



The lower and upper contacts of the Upper Jurassic Bluff Sandstone Member of the Morrison Formation in southeastern Utah

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THE LOWER AND UPPER CONTACTS OF THE UPPER JURASSIC BLUFF SANDSTONE MEMBER OF THE MORRISON FORMATION IN SOUTHEASTERN UTAH

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ABSTRACT—An eolian sandstone, about 92 m thick, forms cliffs around the town of Bluff, Utah. The unit includes what has been termed the Bluff Sandstone Member of the Upper Jurassic Morrison Formation, but its base has been placed at 6 different levels within a stratigraphic interval of about 39 m by various geologists. This has led to much uncertainty as to where the contact with the underlying Middle Jurassic Wanakah Formation is best defined. The top of the member has also been placed at 2 different stratigraphic levels, about 24 m apart.

INTRODUCTION

A thick gray sandstone forms bold cliffs around the town of Bluff, Utah (Fig. 1). The name "Bluff sandstone" was applied to this unit by Baker and others (1936, p. 15, 21; pl.19A), but no type section or locality was designated. South of Bluff, the entire cliff-forming sandstone is 91.4 m thick. The base of the member has been placed at 6 different levels over a stratigraphic interval of about 39.3 m by various geologists. Consequently, the different interpretations regarding the lower contact have altered the strata assigned to the Upper Jurassic Bluff Sandstone Member of the Morrison Formation, as well as strata assigned to the underlying Middle Jurassic Wanakah Formation. The upper contact of the Bluff has also been placed at 2 different levels about 24 m apart.

STRATIGRAPHY

Sources of Data

The stratigraphic positions of the various parts of the San Rafael Group and their relations to overlying and underlying rocks are shown in Figure 2. The composite Bluff section (section 1, Fig. 2) was measured at several places: (1) the Carmel Formation and Entrada Sandstone were measured in SW1/4 Sec. 29, and SE1/4, Sec. 30, T. 40 S., R. 21 E.; (2) the Wanakah Formation was measured in SW1/4 Sec. 19 and NW1/4 Sec. 30, T. 40 S., R. 22 E.; and (3) thickness of the sandstone unit of the Morrison Formation and the Wanakah Formation calculated from mapped exposures on a topographic map in NW1/4 Sec. 19, T. 40 S., R. 22 E. Section 2 (Fig. 2) combines the interval penetrated in the Pan American Corp. Government Featherstone 1 drill hole in SW1/4 Sec. 24, T. 40 S., R. 22 E. with parts of the sandstone unit and the Recapture Member of the Morrison Formation that were measured in outcrops east of the drill hole location. The Recapture Creek section (section 3, Fig. 2) was measured by Cadigan (1952) and published in Craig (1959). The section, reproduced here in graphic form from Cadigan (1952, p. 21-32) extends east from Bluff to St. Christophers Mission (Fig. 1), then to a small knoll on the east side of Recapture Creek near its junction with the San Juan River; location is in Secs. 28, 29, and 30 T. 40 S., R. 22 E. Units A-D shown along the side of section 3

(Fig. 2) are subdivisions of the "Bluff sandstone" recognized by Cadigan and explained in greater detail in a report by Craig and Cadigan (1958, p. 182-185). The unit labeled sandstone unit (Fig.

