UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Measured Sections of the Jackpile sandstone of the Morrison Formation, the Burro Canyon Formation, and the Encinal Canyon Member of the Dakota Sandstone on the eastern side of the San Juan Basin, New Mexico

by

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By W. M. Aubrey

INTRODUCTION

The 10 sections presented here were measured on the eastern side of the San Juan Basin (fig. 1) as part of an ongoing regional stratigraphic and sedimentologic study to determine the tectonic and depositional history of north-central New Mexico during latest Jurassic to earliest Late Cretaceous time (Aubrey, 1986, 1988). These sections describe a sheetlike layer of relatively coarse-grained, locally conglomeratic, fluvial sandstone that represents this time interval in the region. At different localities the layer is thought by various workers to be composed of the Jackpile sandstone, an economic unit at the top of the Brushy Basin Member of the Morrison Formation (Upper Jurassic), the Burro Canyon Formation (Lower Cretaceous) and the Encinal Canyon Member of the Dakota Sandstone (Upper Cretaceous). This coarse clastic interval, which occurs between the generally less coarse facies that make up the underlying Jurassic and overlying Cretaceous sequences, has a complex depositional history which is only incompletely understood.

Locations of the sections are shown on figure 1. They are illustrated in the cross-section in plate 1 and their descriptions are given at the end of the report.

STRATIGRAPHIC UNITS

Six stratigraphic units are included in the uppermost Jurassic to lowermost Upper Cretaceous part of the stratigraphic sequence on the eastern side of the San Juan Basin. The complex interrelationships of these units, as currently understood, are shown in the stratigraphic section on Plate 1. The various units are described briefly in ascending order below.

The mudstone unit of the Brushy Basin Member of the Morrison Formation consists of thick montmorillonitic beds of light grayish-green mudstone, claystone, and siltstone that locally contain thin sandstone and conglomeratic lenses. The mudstone unit contains scattered thin limestone beds and thin well-indurated orange and grayish-green zeolitic beds (Bell, in press). The Brushy Basin mudstone unit is interpreted to be lacustrine in origin (Bell, in press), and is considered to be late Jurassic in age in the San Juan Basin (Santos, 1970).

The Jackpile sandstone of economic usage (Freeman and Hilpert, 1956) overlies the Brushy Basin mudstone unit in the southern part of the field area where it is regarded as an informal unit at the top of the Brushy Basin Member of the Morrison Formation. The Jackpile is a white, kaolinitic, fine- to medium-grained, crossbedded, fluvial sandstone unit containing thin interbeds of pale-green mudstone and siltstone. It is generally devoid of carbonaceous plant debris. The Jackpile locally interfingers with the underlying mudstone unit of the Brushy Basin Member and is thought to be of Late Jurassic age although no age diagnostic fossils have been found in it.

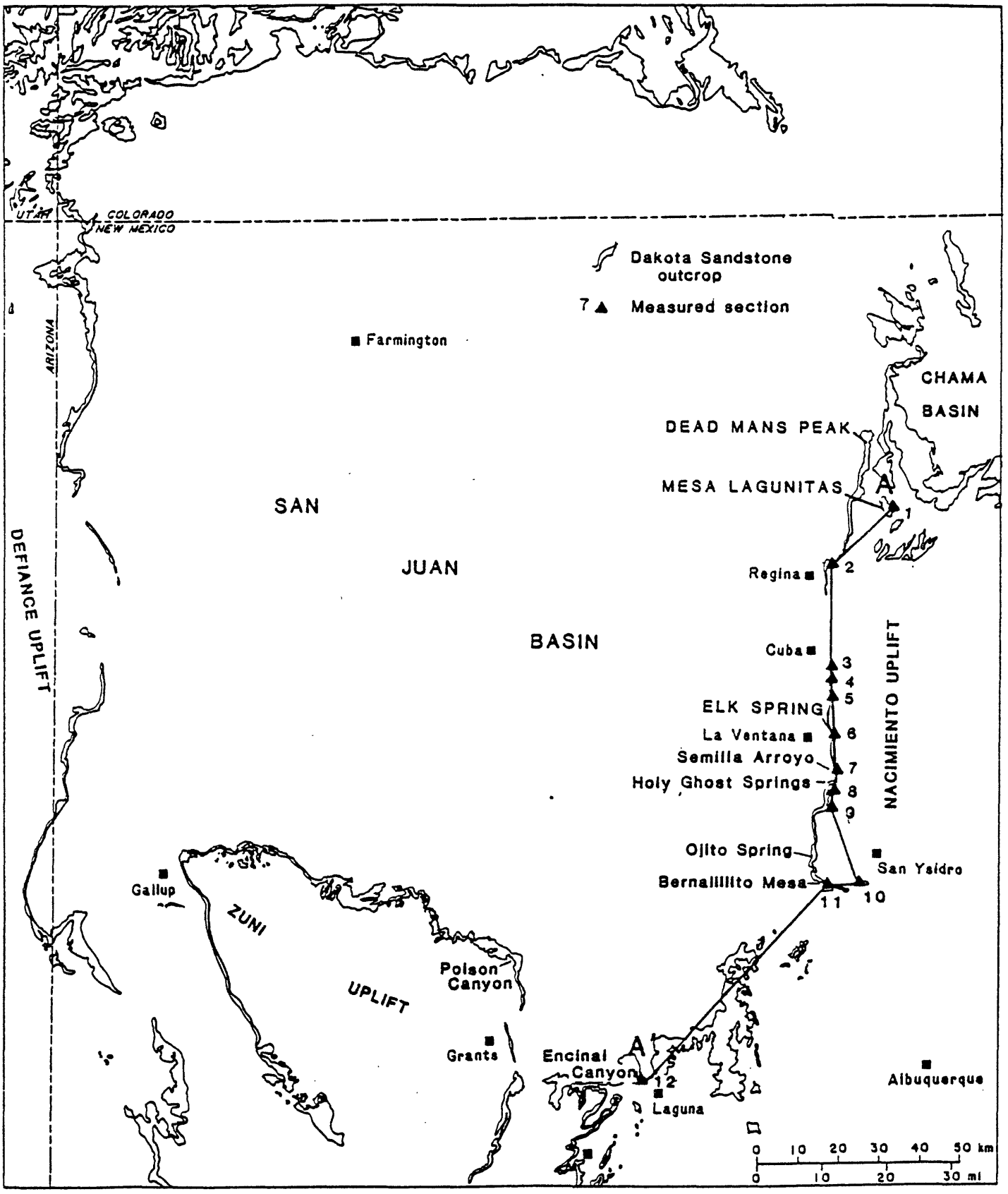

Figure 1. Index map showing location of measured sections, line of section, and study area in the eastern San Juan Basin, New Mexico

A sandstone unit similar to the Jackpile rests on the Brushy Basin mudstone unit in the northern part of the study area and is considered to be Burro Canyon Formation by most recent authors (McPeek, 1965; Saucier, 1974; Ridgley, 1977, 1979). The Burro Canyon Formation in this area is a tan, kaolinitic, fine- to medium-grained, crossbedded, fluvial, locally conglomeratic sandstone unit containing interbedded green and red claystone and siltstone. Conglomerates in the Burro Canyon are characterized by abundant tan, non-porous, somewhat earthy-looking chert. No age diagnostic fossils have been found in the unit in New Mexico. However, the unit would be Early Cretaceous in age if it correlates with the Burro Canyon Formation at its type locality in southwestern Colorado (Stokes, 1952; Tschudy and others, 1984) about 150 mi (240 km) to the northwest.

The relationship between the Jackpile sandstone and the Burro Canyon is unclear. These sandstone units are very similar lithologically and occupy essentially the same stratigraphic position; they may or may not be stratigraphic equivalents. The most noticeable difference between the units is that the Burro Canyon is commonly conglomeratic whereas the Jackpile generally lacks conglomerate, except for a few pebbles that occur locally near its base. Saucier (1974) applied the name Burro Canyon to sandstone strata between the mudstone unit of the Brushy Basin and the Dakota Sandstone as far south as La Ventana, New Mexico (fig. 1). His strongest argument for this is that the sandstone in the interval north of La Ventana is locally conglomeratic. Santos (1975) mapped the Jackpile sandstone in essentially the same stratigraphic position as Saucier's Burro Canyon as far north as Cuba about 14 m (20 km) north of La Ventana. Thus, between La Ventana and Cuba, what is basically the same stratigraphic unit has been given different names by different authors.

The Encinal Canyon Member (Aubrey, 1986, 1988) of the Dakota Sandstone forms a discontinuous unit at the base of the Dakota Sandstone. The Member rests unconformably on the Jackpile sandstone or the Burro Canyon Formation, except where it locally scours completely through the Jackpile or Burro Canyon and rests on the underlying Brushy Basin mudstone unit (pl. 1). The Encinal Canyon is generally a silvery-gray or light-brown, quartzose, fine- to medium-grained, crossbedded, fluvial sandstone that is characterized by conglomeratic beds containing abundant white, angular, chalky chert clasts and by locally abundant carbonaceous debris. The Encinal Canyon often contains thin dark-gray shale and mudstone beds. Sandstone beds in the Member are commonly clay-rich or calcite cemented. However they can also be clean and silica cemented, especially near the top of the unit. The Encinal Canyon Member probably is early Cenomanian (earliest Late Cretaceous) in age (Aubrey, 1986, 1988).

The Oak Canyon Member of the Dakota Sandstone lies directly on the Encinal Canyon Member of the Dakota Sandstone or, wherever the Encinal Canyon is absent, on the Jackpile sandstone or the Burro Canyon Formation. In the area between San Ysidro and Cuba, the Oak Canyon is composed primarily of marine shale. However, thin transgressive lag deposits of sandstone or pebbly sandstone at the base of the Oak Canyon also occur locally in this area. The marine shale contains a bentonite marker bed, approximately six inches to a foot thick that aids in correlation (pl. 1). In the area north of Cuba and in the area around Laguna, the Oak Canyon consists of continental and marginal marine as well as marine sandstone, mudstone and shale. Throughout the entire study area, the contact between the Oak Canyon and the underlying units is sharp, with little relief. This flat surface, with marine or paralic rocks

above and continental rocks below, is interpreted to be a transgressive erosion surface. An exception is at Mesa Lagunitas where possible continental rocks of the Oak Canyon overlie the fluvial Encinal Canyon and the nature of the contact less clear. However, at least locally, the contact is still sharp and planar. Where present, sandstone at the base of the Oak Canyon consists of silica-cemented grayish-orange or brown beds that form a resistant, slightly overhanging ledge above the Encinal Canyon, Burro Canyon or Jackpile sandstone units.

The Cubero Sandstone Tongue of the Dakota Sandstone is composed mostly of very fine to fine-grained sandstone that is commonly silty and contains locally abundant carbonaceous debris. It tends to form a resistant cliff between underlying shale units in the Oak Canyon Member of the Dakota Sandstone and overlying marine shales of the Mancos Shale. The Cubero Sandstone is probably of marine origin throughout most of the field area (Landis and others, 1973), except in the Mesa Lagunitas area where it was deposited in a variety of shoreline environments (Grant and Owen, 1974).

CONTACTS

The contact between the Jackpile sandstone and the underlying Brushy Basin mudstone unit is generally gradational or interfingering (Beck and others, 1980), however, in some places it is erosional. In this report, the contact is placed at the base of the lowest indurated sandstone bed of the cliff or ridge that forms the Jackpile sandstone. Poorly cemented, slope forming sandstone beds that may occur locally at the top of the mudstone unit of the Brushy Basin Member generally grade laterally or vertically into the Brushy Basin mudstone and, for stratigraphic and mapping convenience, are included in the Brushy Basin mudstone unit.

The contact between the Burro Canyon Formation of Saucier (1974) and the Brushy Basin mudstone unit is generally sharp and erosional. For instance, in the area of the Elk Spring section (section 6), the contact is sharp and there are ripup clasts of Brushy Basin locally within the lowest beds of the Burro Canyon. However, in some places, the Burro Canyon and the Brushy Basin appear to interfinger or have a gradational contact. There are sandstone beds in the upper part of the Brushy Basin mudstone unit at the top of the ridge immediately north of Elk spring (units 3-10, section 6 at Elk Spring), that resemble Burro Canyon, especially in the composition of the pebbles they contain. These beds may be a tongue of Burro Canyon in the Brushy Basin. Near Dead Mans Peak (fig. 1) north of the study area (NE 1/4 sec. 7, T. 25 N., R. 2 E.) it is possible to trace a thin sandstone unit that occurs within the green fine-grained facies of the upper part of the Brushy Basin westward into the main body of the the Burro Canyon. The contact in the Dead Mans Peak area generally is a scour surface, but appears locally to be gradational.

