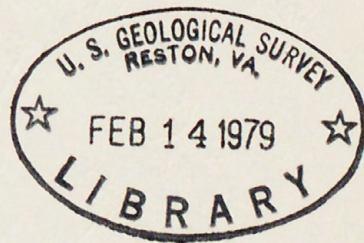


(200)  
R290  
no. 79-248

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



(200)  
R290  
no. 79-248



✓ UNITED STATES (DEPARTMENT OF THE INTERIOR)  
GEOLOGICAL SURVEY

TM  
cm  
Twards

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

By <sup>ayton</sup> D. D. Dickey and <sup>amso</sup> J. C. Wright <sup>1927</sup> <sup>1923-1968</sup>

Open-File Report 79-248

1979

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

296798

## Contents

	Page
Introduction-----	1
Coconino County - Arizona-----	4
Echo Monocline section (43)-----	4
Kaibito section (48)-----	18
Blue Canyon section (49)-----	27
Cow Springs section (59)-----	37
References-----	49

---

## Illustrations

---

Figure 1. Map showing locations of stratigraphic sections-----	3
--	---

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

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

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 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 slightly different texture than 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 the 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

Some of what is called Navajo Sandstone in these sections has been named Page Sandstone (Peterson and Pipiringos, in press).

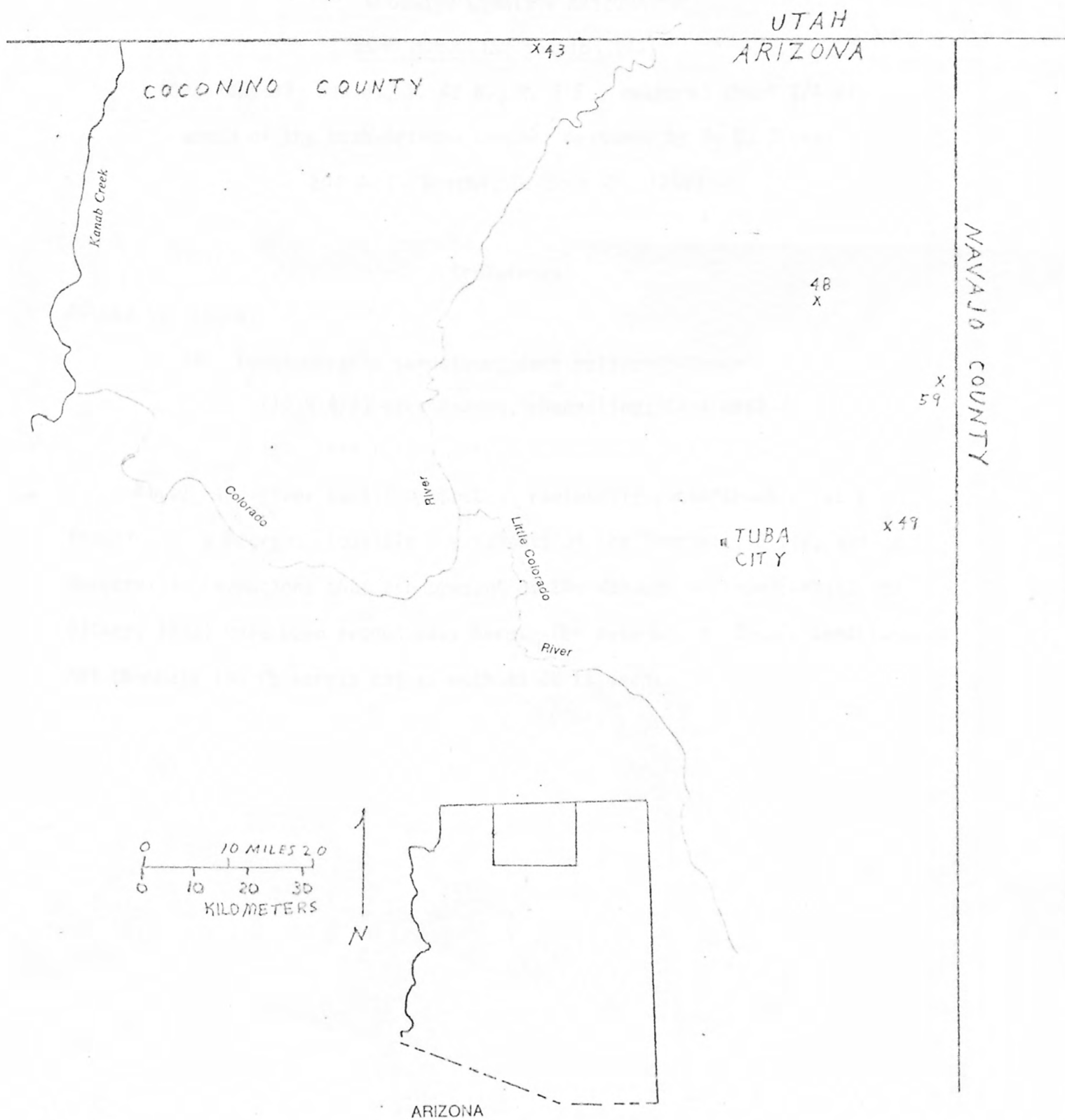


Figure 1. Map showing locations of stratigraphic sections in this report.

(Section numbers are in system referred to by Wright, J. C., and Dickey, D. D., 1963.)

COCONINO COUNTY - ARIZONA

ECHO MONOCLINE section (43)

[Sections 33 and 34, T. 42 N., R. 7 E., measured about 1/4 mi south of the Utah-Arizona border; measured by D. D. Dickey and J. C. Wright, October 29, 1956]

Feet

Cretaceous

Dakota Sandstone:

36. Conglomeratic sandstone, dark yellowish-brown  
(10YR 4/2) crossbedded, channeling; caps mesa.  
Thickness not measured.

Note: The lower Dakota contact is regionally unconformable; at a fraction of a degree. Possible equivalents of the Morrison, Bluff, and Summerville Formations that are present at the Wahweep section (Wright and Dickey, 1978) have been eroded away here. The base of the Dakota Sandstone has channels 100 ft across and as much as 20 ft deep.

