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Triassic-Jurassic stratigraphy, San Ysidro area, Sandoval County, New Mexico

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TRIASSIC-JURASSIC STRATIGRAPHY, SAN YSIDRO AREA, SANDOVAL COUNTY, NEW MEXICO

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Abstract—Triassic and Jurassic strata are prominently exposed by faults and folds in the nexus of the San Ysidro area in Sandoval County, New Mexico. The Triassic strata are assigned to the Middle Triassic Moenkopi Formation overlain by the Upper Triassic Chinle Group, a section of mostly siliciclastic red beds about 582 m thick. The Jurassic strata are assigned to the (ascending) Middle Jurassic Entrada and Todilto, Middle-Upper Jurassic Summerville, and Upper Jurassic Morrison Formations—a section about 416 m that that records eolian, lacustrine, evaporitic, coastal plain, and fluvial deposition. The Triassic-Jurassic strata of the nexus are a characteristic section of these strata on and along the edge of the southern Colorado Plateau.

INTRODUCTION

The Triassic-Jurassic rocks exposed in the San Ysidro area (seen on the First-Day Field Trip of this conference) are spectacularly exposed in tilted sections by regional folds and fault blocks. Here I present a brief summary of the stratigraphy of these rocks (Fig. 1) based on more detailed reviews by Lucas and Heckert (1996), Anderson and Lucas (1996), and Lucas (2021a, b). I do note that some of the stratigraphic nomenclature used here remains under discussion (e.g., Dickinson, 2018; Cather, 2021), but the stratigraphic nomenclature of the Triassic and Jurassic strata in the nexus region presented here is based on regional studies in New Mexico, Arizona, Utah, and Colorado (see Lucas, 2021a, b).

The oldest Triassic strata in the San Ysidro area belong to the Middle Triassic Anton Chico Member of the Moenkopi Formation as first identified by Lucas and Hayden (1989) and were assigned to the Triassic based on their vertebrate paleontology and magnetostratigraphy (Lucas, 2004). Prior to the work of Lucas and Hayden (1989), these rocks were identified as an upper, red-bed member of the Permian San Andres Formation (Wood and Northrop, 1946) and mapped as the Permian Bernal Formation, which was a formal name given to the San Andres upper red-bed member in the 1950s. (Note that Woodward and Ruetschilling [1976] combined these strata with the Glorieta Sandstone as Bernal and Glorieta undivided; see also Woodward [1987], who identified this unit as Bernal Formation). The Moenkopi strata are most visible along the western flank of the Sierra Nacimiento as a red-bed slope between underlying Permian Glorieta Sandstone and the overlying Upper Triassic Shinarump Formation of the Chinle Group, also called Agua Zarca in Woodward and Ruetschilling (1976). Here, the Moenkopi strata are as much as 39 m thick and consist of grayish-red, trough cross-bedded, fine- to medium-grained litharenite sandstone and intraformational conglomerate composed of clasts of mudstone, siltstone, and calcrete, interbedded with siltstone and mudstone.

The overlying remainder of the Triassic section near San Ysidro belongs to the Upper Triassic Chinle Group, divided here (in ascending order) into the Shinarump, Salitral, Poleo, and Petrified Forest Formations (Fig. 1; see also Lucas and Heckert [1996] and Lucas [2021a]). The Shinarump Formation (also called Agua Zarca Member/Formation by some workers, as noted above) is as much as 61 m of sandstone and conglomerate. The sandstone is white to brown, medium- to coarse-grained quartzarenite that is usually trough cross-bedded. Conglomerate beds are siliceous, composed of clasts of chert, metaquartzite, petrified wood, and sedimentary rock rip-ups from underlying strata. The Arizona name Shinarump is preferred here to the Agua Zarca because both names refer to the same lithosome, and Shinarump is the older name applied across much of the Four Corners states, so Agua Zarca seems an unnecessary local synonym.

The Salitral Formation has a maximum thickness of 102 m but is usually much thinner, less than 20 m thick. It consists of color-mottled (purple, blue, and red) mudstone with numerous calcrete nodules and is largely a succession of paleosols.