The base of the Encinal Canyon Member is an erosional unconformity. It forms a sharp contact with underlying units that has as much as a hundred feet of local relief. In the study area, basal Encinal Canyon beds are distinguished from those in the underlying Jackpile or Burro Canyon by their darker brown or gray color, and by the presence of carbonaceous debris, gray shale beds and clasts of white angular somewhat chalky chert.

The position of the basal contact of the Encinal Canyon member is uncertain in the Cuba section (section 3). The Encinal Canyon may include the

entire sandstone interval between the Brushy Basin mudstone and the Oak Canyon shale or, conversely, it may include only the upper half of the sandstone interval (pl. 1). Unit 19 near the base of the sandstone interval is a gray carbonaceous mudstone. Such mudstones do not generally occur in pre-Dakota rocks suggesting that the entire interval is Encinal Canyon. The stratigraphic relations are uncertain here, however, because pebbles in the pebbly sandstone (unit 17) that occurs several feet below unit 19 are more characteristic of the Burro Canyon than the Dakota, and because the gray color of the mudstone in unit 19 grades laterally into a grayish-green color that is more characteristic of the Jackpile than the Dakota. It may be that only the upper half of the interval is Encinal Canyon. Only the upper half has locally abundant carbonaceous debris, typical of the Encinal Canyon elsewhere, whereas the lower half of the sandstone appears to lack carbonaceous debris (although it is difficult to determine the presence of organic material because outcrop exposure is very poor). Unit 23, which occurs in the middle of the sandstone interval, contains abundant large, white, angular chert clasts characteristic of basal Encinal Canyon conglomerates; thus, it may be the basal Encinal Canyon unit.

The basal contact of the Oak Canyon Member is an erosional transgressive surface. This surface is sharp with little relief and is easily recognized even though a variety of facies and lithologies occur above and below it throughout the area. The erosion that occurred along this surface is the result of the migration of a high energy shoreline across the region during a time of net deposition. Therefore the surface is considered to mark a diastem within the Dakota (except where it happens to lie directly on the Burro Canyon or Jackpile) rather than an unconformity.

The base of the Cubero Sandstone Member of the Dakota Sandstone is placed at the base of the first resistant or reasonably persistent sandstone bed above the Oak Canyon Member.

METHODS

Sections were measured with a Jacob's staff and steel tape measure; median grain was estimated in the field with a hand lens. Color descriptions are from the Geological Society of America Color Chart (Goddard and others, 1979).

ACKNOWLEDGMENTS

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MEASURED SECTIONS

Section 10.--San Ysidro

[Located approximately 4 1/2 miles southwest of San Ysidro, N. Mex. (fig. 1). Measured in NE 1/4 sec. 28, T. 15 N., R. 1 E., San Ysidro 7 1/2-minute quadrangle, Sandoval County, New Mexico.]

		Thickness	
		M	F
Top of measured section.			
Dakota Sandstone (incomplete):			
Cubero Sandstone Member (incomplete):			
28.	Sandstone, quartzose, burrowed.....	unmeasured	
Oak Canyon Member:			
27.	Black shale, undescribed.....	15.2	49.9
26.	Bentonite, very pale orange (10YR8/2)	0.03	0.1
25.	Black shale, undescribed.....	1.1	3.6
24.	Bentonite, very pale orange (10YR8/2).....	0.3	0.9
23.	Black shale, undescribed.....	4.3	14.0
	Total Oak Canyon Member.....	20.9	68.5
Encinal Canyon Member:			
22.	Sandstone, very pale orange (10YR8/2) with dark-yellowish-orange (10YR6/6) staining; fine-grained, well-sorted, subrounded; moderately silica cemented; quartzose; possible burrows in top few inches.....	1.5	5.0
21.	Shaley coal with some thin sand lenses, light-gray (N7) to black (N1).....	1.7	5.5
20.	Sandstone, very light gray (N8) with dark-yellowish-orange (10R6/6) staining; faint trough crossbeds; very fine grained; moderately well sorted, subrounded; moderately silica cemented; quartzose; with plant impressions, carbonaceous layers and local pebbly layers at bottom of some scours.....	5.3	17.5

Section 10.--San Ysidro--Continued

	Thickness M	Thickness F
Dakota Sandstone:--Continued		
Encinal Canyon Member:--Continued		
19. Interbedded quartzose sandstone and coaly shale, light-gray (N7) to dark-gray (N3); medium-grained to very fine grained; moderately well to moderately sorted, subrounded; moderately clay and silica cemented.....	0.6	2.0
18. Conglomerate, light-gray (N7); fine-grained sand to pebbles 1 1/2 in. (4 cm) in length; poorly sorted, subrounded to angular; moderately clay and limonite cemented; carbonaceous debris; pebbles include white chalky chert, gray chert, black chert and quartz.....	0.2	0.5
Total Encinal Canyon Member.....	9.3	30.5
Total Dakota Sandstone (incomplete).....	30.3	99.0
Morrison Formation (incomplete):		
Jackpile sandstone:		
17. Mudstone, sandy, greenish-gray (5GY6/1); mud and very fine grained sand.....	2.0	6.5
16. Sandstone, light-greenish-gray (5GY8/1), very fine grained; moderately well sorted, subrounded; poorly clay cemented; quartzose.....	0.8	2.5
15. Sandstone, white (N9) to very pale orange (10YR8/2); faint trough crossbeds; fine-grained to very fine grained; moderately well sorted, subrounded; poorly clay cemented; quartzose; 1/4 in. (.6 cm) thick hematite stained zones at top and bottom.....	8.5	28.0
14. Mudstone, sandy, pale-olive (10Y6/2).....	0.6	2.0
13. Sandstone, very pale orange (10YR8/2) with dark-yellowish-orange (10R6/6) staining; very broad shallow troughs filled by nearly horizontal and slightly dipping beds; fine-grained to very fine grained, moderately well sorted, subrounded; moderately to poorly clay cemented; quartzose; 1/4 in. (.6 cm) thick hematite stained zone at the top.....	1.8	6.0

Section 10.--San Ysidro--Continued

		Thickness	
		M	F
Morrison Formation:--Continued			
Jackpile sandstone:--Continued			
12.	Interbedded muddy sandstone and sandstone, grayish-yellow-green (5GY7/2); mud to very fine grained sand; moderately well sorted, subrounded; poorly clay cemented.....	0.9	3.0
11.	Sandstone, very pale orange (10YR8/2); fine-grained to very fine grained; moderately well sorted, rounded to subrounded; moderately to poorly clay cemented; quartzose with less than 1 percent black accessory grains; some isolated hematite stained nodules.....	0.9	3.0
10.	Sandstone, muddy, grayish-green (5GY6/1); pinches out laterally.....	0.6	2.0
9.	Sandstone, very pale orange (10YR8/2) to grayish-orange (10YR7/4) with some pale-olive (10Y6/2); broad shallow trough crossbeds and thin tabular crossbeds; generally fine grained to very fine grained with medium and coarse grains along some cross-laminations and bedding planes; moderately well sorted, rounded to subrounded; moderately clay cemented; quartzose; grayish-olive (10Y4/2) mudstone clasts up to 1/4 in. (.6 cm) long along some bedding planes.....	3.7	12.0
8.	Sandstone, very pale orange (10YR8/2); fine-grained to very fine grained; moderately well sorted, rounded to subrounded; poorly clay cemented; quartzose; 2 in. (5 cm) thick zone of grayish-olive (10Y4/2) mudstone clasts up to 3/4 in. (2 cm) in length in the upper 1 1/2 ft (45 cm).....	0.9	3.0

Section 10.--San Ysidro--Continued

	Thickness M	Thickness F
Morrison Formation:--Continued		
Jackpile sandstone:--Continued		
7. Sandstone, very pale orange (10YR8/2) with dusky-brown (5YR2/2); bottom is trough crossbedded with troughs up to 2 ft (60 cm) thick, possible horizontal laminations in the top 1 ft (30 cm); fine-grained to very fine grained; moderately well sorted, subrounded to rounded; moderately calcite cemented; quartzose; calcareous nodules up to 1/2 in. (1.25 cm) in diameter increase in abundance toward the top.....	2.1	7.0
Total Jackpile sandstone.....	22.8	75.0
Brushy Basin mudstone unit (incomplete):		
6. Sandstone, very pale orange (10YR8/2); fine- to coarse-grained; poorly sorted, subrounded; poorly clay cemented; quartzose with less than 1 percent pink and black accessory grains.....	3.0	10.0
5. Mudstone, sandy, grayish-olive (10Y4/2); mud and very fine grained sand.....	0.2	0.5
4. Sandstone, grayish-orange (10YR7/4) to very pale orange (10YR8/2); medium-grained to very fine grained; moderately well to poorly sorted, subrounded; poorly clay cemented.....	1.2	4.0
3. Mudstone, grayish-olive (10Y4/2).....	0.2	0.5
2. Sandstone, very pale orange (10YR8/2); very fine grained; moderately well sorted, subrounded; poorly clay cemented, quartzose with less than 1 percent pink and black accessory grains.....	0.8	2.5
1. Sandy mudstone, grayish-olive (10Y4/2); mud and very fine grained sand.....	0.8	2.5
Total Brushy Basin Member mudstone unit (incomplete).....	6.2	20.0
Total Morrison Formation (incomplete).....	29.0	95.0

Section 9.--Zia Section

[Located on the northeast side of Highway 44 approximately 11 miles north-northwest of San Ysidro, N. Mex. (fig. 1). Measured in S 1/2 sec. 26, T. 17 N., R. 1 W., Holy Ghost Spring 7 ½-minute quadrangle, Sandoval County, New Mexico.]

	Thickness	
	M	F
Top of measured section (present erosion surface).		
Morrison Formation (incomplete):		
Jackpile sandstone:		
22. Interbedded sandstone and pebbly sandstone, very light gray (N8) with moderate-reddish-brown (10R4/6) and pale-yellowish-orange (10YR8/6) staining; trough crossbedded; laterally asymmetrical channels and large symmetrical channels occur along the basal surface containing troughs up to 4 ft (120 cm) thick at the base and 1 ft (30 cm) thick at the top, the basal surface is scoured with up to 10 ft (3.3 m) of relief; medium-grained sand to pebbles up to 3/4 in. (2 cm) in length; moderately well to poorly sorted, subrounded to angular; moderately clay and silica cemented [lateral to the section there are extensive layers of weathered calcite cemented nodules up to 2 ft (60 cm) thick, nodules are up to 3 in. (7.5 cm) in diameter but are generally less than 1 1/2 in. (4 cm) in diameter]; quartzose; pebbles include rounded to angular white chalky chert, gray chert, black chert and red chert; there are abundant quartz granules.....	3.0	10.0
21. Interbedded mudstone and sandstone, light-gray (N7) to very light gray (N8) with pale-yellowish-orange (10YR8/6) staining (sandstone), pale-olive (10YR6/2) (mudstone); fine-grained to medium-grained; moderately well sorted, subrounded; poorly clay cemented; quartzose with less than 1 percent pink and black accessory grains; partly covered with at least three mudstone layers one at the base, one near the middle and one near the top.....	3.0	10.0

