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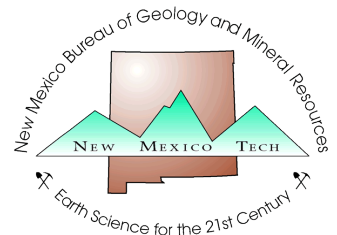
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# The Middle Jurassic Summerville Formation, northern New Mexico —a rebuttal of Condon, 1993

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## Introduction

Nothing new is presented in Condon's reply (Condon, 1993) to our paper on the Summerville Formation and related strata in northern New Mexico (Anderson and Lucas, 1992). Condon resorted to trivializing our objection to using preoccupied stratigraphic names, calling it specious, and also to searching the stratigraphic code (NACSN, 1983) for loopholes in order to justify perpetuating his confusing duplication of names. Clearly usage of the name Wanakah as a stratigraphic unit in New York has precedence over usage in southwest Colorado. Significantly, Condon did not choose to defend regional correlations proposed by workers at the U.S. Geological Survey based on the "Bed at Black Steer Knoll." We interpret this as an admission that regional correlations based on the "Bed at Black Steer Knoll" are unsupportable.

Generally, arguments set forth by Condon only strengthen our conclusion that the last 25 years of effort by workers of the U.S. Geological Survey to revise Middle and Upper Jurassic stratigraphy and sedimentation models on the Colorado Plateau have been based on (1) continued use or creation of redundant and parochial stratigraphic names, (2) purported tracing of marker beds that cannot be traced by other investigators in the field, (3) postulating regional unconformities for which no stratigraphic or geochronologic evidence exists and using these "unconformities" as formation contacts, and (4) creating sedimentological models to which stratigraphic units are retrofitted regardless of the actual stratigraphic relationships.

## Preoccupied stratigraphic names should not be used

We pointed out that the term "Wanakah Shales," introduced by Grabau (1917) for Devonian strata in New York, has priority over Burbank's (1930) "Wanakah Member of the Morrison Formation." Indeed, the Middle Devonian Wanakah Member of the Ludlowville Formation (the Hamilton Group) is a well recognized stratigraphic unit used in many publications, including the Geologic Map of New York published by the New York State Museum of Science/New York Geological Survey (Rickard and Fisher, 1970a, b) and more recently by Miller (1991) in a discussion of Devonian stratigraphy. Grabau (1917, p. 338) introduced the name in a footnote to refer to an already well known unit, "the lower Hamilton Shales" of western New York. Cooper (1930, p. 225) subsequently designated and described a type section for what he termed the Wanakah Member of the Ludlowville Formation of the Hamilton Group. This unit is listed and described in the most recent U. S. Geological Survey Lexicon of Geologic Names (Keroher, 1966) and has never been recommended for abandonment by the original author nor the U. S. Geological Survey.

Condon challenges the idea that Grabau's use of Wanakah has priority over Burbank's on the ground that Grabau's introduction of the name Wanakah Shales did not constitute "an adequate definition of a new stratigraphic name . . . in 1917." Obviously, Condon is alone in this belief, since all stratigraphers who have worked in western New York, and geologists of the New York Geological Survey, have recognized Grabau's Wanakah Shales as a valid stratigraphic unit. Even Burbank (1930) acknowledged Grabau's priority, although he thought no confusion would arise from giving the same name to two geographically disparate units.

Much confusion would arise if the criteria demanded by Condon were applied to many of the stratigraphic names introduced in the 1800s and early 1900s. Well understood and widely used names such as Shinarump, casually used by Powell (1876) but in

no way carefully defined as a stratigraphic unit, and Redwall Limestone, introduced by Gilbert (1875) but not named for a geographic location, would have to be considered invalid using Condon's criteria.