ECHO MONOCLINE section--Continued

Feet

Middle Jurassic

Entrada Sandstone:

35. Sandstone, greenish-white (5GY 9/1) to very pale orange (10YR 8/2) weathers same color; a few greenish gray (5GY 7/1) streaks and one red band (not persistent) occur 140 ft below the top of the unit; very fine grained, moderately well sorted, moderately well cemented, composed of subrounded quartz with orange and black accessory grains abundant and red accessory grains sparse. Large-scale and some medium-scale wedging planar crossbeds; a fairly extensive horizontal parting occurs 70 ft below the top; a few horizontal truncation planes persist for as much as 2 mi. Some limonite concretions near base. Forms slickrim cliffs except for the upper 150 ft which forms a steep cliff. The unit may be 50-100 ft thicker than measured if the is slightly greater than estimated----- 420.0



ECHO MONOCLINE section--Continued

Feet

Entrada Sandstone--Continued

<p>34. Sandstone, greenish-white (<u>5G</u> 9/1), very fine grained, silty, moderately well sorted, moderately well cemented; limonite stains and nodules, particularly at the upper contact; even-bedded to structureless; units 33 and 34 form a ledge protected by unit 35. Units 33 and 34 may represent an old soil-----</p>	4.0
<p>33. Siltstone, clayey, very pale green (<u>10G</u> 8/2), grades upward to sandstone. Forms part of soft ledge protected by more resistant Entrada above-----</p>	1.0
<p>32. Sandstone, like unit 31 in color and lithology but partially bleached white, particularly about 3 ft below top; bedding disrupted and more contorted; weathers to shaly fragments and hoodoo forms-----</p>	12.5
<p>31. Sandstone, light-brown (<u>5YR</u> 6/4), upper 2 ft partially bleached white. Very fine grained, silty; disturbed indistinct bedding; forms ledge. Partings of shale, grayish-red (<u>10R</u> 4/2), with visible biotite occur 1 1/2 ft above base and 2 ft below top of unit-----</p>	<u>10.5</u>
<p style="text-align: right;">Total of Entrada Sandstone-----</p>	<u>448.0</u>

ECHO MONOCLINE section--Continued

	Feet
Carmel Formation:	
Gypsiferous unit:	
30. Interbedded siltstone (70 percent), sandstone, very fine grained (25 percent), and claystone (5 percent); reddish-orange (10R 5/6); poorly exposed on slope; probably thin even bedded-----	32.0
29. Clay, grayish-red-purple (5RP 4/2), bentonitic; specks of efflorescent mineral forms on weathered surfaces-----	0.5
28. Sandstone and siltstone, pale-red (10R 6/2) to moderate reddish-brown (10R 4/6), some small white mottling; forms slope-----	3.0
27. Sandstone, like unit 22 except that it is low-angle crossbedded-----	0.5
26. Sandstone, very light gray (N 8), medium-grained, subrounded, moderately well cemented, moderately well sorted; abundant orange, black, light and dark purple, light green, and pale yellow accessory grains. Forms conspicuous white band-----	3.0

ECHO MONOCLINE section--Continued

Feet

Carmel Formation--Continued

Gypsiferous unit--Continued

25. Sandstone, like unit 23 except that it is very fine to fine-grained, and contains fewer "Entrada berries". Six feet above base is a 3-in.-thick white streak, and about 9 ft above base is a clay parting. The upper 10 ft contain abundant granules and sparse pebbles, and grain-size is slightly coarser----- 22.0
24. Sandstone, very pale red (10R 7/2), very fine to fine grained; moderately well sorted, moderately well cemented; rounded to subrounded quartz grains with orange, black, light purple, and sparse vivid green accessory grains; even bedded. There is a split of sandstone like unit 23 3-6 in. above the base----- 2.0
23. Sandstone, very dark reddish-brown (10R 2/4), very fine grained, poorly sorted, moderately well cemented; medium grained gray frosted "Entrada berries" form 10 percent of rock, contains sparse granules; whole unit is one even or structureless bed----- 2.0

ECHO MONOCLINE section--Continued

Feet

Carmel Formation--Continued

Gypsiferous unit--Continued

22. Sandstone, light-brown (5YR 6/4) to very pale red (10R 7/2), fine-grained, moderately well sorted, moderately well cemented; rounded to subrounded quartz grains with orange, black, light purple, and sparse vivid green accessory grains; thin to thick even beds with irregular to disturbed laminae----- 7.0
21. Sandstone, brown (5YR 5/4), medium- to fine-grained, moderately well sorted, rounded to subrounded grains, black accessory grains; some laminae contain coarse grains and granules, especially in crossbedded upper part; mostly indistinctly even bedded----- 8.0
20. Sandstone, light grayish-red (10R 5/2) locally bleached white at top, very fine grained, moderately well sorted, moderately well cemented; contains pink, black, and vivid green accessory grains; even bedded to slightly irregularly bedded at top----- 7.0
19. Sandstone, white (N 9) medium-grained, well-cemented, rounded grains; contains lavender, black, red, and vivid green accessory grains; even bedded----- 1.0
18. Siltstone and shale, silty, dark reddish-brown (10R 3/4), very thin-bedded to laminated----- 6.0

ECHO MONOCLINE section--Continued

Feet

Carmel Formation--Continued

Gypsiferous unit--Continued

17. Sandstone like unit 16, except that it has some small- to medium-scale low-angle crossbedding; top foot is bleached white and contains carbonate nodules as much as 1 cm in diameter----- 13.5
16. Sandstone, very pale red (10R 7/2), fine- to medium-grained, moderately well sorted; moderately well cemented; contains black and pink accessory grains; some laminae contain coarse grains and granules; even-bedded----- 8.0
15. Sandstone, dusky-red (10R 3/2), very fine grained, silty, poorly sorted, well-cemented; forms recess----- 4.5
14. Sandstone, greenish-white (5GY 9/1), thin blue-colored band at top; fine grained, poorly sorted moderately well cemented; contains black and pink accessory grains; even bedded----- 2.0
13. Shale, grayish-purple (5P 4/2) clay with biotite----- 0.25

