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GEOLOGICAL SURVEY

Stratigraphic Sections of Jurassic San Rafael Group and Adjacent Rocks in Valencia and Sandoval Counties, New Mexico

By J. C. Wright, D. D. Dickey, and V. L. Freeman

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This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards.

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Illustrations

Stratigraphic Sections of Jurassic San Rafael Group and Adjacent Rocks in Valencia and Sandoval Counties, New Mexico

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Introduction

These sections were measured prior to 1960, before adoption of the metric system. Publication was delayed by other assignments of the authors and later by the untimely death of J. C. Wright. They are being released at this time because of the increased interest in the uranium potential of Jurassic rocks.

The Wingate Sandstone referred to in these sections has been renamed Iyanbito Member of the Entrada Sandstone (Green, 1974). The San Rafael Group is represented by the Bluff, Summerville, Todilto, and Entrada Formations in these measured sections.

Figure 1 is a map showing the locations of the stratigraphic sections included in this report. The following terms were found convenient in helping to describe stratigraphic sections on the Colorado Plateau.

Entrada berries.--Very well rounded, nearly spherical, frosted sand grains larger than grains of the matrix and composing a very small part of the total volume. They are common in the Entrada Sandstone, but are not exclusive to it

Slickrim.--A slightly rounded or curved cliff of sandstone as opposed to vertical cliff

Stonepecker holes.--Small holes, a few millimeters to a few centimeters in diameter in the face of a sandstone cliff. They usually form in horizontal rows along a thin bed of material of a slightly different texture from the main sandstone body

Hoodoos.--Weathering style characteristic of sandstone and siltstone beds with disrupted internal bedding. The hoodoo forms stand in columns and have an appearance of rounded boulders stacked on top of each other. "Boulder" tops and bottoms of adjacent columns are at the same stratigraphic level because they are controlled by softer thin beds or bedding planes

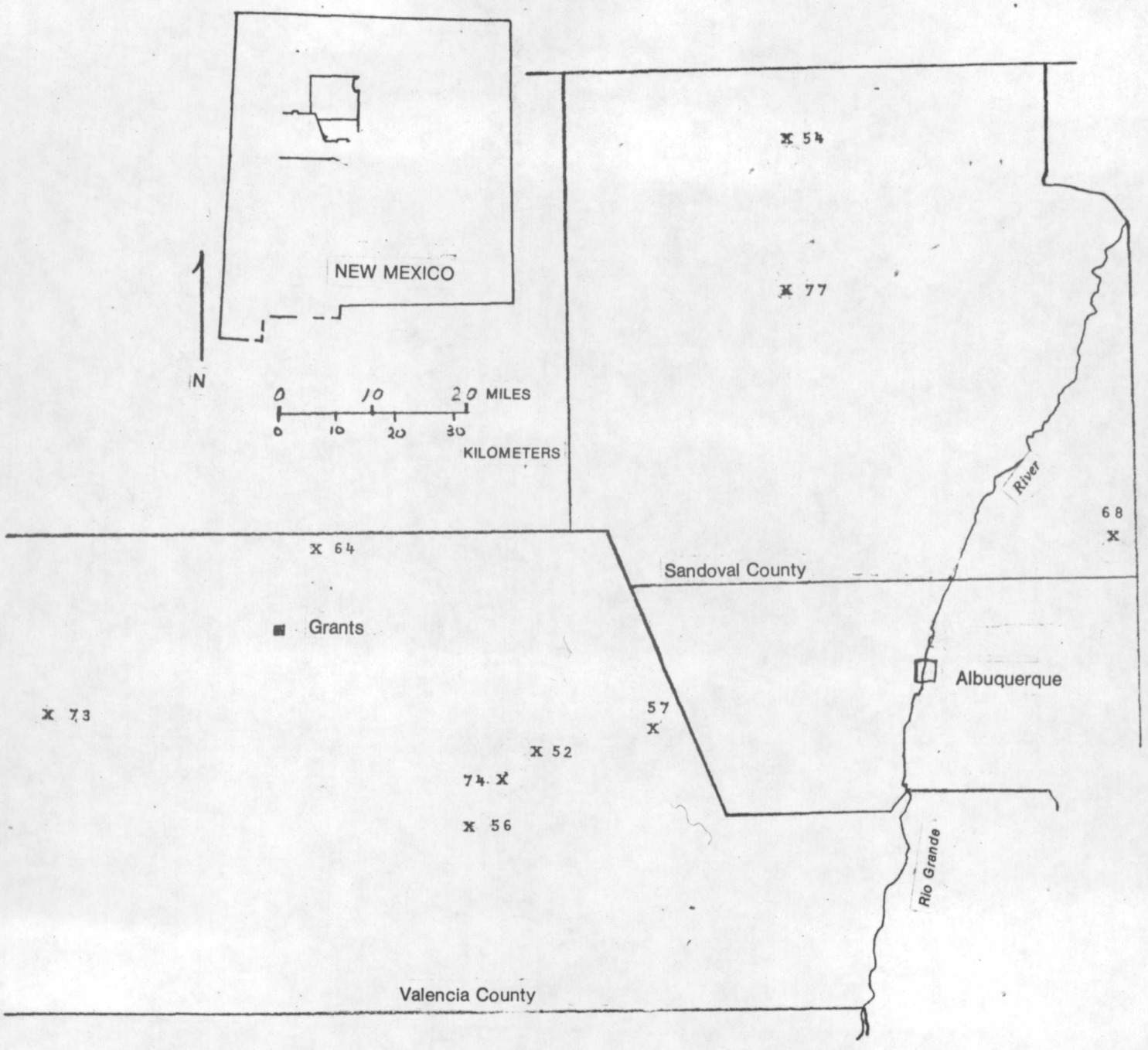

Figure 1. Map showing locations of stratigraphic sections in this report. (Section numbers are in system referred to by Wright and Dickey, 1963.)

NEW MEXICO - VALENCIA COUNTY

SANDY MINE section (52)

[Entrada Sandstone measured in the SE 1/4, sec. 27, T. 9 N., R. 5 W.; Todilto and Summerville Formations measured about 1 mi west in sec. 28; measured by J. C. Wright and D. D. Dickey with K. J. Monson and W. B. Satterthwaite, July 13, 1957]

	Feet
Middle Jurassic	
Bluff Sandstone:	
43. Sandstone, yellowish gray (5Y 7/2); weathers grayish brown (5YR 6/2), very fine to fine grained, moderately well sorted; composed of well-rounded quartz grains, many of which are frosted, and orange and black and white chert accessory grains; well-cemented; thin even strata. Forms vertical cliff estimated to be 60 ft high, which probably represents nearly the entire thickness of the formation; only lower 20 ft examined. Approximately----------	60.0
Total of Bluff Sandstone----------	60.0

Note: The Bluff-Summerville contact is conformable; irregularities of contact are less than 1 in.

SANDY MINE section--Continued

		Feet
Summerville Formation:		
42.	Mudstone, dusky red (10R 3/2), weathers same, poorly sorted; silt grains most abundant; disturbed flat bedding. Forms recess----------	2.0
41.	Sandstone, like unit 39----------	9.0
40.	Siltstone, like unit 38----------	1.5
39.	Sandstone, like unit 35, but forms hoodoos on a vertical cliff----------	4.5
38.	Siltstone, grayish red (10R 4/2), with irregular streaks of light greenish gray (5GY 8/1), very firmly cemented, has easily seen gradational contacts. Forms hoodoos in a recess----------	2.0
37.	Sandstone, like unit 35. Forms uppermost projecting ledge in Summerville Formation----------	9.5
36.	Siltstone, reddish brown (10R 4/4), with some streaky, white bleached areas outlining disturbed and disrupted bedding; weathers to hoodoos or poorly exposed steep slopes----------	10.0
35.	Sandstone, like unit 29; also contains a little white chert or kaolinized feldspar as an accessory mineral----------	5.5
34.	Siltstone, like unit 28----------	9.5
33.	Sandstone, like unit 29----------	2.5
32.	Siltstone, like unit 25, weathers to hoodoos in a recess between sandstone ledges----------	4.0

SANDY-MINE section--Continued

	Feet
Summerville Formation--Continued	
31. Sandstone, like unit 29----------	1.5
30. Siltstone, like unit 28----------	2.5
29. Sandstone, grayish orange pink (5YR 8/2) weathers grayish brown (5YR 6/2), very fine grained, well sorted; composed of well-rounded clear quartz grains with orange and black accessory grains; firmly cemented; bedding very indistinct, probably low-angle cross-strata. Forms the lowest conspicuous ledge in the upper part of the Summerville Formation--------	2.0
28. Siltstone, pale red (10R 6/2) to grayish red (10R 4/2), weathers to latter color; the lighter colored beds are well sorted and contain orange and black accessory grains; the darker colored beds are clayey and any accessory grains are masked by the dark color; very thin to thin planar beds. Poorly exposed on steep slope----------	47.5
27. Sandstone, very silty, light grayish red (10R 5/2), weathers grayish brown (5YR 6/2), structureless with a suggestion of disrupted laminae. Forms hoodoo ledge----------	8.5

SANDY MINE section--Continued

	Feet
Summerville Formation--Continued	
26. Sandstone, white (N 9), weathers grayish orange pink (5YR 8/2), very fine grained, well-sorted; contains orange and black accessory grains; firmly cemented; structureless or indistinct bedding; lower contact sharp, upper contact irregular reworked and gradational for about 3 in. Forms slickrim ledge-------	5.5
25. Siltstone, pale red (10R 6/2), weathers light grayish red (10R 5/2), sandy, moderately well sorted; thin to thick massive beds with disrupted internal laminae. Forms bench and a recess beneath overlying sandstone----------	6.0
Total of Summerville Formation----------	133.5

Note: The Summerville-Todilto contact is covered.