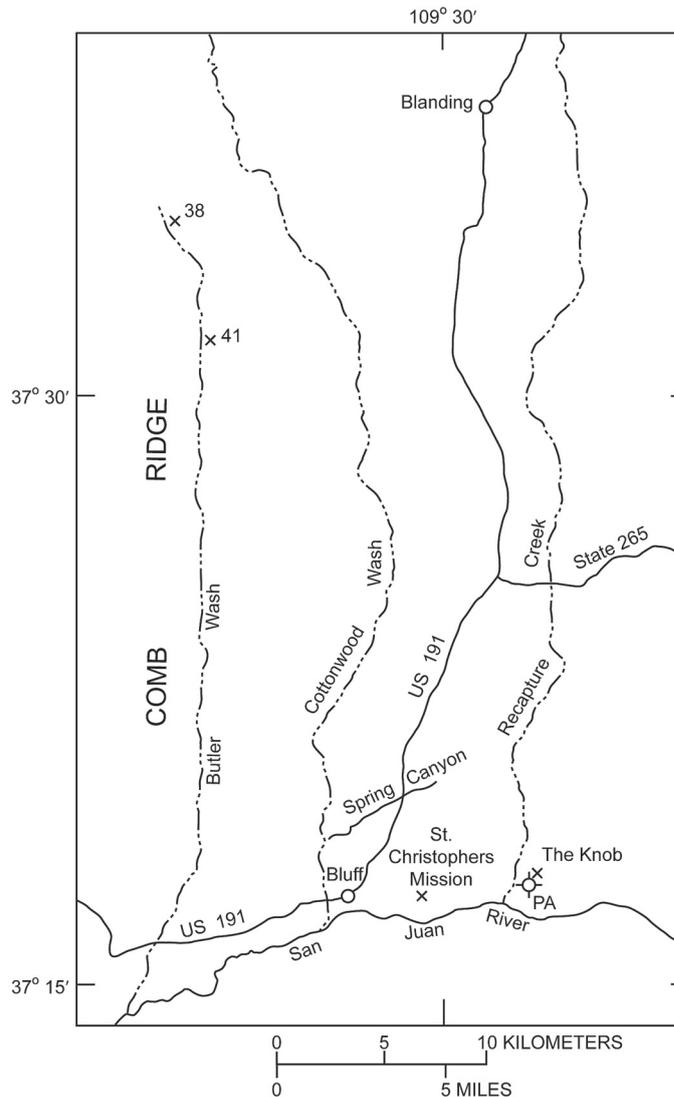


FIGURE 1. Index map of Bluff-Blanding area, Utah. In upper Butler Wash numbers 38 and 41 refer to measured sections discussed in text. PA indicates Pan American Corp. Government Featherstone drill hole.