Condon fails to understand that long-used and widely accepted stratigraphic names, such as Grabau's term Wanakah, are valid and take priority over later usages even if the original definitions do not meet current or (what Condon imagines to be) earlier standards. Failure to understand and implement this basic concept is a recipe for nomenclatural chaos. Condon's claim that "the Wanakah of the eastern Colorado Plateau has been the subject of much more study than the New York unit" can only mean that he is unaware of extensive geological and paleontological literature on the New York Wanakah.

## The "Beclabito Member of the Wanakah" is correlative with the Summerville

At the heart of our disagreement with Condon and his colleagues is the correlation of San Rafael Group units on the Colorado Plateau from west-central New Mexico to southwestern Colorado to east-central Utah. The correlation we propose is supported by all available litho- and biostratigraphy and is advocated by most workers, including Harshbarger et al. (1957), Imlay (1980), Kocurek and Dott (1983), and Ridgley (1989), among others. This correlation (Fig. 1a) recognizes the main body of the Entrada Sandstone across the Colorado Plateau. The overlying Todilto Formation in northern New Mexico/southwestern Colorado represents a salina lake (Lucas et al., 1985) or a marine embayment (Harshbarger et al., 1957; Ridgley, 1989) related to a rise in regional base level due to the transgression of the Curtis-Stump (early-middle Callovian) seaway. The Sundance Formation of South Dakota-Wyoming was also deposited during this transgression; the ichthyofauna of the Todilto Formation is also found in the Sundance Formation, lending further support to the correlation (Schaeffer and Patterson, 1984).

The Summerville Formation of our usage overlies the Todilto Formation or, where the Todilto is absent, the main body of the Entrada Sandstone from Cimarron County in western Oklahoma to near Moab in east-central Utah. West of Moab, to the San Rafael Swell, however, the Summerville overlies the shallow-marine Curtis Formation which, not surprisingly, occupies the same stratigraphic position as the Todilto Formation. Regional stratigraphic relationships, fossils, and lithology thus support the correlation advocated by most workers between west-central New Mexico and the San Rafael Swell of Utah: Entrada = Entrada, Todilto ≈ Curtis, and Summerville ≈ Summerville, with the recognition that part of the upper Curtis may grade eastward or southeastward into lower Summerville strata (Fig. 1a).

Condon and his colleagues (especially O'Sullivan, 1980a, b), however, propose a very different correlation (Fig. 1b). They claim that careful tracing of key marker beds shows the "Wanakah Formation" of southwestern Colorado (and west-central New Mexico) to be older than the Summerville Formation of east-central Utah. According to Condon, the Wanakah is correlative with the Curtis. This apparently indicates to him that the Todilto is older than the Curtis and that the Entrada Sandstone of west-central New Mexico is older than the Entrada of Utah (Fig. 1b). Ironically, it was Condon's predecessors (Baker et al., 1947) who correlated the Entrada Sandstone into the southern San Juan Basin.

In our original article we refuted the Wanakah-Curtis correlation by pointing out that the so-called "marker bed"—"Bed at

San Rafael Swell, Utah		San Juan Basin, New Mexico
Morrison Formation	Brushy Basin Member	Morrison Formation
	lower members	Zuni Sandstone
Summerville Formation		Bluff Sandstone
Curtis Formation		Summerville Formation
		?—?
		Todilto Formation
Entrada Sandstone		Entrada Sandstone

A

San Rafael Swell, Utah		San Juan Basin, New Mexico
Morrison Formation		Morrison Formation
Summerville Formation		Cow Springs Sandstone
Curtis Formation		Horse Mesa Member
		Beclabito* Member
Entrada Sandstone		Todilto Member
		Entrada Sandstone

B

\* = Summerville Formation of A

FIGURE 1—Correlation of Middle and Upper Jurassic units between Utah and northwestern New Mexico: A) correlation suggested by Anderson and Lucas (1992); B) correlation inferred by Condon.

