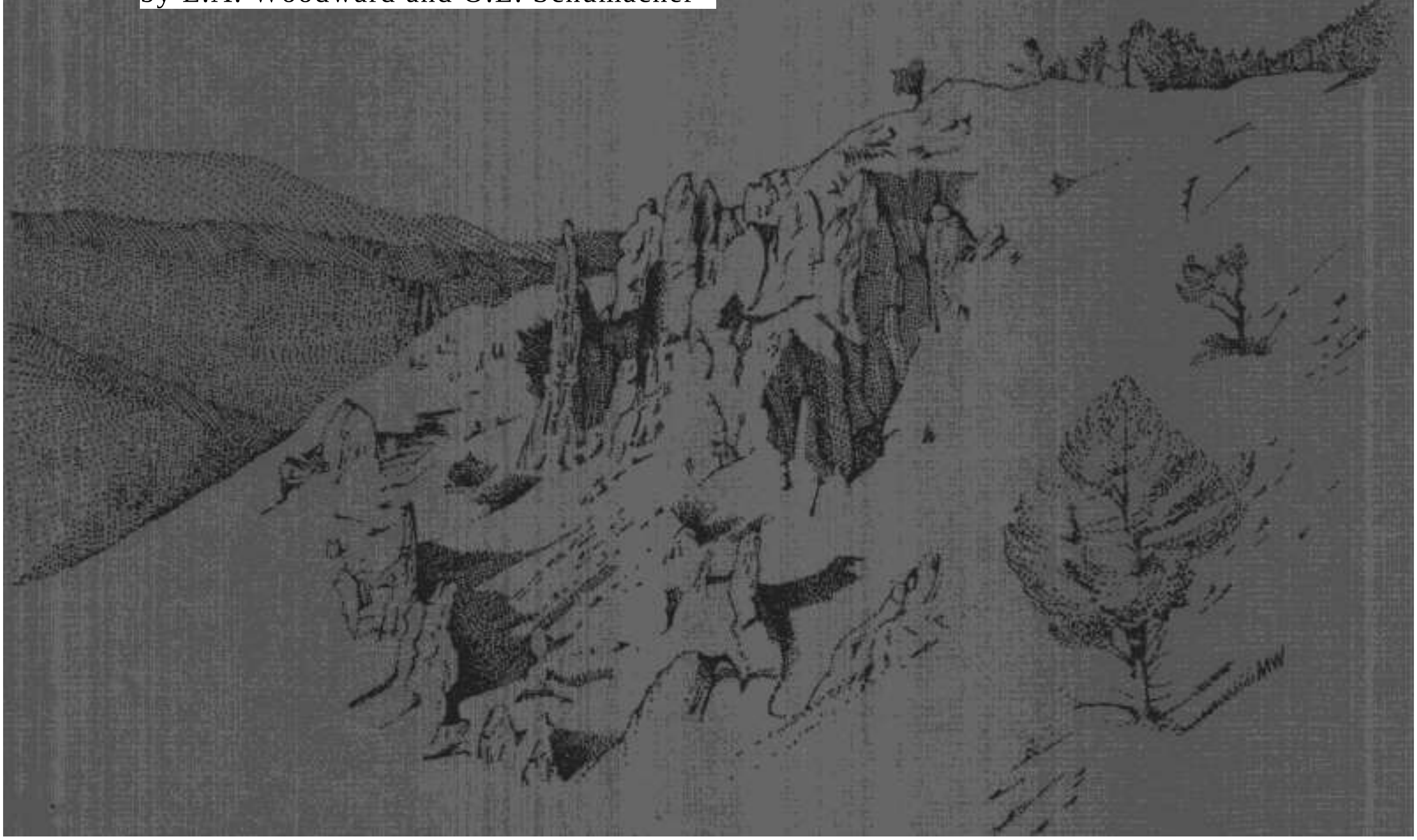
Circular 129

Morrison Formation of Southeastern San Juan Basin, New Mexico

by L.A. Woodward and O.L. Schumacher



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by Lee A. Woodward and
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University of New Mexico