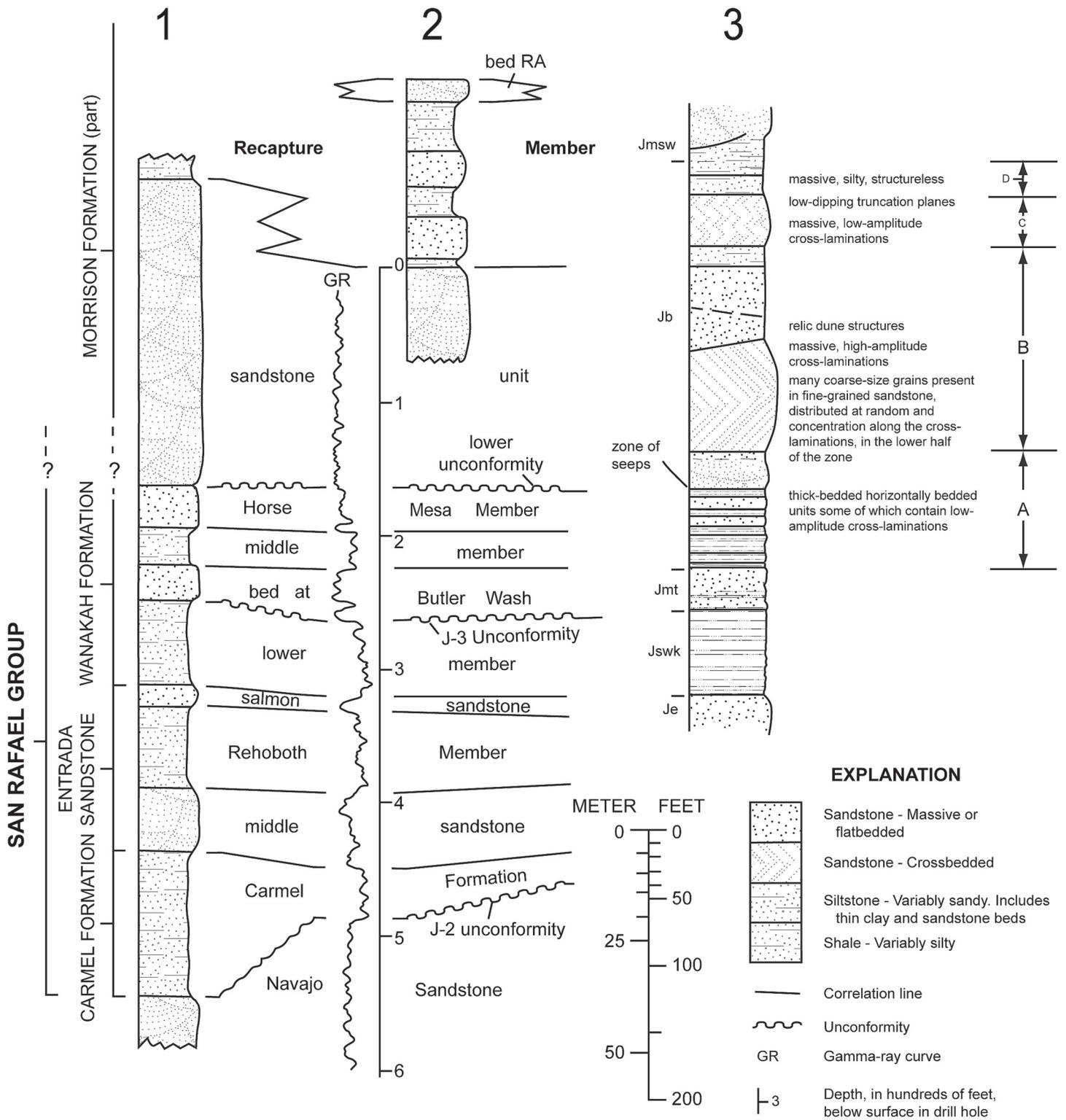


FIGURE 2. Stratigraphic diagram showing correlation of some Jurassic units near Bluff, Utah. Locations and source of data given in text. Symbols used on section 3 include: Jmsw, Salt Wash Member of Morrison Formation; Jb, Bluff Sandstone (of formational rank); Jmt, Moab Tongue of Entrada Sandstone; Jswk, Wanakah Formation; Je, Entrada Sandstone. Units A-D are subdivision of the "Bluff sandstone" recognized by Cadigan (1952) and explained in the text. In section 3, horizon marked "zone of seeps" was contact used by O'Sullivan (1997, 2000).

2) includes the Bluff Sandstone Member of the Morrison Formation and some of the uppermost part of the Wanakah Formation (Peterson, 2010, oral commun.).

Zone of Seeps

The various contacts of the Bluff Sandstone Member can be related to a convenient reference feature described by Gregory (1938, p.74) as a “zone of seeps” in a measured section at the town of Bluff. Gregory (1938, p. 23) described the zone of seeps, also termed the “spring line” as follows:

“High on the canyon walls along the San Juan River and Butler Wash the spring line at the base of the bare Bluff sandstone is marked by a band of green vegetation formed by plant species that seem out of place in the present scheme of distribution. In contrast to the vegetation common to the Upper Sonoran zone, growing along the river below and on the mesa tops above, the plants tucked away in moist niches on the cliffs include *Aquilegia micrantha*, *Primula farinosa*, *Solidago canadensis*, *Mimulus cardinalis*, *Oenothera biennis* var. *grandiflora*, *Shepherdia rotundifolia*, and *Epipactis gigantea*. Eastwood [1896] speaks of this habitat as “a boreal oasis in the midst of a Sonoran desert”, perhaps dating from a time when the climate of the whole San Juan region was colder.”

The common names of the plants include columbine, primrose, goldenrod, monkey flower, evening primrose, buffalo berry, and stream orchid. Water percolating through the overlying sandstone continues to provide some moisture for the plants and springs along the zone of seeps, but in several places the seeps and springs have largely dried up.

