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Stratigraphic Sections of Jurassic San Rafael
Group and Adjacent Rocks in Apache County,
Arizona

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.

WRIGHT & DICKEY

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

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 Bluff, Summerville, Entrada, and Carmel are the only formations of the San Rafael Group that are present in these 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 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 form 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 of bedding planes

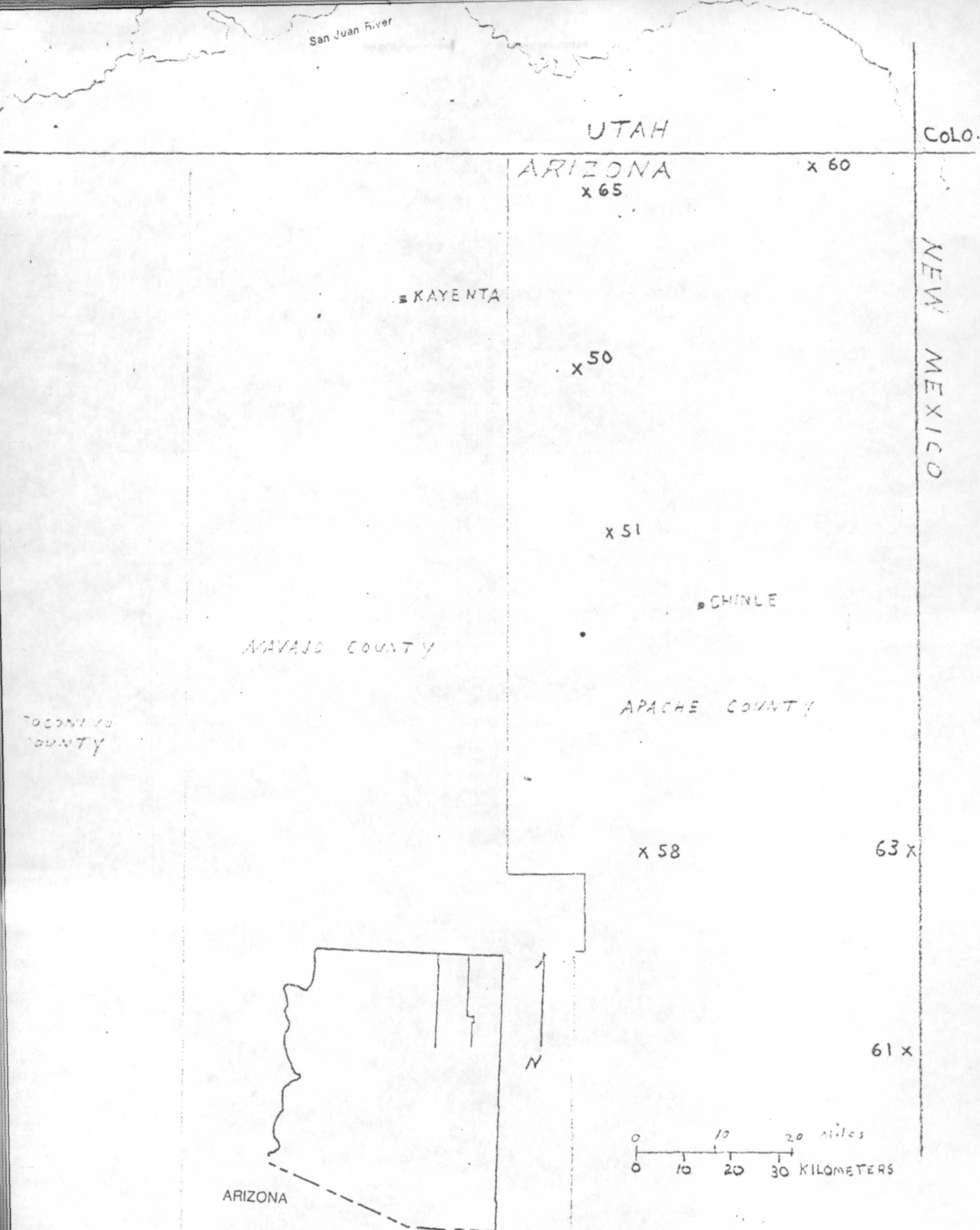


Figure 1. Map showing locations of stratigraphic sections in this report. (Section numbers are in system referred to by Wright, J. C., and Dickey, D. D., 1963.)

ARIZONA - APACHE COUNTY

TYENDE section (50)

[Approximately 1at 36°35' N., long 109°49' W. measured on eastern side of northeast projecting point, base just south of the road; measured by J. C. Wright and D. D. Dickey, May 26, 1957]

Feet

Upper Jurassic

Morrison Formation (incomplete):

29. Sandstone, like unit 27, but with scour channels about 1 ft deep at base. Top of section, not top of exposure-----	2.0
28. Poorly exposed; probably mostly claystone like unit 26-----	12.0
27. Sandstone, like unit 25 in color and lithology; low- angle cross-strata; basal contact channels a few inches deep-----	1.0
26. Claystone, greenish-gray (<u>SGY</u> 7/1), silty, laminated; poorly exposed in recess-----	<u>1.0</u>
Total of incomplete Morrison Formation-----	<u>16.0</u>

Note: The Morrison-Cow Springs contact is poorly exposed; appears transitional and conformable.

TYENDE section--Continued

Feet

Middle Jurassic

Cow Springs Sandstone:

25. Sandstone, like unit 23 in color and lithology except
that black accessory grains are more common; thin
even beds. Forms slope above cliff----- 7.5
24. Sandstone, like unit 23 in color and lithology except
that it is fine-grained and the very abundant
accessory white chert is prominent megascopically as
well as under the hand lens. The lower 4 ft are thin,
even bedded; the remainder comprises thin wedging
planar sets of medium-scale cross-laminae----- 26.5
23. Sandstone, greenish-white (5GY 9/1), weathers light-gray
(N 7), very fine grained, moderately well sorted;
composed of subrounded quartz grains with amber-stained
quartz, white chert, and red and black grains as
accessories, moderately well cemented; thick wedging
planar sets of large-scale cross-laminae without
horizontal truncation planes. Forms cliff----- 49.0
- Total of Cow Springs Sandstone----- 83.0

Note: The Cow Springs-Summerville contact appears conformable.