Black Steer Knoll”—used to support this correlation varies considerably in lithology, thickness, and exact stratigraphic position and cannot be directly traced (Anderson and Lucas, 1992, p. 89, figs. 2, 5). Since there is no marker bed that can be traced from southwestern Colorado to east-central Utah, the lithostratigraphic basis for a Curtis–Wanakah correlation presented by O’Sullivan (1980a, b) and cited by Condon and Peterson (1986, p. 15) does not exist.

In the final analysis of critical correlation factors the position, recognition, and extent of the J–3 unconformity may have more implications than arguing age relationships of Curtis–Summerville (which overlap in part) and the age relationship of both of them to the “Wanakah.” The J–3 unconformity at the base of the Curtis Formation in Utah marks a transgression; a pebbly zone at the base of the Todilto in the southwestern San Juan Basin marks that transgressive surface. Both lie at the top of the Entrada Sandstone; so stratigraphic position, regional stratigraphic relationships, position in facies tract, and paleogeography, all suggest that the pebbly zone at the base of the Todilto is penecontemporaneous with the J–3 unconformity. This correlation is further discussed below with regard to the U.S. Geological Survey’s perception of the Cow Springs Sandstone.

Condon calls on other evidence to support the Wanakah–Curtis correlation. He cites O’Sullivan (1980b) and O’Sullivan and Pierce (1983), who have shown the lower and middle Wanakah grading northward into the Entrada in east-central Utah. Condon concludes that “few, if any, strata previously called Summerville in the San Juan Basin can be traced into the type Summerville.” What he fails to point out is that O’Sullivan (1980a, b) and O’Sullivan and Pierce (1983) traced the upper part of the Wanakah all the way to the San Rafael Swell where they miscorrelated it with the Curtis Formation. The point is that Summerville (= Wanakah) strata are continuous throughout the Colorado Plateau, although the unit is relatively thin in southeastern Utah. McKnight’s (1940) interpretation of the Middle Jurassic stratigraphy northwest of Moab, reproduced by Condon as his figure 2, is endorsed by us.

Condon reasserts the erroneous correlation (locally) of the “Bed at Black Steer Knoll” of O’Sullivan (1980b) and refers to O’Sullivan and Pierce (1983) to argue that strata, which McKnight labelled Summerville (and which lie above the Moab Tongue of the Entrada Sandstone on the southwestern end of McKnight’s cross section), are not Summerville. This is an assertion for which Condon presents no evidence. Furthermore, Condon’s statement that rocks southeast of Moab, which we termed Summerville, “consist of Entrada, Curtis, and Summerville equivalents and therefore cannot be called Summerville” runs contrary to established stratigraphic practice. These rocks are lithologically similar to, and continuous with, Summerville strata and should be mapped as Summerville Formation even if they include strata correlative with the Curtis Formation.

The rather superficial reasons for the Summerville–to–Wanakah name change are discussed by Condon and Peterson (1986, p. 15). In addition, a written communication from Condon to Anderson (February, 1986) states “Had O’Sullivan’s revised interpretation been known to me earlier, I wouldn’t have gone ahead with the name change in the San Juan Basin.” The “revisions” alluded to by Condon are those of O’Sullivan in which he acknowledged that the Summerville was not cut out entirely by pre-Morrison erosion in the four-corners area. The “name change,” of course, refers to the change from Summerville to Wanakah. A subsequent written communication from Condon to Anderson (February, 1988) includes the following: “Although the interpretation now is that the Summerville is not cut out entirely in areas as far south as Uravan, the fact remains that the nomenclature was formally changed in much of south-central and southeast Utah by O’Sullivan (1980a).” From this we conclude that an unnecessary name change was made, and Condon and Peterson (1986) saw some utility in honoring the change.

The rejection of the name Wanakah by us (Anderson and Lucas, 1992) is not the first nor the most significant rejection. We merely pointed out that it was a preoccupied name, and that it was inappropriate and superfluous in New Mexico. In fact “Zuni Formation” would have been a more enlightened choice if a name change were needed, and it most definitely has precedence over Wanakah. The first and most significant rejections of the name Wanakah in New Mexico were the mappers of the ‘50s, ‘60s, ‘70s and ‘80s who used Todilto–Summerville–Bluff for these strata, nearly unanimously.

