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PROBLEMS OF THE TRIASSIC STRATIGRAPHY IN THE CANADIAN RIVER BASIN, QUAY, SAN MIGUEL, AND GUADALUPE COUNTIES, NEW MEXICO

by

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INTRODUCTION AND ACKNOWLEDGMENTS

The basis of this summary is primarily a three-week study of the proposed Dunes reservoir site and vicinity on the Canadian River 15 miles east of Logan in March, 1957, supplemented by information from earlier reconnaissance trips to Quay and Guadalupe counties in 1952, 1954, and February 1957; a study of the Santa Rosa area in 1956; investigation of Los Esteros reservoir site leakage on the Pecos River (1954 to 1970) and Ute Dam spillway problems (1967-71); reconnaissance mapping and field conferences in the Tucumcari 2-degree quadrangle in 1971; and field tracing of the "canyon sandstone" at Conchas Dam in 1972. Cenozoic stratigraphy and engineering geology of the area are discussed in papers presented elsewhere in this Guidebook. Reference lists appended include unpublished reports on some of these investigations.

The field companionship and observations of Alfred Clebsch, Jr., Fred Trauger, Warren I. Finch, E. G. Lappala, and Gus Eiffler on various reconnaissance trips are gratefully acknowledged. The detailed mapping of the treacherous Canadian canyon, tributary gullies, and upland dunes in March, 1957 could not have been accomplished in the time available without the services of an unusually fearless and powerful horse, Chico, and cooperation of local ranchers. The field work was done in the course of studies made for the U.S. Geological Survey (1952), New Mexico State Land Office (1954), State Engineer (1956-70), and New Mexico Bureau of Mines (1971); and as a personal contribution to the field conference (1972). Topographic maps used as a base for detailed mapping in 1957 (Spiegel, 1957 b) were made by the Hydrographic Survey Section of the State Engineer Office in 1957, under the direction of Fred Allen.

REGIONAL SETTING AND TRIASSIC STRATIGRAPHY

The Canadian River and its tributaries are entrenched in a thick section of nearly horizontal, predominantly reddish-brown rocks that extends from the southern margin of the Raton basin near Springer, New Mexico, eastward to the Cretaceous rocks exposed around the western edge of the Mississippi embayment in Oklahoma and Texas. The upper part of this section has been identified as Jurassic in New Mexico, but the remainder is unquestionably Triassic except for Permian rocks exposed in the Bravo dome and the Texas Panhandle. The broad assymetrical arch traversed by the Canadian River between Cretaceous outcrops has two major high points, one at Bravo dome in Oldham County, Texas, just east of Quay County, New Mexico, and another at Sabinoso dome, New Mexico, above Conchas Reservoir. Low arches just below the mouth of Ute Creek and in lower Revuelto Creek also are responsible for abrupt local changes in the rocks exposed. These features apparently were not recognized in other mapping (Berkstresser and Mourant, 1966; Dane and Bachman 1965), probably due to lack of roads to some of the critical outcrops. A slight reversal of dip west of Brave dome raises a series of massive sandstones and locally interbedded mudstones upstream. These beds generally rise parallel to the river gradient, but with minor flexures, to a river bend about 3 miles west-southwest of Logan (Fig. 1) where a slight but important flexure (herein called the Ute anticline) carries the sandstone section below the river channel. The structure can still be seen in lake-side bluffs, despite partial submergence by Ute reservoir. It is referred to informally by Bates (1946) as a "prominent anticline" on the basis of subsurface data, and is illustrated in cross-section as Bates' Figure 2.

The massive sandstone exposed in the river bluffs of the Canadian River near Logan has been referred to informally by Kottlowski (pers. commun.) as the "Logan" Sandstone and herein for convenience will be referred to as the Logan Sandstone, without quotes. Sandstones in the lower part of Ute Creek, just west of the flexure, and upstream on the Canadian as far as Sabinoso dome are unquestionably stratigraphically higher than the Logan Sandstone. The section of sandstone and mudstone above the Logan has been referred to the Chinle. The Logan, or its lateral equivalent, does not crop out again between Ute Creek and the Los Esteros Creek area in the Pecos River valley (T. 11 N., R. 21 E.).