Todilto Limestone:	
24. Limestone, dark gray (N 3), weathers same, microcrystalline, thin massive beds----------	2.0
23. Sandstone, pale yellowish gray (5Y 8/2) weathers yellowish orange (10YR 7/6), very fine grained, well sorted, well cemented; poorly exposed. Measurement of unit involves offset with considerable uncertainty because of undulating beds and poor exposures----------	17.0

SANDY MINE section--Continued

	Feet
Todilto Limestone--Continued	
22. Limestone, light gray (N 7), weathers dark gray (N 3), finely crystalline; dark color suggests that it contains some gypsum; irregular thin to thick massive beds. Poorly exposed----------	2.0
21. Sandstone, yellowish orange (10YR 7/6), weathers yellowish brown (10YR 5/2), fine grained, moderately well sorted; composed of quartz grains cemented by calcite and gypsum; spongy fragmental texture suggesting the solution of a much greater amount of original gypsum. Poorly exposed on slope----------	4.0
20. Sandstone, light gray (N 7), to pale yellowish orange (10YR 8/6), very fine grained, well sorted; composed of well rounded grains of clear quartz; well cemented; abundant calcite; less limy at top. Poorly exposed on slope----------	14.5
19. Limestone, light gray (N 7) to medium dark gray (N 4), silty with increasing amounts of silt towards top; thin- to thick-bedded. Forms ledge; grades into overlying unit----------	34.0
18. Limestone, like unit 16, weathering shows thin even laminations----------	15.5
17. Diabase sill, 17 ft thick (not part of Todilto)	

SANDY MINE section--Continued

Feet

Todilto Limestone--Continued

16. Limestone, medium light gray (N 6), to medium dark gray (N 4); thin to very thin bedded; quite sandy in lower one-half foot; commonly deformed into sharp anticlinal folds about 3 ft high and tens of feet long. Forms base of prominent ledge---------- 4.0

Total of Todilto Limestone---------- 93.0

Note: The Todilto-Entrada contact is poorly exposed; appears conformable.

Entrada Sandstone:

Upper member:

15. Sandstone, white (N 9), weathers same to very pale orange (10YR 8/2) very fine to fine grained, moderately well to well sorted; composed of subrounded to subangular quartz, common red, orange, black, green, and amber accessory grains; well cemented; bedding not well exposed, assumed to be large-scale very low-angle cross-laminae. Forms steep covered slope---------- 29.0

SANDY MINE section--Continued

Feet

Entrada Sandstone--Continued

Upper member--Continued

14. Sandstone, light brown (5YR 6/4), weathers same, lower foot pinkish gray (5YR 8/1), fine to very fine grained, moderately well to well sorted; composed of subrounded to subangular quartz grains with black accessory grains, other accessory grains masked; individual laminae contain abundant well-rounded, frosted, medium-grained Entrada berries. Lower foot, medium- to fine-grained; composed of rounded quartz grains and abundant red, green, black, orange, and uncommon white chert accessory grains. Composed of thick planar-sets of large- to medium-scale cross-laminae. Forms slickrim cliff---------- 46.0

Total of upper member---------- 75.0

Note: The upper member-medial member contact is slightly irregular.

SANDY MINE section--Continued

	Feet
Entrada Sandstone--Continued	
Medial silty member:	
13. Siltstone and sandstone like unit 10 in color and lithology; laminated to thin bedded, micaceous. Forms slope or soft irregularly weathering cliff---	6.5
12. Siltstone and sandstone, like unit 10 in two graded beds----------	4.5
11. Sandstone, very silty, white (N 9), weathers very pale red (10R 7/2), very fine grained, well to moderately well sorted; composed of quartz with abundant orange, black and rare green accessory grains; moderately well cemented; some small-scale cross-laminae. Forms minor white ledge----------	0.5
10. Siltstone, sandy, and sandstone, silty. Siltstone reddish brown (10R 4/4). Sandstone same color and very light gray (N 8), weathers same color. Internally disrupted bedding in probably three graded beds with white sandstone forming base of each bed. Forms slope----------	8.5
Total of medial silty member----------	20.0
Total of Entrada Sandstone----------	95.0

Note: The Entrada-Chinle contact is covered; locally appears conformable; regionally unconformable.

SANDY MINE section--Continued

Feet

Upper Triassic

Chinle Formation (incomplete):

9. Siltstone, like unit 2. Forms ledgy slope---------- 10.5

8. Limestone, like unit 5, but contains some very small scale cross-laminations. Unit forms ledge--------- 1.0

7. Siltstone, like unit 2; mostly flat or irregularly laminated; some very small scale cross-lamination. Forms slope---------- 4.5

6. Sandstone, very silty, reddish brown (10R 4/4), grayish blue (5PB 5/2), and very pale red (10R 7/2), weathers same, irregularly bedded. Forms minor ledge------- 0.5

5. Limestone, pale reddish purple (5RP 6/2), and grayish red (10R 4/2), weathers same, silty; irregularly laminated. Forms ledge---------- 1.0

4. Siltstone like unit 2, but some strata very limy----- 3.0

3. Siltstone, very light gray (N 8), weathers dark pinkish gray (5YR 7/1), ripple laminated. Forms minor ledge---------- 0.5

2. Mostly covered; siltstone, pale grayish blue (5PB 6/2) and grayish red (10R 4/2), weathers same to dark reddish brown (10R 3/4), clayey, micaceous; irregularly laminated. Forms slope---------- 2.0

SANDY MINE section--Continued

	Feet
Chinle Formation--Continued	
1. Siltstone, light brownish gray (5YR 6/1), weathers same to greenish gray (5GY 6/1), laminated; weathers flaggy; yellowish green uranium mineralization along fractures----------	3.0
Total of incomplete Chinle Formation----------	>26.0

NEW MEXICO - SANDOVAL COUNTY

SAN MIGUEL CANYON section (54)

[Entrada Sandstone and Todilto Limestone measured in SW 1/4 sec. 1, T. 19 N., R. 1 W., about 100 yds south of the arroyo. Summerville and Morrison Formations measured about 1/2 mi further south in the NW 1/4 sec. 12, and NE 1/4 sec. 11; measured by J. C. Wright and D. D. Dickey with K. J. Monson and W. B. Satterthwaite, August 3, 1957]

	Feet
Upper Cretaceous	
Dakota Sandstone (incomplete):	
18. Conglomeratic sandstone. Forms hogback----------	>25.0
Total of incomplete Dakota Sandstone----------	>25.0

Note: The Dakota-Morrison contact shows channels a few feet deep.

SAN MIGUEL CANYON section--Continued

Feet

Upper Jurassic

Morrison Formation:

Brushy Basin Member:

17. Mostly covered; mudstone, shale, and sandstone. Mudstone dusky yellow green (5GY 5/2), speckled with moderate reddish brown (10R 4/6); grain size ranges from clay through fine sand; sand grains are clear quartz, gray and orange grains. Sandstone, fine to very fine grained, pinkish white (5R 9/4) and minor orange; probably some small-scale cross-laminae. Shale, brownish red and green. Unit contains some greenish gray siliceous beds. Forms covered slope---------- 184.5

Total Brushy Basin Member---------- 184.5

Note: The Brushy Basin-Westwater Canyon contact is not exposed.

Feet

Morrison Formation--Continued

Westwater Canyon Member:

16. Poorly exposed; sandstone (about 90 percent); claystone (about 10 percent). Sandstone grayish orange pink (10R 8/2) to light grayish orange (10YR 8/4), upper 20 ft are greenish yellow (10Y 6/4), fine grained, poorly to moderately well sorted with grains as large as coarse in size; composed of subrounded to rounded quartz grains, some spherical gray frosted coarse Entrada berries and subangular feldspar grains. In the top 20-ft-thick bed all grains have a dirty coating; bed probably cross-bedded. Forms mostly covered slope---------- 57.0

15. Mostly covered; claystone and sandstone. Claystone, light brownish gray (5YR 6/1), and greenish gray (5G 7/1). Sandstone, probably very fine grained. Unit forms covered slope---------- 78.0

SAN MIGUEL CANYON section--Continued

Feet

Morrison Formation--Continued

Westwater Canyon Member--Continued

14. Sandstone, yellowish orange (10YR 7/6), weathers same, fine grained with abundant medium and very fine grains, moderately well sorted, moderately well cemented; composed of subrounded quartz most of which is stained orange, common feldspar (10 percent) red, black, and rare green accessory grains; bedding not visible in poor exposure. Forms slope---------- 18.0

Total Westwater Canyon Member---------- 153.0

Note: The Westwater Canyon-Recapture Shale contact is poorly exposed; possibly slightly irregular.