The zone of seeps (Fig. 3) consists of a sequence of beds 1.5 m to 2.3 m thick that commonly forms a conspicuous reentrant in the cliff face. At its base, where typically exposed, there is generally a coarse grained sandstone (Fig. 3C, bed C) about 0.3 m thick that tends to form a ledge. Bed C is overlain, in most places, by a reddish-brown siltstone as much as 0.6 m thick. The upper part of the reentrant is about 1.3 m thick.

Lower Unconformity

An unconformity at the base of bed C (Figs. 3A, B) which I term the “lower unconformity,” was previously thought to be the J-5 unconformity (O’Sullivan, 1997, 2000) and to define the base of the Bluff Sandstone Member. However, Peterson and Turner (2010, this volume) interpreted the base of the Bluff Sandstone Member and the J-5 unconformity to lie about 22 m above the zone of seeps. The lower unconformity is underlain by 116 m of Middle Jurassic strata (Fig. 2), the description of which is given in several published reports (for example, Condon, 1989; Gregory 1938; O’Sullivan, 2000). The only measured section of the Bluff Sandstone Member and related rocks known to me is that of Cadigan (1952, p. 21-30) which was also included in a report by Craig (1959, Recapture Creek section number 163) it was not, however, designated as a reference section.

The lower unconformity clearly bevels across underlying rocks in places. Examples include: (1) about 6.5 km east of Bluff (Figs. 3, A, B) where about 3 m of strata in a horizontal distance of 61 m were cut out; (2) near the head of Butler Wash (Fig. 1) close to section 41 (O’Sullivan, 1980) where the Horse Mesa Member of the Wanakah Formation (formerly bed at Black Steer Knoll) and 16 m of overlying red sandstone and siltstone were removed southward; (3) about 7 km to the north of section 41 and near section 38 (Fig. 1) where a thin gray sandstone and 2.5 m of red siltstone were also removed southward; and (4) the thinning of the Horse Mesa Member from as much as 18 m in areas east of Bluff to as little as 6 m near Bluff (O’Sullivan, 1997) was probably caused by beveling. Carr-Crabaugh and Kocurek (1998, p. 222) observed that the uppermost Wanakah Formation including the Horse Mesa “...either never developed fully or was removed by erosion associated with the formation of the J-5 surface...” Their J-5 surface is now the lower unconformity.

Base of Bluff Sandstone Member

The base of the Bluff Sandstone Member has been placed at different levels as described below; all are related to the lower unconformity associated with the zone of seeps.

(1) Cadigan (1952, p. 32) placed the base of the Bluff Sandstone Member at the top of what he referred to as the Moab Tongue [of the Entrada Sandstone]. In Cadigan’s measured Recapture Creek section as published by Craig (1959, section 163; reproduced as section 3, Fig. 2), the unit labeled “Jmt” (Moab Tongue) is now best referred to as the bed at Butler Wash of the Wanakah Formation in the Bluff area. This unit is overlain by 17 m (56 ft) of sandstone and siltstone. The overlying 1.5 m (5 ft) is sandstone “... horizontally laminated (?) ...with varicolored siltstone and very fine grained sandstone in the top foot ...” I consider the uppermost part of this unit to be the zone of seeps, which places the base of Cadigan’s “Bluff sandstone” 18.2 m (60 ft) below the zone of seeps.

(2) Lucas (2004, fig. 8) and Dickinson and Gehrels (2009, p. 417) placed the base of the Bluff Sandstone Member at the base of the Horse Mesa Member, which in the Bluff area lies 6-12 m below the zone of seeps.