TYENDE section--Continued

Feet

Summerville Formation:

22. Sandstone, reddish-orange (10R 5/6) with streaks of greenish-white (5GY 9/1), weathers same colors, color changes laterally along cliff from brown to white; like unit 21 in lithology and bedding except that beds are slightly thinner and probably even more disrupted internally; contains a purple claystone parting about 2 ft above the base----- 10.5
21. Sandstone, greenish-white (5GY 9/1) with streaks of reddish-brown (10R 4/4) near the base, weathers same colors; very fine grained, well sorted; composed of clear and some amber-stained subrounded to rounded quartz grains with black accessory grains; moderately well cemented; thin even beds with irregular to disrupted internal laminae. Forms cliff. About 1 mi west, this unit and overlying unit can be seen to pass southwestward into typical reddish-brown vertically jointed beds that have been traced to Dinnehotso, where they are equivalent to Craig and others (1959), units 17 and 18 of the upper part of the Summerville. From a distance this unit would be included within the white Cow Springs, particularly where the overlying unit is also white----- 20.5

TYENDE section--Continued

Feet

Summerville Formation--Continued

20. Siltstone, light grayish-red (10R 5/2), weathers reddish-brown (10R 4/4); thin massive beds with disrupted internal laminae. Weathers to small hoodoo-like knobs in recess----- 6.0
19. Siltstone, moderate reddish-orange (10R 6/6), weathers same color; in massive beds 3-10 ft thick with greatly disrupted internal-laminae. Weathers to hoodoo cliff. This unit and overlying unit traced from here to Dinnehotso, where they were identified as Summerville both by Harshbarger and others (1957, p. 64) and by Craig and others (1959) (units 15 and 16)----- 42.0
18. Sandstone, like unit 16, but very fine to silt-size grains. Forms ledge----- 1.0
17. Siltstone, like unit 15 in color and lithology; indistinct, probably disturbed even laminae. Forms slope----- 6.0

TYENDE section--Continued

Feet

Summerville Formation--Continued

16. Sandstone, white (N 9), weathers light-gray (N 7), fine-grained, moderately well to well-sorted; composed of rounded to subrounded clear to gray quartz grains, the majority of which look like "Entrada berries," with abundant varicolored accessory grains; moderately well cemented; thin planar sets of medium scale low-angle cross laminae. Forms conspicuous ledge and bench. Interpreted as a basal fluvial reworking of Entrada sands in Summerville time----- 2.0
- Total of Summerville Formation----- 88.0

Entrada Sandstone:

Medial silty member:

15. Siltstone, reddish-orange (10R 5/6) weathers same color; in massive structureless beds mostly 1 to 2 ft thick separated by even laminated beds about 1 to 2 in. thick; near the top is one massive structureless bed about 15 ft thick; below this thick bed is a purple claystone parting with a bleached zone above and below. Poorly exposed on broad bench and low weak cliff where it weathers to hoodoos----- 31.0
- Total of medial silty member----- 31.0

TYENDE section--Continued

Feet

Entrada Sandstone--Continued

Lower sandy member:

14. Sandstone, silty, moderate reddish-orange (10R 6/6),
weathers same color, very fine grained, almost silt-
stone; moderately well to well sorted, moderately well
cemented; indistinct thick sets of medium to large-scale
cross laminae. Poorly exposed on broad bench----- 9.0
13. Sandstone, white (N 9), very fine grained, moderately
well sorted; composed of quartz with orange and black
accessory grains; firmly cemented; bedding in-
distinct and disturbed, probably originally was
thin sets of small-scale cross-laminae, upper
part shows brecciation indicative of solution
of gypsum----- 3.0

TYENDE section--Continued

Feet

Entrada Sandstone--Continued

Lower sandy member--Continued

12. Sandstone, light-brown (5YR 6/6), weathers moderate reddish-orange (10R 6/6), very fine grained, moderately well to well-sorted; composed of clear quartz with very few accessory grains; some beds have abundant fine-to medium-grained well rounded frosted quartz grains; thick wedging planar sets of medium to large-scale cross-laminae. Locally, in the lower 10 ft, cross laminae have been completely obliterated by slump during deposition or by later settling during

total solution of an underlying gypsum bed-----	<u>33.0</u>
Total of lower sandy member-----	<u>45.0</u>
Total of Entrada Sandstone-----	<u>76.0</u>

Note: The Entrada-Carmel contact appears conformable, but is somewhat irregular because of probable solution of gypsum bed.

TYENDE section--Continued

Feet

Carmel Formation:

- | | |
|---|------|
| 11. Sandstone like unit 8. Upper 1 or 2 ft is a mass of
spongy sandstone breccia, probably a residual
concentration of sand impurities from a dissolved
thick gypsum bed. Sandstone caps a fairly extensive
bench----- | 6.0 |
| 10. Claystone, like unit 2 with a few thin interbeds of
sandstone like unit 8----- | 23.0 |
| 9. Siltstone, sandy, light-brown (5YR 6/6), with
reddish-brown laminae, stains pink; thin even
laminae. Near the top are two thin sandstone beds
similar to unit 8----- | 6.0 |
| 8. Sandstone, like unit 3 except it is composed mostly
of small-scale cross-laminae (not ripple laminae);
contains several partings of claystone like
unit 2----- | 3.0 |
| 7. Sandstone, brown (5YR 5/4), stains pink, very fine
grained, well-sorted; composed of well-rounded
clear quartz grains with very few accessory grains;
moderately well cemented; massive. Weathers to a
weak slope----- | 3.0 |
| 6. Claystone, like unit 2 with two thin beds of
sandstone like unit 3 near the top----- | 8.0 |

TYENDE section--Continued

Feet

Carmel Formation--Continued

5. Sandstone, like unit 3 in lithology but orange stain on most of quartz grains colors it pale reddish-orange (10R 7/6). Upper half has small-scale cross-laminae----- 1.0
4. Claystone, like unit 2----- 1.0
3. Sandstone, white (N 9), stained pink, very fine grained, silty, moderately well sorted; composed of subangular to subrounded quartz grains with abundant orange, common black, and rare green accessory minerals; moderately well cemented; thin even laminae and ripple laminae----- 1.0
2. Claystone, orange-pink (10R 6/4), weathers moderate orange-pink (10R 7/4), laminated. Interbedded are a few thin ripple-laminated beds of limy siltstone of the same color but mottled yellowish-gray (5Y 8/1). Unit forms a covered slope----- 24.0
1. At least 20 ft of Carmel is covered on the flat north of the road. Slope is probably claystone and siltstone. Sandstone ledges appear on this very gentle slope. Base of measured section 150 ft south of road----- >20.0
- Total of incomplete Carmel Formation----- >96.0

BLACK MOUNTAIN section (51)

[Approximately lat 36°17' 1/2" N., long 109°45' W.,
measured on cliff about 1/2 mi east of spring; measured
by D. D. Dickey and J. C. Wright, May 27, 1957]

Feet

Middle Jurassic

Cow Springs Sandstone:

14. Sandstone, lower 5 ft white (N 9), remainder dusky-
yellow (5Y 6/4), weathers same colors; fine grained,
well sorted; composed of subrounded to rounded
clear quartz with orange, black, and pink accessory
grains; moderately well cemented; even thin beds
and laminae and some small-scale low-angle
cross laminae. Poorly exposed on mesa top.
Top of local exposure----- 35.0
13. Siltstone with thin interbeds of sandstone. Silt-
stone, reddish-brown (10R 4/4), weathers same color;
thick contorted beds with irregular laminae.
Sandstone, white (N 9), stains brown, very fine
grained, silty; abundant orange and black
accessory grains; thin, slightly irregular beds.
Forms partly covered slope above cliff----- 15.0
12. Sandstone, like unit 10. Top few inches reworked
into even beds----- 23.0
11. Sandstone, like unit 10 in color and lithology
except that it is very fine grained. Even,
slightly irregular laminae and thin beds----- 7.0

BLACK MOUNTAIN section--Continued

Feet

Cow Springs Sandstone--Continued

10. Sandstone, yellowish-gray (5Y 8/1), weathering same color to light greenish-gray (5GY 8/1), fine-grained, well-sorted; composed of subrounded to rounded clear quartz grains with orange, black, pink, dark-gray, and black accessory grains and also white chert; moderately well cemented; one tabular coset of thick planar sets of medium-scale cross-

laminae. Forms part of cliff----- 5.0

Total Cow Springs Sandstone----- 85.0

Note: The Cow Springs-Summerville contact is flat and conformable.