The sequence of Triassic rocks exposed in the Conchas Dam area was studied locally by the Corps of Engineers in connection with the construction of the dam and appurtenant irrigation canal and tunnel. A unit called the "canyon sandstone formation" was logged in numerous drill holes in 1936 (U.S. Corps of Engineers, 1936 a, b) and mentioned by Matthes (1936) and Crosby (1940). The unit crops out in the canyon of the Canadian River at the dam site and upstream in the Conchas arm of the reservoir, where it was later incorrectly identified as the Santa Rosa sandstone (Griggs and Hendrickson, 1951; Wanek, 1962; Dane and Bachman, 1965). However, the unit cannot be traced into either the type section of the Santa Rosa Sandstone or the Logan Sandstone, and is believed by the writer to be part of the middle sandstone member of the Chinle.

Downstream from the Logan area, massive sandstone (with thicknesses of red and green mudstone increasing eastward) was traced to outcrops in Trujillo Creek (Texas and New

Figure 1. Aerial view southwest from above Logan (up Canadian R.) showing outcrops of Trujillo Formation and Ute dam site (downstream from upper Bend). Light-colored rim of Canadian River at upstream margin of photo is west limb of Ute anticline. Photo by N. S. Long.

Mexico) that are in the lower part of a unit described as the Trujillo Formation by Gould (1907). On the west flank of the Bravo dome, below the lowermost of the Logan or basal Trujillo sandstones, a section of variegated mudstones and friable white sandstones (Gould's Tecovas Formation) intervenes between the Logan or basal Trujillo sandstones and the eroded top of a thick Permian section of gypsiferous terra cotta sandstones (Gould's Quartermaster Formation) capped by a massive 10-foot bed of dolomite, referred to by Gould as the Alibates lentil of the Quartermaster Formation.

The problem of Triassic stratigraphy in the Canadian River drainage basin is simply this: a thick section of alternating fluvial sandstone and mudstone of Triassic age is well exposed in canyons of the Canadian River and its tributaries from the Sabinoso area above Conchas Lake to Bravo dome in the Texas Panhandle. The traceable units of sandstone are obvious: a thick resistant section in the Canadian River near Logan (Fig. 2), and a thinner, generally softer sandstone, reported by Finch to be uranium bearing, which crops out higher in the section.

Two distinct sandstone units of probable Triassic age which are well developed locally, but which are not traceable throughout the field trip area, are the Redonda Formation, and the "canyon sandstone formation" of Matthes (1936) at Conchas Dam. Griggs and Read (1959) give some good stratigraphic evidence for raising the Redonda from a member of the Chinle to formational status. However, there is no valid reason for assignment of the "canyon sandstone formation" to the Santa Rosa, as was done by Griggs and Hendrickson (1951), Wanek (1962), and Dane and Bachman (1965).

Geologists have tried to classify the complex assemblage of rocks into a few idealized widespread units on the basis of local studies. The regional study of the Triassic by McKee, and others (1959) unfortunately was based primarily on subsurface data in the Canadian River valley. Because it disregarded the excellent key outcrops along the river, that study is of little value for local details seen in the Conference area. The McKee

Figure 2. Basal Chinle (slumped sandstone on mudstone slope) resting on Trujillo Formation (massive sandstone). View south in deep gully 0.2 mile upstream from south abutment of Ute Dam, T. 13 N., R. 33 E., Sec. 21. Photo taken in March 1957, prior to construction of dam.

report does provide useful data concerning regional thickness trends and lithologic variations. Disagreement among geologists as to the nomenclature to be used for Triassic units is due to a combination of factors: difficulty of access to many of the good outcrops in the Canadian River, Trujillo Creek, and Bravo dome, the discontinuity of outcrops across the Tucumcari basin, the great area of discontinuous exposures, the sparsity of good subsurface data, numerous and rapid facies changes, and the presence of the New Mexico-Texas state line.