Recapture Shale Member:

13. Claystone (90 percent), dusky red (10R 3/2), and greenish gray (5G 7/1), silty, weathers shaly. Sandstone, very fine grained, poorly exposed in thin beds. A very thin sandstone bed 2 ft below the top of the unit is fine- to medium-grained quartz sand with abundant red and orange accessory grains. Forms slope---------- 109.0

SAN MIGUEL CANYON section--Continued

	Feet
Morrison Formation--Continued	
Recapture Shale Member--Continued	
12. Sandstone (90 percent), with very thin interbeds of claystone (10 percent). Sandstone very pale red (10R 7/2), to pale red (10R 6/2), fine to very fine grained, moderately well to well sorted; composed of subrounded clear quartz with abundant orange and black accessory grains, one bed near base has very small dark red clay chips; moderately well cemented; believed to be in mostly flat beds with many internal low-angle small-scale cross-laminae. Claystone, dusky red (10R 3/2), lamellar; silty and sandy. Forms slope----------	131.0
11. Conglomeratic sandstone, grayish pink (5R 8/2) speckled with medium dark gray (N 4) pebbles and granules and grayish red (10R 4/2) clay chips; composed of clean amber stained quartz grains, black sand grains, gray pebbles and granules, and dark red mud chips in lenses and irregular cross beds; very weathered. Forms slope----------	2.0
Total of Recapture Shale Member----------	242.0
Total of Morrison Formation----------	579.5

Note: The Morrison-Summerville contact is poorly exposed.

SAN MIGUEL CANYON section--Continued

Feet

Middle Jurassic

Summerville Formation:

10. Siltstone (55 percent), sandstone (30 percent), and claystone (15 percent), poorly exposed. Siltstone, grayish orange pink (10R 8/2) to grayish red (10R 4/2), some sandy, some clayey, probably mostly flat bedded with minor ripple laminae and very small scale cross-laminae. Sandstone, grayish pink (5R 8/2) to light greenish gray (5GY 8/1), very fine to fine-grained, moderately well sorted, some beds silty; composed of subangular to subrounded clear quartz grains with abundant orange and black and common white chert accessory grains; moderately well cemented; believed to be flat bedded possibly some internal cross-laminae. Claystone dusky red (10R 3/2), weathers shaly. Forms slope---------- 93.0

Total of Summerville Formation---------- 93.0

Note: The Summerville-Todilto contact is not exposed.

SAN MIGUEL CANYON section--Continued

	Feet
Todilto Limestone:	
9. Limestone, medium gray (N 5), weathers same, microcrystalline, massive. Forms float on dip slope of gypsum unit----------	1.0
8. Gypsum, white (N 9), weathers to medium light gray (N 6), pure, massive. Forms prominent capping to Entrada Sandstone scarp----------	70.0
7. Limestone, medium light gray (N 6), weathers light olive gray (5Y 6/1), to medium dark gray (N 4), microcrystalline, thinly laminated, ripple-marked. Weathers to a papery and shaly ledge concealed by slumped masses of the overlying gypsum. Fetid odor	12.0
Total of Todilto Limestone----------	83.0

Note: The Todilto-Entrada contact is poorly exposed; appears conformable.

Entrada Sandstone:

Upper member:

6. Sandstone, grayish yellow (5Y 8/4), almost entirely covered, probably very fine grained, poorly cemented; very indistinct bedding in part, part of unit consists of tabular sets of large-scale cross-strata. Probably similar to unit 5 except for color. Forms steep covered earthy slopes---------- 60.0

SAN MIGUEL CANYON section--Continued

	Feet
Entrada Sandstone--Continued	
Upper member--Continued:	
5. Sandstone, orange white (5YR 9/4) to light greenish gray (5GY 8/1), weathers same, very fine to fine grained, silty, poorly sorted; composed of clean subrounded to subangular quartz grains with accessory hematite silt grains and rare very fine green chert grains; poorly cemented, sand is singularly free of cement; very indistinct bedding, mostly in tabular sets about 10 ft thick of cross-strata. Forms steep earthy cliff or slope. The lithologic change between units 4 and 5 is gradational----------	42.0
Total of upper member----------	102.0
Medial member:	
4. Sandstone, like unit 2, flat-bedded units 2 and 4 are a subtly darker color than crossbedded unit 3; the difference is indistinguishable on the color chart. The three units together form the lower reddish-orange part of the Entrada Sandstone that is so prominent in the Rio Gallina and Chama River valleys----------	33.0

SAN MIGUEL CANYON section--Continued

	Feet
Entrada Sandstone--Continued	
Medial member--Continued:	
3. Sandstone, like unit 2 in color and lithology; upper 30 ft is divided into tabular cosets about 10 ft. thick of wedging planar sets of medium- to large-scale cross-laminae; the lower 11 ft are gradational between units 2 and 3, with some irregular flat bedding and some thin sets of cross-strata. About 2 ft above base is a thin bed of purple clay with bleached white zones above and below it. Unit forms part of steep rounded cliff----------	45.0

SAN MIGUEL CANYON section--Continued

	Feet
Entrada Sandstone--Continued	
Medial member--Continued	
2. Sandstone, very silty, moderate reddish orange (10R 6/6), weathers same, very fine grained with abundant silt grains, moderately well to poorly sorted; contains common medium-grained Entrada berries of rounded gray frosted quartz and subrounded white chert, also some accessory silt grains of hematite; firmly cemented, thin to very thin irregular disturbed even beds. Forms steep rounded cliff, concealed in most places by valley alluvium. About 3 ft and 8 ft above the base are very thin beds of purple clay with bleached white zones about 2 in. thick above and below them----------	36.0
Total of medial member----------	114.0
Total of Entrada Sandstone----------	216.0

Note: The Entrada-Chinle contact is mostly concealed; appears conformable.

SAN MIGUEL CANYON section--Continued

Feet

Upper Triassic

Chinle Formation (incomplete):

1. Claystone, reddish brown (10R 4/4) with some streaks of greenish gray (5GY 6/1), weathers reddish brown (10R 4/4) to grayish red (5R 4/2); thinly laminated, weathers to a steep earthy slope, covered in most places by valley alluvium. Near the middle are several thin beds of siltstone, clayey, light greenish gray (5GY 8/1); ripple laminated---------- >133.5

Total of incomplete Chinle Formation---------- >133.5

NEW MEXICO - VALENCIA COUNTY

PETOCH BUTTE section (56)

[NW 1/4 sec. 6, T. 7 N., R. 6 W.; measured by V. L. Freeman, October 1954]

	Feet
Upper Cretaceous	
Dakota Sandstone (incomplete):	
16. Sandstone, with 4.0 ft of conglomerate at base; unit fills channels cut in Bluff Sandstone---------	20.0
Total of incomplete Dakota Sandstone----------	20.0
Middle Jurassic	
Bluff Sandstone:	
15. Sandstone, white (N 9), moderate greenish yellow (10Y 7/4), pale greenish yellow (10Y 8/2), dark yellowish orange (10YR 6/6), and pale yellowish orange (10YR 9/6); fine to medium grained, well sorted except for presence of minor argillaceous beds; composed of subrounded grains of quartz and rare red and black accessory grains that are smaller than average quartz grains; friable; bedding indistinct, but apparently mostly cross-bedding that appears eolian. Unit forms cliff-----	221.4

PETOCH BUTTE section--Continued

	Feet
Bluff Sandstone--Continued	
14. Sandstone, yellowish gray (5Y 7/4) to moderate greenish yellow (10Y 7/4), fine to medium fine grained, moderately sorted; composed of subrounded to rounded grains of slightly stained quartz and black, orange, and green accessory grains; friable; parallel bedding. Unit forms cliff except for two poorly exposed small benches formed at argillaceous zones----------	34.8
Total Bluff Sandstone----------	256.2
Summerville Formation:	
13. Sandstone, like unit 12; at the top, middle, and base of unit are 1-2 ft zones of sandstone, very argillaceous, pale olive (10Y 6/2) and grayish red (10R 4/2), very fine grained----------	17.4
12. Sandstone, yellowish gray (5Y 8/1) with minor light greenish gray (5G 8/1), very fine grained, well sorted, grains of quartz with orange and gray accessory grains; friable with some calcareous cement; bedding not visible----------	22.3

PETOCH BUTTE section--Continued

	Feet
Summerville Formation--Continued	
11. Sandstone, slightly argillaceous with very argillaceous bands, yellowish gray (5Y 8/1) with very argillaceous bands and streaks of grayish red (10R 4/2), very fine grained, well sorted, grains of quartz with orange and gray accessory grains; friable. Unit weathers into large rounded blocks--	26.6
10. Sandstone, yellowish gray (5Y 8/1), very fine grained, well sorted, grains of quartz with orange and gray accessory grains; friable with some calcareous cement. Unit poorly exposed----------	23.2
Total Summerville Formation----------	89.5
Todilto Limestone:	
9. Limestone (75 percent) with thin interbedded sandstone (25 percent), limestone, brownish gray (5YR 5/1) to yellowish gray (5Y 8/1), slightly sandy, dense with recrystallized specks; sandstone like unit 8----------	1.0