(3) I placed the base of the Bluff Sandstone Member at the lower unconformity, which I thought was the J-5 unconformity associated with the zone of seeps (O’Sullivan, 1997, 2000). Carr-Crabaugh and Kocurek (1998, fig. 10A) also place the base of the Bluff Sandstone Member at this horizon. Lupe (1983) traced a “datum” through northwestern New Mexico that “... likely corresponds to the J-5 unconformity ...” The “datum” is a regional disconformity with relief that is “... locally more than 10 m ...” (U.S. Geological Survey, 1980, p. 48). The datum (Lupe, 1983) can be projected into the lower unconformity at Bluff. Also, a comparison of drill hole data (Lupe, 1983, section 300) and O’Sullivan (1997, section 17) showed the datum and the lower unconformity to be at the same stratigraphic position.

(4) Gregory (1938) in his section 19 (p. 74), measured at the town of Bluff, placed the base of the Bluff Sandstone Member some 3.5 m (12 ft) above the zone of seeps, the intervening unit

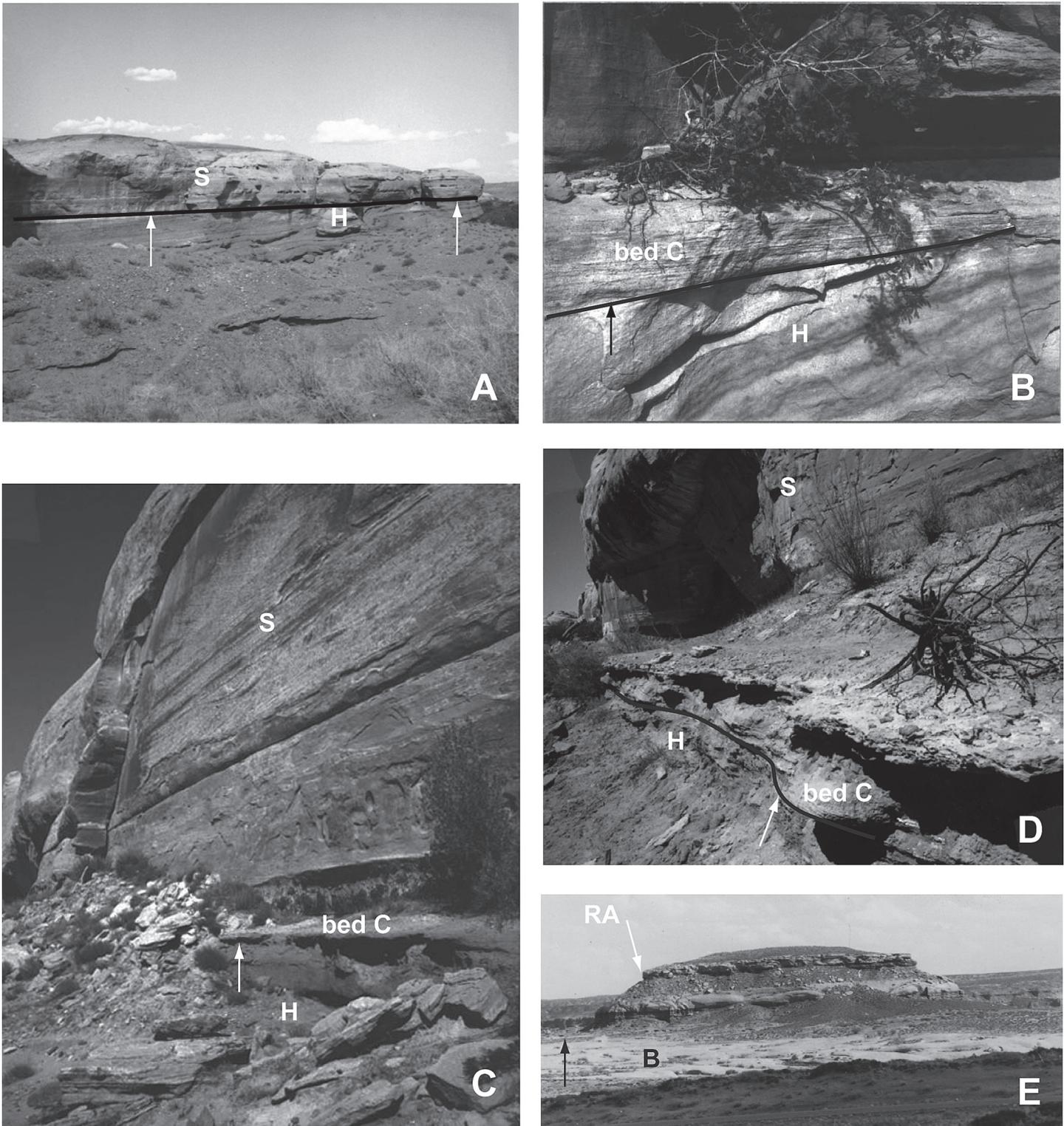


FIGURE 3. Views of some Jurassic rocks in southeastern Utah. Symbols used include; H, Horse Mesa Member of the Wanakah Formation; and S, sandstone unit includes uppermost part of Wanakah Formation and Bluff Sandstone Member of Morrison Formation. Figure 3, A-D, arrows point to lower unconformity at base of zone of seeps. Figure 3A, view northward in NW1/4, Sec. 22, T. 40 S., R. 22 E. Unconformity truncates 3 m in a horizontal distance of 61 m. Figure 3B is close-up view of part of Figure 3A; bed C is 0.3 m thick and is underlain by lower unconformity. Figures 3C and 3D are views of the zone of seeps and the lower unconformity. Figure 3C is located in NW1/4, Sec. 28, T. 40 S., R. 22 E; bed C is 0.3 m thick. Figure 3D is located on Spring Canyon in NE1/4, Sec. 13, T. 40 S., R. 21 E; Bed C is 0.42 m thick. Figure 3E is view eastward of The Knob, located on the east side of Recapture Creek in SW1/4, Sec. 24, T. 40 S., R. 22 E. Arrow points to top of Bluff Sandstone Member (B) of Morrison Formation. RA is fluvial sandstone in the Recapture Member of the Morrison Formation.

being described as a white crossbedded sandstone. Below this unit and the zone of seeps he measured 17 m (56 ft) of sandstone and lenses of shale and then strata of the bed at Butler Wash.