ECHO MONOCLINE section--Continued

Feet

Carmel Formation--Continued

Gypsiferous unit--Continued

12. Sandstone, light-brown (5YR 5/6) at bottom to pinkish-gray (5YR 8/1) at top; fine grained, well sorted, subrounded, moderately well cemented; contains common black, pink, and sparse vivid green accessory grains; irregularly even-bedded at bottom, medium-scale wedging planar crossbeds in upper part. Forms cuesta----- 32.25
11. Sandstone, grayish-orange-pink (5YR 7/2) to reddish-brown (10R 4/4); fine- to very fine grained; poorly sorted; composed of rounded clear quartz with common pink, peach, black, and sparse vivid green accessory grains; occasional beds contain volcanic granules and small pebbles; bedding irregular at bottom, becoming even-bedded and low-angle crossbedded upward. Subordinate interbedded shales, dark reddish brown (10R 3/4). Unit contains pipes (see unit 8); forms ledgy cuestas----- 65.0

ECHO MONOCLINE section--Continued

Feet

Carmel Formation--Continued

Gypsiferous unit--Continued

10. Interbedded shale and siltstone, sandy, reddish-brown (10R 4/4), some streaks of greenish-white (5GY 9/1) in siltstone, and streaks of grayish-blue (5PB 5/2) in shale; some biotite in shale; in very thin even beds; forms slope----- 13.5
9. Sandstone, like unit 8, except that there is much small-scale distortion and remnants of cross-bedding; no distinct pipe structures. Nodules as much as 3 cm in diameter filled by clear rhombohedral soft mineral that reacts only weakly with concentrated hydrochloric acid----- 52.0

ECHO MONOCLINE section--Continued

Feet

Carmel Formation--Continued

Gypsiferous unit--Continued

8. Sandstone, like white part of unit 6, interbedded with pebbly sandstone like unit 7, some of which has been bleached white; the white sandstone differs from the red only in lacking granules and pebbles and in being more distinctly evenbedded. The massive pebbly beds like unit 7 commonly have a concentration of granules and pebbles in the bottom few inches. Whole unit is much contorted on a large scale; numerous vertical pipes (springs?) are filled by bleached, better-cemented, similar sandstone and cut through the whole unit; they range from one-half to about 6 ft in diameter; the largest have red cores in the center----- 36.0
7. Sandstone, reddish-brown (10R 4/4), fine-grained, poorly sorted, moderately well cemented, structureless; numerous subangular granules and pebbles as much as 2 cm in diameter of volcanic grains and chert are dispersed throughout the unit----- 10.5



ECHO MONOCLINE section--Continued

Feet

Carmel Formation--Continued

Gypsiferous unit--Continued

6. Poorly exposed. Interbedded red silty sandstone (85 percent) and white sandstone (15 percent). Sandstone, moderate-red (5R 4/4), silty, very fine grained, poorly exposed. Sandstone, white (N 9), very fine to medium-grained, moderately well to poorly sorted, moderately well to well-cemented; contains pink, black, and vivid green accessory grains; even-bedded or low-angle crossbedded.

Forms ledges on slopes----- 36.0

Total of gypsiferous unit of Carmel

Formation----- 367.5

ECHO MONOCLINE section--Continued

Feet

Navajo Sandstone (incomplete):

Thousand Pockets Tongue:

5. Sandstone, predominantly light-grayish-orange (10YR 8/4) with some dark-pink (5R 6/4), very fine, fine- and medium-grained with fine-grained predominating; moderately well to well-sorted, moderately well-cemented; large grains rounded, small ones subrounded; pink, peach, and black accessory grains; large-scale planar crossbedding; lower 5-10 ft has medium-scale tabular crossbedding. Forms dip slope. The unit is widely spread over a warped monoclinial surface with few horizontal beds to measure. Total error (if all errors are in same direction) may be as much as 50 ft but 25 ft is more likely----- 200.0
- Total of Thousand Pockets Tongue----- 200.0

ECHO MONOCLINE section--Continued

Feet

Carmel Formation--Continued

Judd Hollow Tongue:

- |  |              |
|--|--------------|
| 4. Sandstone, light grayish-red (5R 5/2), weathers dark grayish red (5R 3/2), very fine grained, moderately well sorted, well-cemented; thin even beds and low-angle crossbeds. Forms persistent ledge with horizontal upper and lower contacts-----                                 | 3.0          |
| 3. Sandstone, moderate-red (5R 5/4) and grayish-orange-pink (5YR 8/2), very fine grained; otherwise lithology like unit 2; even beds to irregular disturbed thin beds. Offset about 1500 ft south to measure upper part of section. Units 2, 3, and 4 recognized at both points----- | <u>8.0</u>   |
| Total of Judd Hollow Tongue-----   | <u>11.0</u>  |
| Total of Carmel Formation-----   | <u>378.5</u> |

ECHO MONOCLINE section--Continued

Feet

Jurassic and Triassic(?)

Navajo Sandstone (incomplete)--Continued

2. Sandstone, moderate-red (5R 5/4), partly bleached to very pale orange (10YR 8/2), fine to very fine grained, moderately well cemented, moderately well sorted, subrounded quartz sand with black and peach-colored accessory grains, and medium-grained, gray frosted, spherical "Entrada berries"; large-scale wedging planar crossbeds; a nonpersistent horizontal truncation plane at base----- 48.0
1. Sandstone, weathers very pale-orange (10YR 8/2), large-scale wedging planar crossbeds----- >200.0
- Total of incomplete Navajo Sandstone----- >448.0

KAIBITO section (48)

[Measured at approximately lat  $36^{\circ}33' 1/2''$  N., long  $111^{\circ}03'$  W.;  
about 2-3 mi south of Kaibito near the center fork of  
Kaibito Wash; measured by D. D. Dickey and  
J. C. Wright, May 20-21, 1957]

Note: Top of exposure on mesa rim.