Summerville Formation:

9. Sandstone, greenish-gray (5GY 7/1) to white (N 9), includes dark-green streaks a few inches long in the lower 10 ft; very fine grained, well to moderately well sorted; composed of subangular to subrounded clear quartz with abundant orange and black accessory grains and a few gray frosted medium-grained "Entrada berries"; moderately well cemented; bedding same as unit 8, but only about 70 percent cross-strata. Forms even bedded appearing part of white cliff----- 35.0

BLACK-MOUNTAIN section--Continued

Feet

Summerville Formation--Continued

8. Sandstone, brown (5YR 5/4) to white (N 9), white outlines bedding; very fine grained, well-sorted; thin planar sets of medium- to small-scale cross-laminae (80 percent) divided into thin tabular cosets by even, thin, disturbed laminae (20 percent). Forms brown-and-white streaked unit on cliff----- 31.0
7. Claystone, moderate red (5R 4/4), with biotite flakes; laminated, weathers shaly. Forms prominent but not persistent recess on cliff. Where this unit is not present, unit 6 merges into the overlying sequence, with 1 or 2 ft of flat beds at this horizon----- 0.5
6. Sandstone like unit 4----- 6.5
5. Sandstone, silty, like unit 3----- 10.0
4. Sandstone, brown (5YR 5/4), weathers same color, very fine grained; composed of subangular quartz with common black and uncommon white accessory grains; thin sets of small- to medium-scale cross-laminae. Forms band on cliff----- 7.0
3. Sandstone, silty, like unit 2, but very fine grained----- 27.0

BLACK MOUNTAIN section--Continued

Feet

Summerville Formation--Continued

2. Siltstone, sandy, moderate-red (5R 5/4) with
minor white mottling and some dark-purple streaking,
weathers reddish-orange (10R 5/6); sand is all very
fine grained, well-sorted; moderately well cemented;
one massive bed with internal disturbed lamination;
weathers to a cliff tending to hoodoo form, with
prominent recesses at base and top----- 8.0
1. Only 2-4 ft of basal part of Summerville Formation is
concealed----- 3.0
- Total of Summerville Formation----- 128.0

Note: Summerville Formation-Entrada Sandstone not exposed here, but
they are exposed about 1/2 mi east.

GANADO section (58)

[Measured approximately lat 35°42' N., long 109°41' W.; 7 1/2 mi west of Ganado and 3 1/2 mi north of Cornfields Dayschool.

Measured just west of a north-south ridge which projects from the main cliff; measured by J. C. Wright and D. D. Dickey, May 26, 1957]

Feet

Middle Jurassic

Cow Springs Sandstone:

Fallen blocks from Cow Springs have abundant white chert as accessory mineral.

Note: The Cow Springs-Summerville contact appears conformable.

Summerville Formation:

10. Sandstone, white (N 9), with streaks of reddish-brown, weathering same colors, very fine grained, silty, moderately well sorted, with common black silt and some amber-stained quartz and white chert as accessory grains; moderately well cemented; in tabular beds 2-5 ft thick, some with even laminae and some with low-angle cross-laminae. Forms vertical cliff----- 50.0

GANADO section--Continued

Feet

Summerville Formation--Continued

9. Siltstone, some beds slightly sandy, reddish-orange (10R 5/6), other beds not sandy, moderate reddish-brown (10R 4/6). In the lower 46 ft the beds are mostly 1-3 ft thick with indistinct even laminae or disturbed even laminae. In the upper 38 ft stratification is very indistinct but beds appear to be 5-10 ft thick with very disturbed and disrupted internal laminae. There is a prominent recess 46 ft above the base and another with a white band 70 ft about the base. Forms slightly rounded jointed cliffs-----

84.0

Total of Summerville Formation----- 134.0

Note: The Summerville-Entrada contact appears conformable.

GANADO section--Continued

Feet

Entrada Sandstone:

8. Sandstone, reddish-orange (10R 5/6), weathers same color, irregularly streaked with white throughout the unit, with particularly prominent white bands in the lower 5 ft and upper 3 ft; very fine grained, silty, poorly sorted; in beds about 4 ft thick, some with irregular even laminae, a few with indistinct low-angle cross-laminae, and nearly all showing some post-depositional disturbance. Mostly weathers to a steep slope, locally to vertical cliffs. Uppermost 3 ft is very disturbed as though reworked. Distinction from Summerville is very subtle and uncertain----- 32.0
- Total of Entrada Sandstone----- 32.0

Carmel Formation:

7. Claystone like that in unit 3 except that it is slightly silty. Near the middle of the unit is a 1/2-ft-thick bed of siltstone, white (N 9), thinly laminated----- 7.5
6. Sandstone, like that in the middle of unit 5. Breaks in conspicuous jointed blocks and from a distance looks like a limestone ledge----- 1.0

GANADO section--Continued

Feet

Carmel Formation--Continued

5. Claystone like the claystone in unit 3. Near the middle of the unit is a 1/2-ft-thick bed of sandstone like unit 4 except that it is firmly cemented with calcite. Unit forms a poorly exposed slope----- 22.5
4. Sandstone, greenish-white (5GY 9/1), weathers same color; very fine grained, moderately well sorted, poorly cemented; composed of rounded quartz grains with a few orange stained quartz accessory grains. Poorly exposed on slope----- 6.0
3. Interbedded siltstone (60 percent) and claystone (40 percent). Siltstone, reddish-orange (10R 5/6), in structureless beds 1 to 5 ft thick. Claystone, moderate-red (5R 4/4), laminated, in units 1 to 5 ft thick; contains a few thin beds of white sandstone like unit 4. Poorly exposed on slope----- 33.0
2. Sandstone, like unit 1 in color and lithology except that it is slightly paler brown; thin even beds. Weathers to form top of bench----- 3.0
- Total of Carmel Formation----- 73.0

Note: The Carmel-Wingate contact; Wingate cross-strata are truncated but beds appear conformable.

GANADO section--Continued

Feet

Upper Triassic

Wingate Sandstone (incomplete):

1. Sandstone, pale-brown (5YR 7/6), weathers grayish-brown. (5YR 6/2), fine-grained, well-sorted; composed of glassy subrounded quartz grains with gray and black accessory grains; firmly cemented; a single thick set of large-scale cross-strata.