Due to unfortunate provincialism, Gould's terminology of Tecovas and Trujillo for the complete Triassic section in Texas was not followed in New Mexico. The term Santa Rosa was extended erroneously from outcrops in the Pecos Valley into the Conchas Dam area by Griggs and Hendrickson (1951), and Dane and Bachman (1965), and to the Logan area by Berkstresser and Mourant (1966), and Dane and Bachman (1965). The writer has noted the following arguments against identification of the sandstones exposed at Conchas Dam and Logan as "Santa Rosa."

(1) The Santa Rosa in the Pecos Valley locally contains a basal mudstone section resembling some lithologies of Gould's Tecovas (Clebsch, 1957, oral comm.)

(2) The Chinle in the area north and east of Santa Rosa, (Dinwiddie, 1967); and elsewhere in north-central New Mexico has been noted to contain a persistent middle sandstone member. This and other less persistent sandstones, particularly in the lower member of the Chinle (Spiegel, 1957a; State Engineer Office, 1961) can be mistaken for sandstones lower in the Triassic section (Santa Rosa) when the stratigraphic position cannot be verified independently, such as by Permian outcrops, well samples, and cores. Clebsch (in Dinwiddie, 1967) has correctly mapped sandstones in northeastern Guadalupe County as Chinle. Griggs and Hendrickson (1951, p. 27) have generally correctly described the extent of the middle sandstone of the Chinle in San Miguel County, but mapped sandstones in the middle Chinle as Santa Rosa. However, they expressed some doubts (p. 26) as to the validity of the assignment of the sandstones at Conchas to the Santa Rosa. The presence of sandstones in shallow drill holes in lower Chinle beds near Ute dam site (State Engineer Office, 1961) was confirmed by an excellent outcrop created during excavation for the north abutment of the spillway of Ute Dam.

(3) Deep drill-hile data at Dunes (see well log 1) and Ute Dam sites (Bechtel, 1962 a, b; 1963) indicated the presence of Tecovas lithologies below the Logan Sandstone, and Tecovas-like outcrops are observable at the base of sandstone bluffs at a number of locations down-river from Logan. These outcrops are characterized by red mudstone and a friable white sandstone similar to outcrops on the west flank of Bravo dome, where they were identified by Gould (1907) as Tecovas.

(4) The gentle westward dip of the rocks west of Ute Creek carries the top of the Chinle down nearly to the Canadian River at the west edge of the Tucumcari 2-degree quadrangle (Section 4, T. 13 N., R. 30 E.), and although the dip reverses upstream, only the upper third to half of the Chinle is exposed in the Conchas area to the west. The limited thickness of the Triassic section exposed below Jurassic rocks northeast of Conchas Dam is further evidence that the "canyon sandstone" beds at Conchas Dam are not Santa Rosa, but local sandstone in the upper to middle part of the Chinle. Dam-site test holes show that sandstone and red mudstone extend to at least 240 feet below river level at Conchas Dam (Crosby, 1940). Some of these deeper beds (see well log 2) could be equivalents of the upper part of the Santa Rosa or, more likely, the Santa Rosa could be even deeper than 240 feet below Conchas Dam.

(5) Well Log 3, from a 1946 oil test (Waggoner & Wharton, Upton #1) in the northwest corner of Sec. 25, T. 18 N., R. 26 E., at elevation 4,875 feet (well 5 in Wanek's list of wells) near the top of a sandstone mapped by Wanek (1962) as "middle sandstone member of the Chinle," indicates a 120-foot section of predominantly hard sandstone at a depth of 681 to 801 feet, underlain by a 144-foot section of sandy shale, in turn underlain by anhydrite. These sections are interpreted herein to be, respectively, Trujillo Formation (restricted), Tecovas Formation, and the upper Quartermaster or Bernal Formation.

If the log of this well were added to Wanek's measured section #4 in his graphic correlation it would appear more logical to correlate the thick sandstone at the base of Wanek's measured Section #5 with the middle sandstone member of the Chinle rather than with the Santa Rosa.

