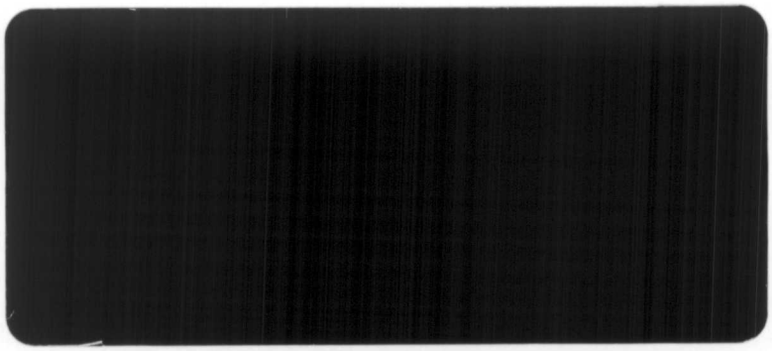

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Stratigraphic Sections of Jurassic San Rafael Group and Adjacent Rocks in San Juan and McKinley Counties, New Mexico

By J. C. Wright and D. D. Dickey

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

Contents

Illustration

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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 Bluff, Summerville, Todilto, and Entrada are the formations assigned to the San Rafael Group in these sections.

Figure 1 is a map showing the locations of the stratigraphic sections included in this report. We found the following informal terms to be 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 a 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

