



Triassic rocks of the Santa Rosa country

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1972, pp. 84-90. <https://doi.org/10.56577/FFC-23.84>

in:

East-Central New Mexico, Kelley, V. C.; Trauger, F. D.; [eds.], New Mexico Geological Society 23rd Annual Fall Field Conference Guidebook, 236 p. <https://doi.org/10.56577/FFC-23>

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TRIASSIC ROCKS OF THE SANTA ROSA COUNTRY

by

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INTRODUCTION

Existence of Triassic rocks in eastern New Mexico was early recognized (Cummins, 1890 and Cope, 1903), and the use of Cummins' Texas term, Dockum Group, was first applied to specific areas in eastern New Mexico by Darton (1922, p. 183). At that time he also designated the Santa Rosa Sandstone as a part of the group. However, he did not use the Arizona term, Chinle Shale (Gregory, 1915), for the remainder of the group as is now done. In a subsurface study of the Triassic in the Permian basin of West Texas Adams (1929, p. 1045) stated that "the names Santa Rosa and Chinle, as used for the Triassic of central New Mexico, are extended to include the equivalent formations in the Texas section." Today usage of the formational names "Santa Rosa Sandstone" and "Chinle Shale" is well established in eastern New Mexico where the units are in rather clear-cut and consistent relationship to the normal stratigraphic succession above and below.

In 1928 Darton defined the Upper Triassic Dockum Group of eastern New Mexico as all the beds between the Permian (his Chupadera formation) and the Exeter Sandstone (his Wingate) above. In 1946 Dobrovolsky and Summerson mapped a top part of the Chinle as a Redonda Member, and in 1959 Griggs and Read recommended separation of this unit from the Chinle and termed it the Redonda Formation.

Owing principally to lack of relief and marked deformation in eastern New Mexico complete sections of the Triassic in one place at the surface are uncommon. Only three such places exist, two in the north Sandia Mountains just east of the Rio Grande trough and one at the southern end of the Colorado Rockies south of Las Vegas (Fig. 1), but these both lack the Redonda. A somewhat spread out section may be pieced together through a 30-mile stretch between Santa Rosa and Luciana Mesa, but much outcrop is covered. The following section was measured near Apache Springs, 13 miles south of Las Vegas along the Anton Chico monocline (Kelley, 1972a) in the N½ secs. 1, 2, T. 13 N., R. 16 E.

TRIASSIC SECTION NEAR APACHE SPRINGS, SAN MIGUEL COUNTY, NEW MEXICO

Jurassic Exter Sandstone
Triassic
Chinle Formation

No.	Description	Thick. Ft	Cum. Ft
UPPER SHALE MEMBER			
53	Siltstone and claystone, reddish brown, party covered	112	403
52	Sandstone, brown, fine to medium grained, thin bedded, forms low bench east of U.S. Highway 84	30	291
51	Sandstone, light reddish-brown, medium grained, thin to thick bedded	11	261
50	Siltstone and claystone, reddish brown, a		

	few 1-ft fine-grained reddish-brown sandstone ledges	131	250
49	Sandstone, tan brown, fine grained, laminated, forms low ridge	10	119
48	Siltstone and claystone, reddish brown, some thin fine-grained sandstone	109	109
	Total:	403	

CUERVO SANDSTONE MEMBER

47	Sandstone, greenish and brownish gray, medium grained, thin to thick bedded, forms hogback crest, no. 4	81	205
46	Siltstone and claystone, reddish brown, saddle and slope to no. 47	83	124
45	Sandstone, brownish gray, medium grained, thin bedded, forms hogback no. 3	34	41
44	Sandstone, greenish gray, medium grained, medium to thick bedded	7	7
	Total:	205	