Section 9.--Zia Section--Continued

	Thickness	
	M	F
Morrison Formation:--Continued		
Jackpile sandstone:--Continued		
20. Sandstone, very pale orange (10YR 8/2) with pale-yellowish-orange (10YR8/6); trough crossbeds; generally fine grained to very fine grained with some fine- to coarse-grained poorly sorted zones up to 2 ft (60 cm) thick; moderately well sorted, subrounded; moderately to poorly clay and silica cemented; quartzose; grayish-olive (10Y4/2) sandy mudstone clasts up to 6 in. (15 cm) in length are present near the basal surface.....	4.6	15.0
19. Interbedded sandstone, pebbly sandstone and sandy conglomerate, very pale orange (10YR8/2) and pale-yellowish-orange (10YR8/6); probable scour and fill structures with scours up to 5 ft (1.5 m) deep and troughs up to 6 in. (15 cm) thick within scour fill, some scour fill appears massive; fine-grained sand to pebbles up to 1 in. (2.5 cm) in length; poorly to moderately sorted, subrounded to angular; moderately to poorly clay and silica cemented; pebbles include white angular chert, quartz, gray chert and black chert up to 1 1/2 in. (4 cm) in length and grayish-yellow-green (5GY7/2) sandy mudstone clasts up to 1 in. (2.5 cm) in length; dusky-yellow-green (5GY5/2) mudstone lenses occur locally in the top 2 ft (60 cm).....	3.0	10.0
18. Sandstone, grayish-yellow (5Y8/4) with some moderate-red (5R5/4) in the bottom 5 ft (1.5 m); probable trough crossbeds up to 6 in. (15 cm) thick, possible horizontal beds in the top 5 ft (1.5 m) with trails and/or small horizontal burrows on some bedding surfaces; fine-grained to very fine grained; moderately well sorted, subrounded; moderately to poorly clay and silica cemented; quartzose with less than 1 percent black accessory grains; a few thin lenses of pale olive (10Y6/2) mudstone occur in top 5 ft (1.5 m).....	4.6	15.0
17. Sandstone, moderate-orange-pink (10R7/4); fine-grained to very fine grained; moderately sorted, subrounded; poorly clay cemented; quartzose with less than 1 percent accessory black grains.....	1.5	5.0

Section 9.--Zia Section--Continued

		Thickness M	Thickness F
Morrison Formation:--Continued			
Jackpile sandstone:--Continued			
16.	Mudstone, sandy, pale-olive (10Y6/2), very fine grained sand.....	0.3	1.0
15.	Sandstone, moderate-orange-pink (10R7/4) to pale-reddish-brown (10R5/4); trough crossbeds up to 1 1/2 ft (45 cm) thick; fine- to medium-grained; moderately well sorted, subrounded; moderately to poorly clay and silica cemented; quartzose; 6 in. (15 cm) conglomeratic zone containing grayish-yellow-green (5GY7/2) mudstone clasts up to 1 1/2 in. (4 cm) in length located along basal surface.....	5.5	18.0
14.	Sandstone, moderate-pink (5R7/4) to moderate-red (5R5/4); massive to trough crossbeds up to 6 in. (15 cm) thick with possible occasional ripples; fine-grained to very fine grained; moderately well sorted, subrounded; quartzose; moderately clay and silica cemented.....	1.5	5.0
13.	Interbedded sandstones and pebbly sandstone; moderate-red (5R5/4) to moderate-reddish-orange (10R6/6); large trough crossbeds up to 2 ft (60 cm) thick; fine- to medium-grained sand with scattered pebbles; moderately to poorly sorted, subangular to subrounded; moderately clay and silica cemented; pebbles include light-greenish-gray (5GY8/1) mudstone clasts.....	1.5	5.0
12.	Interbedded sandstones, pebbly sandstones and conglomerates, very pale green (10G8/2) to moderate-pink (5R7/4) with pale-yellowish-orange (10YR8/6) staining; scour and fill structures with scours up to 6 ft (1.8 m) deep and occasional trough crossbeds up to 6 in. (15 cm) thick; very fine grained sand to pebbles up to 2 in. (5 cm) in length; moderately well to poorly sorted; angular to subrounded; moderately calcite and clay cemented; pebbles black, gray and tan smooth chert, white angular chalky chert and quartz up to 1 in. (2.5 cm) in length and light-greenish-gray (5GY8/1) mudstone clasts up to 2 in. (5 cm) in length.....	2.3	7.5
	Total Jackpile sandstone.....	30.8	101.5

Section 9.--Zia Section--Continued

		Thickness	
		M	F
Morrison Formation:--Continued			
Jackpile sandstone:--Continued			
Brushy Basin mudstone unit (incomplete):			
11.	Mudstone, sandy, grayish-olive-green (5GY3/2) and grayish-olive (10Y4/2).....	3.7	12.0
10.	Mudstone, grayish-olive (10Y4/2).....	0.3	1.0
9.	Sandstone, very pale orange (10YR8/2); trough crossbedded, troughs up to 6 in. (15 cm) thick; fine- to very fine grained; moderately well sorted, subrounded; poorly clay cemented; quartzose with less than 1 percent black and green accessory grains.....	2.0	6.5
8.	Mudstone, grayish-olive (10Y4/2).....	0.6	2.0
7.	Mudstone, sandy, grayish-olive (10Y4/2), very fine grained sand.....	1.2	4.0
6.	Sandstone, muddy, pale-olive (10Y6/2), slightly calcareous, very fine grained sand and mud.....	0.2	0.5
5.	Mudstone, light-olive-gray (5Y5/2).....	0.5	1.5
4.	Siltstone, grayish-olive-green (5GY3/2).....	0.9	3.0
3.	Mudstone, dusky-yellow-green (5GY5/2).....	0.2	0.6
2.	Limestone nodules, light-olive-gray (5Y6/1).....	0.1	0.3
1.	Clinoptiolitic mudstone, moderate-reddish-brown (10R4/6) and grayish-olive (10Y4/2).....	0.6	2.0
	Brushy Basin mudstone unit (incomplete).....	10.3	33.4
	Total Morrison Formation (incomplete).....	41.1	134.9

Section 8.--Holy Ghost Springs

[Located near Holy Ghost Spring. Measured in N 1/2 sec. 11, T. 17 N., R. 1 W., Holy Ghost Spring 7 1/2-minute quadrangle, Sandoval County, New Mexico (fig. 1).]

		Thickness	
		M	F
Top of measured section.			
Dakota Sandstone (incomplete):			
Cubero Sandstone Member (incomplete):			
25.	Sandstone, quartzose.....unmeasured		
Oak Canyon Member:			
24.	Shale, black, mostly covered.....	4.8	15.8
23.	Bentonite, medium-gray (N5).....	0.1	0.2
22.	Shale, black, mostly covered.....	0.75	2.5
21.	Bentonite, yellowish-gray (5Y8/1).....	0.2	0.5
20.	Shale, black, mostly covered.....	4.2	13.9
19.	Bentonite, yellowish-gray.....	0.03	0.1
18.	Shale, black, mostly covered.....	1.5	5.0
	Total Oak Canyon Member.....	11.6	38.0
Possible Encinal Canyon Member of the Dakota Sandstone:			
17.	Interbedded sandy conglomerates and sandstones, white (N9) to very light gray (N8) with medium-gray (N4) and dark-yellowish-orange (10YR6/6) staining; possible trough crossbeds; fine-grained sand to pebbles up to 3 in. (7.5 cm) in length; poorly to moderately sorted, subrounded to subangular; moderately clay and silica cemented; quartzose; pebbles include white chalky chert, gray, red and black smooth chert and light-gray sandstone clasts; a light-gray (N7) sandy siltstone lens 2 ft (60 cm) long occurs at the base.....	2.4	8.0
	Total Possible Encinal Canyon Member.....	2.4	8.0
	Total Dakota Formation (incomplete).....	14.0	46.0

Section 8.--Holy Ghost Springs--Continued

		Thickness	
		M	F
Morrison Formation (incomplete):			
Jackpile sandstone:			
16.	Sandstone, white (N9) with medium-gray (N4) and dark-yellowish-orange (10YR6/6); trough crossbeds up to 2 ft (60 cm) deep at the base decrease upward to 6 in. (15 cm) at the top; fine- to coarse-grained, moderately to poorly sorted; moderately clay and silica cemented; quartzose; contains limonite stained hollow nodules.....	6.1	20.0
15.	Pebbly sandstone, white (N9) with medium-gray (N4) and dark-yellowish-orange (10YR6/6) staining; fine sand to pebbles up to 1 1/2 in. (4 cm) in length; poorly sorted, subrounded to subangular; moderately clay and silica cemented; quartzose with less than 1 percent pink and black accessory grains; pebbles include red, tan and gray chert clasts.....	0.6	2.0
14.	Sandstone, white (N9) with medium-gray (N5) and dark-yellowish-orange (10YR6/6) staining; large 6 ft (1.8 m) deep trough crossbeds at the base decreasing upward to troughs 1 1/2 ft (45 cm) deep at the top; fine- to medium-grained; moderately well sorted, subrounded, moderately clay and silica cemented; quartzose; contains limonite stained hollow nodules.....	5.2	17.0
13.	Sandstone, white (N9) with medium-gray (N5) and dark-yellowish-orange (10YR6/6) staining; slightly dipping (less than five degrees) parallel beds; fine-grained; moderately well sorted, subrounded; moderately clay and silica cemented; quartzose with less than 1 percent pink and black accessory grains; contains limonitic stained nodules which are hollow at their centers.....	4.3	14.0
12.	Sandstone, white (N9) with medium-gray (N5) and dark-yellowish-orange (10YR6/6) staining; fine- to coarse-grained; poorly sorted, subrounded; moderately clay and silica cemented; quartzose; cavities up to 1 1/2 in. (4 cm) in length which may represent weathered out clay clasts.....	0.3	1.0

Section 8.--Holy Ghost Springs--Continued

		Thickness	
		M	F
Morrison Formation:--Continued			
Jackpile sandstone:--Continued			
11.	Covered interval, generally white (N9) to very pale orange (10YR8/2) and more rarely pale-olive (10Y6/2) to grayish-olive (10Y4/2) sandstone; mudstone and sandy mudstone lenses in the bottom few feet; mudstones were observed in outcrop about 100 ft (30 m) southwest of measured section, however, lateral reconnaissance of float, soil and rare outcrops indicate most of the interval is covered sandstone.....	8.5	28.0
10.	Sandstone, very pale orange (10YR8/2) to dark-yellowish-orange (10YR6/6); possible trough crossbeds up to 1 1/2 ft (45 cm) thick; fine- to medium-grained; moderately well sorted, subrounded; moderately clay and silica cemented with local zones of calcite cement; quartzose with less than 1 percent pink and black accessory grains; light-greenish-gray (5GY8/1) mudstone clasts up to 4 in. (10 cm) in length along basal surface; intensity of limonitic staining increases upward.....	4.0	13.0
9.	Sandstone, white (N9) with medium-gray (N4), moderate-reddish-orange (10R6/6) and dark-yellowish-orange (10YR6/6) staining; trough crossbeds up to 3 ft (90 cm) thick; fine-grained; moderately well sorted, subrounded; moderately clay and silica cemented; quartzose with less than 1 percent pink, gray, black and rusty black accessory grains.....	2.4	8.0
8.	Sandstone, white (N9) with medium-light-gray (N6) and grayish-orange (10YR7/4) staining; broad trough crossbeds up to 1 1/2 ft (45 cm) thick; fine- to medium-grained; moderately well sorted, subrounded; moderately clay and (minor) calcite cemented; quartzose; clay clasts up to 1/4 in. (.6 cm) in length occur locally along some bedding surfaces.....	6.1	20.0

Section 8.--Holy Ghost Springs--Continued

	Thickness	
	M	F
Morrison Formation:--Continued		
Jackpile sandstone:--Continued		
7. Sandstone, white (N9) with medium-gray (N5) and pale-yellowish-orange (10YR8/6) staining; broad trough crossbeds up to 1 1/2 ft (45 cm) thick; fine-grained; moderately well sorted, subrounded; moderately calcite cemented; quartzose with less than 1 percent pink, black and rusty black accessory grains; weathered, calcite cemented nodules up to 3 in. (7.5 cm) in diameter superimposed on trough crossbeds.....	4.6	15.0
6. Sandstone, white (N9) with medium-gray (N4) and dark-yellowish-orange (10YR6/6) staining; broad trough crossbeds up to 4 ft (1.2 m) thick; fine-grained; moderately well sorted, subrounded; moderately clay and silica cemented; quartzose with less than 1 percent pink and black accessory grains.....	4.3	14.0
5. Sandstone, white (N9); thin discontinuous horizontal laminations containing grayish-yellow-green (5GY7/2) mudstone clasts; fine- to medium-grained; moderately sorted; subrounded; poorly calcite cemented; quartzose with less than 1 percent pink, black and rusty black accessory grains.....	0.3	1.0
4. Sandstone, white (N9) with pale-yellowish-orange (10YR8/6) and medium-gray (N5) staining; trough crossbeds up to 4 ft (1.2 cm) thick; fine-grained to very fine grained; well-sorted, subrounded; moderately calcite cemented; quartzose with less than 1 percent black, pink, green and rusty black accessory grains.....	0.6	2.0
3. Sandstone, white (N9) with yellowish-gray (5Y8/1), very pale orange (10YR8/2) and medium-gray (N4) staining; horizontal laminations; fine-grained to very fine grained; moderately well sorted, subrounded; moderately calcite cemented; quartzose with less than 1 percent pink, gray and black grains and rusty black accessory grains.....	0.9	3.0

Section 8.--Holy Ghost Springs--Continued

	Thickness	
	M	F
Morrison Formation:--Continued		
Jackpile sandstone:--Continued		
2. Sandstone, white (N9) with pale-yellowish-orange (10YR8/6) and medium-gray (N4) staining; broad troughs up to 1 1/2 ft (45 cm) thick; fine- to medium-grained; moderately well sorted, subrounded; moderately calcite cemented; quartzose with less than 1 percent pink and rusty black accessory grains.....	0.9	3.0
Total Jackpile sandstone.....	49.1	161.0
Brushy Basin Member mudstone unit incomplete:		
1. Mudstone, grayish-olive-green (5GY3/2).....	0.3	1.0
Total Brushy Basin mudstone unit (incomplete).....	0.3	1.0
Total Morrison (incomplete).....	49.7	163.0

Section 7.--Semilla Arroyo Section

[Located on hogback north of Arroyo Semilla. Measured in SE 1/4 sec. 25, T. 18 N., R. 1 W., La Ventana 7 1/2-minute quadrangle, Sandoval County, New Mexico (fig. 1).]