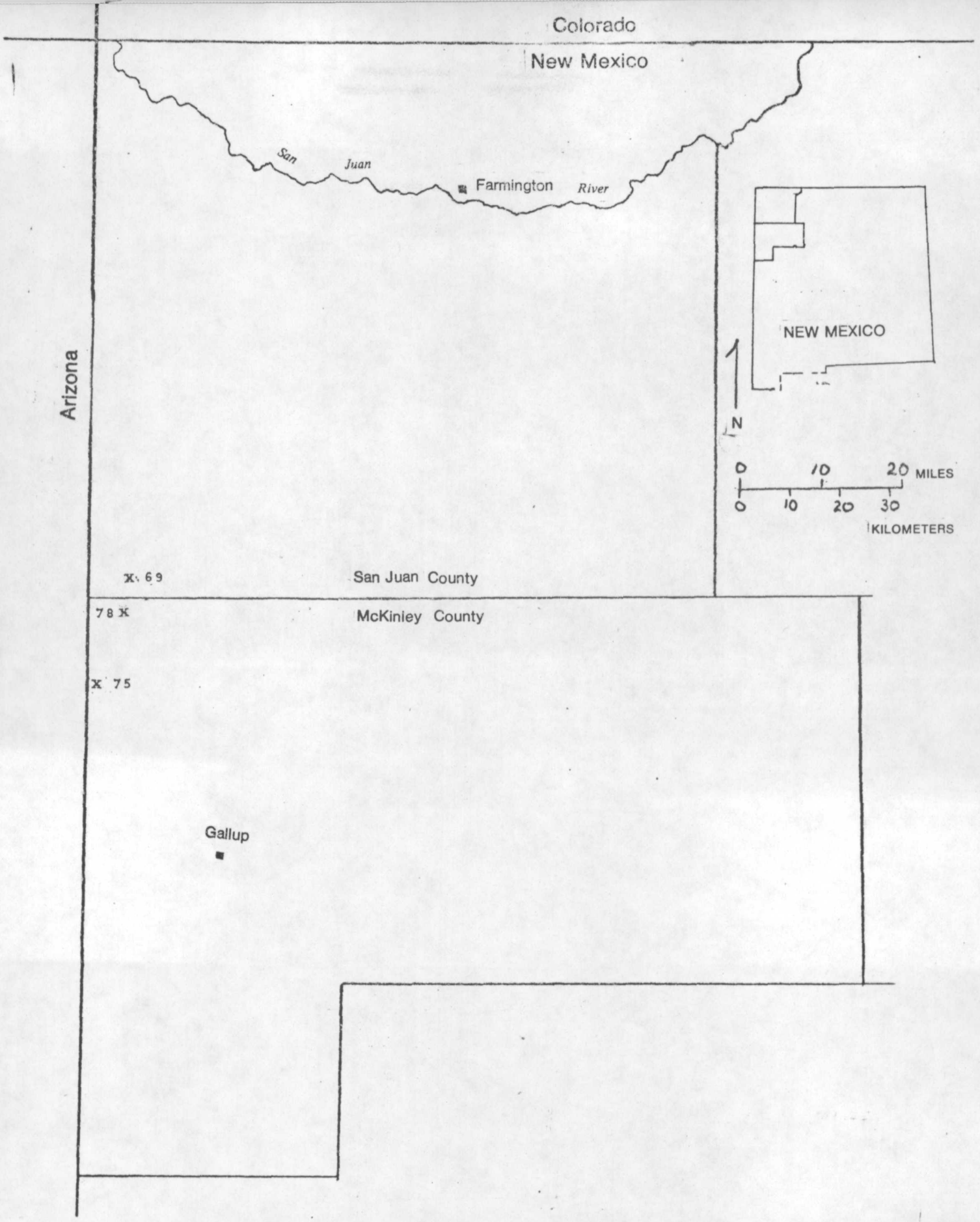

Figure 1.--Map showing the locations of stratigraphic sections included in this report. Section numbers are in system referred to by Wright, J.C., and Dickey, D. D., 1963, Block diagram of the San Rafael Group and underlying strata in Utah and part of Colorado: U.S. Geological Survey Oil and Gas Investigations Chart OC-63.

SAN JUAN COUNTY - NEW MEXICO

CRYSTAL section (69)

[Measured at approximately lat 36°1-1/2'N., long 108°57'W.; about 1-2 mi south-southeast of the village of Crystal; measured by J. C. Wright and D. D. Dickey with W. B. Satterthwaite and K. J. Monson, August 9, 1957]

Feet

Morrison Formation (incomplete, not measured):

Recapture Shale Member:

22. Poorly exposed, lower part composed of white sandstone and light grayish-red (10R 5/2) claystone. Forms valley filled with alluvium. Not measured.

Note: The Morrison-Bluff contact is not exposed.

CRYSTAL section

Feet

Bluff Sandstone (incomplete)

21. Poorly exposed. Sandstone, light brown (5YR 6/4) to grayish orange pink (5YR 8/2), weathers same colors, very fine to fine grained, well to moderately well sorted; composed of subrounded to rounded quartz grains with black, orange, and subangular white chert accessory grains; fair to poorly cemented; bedding medium- to large-scale, cross-laminae with a number of horizontal truncation planes. Thickness only approximate because of poor lower contact and lack of control of dip---------- 154.0

Total of incomplete Bluff Sandstone---------- 154.0

Note: The Bluff-Summerville contact is not exposed; presumably the top of the Summerville forms a dip slope. Offset one-half mile to west to measure the Summerville Formation.

Feet

Summerville Formation:

20. Sandstone, reddish orange (10R 5/6) to very pale red (10R 7/2), lighter color present in upper half only, weathering same colors, very fine to fine grained, moderately well sorted; composed of subrounded to rounded quartz grains with black and some purple accessory grains, many larger grains spherical, frosted; moderately well cemented; lower half planar, irregularly laminated, upper half planar, irregularly laminated with some tabular planar sets a few feet thick of medium-scale cross-laminae. Unit forms slickrim cliff---------- 58.0

CRYSTAL section--continued

	Feet
Summerville Formation--continued:	
19. Poorly exposed. Sandstone and minor claystone, moderate reddish brown (10R 4/6) to reddish orange (10R 5/6), very fine to fine grained, moderately well sorted; composed of subrounded and rounded quartz grains with black accessory grains and some gray frosted medium grained Entrada berries; moderately well cemented; planar indistinct slightly irregular beds. Claystone is grayish-red (10R 4/2), silty, in thin flat beds. Unit forms covered slope with recess at top of unit----------	57.0
Approximate total of Summerville Formation---------	115.0

Note: The Summerville-Todilto contact is not exposed; beds parallel.

