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OUTCROPPING PERMIAN SHELF FORMATIONS OF EASTERN NEW MEXICO

by

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INTRODUCTION

Permian beds of Leonardian and Guadalupian ages comprising the Yeso, San Andres, and Artesia units are at or near the surface in expansive areas west of the Pecos River. The area is one of low regional dip extending across eastern New Mexico from the Pedernal uplift on the west into Texas on the east, a distance of some 200 miles. East of the Pecos, however, the Permian rocks lie mostly in the subsurface. In the area west of the Pecos only Permian Abo and Pennsylvanian Magdalena beds intervene between Yeso, the oldest formation treated here, and the basement Precambrian. The Abo and Magdalena Formations wedge out westward by thinning and overlap onto the buried late Pennsylvanian to Leonardian landmass. The Yeso likewise wedges by overlap across the Abo and onto the landmass, and very locally around Pedernal Peak appears to be overlapped by the overlying Glorieta. Except for the Yeso and Glorieta the best exposures of the Permian units discussed here lie far to the south along the Pecos Valley, the southern Pecos slope, and in particular the Guadalupe Mountains.

GENERAL STRATIGRAPHY

The Permian units consist mostly of medium- to very fine-grained clastics, gypsum, and carbonates whose proportions vary in the several mappable facies and formations. Except in the Yeso and Glorieta, medium-grained clastics are absent or rare, and no coarse-grained sandstone is present, thus causing the rocks to stand in distinct contrast with the coarse-grained sandstones and conglomerates of the underlying Abo and overlying Triassic Santa Rosa Formations. Likewise arkosic and clayey sandstone is uncommon to rare in Permian units, although some sandstone is sparsely muscovitic. Claystone probably is also uncommon as is shaliness. The most common fine clastic is probably best termed mudstone at least until more information on these rocks is available.

The Yeso and San Andres Formations were named by Lee in 1909 and the Glorieta by Keyes in 1915. Despite this, Darton (1922, p. 181) introduced the term Chupadera Formation and relegated the earlier terms to members. In doing this Darton noted "that while Lee's terms were discernible in places, it was impracticable to separate them generally." In the Chupadera Mesa country there is much mixing of the lithologies which are elsewhere more clearly separated into formations. In the southern Chupadera Mesa and adjoining areas there is much gypsum, some redbeds, and sandstone in the San Andres. The Glorieta type sandstone is not very thick in the basal position and such sandstone occurs higher and even at or near the top. The Yeso, however, is reasonably characteristic of many other areas. In lumping the now widely accepted units under Chupadera, Darton may have suffered from having known much more than others on a regional basis. However, he had neither the means nor the time to work out the facies problems. He very likely had seen the intertonguing of Glorieta sandstones with the San Andres in the Lincoln County area. After leaving his work in New Mexico he reported to friends that the Chupadera stratigraphy was the one problem he would have most liked to restudy.

The Chupadera formation included all beds between the underlying Abo Formation and the overlying Triassic Dockum Group. By 1928 Darton (State Geologic Map) had traced his Chupadera throughout the Pecos country where it embraced in its higher part all the beds now designated as Artesia Group, including the Capitan Limestone and the Bernal Formation. Only slightly later, Fiedler and Nye (1933, p. 44) proposed the term, Pecos Formation (now abandoned) for all the beds in the Pecos Valley between the San Andres and the Triassic.

Needham and Bates (1943), in company with Geological Survey geologists of that time, found the triparte subdivision of the Chupadera beds into Yeso, Glorieta, and San Andres quite acceptable for central and western New Mexico. In fact one of the best and most consistent formation boundaries in New Mexico is that between the Yeso and the San Andres. The same cannot be said for the Glorieta and San Andres, and recent work has shown (Kelley, 1971, p. 9-12) that the Glorieta is a facies of the lower part of the San Andres (Fig. 1).

