Salt Deposits of the Mescalero Plains Area, Chaves County, New Mexico

U.S. Geological Survey
C. L. Jones

1974

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Federal Center, Denver, Colorado 80225

SALT DEPOSITS OF THE MESCALERO PLAINS AREA, CHAVES COUNTY, NEW MEXICO

By

C. L. Jones

Open-file report 74-190

1974

CONTENTS

ILLUSTRATIONS

TABLE

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Federal Center, Denver, Colorado 80225

SALT DEPOSITS OF THE MESCALERO PLAINS AREA, CHAVES COUNTY, NEW MEXICO

By

C. L. Jones

ABSTRACT

Salt deposits in the Mescalero Plains area of Chaves County, N. Mex., belong to the Guadalupian and Ochoan Series of Late Permian age. The Guadalupian deposits are part of a complex succession of red beds and evaporite deposits known as the Artesia Group. The Artesia is 1,200-1,800 feet (365-550 m) thick and is about one-half rock salt and anhydrite and one-half dolomite and red beds composed of sandstone, siltstone, and shale. Much of its rock salt is clayey and is intercalated between beds of sandstone and siltstone. The thickest and most clay-free seams of rock salt are in the Salado Formation of the Ochoan Series. The Salado is as much as 820 feet (250 m) thick; it is dominantly rock salt that contains minor amounts of anhydrite, polyhalite, and clay, and traces of sylvite and carnallite. The salt in the Salado underlies an eastwardly thickening wedge of overburden as much as 1,580 feet (480 m) thick, and it has undergone partial or complete solution beneath large sections of the overburden.

Oil and gas are produced at more than 50 fields in and near the area. Their presence elsewhere is a geologic possibility. Occurrences of potassium salts have been prospected, but there are no significant potash resources.

INTRODUCTION

Salt deposits underlying the Mescalero Plains area of the Pecos River valley in southeastern Chaves County, N. Mex., have been studied by the U.S. Geological Survey on behalf of the Division of Waste Management and Transportation, U.S. Atomic Energy Commission. The

study is the fourth in a series dealing with bedded salt deposits in eastern New Mexico (fig. 1). The purpose of the study is to provide geological information required by the Atomic Energy Commission in matters related to possible siting of a nuclear waste facility in the bedded salt deposits of eastern New Mexico.

The present study synthesizes and interprets data obtained from geophysical logs of boreholes drilled in exploration for petroleum. All the boreholes from which data were obtained are located on the isopach and structure maps (figs. 4, 5, and 6). The study and maps are of the reconnaissance type and are designed to outline major elements in the character, structure, and distribution of bedded salt deposits in the Mescalero Plains area of the Pecos River valley.

Published data on the geology of the area is meager. Semmes (1920) described diabasic dikes in and near the northern part of the area. Kelley (1971) mapped the part of the area that is west of the 104° meridian in his study of the New Mexico section of the Pecos drainage basin south of De Baca County.

Acknowledgments.--The study was discussed with D. M. Van Sickle and P. C. Aguilar of the U.S. Geological Survey, and their contributions of information on Permian rocks of the area are appreciated.

Geography

The Mescalero Plains area occupies a 1,300-mi^2 (2,092-km^2) section of the Pecos River valley in southeastern Chaves County, N. Mex. The area includes a small part of the broad alluvial-filled trough, known