### The Todilto is a separate formation

Gregory (1916) introduced the term Todilto Limestone as a unit of formational rank. As presently mapped, the Todilto Formation is present across much of northern New Mexico from the Arizona/New Mexico state line to as far east as western Quay County and in southwestern Colorado as far north as Montrose, an area of approximately 88,000 km<sup>2</sup>. Virtually all mappers, especially those of the U.S. Geological Survey, have mapped the Todilto across this area as a unit of formational rank. Condon’s assertion that the Todilto should instead be regarded as a member of the Wanakah Formation is similar to his assertions about the invalidity of Grabau’s Wanakah; it indicates a lack of understanding of basic stratigraphic principles and an apparent lack of knowledge of the relevant practice.

To all those familiar with the Todilto Formation, its carbonates and evaporites present a striking contrast to the adjacent San Rafael Group strata that are mostly siliciclastic eolianites (Entrada) and tidal flat-sabkha deposits (Summerville). This contrast makes the Todilto a readily mappable and traceable unit throughout its outcrop belt, and also one easily recognized from subsurface data. For these reasons a vast majority of workers have long recognized and readily mapped the Todilto as a unit of formational rank. We agree with Condon and the Code of Stratigraphic Nomenclature that “formations are fundamental units in lithostratigraphic classification.” The Todilto Formation is in fact the most unique, fundamental, and readily mappable lithologic unit in the San Rafael Group.

### Horse Mesa is a redundant name

Eolianites in the Upper San Rafael Group on the Colorado Plateau have been given a bewildering array of names: Bluff, "Cow Springs," Junction Creek, Zuni, Mesita, and Horse Mesa. In northwestern New Mexico most of the eolianites represent a single lithosome to which the name Bluff Sandstone of Gregory (1938) is properly applied (Anderson and Lucas, 1992). The Horse Mesa Member of Condon and Huffman (1988) is a redundant name for the Bluff Sandstone. The "subtle" differences between it and the Bluff Sandstone elsewhere referred to by Condon to justify recognition of the Horse Mesa as a distinct unit are very subtle indeed. They are minor sedimentological differences that do not merit recognition of the Horse Mesa as a separate unit.

Just as the Horse Mesa is superfluous, so also is the Beclabito Member of the Wanakah Formation which Condon and Huffman (1988) applied to the Summerville Formation. An important point, obvious to all, is that too much nomenclature has been created for Middle and Upper Jurassic in the southwestern interior mostly by workers of the U.S. Geological Survey. Our work has been designed to present reproducible lithostratigraphic correlations of the Middle and Upper Jurassic strata. These correlations (Anderson and Lucas, 1992) demonstrate that a variety of recently introduced names, including the Horse Mesa and Beclabito Members of the Wanakah, are unnecessary. Condon's arguments to preserve these and other names are based on correlations that we (and others) cannot replicate.

### Cow Springs is a superfluous name in New Mexico

In addition to introducing unnecessary nomenclature, Condon continues to advocate the use of obsolete and superfluous nomenclature in the San Juan Basin. He and his colleagues would recognize the Cow Springs Sandstone, even though previous U.S. Geological Survey authors (Dane 1956; Dane and Bachman, 1965; Maxwell, 1976, 1979, 1982) have indicated their preference for the name Zuni Sandstone. Zuni has precedence over Cow Springs, having been introduced by Dutton (1885) for strata overlying the Wingate (= Entrada) near Fort Wingate, New Mexico, and underlying the Dakota Sandstone. However, when Dutton extended his type Wingate (= Entrada) from Fort Wingate southward to Zuni Pueblo, he misrelated it with the older Rock Point Formation of the Chinle Group. At this locale he thus erroneously included the Wingate (= Entrada) with the overlying Zuni Sandstone.