In 1962 Tait and others introduced the term Artesia Group to embrace five formations (Grayburg, Queen, Seven Rivers, Yates, and Tansill). This was done mostly to erase confusion that had resulted from the simultaneous conflicting usage of Lang's (1937) Chalk Bluffs formation, the Oklahoma term, Whitehorse Group (DeFord and Lloyd, 1940), and the Bernal Formation (Bachman, 1953) for beds of this group in central and northeastern New Mexico. Definition of the Artesia term by Tait and others required, and in fact accomplished, better description and correlation of the Artesia formations between the subsurface and the surface. The term was further deemed important and useful for surface outcrops where poor exposures and indistinctive lithologies made mapping of the formation either impossible or too uncertain. Although the term, Artesia Group, is a useful term, the constituent formations have been mapped separately in the Pecos Valley northward as far as Santa Rosa (Kelley, 1971, pls. 2, 4, fig. 7; Kelley, 1972b maps 1, 2). Tait and his coworkers recommended discarding the term, Bernal Formation, in favor of Artesia Group, but I have recommended retention of Bernal as a well entrenched, useful, and prior term for areas of central and northeastern New Mexico which lack continuity with the more widespread outcrops along much of the Pecos Valley of New Mexico.

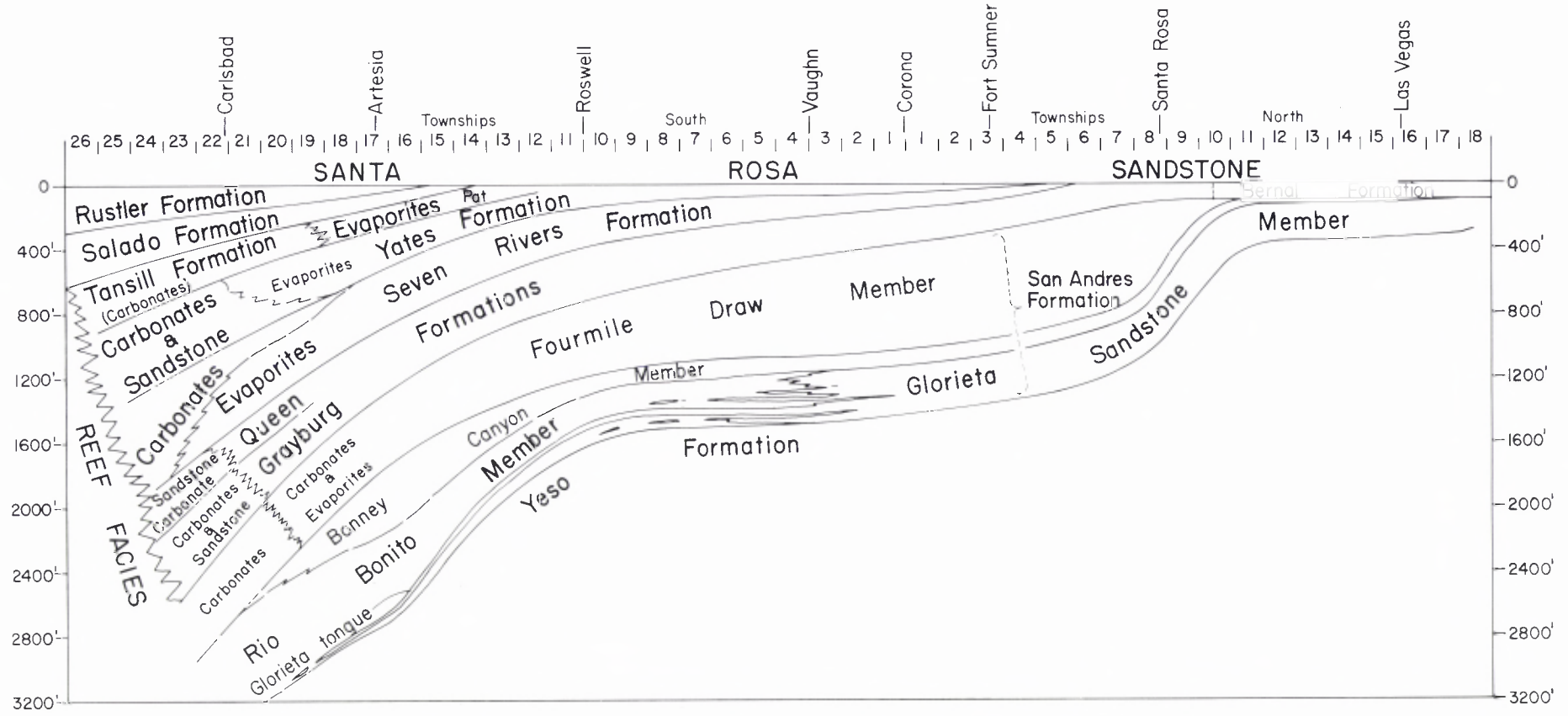

Figure 1. South to north stratigraphic section showing Grayburg and Queen Formations overstepping San Andres Members and Triassic Santa Rosa overstepping Permian Formations.