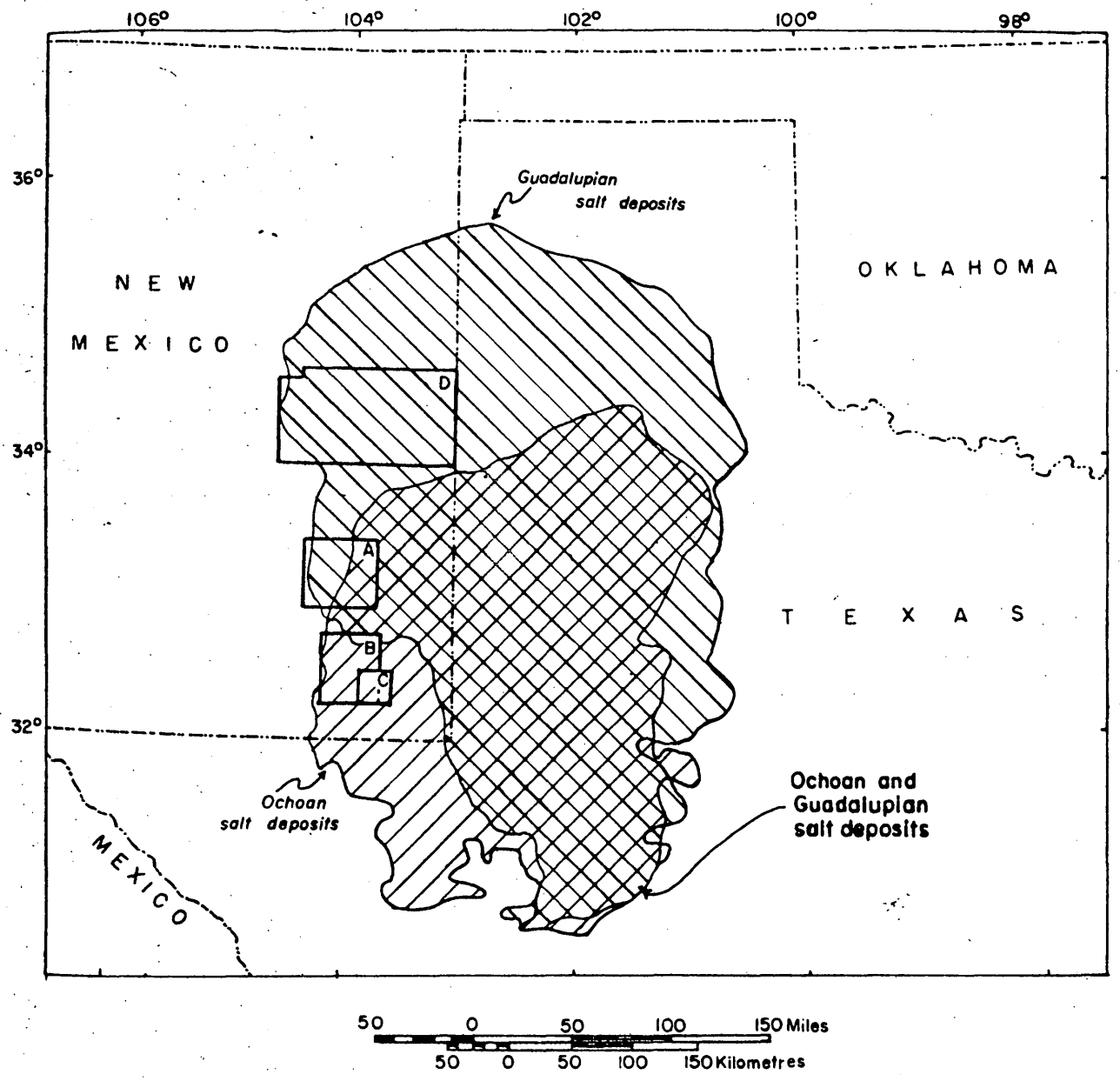


Figure 1.--Map of Permian basin, southeastern New Mexico and western Texas, showing locations of: A, Salt deposits of the Mescalero Plains area (this report); B, Carlsbad potash area (Brokaw and others, 1972); C, Los Medaños area (Jones, 1973); and D, Clovis-Portales area (Jones, 1974).

locally as the Roswell artesian basin, which extends from the Pecos River westward across much of central Chaves County. Most of the area, however, is part of a westward-sloping plain that rises from the top of gypsum-capped bluffs along the east side of the Pecos to the base of the sharp escarpment at the western edge of the Llano Estacado. The plain is an erosion surface carved in a bedrock of Triassic red beds and Permian evaporites, and is widely veneered with fluvial deposits and drifted sand; it is poorly drained and all streams are ephemeral.

The area between the Pecos River and the Llano Estacado is part of an extensive grassland region having strongly alkaline soil and little rainfall. Like most other sections of southeastern New Mexico, the area is devoted to extracting hydrocarbons from Pennsylvanian and Permian rocks and to raising cattle. The economy of the area is very dependent on the oil and gas industry; cattle raising is of secondary importance.