PETOCH BUTTE section--Continued

	Feet
Todilto Limestone:	
8. Sandstone, yellowish gray (5Y 8/1), very fine grained; well sorted, grains of quartz with rare orange, green, red, and black accessory grains; slightly friable, calcareous cement; parallel bedding. At top are three very thin beds of limestone like those in unit 9----------	2.3
Total Todilto Limestone----------	3.3
Entrada Sandstone:	
Upper member:	
7. Sandstone, grayish orange (10YR 7/4) at base to yellowish gray (5Y 8/1) at top, fine to medium fine grained, moderately well to well sorted, rounded, grains of quartz with orange, red, black and green accessory grains; very friable; crossbedding, medium- to large-scale low-angle-----	140.7
6. Sandstone, light brown (5YR 6/6), fine grained, moderately well to poorly sorted with coarse grains in stringers near base; rounded grains of stained quartz and black, white, orange, and green accessory grains; friable; cross-bedding, medium- to large-scale low-angle----------	52.0
Total upper member----------	192.7

PETOCH BUTTE section--Continued

	Feet
Entrada Sandstone--Continued	
Medial member:	
5. Sandstone, argillaceous, moderate reddish orange (10R 6/6) to (10R 5/6), very fine to fine grained, well sorted, but with scattered coarse grains and locally in stringers, rounded grains of stained quartz and black accessory grains; claystone in stringers total about 5 percent of unit; parallel thin bedding marked by clay-rich lines and coarse grains; unit shows uncommon bleached spots; weathering shows tendency to form rounded knobs (hoodoo) especially near top----------	22.5
4. Sandstone, very argillaceous, moderate reddish brown (10R 4/6), fine grained, poorly sorted, rounded grains of quartz and gray accessory grains; claystone present in very thin stringers; unit shows common bleached specks and spots; bedding indistinct but probably very thin and parallel----------	7.2

PETOCH BUTTE section--Continued

	Feet
Entrada Sandstone--Continued	
Medial member--Continued	
3. Sandstone (80 percent) and claystone (20 percent). Sandstone, moderate reddish orange (10R 6/6) locally bleached in spots and blotches and along bedding at base; very fine to fine grained, moderately well sorted, some coarse grains in stringers; scattered rounded grains of quartz and rare orange and pale green accessory grains. Claystone in thin beds and discontinuous stringers, dark reddish brown (10R 3/4), free of silt and sand; parallel bedding----------	4.9
Total medial member----------	34.6
Total Entrada Sandstone----------	227.3

PETOCH BUTTE section--Continued

Feet

Upper Triassic

Wingate(?) Sandstone:

2. Sandstone, moderate reddish orange (10R 6/6), bleached spots (3/4 in. in diameter) common, fine grained, moderately well sorted, rounded grains of stained quartz with white and black accessory grains; stringers of coarse grains are common, also some scattered coarse grains, coarse grains are quartz and black and red fine-grained rock fragments (chert?); very friable; crossbedded, medium- and large-scale low-angle---------- 38.3

1. Sandstone (80 percent), claystone (20 percent) and minor conglomerate. Sandstone, moderate reddish orange, very fine grained, well to moderately well sorted; composed of rounded grains of stained quartz with white, black, red (rare), and green (rare) accessory grains; friable, some calcareous cement; contains stringers of very coarse grains and granules; thin to thick crossbedded units separated by claystone. Claystone, grayish red (10R 4/2), very silty; in strata from a film to several inches in thickness. Conglomerate at base contains pebbles to 3/4 in. in maximum diameter---------- 9.0

Total Wingate(?) Sandstone---------- 47.3

Chinle Formation (not measured)--several hundred feet of exposure.

NEW MEXICO - VALENCIA COUNTY

CORREO section (57)

[Measured in the NW 1/4, sec. 22, and SW 1/4, sec. 15, T. 9 N., R. 3 W., just east of tributary wash to Rio San Jose, about 3 1/2 mi N. 30° E. of the railroad overpass of old U.S. Highway 66; measured by J. C. Wright with K. J. Monson, July 15 and August 12, 1957]

	Feet
Middle Jurassic	
Bluff Sandstone (incomplete):	
29. Sandstone, very pale orange (10YR 8/2) to pale yellowish orange (10YR 8/6), weathers grayish orange (10YR 7/4), fine grained, well to moderately well sorted; composed of clear quartz with abundant accessory grains of white chert, black silt and amber-stained quartz; thick wedging planar sets of medium- and large-scale cross-strata, contains a few thin flat beds near base. Contact with unit 28 is gradational. Forms top of cliff and bench about 1/2 mi. broad---	>70.0

CORREO section--Continued

	Feet
Bluff Sandstone (incomplete)--Continued:	
28. Sandstone, light brown (5YR 6/6) to moderate reddish brown (10R 4/6), weathers light brown (5YR 6/6) like unit 26 in lithology and bedding, also contains accessory white chert grains. Contains a few thin cross-sets in upper part. Forms main part of vertical cliff----------	40.5
27. Sandstone, orange pink (5YR 7/4), weathers same, fine grained, moderately well sorted, firmly cemented; composed of clear quartz with some medium-grained quartz Entrada berries and some white chert accessory grains; a tabular set of low-angle cross-strata. Forms part of vertical cliff----------	2.5

CORREO section--Continued

	Feet
Bluff Sandstone (incomplete)--Continued	
26. Sandstone, orange pink (5YR 7/4) weathers same, locally has streaks of dark reddish brown (10R 3/4), caused by abundant hematite cement, fine to very fine grained, well sorted, firmly cemented; composed of clear quartz grains with common well-rounded medium-grained Entrada berries of gray-frosted quartz, and also of black and red grains, thin flat beds. Forms lower part of vertical cliff----------	14.0
Total of incomplete Bluff Sandstone----------	>127.0

Note: The Bluff-Summerville contact appears flat, conformable, and gradational.

Summerville Formation:	
25. Siltstone, like unit 16----------	1.5
24. Sandstone, like unit 13; also has white chert as accessory grains. Forms prominent ledge----------	2.5
23. Siltstone, like unit 17----------	8.0
22. Sandstone, like unit 13. Forms prominent ledge------	1.5
21. Siltstone, like unit 17----------	11.5
20. Sandstone, like unit 13. Forms prominent ledge------	3.5
19. Siltstone, like unit 16----------	1.5
18. Sandstone, like unit 13----------	1.0

CORREO section--Continued

Feet

Summerville Formation--Continued

17. Siltstone, reddish orange (10R 5/6), weathers to moderate reddish orange (10R 6/6), on steep earthy slopes; slightly sandy; probably thin planar beds---------- 17.0

16. Siltstone, grayish red (10R 4/2) to pale reddish brown (10R 5/4), with a few streaks mottled greenish gray (5G 7/1), weathers pale red (10R 6/2) on steep earthy slopes, darker colored beds clayey; greenish-gray mottled beds, quite limy; concealed on slope, but appears to consist of thin planar beds---------- 37.0

15. Sandstone like unit 13, but does not form ledge------ 3.0

14. Siltstone, like unit 12, but almost completely exposed on a steep slope---------- 7.0

13. Sandstone, pinkish white (5YR 9/2), weathers orange pink (5YR 7/4), very fine grained, well sorted, firmly cemented; composed of clear quartz with abundant black and amber-stained accessory grains; structureless to indistinctly bedded. Forms minor ledge---------- 4.5

CORREO section--Continued

	Feet
Summerville Formation--Continued	
12. Concealed except for upper 2 ft. Probably mostly siltstone, pale red (10R 6/2) weathers same, sandy, moderately well sorted, moderately well cemented; irregular thin, planar laminae. Concealed under talus slope----------	8.0
Total of Summerville Formation----------	107.5
Todilto Limestone:	
11. Limestone, medium-gray (N 5), finely crystalline-----	0.5
10. Gypsum, white (N 9), nearly pure, thin to thick planar massive beds. Forms ledge on cliff and badlands on bench----------	86.0
9. Limestone, medium gray (N 5) to dark gray (N 3), silty near base and top, middle third is purer limestone and contains many fine fragments of limestone and possibly fossil fragments, thin planar laminations considerably contorted beneath gypsum. Forms prominent dark ledge----------	19.5
Total of Todilto Limestone----------	106.0

Note: The Todilto-Entrada contact appears flat and conformable.