YESO FORMATION

The Yeso Formation consists of gypsum, fine- to medium-grained sandstone, carbonates, and some green or reddish-brown siltstone. By surface distribution it is a central New Mexico formation, being found predominantly between longitudes 105-107 west. The principal outcrops relevant to this guidebook are from west of Vaughn to around the Pedernal Hills where the formation surfaces wide valleys and several prominent mesa slopes, as near Duran. However, the most notable occurrences for eastern New Mexico are those of the Sacramento Mountains area where full sections between the underlying Abo and overlying San Andres are found in several places. Northrup and Pray (Pray, 1961) measured two nearly complete sections, 1,339 and 1,200 feet thick, and Kelley (1971, p. 6) measured one complete section 1,220 feet thick. Several hundred feet of carbonate are prominent in the Sacramento sections, especially in the middle of the formation.

Good partial exposures of the Yeso occur in the Pedernal Hills and in southeastern Torrance County at Jumanes, Duran, and Chupadera Mesas (Fig. 2). Thicknesses of 1,000 to 1,500 feet have been estimated from poor exposures in the Gallinas Mountains (Kelley, 1972b) where both a top with Glorieta sandstone and a bottom on Abo redbeds are present. Around the Pedernal Hills the Yeso rests by overlap on Precambrian rocks. In places coarse Precambrian debris is found in the Yeso, but by and large the Yeso has remarkably little contribution of material from the buried hills. The Yeso is obviously thin near the hills as a result of the onlapping burial, and in places it must reach zero as the overlying Glorieta Sandstone Member rests or nearly rests on the Precambrian. Further suggesting of thinning by overlap lies in the absence of the lower Meseta Blanca Member which is present to the north along Glorieta Mesa and to the west in the Sandia Mountains.

In the Chupadera Mesa to Socorro country, Wilpolt and others (1946, sheet 2) divided the Yeso into the following members.

Joyita Sandstone Member (Needham and Bates, 1943)	50-60 feet
Canas Gypsum Member (Needham and Bates, 1943)	0-100 feet
Torres Member (Sandstone, siltstone, carbonate, gypsum)	300-600 feet
Meseta Blanca Sandstone Member (Wood and Northrop, 1946)	100-200 feet

Ordinarily these units, with the exception of the lower one, are shown only in graphic measured sections and have not been divided on maps owing to generally poor exposures.

SAN ANDRES FORMATION

Read and Andrews (1944) divided the San Andres Formation into three members in order upward: Glorieta Sandstone Member, Limestone member, and Upper member. They put the Glorieta in the San Andres rather than by itself because of intertonguing by the Limestone member and the Glorieta along the west side of Glorieta Mesa. About the same time Wilpolt and others (1946) had mapped a Yeso-like parting in the Glorieta along the west side of Chupadera Mesa which they suggested indicated tonguing into the Yeso. However, since they did not map the pinching-out of either the upper or lower ledge of the Glorieta, tonguing is really unknown. Later the Glorieta and the Upper member (Bernal) were separated from the San Andres by most workers until regional mapping in Lincoln County demonstrated clearly that the Glorieta is a facies of the lower part of the San Andres Formation (Kelley, 1971, p. 9-12).

In the Pecos slope country, between the Capitan Mountains on the north and the Guadalupe Mountains on the south, the San Andres Formation has been divided, in order upward, into Rio Bonito, Bonney Canyon, and Fourmile Draw Members (Kelley, 1971, p. 6, 7). The first has its type locality near the northern end of the Guadalupe Mountains and the others along the Hondo River drainage west of Roswell. Thin Glorieta sandstone tongues first appear low in the Rio Bonito Member in the northern part of the Guadalupe Mountains. They thicken northward in two or three tongues until about latitude 34 north (Figs. 1, 2) where they begin to make up nearly one-half of the Rio Bonito Member. In the Tecolote Hills, T. 35., R. 12 E., carbonate tongues wedge out northward and sandstone becomes predominant around the Gallinas Mountains and in the mesas east of Corona. Northward the entire San Andres of the Rio Bonito interval becomes sandstone as shown in the northern part of the Corona mesas, Chupadera Mesa, and especially Duran Mesa, as may be seen along U.S. Highway 54 a few miles southwest of Duran.