The Poleo Formation is similar to the Shinarump in being a unit of sandstone and conglomerate. However, the two formations can be readily distinguished by sandstone matrix mineralogy (Shinarump = quartzarenite; Poleo = micaceous litharenite) and the clast compositions of their conglomerate beds (Shinarump = mostly chert; Poleo = mostly calcrete). The Poleo has a maximum thickness of 40 m in the San Ysidro area, and its base is marked by stratigraphic relief, scour-and-fill, and erosional rip-ups—an obvious disconformity. The Poleo is of early Norian age, whereas the underlying Salitral is of late Carnian age, so the duration of the disconformity may be as much as a few million years but is difficult to quantify with existing data (Lucas, 2021a).

The Petrified Forest Formation, as much as 340 m thick, is mostly reddish-brown mudstone that contains some lenticular beds of trough cross-bedded or laminated litharenite sandstone and calcrete-clast-dominated conglomerate. In the uppermost Petrified Forest Formation, a 2–15-m-thick, bench-forming litharenite and intraformational conglomerate interval is the Correo Sandstone Bed. The age of one volcanic ash bed in the Petrified Forest Formation in Arizona is constrained by detrital zircons to be ~213 to 209 Ma, which is Norian, and this is consistent with the biostratigraphy (Riggs et al., 2003; Lucas, 2021a).

Jurassic strata overlie Triassic strata in the nexus and across

much of northern New Mexico at a substantial unconformity. This Triassic-Jurassic unconformity represents a hiatus of the last few million years of Triassic time (~205–201 Ma) as well as the Early Jurassic and much of the Middle Jurassic (~201–165 Ma). Thus, it has a duration of ~40 Ma.

A diversity of lithostratigraphic nomenclature has been applied to the Jurassic strata in the San Ysidro area. The nomenclature used here is that used on the state geologic map of New Mexico (New Mexico Bureau of Geology and Mineral Resources, 2003) and is explained in detail by Anderson and Lucas (1996), Lucas and Anderson (1998), and Lucas (2021b). It differs from that of Cather (2021) in minor respects discussed below. The Middle Jurassic Entrada Sandstone is at the base of the Jurassic section in the San Ysidro area and consists of two members: (1) Dewey Bridge Member, as much as 18 m thick, consisting of intercalated beds of reddish-brown to reddish-orange, laminar and ripple-laminar sandstone and siltstone; and (2) the overlying Slick Rock Member, pinkish-gray, yellowish-gray, and moderate reddish-orange, very fine- to medium-grained sandstone that is mostly trough cross-bedded with some tabular bedding and up to 122 m thick.