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New Mexico State Bureau of Mines and Mineral Resources
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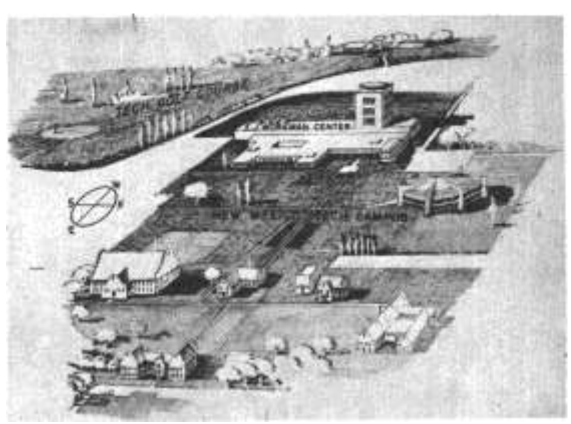

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Abstract

Exposures of the Morrison Formation (Jurassic) between Cuchillo Arroyo and Cuba, New Mexico include all the strata above the Todilto Formation (Jurassic) and below the Dakota Formation (Cretaceous). Four members recognized in the southern part of the area are, in ascending order: a lower member composed of reddish-brown and maroon-brown mudstone and gray, very fine-grained sandstone; the Westwater Canyon Member composed of cliff-forming, feldspathic sandstone; the Brushy Basin Member composed of red and green mudstone and sandstone interbeds; and, the upper member composed of whitish, kaolinitic sandstone, and minor amounts of green mudstone. In the northern part of the area only three members are present: the lower member, the Brushy Basin Member, and the upper member.

The lower member contains beds correlative with the Summerville Formation and the Recapture Member of the Morrison Formation of the Laguna area. The Westwater Canyon Member is sandstone in the south but grades northward into mudstone similar to that in the Brushy Basin Member. The upper member correlates with the Jackpile sandstone (Jackpile ore-bearing bed) of the Laguna area on the basis of lithologic similarity and stratigraphic position.