North of the Capitan Mountains the Bonney Canyon thins and is difficult to recognize. It may pinch out or turn partly to gypsum, thus making it indistinguishable from the overlying Fourmile Draw Member. The lower, Rio Bonito and Glorieta, part of the San Andres Formation are in the subsurface east of the Jicarilla Mountains, 30 miles north-northwest of Capitan (Fig. 2). When the section reappears east of Tecolote, 20 miles southwest of Corona in T. 3 S., R. 13 E., it cannot be determined whether the highest Glorieta beds are coincident with the top of the Rio Bonito, the thin Bonney Canyon or the lowermost Fourmile Draw. In any event from this area northward and on into central New Mexico there is nearly everywhere an interval of gray to dark-gray finely crystalline dolomite up to about 100 feet in thickness between thick Glorieta Sandstone below and evaporitic San Andres carbonates above. This interval could be the highest part of the Rio Bonito section, which it resembles in places by the thickness of its ledges, or it could be the Bonney Canyon Member. I have chosen the latter mostly because it preserves the terminology of the threefold division of the San Andres made in the Pecos country. It has been mapped on the Fort Sumner Sheet (Kelley, 1972b, map 1) as Bonney Canyon. The alternative would have been to map the unit as a high tongue of the Rio Bonito Member.

The Bonney Canyon as it occurs in the area of the Fort Sumner sheet is the San Andres as mapped in most of central New Mexico east of the Rio Grande. In central New Mexico the Bernal rests on the Bonney Canyon with the Fourmile Draw Member having either never been deposited or eroded prior to Bernal disposition. This situation also exists in the stratigraphy from Roswell to Ruidoso (Fig. 3). Around Clines Corners, in R. 12 E. astride the Pedernal uplift, Bernal rests on Bonney Canyon, but some 20 miles easterly, as exposed several miles northwest of Vaughn, Fourmile Draw intervenes between Bonney Canyon and the Bernal.

The Fourmile Draw Member has been traced from the Guadalupe Mountains northward along the Pecos slope to the