		Thickness	
		M	F
Top of measured section.			
Dakota Sandstone (incomplete):			
Cubero Sandstone Member (incomplete):			
28.	Sandstone, quartzose, light-gray to pale-orange.....unmeasured		
Oak Canyon Member:			
27.	Shale, black, mostly covered.....	3.9	12.9
26.	Bentonite, grayish-orange-pink (5YR7/2).....	0.03	0.1
25.	Shale, black, mostly covered.....	1.3	4.3
24.	Bentonite, grayish-yellow (5Y8/4).....	0.2	0.6
23.	Shale, black, mostly covered.....	5.8	19.0
22.	Pebbly sandstone, moderate-orange-pink (10R7/4); fine-grained sand to pebbles up to 1 1/2 in. (4 cm) in length; poorly sorted, subrounded; moderately silica cemented; slightly carbonaceous at the top; quartzose; pebbles include black chert, gray chert, white angular chalky chert and red quartzite; burrowed.....	0.9	3.0
	Total Oak Canyon Member.....	12.1	39.9
	Total Dakota (incomplete).....	12.1	39.9
Morrison Formation:			
Jackpile sandstone (?):			
21.	Sandstone, moderate-orange-pink (10R7/4), fine- to coarse-grained; faintly crossbedded; poorly sorted, subrounded; moderately calcite cemented; quartzose.....	0.5	1.5
20.	Mudstone, sandy, yellowish-gray (5Y7/2) to moderate-orange-pink (10R7/4), very fine grained sand and mud.....	1.5	5.0

Section 7.--Semilla Arroyo Section--Continued

		Thickness	
		M	F
Morrison Formation:--Continued			
Jackpile sandstone:--Continued			
19.	Pebbly sandstone, moderate-reddish-brown (10R4/6), pale-yellowish-orange (10YR8/6) and dark-yellowish-orange (10YR6/6); fine sand to pebbles up to 1/2 in. (1.25 cm) in length; poorly sorted, subrounded; moderately silica cemented; quartzose; granules include quartz; pebbles include white, black and gray chert, pink quartzite and green claystone clasts.....	0.8	2.5
18.	Mudstone, sandy, dusky-yellow-green (5GY5/2), very fine sand and mud.....	1.2	4.0
17.	Sandstone, moderate-pink (5R7/4), moderate-red (5R4/6) and dark-yellowish-orange (10YR6/6) staining; fine grained; moderately well sorted, subrounded; poorly clay and (minor) calcite cemented with lenses that are moderately silica cemented; quartzose.....	1.5	5.0
16.	Sandstone, moderate-orange-pink (5YR8/2) with pale-yellowish-orange (10YR8/6) staining; trough crossbeds up to 1 1/2 ft (45 cm) thick; fine-grained; moderately well sorted, subrounded; moderately to poorly calcite cemented; quartzose with less than 1 percent black accessory grains; weathered out yellowish-gray (5Y7/2) clay clasts up to 1/2 in. (1.25 cm) in length along some scour surfaces.....	3.0	10.0
15.	Sandstone, grayish-orange-pink (10R8/2) with pale-yellowish-orange (10YR8/6) and grayish-brown (5YR3/2); broad trough crossbeds up to 2 ft (60 cm) thick; fine-grained; moderately well sorted, subrounded; moderately calcite and silica cemented; quartzose with less than 1 percent black accessory grains.....	2.1	7.0
14.	Mudstone, sandy, dusky-yellow-green (5GY5/2) to grayish-olive-green (5GY3/2).....	1.5	5.0

Section 7.--Semilla Arroyo Section--Continued

	Thickness	
	M	F
Morrison Formation:--Continued		
Jackpile sandstone:--Continued		
13. Sandstone, moderate-orange-pink (10R7/4) to grayish-orange-pink (10R8/2) with pale-yellowish-orange (10YR8/6) staining; trough crossbeds up to 1 1/2 ft (45 cm) thick; fine- to coarse-grained; moderate to poorly sorted, subrounded to subangular; moderately to poorly calcite and clay cemented; quartzose with less than 1 percent green and rusty black accessory grains; zones of weathered calcite-cemented nodules up to 6 in. (15 cm) in diameter; abundance of nodules increases towards the top.....	4.6	15.0
12. Sandstone, grayish-orange-pink (10R8/2); trough crossbeds up to 1 ft (30 cm) thick; fine-grained; moderately well sorted, subrounded; moderately calcite cemented; quartzose with less than 1 percent black accessory grains; local coarse sand and granule zones, generally coarsens upwards.....	0.8	2.5
11. Sandstone, pinkish-gray (5YR8/1); possible trough crossbeds up to 3 ft (90 cm) thick with possible ripples; fine-grained to very fine grained; moderately well sorted, subrounded; moderately calcite cemented; quartzose with less than 1 percent pink, black and green accessory grains; conglomeratic at the base with pebbles up to 1/2 in. (1.25 cm) in length.....	0.8	2.5
10. Sandstone, white (N9) with grayish-orange-pink (5YR7/2) and pale-yellowish-orange (10YR8/6); ripples (possibly some climbing ripples) amplitude about 3/10 in. (.75 cm) and wavelength 3 to 4 in. (.75 to 10 cm); fine-grained; well sorted, subrounded; moderately calcite and clay cemented; quartzose less than 1 percent pink, black and green accessory grains.....	2.7	9.0

Section 7.--Semilla Arroyo Section--Continued

	Thickness M	Thickness F
Morrison Formation:--Continued		
Jackpile sandstone:--Continued		
9. Sandstone with local thin [1-2 in. (2.5 to 5cm) thick] sandy conglomerates; very light gray (N8) to moderate-brown (5YR3/4) and dusky-brown (5YR2/2); massive to faintly crossbedded with possible occasional ripples; fine-grained sand to pebbles up to 1 1/4 in. (3 cm) in length; moderately to poorly sorted, subrounded; strongly calcite and silica cemented, exhibits quartz overgrowths; quartzose with less than 1 percent pink, black, green, brown and rusty black accessory grains; pebbles include abundant white chalky and smooth chert, abundant gray vuggy, black, and red chert and green clay clasts, and some quartzite clasts; silicified log at base is 1 ft (30 cm) in diameter by at least 30 in. (75 cm) in length, partially weathered out clay clasts up to 6 in. (15 cm) long and 2 in. (5 cm) thick also occur at the base.....	3.0	10.0
Total Jackpile sandstone (?).....	24.0	79.0
Brushy Basin Member mudstone unit (incomplete):		
8. Mudstone and muddy sandstone, grayish-olive (10Y4/2).....	0.6	2.0
7. Sandstone, pale-yellowish-green (10GY7/2); very fine grained; moderately well sorted, subrounded; poorly clay cemented; quartzose with less than 1 percent pink accessory grains.....	0.2	0.5
6. Mudstone, grayish-olive-green (5GY3/2) with dark-yellowish-orange (10YR6/6) staining.....	0.5	1.5
5. Mudstone, sandy, grayish-olive-green (5GY3/2); very fine grained sand and mud.....	0.6	2.0
4. Sandstone, muddy, grayish-olive (10Y4/2) to pale-olive (10Y6/2), very fine grained sand and mud.....	0.3	1.0
3. Sandstone, grayish-olive (10Y4/2) to pale-olive (10Y6/2); very fine grained; moderately well sorted, subrounded; poorly clay cemented; quartzose with less than 1 percent pink and black accessory grains.....	0.3	1.0

Section 7.--Semilla Arroyo Section--Continued

	Thickness	
	M	F
Morrison Formation:--Continued		
Brushy Basin Member mudstone:--Continued		
2. Mudstone, yellowish-gray (5Y8/1) with dark-yellowish-orange (10YR6/6) staining.....	0.2	0.5
1. Mudstone, dusky-yellow-green (5GY5/2).....	0.5	1.5
Total Brushy Basin mudstone unit (incomplete).....	3.2	10.0
Total Morrison (incomplete).....	27.2	89.0

Section 6.--Elk Spring Section

[Located near Elk Spring. Measured in S 1/2 sec. 36, T. 19. N., R. 1 W., La Ventana 7 1/2-minute quadrangle, Sandoval County, New Mexico (fig. 1).]

	Thickness	
	M	F
Top of measured section.		
Dakota Sandstone (incomplete):		
Cubero Sandstone Member (incomplete):		
33. Sandstone, mostly covered, burrowed.....unmeasured		
Oak Canyon Member:		
32. Shale, black, mostly covered with possible thin bentonite bed between 15 and 20 ft (4.5-6 m) above base.....	15.2	50.0
Total Oak Canyon Member.....	15.2	50.0
Encinal Canyon Member:		
31. Sandstone, very pale orange (10YR8/2) to grayish-orange (10YR7/4) with dark-yellowish-orange (10YR6/6) staining;, trough crossbedded; fine- to medium-grained; moderately well sorted, subrounded; moderately clay and silica cemented; quartzose; limonitic plant impressions include cast of a log 6 in. (15 cm) in diameter and at least 3 ft (90 cm) in length.....	1.2	4.0
30. Sandstone and pebbly sandstone, light-gray (N7) with dark-yellowish-orange staining (10YR6/6); trough crossbeds are up to 1 ft (30 cm) thick; fine-grained sand to pebbles up to 1 1/2 in. (4 cm) in length; moderately to poorly sorted, subrounded to angular; moderately to poorly clay and silica cemented; quartzose; commonly contains coarse grains and granules of chalky chert; pebbles contain white to tan, angular to subrounded chalky chert, gray chert and light-gray (N7) siltstone clasts; carbonaceous debris is scattered throughout and concentrated along some bedding planes; scour surface at base is up to 1 1/2 ft (45 cm) deep.....	1.5	5.0
Total Encinal Canyon Member.....	2.7	9.0
Total Dakota Sandstone (incomplete).....	17.9	59.0