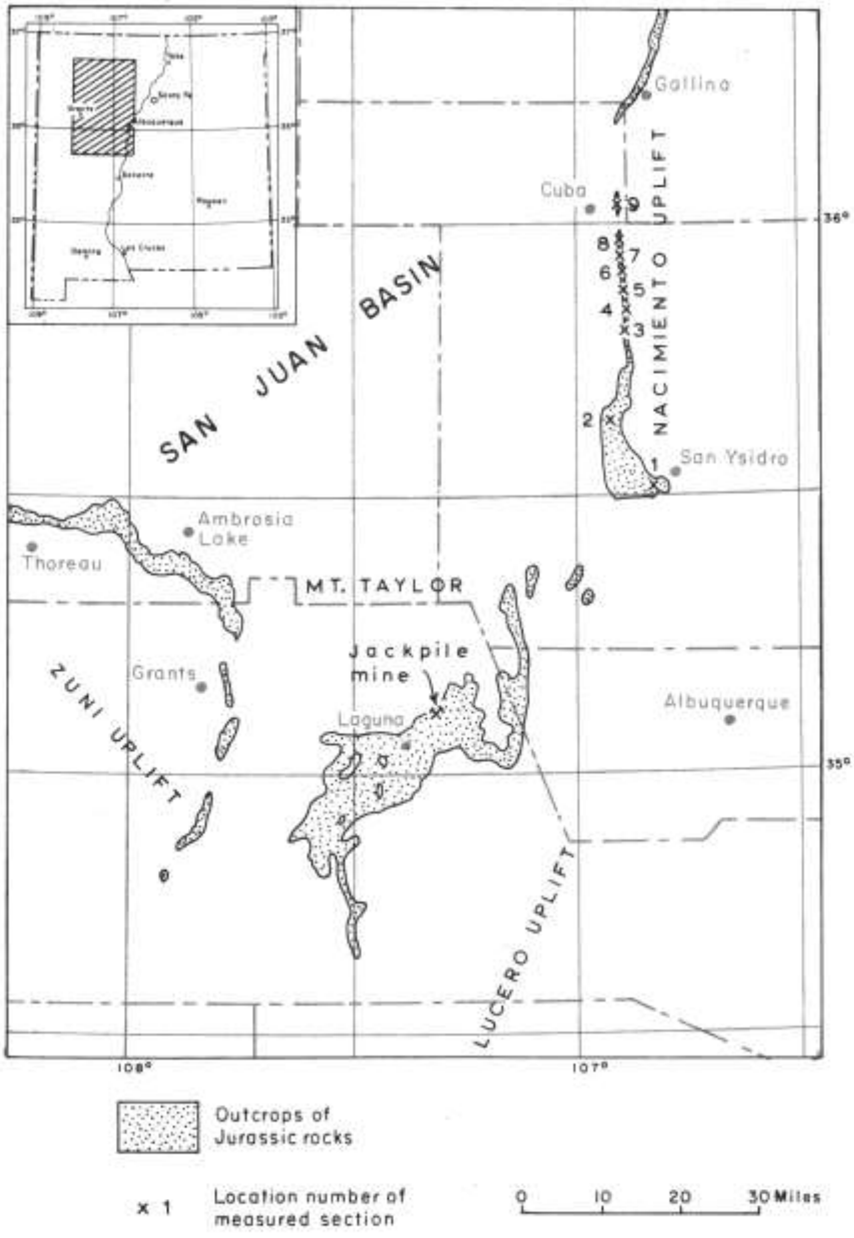


Figure 1 – Location and index map.

Introduction

Since the discovery in the 1950s of large reserves of uranium in the Morrison Formation (Jurassic) near Grants, New Mexico (Melancon, 1963) the stratigraphy of this formation throughout northwestern New Mexico has continued to receive much attention. Numerous studies of the Morrison have been made in the vicinity of Ambrosia Lake, Grants, and Laguna (fig. 1), resulting in the definition of several formal members. The presence of large amounts of uranium in the northeast-trending Jackpile sandstone (Jackpile ore-bearing bed), the uppermost unit of the Morrison Formation near Laguna (Moench and Schlee, 1967), has lead to exploration along this trend toward the area of this report.

The lower members of the Morrison recognized near Grants have been traced northeastward to the vicinity of Cuchillo Arroyo (fig. 1, location 2) by Freeman and Hilpert (1956). However, from Cuchillo Arroyo northward toward Cuba (fig. 1) sudden changes in facies make correlation of units within the Morrison uncertain (Swift, 1956). The present report presents stratigraphic and lithologic details and suggests correlations between Cuchillo Arroyo and Cuba. Although the Morrison in this area apparently lacks commercial deposits of uranium, the data presented here are of considerable interest in regional stratigraphic analyses.

Problems of nomenclature and different horizons chosen for the upper and lower contacts of the Morrison Formation have resulted in confusion, and therefore, a brief discussion of these problems provides background for the present study.

In a reconnaissance report concerning the area between San Ysidro and Gallina (fig. 1), Renick (1931) included in the Morrison all the strata above the Todilto Formation and below the Dakota Formation (Cretaceous) (fig. 2). He reported a measured section near Cuchillo Arroyo, where Freeman and Hilpert later measured the formation, and noted two informal members, a lower maroon shaly unit and an upper sandstone and variegated shale unit.

The basic references on Jurassic stratigraphy in northwestern New Mexico are two reports by Baker and others (1936, 1947). They placed the top of the Morrison at the contact with overlying Cretaceous beds and originally included the Todilto as a member within the Morrison (1936),