Weathers to prominent massive ledge----- >10.0

Total of incomplete Wingate Sandstone----- >10.0

EAST RED MESA section (60)

[Measured in the SE 1/4 sec. 6, T. 41 N., R. 29 E., at the
northeast end of a butte 5 mi east of the Red Mesa Trading Post;
measured by J. C. Wright and D. D. Dickey with
W. B. Satterthwaite, July 10, 1957]

Feet

Middle Jurassic

Bluff Sandstone:

21. Sandstone, yellowish-gray (5Y 8/1), weathers same color
to pale red (10R 6/2), very fine grained, well-
sorted, poorly cemented; composed of clean
subrounded quartz grains, with amber and black
accessory grains and also white chert; even beds and
low-angle cross-strata. Forms inaccessible
vertically jointed cliff. Lithology described
from fallen blocks. Thickness estimated by
comparison with measured Summerville Formation.
Upper contact is probably slightly above top

of visible cliff----- ~100.0

Total of Bluff Sandstone----- ~100.0

Note: Bluff-Summerville contact is conformable here.

EAST RED MESA section--Continued

Feet

Summerville Formation (upper part):

20. Siltstone, like unit 16, but in beds about 2 ft thick-----	15.5
19. Sandstone, like unit 17, but stained brown (10R 5/4), and has a few horizontal siltstone partings-----	5.5
18. Siltstone, like unit 16-----	<u>3.0</u>
Total of Summerville Formation (upper part)-----	<u>24.0</u>

Entrada Sandstone:

Moab Tongue equivalent:

17. Sandstone, white (<u>N</u> 9) to light-brown (<u>5YR</u> 6/4), weathers same colors to brown (<u>5YR</u> 5/4); like unit 15 in lithology, but well sorted; indistinct thin even beds (50 percent), and low-angle, small- scale cross-strata (50 percent). Forms prominent white ledge on cliff-----	17.5
16. Siltstone, reddish-brown (10R <u>4</u> /4), weathers same color; sandy; disturbed internal laminae in beds about 1 ft thick which form hoodoos on cliff. A 1/2-ft- thick ledge of sandstone like unit 15, 6 ft above base-----	11.0

EAST RED MESA section--Continued

Feet

Entrada Sandstone--Continued

Moab Tongue equivalent--Continued

15. Sandstone, white (N 9), very fine grained, well to moderately well sorted, poorly cemented; composed of subrounded clear, clean frosted quartz grains with some rounded fine grains, white chert, and black, orange, and red accessory grains. Forms small ledge with well-cemented nodules weathering out at top----- 5.5
- . Total Moab equivalent----- 34.0

Summerville Formation (lower part):

14. Siltstone, very sandy, moderate reddish-brown (10R 4/6), weathers same color, probably thin, slightly disturbed even bedding. Contains about six purple claystone partings, each bounded by white very fine grained sandstone. Forms steep slope----- 41.0
- Total of Summerville Formation (lower part)----- 41.0
- Total of Summerville Formation (including Moab equivalent in Entrada Sandstone)----- 99.0

Note: Summerville-Entrada contact is even, conformable, and gradational.

EAST RED MESA section--Continued

Feet

Entrada Sandstone:

Medial silty member:

13. Siltstone, very sandy, pale reddish-brown (10R 5/4),
weathers reddish-orange (10R 5/6); disturbed internal
laminae in beds about 2 ft thick. Forms hoodoos
on steep slope----- 8.0

12. Sandstone, moderate reddish-brown (10R 4/6) to
white (N 9), weathers same colors, very fine grained,
well-sorted, composed of subrounded clear quartz
with orange and black accessory grains; moderately
well cemented; irregularly even-bedded (60 percent)
with thin tabular sets of medium-scale to small-scale
cross-strata (40 percent). Forms cliff with
a 2-ft white band at top----- 15.0

11. Siltstone, very sandy, reddish-orange (10R 5/6),
weathers moderate reddish-orange (10R 6/6); most
sandstone is very fine grained, contains a few fine-
grained, well-rounded "Entrada berries"; probably
thin even beds about 1-2 ft thick. Forms
covered steep slope----- 18.0

Total of medial silty member of Entrada

Sandstone----- 41.0

Note: Entrada-Carmel contact is even and conformable.

EAST RED MESA section--Continued

Feet

Carmel Formation:

10. Siltstone, moderate reddish-brown (10R 4/6),
weathers reddish-brown (10R 4/4), contains some
very fine sand grains; very thin even beds. Minor
claystone partings. Forms slope----- 12.0
9. Claystone, grayish-red (10R 4/2), micaceous, weathers
shaly; includes thin interbeds of sandstone like unit 4.
Weathers to form top of broad bench----- 7.5
8. Sandstone, yellowish-gray (5Y 8/1), weathers same color to
very pale red (10R 7/2); lithology like unit 4
including sparse chert granules; indistinct,
probably even bedding. Forms ledge and broad
bench----- 1.0
7. Mostly covered. Claystone (70 percent) with
interbedded siltstone (15 percent) and
sandstone (15 percent). Claystone, grayish-
red (10R 4/2), contains very small mica flakes, thinly
laminated, weathers shaly. Siltstone, very
sandy, reddish-orange (10R 5/6). Sandstone
like unit 4. Forms slope----- 15.0
6. Sandstone, orange-pink (10R 6/4), weathers same color
with light-gray dapples; lithology same as unit 4;
persistent thin even bed. Forms minor ledge----- 0.5

EAST RED MESA section--Continued

Feet

Carmel Formation--Continued

5. Mostly covered; claystone, grayish-red (10R 4/2), weathers shaly. Contains some interbeds of siltstone, sandy, reddish-brown (10R 4/4). Forms slope----- 4.5
4. Sandstone, orange-pink (5YR 7/4), weathers same color to light brown (5YR 6/4), very fine to fine-grained, moderately well sorted; composed of subrounded very fine quartz grains with black accessory grains and abundant well-rounded fine grains, and a few chert granules; moderately well cemented with calcite; irregularly even bedded. Forms minor ledge----- 2.0
3. Sandstone (90 percent), with interbedded claystone (10 percent). Sandstone white (N 9), very fine to fine-grained, moderately well sorted; composed of quartz grains, coarser ones well-rounded, finer ones subrounded, with orange accessory grains and black silt accessory grains; in indistinct thin even beds. Claystone, grayish-red (10R 4/2), weathers dusky red (10R 3/4), micaceous, laminated, in very thin beds; weathers shaly. Unit forms covered slope----- 4.5

EAST RED MESA section--Continued

Feet

Carmel Formation--Continued

2. Sandstone, reddish-orange (10R 5/6), weathers same color to pale yellowish-brown (10YR 6/2), very fine grained, moderately well sorted, moderately well cemented; contains black silt accessory grains and some chert granules, particularly in lower part. Even structureless beds; probably reworked Navajo

Sandstone. Forms cap on Navajo bench----- 5.0

Total Carmel Formation----- 52.0

Note: Carmel-Navajo contact appears even and conformable over several hundred feet; marked by abundant gray and white subangular chert pebbles, and rarer ones of banded gray agate.