Section 6.--Elk Spring Section--Continued

		Thickness	
		M	F
Morrison Formation (incomplete):			
Jackpile sandstone (?):			
29.	Sandstone, moderate-pink (5R7/4); contains broad trough crossbeds up to 2 ft (60 cm) thick, thin tabular (?) beds and broad shallow crossbeds; fine-grained; moderately well to well sorted, subrounded; moderately clay and silica cemented; quartzose.....	5.2	17.0
28.	Conglomerate and pebbly sandstone, very pale orange (10YR8/2) with moderate-reddish-brown (10R4/6) staining; massive; fine-grained sand to pebbles up to 3/4 in. (2 cm) in length; poorly sorted, subrounded to angular; moderately silica and clay cemented; quartzose; pebbles consist of pale-olive (10Y6/2) mudstone clasts up to 1/4 in. (.6 cm) in length and gray, black, tan, and reddish-brown chert, milky quartz and tan to white chalky chert up to 3/4 in. (2 cm) in length; scour at base is up to 3 ft (90 cm) deep.....	0.9	3.0
28.	Sandstone, very pale orange (10YR 8/2) to white (N9); discontinuous nearly parallel laminations that appear to form broad troughs; fine-grained to very fine grained; moderately well sorted, subrounded; moderately clay and silica cemented; quartzose with less than 1 percent rusty black accessory grains.....	1.5	5.0
27.	Sandstone, partly covered, grayish-orange-pink (10R8/2) to moderate-red (5R5/4); fine- to very fine grained; moderately well sorted, subrounded; poorly clay cemented; quartzose; contains thin zones of pale-olive (10Y6/2) mudstone clasts which are up to 1/8 in. (.3 cm) in length.....	0.9	3.0
26.	Mudstone, dusky-yellow-green (5GY5/2) [contains thin layers of sandstone approximately 1 in. (2.5 cm) thick at 3 1/2 ft (1 m), 4 ft (1.2 m) and 5 ft (1.5 m) above the base of the unit which are pale-pink (5RP8/2) to grayish-red-purple (5RP4/2); moderately well sorted, subrounded; moderately silica cemented with some clay matrix; quartzose].....	2.1	7.0

Section 6.--Elk Spring Section--Continued

		Thickness	
		M	F
Morrison Formation:--Continued			
Jackpile Sandstone:--Continued			
25.	Sandstone, grayish-pink (5R8/2) with moderate-red (5R5/6) staining; faint crossbeds; medium-grained to very fine grained; moderately to poorly sorted, subrounded; poorly clay and silica cemented; quartzose with less than 1 percent gray accessory grains; top 1/4 in. (.6 cm) is limonite cemented.....	0.8	2.5
23.	Interbedded sandy mudstone and sandstone, grayish-yellow-green (5GY7/2); very fine grained sand and mud; partly covered.....	2.1	7.0
22.	Covered.....	3.0	10.0
21.	Sandstone, very pale orange (10YR8/2) to moderate-orange-pink (5YR8/4); faintly crossbedded; fine- to medium-grained; moderately sorted, subrounded; moderately to poorly silica cemented; quartzose; several zones of yellowish-gray (5Y8/1) mudstone clasts up to 1/2 in. (1.25 cm) long.....	2.1	7.0
20.	Sandstone, very pale orange (10YR8/2) to moderate-orange-pink (5YR8/4); broad trough crossbeds up to 3 ft (90 cm) thick, ripples also occur at the top of this unit approximately 300 yards south of the measured section; fine- to medium-grained; moderately sorted, subrounded; strongly silica cemented, trace of clay; quartzose.....	3.8	12.5
19.	Pebbly sandstone, very pale orange (10YR8/2) to moderate-reddish orange (10R6/6); very fine grained sand to pebbles up to 3/4 in. (2 cm) in length; poorly sorted, subrounded to subangular; strongly silica cemented, trace of clay; quartzose; pebbles include white and reddish brown chert.....	0.3	1.0
18.	Sandstone, very pale orange (10YR8/2) to moderate-orange-pink (5YR8/4); massive; fine- to medium-grained; well-sorted, subrounded; strongly silica cemented, trace of clay; quartzose.....	3.0	10.0

Section 6.--Elk Spring Section--Continued

	Thickness M	Thickness F
Morrison Formation:--Continued		
Jackpile sandstone:--Continued		
17. Interbedded conglomerates and pebbly sandstones, white (N9) to very light gray (N8) with moderate-reddish-brown (10R4/6) staining; massive to trough crossbedded; very fine grained sand to pebbles up to 1 3/4 in. (4.5 cm) in length; poorly to moderately sorted, subrounded to angular; moderately clay, silica and calcite cemented; pebbles include white and tan angular chert (some fossiliferous), tan smooth chert, gray vuggy chert, black chert, reddish-brown chert.....	2.0	6.5
16. Sandstone, dark-reddish-brown (10R3/4) and very pale orange (10YR8/2); broad trough crossbeds up to 2 ft (60 cm) thick; fine- to coarse-grained; moderate to poorly sorted, subrounded; moderately clay cemented with lenses of calcite cement; quartzose.....	1.5	5.0
Total Jackpile sandstone (?).....	29.2	96.5
Conglomeratic sandstone unit in upper part of the Brushy Basin mudstone unit (?):		
15. Mudstone, dusky-yellow-green (5GY5/2), dark-reddish-brown (10R3/4), partly covered.....	3.0	10.0
14. Sandstone, moderate-red (5R5/4), very pale orange (10YR8/2), and moderate-orange-pink (10R7/4); fine-grained to very fine grained; moderately well sorted, subrounded; moderately clay cemented; quartzose with less than 1 percent black accessory grains.....	0.9	3.0
13. Mudstone, dusky-yellow-green (5GY5/2).....	1.5	5.0
12. Sandstone, moderate-red (5R5/4); fine-grained to very fine grained; moderately well sorted, subrounded; moderately clay and silica cemented, quartzose.....	0.9	3.0
11. Mudstone, sandy, grayish-yellow-green (5GY7/2); very fine sand with mud; partly covered.....	2.1	7.0

Section 6.--Elk Spring Section--Continued

		Thickness	
		M	F
Morrison Formation:--Continued			
Conglomeratic sandstone unit in upper part of the			
Brushy Basin mudstone unit (?):--Continued			
10.	Sandstone, grayish-red (10R4/2); fine- to medium-grained; moderately sorted, subrounded; moderately clay and silica cemented; quartzose with less than 1 percent white accessory grains (clay nests).....	2.4	8.0
9.	Sandstone, moderate-reddish-orange (10R6/6) to moderate-orange pink (5YR8/2); trough crossbeds up to 8 in. (20 cm) thick; fine- to coarse-grained with some pebbles up to 1/2 in. (1.24 cm) in length in the bottom 6 in. (15 cm); moderately well to poorly sorted, subrounded; moderately clay and silica cemented; quartzose with less than 1 percent black accessory grains; scours at base up to 3 ft (90 cm) deep.....	2.3	7.5
8.	Sandstone, pale-reddish-brown (5R5/4); faintly crossbedded (discontinuous wavy beds); fine- to medium-grained; moderately well sorted, subrounded; moderately clay and silica cemented; quartzose.....	0.5	1.5
7.	Sandstone, light-brown (5YR6/4); faint trough crossbeds; medium-grained to very fine grained; moderately sorted, subrounded; moderately clay, silica and calcite cemented with abundant calcareous nodules; quartzose.....	0.3	1.0
6.	Sandstone, grayish-orange (10YR7/4) to moderate reddish-orange (10R6/6); parallel laminations; very fine grained; well-sorted, subrounded; moderately clay and silica cemented; quartzose with less than 1 percent black accessory grains.....	0.2	0.5
5.	Sandstone, grayish-orange (10YR7/4); trough crossbedded with troughs up to 6 in. (30 cm) thick; medium-grained to very fine grained; moderately sorted, subrounded to rounded; moderately clay and silica cemented with some calcite cemented nodules up to 3/4 in. (2 cm) in length; quartzose with some clay nests and less than 1 percent, gray and black accessory grains.....	0.6	2.0

Section 6.--Elk Spring Section--Continued

	Thickness M	Thickness F
Morrison Formation:--Continued		
Conglomeratic sandstone unit in upper part of the Brushy Basin mudstone unit:--Continued		
4. Conglomerate, medium gray (N6), yellowish-gray (5Y8/1) and pale-yellowish-orange (10YR8/6); massive to trough crossbedded; fine-grained sand to pebbles up to 1 in. (2.5 cm) in length; poorly sorted, subrounded to angular; poorly to moderately clay and silica cemented; quartzose; pebbles include pale-yellowish-orange and white angular chert, gray chert, black chert, quartz, reddish-brown chert, tan chert and grayish-yellow-green (5GY7/2) mudstone clasts.....	1.2	4.0
3. Pebbly sandstone, mottled very light gray (N8), medium-dark-gray (N4), moderate-red (5R4/6), and dark-yellowish-orange (10YR6/6); fine-grained sand to pebbles up to 1/2 in. (1.25 cm) in length; poorly sorted, subrounded; poorly clay cemented; quartzose; pebbles include quartz, gray and white chert and clay clasts.....	0.5	1.5
Total conglomeratic sandstone unit in upper part of Brushy Basin mudstone unit (?).....	16.4	54.0
Brushy Basin mudstone unit (incomplete):		
2. Sandstone, muddy, pale-olive (10Y6/2) with pale-brown (5YR5/2).....	0.5	1.5
1. Mudstone, dusky-yellow-green (5GY5/2).....	0.6	2.0
Total Brushy Basin Member (incomplete).....	1.1	3.5
Total Morrison Formation (incomplete).....	46.7	154.0

Section 5.--Los Pinos Arroyo Section

[Located on hogback north of Arroyo de los Pinos. Measured in S 1/2 sec. 11, T. 19 W., R. 1 W., San Pablo 7 1/2-minute quadrangle, Sandoval County, New Mexico (fig. 1).]

		Thickness	
		M	F
Top of measured section.			
Dakota Sandstone (incomplete):			
Cubero Sandstone Member (incomplete):			
23.	Quartzose sandstone, resistant.....unmeasured		
Oak Canyon Member:			
22.	Shale, black, mostly covered.....	16.5	54.0
21.	Bentonite, covered.....	0.03	0.1
20.	Black shale, mostly covered.....	1.2	4.0
19.	Bentonite, yellowish-gray (5Y7/2).....	0.3	1.0
18.	Shale, medium dark gray (N4) to dark gray (N3).....	6.4	21.0
17.	Sandstone, dark-yellowish-orange (10YR6/6) to very light gray (N8); possible small troughs, ripples; fine- to medium-grained; poorly to moderately sorted, subrounded; quartzose; burrowed.....	0.8	2.5
	Total Oak Canyon Member.....	25.2	82.6
Encinal Canyon Member:			
16.	Sandstone and sandy conglomerate, very light gray (N8) with dark-yellowish-orange (10YR6/6) staining; trough crossbeds up to 2 ft (60 cm) thick; fine-grained sand to pebbles up to 2 in. (5 cm) in length; poorly to moderately sorted, subrounded to angular; silica-cemented with quartz overgrowths; quartzose; conglomerates occur at the bases of some scour surfaces, pebbles include white angular chalky chert clasts, gray and black smooth chert clasts, pink quartzite clasts and light-bluish-gray quartz clasts; woody plant impressions and limonite and hematite staining occur along some bedding planes; black disseminated carbonaceous debris scattered throughout the unit.....	4.1	13.5
	Total Encinal Canyon Member	4.1	13.5

Section 5.--Los Pinos Arroyo Section--Continued

	Thickness M	Thickness F
Dakota Sandstone:--Continued		
Probable Encinal Canyon Member:		
15. Sandstone, white (N9) to very pale orange (10YR8/2) with dark-yellow-orange (10YR6/6) staining; broad trough crossbeds up to 2 ft (60 cm) thick and some possible horizontal laminations; fine-grained sand to pebbles up to 1/4 in. (.6 cm) in length; poorly to moderately sorted, subrounded to subangular; silica- and calcite- (minor) cemented; quartzose with less than 1 percent black accessory grains; conglomeratic zones occur along some bedding planes in the bottom 5 ft (1.5 m), pebbles include quartz lasts and white angular chalky chert clasts; hematite and limonite staining occur along some bedding surfaces.....	3.0	10.0
Total Probable Encinal Canyon Member.....	3.0	10.0
Total Dakota Sandstone.....	32.3	106.1
Morrison Formation (incomplete):		
Jackpile sandstone (?):		
14. Sandstone, very pale orange (10YR8/2); fine- to coarse-grained; poorly sorted, subangular to rounded; poorly clay and calcite cemented; quartzose with less than 1 percent black accessory grains.....	0.9	3.0
13. Mudstone, greenish-gray (5GY6/1).....	0.9	3.0
12. Siltstone, yellowish-gray (5Y7/2).....	1.1	3.5
11. Sandstone, sandy, yellowish-gray (5Y7/2).....	0.5	1.5
10. Sandstone, very pale orange (10YR8/2), dark-yellowish-brown (10YR4/2) and light-brown (5YR5/6); parallel or nearly parallel horizontal bedding; fine-grained; well-sorted, subrounded; quartzose with less than 1 percent black accessory grains weathered calcite cemented nodules up to 1 in. (2.5 cm) diameter.....	3.2	10.5