Feet

Todilto Formation:

18. Limestone, pinkish gray (5YR 8/1), weathers same, fine grained some of it sandy; flat bedded; forms ledge. This unit and underlying unit have varying compensating thicknesses---------- 5.0

17. Sandstone, very pale red (10R 7/2), very fine grained, silty; has a few stringers of limestone, light grayish red (10R 5/2), weathers same to pale red (10R 6/2). Unit laminated, generally planar or in gentle undulations with wavelength of a few feet. Weathers platy---------- 7.0

Total Todilto Formation---------- 12.0

Note: The Todilto-Entrada contact is concordant and slightly irregular with a couple feet of relief. Line of section offset on this contact to south side of fault to measure lower part of section.

Entrada Sandstone:

Upper sandy member:

16. Sandstone, like unit 15, but mostly irregular flat beds; poorly exposed in upper 20 ft---------- 27.0

Note: Local top of Jurassic exposures overlain by a pebbly white sandstone, probably Tertiary Chuska Sandstone. Offset about 1/4 mi west across a covered valley and used unit 14 to locate continuation of section. Repetition of units 13, 14, and 15 establish reasonably accurate offset.

Feet

Entrada Sandstone--continued:

Upper sandy member--continued:

15. Sandstone, reddish orange (10R 5/6) to moderate reddish brown (10R 4/6), weathers same, very fine grained; some beds have an admixture of fine grains composed of subrounded to subangular clear quartz with black accessory grains; thick tabular cosets of wedging planar sets of medium-scale cross-strata and other tabular cosets of irregular planar strata. Forms rounded slickrim and soil covered bench---------- 57.0

14. Sandstone, grayish orange pink (5YR 8/2), fine to medium grained, well sorted; composed of rounded clear glassy quartz grains; firmly cemented; a tabular set of low angle, cross strata. Forms small ledge---------- 1.0

13. Sandstone, reddish orange (10R 5/6), weathers same, very fine to fine grained, well sorted; contains black accessory grains; firmly cemented; thick wedging planar sets of large-scale cross-strata. Forms steep rounded slickrim cliff---------- 25.0

	Feet
Entrada Sandstone--continued:	
Upper sandy member--continued:	
12. Sandstone, reddish orange (10R 5/6), weathers same, very fine to fine grained, slightly silty, moderately well to poorly sorted; contains black accessory grains and some medium-grained well-rounded Entrada berries of gray frosted quartz, clear quartz, and white chert; firmly cemented; thin wedging planar sets of low-angle small- and medium-scale crossbeds; has horizontal truncation planes about 2-5 ft apart, appears fluvial. Forms vertical cliff----------	53.0
Total of upper sandy member----------	163.0
Medial silty member:	
11. Siltstone, reddish orange (10R 5/6), weathers same; a few blebs and mottled streaks are bleached very pale orange (10YR 8/2); moderately well sorted; contains black accessory grains, has irregular blebs of authigenic quartz as much as nearly a centimeter in size; very firmly cemented; massive beds 2-4 ft thick with disrupted internal laminate. Weathers to hoodoo cliff----------	35.0

CRYSTAL section--continued

	Feet
Entrada Sandstone--continued:	
Medial silty member--continued:	
10. Covered, probably the same as unit 11----------	6.0
9. Sandstone, reddish brown (10R 4/4) in part bleached orange white (10YR 9/2), very fine grained, moderately well sorted; contains black accessory grains; firmly cemented with calcite; thin trough sets of low-angle small-scale cross-strata. Forms ledge and weathers to plates----------	2.0
Total of medial silty member----------	43.0
Total of Entrada Sandstone----------	206.0

Note: The Entrada-Wingate contact is poorly exposed; base of unit 9 has irregularities of 1 or 2 in.

