandstone

Anderson (1983a, b) presented a summary of nomenclatural changes and stratigraphy relating to the Zuni Sandstone, correctly pointing out that the Zuni had been defined by Dutton (1885) to include all rocks between Triassic and Cretaceous strata in the Zuni Pueblo area. Anderson (1983a, b) presented a measured section near Zuni and established a principal reference section for the unit. As defined by Anderson (1983a, b), the Zuni consists of the undivided Entrada and Cow Springs Sandstones in areas where intervening rocks of the San Rafael Group do not separate the units or where the units cannot be distinguished by a conspicuous notch that is lateral to the Todilto Limestone.

Anderson and Lucas (1992, p. 88) redefined the Zuni to include only rocks equivalent to the Cow Springs Sandstone (about the upper half of Dutton's Zuni Sandstone) and referred to the combined unit as the "Zuni-Entrada" where the formations cannot be divided. This is a corruption of Dutton's and Anderson's original definition of the formation; a change that is unwarranted. Anderson and Lucas (1992, p. 88) conceded that "no basis exists for subdividing the sandpile" in many places. This being the case, there is no purpose served in applying two formation names (Entrada and Zuni) to the sequence instead of just the name Zuni. Moreover, the rocks identified by Anderson and Lucas (1992) as the Acoma Tongue of the Zuni are stratigraphically above and thus are unrelated to the "type" Zuni. Rather than clarifying regional stratigraphic relationships, recognition of a Zuni Sandstone in the Acoma Sag area obscures stratigraphic relations in the southern San Juan Basin.

Summary

Anderson and Lucas (1992, p. 87) said that there is an ongoing attempt to discredit the findings of earlier USGS investigators in an attempt to, "find a way to get the eolianites into the Morrison Formation," even though eolianites in the Morrison Formation have been described in many areas in the Western Interior. An-

derson and Lucas (1992, pp. 87, 91) gave examples of supposed "contrivances" that they said were presented to prove the presence of the J–5 unconformity below eolian rocks in the Four Corners area. Additionally, Anderson and Lucas (1992, p. 91) said that, "The Summerville can be physically traced into southeastern Utah," while also stating (p. 89) that, "White Wash, Utah . . . [is] a long distance from . . . Blanding and between which the San Rafael Group strata cannot be directly traced."

These contradictory statements indicate an incomplete understanding of the physical relations of Middle and Upper Jurassic rocks in the eastern Colorado Plateau by Anderson and Lucas (1992). All stratigraphic and nomenclatural changes made by USGS investigators concerning these rocks have been based on geological observations and reflect findings on the rocks under study. The goal of Condon and Peterson (1986), Condon and Huffman (1988), and Condon (1989a, b), among others, was to conduct accurate stratigraphic and sedimentological studies of rocks to understand the depositional history of the area. When detailed geological studies indicated that rocks southeast of Moab were not equivalent to the type Summerville Formation, changes were made to state those findings. Nomenclatural changes in New Mexico were made to tie the whole area together, a goal not unlike that of Anderson and Lucas (1992). Condon and Peterson (1986), Condon and Huffman (1988), and Condon (1989a, b) did not extend the J–5 unconformity into northwestern New Mexico.

A simplified, but incorrect, view of Middle and Upper Jurassic stratigraphic correlations in the eastern Colorado Plateau, such as that presented by Anderson and Lucas (1992), hinders our understanding of the depositional history and paleogeography of the area.

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