LOWER SHALE MEMBER

43	Siltstone and claystone, reddish brown thin bedded, slope former, some thin (1 ft) fine-grained brown sandstone	38	388
42	Siltstone, brownish gray, fine grained, laminated	13	350
41	Siltstone, reddish brown, thin bedded, some thin fine-grained brown sandstones	45	337
40	Sandstone, mauve brown, fine grained, laminated	5	292
39	Siltstone, reddish brown, thin bedded, slope former, some thin fine-grained brown sandstones	12	287
38	Sandstone, brownish gray, fine grained, thin bedded	10	275
37	Conglomerate, brownish gray, limestone pellets	1	265
36	Sandstone, brownish gray, fine grained, thin to medium bedded	4	264
35	Siltstone and sandstone, greenish gray and reddish brown, saddle	73	260
34	Sandstone, brownish gray, medium grained, thin bedded	10	187
33	Sandstone, greenish gray, medium to fine grained, laminated and thin bedded	17	177
32	Sandstone, brownish gray, medium grained, medium bedded	26	160
31	Sandstone, greenish brown, medium grained, thin bedded, hogback no. 2	16	134
30	Sandstone, yellowish tan, medium grained, thin bedded	4	118
29	Sandstone, light gray, medium grained, thin bedded	6	114
28	Conglomerate, gray-brown, pebbles		

and cobbles, subround, limestone and sandstone	2	108
27 Siltstone, reddish brown, thin bedded	22	106
26 Sandstone, brown, medium to fine grained, thin bedded and laminated, micaceous	24	84
25 Siltstone, brown, thin bedded	6	60
24 Siltstone, brownish gray, laminated micaceous	4	54
23 Covered	13	50
22 Conglomerate, gray and buff, angular sandstone pebbles	4	37
21 Covered in grassy flat	18	33
20 Siltstone, brownish gray, laminated, micaceous	5	15
19 Covered, in grassy flat	10	10
Total:	388	

SANTA ROSA SANDSTONE

18 Sandstone, reddish brown, medium grained, medium bedded, laminated, micaceous, caps ridge	15	194
17 Sandstone, white, medium grained, medium bedded	17	179
16 Sandstone, grayish white, medium grained thin and medium bedded, crossbedded	10	162
15 Sandstone, grayish green, medium grained, thin bedded and cross bedded	8	152
14 Sandstone, white, coarse grained, medium grained, cross bedded	11	144
13 Siltstone, reddish brown, top 1.5 ft greenish gray	11	133
12 Sandstone, dark purplish brown, medium to coarse grained, thin bedded	16	113
11 Sandstone, greenish gray, medium grained, medium bedded	6	97
10 Conglomerate, greenish brown, angular granules and pebbles are limestone, sandstone and quartz	3	91
9 Sandstone, greenish gray, coarse grained, arkosic	12	88
8 Sandstone, purplish brown, coarse grained, thick bedded	14	76
7 Sandstone, coarse grained, medium bedded, arkosic	14	62
6 Sandstone, mauve brown, medium grained, laminated	12	48
5 Conglomerate, green and brown, angular granules and pebbles are limestone, and stone, and quartz, some carbonized wood	6	36
4 Sandstone, reddish brown, medium grained, thick and medium bedded	11	30
3 Sandstone and siltstone, dark brown, laminated	10	19
2 Sandstone, light gray, coarse grained, medium bedded	3	9
1 Sandstone, dark tannish brown, medium to coarse grained, conglomeratic, rests on tan brown Bernal Formation	6	6
Total:	194	
Total, Dockum Group:	1,190	

Permian Bernal Formation

SANTA ROSA SANDSTONE

In the Santa Rosa country the Santa Rosa Sandstone occurs mostly west of or in canyon of the Pecos River, and owing in large part to regional eastern dip, is covered by the overlying Chinle east of the river bluffs. The best exposures are in the Pecos Canyon or its western tributaries such as along Pintada Canyon. Additional good exposures occur north of Anton Chico toward Apache Springs. Several large exposures occur elsewhere north of the Conchas River along and above the Variadero monocline, along Trementina Creek, along the Canadian River canyon from Conchas Dam northward, and along Garita Creek, especially at the northern end of the Garita monocline (Fig. 1).