Jurassic and Triassic(?)

Navajo Sandstone (partial):

1. Sandstone, light-brown (5YR 6/4) to grayish-orange (10YR 7/4), weathers same colors, very fine grained, well-sorted, moderately well cemented; composed of rounded to subrounded clear quartz grains with very fine-grained orange accessory grains and black silt accessory grains; thick wedging planar sets of large-scale cross-strata. Rounded bare

rock exposures on broad bench----- >75.0

Total of incomplete Navajo Sandstone----- >75.0

LUPTON section (61)

[Measured at approximately long 109°04' W., lat 35°20' N., about 3/4 mi southeast of U.S. Highway 66, and 1 mi west of the Arizona State boundary; measured by J. C. Wright and D. D. Dickey with W. B. Satterthwaite and K. J. Monson, July 16, 1957]

Feet

Cretaceous

Dakota Sandstone:

24. Sandstone, conglomeratic in channels at

base and in lenses within sandstone. Forms

ledge at top of cliff----- >30.0

Total of Dakota Sandstone----- >30.0

Note: Dakota-Morrison contact is regionally unconformable; locally channels a few feet.

LUPTON section--Continued

Feet

Upper Jurassic

Morrison Formation:

Westwater Canyon Sandstone Member:

23. Sandstone, very pale red (10R 7/2), red (5R 5/6),
some yellowish-gray (5Y 7/4), weathers moderate
orange-pink (10R 7/4), very fine- to medium-grained,
moderately well sorted, composed of subrounded
very fine grains, rounded fine to medium grains;
medium grains are gray-frosted quartz grains and some
feldspar; moderately well cemented; mostly irregularly
even bedded and low-angle cross-laminae. A few
light-gray claystone partings, and some clayey
sandstone. Forms slope beneath Dakota ledge----- 104.0
Total of Westwater Canyon Member----- 104.0

Note: Westwater Canyon-Recapture contact is concealed.

LUPTON section--Continued

Feet

Recapture Member:

22. Sandstone, reddish-orange (10R 5/6), some light-brown (5YR 6/4), weathers same colors to pinkish-gray (5YR 8/1), fine to very fine grained, poorly cemented, moderately well to well-sorted; composed of subangular to subrounded quartz with black and orange accessory grains; thick sets of large-scale cross-laminae visible at bottom, bedding at top believed to be both even- and cross-bedded. Upper few feet are claystone, blackish-red (5R 2/2); probably irregular thickness. Forms slope or minor ledge weathered back from main slickrim

cliff----- 93.0

Total of Recapture Member----- 93.0

Total of Morrison Formation----- 197.0

Note: Morrison-Bluff contact appears even and conformable.

LUPTON section--Continued

Feet

Middle Jurassic

Bluff Sandstone:

21. Sandstone, color ranges from yellowish-white (5Y 9/1) to reddish-orange (10R 5/6), weathers same colors; very fine to fine grained, well sorted, moderately well cemented; composed of subrounded quartz, common orange, black, rare green, and uncommon white chert accessory grains; lower 50 ft cross-laminated in thick planar sets of large-scale, sweeping cross-laminae, upper part of unit indistinct, probably even-bedded with minor cross-bedding.

Forms upper part of major slickrim cliff----- 154.0

Total of Bluff Sandstone----- 154.0

Note: Bluff-Summerville contact is horizontal plane which forms a recess.

Summerville Formation:

20. Sandstone, pinkish-gray (5YR 8/1), weathers same color; lithology same as unit 17, lower 6 ft and upper 6 ft horizontal wavy laminae, middle of unit small- to medium-scale cross-laminae. Forms part of slickrim cliff----- 28.0

LUPION section--Continued

Feet

Summerville Formation--Continued

19. Sandstone, light greenish-gray (5GY 8/1) and orange-pink (10R 6/4), weathers same colors; lithology like unit 17; irregular even laminae and minor very small scale cross-laminae; horizontal truncation planes at both top and bottom of unit, lower one does not form a recess, upper one forms prominent recess. Forms part of slickrim cliff----- 20.0
18. Sandstone, dark-pink (5R 6/4), moderate orange-pink (10R 7/4), some grayish orange-pink (10R 8/2), lithology like unit 17; tabular planar sets 2-4 ft thick, medium-scale cross-strata. Forms part of slickrim cliff----- 22.0
17. Sandstone, grayish-orange-pink (10R 8/2), minor light-red (5R 6/6), very fine grained, well-sorted, composed of subangular clear quartz, with abundant black and orange accessory grains; moderately well cemented; thick wedging and lensing planar sets of large-scale cross-laminae. Forms slickrim cliff. Extensive horizontal truncation plane at base of unit; a lenticular thin bed of red clayey siltstone on this plane causes a prominent recess locally----- 46.5
- Total of Summerville Formation----- 116.5

Note: Summerville-Entrada contact is an extensive horizontal truncation plane.

LUPTON section--Continued

Feet

Entrada Sandstone:

Upper sandy member:

16. Sandstone, very silty, greenish-white (5GY 9/1) to light orange-pink (10R 8/4), weathers very light gray (N 8), very fine grained, very silty, moderately well sorted; contains black accessory silt grains; a single coset of thin to thick wedging planar sets of medium- and large-scale cross-laminae; no truncation planes within unit. Unit forms upper part of slickrim cliff----- 58.0
15. Sandstone, silty, like unit 14 except that it commonly weathers to light brownish-gray (5YR 6/1), and disturbance of the distinct cross-strata is very rare. Forms part of slickrim cliff----- 97.0
14. Sandstone, very silty, like unit 13 in color and lithology. In tabular beds 4-10 ft thick. Most of these tabular beds are cosets of wedging planar sets of medium- to large-scale cross-laminae; some of the tabular beds show contortion as in the underlying unit. Forms part of slickrim cliff; stonepecker holes are common along bedding plane----- 82.5

LUPTON section--Continued

Feet

Entrada Sandstone--Continued

13. Sandstone, very silty, reddish-orange (IOR 5/6)
streaked with white (N 9), weathers same colors,
moderately well sorted; contains common black accessory
silt grains; in tabular beds about 3-5 ft thick;
nearly all of these beds appear to have originally
contained medium- to large-scale cross-strata;
in some places this original cross-stratification
is still quite regular and distinct but in most
places the cross-strata are indistinct and disturbed,
or are completely obliterated and reworked and are
now contorted beds. The basal 15 ft is slightly
finer grained and almost entirely contorted;
it perhaps should be placed in the medial silty
member, but has been included in the upper sandy
member because it weathers as a part of the upper
slickrim cliff----- 57.0
Total of upper sandy member----- 294.5

LUPTON section--Continued

Feet

Entrada Sandstone--Continued

Medial silty member:

12. Siltstone, orange-pink (10R 6/4), weathers reddish-orange (10R 5/6), contains some white mottling which outlines contorted bedding in basal 10 ft; contains authigenic gray chert blebs and fine stringers; thick beds within internally disrupted laminae, weathers to hoodoos on nearly vertical cliff; upper contact is gradational and was placed at the top of hoodoo weathering----- 18.5
11. Siltstone, reddish-orange (10R 5/6), weathers same color; mottled and streaked white (N 9); thin to thick, indistinct, irregular to disturbed even beds; locally a 2-ft thickness of low-angle cross-strata was observed. Forms lowest part of cliff----- 11.0
10. Sandstone, pinkish-white (5YR 9/2), weathers same color; lithology and bedding same as unit 9, but better cemented and forms ledge----- 1.0

LUPTON section--Continued

Feet

Entrada Sandstone--Continued

Medial silty member--Continued

9. Sandstone, light-brown (<u>5YR</u> 6/6), weathers same color; very fine grained, well-sorted, composed of clear, glassy quartz grains with almost no accessory grains; moderately well cemented; small-scale low-angle cross-strata. Forms recess beneath unit 10-----	1.0
8. Siltstone, like unit 7, but with a few inches of white, very fine-grained sandstone at the base. A single massive bed with indistinct contorted laminae-----	2.5
7. Siltstone, light-brown (<u>5YR</u> 6/4), weathers dark reddish-orange (<u>10R</u> 5/6); sandy, poorly sorted, contains abundant well-rounded medium-grained gray-frosted "Entrada berries"; moderately well cemented. At top is about 3 ft of siltstone (not sandy), pale reddish-brown (<u>10R</u> 5/4). Thick massive indistinct beds. Forms poorly exposed slope-----	34.5
Total of medial silty member-----	68.5
Total of Entrada Sandstone-----	363.0

Note: Entrada-Wingate contact is completely covered; it may be as much as 30 ft lower or 10 ft higher.

LUPTON section--Continued

Feet

Upper Triassic

Wingate Sandstone (incomplete):

6. Almost completely covered. A few scattered outcrops suggest unit similar to unit 5----- 92.0
5. Very poorly exposed; probably siltstone similar to that exposed in unit 2 but in thinner less resistant beds; ripple-marked. Forms dip slope----- 32.0
4. Incompletely exposed; probably mostly siltstone like unit 2. Poorly exposed on scarp of small hogback----- 30.0
3. Claystone with minor interbedded sandstone. Claystone, dark reddish-brown (10R 3/4), weathers same color; thinly laminated; weathers flaky. Sandstone, pinkish-white (5YR 9/1), fine-grained, poorly sorted, poorly cemented, contains small clay chips of green sandy claystone. Some spots 2-3 mm across have dead oil stain on quartz grains. Unit forms small hollow between hogbacks----- 17.0
2. Incompletely exposed; siltstone, orange-pink (10R 6/4), weathers same color; moderately well sorted, firmly cemented; low-angle cross-strata; at the top is a 2-ft bed of silty sandstone with well-rounded medium-grained "Entrada berries"----- 20.5

LUPJON section--Continued

Feet

Wingate Sandstone (incomplete)--Continued

1. Siltstone, very sandy, moderate orange-pink (10R 7/4),
weathers moderate reddish-orange (10R 6/6); well-
sorted, contains black accessory grains; firmly
cemented; thin to thick wedging planar sets of
medium-scale low-angle cross-strata. Forms
ledgy cliff. Section begins at base of
exposures which are near the base of the

Wingate Sandstone----- 60.0

Total of incomplete Wingate Sandstone----- >251.5

WINDOW ROCK section (63)

[Measured at approximately lat 109°03' W., long 35°42' N.,
about 2 mi north of Window Rock on cliff east of road;
measured by D. D. Dickey and W. B. Satterthwaite, August 8, 1957]

Feet

Middle Jurassic

Bluff Sandstone (incomplete):

4. Sandstone, very pale red (10R 7/2) to grayish-pink
(5R 8/2), weathers same colors; fine to very fine
grained, moderately well to well-sorted, composed
of subrounded clear quartz grains with accessory grains
of black, orange, and pink minerals and subangular
white chert; moderately well cemented; very thick
wedging sets of large-scale sweeping cross-laminae.

Probably nearly complete thickness of Bluff Sandstone;

top of exposure on cliff----- 114.0

Total of incomplete Bluff Sandstone----- 114.0

Note: The Bluff-Summerville contact is a horizontal plane of reworked
structureless sandstone.

WINDOW ROCK section--Continued

Feet

Summerville Formation:

3. Sandstone, grayish-orange-pink (10R 8/2), weathers same color to pale reddish-brown (10R 5/4), very fine to fine-grained, moderately well to well-sorted, moderately well cemented; composed of subrounded clear quartz grains with accessory grains of orange, black, pink, and green minerals and subangular white grains; bedding is even, irregular (65 percent), and tabular sets averaging 2 ft thick of medium-scale cross-laminae (35 percent); unit contains one very thick set of large-scale cross-laminae.

Forms part of cliff-----	46.0
Total of Summerville Formation-----	46.0

Note: The Summerville-Entrada contact is marked by prominent niche in cliff along a horizontal truncation plane. Entrada below forms rounded cliff; Summerville above commonly forms more nearly vertical cliff. Bedding changes from very thick cosets of wedging planar sets below to thick, tabular cosets of even-bedded strata and cross-strata above. However, this contact may not be at the same horizon throughout the area; niche in the cliff fades locally and then appears along cliff at a horizon a few feet different stratigraphically.

WINDOW ROCK section--Continued

Feet

Entrada Sandstone (incomplete):

Upper sandy member (incomplete):

2. Sandstone, like unit 1, except cross-strata are generally a little smaller scale, and this unit has a few horizontal parting planes; color in upper 70 ft is yellowish-gray (5Y 8/1), in lower 50 ft reddish-brown; color contact gradational and irregular; light color allows varicolored accessory grains to be seen. Unit forms part of slickrim cliff----- 121.0

1. Sandstone, moderate reddish-brown (10R 4/6), weathers pale reddish-orange (10R 7/6). to reddish-orange (10R 5/6) with some white streaks which follow bedding planes or laminae; very fine grained, moderately well sorted, contains some fine-grained spherical, frosted quartz "Entrada berries"; moderately well cemented; thin to very thick wedging planar sets of concave upward-sweeping cross-laminae, very few horizontal parting planes. Unit forms base of cliff----- 86.0
Total of incomplete upper sandy member----- 207.0
Total of incomplete Entrada Sandstone----- >207.0

Note: Bottom of exposure, not bottom of Entrada Sandstone.