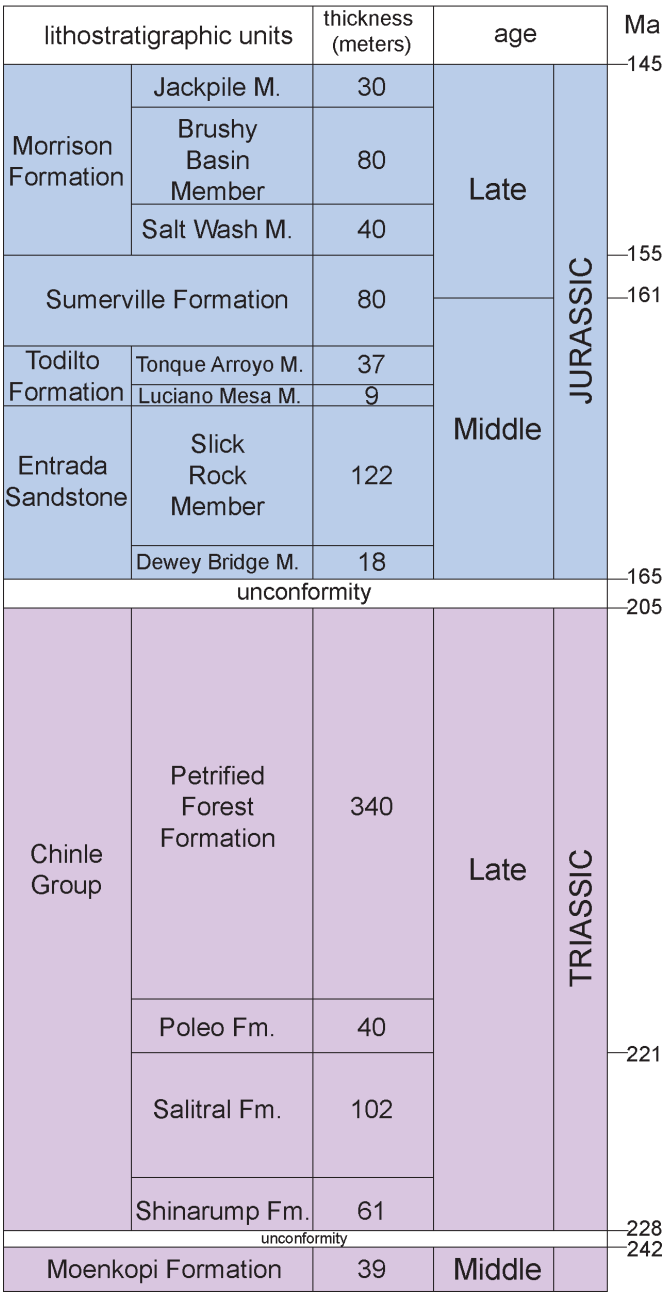

FIGURE 1. Summary of the Triassic-Jurassic lithostratigraphic nomenclature, with maximum thicknesses of stratigraphic units and geologic ages in the San Ysidro area of north-central New Mexico. Numerical ages are approximations based on the timescale of the International Commission on Stratigraphy (https://stratigraphy.org/chart). Note that the age of the Jackpile Member of the Morrison Formation may be Early Cretaceous.

The overlying Todilto Formation is a striking unit that is readily distinguished from the clastic strata that compose the rest of the Jurassic section. It consists of two members: (1) a lower, limestone member (Luciano Mesa Member of Anderson and Lucas, 1996) that is up to 9 m of gray, mostly microlaminated, kerogenic limestone; and (2) an upper, gypsum member (Tonque Arroyo Member of Anderson and Lucas, 1996) that is light gray to white gypsum up to 37 m thick.

Strata of the overlying Summerville Formation are up to 80 m thick. The lower part of the Summerville is maroon or grayish-red siltstone and silty mudstone. Similar overlying strata also include beds of cross-bedded, fine-grained sandstone. Anderson and Lucas (1996) suggested these sandstone beds are of eolian origin and may be equivalent to the Bluff Sandstone to the west/northwest. Note that the mapping of Woodward and colleagues (see Woodward [1987] for a summary) included the entire Summerville interval in the Morrison Formation.

The stratigraphically highest Jurassic beds in the San Ysidro area belong to the Morrison Formation, as much as ~150 m thick. Three members can be recognized: (1) Salt Wash Member; preferred here to Dickinson's (2018) and Cather's (2021) use of Westwater Canyon because the type section of the Westwater Canyon and Salt Wash in the southeastern unit are sections of the same lithostratigraphic unit, so the older name Salt Wash has priority (Anderson and Lucas, 1995); also note that the use of Recapture Member for lower Morrison strata in the nexus (e.g., Woodward, 1987; Cather, 2021) refers to a unit different than the type Recapture, which is part of the Summerville lithosome (Anderson and Lucas, 1995); in the nexus, the Salt Wash Member is up to ~40 m of pale yellow and yellowish-orange, fine- to coarse-grained, trough cross-bedded sandstone with chert-pebble conglomerate lenses interbedded with thinner beds of siltstone and mudstone; grading up into and intertonguing with; (2) the Brushy Basin Member, as much as ~80 m thick, mostly variegated claystone with some lenticular sandstone beds; and (3) the Jackpile Member, up to ~30 m of mostly white, kaolinitic, fine- to coarse-grained, cross-bedded sandstone with some beds of silica-pebble conglomerate and minor interbeds of pale green mudstone and siltstone. The base of the Dakota Sandstone on the Jackpile Member is a substantial unconformity that may represent a hiatus between strata of Late Jurassic age? and strata of early Late Cretaceous (Cenomanian) age. However, note that the age of the Jackpile Member, conventionally assigned to the Late Jurassic because it is part of the Morrison Formation, is uncertain, and the unit may be of Early Cretaceous age (e.g., Cather, 2021).

Data to constrain the ages of the Triassic-Jurassic strata are sparse in the San Ysidro area, so the ages assigned here (Fig. 1) are based on biostratigraphic and radioisotopic data from elsewhere on the Colorado Plateau.

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North of San Ysidro along U.S. Route 550, cuestas of Upper Triassic Chinle Group strata (dark red beds) are overlain by salmon- and yellow-colored sandstones of the Middle Jurassic Entrada Sandstone. The gray cap on the cuestas is the Middle Jurassic Todilto Formation, here mostly a thick interval of gypsum. *Photo by Spencer G. Lucas*