Section 5.--Los Pinos Arroyo Section--Continued

	Thickness	
	M	F
Morrison Formation:--Continued		
Jackpile sandstone:--Continued		
9. Sandstone, very pale orange (10YR8/2), dark-yellowish-brown (10YR4/2) and light-brown (5YR5/6); trough crossbeds up to 3 ft (90 cm) thick; fine-grained; moderately well sorted, subrounded; strongly calcite cemented; quartzose; weathered calcite cemented nodules up to 1 in. (2.5 cm) in diameter.....	0.9	3.0
8. Mudstone, light-olive-gray (5Y5/2).....	2.7	9.0
7. Sandstone, very pale orange (10YR8/2); very fine grained; moderately well sorted, subrounded; poorly clay and (minor) calcite cemented, quartzose with less than 1 percent black accessory grains.....	0.8	2.5
6. Sandstone, very light gray (N8) with dark-yellowish-orange (10YR6/6) and light-brown (5YR5/2); rippled; fine-grained; well-sorted, subrounded; calcite- and silica-cemented; quartzose with less than 1 percent black and green accessory grains.....	1.5	5.0
5. Sandstone, moderate-yellowish-brown (10YR5/6) to dark-yellowish-brown (10YR2/2); faint troughs up to 6 in. (15 cm) thick; fine- to coarse-grained; poorly sorted, subrounded; silica-cemented; quartzose; white angular chert clasts up to 1/4 in. (.6 cm) in length occur along some bedding planes.....	1.5	5.0
4. Conglomerate, sandy, moderate-brown (5YR3/4) to light-brown (5YR5/6), fine-sand to pebbles up to 2 in. (5 cm) in length; poorly sorted, rounded to subangular; calcite- and silica-cemented; granules include quartz; pebbles include abundant white chert clasts, black chert clasts, gray chert clasts and pink quartzite clasts up to an 1 1/2 in. (4 cm) in length and pale-yellowish-green (10GY7/2) very fine grained sandstone clasts up to 2 in. (5 cm) in length.....	0.2	0.5

Section 5.--Los Pinos Arroyo Section--Continued

	Thickness M	Thickness F
Morrison Formation:--Continued		
Jackpile sandstone:--Continued		
3. Sandstone, yellowish-gray (5Y8/1) to dark-yellowish-orange (10YR6/6); trough crossbeds up to 8 in. (20 cm) thick; fine- to medium-grained; moderately well to poorly sorted, subrounded; moderately calcite cemented [bottom 6 ft (1.8 m)], moderately clay cemented [top 5 ft (1.5 m)]; quartzose; local layers of white chert clasts up to 1/2 in (5 cm) in length occur along the bottoms of some troughs.....	3.4	11.0
Total Jackpile sandstone (?).....	17.6	57.5
Brushy Basin mudstone unit (incomplete):		
2. Sandstone, grayish-orange (10YR 7/4) to dark-yellowish-orange (10YR6/6); medium-grained; moderately well sorted, subrounded; poorly cemented; quartzose with less than 1 percent black accessory grains.....	0.5	1.5
1. Siltstone, dusky-yellow-green (5GY5/2).....	0.8	2.5
Total Brushy Basin mudstone unit (incomplete).....	1.3	4.0
Total Morrison Formation (incomplete).....	18.9	61.5

Section 4.--Campo El Deseo Section

[Located on hogback north of Campo El Deseo. Measured in NW 1/4 sec. 24 and SW 1/4 Sec. 13, T. 20 N., R. 1 W., San Pablo 7 1/2-minute quadrangle, Sandoval County, New Mexico (fig. 1).]

		Thickness	
		M	F
Top of the measured section.			
Dakota Sandstone (incomplete):			
Cubero Sandstone Member (incomplete):			
28.	Sandstone, burrowed, very pale orange (10YR8/2) to very light gray (N7).....	unmeasured	
Oak Canyon Member:			
27.	Shale, medium-gray (N3) to dark-gray (N4).....	10.8	35.5
26.	Bentonite, very light gray (N8) to light-gray (N7).....	0.03	0.1
25.	Shale, medium-gray (N3) to dark-gray (N4).....	2.4	8.0
24.	Bentonite, very light gray (N8) to light-gray (N7) with dark-yellowish-orange (10YR6/6).....	0.2	0.5
23.	Shale, medium-gray (N3) to dark-gray (N4).....	0.3	1.0
22.	Sandstone, very pale orange (10YR8/2) with very light gray (N8) and dark-yellowish-orange (10YR6/6) staining; flat laminations; fine-grained; well-sorted, subrounded; strongly silica cemented; quartzose; borrowed.....	1.8	6.0
	Total Oak Canyon Member.....	15.5	51.1
Encinal Canyon Member:			
21.	Coaly shale and sandy shale, black (N1) to medium-light-gray (N6).....	1.8	6.0
20.	Sandstone, very pale orange (10YR8/2) with very light gray (N8) and dark-yellowish-orange (10YR6/6) staining; trough crossbeds up to 6 in. (15 cm) thick and flat laminations; fine-grained; well-sorted, subrounded; strongly silica cemented; quartzose; burrowed.....	0.9	3.0

Section 4.--Campo El Deseo Section--Continued

	Thickness M	Thickness F
Dakota Sandstone:--Continued		
Encinal Canyon Member:--Continued		
19. Coaly shale or shaley coal containing very fine grained sandstone lenses, medium-light-gray (N6) to black (N1).....	3.0	10.0
18. Sandstone, very light gray (N8) with dark-yellowish-orange (10YR6/6) staining; trough crossbeds up to 1 ft (30 cm) thick; very fine grained; well sorted, subrounded; strongly silica and clay cemented; quartzose.....	1.2	4.0
17. Interbedded sandstones, pebbly sandstones and sandy conglomerates, very light gray (N8) with dark-yellowish-orange staining (10YR6/6); possible small broad trough crossbeds; very fine grained sand to boulder size clasts up to 6 in. (15 cm) long; moderately well to poorly sorted, angular to subrounded; strongly silica and clay cemented; abundant scattered carbonaceous debris; quartzose; pebbles include abundant angular to subrounded white chalky chert and white, gray and black smooth chert up to 3 1/2 in. (9 cm) length; carbonaceous siltstone clasts are up to 6 in. (15 cm) in length; 6 in. (15 cm) deep scour surface at base.....3.0 10.0		
Total Encinal Canyon Member (incomplete).....	9.9	33.0
Total Dakota Formation.....	25.4	84.0
Morrison Formation (incomplete):		
Jackpile sandstone (?):		
16. Sandstone, white (N9) with dark-yellowish-orange (10YR6/6) and light gray (N7); trough crossbeds one to 1 1/2 ft (45 cm) deep; fine- to medium-grained; moderately well sorted, subrounded; moderately to poorly clay and silica cemented; quartzose with less than 1 percent black and green accessory grains; possible weathered out armored mudball 6 in. (15 cm) in diameter near the top.....	11.3	37.0

Section 4.--Campo El Deseo Section--Continued

	Thickness	
	M	F
Morrison Formation:--Continued		
Jackpile sandstone:--Continued		
15. Sandstone, grayish-orange (10YR7/4) with grayish-brown (5YR3/2) and dark-yellowish-orange (10YR6/6); broad trough crossbeds; fine-grained; moderately well sorted, subrounded; poorly to moderately silica cemented with minor clay, exhibits quartz overgrowths; quartzose with less than 1 percent red and black accessory grains.....	1.4	4.5
14. Pebbly sandstone, grayish-orange (10YR7/4) with grayish-brown (5YR3/2) and dark-yellowish-orange (10YR6/6); fine-grained sand to pebbles up to 2 in. (5 cm) in length; poorly sorted, subangular; poorly to moderately silica cemented with minor clay, exhibits quartz overgrowths; quartzose with less than 1 percent red and black accessory grains; coarse material includes granules of quartz, pebbles of white chalky chert up to a 1/4 in. (.6 cm) long and clay clasts up to 2 in.(5 cm) in length.....	0.2	0.5
13. Sandstone, dark-yellowish-orange (10YR6/6); fine- to medium-grained; moderately well sorted; subrounded, poorly cemented; quartzose with less than 1 percent black accessory grains.....	0.2	0.5
12. Mudstone, grayish-olive (10Y4/2) to pale-olive (10Y6/2), slightly sandy.....	1.5	5.0
11. Covered, probably friable sandstone.....	0.6	2.0
10. Sandstone with interbedded layers containing abundant mudstone clasts [a 6 in. (30 cm) thick layer at the base, a 3 in. (7.5 cm) thick layer in the middle and a 1 ft (30 cm) thick layer at the top of the unit]; mudstone clasts are dusky-yellow-green (5GY5/2); sandstone is grayish-yellow (5Y8/4) with dark-yellowish-orange (10YR6/6) staining; medium-grained to very fine grained; poor to moderately sorted, subrounded; poorly clay cemented; quartzose with less than 1 percent pink accessory grains.....	1.5	5.0

Section 4.--Campo El Deseo Section--Continued

		Thickness M	Thickness F
Morrison Formation:--Continued			
Jackpile sandstone:--Continued			
9	Sandstone, mostly covered, very pale orange (10YR8/2) to dark-yellowish-orange (10YR6/6); crossbedded; fine- to medium-grained; moderately sorted, subrounded; poorly clay cemented; quartzose; contains greenish-gray (5GY6/1) mudstone clasts up to 1/2 in. (1.25 cm) long on some bedding planes.....	3.0	10.0
8.	Sandstone, very pale orange (10YR8/2) with dark-yellowish-orange (10YR6/6) staining; trough crossbeds up to 1 1/2 ft (45 cm) deep, trough depth may decrease somewhat towards the top; fine-grained; well-sorted, subrounded; moderately to poorly silica cemented with some quartz overgrowths; quartzose with less than 1 percent green grains, black grains and pinkish orange (possibly K-feldspar) accessory grains; clay clasts occur locally along the bases of some troughs.....	5.2	17.0
7.	Sandstone, very pale orange (10YR8/7) to pale-yellowish-orange (10YR8/6); low angle nearly parallel crossbeds; fine- to very fine grained; moderately well sorted, subrounded; moderately silica cemented with quartz overgrowths and minor clay; quartzose with less than 1 percent black accessory grains.....	1.5	5.0
6.	Sandstone with clay clasts up to 3 in. (7.5 cm) in length; hematite stained; fine- to coarse-grained; poorly sorted, subangular; quartzose.....	0.1	0.2
5.	Sandstone, yellowish-gray (5Y7/2); fine-grained; moderately well sorted, subrounded; poorly cemented, friable; quartzose with accessory black and pinkish orange (K-feldspar ?) grains; partly covered.....	2.3	7.5

Section 4.--Campo El Deseo Section--Continued

	Thickness M	Thickness F
Morrison Formation:--Continued		
Jackpile sandstone:--Continued		
4. Sandstone, moderate-reddish-orange (10R6/6) to pale-yellowish-orange (10YR8/2); massive; fine-grained; moderately well sorted, subrounded; moderately to poorly clay cemented; quartzose with less than 1 percent black and green accessory grains.....	2.4	8.0
Total Jackpile sandstone (?).....	31.2	102.2
Brushy Basin mudstone unit (incomplete):		
3. Covered, probably sandstone and /or mudstone.....	2.4	8.0
2. Sandstone, dusky-yellow (5Y6/4); fine grained; moderately to well sorted; subrounded; friable.....	0.5	1.5
1. Mudstone, moderate-brown (5YR3/4) and pale-olive (10Y6/6).....	0.3	1.0
Total Brushy Basin mudstone unit (incomplete).....	3.2	10.5
Total Morrison (incomplete).....	34.1	112.7

Section 3.--Cuba Section

[Located on hogback south of highway 126 near Cuba, N. Mex. (fig. 1). Measured in E 1/2 sec. 11, T. 20 N., R. 1 W., San Pablo 7 1/2-minute quadrangle, Sandoval County, New Mexico.]