GARNET RIDGE section (65)

[Measured at approximately long 109°50' W., lat 36°55' N.; Carmel and Entrada Formations measured on northwest side of ridge near west end, the upper part of the section on southeast side, near west end; measured by J. C. Wright and D. D. Dickey with W. B. Satterthwaite, July 9, 1957]

Feet

Middle Jurassic

Bluff Sandstone (incomplete):

45. Sandstone, pale-orange (10YR 7/2), weathers same color, fine-grained, moderately well to well-sorted, composed of rounded, clear quartz grains with black, orange, red, and some green accessory grains and white chert grains; many medium-grained, frosted gray "Entrada berries"; poorly cemented; lower 8 ft appears structureless, remainder of unit composed of thick planar sets of medium- to large-scale cross-strata----- >15.0
44. Siltstone, like unit 42----- 4.0
43. Sandstone, like unit 41 in color and lithology except for abundant gray-frosted "Entrada berries" near base and in isolated stringers throughout; mostly irregularly bedded. Forms base of cliff----- 6.0
42. Siltstone, sandy, light grayish-red (10R 5/2); irregularly laminated. Forms slope----- 5.0

GARNET RIDGE section--Continued

Feet

Bluff Sandstone (incomplete)--Continued

41. Sandstone, orange-pink (5YR 7/4) in lower half, very pale orange (10YR 9/2) in upper half, fine-grained well to moderately well sorted, poorly cemented; composed of rounded to subrounded clear quartz grains with accessory grains of orange, black, green, and red minerals and white chert. Bedding poorly exposed----- 5.0
- Total of Bluff Sandstone----- >35.0

Summerville Formation (upper part):

40. Sandstone, alternating beds of sandstone like units 38 and 32; thin and thick beds. Forms ragged cliff and top forms bench----- 10.5
39. Unit mostly covered. Interbedded sandstone (65 percent) and siltstone (35 percent). Sandstone like unit 32. Siltstone like unit 37. Forms covered slope----- 12.0
- Total of Summerville Formation (upper part)----- 22.5

GARNET RIDGE section--Continued

Feet

Entrada Sandstone:

Moab Tongue equivalent:

38. Sandstone, white (N 9), weathers pale-reddish-brown
(10R 5/4), fine-grained, well-sorted, poorly
cemented; composed of subrounded quartz with amber,
black, red, and uncommon green accessory grains;
mostly thin structureless beds; claystone or
siltstone partings in lower half; a laminated
bed in the middle of the unit forms a recess;
upper 1 1/2 ft has small-scale cross-strata.
Unit forms ledge. Nodular, weathering crust
in upper few inches suggests possible gypsum
solution----- 9.5
- Total of Moab Tongue equivalent----- 9.5

Summerville Formation (lower part):

37. Siltstone, sandy, dark-reddish-brown (10R 3/4),
with thin interbeds of sandstone, light greenish
gray (5GY 8/1) and light grayish red
(10R 5/2). Forms slope----- 8.5
36. Sandstone, like unit 32 in color and lithology;
very thin beds----- 8.0
35. Sandstone, like unit 34 in color and lithology; lower
2 ft massive bedded, remainder very thin-bedded.
Forms ragged ledge----- 5.0

GARNET RIDGE section

Feet

Summerville Formation (lower part)--Continued

34. Sandstone, like unit 32 in color and lithology, with a little more silt; irregularly laminated. Contact with overlying unit shows undulations 1-2 ft broad and as much as 1 ft in amplitude----- 2.0
33. Sandstone, like unit 32. Interbedded sandstone (60 percent), siltstone (30 percent), and claystone (10 percent). Sandstone like unit 32.
Siltstone like unit 31 thin and very thin even beds, some internal distortion.
Claystone, purple, laminated, and very thin bedded.
Forms slope----- 5.0
32. Sandstone, pale-red (10R 6/2), lower few inches light greenish-gray (5GY 8/1), very fine grained, moderately well sorted; composed of quartz with abundant orange and black accessory grains. Forms minor ledge----- 1.0

GARNET RIDGE section--Continued

Feet

Summerville Formation (lower part)--Continued

31. Siltstone (70 percent), sandstone (20 percent), and claystone (10 percent), alternating in very thin beds. Siltstone, reddish-brown (10R 4/4), sandy. Sandstone, yellowish-gray (5Y 8/1), very fine grained, moderately well sorted, moderately well cemented; composed of quartz with orange and black accessory grains and rare green accessory grains. Claystone, grayish-red (5R 4/2) and dark-reddish-brown (10R 3/4), lower 10 ft even-bedded, remainder of unit contorted bedding, contortions a few inches to a few feet broad, upper 10 ft not as strongly contorted.

Forms slope-----	<u>37.0</u>
Total of Summerville Formation (lower part)-----	<u>66.5</u>
Total of Summerville Formation (including	
Moab Tongue equivalent in Entrada Sandstone)-----	<u>98.5</u>

Note: The Summerville-Entrada contact appears even and conformable.

GARNET RIDGE section--Continued

Feet

Entrada Sandstone:

Medial silty member:

30. Sandstone, reddish-orange (10R 5/6), weathers same color;
1 ft above base is a prominent pinkish-gray (5YR 8/1)
band; very fine grained, silty, moderately well sorted,
composed of subrounded quartz grains, orange and black
accessory grains; contorted bedding; weakly cemented.
Forms covered slope----- 23.5
29. Sandstone, light-brown (5YR 6/6), weathers brown
(5YR 4/6), very fine grained, well-sorted, moderately
well cemented; composed of subrounded clear quartz
grains with abundant black and rare red and green
accessory grains. Basal foot is white (N 9).
Irregular thin even beds; top 1 ft is indistinctly
cross-stratified. Forms prominent ledge and bench
near the top of the Entrada Sandstone. Used
4 1/2° as dip----- 8.0

GARNET RIDGE section--Continued

Feet

Entrada Sandstone--Continued

Medial silty member--Continued

28. Grades from sandstone in lower part to siltstone in upper part. Sandstone, moderate reddish-orange (10R 6/6) very fine grained, silty. Siltstone, pale-reddish-brown (10R 5/4). Whole unit weathers and stains reddish-brown (10R 4/4); thick massive beds with disrupted internal laminae; uppermost few feet have contorted bedding that has been truncated by the overlying sandstone. Forms poorly exposed slope or hoodoo cliffs. Measured dip at top of unit $4\frac{1}{2}^{\circ}$, used 5° as average dip----- 29.0
27. Sandstone, light-brown (5YR 6/4), weathers moderate reddish-orange (10R 6/6), very fine grained, silty, moderately well sorted; composed of subangular clear quartz grains with common black accessory grains; poorly cemented; thin even beds. Forms indistinct ledge on slope----- 2.0
- Total of medial silty member----- 62.5

GARNET RIDGE section--Continued

Feet

Entrada Sandstone--Continued

Lower sandy member:

26. Sandstone, light-brown (5YR 6/4), weathers moderate reddish orange (10R 6/6), very fine and fine grained, silty, moderately well sorted, moderately well cemented; composed of subrounded clear quartz grains; basal laminae contain abundant coarse-grained well-rounded "Entrada berries" of gray-frosted quartz and gray and white chert; thick wedging planar sets of large-scale cross-laminae. Forms reddish slopes and rounded slickrims. Used 6° as dip----- 52.0
25. Sandstone, orange-pink (5YR 7/4), weathers grayish-orange pink (5YR 7/2), fine- and very fine grained, silty, moderately well sorted; composed of subrounded clear quartz grains; some beds, particularly the basal one, contain abundant coarse-grained, well-rounded gray-frosted "Entrada berries" and some "berries" of gray and white chert; moderately well cemented; thin wedging planar sets of medium-scale cross-strata. Forms broad, ledgy bench. Used 7° as dip----- 32.0
24. Sandstone, light-brown (5YR 6/4), weathers pale reddish brown (10R 5/4); lithology same as unit 1, but "Entrada berries" are more abundant; massive bed with disrupted internal lamination. Weathers to hoodoos. Used 8 1/2° as dip----- 6.0