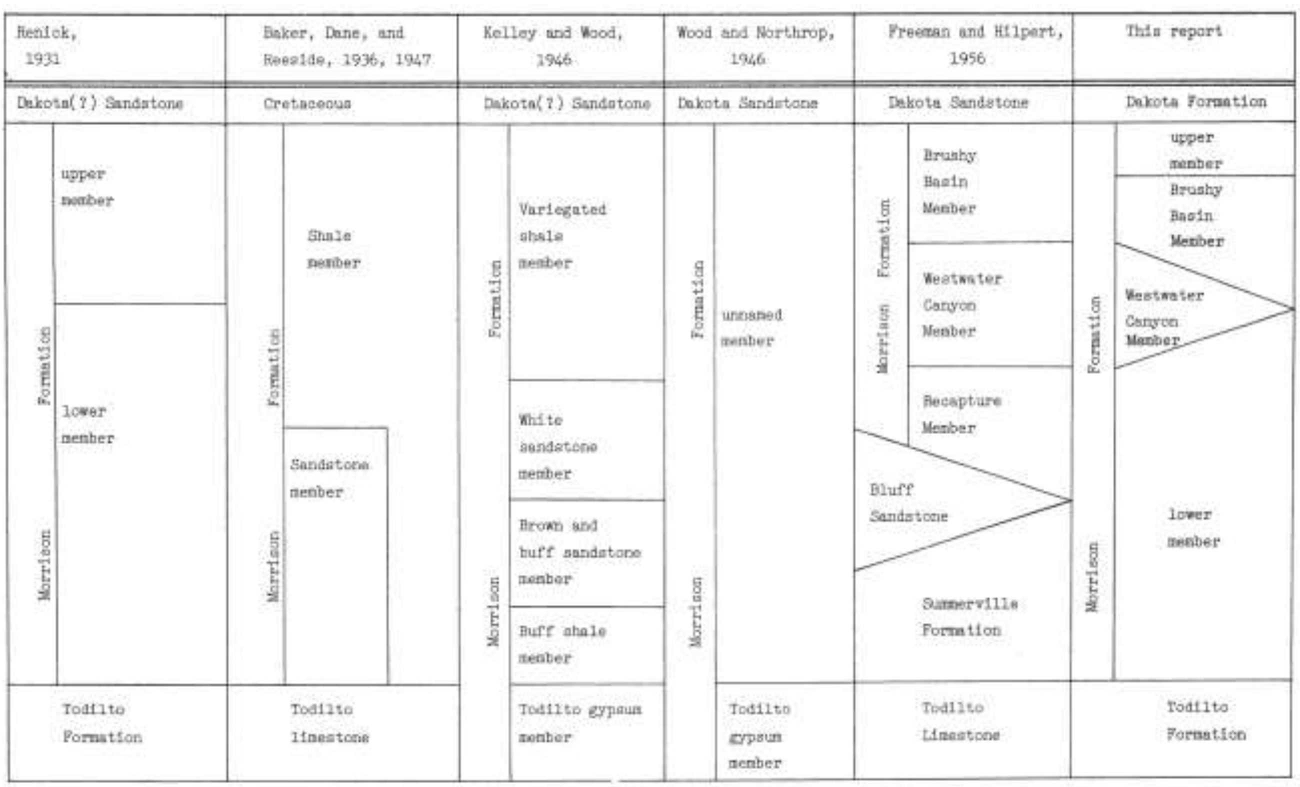


Figure 2 – Nomenclature used for rock units along southern and eastern edge of San Juan basin, New Mexico.

but later (1947) placed the base of the Morrison directly above the Todilto (fig. 2).

Wood and Northrop (1946), on their reconnaissance map of the Nacimiento uplift and adjacent areas, considered the Todilto a member of the Morrison Formation, but showed the Todilto as a separate unit, and did not indicate any subdivisions within that part of the Morrison above the Todilto Member (fig. 2).

In the area of the Lucero uplift, Kelley and Wood (1946) considered the Morrison to include the Todilto as a member and to extend upward to the base of the Dakota(?) Formation (fig. 2). In addition to the Todilto, they also recognized several informal members in the Morrison.

Harshbarger and others (1951), in discussing the Jurassic rocks near Thoreau, placed the base of the Morrison higher than Baker and others (1947), noting the Summerville Formation above the Todilto and below the Morrison. The Summerville has its type section in southeastern Utah (Gilluly and Reeside, 1928; Baker and others, 1936), and this. unit as described near Thoreau appears to correlate with the buff shale member of the Morrison reported by Kelley and Wood (1946) in the Lucero uplift. Harshbarger and others (1951) divided their restricted Morrison Formation into four members: in ascending• order, the Bluff, the Recapture, Westwater Canyon, and Brushy Basin. These members also have their type sections in southeastern Utah (Baker and others, 1936; Gregory, 1938).