The Santa Rosa consists dominantly of medium-grained sandstone in medium to thick beds that may be crossbedded and lenticular. The dominant colors are yellowish brown or buff, but reddish-brown, purplish brown, and lavender hues are also common. Conglomerate in lenses and beds of some persistence are common in the lower part of the formation. Reddish-brown mudstone units divide the formation variously into several units which may in places be followed for several miles. Gorman and Roebeck (1946) divided the formation into Sandstones 1 to 4 in the Esterito dome area during study of asphalt deposits. Read, Sample, and Shelton (personal communication) made a similar subdivision into three units. Near Santa Rosa, shale breaks are not common and sandstone is predominant in full thickness of 150 to 200 feet. However, differences between the lower and upper parts are apparent in section measuring, the lower part being reddish and purplish brown and conglomeratic, the upper part buff to yellowish brown or white with less conglomerate.

A type locality and section have been designated just north of Santa Rosa (Kelley, 1972b, p. 21-22) and thicknesses have been found to range from 187 to 217 feet. These compare closely with the thickness of 205 feet given above in the Apache Springs section. Lithology in the lower part differs noticeably from that of the upper part. The lower part typically exhibits lavender to purplish-brown colors and more conglomerate whereas the upper beds are generally buff, massive well-cemented sandstone.

In eastern New Mexico the Santa Rosa rests unconformably on Permian rocks ranging from Ochoan Dewey Lake and Rustler Formations in the south, east of Carlsbad, to Precambrian in the north on the subsurface Sierra Grande arch 15 miles east of Springer. (Wood, Northrop, and Griggs, 1953). In the Santa Rosa country it truncates Artesia units downward from Yates in the Fort Sumner latitude northward to Grayburg or Bernal in the Santa Rosa latitude. From east to west at the Santa Rosa latitude it truncates beds downward from high Artesia near the Texas line to lowest Artesia Grayburg or Bernal toward the Pedernal uplift where it locally rests on Precambrian (Read and others, 1945). Locally the base is erosionally irregular by reason of channels, swales, and solution of karst surfaces.

CHINLE FORMATION

The Chinle has been extended widely into New Mexico from the type locality near Chinle, Arizona. It is typically a thick red-brown mudstone, but in many areas contains numerous sandstone and conglomerate beds, lentils, or tongues, none of which has the great continuity of the forma-