Wingate Sandstone (incomplete):

Lukachukai(?) Member:

8. Poorly exposed. Siltstone, moderate reddish brown (10R 4/6), weathering reddish orange (10R 5/6), slightly clayey, moderately well sorted. Forms steep earthy slope with a few light greenish-gray (5G 8/1) streaks---------- 25.0

CRYSTAL section--continued

	Feet
Wingate Sandstone (incomplete)--continued:	
Lukachukai(?) Member--continued:	
7. Covered on a bench about 150 ft wide; soil suggests a siltstone or very fine grained sandstone, weathering reddish orange (10R 5/6)----------	27.0
6. Sandstone, like unit 4----------	2.5
5. Covered, probably siltstone; clayey like unit 3. Upper one-half foot is massive with indistinct disrupted laminae----------	9.5
4. Sandstone, pale reddish orange (10R 7/6) to moderate orange pink (5YR 8/4), weathers same, very fine grained, slightly silty, moderately well sorted; contains black accessory grains; firmly cemented; stratification indistinguishable. Forms massive ledge with upper contact grading into overlying unit, lower contact sharp----------	3.0
3. Covered on earthy slope. Small exposure just beneath unit 4 suggests it is siltstone, very clayey, dark reddish brown (10R 3/6), poorly sorted, containing biotite(?); thinly laminated----------	5.0
Total Lukachukai(?) Member----------	72.0

	Feet
Wingate Sandstone (incomplete)--continued:	
Rock Point Member (incomplete):	
2. Siltstone, like unit 1 but subtly lighter color, subtly coarser grains, and rounded slickrim-type weathering on bench suggests that it may be cross-stratified; no strata are discernible. Upper contact of unit not well exposed but the surface seems to undulate about 1 or 2 ft----------	21.0
1. Siltstone, moderate reddish orange (10R 4/6), weathers same, well sorted; contains black accessory grains; firmly cemented; indistinct planar very thin beds and laminae in tabular cosets about 3 ft thick; a few low-angle small-scale cross-strata may be present. Forms rounded to vertical steep cliff. Top of unit is a thin bed of fine silt, pale reddish brown (10R 5/4) with a zone of white bleaching above it. Base not exposed locally----------	49.0
Total of incomplete Rock Point Member----------	70.0
Total of incomplete Wingate Sandstone----------	142.0

TWIN BUTTES WASH section (75)

[Measured at approximately long 109°01'W., lat 35°51'N.; the Wingate and Entrada Sandstones about 1 1/4 mi north of the Wash and the upper part of the section about 1/4 mi south of the Wash; measured by J. C. Wright and D. D.Dickey with K. J.Monson and W. B. Satterthwaite, July 17, 1957]

Note: The Dakota-Morrison contact is a regional unconformity, concealed on line of section.

Feet

Morrison Formation:

Westwater Canyon Member:

18. Sandstone, grayish orange pink (10R 8/2), to brownish gray (5YR 5/1), weathers moderate reddish orange (10R 6/6), fine to coarse grained, moderately well to poorly sorted, moderately well cemented; composed of rounded quartz and some weathered feldspar; many beds have dirty-gray coating on grains. Conglomeratic lenses have pebbles as much as 1 in. in diameter. Mostly small- to large-scale cross-stratification, some channeling. Forms cliff and slope beneath Dakota rim. Along strike, the Brushy Basin Member may be present between this unit and Dakota Sandstone, approximately---------- 210.0

Total of Westwater Canyon Member, approximately---- 210.0

Note: The Westwater Canyon-Recapture contact is concealed.

	Feet
Morrison Formation--continued:	
Recapture Member:	
17. Mostly covered. Alternating thin beds of sandstone (70 percent) and claystone (30 percent). Sandstone, white (N9) to light greenish gray (5GY 8/1), weathers same, very fine grained, moderately well sorted, composed of subangular clear quartz with black, orange, and rare green accessory grains; firmly cemented; probably flat bedded and small scale crossbedded. Claystone, dusky red (10R 3/2), weathers shaly----------	147.0
Total of Recapture Member----------	147.0
Total of Morrison Formation, approximately---------	357.0

Note: The Morrison-Bluff contact is concealed.