In the Grants area, Craig and others (1955) used the same nomenclature (fig. 2) as used by Harshbarger and others near Thoreau, but considered the Bluff to be a separate formation. Freeman and Hilpert (1956) then extended the nomenclature used by Craig and others eastward to Laguna and northeastward to Cuchilla Arroyo (figs. 1 and 2, location 2). At the latter locality, however, the Bluff Sandstone is missing and the Recapture Member of the Morrison Formation rests directly on the Summerville Formation (Freeman and Hilpert, 1956).

Eight complete sections and one partial section (location 4) of the Morrison Formation were measured. Descriptive terms for bedding and grain size are the same, respectively, as used by McKee and Weir (1953) and Wentworth (1922).

Richard Ruetschilling and Ruben Martinez assisted in measuring several of the sections.

Stratigraphy

In the southern part of the area studied, four members of the Morrison Formation are recognized. To the north, near Cuba, only three members are recognized because of a facies change within the Westwater Canyon Member.

The lower member consists of reddish-brown and maroon-brown mudstones with gray, very fine-grained sandstone interbeds. Above the lower member is the Westwater Canyon Member which is mostly cliff-forming sandstone in the southern part of the area; toward the north, this member changes to brick-red mudstone with subordinate sandstone interbeds; near Cuba the Westwater Canyon cannot be recognized. The Recapture Member is composed mostly of green and brick-red mudstone with subordinate intercalated sandstones. It overlies the Westwater Canyon in the southern part of the area, and overlies the lower member in the northern part of the area. The upper member consists mainly of sandstone with subordinate green shale. Locally, green shale occurs at the top of the unit, just below the overlying Dakota Formation (Cretaceous).

Lower Member

The lower member of the Morrison 'Formation is composed of 325 to 440 feet of approximately equal amounts of reddish-brown and maroon-brown mudstone and gray, very fine to fine-grained sandstone, with minor amounts of green mudstone. Locally thin beds of gray, elastic limestone are present. This member forms a saddle or slope beneath the cliff-forming sandstone of the overlying Westwater Canyon Member (fig. 3).

Bedding is rarely seen within the mudstone or sandstone intervals. These intervals mostly range from 1 to 6 feet thick, but locally the sandstone intervals may be up to 10 feet thick. The mudstone is easily eroded and the sandstones are friable, forming slopes or low, rounded ledges.

The lower member rests concordantly on the Todilto Formation (Jurassic) and interfingers with the overlying Westwater Canyon Member. At most localities the lower member is poorly exposed, being covered by soil in a strike valley bounded by resistant ridges of gypsum and sandstone.

Near Cuchillo Arroyo (location 2) the mudstone in the lower part of this member is pale reddish-brown and probably correlates with the Summerville Formation (Freeman and Hilpert, 1956); to the north, however, the mudstones in this member are more uniformly darker, being maroon brown. Separating the Summerville and the Recapture is made difficult by this northward change in color. in combination with poor exposures at most localities; therefore, they are both included in the lower member of the Morrison Formation of this report.

Westwater Canyon Member

This unit consists principally of cliff-forming sandstone in the southern part of the area (figs. 3, 4); these sandstone beds grade into brick-red and green mudstone toward the north (figs. 5 and 6). This facies change takes place by thinning of the sandstone intervals and thickening of the intercalated mudstone intervals northward (fig. 7).

The sandstone is mostly thick-bedded, slightly feldspathic to arkosic, fine to very coarse grained and locally conglomeratic, and yellowish to tan or pink. Within the sandstones in the southern part of the area are discontinuous mudstone layers and lenses (fig. 3). Scour and fill structure is characteristic of most of the sandstone beds, and, to the north, the beds become noticeably lenticular (fig. 5). Conglomeratic lenses up to 1 foot thick contain pebbles up to 1 inch in diameter, and are found throughout this member. Thin beds of gray, elastic limestone occur locally in the mudstone intervals.

The Westwater Canyon Member interfingers with the underlying member. In the southern part of the area the top of the Westwater Canyon Member is readily placed at the top of the highest, thick, cliff-forming sandstone. Northward, though, the top of the Westwater Canyon Member is difficult to locate because the overlying Recapture Member is very similar to the red and green mudstone, with subordinate sandstone interbeds characteristic of the northern facies of the Westwater Canyon Member.