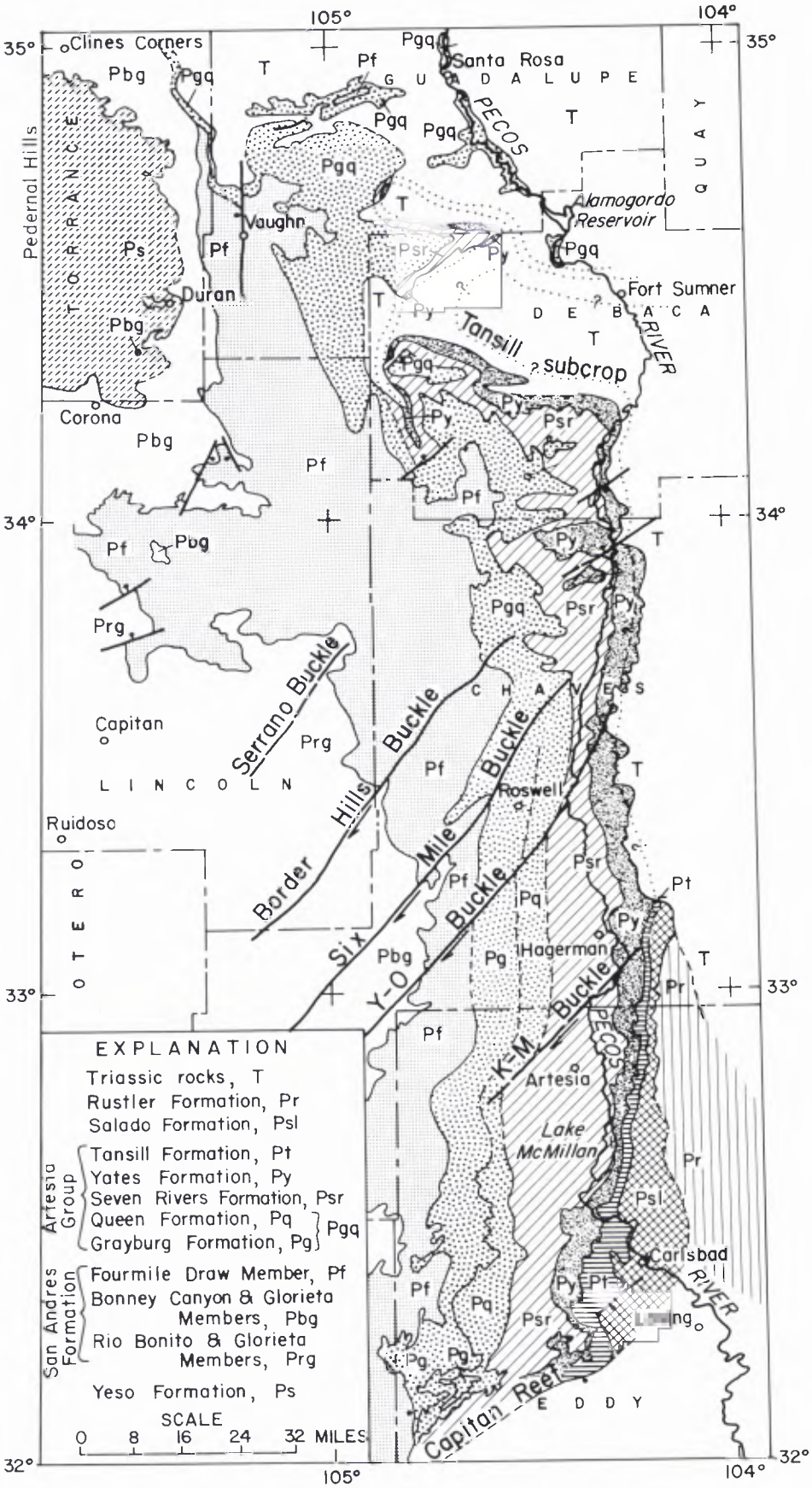

Figure 2. Map showing bedrock distribution of Permian and Triassic rocks in the Pecos Valley country.

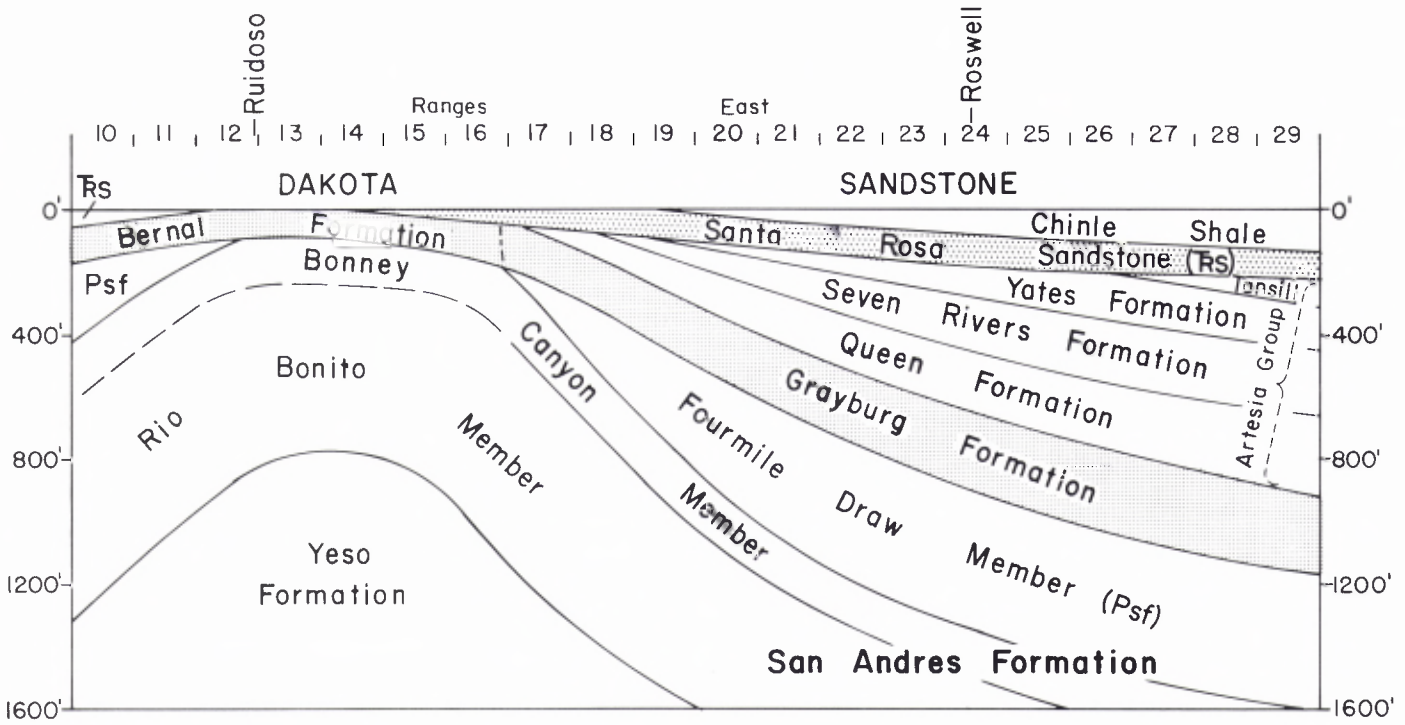

Figure 3. West to east stratigraphic section showing overstepping of Artesia Group across San Andres and Triassic Santa Rosa across the Artesia.