Feet

Bluff Sandstone:

16. Sandstone, white (N9), weathers same, fine grained, moderately well sorted composed of subangular to subrounded quartz with abundant black and orange and some purple and green accessory grains; firmly cemented; alternating thick flat beds (50 percent), and sets of cross laminae, medium to large scale (50 percent). Forms white, rounded cliff on steep slope---------- 80.0

15. Sandstone, reddish orange (10R 5/6) to dark yellowish gray (5Y 7/1), weathers same, fine grained, moderately well sorted; composed of subrounded to subangular quartz grains with orange and black accessory grains; alternating thick beds with flat slightly irregular laminae (40 percent), and others with large-scale cross-strata (60 percent). Conglomeratic lenses have granules and pebbles of feldspar, chert, quartz, and sandstone. Unit forms rounded ledge----- 64.0

Feet

Bluff Sandstone--continued:

14. Sandstone, 50 percent flat-bedded, 50 percent cross-bedded. Flat-bedded sandstone, reddish brown (10R 4/4), weathers same to pale reddish brown (10R 5/4), very fine grained, firmly cemented, moderately well sorted; irregularly laminated in thick flat beds. Crossbedded sandstone, orange pink (5YR 7/4) weathers same to pale orange (10YR 7/2), fine to medium grained, well sorted; composed of very well rounded frosted quartz grains with angular accessory grains of white chert and black and orange minerals; poorly cemented; a very clean sandstone; large scale cross laminae in thick sets with horizontal truncation planes at top and bottom. Forms ledgy, rounded slope above unit 13---------- 220.0

Feet

Bluff Sandstone--continued:

13. Sandstone, orange pink (5YR 7/4), weathers same to very pale orange (10YR 8/2), fine to very fine grained, well sorted, poorly cemented; composed of rounded quartz grains with accessory grains of orange and black minerals and subangular white chert, a clean sand; very thick planar sets of large-scale sweeping cross-laminae, forms vertical and rounded slickrim cliff with bench on top---------- 72.0

Total of Bluff Sandstone---------- 72.0

Note: The Bluff-Summerville contact appears flat; may form niche in cliff but concealed on line of section.

Summerville Formation:

12. Sandstone, dark reddish brown (10R 3/6), to light brown (5YR 6/4), weathers same, very fine grained, well to moderately well sorted, composed of subangular to subrounded quartz, with common orange and black accessory grains and rare white chert grains and Entrada berries; firmly cemented (85 percent), indistinct and disturbed, flat bedding, small-scale cross-lamination (15 percent); 45 ft above base is an 8 ft thick bed of large-scale cross-laminae. Forms partly covered slope---------- 82.0

	Feet
Summerville Formation--continued:	
11. Sandstone, reddish orange (10R 5/6), to light brown (5YR 6/6), weathers same to pale orange (10YR 7/2), very fine to fine grained, well to moderately well sorted composed of subrounded to rounded quartz with orange and black accessory grains, and white chert accessory grains and some spherical, rounded, gray-frosted Entrada berries; firmly cemented; flat bedded with some medium- and small-scale cross-lamination without flat beds as much as 3 ft thick. Forms banded ledgy cliff above massive Entrada slickrim----------	65.0
Total of Summerville Formation----------	65.0

Note: The Summerville-Entrada contact appears even; truncates Entrada cross-strata.