	Feet
Cretaceous	
Mancos(?) Shale (incomplete):	
25. Claystone, black ( <u>N 1</u> ), weathers medium gray ( <u>N 5</u> ), laminated with minor interbeds of sandstone and limy siltstone. Poorly exposed on sloping rim-----	<u>&gt;50.0</u>
Total of incomplete Mancos(?) Shale-----	<u>&gt;50.0</u>
Dakota Sandstone:	
24. Sandstone, very pale-orange ( <u>10YR 8/2</u> ) to yellowish-orange ( <u>10YR 7/6</u> ), most beds very fine grained; composed of quartz with minor black accessory grains; lenses of medium- grained sandstone contain white and red accessory grains; a few pebbles along basal contact; cross- stratified. Forms capping ledge of cliff-----	<u>26.0</u>
Total of Dakota Sandstone-----	<u>26.0</u>

Note: The Dakota-Cow Springs contact is undulating with erosional  
channel cuts as much as 5 ft deep.

KAIBITO section--Continued

Feet

Middle Jurassic

• Cow Springs Sandstone:

23.	Sandstone, pale yellowish-gray (5Y 8/2), very fine grained, moderately well sorted; composed of subangular to subrounded quartz grains with common black accessory grains; lower half has indistinct wavy even laminae and thin beds; upper half is cross-stratified in large sets like unit 22. Forms rounded to vertical cliff protected by Dakota ledge-----	88.0
22.	Sandstone, greenish-white (5GY 9/2) to grayish-yellow-green (5GY 7/2), fine-grained, moderately well to poorly sorted; composed of subrounded clear quartz with orange, red, and black accessory grains; thick to very thick wedging planar sets of medium- to large-scale cross-laminae. Joint faces through entire thickness form shear vertical cliffs-----	<u>158.0</u>
	Total of Cow Springs Sandstone-----	<u>246.0</u>

Summerville(?) Formation:

21.	Sandstone, like unit 19-----	3.0
20.	Sandstone, like unit 18, but reddish-brown color is minor-----	42.0

KAIBITO section--Continued

Feet

Summerville(?) Formation--Continued

19. Sandstone, grayish-yellow-green (5GY 6/2) and subordinate dark reddish-brown (10R 3/2), very fine grained, clayey, poorly sorted; composed of subangular quartz grains; even laminae; forms weak bed protected by sandstone above----- 2.0
- Total of Summerville(?) Formation----- 47.0

Entrada Sandstone:

Medial member:

18. Sandstone, moderate-reddish-brown (10R 4/6) (70 percent), like unit 3, and white (N 9) (30 percent). White sandstone, fine-grained, moderately well sorted; composed of white rounded quartz grains, with abundant orange accessory grains some of which may be orange-stained quartz, also black and rare green accessory grains. Bedding as in unit 3. Forms prominent white-streaked red cliff. Reddish-brown sandstone forms only about 15 percent of rock in the upper 50 ft----- 143.0

KAIBITO section--Continued

Feet

Entrada Sandstone--Continued

Medial member--Continued

17. Sandstone, greenish-white (5GY 9/1) (60 percent) and reddish-brown (10R 4/6) (40 percent), very fine grained, poorly sorted; composed of subangular to subrounded grains of quartz; white sandstone contains about 10 percent quartz grains with orange stain, and also common black accessory grains; thin to thick wedging planar sets of medium-scale cross-laminae; upper 10 ft are even-bedded, white. Forms rounded cliff----- 55.0
- Total of medial member----- 198.0

Lower sandy member:

16. Sandstone, color and lithology like unit 15 with a larger percentage of lighter orange-colored rock. Predominantly cross-stratified in tabular sets 1-5 ft thick of medium-scale cross-laminae separated in places by thin beds of structureless sandstone. Forms rounded cliff----- 103.5



KAIBITO section--Continued

Feet

Entrada Sandstone--Continued

Lower sandy member--Continued

15. Sandstone, predominantly reddish-orange (10R 5/6) but may be pale-orange (10YR 7/2) with irregular streaks of orange-white (10YR 9/2), very fine grained, moderately well sorted, a few orange-stained medium-grains; composed of subrounded to subangular clear quartz grains; color of rock is caused by orange stain on grains; abundant orange and black accessory silt grains, rare green accessory grains; indistinctly evenly laminated. Forms rounded cliff on side of wash----- 41.0
- Total of lower sandy member----- 144.5

KAIBITO section--Continued

Feet

Kaibito Unit:

14. Sandstone, white ( <u>N</u> 9), very fine to fine-grained, moderately well sorted, composed of subrounded to rounded clear quartz, with abundant orange, common black and rare green accessory grains; towards the top are irregular streaky areas the same color as unit 15; thick to very thick sets of medium- to large-scale cross-laminae. Forms mostly covered slope. The thickness of this unit is approximate because it is measured across a broad flat about 2000 ft wide and the average dip cannot be determined accurately-----	172.0
13. Mostly covered; sandstone, weathers reddish-brown ( <u>10R</u> 4/4), very fine grained, much disturbed bedding. Contains some white sandstone with very abundant orange accessory grains. Weathers to broad dune-covered flat-----	<u>27.5</u>
Total of Kaibito unit approximately-----	<u>199.5</u>
Total of Entrada Sandstone-----	<u>542.0</u>

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

KAIBITO section--Continued

	Feet
Carmel Formation:	
12. Sandstone, like unit 8, but with some medium-scale cross-laminae-----	7.0
11. Siltstone, very sandy and clayey, dark reddish- brown (10R 3/6); irregularly bedded, very poorly exposed on weathered slope. Near middle are two sandstone ledges, white (N 9), very fine to fine-grained, with pink and black accessory grains-----	19.0
10. Sandstone, white (N 9), very fine grained, moderately well sorted; composed of subrounded clear quartz with pink and black accessory grains; indistinct medium-scale cross-laminae and even beds. Forms ledge-----	14.0
9. Claystone, like unit 7, poorly exposed. Contains four thin beds of sandstone like unit 8, but with small-scale cross-laminae-----	32.0
8. Sandstone, white (N 9), very fine to fine-grained, moderately well sorted; composed of subrounded clear quartz with pink, black, and green accessory grains indistinctly bedded in slightly irregular beds. Forms minor ledge-----	1.0