The area is sparsely populated. Most of its inhabitants are in the farming communities of Dexter (population 885) and Hagerman (population 1,144). Roswell, a community of 50,000 inhabitants and the county seat of Chaves County, lies 7 miles (11 km) west of the area; it is served by U.S. Highways 70, 285, and 380 and by a branch line of the Atchinson, Topeka, and Santa Fe Railroad, which gives access to transcontinental rail service at Clovis, N. Mex.

Geologic setting

The Mescalero Plains area occupies a part of the western flank of the Permian basin--a composite sedimentary and structural depression that underlies much of southeastern New Mexico and western Texas between the

101° and 105° meridians. This basin was an area of widespread deposition of rock salt and other evaporites during great parts of the Guadalupian and Ochoan Provincial Series (Early and Late Permian age). The centers of evaporite deposition shifted from place to place within the basin as the Permian progressed, and there are sharp changes in the succession, character, and thickness of salt-bearing deposits from one place to another. In general, the highest deposits containing rock salt are progressively younger from north to south, and the underlying or lower deposits of rock salt thin and die out southward by direct gradation to anhydrite or by pinchout between tongues of anhydrite or sandstone (fig. 2). The clay and sand contents of the rock salt deposits that accumulated during the Guadalupian tend to be greater than those of the deposits that accumulated during the Ochoan. In addition, nearly all of the Guadalupian deposits are free of potassium salts, whereas large sections of the Ochoan deposits contain traces to large amounts of polyhalite and other hydrous potassium and magnesium salts throughout much of eastern New Mexico.

The salt deposits and overlying rocks in the Mescalero Plains area are all of sedimentary origin, with the exception of a small igneous dike near the north end of the area. The sedimentary rocks are of Permian, Triassic, Tertiary, and Quaternary age; the igneous dike is considered to be of Tertiary age. The stratigraphic chart (table 1) shows the general relationship and character of the sedimentary formations in the area.