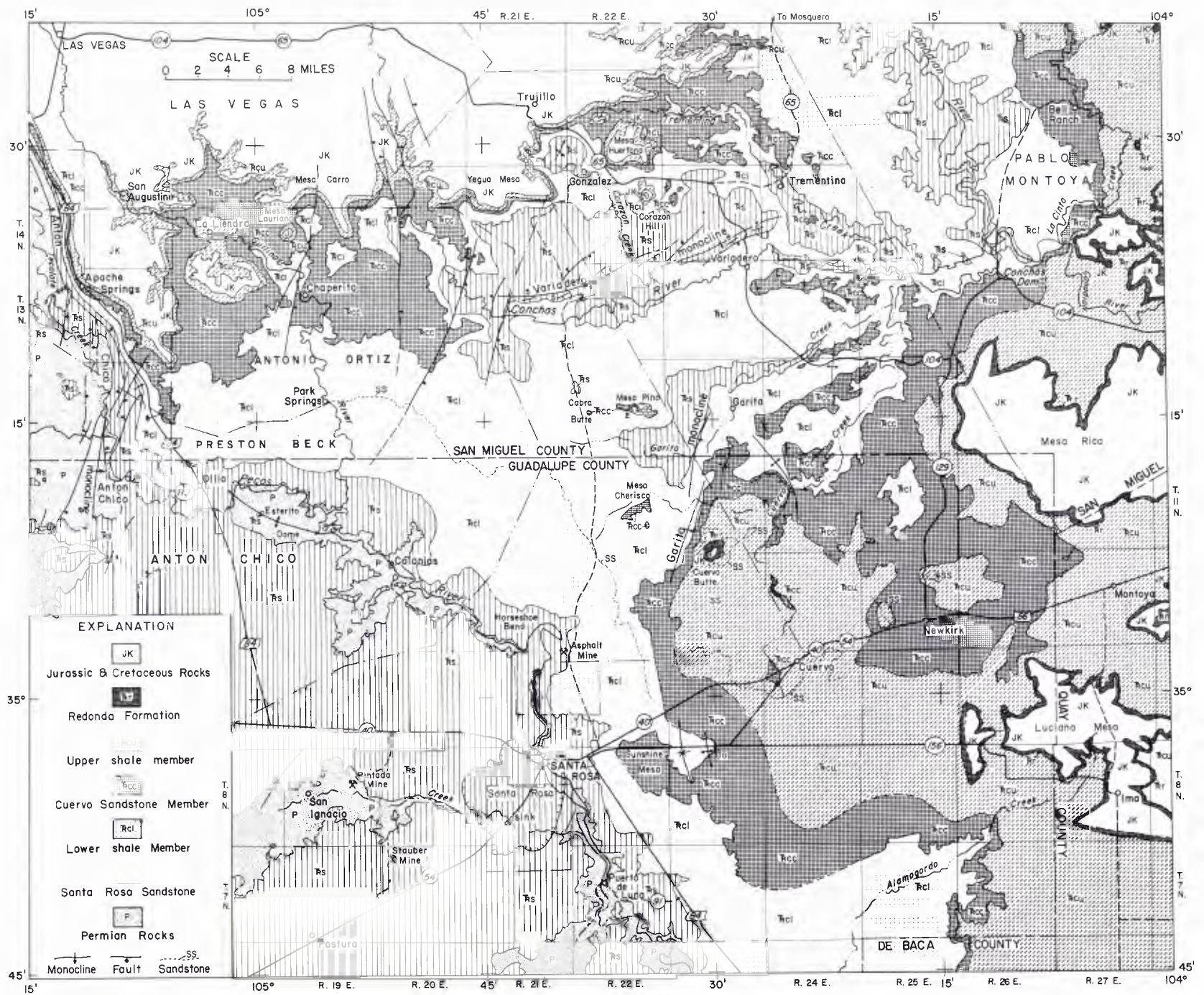


Figure 1. Geologic map of the Santa Rosa country. Cenozoic deposits omitted.

tion as a whole. In many places the formation has been divided into local members characterized by sandstone or distinctive mudstone-sandstone sequences. Overall mudstone is dominant. To the east and north of Santa Rosa there are numerous sandstone beds distributed through the Chinle. In this area a well-developed sequence of gray, buff, and brown sandstone beds has made it possible to map the Chinle into three members (Griggs and Hendrickson, 1951, p. 27). Wanek (1962) also mapped three members locally around Sabinoso, and recently Baltz (1972) has mapped them at Las Vegas. On the accompanying geologic map these are named: Lower shale member, Cuervo Sandstone Member, and Upper shale member (Kelley, 1972b). This division was mapped first in the country east of Santa Rosa but its best development and exposure are north of Santa Rosa. These occurrences are stressed in the following descriptions.

LOWER SHALE MEMBER

The Lower shale member is spread across broad benches above the Santa Rosa Sandstone to the east of the Pecos River. Its lower part is usually poorly exposed, being covered by soil, wind-blown sand, terrace gravel, or caliche. North of Horseshoe Bend on the Pecos River the member extends across a low divide into the Conchas River drainage and thence to the Canadian River north of Conchas Dam. Good exposures are seen along U.S. Highway 84 between Santa Rosa and Fort Sumner. The upper part of the member is the better exposed part of the unit, especially along the lower slopes of mesas held up by the overlying Cuervo Sandstone Member.