KAIBITO section--Continued

	Feet
Carmel Formation--Continued	
7. Claystone, dark reddish-brown (10R 3/4), minor green mottling; thinly laminated, weathers shaly; poorly exposed on covered slope-----	18.0
6. Sandstone, white (N 9), very fine grained, well-sorted composed of subrounded to rounded clear quartz grains with red, pink, and black accessory grains; small-scale cross-laminae. Forms ledge-----	6.0
5. Sandstone, reddish-orange (10R 5/6), very fine grained, moderately well to poorly sorted; composed of rounded grains; indistinctly bedded in slightly irregular beds. Weathers back on bench-----	9.0
4. Sandstone, white (N 9), very fine grained, moderately well sorted; composed of subangular quartz with pink and black accessory grains; predominantly flat-bedded with some small-scale cross-laminae and ripple marks. Forms ledge-----	11.0
3. Siltstone, like unit 2 but clayier and lacks sand impurities-----	10.0
2. Siltstone, moderate reddish-brown (10R 4/6), sandy, clayey, poorly sorted; bedding indistinct but appears even. Forms steep slope-----	<u>8.0</u>
Total of Carmel Formation-----	<u>135.0</u>

KAIBITO section--Continued

Feet

Jurassic and Triassic(?)

Navajo Sandstone (incomplete):

1. Sandstone, orange-pink (5YR 7/4), weathers same color to very pale-orange (10YR 8/2); fine- to very fine grained, poorly sorted; thick sets of large-scale cross-strata. Upper 5-10 ft slumped; uppermost foot reworked and contains round medium grains.

Dissected; forms steep canyons----- >75.0

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

BLUE CANYON section (49)

[Approximately lat 36°10' N., long 110°53' W. Measured on the north side of the canyon; measured by D. D. Dickey and J. C. Wright, May 23, 1957]

Dakota Sandstone present but not measured.

Top of Jurassic section.

Feet

Middle Jurassic

Cow Springs Sandstone:

29. Sandstone, yellowish-green (10GY 6/2) to greenish-yellow (10Y 6/4), weathers mostly yellowish-green, very fine grained, silty, moderately well sorted; predominantly thin flat beds; where upper part has weathered beneath pediment it is yellowish-orange (10YR 7/6) with prominent Liesegang rings of orange color obscuring bedding. Forms upper part of cliff----- 94.0
28. Sandstone, pale-orange (10YR 7/2), fine-grained, well-sorted; composed of subrounded clear quartz with black and orange accessory grains; moderately well cemented; thin to thick planar sets of medium-scale cross-laminae----- 3.0

BLUE CANYON section--Continued

Feet

Cow Springs Sandstone--Continued

27. Sandstone, light greenish-gray (5GY 8/1), weathers very pale orange (10YR 8/2), very fine grained, well-sorted; composed of clear subangular quartz with orange, black, and pink accessory grains; even bedded. .Forms nearly white band on cliff----- 19.0
26. Sandstone, pale-orange (10YR 7/2), weathers same color, has streaks of orange iron oxide stain; very fine to fine-grained, moderately well sorted; composed of clear subangular to subrounded quartz with orange, pink, and black accessory grains; fair cemented; thick planar sets of large-scale cross-laminae. Forms yellow-orange band on cliff----- 17.0
25. Sandstone, silty, moderate reddish-brown (10R 4/6) and pale yellowish-gray (5Y 8/2), slightly irregular bedding. Units 22, 23, 24, and 25 may be equivalent to the Summerville Formation----- 3.0
24. Sandstone, pale-orange (10YR 7/2) to yellowish-gray (5Y 8/1), weathers same colors; very fine grained, well-sorted; composed of subrounded clear quartz with orange and black accessory grains; moderately well cemented; very thick sets of planar large-scale cross-strata; locally contains lenticular bodies of sandstone like unit 25. Forms cliff----- 84.0

BLUE CANYON section--Continued

Feet

Cow Springs Sandstone--Continued

23. Sandstone, like cross-bedded sandstone in unit 22; thick wedging planar sets of medium- to large- scale cross-strata-----	18.0
22. Sandstone, yellowish-gray (5Y 8/1), weathers same color to dark pinkish-gray (5YR 7/1), very fine grained, moderately well to well-sorted; composed of subrounded, clear quartz with orange and black accessory grains; moderately well cemented; even bedded; the lower 5 ft contain prominent greenish-gray (5G 5/1) very thin beds of silty very fine grained well-cemented limy sandstone that weather as plates. Green color notable at break on cliff. Middle 5 ft of unit has thin sets of small-scale cross-strata and is fine-grained-----	15.0
Total Cow Springs Sandstone-----	<u>253.0</u>

Note: The Cow Springs-Entrada contact appears conformable.



BLUE CANYON section--Continued

Feet

Entrada Sandstone:

Medial member:

21. Sandstone, yellowish-gray (5Y 8/1) weathers same color, very fine grained, moderately well sorted; composed of subangular to subrounded clear quartz with orange, black, red, and rare green accessory grains; moderately well cemented; thick planar sets of medium- to large-scale cross-laminae. Forms cliff----- 20.5
20. Sandstone, silty, reddish-brown (10R 4/4), lower 2 ft and a few other streaks are yellowish-gray, moderately well sorted; predominantly thin even beds; some small-scale cross-laminae. Forms uppermost red band. This unit probably belongs in the medial member but could be included in the lower sandy member----- 16.5
- Total of medial member----- 37.0

Lower sandy member:

19. Sandstone, like unit 18, but yellowish-gray (5Y 8/1)----- 10.0

BLUE CANYON section--Continued

Feet

Entrada Sandstone--Continued

Lower sandy member--Continued

18. Sandstone, reddish-orange (10R 5/6) streaked with yellowish-white (5Y 9/1), very fine grained, moderately well to well-sorted; irregular thin beds and laminations (65 percent), thin sets of small-scale cross-laminae (35 percent); one purple claystone parting noted. Forms rounded cliff and hoodoos----- 70.0
17. Sandstone, mostly reddish orange (10R 5/6) at the bottom, and yellowish-white (5Y 9/1) at the top; no sharp color contact, streaks of both colors throughout; fine-grained, well-sorted; composed of rounded clear quartz with orange, black, pink, red, and rare green accessory grains; moderately well cemented; several purple clay partings along cross-strata; thick planar sets of medium-scale cross-laminae (70 percent) and even beds (30 percent) transitions in bedding types along strike and vertically; even beds confined mostly to lower orange zone. Forms soft cliff----- 71.0
16. Claystone, dusky-red (10R 3/2)----- 1.0

BLUE CANYON section--Continued

Feet

Entrada Sandstone--Continued

Lower sandy member--Continued

15. Sandstone, light greenish-gray (5GY 8/1), very fine grained, silty, contains abundant black and common red and orange accessory grains; moderately well cemented; thin even beds. Forms covered slope----- 3.0
14. Sandstone, yellowish-gray (5Y 8/1), very fine grained, moderately well to well-sorted; composed of subangular to subrounded clear quartz with abundant orange and common black and red accessory grains; composed of thick planar sets of medium-scale cross-laminae; small-scale cross-laminae in upper 5 ft; lower 5 ft are indistinctly laminated and disturbed. Forms dip slope----- 22.0
13. Sandstone, moderate reddish-brown (10R 4/6) weathers same color, very fine grained; indistinctly cross-laminated, slightly disturbed. Forms prominent red band on cliff----- 7.5
12. Purple claystone parting; discontinuous----- <0.1

BLUE CANYON section--Continued

Feet

Entrada Sandstone--Continued

Lower sandy member--Continued

11. Sandstone, silty, mottled reddish-orange (10R 5/6) and yellowish- (5Y 8/1), weathers same colors; very fine grained, moderately well sorted, moderately well cemented; disturbed and disrupted bedding with of medium-scale cross-laminations visible. Forms whitish rib on cliff----- 7.5
- Total of lower sandy member----- 192.0

Kaibito unit:

10. Sandstone, white (N 9) to yellowish-gray (5Y 8/1), weathers same colors, fine and very fine grained, well-sorted; composed of rounded clear quartz with orange, black, and rare pink and green accessory grains; moderately well cemented with calcite; thick to very thick wedging planar sets of large- to medium-scale cross-laminae. Forms rounded slickrim cliff----- 75.0
- Total of Kaibito unit----- 75.0
- Total of Entrada Sandstone----- 304.0

Note: The Entrada-Carmel contact appears conformable; taken several feet above uppermost clay bed at lowest thick sets of medium-scale cross-laminae.

BLUE CANYON section--Continued

Feet

Carmel Formation:

9. Sandstone, yellowish-gray (5Y 8/1), weathers same color to white (N 9), very fine to fine-grained, well-sorted; composed of rounded clear quartz grains with abundant orange and black and common red and green accessory grains; moderately well to poorly cemented; very low angle small-scale cross-laminae, and some even and some disturbed bedding; minor interbeds of reddish-brown and green clay, one of which (23 ft above the base) has large sandfilled mudcracks. Forms white cliff----- 50.0
8. Sandstone, very silty, reddish-orange (10R 5/6), very fine grained, moderately well sorted, moderately well cemented; indistinct even, possibly disturbed bedding. Forms red band with some hoodoos on cliff----- 10.0
7. Sandstone, very light-gray (N 8), medium-grained, poorly sorted, with grains ranging from very fine to granules; composed of subrounded to rounded clear quartz with minor feldspar and chert, and orange, black, red, and green accessory grains; moderately well cemented; channels a few inches into underlying unit----- 1.5

BLUE CANYON section--Continued

Feet

Carmel Formation--Continued

6. Sandstone, like unit 4, but the white sandstone predominates and no lenticular bedding was observed----- 19.0
5. Claystone, dusky red-purple (5RP 3/2), very micaceous----- 0.5
4. Sandstone, greenish-white (5GY 9/1), interbedded with reddish-brown (1OR 4/4) sandstone. Both sandstones are very fine to fine-grained, moderately well sorted; composed of subrounded clear quartz grains with orange and black and rare green accessory grains; moderately well cemented; even, thin, lenticular beds; minor red and green claystone streaks within sandstone; white sandstone is slightly coarser than the brown. Forms ribbed cliff----- 35.0
3. Sandstone, very light-gray (N 8) to white (N 9), weathers same colors, fine-grained, moderately well sorted; composed of subrounded to rounded clear quartz grains with abundant black and common red and green accessory grains; moderately well cemented; mostly thin even beds with some large-scale low-angle cross-strata. Forms prominent massive double ledge on cliff----- 30.0

BLUE CANYON section--Continued

Feet

Carmel Formation--Continued

2. Claystone, grayish-red (10R 4/2) to moderate reddish-brown (10R 4/6), weathers shaly, upper 20 ft contains biotite. White (N 9), sandstone ledges within the unit are very fine to fine-grained, moderately well sorted; composed of subangular to subrounded clear quartz with abundant orange and black accessory grains; moderately well cemented; indistinct bedding, some disturbed; sandstone ledges are at 20-22, 43-47, and 60-76 ft above the base----- 108.0
- Total of Carmel Formation----- 254.0

Note: The Carmel-Navajo contact is poorly exposed; appears conformable.

Jurassic and Triassic(?)