CORREO section--Continued

Feet

Entrada Sandstone:

Upper sandy member:

8. Sandstone, light greenish gray (5GY 8/1), weathers same, very fine grained, moderately well to poorly sorted; composed of subangular clear quartz grains with common black accessory grains; poorly cemented, weathered soil suggests a clayey cement, but this is not visible in the fresh sandstone; bedding not visible but on the one cliff face visible at a distance it appears to consist of thin to thick planar beds. Forms clayey steep slope---- 23.0

7. Sandstone, grayish orange pink (5YR 7/2), weathers same, very fine grained, moderately well to poorly sorted; composed of subangular quartz grains with abundant black silt accessory grains; firmly cemented; cross-stratified. Poorly exposed on steep slope. Gradational contact with unit above---------- 13.0

6. Siltstone, dusky red (10R 3/2) slightly clayey, poorly sorted; probably thin planar beds. Poorly exposed on steep slope---------- 8.5

5. Claystone, very silty, grayish red (5R 4/2) with thin light greenish gray (5GY 8/1) bleached zones above and below it---------- 1.0

CORREO section--Continued

	Feet
Entrada Sandstone--Continued	
Upper sandy member--Continued	
4. Sandstone, orange pink (5YR 7/4) weathers same, fine grained, well to moderately well sorted; composed of subrounded to subangular clear quartz grains with abundant black, gray, and green accessory grains mostly of coarse silt size; firmly cemented; thick wedging planar sets of large-scale, cross-strata; near the middle is about 15 ft of thin flat beds of slightly finer grain size, almost identical in lithology to unit 3. Forms steep dissected slopes-	53.0

CORREO section--Continued

Feet

Entrada Sandstone--Continued

Upper sandy member--Continued

3. Sandstone, moderate reddish orange (10R 6/6), weathers same, very fine grained, moderately well to well sorted; a few beds contain abundant medium-grained well-rounded gray-frosted Entrada berries, fine black silt is present as a sparse accessory throughout; firmly cemented; composed dominantly of thin flat beds with minor thin sets of small- to medium-scale cross-strata; about 30-40 ft above base is a zone of thick sets of medium- and large-scale high-angle cross-strata; about 500-1,000 ft away (and also in Stewart and others (1972, p. 211) section 1 1/4 mi. west) this whole unit is cross stratified. About 5 ft beneath the top is a discontinuous parting of silty purple clay. Forms dissected low slickrim cliffs and badlands. At the base of the unit is about 1 1/2 ft of sandstone, moderate orange pink (5YR 8/4) to white (N 9), weathers same, very fine to fine grained, silty, moderately well to poorly sorted; contains abundant medium- to coarse-grained, well-rounded frosted Entrada berries of gray quartz and minor red and black quartz; firmly cemented; thin trough sets of small-scale cross-

CORREO section--Continued

	Feet
Entrada Sandstone--Continued	
Upper sandy member--Continued	
laminae, bottom surface has erosion channels about 1 ft deep and 5 ft across----------	91.0
Total upper sandy member----------	189.5

CORREO section--Continued

	Feet
Entrada Sandstone--Continued	
Medial silty member:	
2. Claystone (45 percent) interbedded with slightly clayey siltstone (40 percent) and slightly sandy siltstone (15 percent); claystone dark reddish brown (10R 3/4). Clayey siltstone, reddish brown (10R 4/4). Sandy, siltstone, orange pink (10R 6/4) to light greenish gray (5GY 8/1); moderately well sorted; firmly cemented; ripple laminae and small-scale cross-laminae in small shallow trough sets. Claystone and clayey siltstone appear to have thin flat beds and weather to poorly exposed pale reddish brown (10R 5/4) slopes in badland topography with minor 1-2 ft thick ledges of the sandy siltstone----------	45.5
Total of medial silty member----------	45.5
Total of Entrada Sandstone----------	235.0

Note: The Entrada-Chinle contact is not exposed; basal 2 or 3 ft of Entrada Sandstone is recognized only by reddish soil. Locally float in soil suggests that a purple clay parting is present at contact.

CORREO section--Continued

Feet

Upper Triassic

Chinle Formation:

Correo Sandstone Bed:

1. Sandstone, light gray (N 7), weathers same, fine grained, well sorted, arkosic; composed of quartz and about 15 to 20 percent pink feldspar with common black and dark green accessory grains; firmly cemented with calcite; thin sets of low-angle small-scale cross-strata. Forms ledge with abundant medium-gray float beneath it. Not measured, examined only uppermost foot---------- ----

NEW MEXICO - VALENCIA COUNTY

ELKINS partial section (64)

[Measured near W 1/4-corner, sec. 9, T. 12 N., R. 9 W.,
2.1 mi east of blacktop road at the junction to
H. C. Elkins place near foot of cliff; measured by
D. D. Dickey with K. J. Monson, July 14, 1957]

Note: This section supplements one at the same locality extending to the Dakota Sandstone, published by Rappaport and others, 1952, p. 51.

	Feet
Middle Jurassic	
Entrada Sandstone (incomplete):	
Upper sandy member (incomplete):	
5. Sandstone, weathers reddish orange (10R 5/6); composed of thick wedging planar sets of large-scale cross-laminae. Lower contact flat and even; shows only a few inches of irregularity. Lower 25 ft forms jointed vertical cliff----------	>25.0
Total of incomplete upper sandy member--------	>25.0
Medial silty member (reported as Carmel Formation in Rappaport and others, 1952):	
4. Siltstone, very sandy, brown (5YR 5/4), to reddish brown (10R 4/4), weathers same to reddish orange (10R 5/6) with some white dapples; disturbed to disrupted laminae in thin to thick beds; a few dark reddish brown (10R 3/4) clay partings near base. Weathers to slope and hoodoo cliff----------	37.5

ELKINS partial section--Continued

	Feet
Entrada Sandstone (incomplete)--Continued	
Medial silty member--Continued	
3. Sandstone, light brown (5YR 6/4) to reddish orange (10R 5/6), weathers reddish orange (10R 5/6) some horizontal streaks of pinkish white (10R 9/2) and white band at top of unit; lithology like that of unit 2; irregular to disrupted laminae within thin to thick beds. Forms rounded ledges on slope. Although this unit is lithologically similar to the underlying Wingate Sandstone, it has been placed in the Entrada Sandstone because of bedding structure; it is presumed to be a reworking of the Wingate material. The lower and upper contacts are both even and conformable---	15.0
Total of medial silty member----------	52.5
Total of incomplete Entrada Sandstone---------	>77.5

Note: Entrada-Wingate contact appears flat and conformable along 100 ft of exposure.

ELKINS partial section--Continued

	Feet
Upper Triassic	
Wingate Sandstone (incomplete):	
2. Sandstone, orange pink (5YR 7/4), weathers same, fine-grained at bottom to medium grained at top, well sorted, moderately well cemented; composed of rounded clean quartz grains with accessory grains of black, gray, rare red, and green minerals, and white chert; thick sets of large-scale cross-strata, except for lower few feet which appear to be irregularly planar bedded. Forms bare rounded exposures where not covered with alluvium----------	30.5
1. Sandstone, reddish orange (10R 5/6), weathers same to orange pink (10R 6/4), fine grained, moderately well sorted; composed of rounded quartz grains with accessory grains of white chert and black minerals, and medium-grained well-rounded, spherical, frosted quartz Entrada berries; irregular to possibly disturbed planar bedding. Forms mostly covered slope with outcrops in gully----------	16.5
Total of incomplete Wingate Sandstone---------	>47.0

Note: Base of exposure.

NEW MEXICO - SANDOVAL COUNTY

PUERTECITO section (68)

[Measured in SW 1/4 sec. 10, T. 12 N., R. 6 E;
measured by J. C. Wright with K. J. Monson, August 8, 1957]

Feet

Middle Jurassic

Note: Top of exposure.

Todilto Limestone:

11. Limestone, medium gray (N 5), weathers dark yellowish brown (10YR 4/2), contains abundant gypsum in small blebs a few millimeters in diameter; these blebs distort the otherwise thin even lamination of the limestone; strong fetid odor. Upper surface is irregular due to folding in upper part of bed and thickness ranges from 1 to 3 ft. Forms cap to Todilto ledge---------- 1.5

10. Limestone, medium dark gray (N 4), weathers same, microcrystalline, fetid odor; very thin even flat laminae, weathers platy on ledge protected by gypsiferous limestone above---------- 2.0

PUERTECITO section--Continued

	Feet
Todilto Limestone--Continued:	
9. Siltstone grayish orange (10YR 7/4) at base to dark yellowish brown (10YR 4/2), weathers same, contains very fine sand and abundant interlaminae of calcite and gypsum; very thin even flat laminae; grades into limestone above. Weathers papery in recess----------	2.5
8. Limestone, light gray (N 7), silty and sandy; massive flat bed. Forms small ledge----------	0.5
Total of Todilto Limestone----------	6.5

Note: The Todilto-Entrada contact is flat and conformable; upper few feet of unit 7 may form a transition to the Todilto.