		Thickness	
		M	F
Top of measured section.			
Dakota Formation (incomplete):			
Cubero Sandstone Member (incomplete):			
33.	Quartzose sandstone, very light gray (N9) to very pale orange (10YR8/2), burrowed.....	unmeasured	
Oak Canyon Member:			
32.	Shale, black, mostly covered.....	7.0	22.9
31.	Bentonite, very pale orange (10YR8/2) with dark-yellowish-orange (10YR6/6) staining.....	0.03	0.1
30.	Shale, black, mostly covered.....	1.4	4.5
29.	Bentonite, very pale orange (10YR8/2) with dark-yellowish-orange (10YR6/6) staining.....	0.3	1.0
28.	Shale, black, mostly covered.....	6.4	21.0
27.	Sandstone, very pale orange (10YR8/2) mottled with dark-yellowish-orange (10YR6/6); fine-grained; moderately well sorted, subrounded; strongly silica cemented; quartzose; burrowed.....	0.6	2.0
	Total Oak Canyon Member.....	15.7	51.5
Encinal Canyon Member:			
26.	Sandstone, very pale orange (10YR8/2) mottled with dark-yellowish-orange (10YR6/6); moderately well sorted, subrounded; moderately silica cemented; quartzose; woody plant impressions along some bedding planes and scattered finely disseminated carbonaceous debris.....	0.9	3.0
25.	Sandstone, white (N9) to very pale orange (10YR8/2); very fine grained; moderately well sorted; poorly clay cemented; quartzose; partly covered.....	4.6	15.0

Section 3.--Cuba Section--Continued

		Thickness	
		M	F
Dakota Formation:--Continued			
Encinal Canyon Member:--Continued			
24.	Sandstone, very pale orange (10YR8/2) mottled with dark-yellowish-orange (10YR6/6), very fine grained; moderately well sorted, subrounded; moderately silica cemented; quartzose; woody plant impressions along some bedding planes and scattered finely disseminated carbonaceous debris.....	4.0	13.0
24.	Sandstone, white (N9) to very pale orange (10YR8/2); very fine grained; moderately well sorted, subrounded; poorly clay cemented; quartzose; partly covered.....	6.1	20.0
23.	Interbedded sandy conglomerates and sandstones, very light gray (N8) to dark-yellowish-orange (10YR6/6); fine-sand to pebbles up to 3 1/2 in. (9 cm) in length; moderate to poorly sorted, subrounded to angular; silica-cemented with minor amounts of clay matrix; quartzose; scattered woody plant impressions and carbonaceous debris; pebbles include quartz, white angular chalky chert, gray chert and local carbonaceous sand clasts.....	2.4	8.0
	Total Encinal Canyon Member.....	18.0	59.0
Probable Encinal Canyon Member:			
21.	Covered (probably the same lithology as below).....	4.9	16.0
20.	Sandstone [partly covered with possible intercalated mudstone layers which appear to be dark-yellowish-brown (10YR4/2)] white (N9) to yellowish-gray (5Y8/6); fine- to medium-grained; moderately well sorted, subrounded; poorly cemented (non-calcareous); quartzose with less than 1 percent black and red accessory grains.....	5.3	17.5
19.	Shale, medium-gray (N5) to light-gray (N7), carbonaceous.....	2.1	7.0

Section 3.--Cuba Section--Continued

	Thickness M	Thickness F
Dakota Formation:--Continued		
Probable Encinal Canyon Member:--Continued		
18. Sandstone, white (N9) to grayish-orange (10YR7/6); fine- to medium-grained; trough crossbeds up to 2 ft (60 cm) thick; moderately well sorted, subrounded; silica-cemented with quartz overgrowths; quartzose with less than 1 percent black and red accessory grains; small greenish-gray (5GY6/1) claystone rip up clasts up to 1/3 in. (8 cm) in length concentrated along some bedding planes.....	1.4	4.5
17. Pebbly sandstone, white (N9) to grayish-orange (10YR7/6); fine-grained sand to pebbles up to 1 in. (2.5 cm) in length; poorly sorted, subrounded; silica-cemented; quartzose; pebbles consist of angular to rounded white chert, black and gray smooth chert, pink quartzite and yellowish-gray (5Y7/6) clay clasts.....	0.2	0.5
Total Probable Encinal Canyon Member.....	13.9	45.5
Total Dakota Sandstone (incomplete).....	37.6	156.0
Morrison Formation (incomplete):		
Brushy Basin mudstone unit (incomplete):		
16. Sandstone, very light gray (N8) to yellowish-gray (5Y8/6); medium-grained; moderately well sorted, subrounded; poorly cemented (non-calcareous); quartzose...	2.9	9.5
15. Sandstone, very light gray (N8) to yellowish-gray (5Y8/6); medium-grained, moderately well sorted, subrounded; poorly calcite cemented; quartzose.....	3.0	10.0
14. Sandstone, dark-yellowish-orange (10YR6/6); fine-grained; moderately well sorted; subrounded; poorly cemented; quartzose.....	0.03	0.1
13. Mudstone, moderate-reddish-brown (10R4/6).....	0.1	0.4
12. Siltstone, light-olive-gray (5Y5/2).....	0.5	1.5
11. Sandstone, grayish-yellow-green (5GY7/2); very fine grained; moderately well sorted, subrounded; poorly clay cemented; quartzose with less than 1 percent black grains.....	0.3	1.0

Section 3.--Cuba Section--Continued

		Thickness	
		M	F
Morrison Formation:--Continued			
Brushy Basin mudstone unit:--Continued			
10.	Mudstone, grayish-yellow-green (5GY7/2).....	0.8	2.5
9.	Sandstone, very pale orange (10YR8/2); fine-grained; moderately well sorted, subrounded; poorly cemented; quartzose.....	0.6	2.0
8.	Mudstone, grayish-yellow-green (5GY7/2) to grayish-olive-green (5GY 3/2).....	2.4	8.0
7.	Sandstone, yellowish-gray (5YR7/2); fine-grained; moderately well sorted; subrounded; poorly calcite cemented; quartzose.....	0.8	2.5
6.	Mudstone, light-olive-gray (5YR5/2); slightly calcareous.....	0.2	0.5
5.	Sandstone, yellowish-gray (5YR7/2); fine-grained; moderately well sorted, subrounded; poorly calcite cemented; quartzose.....	0.2	0.5
4.	Mudstone, silty, light-olive-gray (5YR5/2) slightly calcareous.....	0.2	0.5
3.	Sandstone, yellowish-gray (5YR7/2); fine-grained; moderately well sorted, subrounded; poorly calcite cemented; quartzose with less than 1 percent red and black accessory grains.....	0.2	0.5
2.	Sandstone, light-olive-gray (5Y5/2) to pale-olive (10Y6/2).....	2.1	7.0
1.	Clinoptilolite and clinoptilolitic mudstone, moderate-reddish-brown (10R4/6).....	0.6	2.0
	Total Brushy Basin mudstone unit (incomplete).....	14.9	48.5
	Total Morrison Formation.....	14.9	48.5

Section 2.--Regina Section

[Located approximately 4 miles northwest of Regina, N. Mex. (fig. 1). Measured in S 1/2 sec. 13, T. 23 N., R. 1 W., Regina 7 1/2-minute quadrangle, Rio Arriba County, New Mexico.]

	Thickness	
	M	F
Top of measured section.		
Dakota Sandstone (incomplete):		
Oak Canyon Member (incomplete):		
19. Shale, black; mostly covered.....undescribed		
18. Sandstone, grayish-orange (10YR7/4), very fine grained; bioturbated.....	0.3	1.0
Total Oak Canyon Member (incomplete).....	0.3	1.0
Encinal Canyon Member:		
17. Interlaminated very fine grained sandstone and shale, dark-yellowish-orange (10YR6/6) pinkish-gray (5YR8/1) and brownish range (10YR7/4); mostly covered.....	1.5	5.0
16. Sandstone, very light gray (N8) to grayish orange (10YR7/4); poorly defined troughs, fine-grained to very fine grained; moderately well sorted, subrounded; moderately silica and clay cemented; locally contains abundant carbonaceous debris.....	3.0	10.0
15. Sandstone, very pale orange (10YR8/2) to dark-yellowish-orange (10YR6/6); large channels filled with poorly defined crossbedding, overlain by a thin bed containing asymmetrical ripples; fine-grained sand to pebbles; moderately to poorly sorted; subrounded to subangular; moderately silica and clay cemented; pebbles and large intraclasts form lags at the bottom of channels and scours; pebbles include white, gray and black chert up to 1 in length; intraclasts are gray and are commonly greater than 1 ft (30 cm) in length.....	5.8	19.0
14. Sandstone, very pale orange (10YR6/6); horizontally laminated; very fine grained to fine-grained; moderately to well sorted, subrounded; moderately silica and clay cemented.....	2.1	7.0

Section 2.--Regina Section--Continued

		Thickness	
		M	F
Dakota Sandstone:--Continued			
Encinal Canyon Member:--Continued			
13.	Interbedded sandstone and conglomerate, very pale orange (10YR8/2) to very light gray (N8); generally horizontally to massively bedded, some poorly defined small scale crossbeds in the sandstones; fine-grained to pebbles up to 1 1/2 in. (4 cm) long; moderately to poorly sorted, subrounded to subangular; moderately silica and clay cemmented; pebbles include white chalky chert, gray and black chert and reddish gray quartzite.....	3.0	10.0
12.	Conglomerate, very light gray (N8); massive; medium-grained sand to pebbles up to 2 in. (5 cm) in length; subrounded to subangular; poorly sorted; moderately silica and (minor) clay cemented; pebbles include white chalky chert, gray and black chert and reddish gray quartzite; contains rare carbonaceous trash.....	1.2	4.0
11.	Sandstone, very pale orange (10YR8/2) to very light gray (N8); small scale poorly defined crossbeds; fine- to medium-grained; moderately well sorted, subrounded; moderately silica and (minor) clay cemented; contains a few scattered pebbles along some bedding planes, mostly white often angular chalky chert.....	1.2	4.0
10.	Sandstone, very pale orange (10YR8/2) to very light gray (N8); one large tabular planar set; fine- to medium-grained; moderately well sorted, subrounded; moderately silica and clay cemented; contains a few scattered pebbles along some bedding planes; mostly white often angular chalky chert; disseminated carbonaceous debris in the bottom set.....	1.2	4.0
9.	Sandstone, very pale orange (10YR8/2) to very light gray (N8); massive; fine- to medium-grained; moderately well sorted; moderately silica and clay cemented; subrounded; channels into underlying unit.....	1.2	4.0

Section 2.--Regina Section--Continued

	Thickness	
	M	F
Dakota Sandstone:--Continued Encinal Canyon Member:--Continued		
8. Interbedded sandstone and conglomerate; very pale orange (10YR8/2) and very light gray (N8); conglomerates are massive beds about 1 ft (30 cm) thick; pebbles include abundant angular to rounded white chalky chert, gray and black chert, and reddish gray quartzite up to 1 1/4 in. (3 cm) in length; intervening sandstone beds are about 1 ft (30 cm) thick and generally exhibit low angle crossbedding and some possible troughs; fine- to medium-grained sand; moderately well sorted, subrounded; moderately silica and clay cemented; bottom few inches of lowermost sandstone contains disseminated carbonaceous material.....	2.3	7.5
7. Conglomerate, very light gray (N8); massive with some low angle crossbedding; in part clast supported, sandier towards the top; medium-grained sand to pebbles up to 2 3/4 in. (7 cm) in length; abundant angular to rounded white chalky chert, gray and black chert and reddish gray quartzite.....	1.2	4.0
6. Sandstone, very pale orange (10YR8/2), poorly defined small scale troughs and low angle crossbedding, one small tabular planar set, large trough or scour 3 ft (90 cm) deep at top; fine- to medium-grained; moderately well sorted, subrounded; moderately silica cemented.....	2.3	7.5
5. Conglomerate, very light gray (massive; fine-grained sand to pebbles up to 2 in. (5 cm) in length; poorly sorted, subrounded to angular; moderately silica cemented; pebbles include white chalky chert, gray and black chert, and reddish gray quartzite; the conglomerate grades laterally in one direction into fine- to medium-grained sandstone.....	1.1	3.5