(5) Measured sections of some Jurassic rocks by Condon (1989) included a section measured at Bluff. In this section, the unit overlying the bed at Butler Wash is 17.3 m (57) thick and at the top is a conspicuous reentrant that is the zone of seeps. Above the seeps is sandstone, 9.1 m (30 ft) thick that Condon termed Horse Mesa Member and interpreted the top to be the base of the Bluff Sandstone Member. The Horse Mesa Member of Condon (1989) therefore lies above the Horse Mesa Member shown on Figure 2, but the latter was traced eastward (O'Sullivan, 1997) to the Texaco Inc. Navajo Tribe 30D drill hole in Sec. 20, T. 40 S., R. 24 E. where it was identified as Horse Mesa Member in the same drill hole by Condon and Huffman (1994).

(6) Peterson (2010, oral commun.) has interpreted the base of the Bluff Sandstone Member and the J-5 unconformity to be associated with deep erosional cuts about 22 m above the zone of seeps (this is discussed in the Day 1 road log, Peterson and Turner, 2010, 2010).

Upper Contact

The upper contact of the Bluff Sandstone Member has been placed at 2 different stratigraphic levels 24 m apart. Along Recapture Creek, I place the top of the Bluff Sandstone Member at the horizon where eolian beds are overlain by red siltstone beds of the Recapture Member of the Morrison Formation (sections 1 and 2, Fig. 2; Fig. 3E). Craig (1959, Recapture Creek section) placed the top of the "Bluff sandstone" (the Bluff was considered a formation) about 24 m higher at the base of what was termed "Salt Wash member". Nearby, bed RA (section 2, Fig. 2; Fig. 3E) is 38 m above the Bluff Sandstone Member. This unit is 4.8 m thick, overlain by Quaternary gravels, and resembles channel sandstone beds in the Salt Wash Member of the Morrison Formation but was deposited in an area close to the zone of intertonguing between Recapture and Salt Wash Members (see O'Sullivan, 2000). Gregory (1938, p. 76) named the Recapture Member and along Recapture Creek measured the member to be 67-88 m thick. Consequently, both bed RA and the "Salt Wash member" of Cadigan (1952) would be included in the Recapture Member.