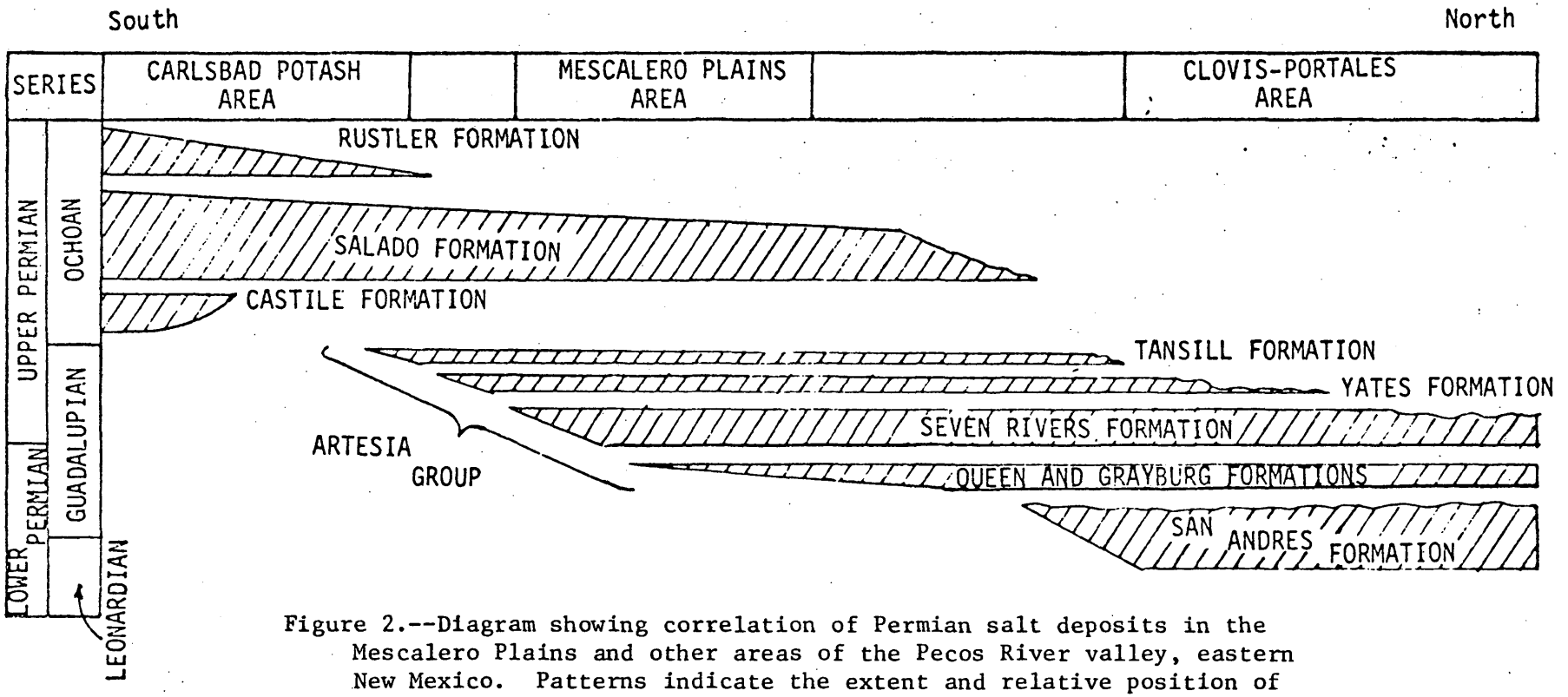


Figure 2.--Diagram showing correlation of Permian salt deposits in the Mescalero Plains and other areas of the Pecos River valley, eastern New Mexico. Patterns indicate the extent and relative position of the salt deposits across southeastern New Mexico.

Table 1.--Stratigraphic chart showing relationship of Permian and younger formations in the Mescalero Plains area, New Mexico

System	Series		Formation	Lithology	Approximate thickness feet (metres)
Quaternary	Holocene			Alluvium and drifted sand	
	Pleistocene		Gatuna Formation	Sandstone and caliche	0- 105 (0- 32)
Unconformity					
Tertiary	Pliocene		Ogallala Formation	Sandstone, siltstone, conglomerate, and caliche	35- 372 (11- 113)
Major unconformity					
Triassic	Upper	Dockum Group	Chinle Formation and Santa Rosa Sandstone	Shale and sandstone; minor amounts of conglomerate	872-1,423 (266- 434)
Major unconformity					
Permian	Upper	Ochoan	Dewey Lake Red Beds	Siltstone and sandstone	0- 40 (0- 12)
			Rustler Formation	Anhydrite, dolomite, and sandstone	0- 124 (0- 38)
			Salado Formation	Rock salt; minor amounts of anhydrite, polyhalite, and potash ores	0- 818 (0- 249)
		Guadalupian	Artesia Group: Tansill Formation	Rock salt, anhydrite, and siltstone	0- 205 (0- 63)
			Artesia Group: Yates Formation	Sandstone; some anhydrite and rock salt	109- 260 (33- 79)
			Artesia Group: Seven Rivers Formation	Anhydrite; minor amounts of rock salt, dolomite, and sandstone	440- 575 (134- 175)
	Lower		Queen and Grayburg Formations	Sandstone and shale; minor amounts of rock salt, anhydrite, and dolomite	>500 (>153)

SALT DEPOSITS AND ASSOCIATED ROCKS

Artesia Group

The oldest salt deposits of the Mescalero Plains area are in the Artesia Group of the Guadalupian Series (Lower and Upper Permian). This group is a complex succession of red-bed and evaporite deposits, and it comprises, in ascending order, the Grayburg, Queen, Seven Rivers, Yates, and Tansill Formations (Tait and others, 1962). It is unconformable with the underlying San Andres Formation of the Leonardian and Guadalupian Provincial Series and is conformable with and gradational upward into the Salado Formation of the Ochoan Series (Upper Permian). The San Andres consists of 1,200-1,500 feet (365-460 m) of dolomite. The Grayburg and Queen Formations have a combined thickness of more than 500 feet (153 m) and are chiefly sandstone and dolomite interbedded with siltstone and a little rock salt. The Seven Rivers Formation is 500-575 feet (153-175 m) thick in the eastern part of the area, it is almost completely an evaporite formation composed dominantly of anhydrite interbedded with sandstone, siltstone, dolomite, and some rock salt. The Yates Formation, 109-260 feet (35-80 m) thick, is sandstone interbedded with thin units of siltstone, anhydrite, and rock salt. The Tansill Formation consists of 205 feet (63 m) of rock salt, anhydrite, and siltstone in the eastern part of the area; a middle unit of siltstone and rock salt, known as the Ocotillo Silt Member of DeFord and Riggs (1941), permits division of the formation into three members that can be readily distinguished on geophysical logs of boreholes (fig. 3).