Although dominantly a reddish-brown mudstone sequence, it contains many thin sandstone units, some of which are traceable for many miles. Both brown and gray sandstone beds are present along with local pebble conglomerate. Near the Gallinas River between Park Springs and Chaperito, there is considerable brown sandstone which in places resembles beds of the Santa Rosa. Along Cuervo Creek near the western end of Conchas Reservoir greenish-gray sandstone resembling the Cuervo Sandstone is prominent at about creek level.

The Lower shale member is intergradational and intertongued with both the Santa Rosa below and the Cuervo above. Thickness appears to range from less than 100 feet in the Conchas Dam area to as much as four or five hundred feet around Fort Sumner. A thickness of 388 feet was measured in the Apache Springs section.

CUERVO SANDSTONE MEMBER

The Cuervo Sandstone Member was named for exposures along Cuervo Creek between Cuervo on Interstate 40 and the Conchas Reservoir (Kelley, 1972b, p. 26-27). Excellent exposures are seen along State Roads 129 and 104. In addition to the many exposures around Cuervo Creek excellent exposures occur in an extensive band of segmented mesas along the lower part of the Canadian escarpment between Apache Springs on the west and Trementina on the east (Pl. 1b). Good exposures occur also around Newkirk and across the Alamo-gordo drainage some 20 miles east of Santa Rosa.

The sandstones of the Cuervo are medium grained and typically greenish gray to light yellowish brown. These colors, especially the former, distinguish the sandstones from those of the Santa Rosa which are characterized by deeper grays, browns, and purplish browns. Alternation of red-brown mud-



Plate 1a. View west across the Canadian River at Sabinoso (T. 17 N., R. 24 E.). Top of Santa Rosa Sandstone is only a few tens of feet below the canyon floor. The lower ledges are Cuervo; the middle ledge Exeter; and the ridge top, Mesa Rica.



Plate 1b. View west from the site of Trementina. Santa Rosa beds in Trementina Creek in foreground; Cuervo Sandstone Member of the Chinle Formation caps the mesa with the Lower shale member on the flat and lower mesa slope.



Plate 1c. Cuervo Sandstone Member overlying the Lower shale member, Pino Creek section. The talus-covered slope and valley bottom is the Lower shale member.

stone with the sandstone units appears to be more prevalent than with the Santa Rosa. Throughout the Cuervo Creek area a triple-ledged division of the unit by mudstone prevails with the lower mudstone being the thicker separation (Pl. 1C). The strong-ledged, mesa or bench development of the Cuervo prevails through a northwest to southeast trending belt. To the southwest erosion has removed the formation, but to the northeast the unit thins by pinching out or gradation of units and beds into mudstone or thin brown sandstone. This can be noted in two places, near Conchas Dam and along the Canadian escarpment between Trementina and Sabinoso. East of these outcrops the Cuervo descends on regional dip beneath the Upper shale member.

The following tri-ledged section of the Cuervo Sandstone Member was measured on the south side of the mesa in sec. 35, T. 13 N., R. 24 E. (Pl. 1C).

CUERVO SANDSTONE SECTION ALONG PINO CREEK

Top eroded, probably not more than 10-15 ft removed.

No.	Description	Thick. Ft	Cum. Ft
17	Sandstone, tan and grayish brown, 2-3 ft crossbeds alternate with parallel beds, medium grained	19	242
16	onglomerate, red brown, limestone pellets and concretionary pebbles, some angular gray limestone and sandstone fragments	4	223
15	Sandstone, brownish gray, medium grained	2	219
14	Conglomerate, like no. 16	5	217
13	Sandstone, brownish gray, medium grained	1	212
12	Conglomerate, greenish gray, concretionary limestone pellets, also bleached sandstone and limestone pebbles	3	211
11	Mudstone, red brown, forms slope up to top ledge	23	208
10	Sandstone, greenish gray, thick bedded, medium grained, cross-laminated in upper 14 ft, locally pebbly	41	185
9	Conglomerate and sandstone, like no. 7 and no. 8	3	144
8	Sandstone, greenish gray, medium grained	1	141
7	Conglomerate, greenish gray, much concretionary and pellet limestone, angular sandstone and limestone fragments	5	140
6	Mudstone, red brown, forms slope above first ledge	42	135
5	Sandstone, red brown, thin bedded, cross-bedded in lower 4 ft, medium grained, local red-brown conglomerate in lower 4 ft	11	93
4	Mudstone, red brown	13	82
3	Conglomerate, gray to grayish brown, red-brown sandstone and gray limestone pebbles	1	69
2	Sandstone, light greenish gray, thin bedded, medium grained,		