Entrada Sandstone:

Upper sandy member:

7. Sandstone, very pale orange (10YR 8/2) to yellowish orange (10YR 7/6), weathers same, very fine to fine grained, poorly sorted; contains medium-grained well-rounded, gray-frosted Entrada berries; indistinct irregular thin planar beds. Poorly exposed on steep slope----------	35.0

PUERTECITO section--Continued

	Feet
Entrada Sandstone--Continued	
Upper sandy member--Continued	
6. Sandstone, light grayish orange (10YR 8/4), weathers same, fine to very fine grained, moderately well to poorly sorted; contains common rounded gray frosted medium and coarse Entrada berries, and occasional accessory subrounded medium-sized pale red quartz grains; firmly cemented with calcite and limonite; black manganese(?) stains present on many surfaces; indistinct irregular thin flat beds and minor thin sets of small and medium-scale cross-laminae. Forms slickrim--------	25.5
5. Siltstone, yellowish orange (10YR 7/6), weathers same; indistinct disturbed and disrupted flat bedding. Poorly exposed on slope. This unit may be a bleached part of the medial silty member, but a purple parting, abrupt color change and difference in weathering form a convenient contact beneath it. Used 20° dip as average of eight measurements in this member and Todilto Limestone----------	12.5
Total of upper sandy member----------	73.0

PUERTECITO section--Continued

	Feet
Entrada Sandstone--Continued	
Medial silty member:	
4. Siltstone, like unit 2, some beds only 1-2 ft thick. Top is sharply marked by 1/10 ft of dark grayish red (5R 3/2) clay, generally concealed under float in a small recess----------	23.0
3. Siltstone, like unit 2, but slightly finer grained; authigenic quartz blebs are very abundant. Forms shallow recess on cliff----------	12.0

PUERTECITO section--Continued

Feet

Entrada Sandstone--Continued

Medial silty member--Continued

2. Siltstone, pale reddish brown (10R 5/4), weathers same, moderately well to poorly sorted; lower 1 ft includes common well-rounded, medium- and coarse-frosted grains of gray and milky quartz as well as abundant subrounded medium and coarse grains of quartz and other materials; irregular blebs of authigenic light gray quartz several millimeters in diameter are common in the lower half of the unit; firmly cemented; massive beds about 5 ft thick with disrupted internal laminae. Weathers to hoodoo cliffs. Unit 2 through 4 are similar in many ways to the uppermost unit assigned to the Chinle Formation at Blakely's San Cristobal Ranch section (Wright and Dickey, 1979), however, it is here assigned to the Entrada Sandstone because the siltstone here is coarser, less well sorted, shows no tendency towards blocky ledges and contains Entrada berries at the base---------- 16.0

Total of medial silty member---------- 51.0

Total of Entrada Sandstone---------- 124.0

Note: The Entrada-Chinle contact is exposed for only a short distance, appears flat; the lower few inches of unit 2 is bleached light greenish-gray (5G 8/1) and contains some reworked material from unit 1.

PUERTECITO section--Continued

	Feet
Upper Triassic	
Chinle Formation:	
1. Claystone, dark reddish brown (10R 3/4); weathers dark reddish brown (10R 3/6), poorly exposed on slope; only 11 ft exposed, but probably more than 100 ft of similar rock as shown in nearby exposures. Used 12° dip which is average of three measurements in units 2 through 4----------	>11.0
Total of Chinle Formation----------	>11.0

NEW MEXICO - VALENCIA COUNTY

EL MORRO section (73)

[Measured in the SE 1/4, sec.3, T. 9 N., R. 14 W., about 3.3 mi east of El Morro Point, and 1.5 mi east of El Morro Post Office; measured by J. C. Wright with W. B. Satterthwaite, July 14, 1957]

	Feet
Upper Cretaceous	
Dakota Sandstone (incomplete):	
16. Sandstone, very light gray (N 8), weathers grayish orange (10YR 7/4), and dark brownish gray (5YR 3/1) on joints, fine grained, firmly cemented; contains fossil wood fragments and has interbeds of gray to black shale; gritty and pebbly near base. Forms ledge at top of cliff and caps mesa----------	>25.0
Total of incomplete Dakota Sandstone----------	>25.0

Note: The Dakota-Bluff(?) contact is erosional with large channeled irregularities.

EL MORRO section--Continued

Feet

Middle Jurassic

Bluff(?) Sandstone:

15. Sandstone, grades from dark pinkish gray (5YR 7/1) in lower part to moderate pink (5R 7/4) in upper part, weathers moderate orange pink (5YR 8/4) and moderate reddish orange (10R 6/6) in the upper part; the 15 ft just below the Dakota Sandstone is conspicuously bleached white (N 9); very fine grained, moderately well sorted; the lower part contains medium- and coarse-grained, rounded, gray frosted Entrada berries and subangular white chert and feldspar(?); firmly cemented; thick sets of large-scale cross-laminae. Forms upper part of vertical cliff---------- 101.0

14. Siltstone, very sandy, light olive gray (5Y 6/1), poorly sorted, with abundant pale red (10R 6/2) clay chips. Forms discontinuous recess---------- 0.5

Feet

Bluff(?) Sandstone--Continued

13. Sandstone, dark pinkish gray (5YR 7/1), weathers moderate orange pink (5YR 8/4), very fine grained, moderately well to poorly sorted; composed of subrounded to subangular quartz grains with calcite film, better rounded fine grains are common; firmly cemented; thick massive beds with very faint laminae suggesting large-scale low-angle cross-strata. Near top are iron-manganese impregnations along a few laminae. Forms lower part of vertically jointed cliff---------- 27.5

Total Bluff(?) Sandstone---------- 129.0

Note: The Bluff(?)-Summerville contact is poorly exposed; appears conformable.

Summerville Formation:

12. Sandstone, moderate orange pink (10R 7/4), weathers grayish orange pink (5YR 7/2), very fine grained, moderately well sorted; composed of subrounded clear and frosted and hematite-stained quartz grains and common rounded gray-frosted medium-grained Entrada berries; moderately well cemented; thin to thick flat beds. Poorly exposed on slope---------- 51.0

EL MORRO-section--Continued

	Feet
Summerville Formation--Continued	
11. Sandstone, with subordinate interbedded claystone. Sandstone like unit 8 in color and lithology; contains a few medium-grained, frosted Entrada berries; thin irregular flat beds with very small scale channels on the base of most beds. Claystone, moderate red (5R 4/4), forms partings and thin beds between the sandstone beds; contains sand-filled mudcracks----------	2.5
10. Sandstone, like unit 8----------	2.0
9. Concealed; probably sandstone like unit 8----------	2.5
8. Sandstone, red (5R 5/6), weathers very pale red (10R 7/2) very fine grained, well sorted; composed of subrounded clear quartz grains and hematite-stained quartz grains with a few black accessory grains; moderately well cemented; massive planar bed. Forms ledge----------	2.0
7. Sandstone, red (5R 5/6), very fine grained, silty, moderately well sorted, poorly cemented; poorly exposed on slope----------	2.5
6. Concealed; soil indicates it is probably similar to unit 7----------	4.5

EL MORRO section--Continued

	Feet
Summerville Formation--Continued	
5. Sandstone, like unit 1, indistinct irregular planar beds. Forms recess on poorly exposed slope--------	9.0
Total of Summerville Formation----------	76.0

Note: The Summerville-Entrada contact is not well exposed; appears conformable.

Entrada Sandstone (incomplete):

4. Sandstone, like unit 1 in color and lithology; the lower two-thirds composed of thick sets of low-angle large-scale cross-laminae and thin sets of small-scale cross-laminae, these grade upward into the upper third, which is thick wedging planar sets of large-scale cross-laminae. Forms top of slickrim cliff----------	31.5
3. Sandstone, like unit 1 in color and lithology; thin planar beds. Forms part of slickrim cliff----------	3.5
2. Sandstone, light red (5R 6/6), weathers moderate red (5R 5/4), medium grained, well sorted; composed of subrounded and rounded quartz grains, some colorless frosted and some coated with a dusty red hematitic film; firmly cemented with calcite; thin planar beds----------	0.5

EL MORRO section--Continued

	Feet
Entrada Sandstone (incomplete)--Continued	
1. Sandstone, very pale red (10R 6/2), weathers light gray (N 7), very fine grained, moderately well sorted; composed of subrounded clear and pink-stained quartz grains with uncommon black and rare green accessory grains; a few laminae have a conspicuous red coloration caused by abundant hematite dust on the quartz grains; moderately well cemented; thick, wedging planar sets of large-scale cross-laminae. Some of the large cross-sets are in themselves large complex cosets; cross beds about 1 ft thick within them contain internal small-scale cross-laminae dipping more steeply than the general cross beds. Such complex cross beds may form all of a set or may be interbedded with ordinary cross beds. Forms slickrim cliff----	69.0
Total incomplete Entrada Sandstone----------	104.5

Note: Local base of exposures.