Within the Mescalero Plains area, the Artesia Group rims the east side of the alluvial-filled Roswell artesian basin. It crops out in low bluffs along the Pecos River and in several small karst valleys in the western part of the area, but only small partial thicknesses near the top of the group are exposed. Away from the area of outcrop, the Artesia extends beneath an eastwardly thickening wedge of Ochoan and younger rocks and reaches a depth of almost 2,200 feet (670 m) below the surface at the western edge of the Llano Estacado.

The full thickness of the Artesia Group between the San Andres Formation below and the Salado Formation above is preserved only in the eastern part of the Mescalero Plains area. Elsewhere, the eroded top of the Artesia either is overlain by the Santa Rosa Sandstone of the Upper Triassic Series or seams of rock salt in the Artesia Group have undergone partial or complete solution reducing its thickness. The Artesia Group ranges in thickness from 1,200 to 1,500 feet (365 to 460 m) in the areas of salt removal. Its thickness increases eastward to about 1,800 feet (550 m) near the southeast corner of the area and to slightly more than 1,400 feet (430 m) near the northeast corner. This increase in thickness amounts to between 200 and 300 feet (60 and 90 m) and provides a crude measure of the thickness of rock salt that has been removed by percolating ground water. The difference in thickness between the southeast and northeast corners of the area is probably depositional in origin, for the group is more thickly bedded in the southeast where it is thickest.

As a somewhat simplistic generalization for the entire Mescalero Plains area, the Artesia Group is about one-half rock salt and anhydrite and about one-half dolomite and red beds consisting of sandstone and siltstone and minor amounts of shale. The bulk of the rock salt is in the middle and upper parts of the group (the Seven Rivers and Tansill Formations, respectively), where it forms seams and lentils as much as 60 feet (18 m) thick. Much of the rock salt in the middle part of the group contains appreciable amounts of clay and sand, and it is intercalated between beds of sandstone and siltstone. The rock salt in the upper part of the group is relatively free of clay and sand. It is indistinguishable from much of that in the overlying Salado Formation of the Ochoan Series. Locally, it is associated with polyhalite. Insofar as has been determined from drilling data, the division between rock salt rich in clay and associated red beds and rock salt relatively free of clastic materials is marked by the Ocotillo Silt Member of the Tansill Formation.

Ochoan Series

The thickest and most halite-rich evaporite deposits in the Mescalero Plains area are in the Ochoan Series of Late Permian age. The Ochoan includes the youngest Permian in the area, but its top is not preserved. It is overlain by the Santa Rosa Sandstone with considerable unconformity, and the break represents most, if not all, of Early and Middle Triassic time. In the stretch between the western edge of the Llano Estacado and the outcrop of the Artesia Group in the western part of the area, the Santa Rosa overlaps the whole thickness of the Ochoan Series.

The Ochoan Series includes, in ascending order, the Salado and Rustler Formations and the Dewey Lake Red Beds. The Salado is one great pile of countless salt beds and other evaporites stacked one above the other, but the younger formations are salt-free units of anhydrite and red beds.

Salado Formation

The Salado Formation underlies the eastern part of the Mescalero Plains area and wedges out westward between the Tansill Formation and Santa Rosa Sandstone in the central part of the area. The Salado crops out at places near the south-central edge of the area, but is covered by different thicknesses of younger rocks where present in other parts of the area. In general, the thickness of rocks covering the Salado increases eastward and amounts to 1,400 feet (425 m) or more beneath the Llano Estacado at the eastern edge of the area.