This unit ranges in thickness from about 100 feet in the south to about 320 feet toward the north (locations 6 and 7) and appears to be absent at the northernmost measured section (location 9).

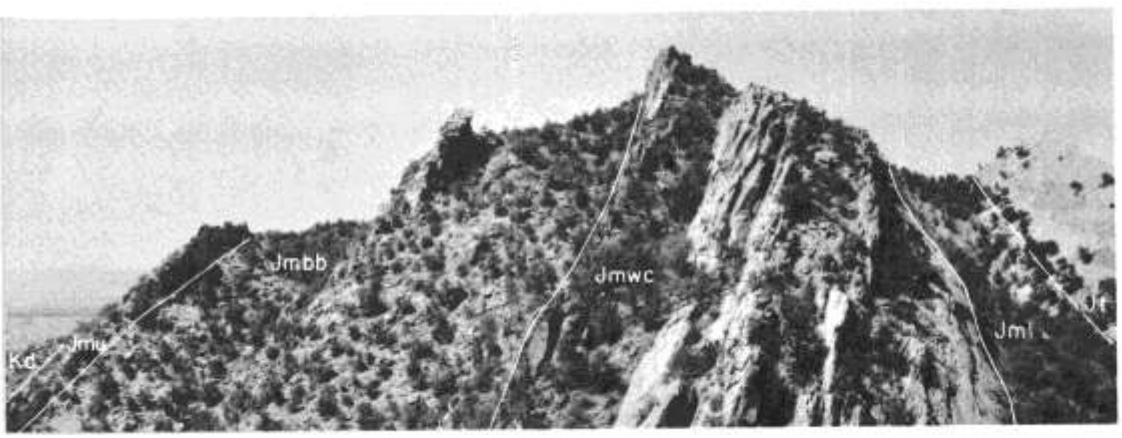
Brushy Basin Member

This unit consists of brick-red and green mudstone with subordinate sandstone interbeds and minor amounts of gray, elastic limestone.

The mudstone mostly forms slopes or a saddle (figs. 4 and 5) although, locally, this unit may be siliceous, hard, and resistant to erosion. Sandstone interbeds are generally 1 to 2 feet thick and range from very fine to coarse grained. Local conglomeratic lenses up to 1 foot thick contain pebbles up to 1/2 inch in diameter. Most of the very fine

Figure 3—View north near Cuchillo Arroyo (location 2) of slope-forming lower member (Jml) and cliff-forming Westwater Canyon Member (Jmwc) of Morrison Formation. Note discontinuous mudstone lenses in Westwater Canyon Member near center of photograph.

Figure 6—View southwest of vertical, north-trending, cliff-forming sandstone beds of Westwater Canyon Member at location 8. Non-resistant, brick-red mudstone is dominant lithology within this interval.



Symbols are Todilto Formation (Jt), lower member of Morrison Formation (Jml), Westwater Canyon Member (Jmwc), Brushy Basin Member (Jmbb), upper member (Jmu), Dakota Formation (Kd).

Figure 4—View north along strike of steeply dipping Morrison Formation 2½ miles south of location 3.