NEW MEXICO - VALENCIA COUNTY

SHEEP CAMP section (74)

[Entrada, Todilto, and Summerville Formations measured in S 1/2 sec. 2, T. 8 N., R. 6 W., Bluff and Morrison Formations in N 1/2 sec. 1, T. 8 N., R. 6 W.; measured by V. L. Freeman, September 1954. Upper part of section published in Freeman and Hilpert, 1956]

	Feet
Upper Cretaceous	
Dakota Sandstone (incomplete):	
25. Sandstone, like basal Dakota unit 23, two silicified 6 in. thick bands, also a few very thin carbonaceous claystone partings----------	15.0
24. Claystone, carbonaceous, sandy. Along strike unit becomes sandstone like unit 23 with very thin partings of carbonaceous claystone. Unit forms re-entrant----------	1.0
23. Sandstone, light yellow (5Y 8/6), medium fine grained, poorly sorted, rounded, granules common, contains grains of clay coated quartz and white (chert?) accessory grains; one 6 in. thick band is highly silicified and white; medium-scale, low-angle very thin crossbedding. Plant remains present----------	4.9
Total of incomplete Dakota Sandstone----------	20.9

SHEEP CAMP section--Continued

	Feet
Upper Jurassic	
Morrison Formation:	
22. Claystone, pale olive (10Y 6/2), weathering to light greenish gray (5G 8/1) and minor grayish red purple; slightly sandy, fine grained; slightly swelling. Forms soft slope----------	43.5
21. Sandstone, white (N 9), medium fine grained, well to moderately well sorted; composed of subrounded grains of quartz with orange and white accessory grains; slightly friable, calcareous cement; indistinct, medium-scale low-angle crossbedding----	6.0
20. Claystone, like unit 18 with two thin beds of sandstone like unit 19 that total 3 ft----------	25.7
19. Sandstone, white (N 9), medium fine grained, well to moderately well sorted; composed of subrounded grains of quartz with orange and white accessory grains; slightly friable, calcareous cement; indistinct, medium-scale low-angle crossbedding----	4.6
18. Claystone, pale olive (10Y 6/2), weathering to light greenish gray (5G 8/1) and minor grayish red purple, slightly sandy, fine grained; slightly swelling. Forms soft slope----------	13.0

SHEEP CAMP section--Continued

	Feet
Morrison Formation--Continued	
17. Sandstone, greenish white (5GY 9/1), fine grained, well to moderately well sorted; composed of subrounded grains of quartz with orange and white accessory grains; slightly friable, calcareous cement; medium-scale low-angle cross-strata. Limy nodules uncommon. Unit is lenticular and interfingers with unit 18----------	8.5
16. Sandstone, argillaceous, very dusky red (between 5RP 2/2 and 10R 2/2) and light greenish gray (5GY 8/1) in about equal amounts in alternating bands, fine-grained, moderately well sorted; composed of subrounded grains of quartz and rare orange accessory grains; hard when fresh; unit weathers to soft slope. Laterally unit contains lens like unit 17----------	16.8

SHEEP CAMP section--Continued

	Feet
Morrison Formation--Continued	
15. Sandstone, dark reddish brown (10R 3/5), fine grained, moderately well sorted, argillaceous; composed of subrounded grains of stained quartz with rare black accessory grains; hard when fresh but weathers to a soft slope. Unit grades into Bluff Sandstone and locally interfingers with Bluff----------	3.7
Lower two units of Morrison probably are equivalent to Recapture Member and remainder to the Brushy Basin Member.	
Total of Morrison Formation----------	121.8

SHEEP CAMP section--Continued

Feet

Middle Jurassic

Bluff Sandstone:

14. Sandstone, light greenish yellow (10Y 7/2) slightly lighter near top, medium and fine grained in gradationally alternating 6 in. thick beds, well to moderately well sorted; subrounded to rounded grains of green clay coated quartz with common white chert and rare orange accessory grains; friable with some zones of heavy limonite cement. Base is poorly exposed, lower part seems to comprise poorly defined parallel bedding; central part (93 ft thick) is a single crossbedded coset with extremely large-scale low-angle sweeping, eolian cross-strata; upper part is poorly defined parallel bedding. Top of unit appears reworked---------- 156.6

SHEEP CAMP section--Continued

Feet

Bluff Sandstone--Continued

13. Sandstone, mostly moderate greenish yellow (10Y 7/4) to pale greenish yellow (10Y 8/2) with some yellowish gray (5Y 8/1) and pale yellowish orange (10YR 9/6), fine to medium fine grained, well to moderately well sorted; composed of subangular to subrounded grains of quartz and uncommon white, orange, green, and black accessory grains, limonite stains uncommon; friable with slight calcareous cement and uncommon white specks of unknown cement, some interstitial clay; includes both parallel bedding and crossbedding, beds are thin to thick, crossbeds are medium-scale, low-angle. Broad bench formed on upper half of unit---------- 110.0

Total of Bluff Sandstone---------- 266.6

Summerville Formation:

12. Claystone, sandy, dark reddish brown (10R 3/4) with thin white bands, top and bottom of unit altered to light greenish gray (5GY 8/1); hackly weathering. Unit forms prominent notch beneath main cliff of Bluff Sandstone---------- 1.7

SHEEP CAMP section--Continued

	Feet
Summerville Formation--Continued	
11. Sandstone, yellowish gray (5Y 8/1), fine grained, moderately well sorted; composed of subangular to subrounded grains of quartz with rare white, orange, red, and black accessory grains; very friable but case-hardened on surface; very thin wavy parallel bedding, massive weathering. Unit contains common concretions 1-6 in. in diameter of limonite and possibly manganese----------	13.7
10. Sandstone, with thin interbeds of claystone like unit 9. Sandstone, yellowish white (5Y 9/1), fine to very fine grained, moderately well to well-sorted; composed of grains of quartz with rare white, black, red, and orange accessory grains; friable with calcareous cement; thick bedded with increase in thickness upward. This unit and two overlying units form transition unit between typical Summerville and typical Bluff----------	72.1
9. Claystone, sandy, dark reddish brown, (10R 3/4), with thin white streaks parallel to the bedding, sand is fine-grained; soft hackly weathering, forms steep slope. This unit forms a prominent red band at base of Bluff cliff----------	45.3

Feet

Summerville Formation--Continued

8. Interval poorly exposed on wide bench, mostly siltstone to very fine grained sandstone, reddish brown (10R 4/4) and yellowish white (5Y 9/1), reddish parts seem argillaceous, moderately well to well sorted; composed of grains of quartz with uncommon orange, black, white, and red accessory grains; slightly friable with calcareous cement; bedding not seen, but red and white coloration occurs in 2-6 ft thick units. There may be a limestone bed near base---------- 31.8

Total of Summerville Formation---------- 164.6

Todilto Limestone:

7. Limestone, olive gray (5Y 4/1), dense, but contains much recrystallized calcite, limestone is free of sand grains; thin bedded, large contortions look like folding; slightly fetid. Unit is very irregular in thickness---------- 5.0

6. Siltstone, light greenish gray (5GY 8/1), very limy with nodules of limestone as much as 6 in. in diameter that probably are pebbles. Unit appears to be locally formed conglomerate that is very restricted in occurrence---------- 2.2

SHEEP CAMP section--Continued

	Feet
Todilto Limestone--Continued	
5. Limestone (90 percent) and siltstone (10 percent) like unit 3; very thin to thin bedded, some beds laminated; weathers flaggy, slabby and platy, some wavy zones near top. Unit contains rare chert in nodules----------	10.6
4. Limestone (70 percent) and siltstone (30 percent) like unit 3; very thin bedded, flaggy weathering. Siltstone beds about half the thickness of limestone beds, beds noticeably lenticular, locally contorted. At top of unit is a horizontal plane that is continuous for several miles and locally truncates contortions in this unit---------	6.8
3. Siltstone and limestone. Siltstone is sandy and limy, light greenish gray (5GY 8/1); forms lower half of unit. Limestone, dark greenish gray (5GY 4/1), dense, fetid, clayey, and slightly sandy; forms upper half of unit, but contains siltstone partings. Unit has thin parallel bedding and weathers slabby. Siltstone and limestone weather as one unit. Not present across canyon to west----	4.3
Total of Todilto Limestone----------	28.9

SHEEP CAMP section--Continued

	Feet
Entrada Sandstone:	
2. Sandstone, greenish white (5GY 9/1) to yellowish white (5Y 9/1) with darker colors in bands not related to bedding, but that appear to be fluid boundaries; very fine and minor fine grained, well sorted; composed of subangular to subrounded grains of clear quartz with rare red, white, black, and orange accessory grains; slightly friable with calcareous cement, local crystalline(?) calcite cement; parallel bedding. Top 2 ft is clayey and grades into Todilto Limestone----------	22.6

Feet

Entrada Sandstone--Continued

1. Sandstone, light brown (5YR 5/6) to pale brown (5YR 8/6), mostly very fine and fine grained with some medium fine grained, mostly well sorted some moderately well sorted; rounded to subrounded grains of limonite(?)-stained quartz with minor black, white (chert), dark red, and orange accessory grains; friable, calcareous cement. Lower 15 ft(+) comprises thin wavy parallel bedding; above is medium- to large-scale very thin crossbedding, mostly low angle some high angle (to 28°). Units are mostly tabular but modified by lenticular units, planar to gentle trough-shaped erosion surfaces. Basal 36 ft is massive weathering, above is slabby and flaggy. Bedding is made visible by darker red clay-rich thin laminae------- 61.6

Total of Entrada Sandstone---------- 84.2

NEW MEXICO - SANDOVAL COUNTY

CACHANA Section (77)

[Measured in the southeast part of Ojo del Espirito Santo, in sec. 36, T. 17 N., R. 1 W. (unsurveyed), about 1/2 mi west of New Mexico Highway 44 where it crosses the Todilto Limestone; measured by J. C. Wright and D. D. Dickey with K. J. Monson and W. B. Satterthwaite, August 3, 1957]

Feet

Upper Jurassic

Morrison Formation:

Brushy Basin Member:

Not measured.