The Salado consists dominantly of rock salt interbedded with thin seams of anhydrite and polyhalite, and numerous filmlike partings of clay and silt. Much of the rock salt is sparingly to moderately argillaceous; it occurs in alternation with seams of rock salt that contain minor amounts of anhydrite, polyhalite, or some other saline mineral. Single grains, veinlets, and small crystalline masses of carnallite ($KMgCl_3.6H_2O$), sylvite (KCl), and kieserite ($MgSO_4.H_2O$) are rare to common in some sections of the formation, and there are, in places, moderately thick pods or lenses of sylvite and carnallite. A few stratabound deposits rich in sylvite and carnallite occur in the

middle and lower parts of the formation in the southern part of the area, but none are as thick or as extensive as the deposits being mined in the Carlsbad potash area.

Subdivisions of the Salado Formation in the Mescalero Plains area include: an unnamed lower member, a middle member known locally as the McNutt potash zone, and an unnamed upper member (fig. 3). The three members are very similar salt-rich units in sections of Lea and Eddy Counties, N. Mex., immediately east and south of the Mescalero Plains area—but all have undergone partial or complete solution in the area of the present report. Salt has been leached from all members in the western part of the area, from the McNutt potash zone and the upper member in the central part, and from the upper member in the eastern part. Where the members have lost their salt, residual anhydrite and clay (derived from seams and inclusions of anhydrite and clay in rock salt) remain, and the thickness of the individual units, and of the formation as a whole, is reduced.

The extent and aggregate thickness of salt beds in the three members of the Salado Formation and in the Tansill Formation above the Ocotillo Silt Member are shown by isopachs drawn at intervals of 100 feet (30 m) on figure 4. The combined thickness of salt beds in the two formations exceeds 850 feet (259 m) near the southeastern corner of the Mescalero Plains area. Virtually all of the total thickness of salt east of the 100-foot (30-m) isopach contour is in the Salado, which has a maximum thickness of salt of almost 800 feet (245 m).

Within the Mescalero Plains area, the Salado Formation has a maximum thickness of 820 feet (250 m) but its full thickness is not preserved. The formation thins from southeast to northwest and reaches a featheredge near the "edge of salt" in the central part of the area (fig. 4). The northwest thinning is believed to reflect a combination of geologic factors involving (1) pre-Late Triassic truncation of the Salado and other formations of the Ochoan Series before the Santa Rosa Sandstone was deposited over them, and (2) post-Triassic (and very probably post-Tertiary) solution and removal of salt by percolating ground water.

Rustler Formation

The Rustler Formation is the youngest Ochoan evaporite-bearing unit in the Mescalero Plains area but, unlike the Salado, it is free of rock salt. Anhydrite and mudstone are the dominant rock types in the Rustler but siltstone and shale occur as persistent beds. The formation ranges from 0 to 124 feet (38 m) in thickness.

Dewey Lake Red Beds

The Dewey Lake Red Beds form the top of the Permian in the Mescalero Plains area, but only small partial thicknesses are preserved beneath the Santa Rosa Sandstone at places near the eastern margin of the area. The formation is composed of siltstone and sandstone, and its thickness is not known to exceed 40 feet (12 m) at any place in the area.