Entrada Sandstone:	
Upper sandy member:	
10. Sandstone, like unit 9 in color and lithology; a single coset of wedging planar cross-sets about 1-3 ft thick; cross strata are medium scale. Forms top of slickrim cliff----------	48.0

Feet

Entrada Sandstone--continued:

Upper sandy member--continued:

9. Sandstone, reddish orange (10R 5/6), weathers moderate reddish orange (10R 6/6), very fine grained, silty, moderately well sorted, contains black accessory grains and rare fine- and medium-grained well-rounded, clear Entrada berries; firmly cemented; tabular cosets of cross-strata 10-25 ft thick, cross-strata are large scale and separated by minor amounts of reworked flat beds. Forms slickrim cliff---------- 173.0

Total of upper sandy member---------- 221.0

Medial silty member:

8. Siltstone, very sandy, moderate reddish orange (10R 6/6), weathers same, moderately well sorted, contains black accessory silt grains; firmly cemented; 17 ft above base is a zone of crystalline calcite nodules 0.5-1.0 cm across; thick tabular beds, some beds have medium- to large-scale cross-laminae, other beds are superficially massive with faint disrupted internal lamination. Weathers to hoodoos on a vertical cliff. Forms a transition to the upper sandy member--------- 28.5

	Feet
Entrada Sandstone--continued:	
Medial silty member--continued:	
7. Siltstone, like unit 5----------	42.0
6. Sandstone, very silty, moderate reddish orange (10R 6/6) very fine grained, moderately well to poorly sorted, color masks accessory grains except in a few laminae that contain coarse grains, granules and small pebbles of clear and milky quartz, and also small red clay chips; firmly cemented; irregular thin flat beds and low-angle small-scale cross-laminae. Unit appears fluvial. Exposed on vertical cliff, approximately----------	5.0
Total medial silty member, approximately----------	75.5
Total Entrada Sandstone, approximately----------	296.5

Note: The Entrada-Wingate contact placed at base of fluvial unit 6; however, unit 5 is very similar to unit 7 and contact may be beneath unit 5.

	Feet
Wingate Sandstone:	
5. Siltstone, reddish orange (10R 5/6), weathers same, moderately well to well sorted, color masks accessories if any; about 10-15 ft above base is a zone of abundant authigenic gray chert firmly cemented, thick massive beds, probably with disrupted internal laminae. Weathers to a hoodoo cliff----------	38.5
4. Covered----------	66.0
3. Sandstone, reddish orange (10R 5/6), weathers same, very fine grained, silty, poorly sorted, contains black accessory silt grains throughout; in upper part, medium- and coarse-grained well-rounded gray-frosted Entrada berries are abundant in some laminae, medium- and coarse-grained subangular to subrounded white chert grains are associated with the berries; firmly cemented; thin to thick, wedging planar sets of medium- and large-scale cross-strata. Forms prominent ledge----------	27.5
2. Covered; grassy, flat valley; used 20° dip, measured on units 1 and 3----------	154.0
Total Wingate Sandstone, approximately----------	286.0

TWIN BUTTES WASH section--continued

	Feet
Chinle Formation:	
1. Limestone, greenish gray (5GY 6/1), weathers medium light gray (N 6), microcrystalline; much fractured with white, crystalline calcite veining. Forms dip slope of prominent hogback. Uppermost exposed limestone arbitrarily taken as top of Chinle Formation---------	2.0
Total Chinle Formation----------	2.0

MCKINLEY COUNTY-NEW MEXICO

TODILTO PARK section (78)

[Measured at approximately lat 35°58'N., long 108°56'W.; the Entrada and Todilto Formations were measured about 1/2 mi north of Todilto Wash on the east side of the Park, the Summerville and Bluff Formations about 1/4 mi further north; measured by J.C.Wright and D. D. Dickey with K. J.Monson and W.B. Satterthwaite, July 18, 1957]

Note: The Morrison-Bluff contact is concealed in alluvium. Bluff may be slightly thicker than indicated by measured exposures.

	Feet
Bluff Sandstone:	
13. Sandstone similar to unit 12; about 3 sets of crossbeds like the thick ones described in unit 12, separated by thin structureless beds----------	38.0

Feet

Bluff Sandstone--continued:

12. Sandstone, pale orange (10YR 7/2) to reddish orange (10R 5/6), weathering same but mostly the lighter color, medium to very fine grained, well to moderately well sorted, firmly cemented; composed of rounded quartz with abundant orange and black accessory grains and common white angular chert grains. Sets on the order of 10-20 ft thick of large-scale planar cross-laminae (60 percent) interbedded with flat structureless beds 1/2-10 ft thick, some of which have minor small-scale cross-laminae-------- 146.0

Total of Bluff Sandstone---------- 184.0

Note: The Bluff-Summerville contact is conformable and gradational.