slopes up across bench; crossbedded	13	68
1 Sandstone, greenish gray with local thin chrome-green layers, thick ledges with swooping cross laminations, gray in top 15 ft, medium grained, top is top of first bench, red-brown Lower shale member below	55	55
Total:	242	

The dashed lines mark the tops of the major sandstone ledges. Along strike these as well as the mudstone separations thicken and thin and the sandstone units locally thicken in channels at their bases.

Even though erosion has largely removed evidence of the western extent of the Cuervo there is some evidence of pinching and grading out along the southwestern exposures. Beginning in T. 11 N., R. 23 E. and southward along the Garita monocline the sandstone beds lose prominence and the sequence although poorly exposed appears thin. This situation prevails southward through Sunshine Mesa where, along State Road 156, the Cuervo may be less than 50 feet thick. Southeastward the exposures are covered beneath pediment gravel and caliche until they crop out again along Alamogordo Creek. Here the Cuervo is typical of the exposures along Cuervo Creek. South of Alamogordo Creek some 10 miles the formation again disappears beneath pediments. The Chinle is exposed rather continuously east of Fort Sumner to Taiban north of U.S. Highway 60. However, there is little in the way of Cuervo except a few thin ledges north and south of Taiban. At the present, it appears that the Cuervo may pinch out southward into the middle part of the Chinle.

The thinning or pinching out does not preclude the reappearance elsewhere to the east or the south at the same stratigraphic position in the Chinle. In the absence of the Cuervo sandstones, the Lower and Upper shale members lose their definition.

The Cuervo appears to attain almost its maximum development near the type locality where thicknesses of 242 and 224 feet have been measured. At Apache Springs a thickness of 205 feet has been obtained and on Alamogordo Creek (Kelley, 1972b, p. 29), 155 feet. It is clearly thinner elsewhere as described above. The Cuervo may be a large tongue in the Chinle which extended southeastward from a source in an ancestral Rockies highland.

UPPER SHALE MEMBER

The Upper shale member crops out in a sinuous band along the lower part of the steep Canadian escarpment from Apache Springs to near Sabinoso in the Canadian River canyon. It also crops out in wide exposures around the slopes of Luciana Mesa and Mesa Rica. Some of the best exposures are around Cuervo and Newkirk in several buttes and small mesas. The member is dominantly red-brown mudstone and overall is the most typical of the Chinle Formation. Reddish-brown sandstone units, up to several tens of feet thick, are found locally. A particularly well developed brown sandstone sequence 25-75 feet in thickness occurs about midway of the Upper shale in the vicinity of Newkirk and Cuervo as shown by dashed lines on the geologic map. This sandstone interval at Newkirk is rather widespread and appears to crop out along both sides of the Canadian River north of Tucumcari.

The following section of the Upper shale member was measured in the SE ¼ sec. 3, T. 9 N., R. 26 E. at the northeast spur of Luciana Mesa and about 6.5 miles ESE of Newkirk.