GARNET RIDGE section--Continued

Feet

Entrada Sandstone--Continued

Lower sandy member--Continued

23. Sandstone, grayish-orange (10YR 7/4), weathers light brown (5YR 6/4), very fine grained, silty, moderately well sorted, composed of subrounded clear quartz grains; some laminae contain abundant medium- and coarse-grained rounded, gray-frosted "Entrada berries"; moderately well cemented, indistinct even beds and low-angle cross-laminae; near center of ledge there is about 2 ft of contorted, slumped beds. Forms massive, jointed ledge. Dip of 8 1/2° measured on

immediately underlying beds-----	<u>17.0</u>
Total of lower sandy member-----	<u>107.0</u>
Total of Entrada Sandstone-----	<u>169.5</u>

Note: The Entrada-Carmel contact is not well exposed, appears conformable; base of Entrada Sandstone has irregularities a few inches deep.

GARNET RIDGE section--Continued

Feet.

Carmel Formation:

- | | |
|--|------|
| 22. Claystone, moderate-red (5R 4/4), thinly laminated,
weathers flaky. Forms slope. Used 8° as dip----- | 7.5 |
| 21. Sandstone, like unit 6 in color and lithology, massive
bed. Forms indistinct ledge----- | 1.0 |
| 20. Concealed, probably interbedded claystone and
siltstone like unit 11. Forms slope. Used
9° as dip----- | 6.0 |
| 19. Sandstone like unit 18 in color and lithology, but
not so well cemented; thin to thick wedging planar
sets of medium- to large-scale cross-laminae. Forms
upper half of prominent ledge. Used 9° as dip----- | 4.5 |
| 18. Sandstone, greenish-white (5GY 9/1), weathers light
gray (N 7), very fine grained, well-sorted, composed
of clear quartz grains with some black accessory
silt grains and some fine-grained, well-rounded,
frosted "Entrada berries"; firmly cemented with
calcite; indistinct disturbed and contorted bedding.
Forms lower half of prominent ledge----- | 5.5 |
| 17. Concealed, probably mostly siltstone, reddish-orange
(10R 5/6)----- | 7.0 |
| 16. Concealed, probably claystone and claystone, silty
like unit 3----- | 16.0 |
| 15. Sandstone, like unit 6. Forms ledge----- | 0.5 |

GARNET RIDGE section--Continued

Feet

Carmel Formation--Continued

14. Poorly exposed. Siltstone and subordinate interbedded claystone. Siltstone, reddish-orange (10R 5/6), thinly bedded. Claystone, moderate red (5R 4/4), thinly laminated. Unit forms slope. Used 10° as dip----- 11.0
13. Sandstone, like unit 6, but poorly cemented, not much calcite. Concealed on slope----- 2.0
12. Sandstone, white (N 9) in lower half and light-brown (5YR 5/6) in upper half, very fine grained, silty, poorly sorted, moderately well cemented; composed of subangular glassy quartz grains with black accessory silt grains; contorted bedding in basal foot, a tabular set of medium-scale low-angle cross-laminae in middle foot, and irregular to disturbed thin even beds in upper foot. Forms ledge on slope.
Dip 10 1/2°----- 3.0
11. Concealed; interbedded claystone, silty claystone, and clayey siltstone, probably in about equal proportions. Claystone, moderate-red (5R 4/4), thinly laminated. Claystone, silty, grayish-red (5R 4/2). Siltstone, clayey, reddish-orange (10R 5/6), laminated. About 10 ft above base is a 1/2-ft-thick bed of sandstone like unit 6.
Unit forms slope----- 43.0

GARNET RIDGE section--Continued

Feet

Carmel Formation--Continued

- | | |
|---|------|
| 10. Sandstone like unit 6----- | 10.0 |
| 9. Claystone, like unit 7----- | 2.5 |
| 8. Sandstone, moderate orange-pink (10R 7/4) mottled
with white spots, weathers light gray (N 7);
fine-grained, well-sorted, firmly cemented with
calcite; composed of well-rounded glassy quartz
grains and contains a few reddish-brown clay chips;
abundant calcite cement; a tabular set of low-angle
small-scale cross-strata. Poorly exposed on
slope----- | 1.0 |
| 7. Concealed, mostly claystone, moderate-red (5R 4/4),
thinly laminated, weathers flaky on slope.
Used 12° dip----- | 18.5 |
| 6. Sandstone, greenish-white (5GY 9/1), weathers
white (N 9), very fine and fine-grained, well-
sorted; composed of rounded clear quartz
grains with black and amber-stained accessory
grains; abundant medium-grained well-rounded
"Entrada berries" near base; firmly cemented
with calcite; massive bed, indistinct laminae
are contorted. Forms persistent ledge on a
dip slope. Measured dip (not too reliable)
is 10°----- | 3.0 |

GARNET RIDGE section--Continued

Feet

Carmel Formation--Continued

- | | |
|--|--------------|
| 5. Concealed, probably claystone and silty claystone,
like unit 3. Used 12° dip----- | 4.5 |
| 4. Siltstone, very sandy, pale reddish-orange (10R 7/6),
weathers same color; very fine grained, poorly sorted,
firmly cemented; massive bed. Barely exposed on
slope----- | 1.5 |
| 3. Concealed, float and soil indicate claystone,
moderate-red (5R 4/4), and claystone, silty,
grayish-red (5R 4/2); thinly laminated, weathers
flaky on slope. Used 12° dip----- | 12.0 |
| 2. Sandstone, like unit 1 in color and lithology.
Thin flat beds, with a few thin sets of small-
scale cross-laminae; upper 5 ft are contorted.
Forms low ledge. Used 12° as dip----- | <u>13.0</u> |
| Total of Carmel Formation----- | <u>173.0</u> |

Note: The Carmel-Navajo contact is flat; reworked material lies on beveled cross-beds of Navajo Sandstone. Clastic chert concentrated on contact.

GARNET RIDGE section--Continued

Feet

Jurassic and Triassic(?)

Navajo Sandstone (incomplete):

1. Sandstone, greenish-white (5GY 9/1), weathers yellowish-white (5Y 9/1); very fine grained, well-sorted, composed of well-rounded glassy quartz grains, with black silt accessory grains; firmly cemented; indistinct thick wedging planar sets of large-scale cross-laminae. Upper surface, which is beveled flat beneath Carmel Formation, has coarse grains and granules of subangular white and gray chert on it. Forms broad flat surface sweeping up onto dip-slope

of Comb Ridge----- >100.0

Total of incomplete Navajo Sandstone----- >100.0

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