Section 2.--Regina Section--Continued

	Thickness M	Thickness F
Dakota Sandstone:--Continued Encinal Canyon Member:--Continued		
4. Sandstone, very pale orange (10YR8/2) and pale-reddish brown (10R5/4); horizontally laminated; fine-grained to very fine grained; subrounded, subangular. Laterally from the section there is a partially exposed channel which scours approximately 5 ft (1.5 m) into the horizontally laminated sandstone. The channel fill is sandstone with conglomerate, very pale orange (10YR8/2); massive sandstone in the lower part with horizontal sandstone laminations and conglomeratic beds approximately 1 ft (30 cm) thick in upper part, conglomerate containing mudstone intraclasts and chert pebbles occurs at base; very fine grained sand to pebbles; poorly sorted; rounded to subangular moderately silica and clay cemented; pebbles include white and gray and black chert clasts up to 3 1/4 (8 cm) in along the long axis; intraclasts of gray shale are up to 9 1/2 in (24 cm) in length.....	2.1	7.0
3. Conglomerate and sandstone, very pale orange (10YR8/2) to very light gray (N8); conglomerate is massive and clast supported in places; sandstone is thinly laminated; very fine grained sand to pebbles up to 1 1/2 in. (4 cm) in length, intraclasts up to 2 ft (60 cm) long; moderately to poorly sorted, subrounded to subangular; moderately silica and clay cemented; pebbles include abundant white chalky chert and gray and black chert; intraclasts are gray mudstone and siltstone; sandstone contains local disseminated carbonaceous debris.....	0.5	1.5

Section 2.--Regina Section--Continued

	Thickness M	Thickness F
Dakota Sandstone:--Continued		
Encinal Canyon Member:--Continued		
2. Sandstone, pale-yellowish-orange (10YR8/6) and very pale orange (10YR8/2); generally poorly bedded, contains a few thin discontinuous conglomerate lenses in lower half, a 1 1/4 ft (45 cm) thick planar tabular set near the middle, and faint trough crossbeds 6 in. (15 cm) to 1 ft (30 cm) thick in the upper part; fine-grained sand to pebbles; moderately to poorly sorted; rounded to subangular; moderately silica and clay cemented; pebbles include subangular to rounded white chalky chert, and gray and black chert up to 1 1/4 in. (3 cm) in length; bleached gray siltstone intraclasts up to 4 in. (10 cm) long occur in the lower part.....	4.3	14.0
Total Encinal Canyon Member.....	34.0	112.0
Total Dakota Sandstone (incomplete).....	34.3	113.0
Morrison Formation:		
Probable Brushy Basin mudstone unit:		
1. Covered.....unmeasured		

Section 1.--Mesa Lagunitas Section

[Located on Mesa Lagunitas. Unsurveyed, 36 17' 45", 106 42' 57", Laguna Peak 7 1/2-minute quadrangle, Rio Arriba County, New Mexico (fig. 1).]

	Thickness M	Thickness F
Top of measured section.		
Dakota Sandstone (unmeasured):		
Oak Canyon Member (?) (incomplete):		
29. Quartzose sandstone, grayish-orange (10YR7/4), rippled and burrowed.....unmeasured		
28. Siltstone, light gray (N7) to white (N9).....	0.3	1.0
Total Oak Canyon Member (incomplete).....	0.3	1.0
Encinal Canyon Member:		
27. Sandstone with occasional granule conglomerates, very light gray (N8) to very pale orange (10YR8/2) with medium-gray (N4) and moderate-yellowish-orange (10YR7/2) staining; fine- to coarse-grained sand with granules; moderately well sorted, subrounded; strongly silica cemented; quartzose.....	5.8	19.0
26. Interbedded sandstone and conglomerate (mostly conglomerate), very light gray (N8) with dark-yellowish-orange (10YR6/6) staining; tabular sets and possible broad troughs up to 2 ft (60 cm) thick; fine-grained sand to pebbles up to 3/4 in. (2 cm) in length; poorly to moderately sorted, angular (chalky chert) to subrounded (most others); strongly silica cemented; quartzose; pebbles include white angular chalky chert, dark-gray to black chert, light-gray chert, white chert, pink chert, K-feldspar (?), reddish-brown chert and quartz.....	4.6	15.0
Total Encinal Canyon Member.....	10.4	34.0
Total Dakota Sandstone (incomplete).....	10.7	35.0
Burro Canyon Sandstone Formation:		
25. Mudstone light-gray (N7) with some black (N1) staining, moderately cemented.....	0.9	3.0
24. Mudstone, very dark red (5R2/6), coarsens upwards.....	0.9	3.0

Section 1.--Mesa Lagunitas Section--Continued

		Thickness	
		M	F
Dakota Sandstone:--Continued			
Burro Canyon Sandstone Formation:--Continued			
23.	Mudstone, light-greenish-gray (5GY8/1) and pale-red-purple (5RP6/2).....	0.2	0.5
22.	Sandstone, very light gray (N8) to grayish-orange-pink (10R8/2), fine- to medium-grained; moderately sorted, subrounded; strongly silica cemented; quartzose with less than 1 percent black and red accessory grains; some black chert granules.....	0.5	1.5
21.	Mudstone, sandy, grayish-yellow-green (5GY7/2), contains some scattered black and dark-reddish-brown (10R3/4) chert (?) clasts up to 1/4 in. (.6 cm) in length.....	2.3	7.5
20.	Mudstone, brownish-gray (5YR4/1); contains dark-reddish-brown (10R3/4) clasts up to approximately 1/4 in. (.6 cm) in length (ripup clasts or mud crack chips ?).....	1.8	6.0
19.	Siltstone, sandy, grayish-red (5R4/2); silt and very fine grained sand.....	0.3	1.0
18.	Sandstone, grayish-red-purple (5RP4/2) with some light-gray (N7); very fine grained; well-sorted, subrounded, poorly clay cemented; quartzose with less than 1 percent black accessory grains.....	0.6	2.0
17.	Siltstone, grayish-red-purple (5RP4/2).....	0.03	0.1
16.	Sandstone, light-gray (N7); quartzose.....	0.1	0.3
15.	Mudstone, dark-yellowish-orange (10YR6/6).....	0.2	0.6
14.	Sandstone, light-brown (5YR6/4) to very pale orange (10YR8/2); fine-grained; subrounded, strongly silica cemented; quartzose with less than 5 percent rusty black accessory grains; possible burrows in the upper 6 (15 cm) in.....	0.8	2.5

Section 1.--Mesa Lagunitas Section--Continued

	Thickness	
	M	F
Dakota Sandstone:--Continued		
Burro Canyon Sandstone Formation:--Continued		
13. Sandstone, partially covered, light-brown (5YR5/6), moderate-orange-pink (5YR8/4) and very pale orange (10YR8/2); fine-grained to very fine grained; moderately well sorted, subrounded; poorly clay cemented; quartzose with less than 1 percent black, dark-brown and rusty black accessory grains.....	7.6	25.0
12. Siltstone, partially covered, dark-reddish-brown (10R3/4).....	3.7	12.0
11. Sandstone with sandy conglomeratic layers along bases of some troughs, light-brown (5YR6/4) and grayish-orange (10YR7/4); broad trough crossbeds up to 2 ft (60 cm) thick and tabular crossbeds up to 1 ft (30 cm) thick; fine-grained to pebbles up to 2 3/4 in. (7 cm) in length; moderately well to poorly sorted, subrounded; moderately clay and silica cemented, abundant interstitial clay; quartzose; pebbles include gray chert, white chert, black chert and tan chert up to 1 1/2 in. (4 cm) in length; very-pale-green (10G8/2) siltstone clasts are up to 2 3/4 in. (7 cm) in length.....	11.0	36.0
10. Sandstone, very pale orange (10YR8/2), grayish-orange (10YR7/4) and light-brown (5YR5/6); faint trough crossbeds up to 3 ft (90 cm) thick with some horizontal laminations near the top; fine-grained to very fine grained; moderately well sorted, subrounded; moderately clay and silica cemented; quartzose with less than 1 percent black accessory grains.....	5.5	18.0
9. Sandstone, pebbly sandstone and sandy conglomerate, light-brown (5YR6/4), pale-yellowish-orange (10YR8/6) and very pale orange (10YR8/2); trough crossbedding up to 2 ft (60 cm) thick; fine-grained sand to boulder-size intraclasts up to 6 in. (15 cm) long; poorly sorted, subangular to rounded; moderately clay and silica cemented; quartzose; pebbles include abundant white chert (rounded to subangular), gray chert, vuggy-fossiliferous gray chert, black, tan and red chert, and reddish-brown quartzite up to 1 1/4 in. (3 cm) in length; clasts of very light gray (N9) to light-gray (N7) siltstone are up to 6 in. (15 cm) long.....	1.7	5.5

Section 1.--Mesa Lagunitas Section--Continued

	Thickness	
	M	F
Dakota Sandstone:--Continued		
Burro Canyon Sandstone Formation:--Continued		
8. Sandstone and pebbly sandstone, pale-yellowish-orange (10YR8/6) to light-brown (5YR5/6); small trough crossbeds; generally fine- to medium-grained sand with scattered pebbles up to 1/4 in. (.6 cm) in length; poorly sorted, subrounded; moderately clay and silica cemented; quartzose; pebbles include tan, black and white chert.....	0.8	2.5
7. Conglomerate, sandy, grayish-orange (10YR7/4) to dark-yellowish-orange (10YR6/6); massive with possible small troughs; medium-grained sand to boulder size intraclasts up to 13 in. (33 cm) in length; very poorly sorted, rounded to subangular; strongly clay and silica cemented; quartzose; pebbles consist of abundant white and tan rounded to subangular calcedonic chert, black chert, gray vuggy chert, red quartzite, reddish-brown chert and quartz up to 1 1/2 in. (4 cm) in length; contains light-gray siltstone clasts up to 13 in. (33 cm) in length at base.....	0.3	1.0
6. Sandstone, very pale orange (10YR8/2) and light-brown (5YR6/4); mostly slightly dipping parallel laminations with some slightly dipping discontinuous laminations and some horizontal laminations; fine- to coarse-grained; moderately to moderately well sorted; quartzose; generally fines upwards.....	0.9	3.0
5. Conglomerate, sandy, pale-yellowish-orange (10YR8/6); fine-grained sand to pebbles up to 3 in. (7.5) in length; poorly sorted, subrounded to subangular; moderately clay and silica cemented; quartzose; pebbles include abundant white chert, gray chert, black chert, tan chert, dark-reddish-brown quartzite, gray vuggy chert and red chert up to 1 in. (2.5 cm) in length and light-gray siltstone clasts up to 3 in. (7.5 cm) long.....	0.6	2.0

Section 1.--Mesa Lagunitas Section--Continued

	Thickness M	Thickness F
Dakota Formation:--Continued		
Burro Canyon Formation:--Continued		
4. Sandstone, very pale orange (10YR8/2) to light-brown (5YR6/4) with dark-yellowish-orange (10YR6/6) staining; parallel laminations; fine-grained to very fine grained; moderately well sorted, subrounded; moderately clay and silica cemented; quartzose with less than 1 percent black accessory grains;.....	2.1	7.0
3. Interbedded, pebbly sandstone and sandy conglomerate, grayish-orange (10YR7/4) and light-brown (5YR6/4); trough crossbeds up to 2 1/2 ft (75 cm) thick; fine-grained sand to pebbles up to 1 1/4 in. in length; moderately to poorly sorted, rounded to subangular; moderately clay and silica cemented; quartzose with less than 1 percent black accessory grains; pebbly zones occur at bases of scours where they are up to 6 in. thick and along crossbeds where they are generally less than 1/2 in. thick; pebbles include abundant white chert (smooth and chalky chert; rounded to angular) some of which contain fossil fragments, gray chert, black chert, tan chert, dark-reddish-brown quartzite, and gray vuggy chert (possibly fossiliferous).....	2.4	8.0
Total Burro Canyon Formation.....	45.2	148.0
Morrison Formation:		
Brushy Basin Member (incomplete, contact covered):		
2. Covered interval, probably mudstone and or sandstone.....	6.4	21.0
1. Siltstone, light-greenish-gray (5GY8/1).....	0.3	1.0
Total Brushy Basin Member (incomplete).....	6.7	22.0
Total Dakota Sandstone (incomplete).....	6.7	22.0

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