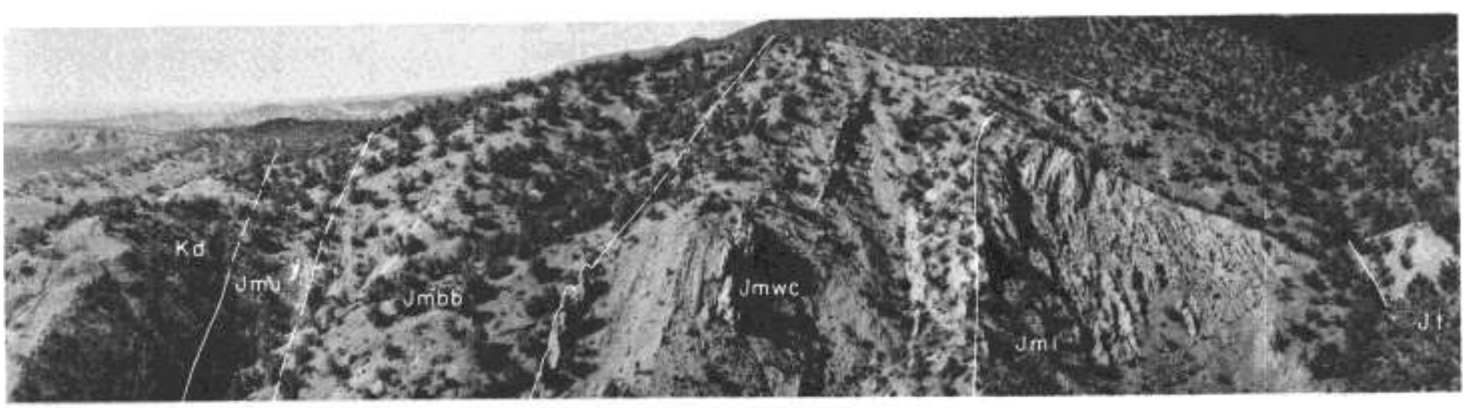


Figure 5—View north of steeply dipping Morrison Formation at location 7. Note lenticular sandstones of Westwater Canyon Member are separated by thick intervals of non-resistant mudstone.

grained sandstone is red or green and quartzose, whereas the coarser grained sandstone is yellowish, tan, or gray and is slightly feldspathic. The sandstone beds tend to form cliffs or ledges (fig. 4).

The Brushy Basin Member ranges from 60 to 220 feet in thickness except at the northernmost measured section (location 9) where it is 25 feet thick. Possibly the Morrison at this latter locality has been tectonically thinned; therefore, the measured thickness should be used with caution.

Upper Member

This unit consists mostly of sandstone with subordinate green or rarely red mudstone interbeds. The sandstone is fine to coarse grained or conglomeratic, thick bedded, and forms ledges or rounded cliffs. Sandstones near the base are mostly yellowish, tan, or rarely pink, and become whitish near the top because of small disseminated kaolinitic specks. Locally, slope- or saddle-forming green mudstone occurs at the top of this unit.

Thickness varies from 75 to 245 feet (fig. 7). The unit is conformable with the underlying Brushy Basin Member and is disconformably overlain along a sharp contact by the carbonaceous sandstone and carbonaceous shale of the Dakota Formation (Cretaceous).

Sandstone beds in the unit are lithologically similar to the Jackpile sandstone (Jackpile ore-bearing bed) of the Laguna area (Moench and Schlee, 1967) and occur at the same stratigraphic position. Thus, the upper member of the Morrison Formation of the present report appears to correlate with the Jackpile—particularly significant because of the northeast-trend of the Jackpile in the Laguna district.

Summary and Conclusions

The Morrison Formation of the study area includes all the strata above the Todilto Formation (Jurassic) and below the Dakota Formation (Cretaceous). Thickness varies from 740 to 950 feet in measured sections free of structural complications. A thickness of 1,046 feet in one section (location 8) may be excessive because of tectonic repetition in the lower member of the formation. The measured thickness of 385 feet at the northernmost section (location 9) may be less than the true stratigraphic thickness because of tectonic elimination of beds.

The lower member of the Morrison Formation of this report includes beds that correlate with the Summerville Formation and Recapture Member of the Morrison Formation in the southern part of the area. Whether beds equivalent to the Summerville are present in the northern part of the area is not known. Thickness of the lower member ranges from 325 to at least 430 feet, and may be as much as 5[1]0 feet.

The overlying Westwater Canyon Member varies in thickness from 100 feet in the southern part of the area, where the unit consists principally of cliff-forming, thick-bedded sandstone, to 330 feet to the north (location 7) where the unit is composed of nearly equal amounts of sandstone and interbedded mudstone. North of location 7 the member changes rapidly to mudstone with subordinate sandstone interbeds. At the northernmost measured section (location 9) Westwater Canyon sandstone beds are not present.

The Brushy Basin Member varies in thickness from 60 to 220 feet in measured sections free of structural complications. At the northernmost locality, this unit is only 25 feet thick, due possibly to elimination of strata by faulting.

The upper member of the Morrison Formation is correlated with the Jackpile sandstone of the Laguna area on the basis of lithologic similarity and stratigraphic position. This unit varies in thickness from 75 to 245 feet in the sections measured, and may be thicker locally, but accurate stratigraphic measurements could not be made at those locations.