The key to the problem lies in the structure and lithology in the Canadian River Canyon just below Conchas Dam, and in deeper subsurface information near Conchas Dam. Is there a sufficient reversal of dip to carry the top of the Logan Sandstone, from an estimated depth below the river of more than 1,000 feet in the axis of the Tucumcari basin (east of the mouth of Atarque Creek) up to the top of Conchas Dam? Or does the thick mudstone facies of the upper Chinle in Quay County, northeastern Guadalupe County (Clebsch, in Dinwiddie, 1967), and southern Harding County interfinger with units of sandstone of the upper Chinle in east-central San Miguel County? A short walk downstream from Conchas Dam along the right bank of the Canadian River is sufficient to determine that (a) the structure is not favorable to the outcrop of the Logan at Conchas Dam, and (b) that the "canyon sandstone formation" at Conchas Dam thins eastward and interfingers with mudstone.

In the writer's 1957 reconnaissance tracing of the Logan Sandstone eastward to Trujillo Creek in Oldham County, Texas, it was noted that the sandstone section of the mapped area (Spiegel, 1957 a, b) split into three sandstone units separated by red mudstones, and that the section was equivalent to sandstone in the lower part of Gould's Trujillo Formation. Therefore the name Trujillo Formation was applied to the Logan, since Trujillo had considerable precedence over "Santa Rosa" (see Balk, Lexicon, this Guidebook). Further reconnaissance in 1971, in part with W. I. Finch, confirmed the extension of the Logan Sandstone facies into the lower part of Gould's Trujillo Formation at Trujillo Creek, with the top of the uppermost massive sandstone crossing Trujillo Creek at the state line about two miles north of Glenrio. The overlying typical sequence of lower shale, middle sandstone, and upper shale members of the Chinle were traced eastward from eastern San Miguel County across the southern part of the Tucumcari 2-degree quadrangle independently by Spiegel and Finch in 1971. The sandstone at Logan is not continuously exposed westward between Logan and bonafide Santa Rosa outcrops in the Pecos Valley.

CONCLUSIONS

The solution, essentially as proposed by Trauger in a memorandum of November 4, 1971, and concurred in by the writer, is to redefine Gould's Trujillo Formation to include only the lower sandstones north of Glenrio (equivalents of the Logan Sandstone) and to assign the upper beds of Gould's Trujillo to the Chinle.

The Santa Rosa in the Pecos Valley probably is equivalent to the combined section of Tecovas and Gould's lower sandstones of the Trujillo, but the sandstone members of the Santa Rosa may not be physically continuous into the Logan Sandstone and are definitely not equivalent to the "canyon sandstone" at Conchas, or the sandstone at Sabinoso dome.

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WELL LOG 1

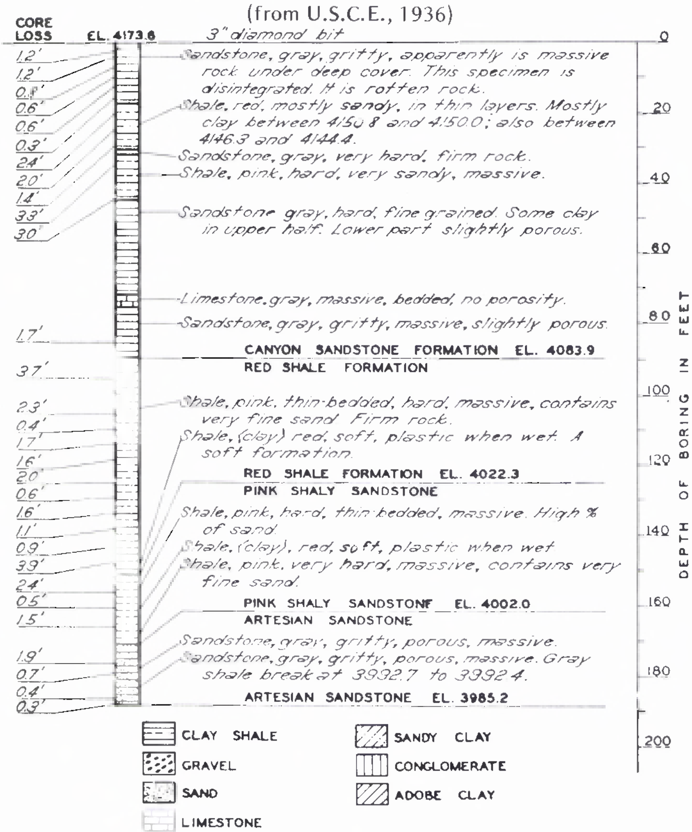
SAMPLE DESCRIPTION OF DUNES #10 TEST HOLE