Vaughn area (Fig. 1). Throughout this area it appears to range in thickness between about 400 and 600 feet. It consists dominantly of dolomite and gypsum, but with numerous thin lenticular intervals of reddish-brown and green mudstone. The gypsum occurs both as beds up to several tens of feet thick, as numerous blebs in dolomite, or granular in mudstone. In a considerable area around the Jicarilla and Gallinas Mountains there is a white, medium-grained sandstone 20-30 feet thick at the top of the member (Kelley, 1971, p. 13). The evaporitic nature of the upper part of the San Andres has been long recognized by workers in the Permian basin in both the subsurface and the surface (Darton, 1922, p. 181 and Fiedler and Nye, 1933, p. 67).

Mourant and Shomaker (1970, p. 14) logged the Hawkins #1 Myrick well (sec. 25, T. 2 N., R. 25 E.) about 6 miles southwest of Fort Sumner and described a 625-foot upper evaporitic interval that is probably Fourmile Draw above a 110-foot carbonate unit that is probably Bonney Canyon. This thickness of evaporitic Fourmile Draw, in places with halite as well as anhydrite or gypsum, appears to extend as far north as Santa Rosa in the subsurface. North of Santa Rosa, dam foundation test-drilling by the U.S. Corps of Engineers in 1960 penetrated 212-278 feet of total San Andres "limestone member" above Glorieta. West of Colonias between T. 10 and 11 N. the Fourmile Draw beds pinch out (Fig. 2) and at the elbow in the Pecos River in T. 11 N., R. 19 #. the Bernal rests on the Bonney Canyon. A similar northward wedge-out of the Fourmile Draw evaporites occurs a little farther south along the Derramadera monocline (Kelley, 1972a, p. 1851) in sec. 26, T. 7 N., R. 15 E. Somewhere between Derramadera and Clines Corners the Fourmile Draw was wedged out by pre-Artesia erosion in the same manner shown in Figure 3 along the eastern flank of the ancient Pedernal arch farther south. The Ancestral Pedernal Mountains of late Pennsylvanian-early Permian age appear to have been reactivated between Leonardian and Guadalupian times. Several still younger rises of the Pedernal axis up into Tertiary time have also been described (Kelley, 1971, p. 60).

ARTESIA GROUP

Division of the Artesia into formations in the subsurface by various multiple logging techniques is easier and more successful than by surface mapping. The reasons for this are complex but appear to be mostly due to great differences in the methods and in the availability and observation of data. Gaps in observation of outcrop and contacts on the surface are, in the case of the Artesia formations, probably greater overall than in the subsurface with well-log data. It is essentially impossible or hardly permissable to observe surface contacts, which might be several miles to several tens of miles apart, and draw a connecting line across topography, especially with low undulating dips. With subsurface "mapping" the logs are placed next to one another and appropriate picks are connected. The Artesia units have been carried over wide areas of New Mexico and Texas by subsurface techniques including lithologic logging with much success, but until very recently little or no division of the Artesia had been attempted on the surface north of Lake McMillan. Results of mapping and the variations within the outcropping formations of the Artesia Group for most of the rest of New Mexico are summarized below.

Grayburg and Queen Formations

Hayes (1964) successfully separated the Grayburg and Queen along the shelf margin northward from the Capitan reef to about T. 20 S., based mostly on carbonate-sandstone differences in the near reef area. However, from about T. 21 S.

northward the two formations are dominated by gypsum and redbeds of like character making separation more difficult. From T. 19 S. to T. 8 S., a distance of 65 miles, the two formations lie almost entirely beneath Quaternary valley fill. About 13 miles north of Roswell the base of the overlying Seven Rivers Formation with the Grayburg-Queen interval (Kelley, 1971, pl. 2) rises from the valley fill on the west side of the Pecos River. From this locality (T. 8 S., R. 25 E.) the redbed Artesia sequence lying between the Seven Rivers Formation and the underlying San Andres Formation can be traced northward, but with no recognizable division between a lower part which is most certainly Grayburg and an upper part that is very likely Queen.