REFERENCES

- Baker, A.A., Dane, C.H., and Reeside, J.B., Jr., 1936, Correlation of the Jurassic formations of parts of Utah, Arizona, New Mexico and Colorado: U.S. Geological Survey Professional Paper 183, 66 p.
- Cadigan, R.A., 1952, The Correlation of the Jurassic, Bluff and Junction Creek Sandstones in southeastern Utah and southwestern Colorado, Masters Thesis, Penn. State College, 163p.
- Carr-Crabaugh, Mary, and Kocurek, Gary, 1998, Continental sequence stratigraphy of a wet eolian system – A key to relative sea-level changes, *in* Shanley, K.W. and McCabe, P.J., eds., Relative role of eustasy, climate, and tectonism in continental rocks: Society for Sedimentary Geology (SEPM) Special Publications No. 59, p. 213
- Condon, S.M., 1989, Stratigraphic sections of the Middle Jurassic Wanakah Formation, Cow Springs Sandstone, and adjacent rocks from Bluff, Utah to Lupton, Arizona: U. S. Geological Survey Oil and Gas Investigations Chart OC-131.
- Condon, S.M., and Huffman, A.C., Jr., 1994, Northwest-southeast-oriented stratigraphic cross sections of Jurassic through Paleozoic rocks, San Juan Basin and vicinity of Utah, Colorado, Arizona, and New Mexico: U.S. Geological Survey Oil and Gas Investigations Chart OC-142.
- Craig, L.C., and Cadigan, R.A., 1958, The Morrison and adjacent formations in the Four Corners area, *in* , Sanborn, A.F., ed., Guidebook to the geology of the Paradox basin, Intermountain Association of Petroleum Geologists 9th Annual Field Conference Guidebook: p. 182-192.
- Craig, L.C., 1959, Measured sections of Morrison and adjacent formations: U.S. Geological Survey Open-File Report 59-24 [variously paged].
- Dickinson, W.R., and Gehrels, G.E., 2009, U-Pb ages of detrital zircons in Jurassic eolian and associated sandstones of the Colorado Plateau: Evidence for transcontinental dispersal and intraregional recycling of sediment: *Geological Society of America Bulletin*, v. 121, no. 3/4; p. 408-433.
- Eastwood, Alice, 1896, Report on a collection of plants from San Juan County in southeastern Utah: California Academy Science Proceedings, 2nd series, v. 6, p. 271-328
- Gregory, H.E., 1938, The San Juan country, a geographic and geologic reconnaissance of southeastern Utah: U.S. Geological Survey Professional Paper 188, 123 p.
- Lucas, S. G., 2004, The Triassic and Jurassic systems in New Mexico *in* New Mexico, a Geologic history, Mack G.H. and Giles, K.A., eds; New Mexico Geological Society Special Publication 11, p. 137-152.
- Lupe, R.D., 1983, Stratigraphic sections of subsurface Jurassic rocks in the San Juan Basin, New Mexico, Colorado, Utah, and Arizona: U. S. Geological Survey Oil and Gas Investigations Chart OC-118.
- O'Sullivan, R.B., 1980, Stratigraphic sections of the Middle Jurassic San Rafael Group from Wilson Arch to Bluff in southeastern Utah: U.S. Geological Survey Oil and Gas Investigations Chart OC-102.
- O'Sullivan, R.B., 1997, Correlation of the Middle Jurassic San Rafael Group from Bluff, Utah to Cortez, Colorado; U.S. Geological Survey Geologic Investigations Series I-2616.
- O'Sullivan, R.B., 2000, Correlation of Middle Jurassic San Rafael Group and related rocks from Bluff to Monticello in southeastern Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-2351.
- U.S. Geological Survey, 1980, Geological Survey Research 1980: U.S. Geological Survey Professional Paper 1175, p. 48.