TODILTO PARK section--continued

Feet

Summerville Formation:

11. Sandstone, color ranges from orange pink (5YR 7/4) to minor amounts of dark reddish brown (10R 3/4), weathers same, very fine to fine grained with the crossbeds generally coarser grained, well to moderately well sorted, firmly cemented; composed of subrounded to rounded quartz with abundant orange and black accessory grains and uncommon angular white chert grains; chert is probably more abundant in crossbeds; very fine sand has fine-grained rounded spherical frosted quartz Entrada berries; bedding is planar in beds 1/4-6 ft thick and average 3 ft thick; about 50 percent of beds have medium to large scale cross laminae. Forms slickrim cliff---------- 106.5

10. Sandstone, light brown (5GR 6/6) to reddish orange (10R 5/6) weathers orange pink (5YR 7/4), very fine grained, silty, well to moderately well sorted, composed of subrounded quartz, black accessory grains visible, other accessory grains masked; firmly cemented, thin to thick flat structureless beds; purple clay parting at top. Forms prominent recess---------- 54.5

TODILTO PARK section--continued

	Feet
Summerville Formation--continued:	
9. Siltstone, orange pink (10R 6/4), weathers same; structureless probably totally disrupted bedding. Forms hoodoos. Probably slumped bed with channels into underlying unit----------	10.0
8. Siltstone, very clayey, pale red purple (5RP 6/2), weathers same, thickness ranges from a feather-edge to 3 ft, shows channeling by unit 9----------	1.0
Total of Summerville Formation----------	172.0

Note: The Summerville-Todilto contact appears conformable with slight irregularities (a few inches).

Todilto Formation:	
7. Limestone, light gray (N 7), weathering same, sandy, thick beds. Forms prominent capping ledge and a dip slope on the Entrada hogback----------	10.0
6. Siltstone, reddish orange (10R 5/6), weathers same, firmly cemented, thinly laminated. Forms ledge------	7.0
5. Claystone, dusky red-purple (5RP 3/2), thinly laminated. Forms recess----------	1.0

	Feet
Todilto Formation--Continued	
4. Siltstone, very sandy, pale reddish brown (10R 5/4) lowest foot bleached light olive gray (5Y 6/1), weathers same; contains accessory amber-stained quartz and black grains; a thick bed with disrupted internal laminae. Forms a ledge swept back above slickrim cliff----------	6.0
Total Todilto Formation----------	24.0
Entrada Sandstone (incomplete):	
Upper sandy member:	
3. Sandstone, moderate orange pink (5YR 8/4), weathers same, very fine grained, silty, moderately well sorted, contains black accessory grains; firmly cemented; wedging planar sets of large-scale cross-laminae. Forms top of slickrim cliff----------	25.5
2. Sandstone, moderate reddish orange (10R 6/6) weathers same, very fine grained, silty, moderately well sorted, contains black accessory grains; firmly cemented; tabular cosets of cross-strata about 1-4 ft thick separated by nearly equal amounts of irregular flat beds. Forms middle of slickrim cliff----------	45.5

TODILTO PARK section--continued

	Feet
Entrada Sandstone (incomplete)--continued	
Upper sandy member--continued	
1. Sandstone, reddish orange (10R 5/6), weathers same, very fine grained, silty, moderately well sorted; contains common black accessory grains; poorly cemented; tabular cosets of cross-strata about 10-15 ft thick with subordinate irregular flat beds between cosets. Forms lower part of slickrim cliff----------	95.5
Total of Upper sandy member----------	166.5
Total of Entrada Sandstone (incomplete)----------	166.5

Note: Local base of exposures.