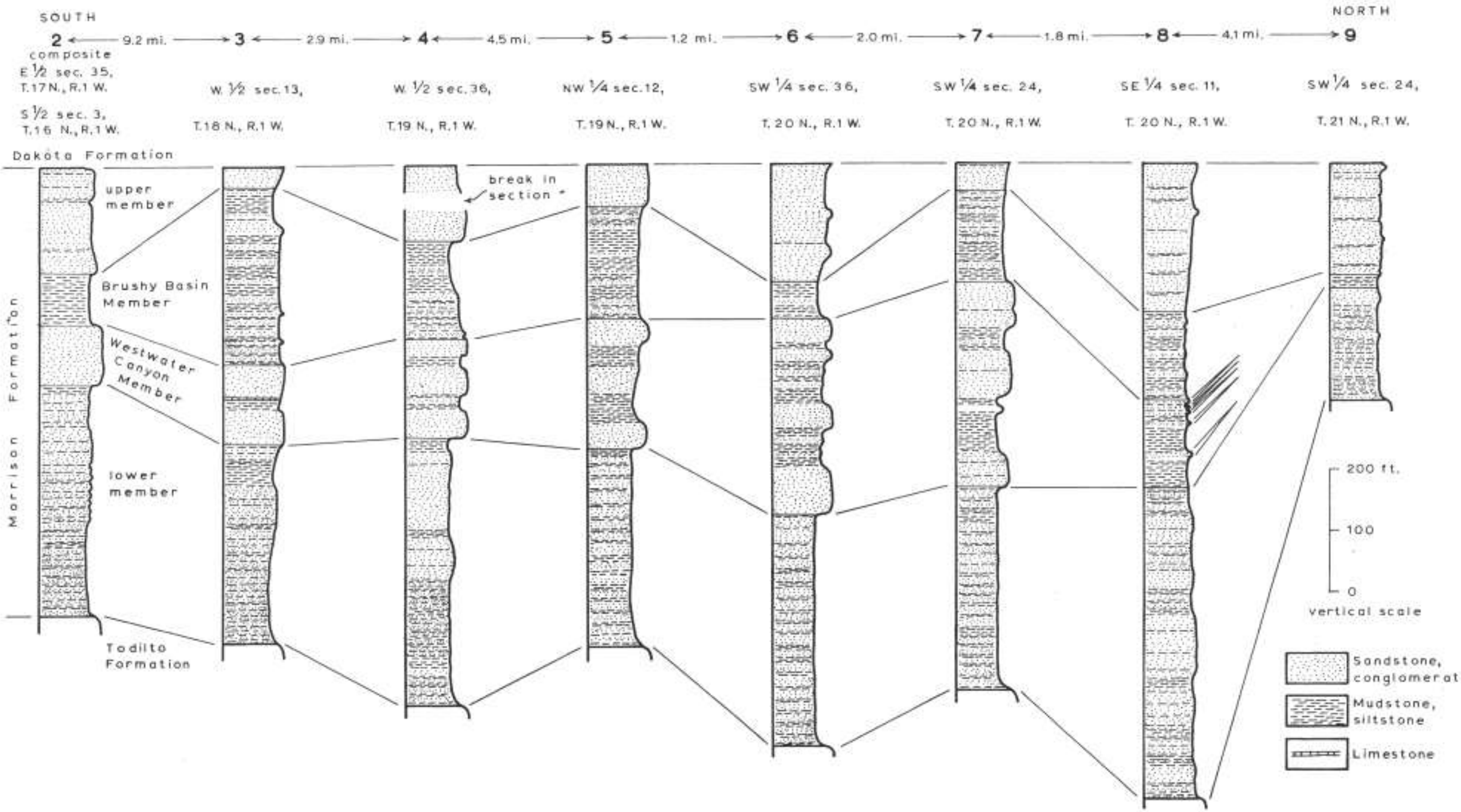


Figure 7 – Columnar sections and inferred correlations of Morrison Formation along the eastern margin of the San Juan basin. Numbers above sections are locations used in fig. 1 and in text.

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