Our definition of the Zuni Sandstone as a post-Entrada unit (Anderson and Lucas, 1992) takes into account the Dutton-misrelation plus the fact that Harshbarger et al. (1957) chose to recognize the Entrada Sandstone as a distinct unit underlying their Cow Springs Sandstone at Zuni Pueblo (Cow Springs was a new name that they used to describe eolian strata above the Entrada at Black Mesa, Arizona). These two factors plus the presence of a depositional break at the top of the Entrada (the local expression of the J-3? unconformity, or the "Todilto notch") make it proper, if not imperative, that two Middle Jurassic units, Entrada and Zuni, be recognized in the Zuni Basin south of the Todilto pinch-out (Anderson, 1993). Most of this is apparently unknown to Condon, who refers to our usage of the Zuni Sandstone as a corruption of Dutton's original definition. This assertion is incorrect. Current usage represents the type of refinement that comes with a better understanding of stratigraphic relationships. Progressive refinement has indeed resulted in the Todilto, Summerville, and Bluff Formations being recognized within the original Zuni interval; where all three are present, the Zuni Sandstone locally consists of only the overlying crossbedded sandstone called the Acoma Tongue of the Zuni, because genetically and lithologically these upper strata are related to the type Zuni. This constitutes progressive refinement of a valid lithostratigraphic concept. Progressive deterioration results when lithostratigraphy is abandoned and "unrecognized time boundaries" are used to

establish formation contacts, as Condon and Peterson (1986) advocated and continue to advocate. The concept of a Morrison Formation, which locally overlies the Zuni, has suffered progressive deterioration as a result of chronostratigraphy being substituted for lithostratigraphy (see section on Morrison Formation below).

With the usage of the name Zuni Sandstone well established and defined (it overlies the Entrada and grades northward into the Summerville and Bluff Formations or their equivalents) it is obvious that the Zuni Sandstone is the same unit which Harshbarger et al. (1957) projected into western New Mexico as the Cow Springs Sandstone. The Cow Springs was a superfluous name the day it was introduced in New Mexico, and we are at pains to understand why the U.S. Geological Survey did not at the time offer an explanation of the relationship between the two units. The failure to do so has thoroughly confused subsequent workers such as Condon and his colleagues. One example of this confusion is brought to the fore by Peterson (1988, p. 19) who clearly illustrates the type Cow Springs as a member of the Entrada Sandstone in a stratigraphic position below the J-3 transgressive unconformity, exactly as stated by us (Anderson and Lucas, 1992, p. 88). Condon in his reply quotes us out of context, neglecting to mention that we correctly presented Peterson's concept of the type Cow Springs as a pre-J-3 unit. Condon instead chose to focus on the supplementary information we included, i.e. that Peterson's type Cow Springs was in addition older than the Todilto. Conventional wisdom as well as sound stratigraphic principles place the Todilto above the J-3 transgressive surface, and hence our inference that pre-J-3 is pre-Todilto. The J-3 surface at the base of the Curtis Formation in southeastern Utah is a transgressive unconformity developed on the Entrada Sandstone, which is precisely what is seen at the base of the Todilto in the San Juan Basin, albeit with the unconformity or diastem marked only by a zone of floating pebbles.

We thus maintain that Peterson's assertion that the type Cow Springs is pre-J-3 also includes the assertion that it is pre-Todilto. The confusing aspect of his work derives from his statement that the type Cow Springs appears to correlate with the Cow Springs at Zuni Pueblo where it is demonstrably post-Todilto (post-J-3). If, as Peterson suggests, the two do correlate, then the J-3 unconformity has been misidentified by him in the type Cow Springs area; this unconformity, if it exists at all in the type area, would be at the base of the Cow Springs rather than at the top. We thus believe the sandstones in the two areas do correlate for the following reasons:

- 1) They have similar lithologies and occupy the same stratigraphic position.
- 2) They both are eolian in origin.
- 3) The Cow Springs section at Zuni grades northward into Summerville and Bluff Formations (= Condon's Wanakah).
- 4) The type Cow Springs grades northeastward into Wanakah beds (Peterson, 1988).