Navajo Sandstone (incomplete):

1. Sandstone, pale-orange (10YR 7/2), weathers same color to orange-white (10YR 9/2), fine-grained, well-sorted; composed of rounded clear quartz grains with orange and black accessory grains; moderately well cemented; thick to very thick wedging planar sets of large-scale cross-laminae; top 5 ft has medium-scale cross-strata and contains abundant small, well cemented spherules. Forms a dissected flat----- >50.0
- Total of incomplete Navajo Sandstone----- >50.0

COW SPRINGS section (59)

[Measured at approximately lat 36°25' N., long. 110°47 1/2' W.,  
about 3 mi east of Cow Springs Trading Post; measured by  
J. C. Wright and D. D. Dickey, May 22, 1957]

Feet

Cretaceous

Dakota Sandstone (incomplete):

29. Claystone, black (N 1), coaly, with blocky fracture  
and thin even lamination. Contains some thin  
interbeds of sandstone. Unit is overlain by  
thick sandstone ledges. Top of measured  
section; not top of exposure----- >35.0
28. Sandstone, very light-gray (N 8), stains light-brown  
(5YR 6/6), very fine grained, silty moderately  
well sorted except that it contains large chips of  
siltstone and claystone; firmly cemented with calcite;  
lamination, if present, concealed on stained joint  
faces, appears massive. Weathers to blocky capping  
ledge----- 11.0
- Total of incomplete Dakota Sandstone----- >46.0

Note: The Dakota-Cow Springs contact is very sharp and even; appears  
conformable over a short distance, but is regionally unconformable.



COW SPRINGS section--Continued

Feet

Middle Jurassic

Cow Springs Sandstone:

27. Sandstone, like unit 26 in color and lithology except that it is slightly silty, has streaks of cement that are moderate pink (5R 7/4) and contains some white accessory grains of chert or feldspar; thick planar wedging sets of low-angle, medium- to large-scale cross-laminae. Weathers to rounded slickrim----- 55.0
26. Sandstone, yellowish-white (5Y 9/4), stains moderate orange-pink (5YR 8/4), very fine grained, well- to moderately well sorted; composed of rounded quartz grains with little or no accessory minerals; moderately well cemented; very indistinct bedding, probably even. Weathers to smooth nearly vertical surfaces which overhang alcoves----- 33.0
25. Sandstone, yellowish-white (5Y 9/4), weathers same color, very fine grained, slightly silty, moderately well sorted; composed of subrounded to rounded quartz grains with rare black accessory grains; firmly cemented; thick to very thick wedging planar sets of large-scale cross-laminae. Forms steep slickrim----- 48.0

COW SPRINGS section--Continued

Feet

Cow Springs Sandstone--Continued

24. Sandstone, light-yellow (5Y 8/6), weathers yellowish-orange (10YR 7/6), very fine grained, silty, poorly sorted; composed of subangular quartz and feldspar(?); firmly cemented with abundant limonite; irregular even-bedded and small-scale cross-stratification----- 3.0
23. Sandstone, silty, greenish-white (5GY 9/1), weathers same color, very fine grained, moderately well sorted; rare black and pale amber accessory grains, thick to very thick wedging planar sets of medium- to large-scale cross-laminae. Upper contact has been scoured out in erosional channels at least 2 ft deep. Forms steep rounded slickrim cliffs----- 55.0
22. Siltstone, sandy, pale yellow-green (5GY 8/2), weathers same color, contains amber and black accessory grains, well-cemented; indistinct thin even beds. Forms recess on cliff----- 2.0
21. Sandstone, greenish-white (5GY 9/1) to white (N 9), weathers same color; like unit 20 in lithology; comprised of thin to thick wedging planar sets of small- to medium-scale cross-strata, thickness and scale of cross-stratification increase from bottom to top. Forms steep rounded slickrim----- 95.0

COW SPRINGS section--Continued

Feet

Cow Springs Sandstone--Continued

20. Sandstone, light greenish-yellow (10Y 7/2) with minor streaks of very pale red (10R 7/2), weathers greenish-yellow white (10Y 9/2), very fine grained, silty, moderately well sorted; composed of well-rounded quartz grains with amber and black accessory minerals; moderately well cemented; thin even beds and thin sets of small-scale cross-strata. Exposed only in gully. This unit, with units 21 and 22, may be a sandy equivalent of the Summerville(?) Formation recognized at Kaibito, Arizona (Kaibito section number 48)----- 19.0
- Total of Cow Springs Sandstone----- 310.0

Note: The stratigraphic position of the Cow Springs-Entrada contact cannot be determined with certainty because both units are sandy and similar. Contact placed here as units 20 and 21 have color and lithology of Cow Springs.

COW SPRINGS section--Continued

Feet

Entrada Sandstone:

Medial silty member:

19. Covered; mostly similar to unit 18. Exposures about 300 ft east of the section indicate that the contact between the Entrada and Cow Springs Sandstones is in the upper 20 ft of this covered zone. For convenience it is arbitrarily placed at the top of this covered zone----- 49.0
18. Mostly covered; sandstone, white (N 9), with bands of pale reddish-brown (10R 5/4). White sandstone, fine-grained, moderately well sorted, moderately well cemented of subrounded clear quartz grains with abundant orange-stained quartz grains and black, red, and rare green accessory mineral grains. Reddish-brown sandstone, silty, very fine grained, poorly sorted, same composition as white sandstone. White sandstone is partly even-bedded and partly cross-stratified; brown sandstone is mostly even-bedded. Forms mostly covered slope----- 36.0
- Total medial silty member----- 85.0

COW SPRINGS section--Continued

Feet

Entrada Sandstone--Continued

Lower sandy member:

17. Covered; probably sandstone like unit 16----- 11.0

16. Sandstone, like unit 15 in color and lithology; a little more than half of the unit is indistinctly even-bedded, the remainder is thin to thick planar sets of small- to medium-scale cross-laminae. Forms rounded slickrim in wash, covered by sand dunes on bench. A sharp change in dip from 4 1/2° to 15° causes uncertainty in the accuracy of the thickness----- 58.0

15. Sandstone, dark reddish-orange with irregular streaks of white (N 9), weathers moderate reddish-orange (10R 6/6), very fine grained, moderately well to poorly sorted, some beds quite silty; composed of subrounded clear quartz with some fine black accessory grains; thin to thick massive beds with indistinct, very disturbed, laminae within them. A few beds show indistinct cross-stratification----- 40.0

Total of lower sandy member----- 109.0

COW SPRINGS section--Continued

Feet

Entrada Sandstone--Continued

Kaibito sandstone unit:

14. Sandstone, like unit 11 in color and lithology, except that some beds are predominantly fine-grained; thick to very thick planar sets of medium- to large-scale cross-strata, the cross-laminae in the upper 10 ft are indistinct and locally slumped. Contains a few thin beds of reddish-orange sandstone as in unit 11 and a few thin beds of reddish-brown claystone, like unit 13. About 10 ft above the base is 1/2 ft of dusky-red (10R 3/2), very pure laminated claystone with a yellow micaceous(?) mineral. Unit is poorly exposed on a bench more than 1/4 mi wide and thickness is approximate----- 94.0
13. Claystone, reddish-brown (10R 4/4), with fairly abundant fine glassy quartz grains dispersed throughout; laminated----- 1.5
12. Sandstone, like unit 11 in color and lithology; comprised of thin sets of small- to medium-scale cross-strata and subordinate even thin interbeds. Exposures like unit 11----- 14.0

COW SPRINGS section--Continued

Feet

Entrada Sandstone--Continued

Kaibito sandstone unit--Continued

11. Sandstone, white (N 9), weathers very light gray  
(N 8), very fine grained, moderately well sorted;  
composed of clean clear rounded quartz grains with red  
and orange (or orange-stained) accessory grains;  
moderately well cemented; lower half comprises thick  
planar sets of medium- to large-scale cross-strata,  
upper half is even-bedded. At top is 1 ft of reddish-  
orange (10R 5/6) very fine grained sandstone with  
disturbed even bedding. Poorly exposed on bench  
but well exposed where dissected in canyon----- 33.0  
Total of Kaibito sandstone unit----- 142.5  
Total of Entrada Sandstone----- 336.5

Carmel Formation:

10. Claystone, like unit 6, color of some beds ranges  
to dark reddish-brown (10R 3/4)----- 18.0

COW SPRINGS section--Continued

Feet

Carmel Formation--Continued

9. Sandstone, light greenish-gray (5GY 8/1), with irregular splotches of orange-pink (10R 6/4), weathers same color, very fine grained, silty, with a few conspicuously rounded frosted medium grains; poorly sorted; contains black accessory silt grains and some amber or amber-stained grains; moderately well to well-cemented; massive bed with indistinct disturbed to disrupted laminae. Generally covered on slope, exposed in wash----- 8.0
8. Poorly exposed; claystone, like unit 6 but includes some silty claystone. Contains 1 or 2 beds of sandstone similar to those in unit 6----- 38.5
7. Sandstone, white (N 9), weathers same color, fine-grained well-sorted; composed of clear clean rounded quartz grains with red, black, and amber accessory grains; thick planar sets of medium-scale cross-strata. Forms poorly exposed slope----- 17.0



COW SPRINGS section--Continued

Feet

Carmel Formation--Continued

6. Poorly exposed; claystone, moderate reddish-brown (10R 4/6), weathers reddish-brown (10R 4/4), laminated. Near the middle and at the top of the unit are 2 ft thick beds of sandstone, greenish-yellow white (10Y 9/2), very fine grained, poorly sorted; composed of rounded clear and gray quartz grains with common black, amber, and red accessory grains; well-cemented with calcite; indistinct irregular bedding. Sandstone forms ledges in slope----- 45.0
5. Sandstone, white (N 9), weathers yellowish-white (5Y 9/2), fine-grained, moderately well sorted; composed of clean clear rounded quartz grains with a few accessory grains of amber, red, and gray quartz or chert; well-cemented with calcite; indistinctly evenly bedded. Forms minor ledge----- 2.0
4. Sandstone, grayish-orange (10YR 7/4), weathers light grayish-orange (10YR 8/4), like unit 3 in lithology but grains have less intense orange stain; indistinctly cross-stratified in thick sets. Forms poorly exposed slope----- 8.5

COW SPRINGS section--Continued

Feet

Carmel Formation--Continued

3. Sandstone, light-brown (5YR 6/6), weathers same color, very fine grained, poorly sorted; composed of clear subrounded quartz grains with very minor spots of black dead oil; moderately well cemented; thin to thick beds with very indistinct irregular bedding; several beds show imperfect graded bedding with a thin layer of reddish-orange (10R 5/6) sandy siltstone at the top; a few beds also show thin sets of small-scale cross-strata.
- Forms poorly exposed slope----- 13.5
2. Sandstone, like unit 1 in color and lithology, massive, poorly exposed----- 1.0
- Total of Carmel Formation----- 151.5

Note: The Carmel-Navajo contact is poorly exposed; has slight erosional unevenness as described below; the units appear conformable.

COW SPRINGS section--Continued

Feet

Jurassic and Triassic(?)

Navajo Sandstone:

1. Sandstone, light orange-pink (10R 8/4), weathers very pale orange (10YR 8/2), very fine to fine-grained, well-sorted; composed of subrounded clear quartz and some white feldspar(?), with black iron oxide accessory grains and traces of a pale green accessory mineral; moderately well cemented; very thick planar sets of large-scale thin cross-beds. Mostly covered by alluvium. Uppermost surface intermittently exposed on a cuesta. At one locality on a projecting point of the cuesta face the Navajo-Carmel contact rises about 5 ft where the Navajo Sandstone was protected from pre-Carmel erosion by a capping layer of resistant white (N 9) crystalline limestone about 1 1/2 ft thick. About 50 ft away from this locality, where a small ravine has cut across the cuesta, pre-Carmel erosion has cut approximately 5 ft deeper in the Navajo Sandstone entirely removing the limestone bed (if it was deposited there)----- >50.0

Total of incomplete Navajo Sandstone----- >50.0

## References

- Peterson, F., and Pippingos, G. N., 1977, Stratigraphic relationships of the Navajo Sandstone to Middle Jurassic Formations in parts of southern Utah and northern Arizona: U.S. Geological Survey Professional Paper 1035-B (in press).
- 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.
- \_\_\_\_\_, 1978, Stratigraphic sections of Jurassic San Rafael Group and adjacent rocks in Kane County, Utah: U.S. Geological Survey Open-File Report
- \_\_\_\_\_.



USGS LIBRARY-RESTON



3 1818 00071193 5