UPPER SHALE MEMBER OF THE CHINLE SOUTHEAST OF NEWKIRK

Triassic Redonda Formation

No.	Description	Thick. Ft	Cum. Ft
8	Sandstone and siltstone, variegated purplish brown and light green, colors are streaked, spotty and partly layered, all as a result of weathering of the Chinle prior to deposition of the Redonda Formation, the weathering resulted in a nodular and concretionary texture, sandstone is fine grained	19	406
7	Mudstone, tan-brown, local thin red-brown sandstone beds in upper 50 ft	228	387
6	Sandstone, tan brown, thin bedded, with local lenses of limestone pebble conglomerate	6	159
5	Mudstone, red brown, thin bedded and laminated	20	153
4	Sandstone, tan brown, medium and thin bedded, medium grained	4	133
3	Sandstone and siltstone, purplish to mauve brown, thin and laminated bedding, medium-grained sandstone	4	129
2	Sandstone, purplish to reddish brown, thick bedded, medium grained. 2-ft limestone pebble conglomerate at base	24	125
1	Mudstone, tan to reddish brown, some friable tan brown sandstone beds in upper one-third, local thin conglomerate lenses, measured across a terrace bench up to the first sandstone ledge, rests on greenish-gray Cuervo sandstone beds	101	101
Total:		406	

Upper Chinle shale member
Units 2, 3, 4 make up the sandstone interval at Newkirk mentioned above.

The thickness differs from place to place probably due to pre-Redonda and pre-Exeter erosion. The following thicknesses have been either measured or calculated from topographic elevations as follows: Apache Springs section, 403 ft; upper Alamogordo Creek area, 400-450 ft; southeast of Newkirk, 406 ft; Lauriana Mesa (T. 14 N., R. 19 E.), 150 ft; Huerfano Mesa (T. 15 N., R. 22 E.), 150 ft; Cuervo Butte, 200 ft.

REDONDA FORMATION

The Redonda Formation occurs only in the eastern part of the Santa Rosa area. It overlies the Upper shale member of the Chinle and is overlain by the prominent thick white Exeter Sandstone in Mesa Redonda, the type locality, south of

Tucumcari. The principal exposures are on the flanks of Luciana Mesa and Mesa Rica, the mesas east of Conchas Dam, and a small outlier at Cuervo Butte.

The Redonda contrasts with the Chinle by even beddedness and a distinctive orange-red coloration. It consists of alternating units of fine-grained sandstone and siltstone. In the Santa Rosa area it ranges in thickness from about 50 to 200 feet, but in the Tucumcari area Dobrovolsky and Summerson (1946) measured thicknesses of as much as 450 feet. The following section was measured on the southwest side of Cuervo Butte during work leading to this paper.

REDONDA SECTION AT CUERVO BUTTE

Jurassic Exeter Sandstone

No.	Description	Thick. Ft	Cum. Ft
13	Sandstone, light tan to grayish brown, top 2 ft bleached, fine grained, but mottled with well rounded medium grained sand	12	138
12	Siltstone, tan brown, clayey	1	126
11	Sandstone, tan brown, fine grained thick bedded	15	125
10	Siltstone, tan brown, clayey	13	110
9	Sandstone, tan, fine grained, thick bedded	20	97
8	Siltstone, tan brown, clayey	2	77
7	Sandstone, tan brown, fine grained, medium bedded and crossbedded, locally mottled with rounded coarse black and white grains of chert and quartz	7	75
6	Siltstone, tan brown, clayey	15	68
5	Sandstone, tan, fine grained, ledge	6	53
4	Siltstone, tan brown, clayey	18	47
3	Sandstone, tan, fine grained, ledge	4	29
2	Siltstone, tan brown, clayey	20	25
1	Sandstone, tan, fine grained, thick bedded Unconformably overlies tan brown Chinle mudstone; upper 15 to 20 ft mottled greenish gray and lavender; top 3 ft is spheroidally weathered and fissures are filled with Redonda sand	5	5
Total:		138	

Along the Canadian escarpment no Redonda beds occur west of R. 28 E., but it is continuously present in the north-south outcrops through the Pablo Montoya grant. The inferred restored wedge edge projects southwesterly around the occurrence at Cuervo Butte. Northward of the eastern end of the Canadian escarpment the wedge edge may swing in subcrop back to the west toward Ocate where similar beds referred to as the Naranjo Formation (Bachman, 1953) are present. The Redonda may be correlative with the Colorado Plateau Wingate Sandstone (Griggs and Read, 1959, p. 2005).

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