Section 2, T. 13 N., R. 35 E., NMPM
(Elevation 3585 ft., on east slope of knob on north bank)
E. A. Chavez, August 1957

Interval	*Description*
Alluvium:	
0 - 5	ss., f.g. to v.g.f., lt. tan to buff (probably wind blown dune sand)
Tecovas:	
5 - 10	ss., v.f.g. lt. tan, micaceous, subrounded grains
10 - 25	Cored: Recover 5.4'—All ss., lt. tan to white, clean, soft friable but consolidated, porous, micaceous
25 - 35	Cored: Recovery 5.7'—All ss., as above
35 - 45	Cored: Recovery 4.55'—All ss., as above but with occasional laminae of micaceous gray siltstone.
45 - 55	Cored: Recovery 4'—All ss., lt. tan to white, clean, friable but consolidated, porous, with occasional inclusions of calcium carbonate forming incrustations and tiny clacite filled cavities.
55 - 65	Cored: Recovery 3.25'—(Top) 2.55' is ss., lt. tan to white, hard compact, slightly calcareous grading to 0.7 of conglomerate, small pebbled, gray to yellowish gray, vy. calcareous with large fragments of gray dolomite at base.
65 - 70	ss., m.g. to v.g.f., white to lt. gray, clean
70 - 75	ss., v.g.f. tan, argillaceous, slightly micaceous.
75 - 80	ss., f.g. to v.f.g. buff to bwn., slightly micaceous.
80 - 85	ss., v.f.g., bwn., rounded grains
85 - 90	ss., as above but vy. clean, well sorted grains
90 - 100	Cored: Recovery 1' 10"—ss., white, m.g., vy. porous and clean w/1" lens of gray siltstone near bottom.
100 - 105	Cored: Recovery 2'—ss., as above
105 - 110	No sample
110 - 125	Cored: Recovery 1' 9"—Top 18½" ss., as above 2½" Dk. gray soft, sticky shale
125 - 145	ss., f.g. to v.f.g. lt. tan to white, micaceous, rounded grains.
145 - 150	ss., v.f.g., tan, micaceous, subangular grains
Alibates:	
150 - 155	Cored: Recovery 1'5" Lt. gry, crystalline and vy. tight ls. w/occasional intrusions of soft white pyritic gypsum. Vugular in places.
155 - 160	Cored: Recovery 1' 10" Lt. Gry. ls. as above grading to dolomite, sporadically vugular.
Quartermaster:	
160 - 161	Shale, gray
161 - 170	Ss., v.f.g., soft, friable lt. bwn., argillaceous, and slightly micaceous
170 - 175	Ss., as above with a lense or red and gray variegated shale at 170'
175 - 180	Ss., as above grading into
180 - 183	Cored: Recovery 2' 1½"—Hard, well consolidated sandy red shale with occasional streaks of blue-gray coloration.
183 - 190	Siltstone, brown, arenaceous
190 - 195	Ss., brown, v.f.g., rounded grains
195 - 209	Ss., as above and argillaceous
209 - 210	sh., red w/blue-gray variegations
210 - 220	Ss., v.f.g., brown, argillaceous and slightly carbonaceous
220 - 230	Siltstone, reddish tan, minutely arenaceous
230 - 235	Siltstone, reddish tan, strongly arenaceous
235 - 240	Shale, red with white variegations

WELL LOG 2

U.S. Corps of Engineers Core Boring H-4
North dike of Conchas Dam, New Mexico
(from U.S.C.E., 1936)