The Grayburg-Queen redbeds sequence is much in prominence along and east of U.S. Highway 285 in the stretch 20 to 40 miles north of Roswell. It consists dominantly of fine-grained, tannish- to reddish-brown sandstone. Thin dolomite beds occur in the lower part. Gypsum is variably distributed from the bottom up in discrete beds, but gypsiferous sandstone is somewhat more abundant in the upper part. Northward the sequence thins gradually and gypsum decreases. The distribution of gypsum, however, is irregular and discontinuous through the Grayburg-Queen sequence. This is the case along the Pecos Canyon south of Santa Rosa and along Pintada Canyon. In both of these places the gypsum is in the middle or lower part of the sequence where also the tan-brown colors in the sandstone give way commonly to light-gray. The farthest north gypsum is a few miles southwest of Colonias in T. 10 N. Here as along Pintada Canyon and at several other exposures of the boundary position with the Fourmile Draw Member, the stratigraphic location of the contact becomes a problem if gypsum is present unless goodly exposures above and below are available.

North of Santa Rosa the Grayburg-Queen interval takes on more of the aspects of the Bernal Formation at its type locality 50 miles northwest up the Pecos River. I have recommended (1972, p. 15) that the term Bernal Formation be retained for occurrences north of Santa Rosa and west of the longitude of about Vaughn.

SEVEN RIVERS FORMATION

The Seven Rivers Formation in the Seven Rivers Hills northwest of Carlsbad consists of a lower evaporitic member and an upper dolomite member known as the Azotea tongue. The tongue gives way to an entirely evaporitic section near the north end of Lake McMillan. The formation is dominated by gypsum that is often dense and massive, causing the formation to hold relatively prominent exposures. These exposures form the bluffs east of the Pecos River for 75 miles northward of Lake McMillan. The base is buried beneath valley alluvium from the Seven Rivers embayment (T. 21 S.) to some 15-20 miles north of Roswell. The top of the formation is poorly or not readily seen north of the pinch-out of the Azotea tongue owing to the fact that the overlying Yates is also quite evaporitic for many miles north of the tongue. Where the Seven Rivers is well exposed in the bluffs, as east of Roswell, the upper contact lies beneath pediment and wind-blown sand cover some distance east of the bluffs. Good exposures of the top are best seen in T. 2 S., about 30 miles south of Fort Sumner, and in the head of Arroyo Yeso in T. 2 N., R. 20 E.

The Seven Rivers thins northward from thicknesses of about 500 feet near the Capitan reef to less than 100 feet in T. 2 to 5 N.

YATES AND TANSILL FORMATIONS

The Tansill is a carbonate sequence in its southernmost exposures along the shelf margin and overlapping the Capitan Limestone of the reef facies. The underlying Yates consists of fine-grained, white to buff sandstone with interbedded dolomite and grayish mudstone along the shelf margin. Back of the reef a short distance the upper part of the formation becomes evaporitic, but the lower dolomitic part extends for nearly 15 miles north of the shelf-reef margin. Northward of Lake McMillan the Yates is dominantly evaporitic with lesser thin beds of gray fine-grained sandstone and greenish or reddish gypsiferous mudstones. Thin carbonate beds, 6 inches to 1 foot thick, extend for many miles and have been observed as far north as T. 2 S.

The Tansill Formation has been traced for about 45 miles north of the shelf edge above and back of the bluffs east of the Pecos River to a point east of Hagerman. The Tansill carbonate facies extends for about 15 miles back of the shelf-reef margin but then gives way to evaporite facies. North of Hagerman the Tansill is lost beneath pediment cover and in places is overlapped by Triassic beds. However, some of the wide Yates outcrop bands east of Roswell may contain unrecognizable Tansill in their eastern part. (Kelley, 1971, pl. 2)

Typical fine exposures of Yates Sandstone occur along the Pecos River bluffs in T. 2, 3 S., R. 25 E. The Yates rests sharply on Seven Rivers gypsum. It consists of light-gray to greenish-gray, fine-grained sandstone and siltstone in the lower 50 to 60 feet. The upper part consists of red and green mudstone, sandstone and gypsum and a few thin dolomite beds. Ironstone concretions consisting of pyrite or marcasite and weathered limonite are common in the Yates.