Westwater Canyon Member:

Makes massive orangish sandstone cliff with minor shale beds near bottom; not measured.

Recapture Member:

22. Sandstone (70 percent) and claystone (30 percent). Sandstone, grayish orange pink (10R 8/2), fine to very fine grained; contains abundant varicolored accessory grains. Probably mostly flat-bedded with some low-angle cross-laminae. Claystone, silty, purple with some greenish gray near top; weathers shaly. Forms steep slope---------- 203.5

CACHANA section--Continued

	Feet
Morrison Formation--Continued	
Recapture Member--Continued	
21. Sandstone, pinkish white (5YR 9/1) at bottom to dark pinkish gray (5YR 7/1), weathers same, fine to to very fine grained; composed of subrounded quartz with abundant orange and black, and common red accessory grains; small- to medium-scale cross-laminae probably within thin to thick planar beds. Forms badly weathered cliff----------	14.5
20. Siltstone (85 percent), sandstone (10 percent), and claystone (5 percent). Siltstone, light greenish gray (5GY 8/1) to pinkish white (5YR 9/1), mostly coarse. Sandstone, very fine grained, silty; contains purple, black, and orange accessory grains. Claystone, very dusky red purple (5RP 2/2), occurs as very thin partings. Unit weathers grayish red purple (5RP 4/2) banded with white (N 9). Forms badland topography with minor sandstone ribs----------	42.0
Total of Recapture Member----------	260.0
Total of incomplete Morrison Formation--------	>260.0

Note: The Morrison-Summerville contact is mostly concealed; appears conformable.

Feet

Middle Jurassic

Summerville Formation:

19. Siltstone (80 percent) with minor sandstone (10 percent) and claystone (10 percent). Siltstone dark reddish brown (10R 3/4), weathers reddish brown (10R 4/4). Sandstone, greenish white (5GY 9/1). Claystone, dusky red (10R 3/2), mostly in lower 10 ft. A 2 in.-thick light-gray sandy limestone occurs about 10 ft above base. Weathers into badland topography---------- 23.0

Total of Summerville Formation---------- 23.0

Note: The Summerville-Todilto contact is not exposed.

Todilto Limestone:

18. Limestone, medium gray (N 5), microcrystalline, slightly fetid odor, represented only by float at top of gypsum---------- 0.5

17. Gypsum, white (N 9), forms brownish-gray (5YR 4/1) soil; pure, except for two thin beds of yellow sandstone about 3 in. thick in lower 25 ft; porous and appears to have swelled during recrystallization. Thickness approximately---------- 121.0

16. Interlaminated limestone and gypsum. Limestone like unit 15. Gypsum, nodular, white. Forms part of bench---------- 5.5

CACHANA section--Continued

	Feet
Todilto Limestone--Continued	
15. Limestone, dark olive gray (5Y 3/1), weathers medium gray (N 5), microcrystalline with a very fine nodular structure; has fetid odor; thinly laminated; weathers platy. Forms capping ledge on Entrada cliff----------	6.0
14. Siltstone, dark brownish gray (5YR 3/1), very thinly laminated; seamed with gypsum, and contains very minor green copper stain. Forms recess----------	1.0
Total of Todilto Limestone, approximately-----	134.0

Note: The Todilto-Entrada contact is well exposed, flat, and conformable.

Entrada Sandstone:

Upper sandy member:

13. Sandstone, like unit 12 in color and lithology; thin flat beds, and thin sets of small-scale low-angle cross-laminae. In bottom 4 ft are flat limonitic concretions along bedding planes, dark yellowish-orange (10YR 6/6). Forms top of vertical cliff----------	26.5

CACHANA section--Continued

	Feet
Entrada Sandstone--Continued	
Upper sandy member--Continued	
12. Sandstone, very silty, yellowish white (5Y 8/1), weathers pale olive (10Y 6/2), very fine grained, very silty, poorly sorted, composed of clear quartz with dark smokey quartz accessories and a few pale green accessory grains; moderately well cemented; bedding imperceptible. At base is a prominent 1/2 ft recess of dark greenish-yellow (10Y 6/6) siltstone. Forms part of vertical cliff----------	17.5
11. Siltstone, like unit 5; 12 ft above base is a line of irregular mottled spots 2-3 in. in size, pale green (5G 7/2)----------	37.5
10. Siltstone, like unit 6----------	4.0
9. Siltstone, like unit 5----------	4.5
8. Siltstone, like unit 6----------	2.0
7. Siltstone, like unit 5----------	1.5
6. Siltstone, like unit 5 in color and lithology; a tabular set of medium-scale low-angle cross-laminae--------	2.0

CACHANA section--Continued

	Feet
Entrada Sandstone--Continued	
Upper sandy member--Continued	
5. Siltstone, orange pink (5YR 7/4), weathers same, sandy, poorly sorted; contains abundant conspicuous well-rounded frosted medium and coarse Entrada berries of gray and clear quartz and white and black chert; moderately well cemented; very thin to thin irregular flat beds. Forms part of vertical cliff-	11.5
Total of upper sandy member----------	107.0
Medial silty member:	
4. Siltstone, reddish orange (10R 5/6), weathers same, slightly clayey, moderately well sorted, contains some black accessory grains, any other accessories are masked by orange color; thick massive flat beds with completely disrupted internal laminae; lower 2 ft is white (N 9) and contains a few gray to black, frosted medium-grained Entrada berries. Mostly forms earthy slope, but locally weathers to hoodoos on protected cliff----------	52.5

CACHANA section--Continued

Feet

Entrada Sandstone--Continued

Medial silty member--Continued

3. Claystone (60 percent) thinly interbedded with siltstone (40 percent). Claystone, dark reddish brown (10R 3/4). Siltstone, reddish orange (10R 5/6) with greenish white (5G 9/1) mottling, clayey and very limy. Unit as a whole weathers to a pale reddish-brown (10R 5/4) slope. The greenish-white mottled siltstone beds are exceedingly limy and slightly more resistant to weathering than the other material---------- 13.0

CACHANA section--Continued

	Feet
Entrada Sandstone--Continued	
Medial silty member--Continued	
2. Sandstone, light greenish gray (5G 8/1) to moderate reddish orange (10R 6/6), very fine grained, silty and clayey, poorly sorted, moderately well cemented; contains conspicuous well-rounded frosted medium- and coarse-grains of gray and amber quartz, bedding is indistinct, small-scale cross-strata suggest the unit is a fluvial reworking of Chinle material. Forms steep covered slope. Has one purple clay parting about 1/10 ft thick at center----------	7.0
Total of medial silty member----------	72.5
Total of Entrada Sandstone----------	179.5

Note: The Entrada-Chinle contact appears nearly even and conformable. Very small scours are present at the base of unit 2. The claystone in unit 3 is considered to be reworked clay from the underlying Chinle Formation. However, it is possible that the contact should be placed between units 3 and 4.

CACHANA section--Continued

Feet

Upper Triassic

Chinle Formation:

1. Claystone, reddish brown (10R 4/4), weathers same to grayish red (5R 4/2), with mottled spots of greenish gray (5GY 7/1). Near base of unit are a few poorly exposed, thin gritty beds, one of which is greenish gray (5GY 6/1); thinly laminated. Forms a steep earthy slope---------- >37.5

Total of the Chinle Formation---------- >37.5

References

Freeman, V. L., and Hilpert, L. S., 1956, Stratigraphy of the Morrison Formation in part of northwestern New Mexico: U.S. Geological Survey Bulletin 1030-J, 36 p.

Green, M. W., 1974, The Iyanbito Member (A new stratigraphic unit) of the Jurassic Entrada Sandstone, Gallup-Grants area, New Mexico: U.S. Geological Survey Bulletin 1395-D, 12 p.

Stewart, J. H., Poole, F. G., and Wilson, R. E., 1972, Stratigraphy and origin of the Chinle Formation and related Upper Triassic strata in the Colorado Plateau region: U.S. Geological Survey Professional Paper 690, 336 p.

Rappaport, I., Hadfield, J. P., and Olson, R. H., 1952, Jurassic rocks of the Zuni Uplift, New Mexico: U.S. Atomic Energy Commission RMO 642.

Wright, J. C., and Dickey, D. D., 1963, Block diagram of the San Rafael Group and underlying strata in Utah and part of Colorado: U.S. Geological Survey Oil and Gas Investigations Chart OC-63.

_____1979, Stratigraphic sections of Jurassic San Rafael Group and adjacent rocks in Rio Arriba and Santa Fe Counties, New Mexico: U.S. Geological Survey Open-File Report 79-247, 29 p.