We nonetheless reject Cow Springs as a stratigraphic name in New Mexico because the name Zuni has precedence and because the excellent development and exposures of the unit at Zuni Pueblo justify a local name.

It is illuminating to go back and further pursue the implications of 3) and 4) above. Given that the Cow Springs strata from both areas correlate with strata of the "Wanakah," they must correlate with each other (logically, if  $a=c$  and  $b=c$ , then  $a=b$ ). We also know that both the type Summerville and type Curtis lie above the J-3 unconformity, so arguing whether the "Wanakah" correlates with the Curtis or the Summerville loses significance. Either correlation results in a "Wanakah" that is post-J-3, and therefore a Cow Springs Sandstone that is post-J-3. And it follows that the

Todilto Formation as part of the "Wanakah" is post-J-3. Thus the confusing, untenable regional correlations proposed by Peterson (1988) are exposed and resolved, a task undertaken here because Condon in his reply defended Peterson.

### The Morrison Formation does not include eolianites

Lithostratigraphic units and the formation concept are apparently unclear to Condon. He would project into the San Juan Basin an "unrecognized time boundary" (Condon and Peterson, 1986, p. 19), presumably an extension of the perceived J-5 unconformity, at the base of the Bluff Sandstone (= their Morrison Formation) in southeastern Utah, and utilize that "time boundary" as the San Rafael Group-Morrison contact. We assert this is not how formation contacts are established. The Condon and Peterson approach is to honor all previous U.S. Geological Survey work on the Morrison Formation in southeastern Utah, recognize the J-5 unconformity at a stratigraphic horizon that supports this previous work, and by definition, assign all strata above this unconformity (unrecognized time boundary) to the Morrison Formation, regardless of lithologies. In this way they can include eolianites in the Morrison Formation, even though eolianites are not in the type area. Not incidentally, we question why the Morrison Formation correlations from Morrison, Colorado, to the San Juan Basin must be done via southeastern Utah. If this correlation were to be attempted down the Front Range and thence into the southeastern San Juan Basin without knowledge of previous work in Utah, eolianites would surely not be included in the Morrison; the eolianites would be correctly included with the underlying San Rafael Group on the basis of sandstone type and lithogenesis.

We also exclude eolianites from the Morrison Formation because "the observed interbedding of eolian rocks with the Morrison referred to by Condon does not exist in the southern San Juan Basin. The interbedding referred to by Condon consists of thin (maximum of 1.5 m), lenticular maroon siltstone and sandstone beds in a dominantly eolian, lighter colored sandstone section that overlies the Bluff-Summerville interval. The siltstones represent interdunal deposits and locally make up 6-8% of the total section. Where present to that extent, the siltstones bleed down over the lighter-colored sands, and their thickness thus is exaggerated. The appearance of this section is (apparently) seductively similar to what is called the Recapture Member of the Morrison Formation, because Condon and his colleagues have included these eolian sandstones in their Recapture. The problem is that the type Recapture is a fluvial sandstone that is coarser-grained and sedimentologically different from the unit that Condon calls Recapture in the San Juan Basin. We do not deny the possibility that the two are chronostratigraphic equivalents, but they are not the same lithostratigraphic or lithogenic units. Therefore, we assign the eolianites to the Zuni Sandstone.

Another example of eolian sandstones in this stratigraphic interval was discussed by Szigeti and Fox (1981). In the Black Hills of South Dakota the Unkpapa Sandstone was recognized by Darton (1899) as a separate formation between the Sundance and Morrison Formations. The Unkpapa is as much as 81.4 m thick and consists chiefly of massive, fine- to very fine-grained sandstones. Its status as a formation separate from the Morrison Formation has long been upheld, particularly by mappers of the U.S. Geological Survey (e.g., Bell and Post, 1971). Indeed, Szigeti and Fox (1981) did not include the Unkpapa eolianites in the Morrison Formation, although Condon, in his reply, cites them when he states that "eolian rocks in the Morrison have also been described in . . . South Dakota." Szigeti and Fox (1981) provided no such description, but instead argued that the Unkpapa and Morrison Formations interfinger in the southern Black Hills, although they noted that "this is partially obscured by landslide deposits" (Szigeti and Fox, 1981, p. 333).