The northernmost Yates outcrops are along Arroyo Salado in T. 5 N. and along the side of a collapse depression in T. 6 N., R. 20 E. about 18 miles southwest of Santa Rosa. No Yates has been identified in the Artesia outcrops along the Pecos River south of Santa Rosa although there are sandstone beds in the Grayburg-Queen that resemble closely the Yates. This fact points up the problem of subdividing the Artesia into formations should the Seven Rivers gypsum pinch out.

In late Permian (Ochoan) and early Triassic time eastern New Mexico and the Pedernal country were considerably stripped by erosion and then covered by the Upper Triassic Santa Rosa Sandstone. In the lower Pecos country of southeastern New Mexico the Santa Rosa rests on Rustler beds. Northward toward the Rockies and westward across the Pedernal arch the Santa Rosa truncates beds downward to the Grayburg or Bernal as shown in Figures 1 and 3.

REFERENCES

Bachman, G. O., 1953, Geology of a part of northwestern Mora County, New Mexico: U.S. Geol. Survey Oil & Gas Inves. Map OM 137.

Darton, N. H., 1922, Geologic structure of parts of New Mexico: U.S. Geol. Survey Bull., 726-E. 275 p.

———, 1928, Geologic map of New Mexico: U.S. Geol. Survey, scale 1:500,000.

DeFord, R. K., and E. R. Lloyd, 1940, West Texas-New Mexico symposium, Part 1: Am. Assoc. Petroleum Geologists Bull., v. 24, p. 1-14.

Fiedler, A. G., and S. S. Nye, 1933, Geology and ground-water resources of the Roswell artesian basin, New Mexico: U.S. Geol. Survey Water-Supply Paper 639, 372 p.

Kelley, V. C., 1971, Geology of the Pecos country, southeastern New Mexico: New Mex. Bur. Mines & Min. Res. Mem. 24, 75 p.

———, 1972a, New Mexico lineament of the Colorado Rockies front: Geol. Soc. America Bull., v. 83, p. 1849-1853

————, 1972b, Geology of the Fort Sumner sheet: New Mex. Bur. Mines & Min. Res. Bull. 98, 56 p.

Keyes, C. R., 1915, Foundation of exact geologic correlation: Iowa Acad. Sci. Proc., v. 22, p. 249-267.

Lang, W. B., 1937, The Permian formations of the Pecos Valley of New Mexico and Tecas: Am. Assoc. Petroleum Geologists Bull., v. 21, p. 833-898.

Lee, W. J., 1909, Stratigraphy of the Manzano Group of the Rio Grande Valley, New Mexico: U.S. Geol. Survey Bull. 389, p. 357-368.

Mourant, W. A., and J. W. Shomaker, 1970, Reconnaissance of De Baca County, New Mexico: New Mex. Bur. Mines and Min. Res. Ground-Water Rpt. 10, 87 p.

Needham, C. E., and R. L. Bates, 1943, Permian type sections in central New Mexico: Geol. Soc. America Bull., v. 54, p. 1653-1667.

Pray, L. C., 1961, Geology of the Sacramento Mountains escarpment, Otero County, New Mexico: New Mex. Bur. Mines & Min. Res. Bull. 35, 144 p.

Read, C. B., and D. A. Andrews, 1944, The upper Pecos River and Rio Galisteo region, New Mexico: U.S. Geol. Survey Oil & Gas Invs. Prelim. Map 8.

Read, C. B., and others, 1944, Geologic map and stratigraphic sections of Permian and Pennsylvanian rocks of parts of San Miguel, Santa Fe, Sandoval, Bernalillo, Torrance and Valencia Counties, north central, New Mexico: U.S. Geol. Survey Oil & Gas Invs. Prelim. Map 21.

Tait, D. B., J. L. Ahlen, A. Gordon, G. L. Scott, W. S. Motts, and M. C. Spitler, 1962, Artesia Group of New Mexico and West Texas: Am. Assoc. Petroleum Geologists Bull., v. 46, p. 504-517.

Wilpolt, R. H., and others, 1946, Geologic map and stratigraphic sections of Paleozoic rocks of Joyita Hills, Los Pinos Mountains, and northern Chupadera Mesa, Valencia, Torrance, and Socorro Counties, New Mexico: U.S. Geol. Survey Oil & Gas Invs. Prelim. Map 61.

Wood, G. H. Jr., and S. A. Northrop, 1946, Geology of Nacimiento Mountains, San Pedro Mountain, and adjacent plateaus in parts of Sandoval and Rio Arriba Counties, New Mexico: U.S. Geol. Survey Oil & Gas Invs. Prelim. Map 57.