WELL LOG 3

Waggoner and Wharton, Upton #1, 1946
NW Cor. Sec. 25, T. 18 N., R. 26 E., NMPM
(Elev. 4875 ft., reported)
Log from files of NMOCC

FROM	TO	THICKNESS IN FEET	
MIDDLE SANDSTONE MEMBER OF THE CHINLE FM (Top eroded):			
0	20	20	Surface, boulders & hard sand rock
20	35	15	Hard sand
35	45	10	Broken shale & sand
45	70	25	Red sand hard
70	80	10	Red sand
80	90	10	Broken sandy shale
90	105	15	Red rock, blue shale
105	122	17	Broken sandy shale
122	158	36	Shale & sand
158	200	42	Red rock and sand
LOWER SHALE MEMBER OF THE CHINLE FM:			
200	290	90	Red shale
290	305	15	Red shale with green shale breaks
305	340	35	Green shale breaks
340	360	20	Red & blue shale & rock brks.
360	385	25	Sandy shale, hd.
385	431	46	Green shale, blue shale and sand
431	490	59	Grey shale, hard sand
490	520	30	Blue sandy shale
520	529	9	Hard red rock broken
529	550	21	Shale, sandy shale
550	575	25	Bentonite green
575	590	15	Bentonite green
590	650	60	Green shale sand breaks
650	681	31	Sand & shale
TRUJILLO SANDSTONE (restricted, this paper):			
681	700	19	Hard sand
700	705	5	Shale (blue)
705	724	19	Hard sand
724	752	28	Sand and green shale
752	783	31	Hard sand & shale
783	801	18	Hard sand
TECOVAS FORMATION (Note that Trujillo and Tecovas combined equal Santa Rosa ss.):			
801	842	41	Sand & shale
842	876	34	Sand & red & green shale
876	920	44	Sand & red & blue shale
920	940	20	Sand
940	955	15	Sand & shale
UPPER MEMBER OF THE QUARTERMASTER FM (Bernal fm.):			
955	1022	67	Anhydrite
1022	1037	15	Red shale
1037	1050	13	Broken Anhy
1050	1098	48	Green shale, sand breaks
1098	1130	32	Broken shale
1130	1131	1	Crevis
1131	1135	4	Sand rock
ALIBATES LENTIL OF THE QUARTERMASTER FM. (San Andres fm.):			
1135	1145	10	Dolomite
1145			
1155	1159	4	Hard sand (Dolomite)
LOWER MEMBER OF THE QUARTERMASTER FM. (Glorieta ss.):			
1159	1179		Sand hard
1179	1184		Broken sand
1184	1239	55	Hard sand
YESO FM:			
1239	1312	73	Broken sand
1312	1351	39	Sand
1351	1364	13	Hard sand
1364	1380	16	Brkn sand
1380	1407	27	Sand & lime
1407	1437		—
1437	1451	14	Broken sand & shale
1451	1494	43	Sand & shale
SANGRE DE CRISTO FM. AND MAGDALENA GROUP, UNDIFF:			
1494	1517	23	Red rock
1517	1539	22	Red rock & sand
1539	1566	27	—
1566	1632	66	Red rock
1632	1663	31	Red rock sandy
1663	1713	50	Red rock
1713	1720	7	Red & blue shale
1720	1743	23	Anhy & Dolomite brks.
1743	1768	25	Broken Anhy & shale
1768	1780		—
1780	1820	40	Anhy & shale red
1820	1853	33	Sandy shale, red & blue, with andhy breaks
1853	1873	20	Red rock
1873	1900	27	—
1900	1941	41	Brkn formation gyp, gravel, shale (granite wash)? Show of gas 1937'
1941	1994	53	Granite Wash
1994	2022	28	Granite wash lime (gas bubbles on pit 1995-2002)
2022	2080	58	Granite wash
2080	2100	20	Shale, gyp, silate, granite wash
2100	2114	14	Granite wash
2114	2132	18	Granite wash, hard
2132	2148	16	Granite wash
2148	2158	10	Hard granite wash
2158	2171	13	Granite Wash
	2171		T. D.