### Conclusion

Condon's reply to our article presents no new data to support his interpretations of Middle and Upper Jurassic stratigraphy and

sedimentation on the Colorado Plateau. Instead he rehashes correlations we refuted and presents nomenclatural arguments (Wanakah of Grabau not a valid unit; Todilto a unit of member rank; Horse Mesa a distinct unit) that reveal his lack of understanding of basic stratigraphic principles and practice. His reply/discussion, in which he explains how he and his colleagues arrived at their conclusions, only reinforces our original evaluation and conclusions. To wit, the work of Condon, Peterson and O'Sullivan on this Middle and Upper Jurassic strata of the Colorado Plateau has confused and obscured a rather straightforward stratigraphy that was quite well understood by the early 1950s.

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**Lois M. Devlin**  
**NMBM&MR Business Services Coordinator**  
**(1922–1993)**



Lois' major relationship with our geologic community was her interest in and promotion of geology for the layperson, although she was directly involved with all aspects of Bureau business. She was fully knowledgeable of our technical publications but always encouraged writing of and distribution of geology (and

mineral-resources) information for everyone—publications such as the Scenic Trips to the Geologic Past, informal road logs to mineral- and fossil-collecting localities, and the popular Geologic Highway Map by the New Mexico Geological Society. Lois often handled the NMBM&MR and NMGS publication booth at meetings of NMGS, GSA, AAPG, and other organizations. Probably more of our "customers" benefited from Lois' advice and service than from most of the scientific-engineering staff.

Born in Webster, South Dakota (1922), Lois Sandvig attended the University of South Dakota. During World War II she was secretary to the commander of the Sioux Falls Army Air Force Base. (He later became president of Oklahoma University.) There she met and married (1944) Edward J. Devlin; after the war they moved to Wellsville, New York, where their two children were born.

When they moved to Socorro, Lois joined our staff (1962) as a typist, then secretary, office manager, Director of Publications and Business Office, and Business Services Coordinator. Our NMBM&MR was, thankfully, a major part of Lois' life, and to us she was as indispensable as one person can be. Working with Judy Vaiza, Norma Meeks, and coworkers she helped to form the experienced core of our business and administration crew, including the distribution of our publications and those of NMGS, USGS, and USBM. Her help with managing the millions of dollars of state and federal funds was a real service to all of us. Thoughtfully, she unobtrusively corrected our errors, thanked us for routine duties, was genuinely sympathetic for problems, and joyful for accomplishments. A valued coworker and to many of the Bureau staff an older sister, Lois had almost a passion for everyone to enjoy our state's geology, scenery, and people.

South Dakota with its rolling Great Plains, grain fields stretching to the horizon, hot humid summers, and frigid winters contrasted with Socorro's green Rio Grande valley, semiarid bordering slopes, and towering skyline mountains. She enjoyed it, raising lovely Linda Devlin Dixon and expert forester David Devlin. In recent years, she joined her brothers and friends, once or twice a year, to visit the globe, often flying Pan Am while Linda was a flight attendant for the airline. Contrast South Dakota and Socorro with Hong Kong, London, Williamsburg, Frankfurt, Juneau, and San Francisco, all of which she enjoyed. As did she enjoy her many friends in Socorro, work with P.E.O., Women's Golf Association, many bridge clubs, luncheons; always gregarious, cheerful, joyful.

A dear, warm friend, an advocate for practical geology, an efficient worker for New Mexico, we appreciate all she has meant to us and our state. She left us 15 July as the sun reached its zenith.

—Frank E. Kottlowski