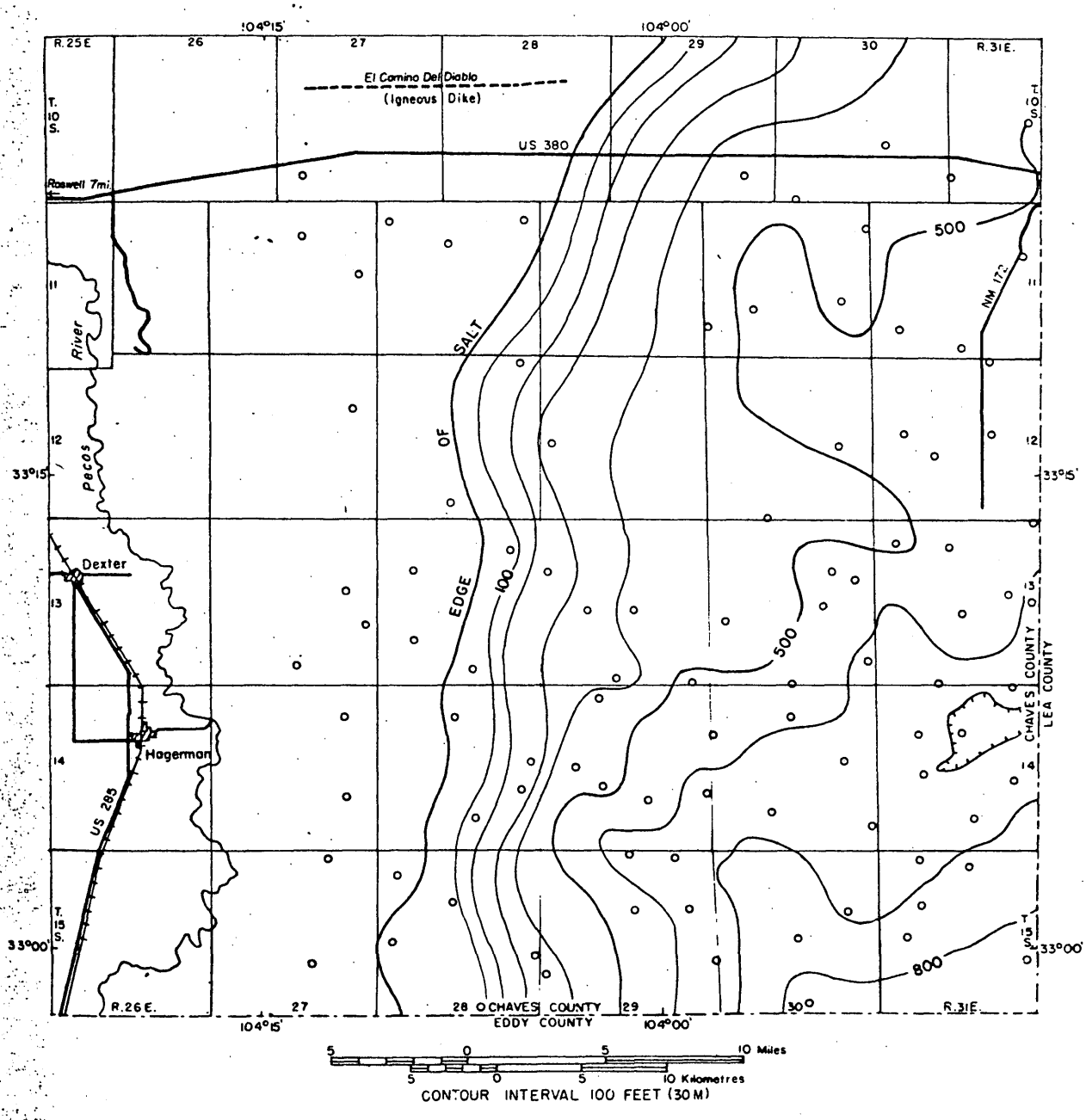


Figure 4.--Isopach map of salt in the Tansill and Salado Formations, Mescalero Plains area, Chaves County, New Mexico. (Note: Salt deposits below the Ocotillo Silt Member of the Tansill Formation are not included as part of the salt-bearing interval.) Open circles are drill holes.

Overburden

The overburden in the Mescalero Plains area is an eastwardly thickening wedge of red beds and other deposits that overlie salt in the Salado and Tansill Formations. The overburden includes in ascending order: (1) residual anhydrite and clay in parts of the Salado Formation from which all salt has been leached, (2) the Rustler Formation and Dewey Lake Red Beds of the Ochoan Series, (3) the Dockum Group of the Upper Triassic Series, (4) the Ogallala Formation of the Pliocene Series, and (5) the Gatuna Formation of the Pleistocene Series. Much of the overburden is covered by unconsolidated alluvium and drifted sand of Holocene age. The general relationship and dominant lithology of the rock units and younger deposits in the overburden are shown in table 1.

The overburden of Permian and younger rocks ranges from 145 to 575 feet (45 to 175 m) in thickness at the edge of salt in the central part of the area (fig. 5). The thickness increases eastward from the edge of salt and reaches as much as 1,580 feet (480 m) near the western edge of the Llano Estacado in the northeastern part of the area; it is 1,500 feet (460 m) or more under all sections of the Llano Estacado.

STRUCTURE

The Mescalero Plains area occupies a part of the broad, gently dipping west flank of the Permian basin. The dominant structure in this section of the basin is a gentle homoclinal dip of no more than 1° eastward. In places this regional dip is interrupted by slight

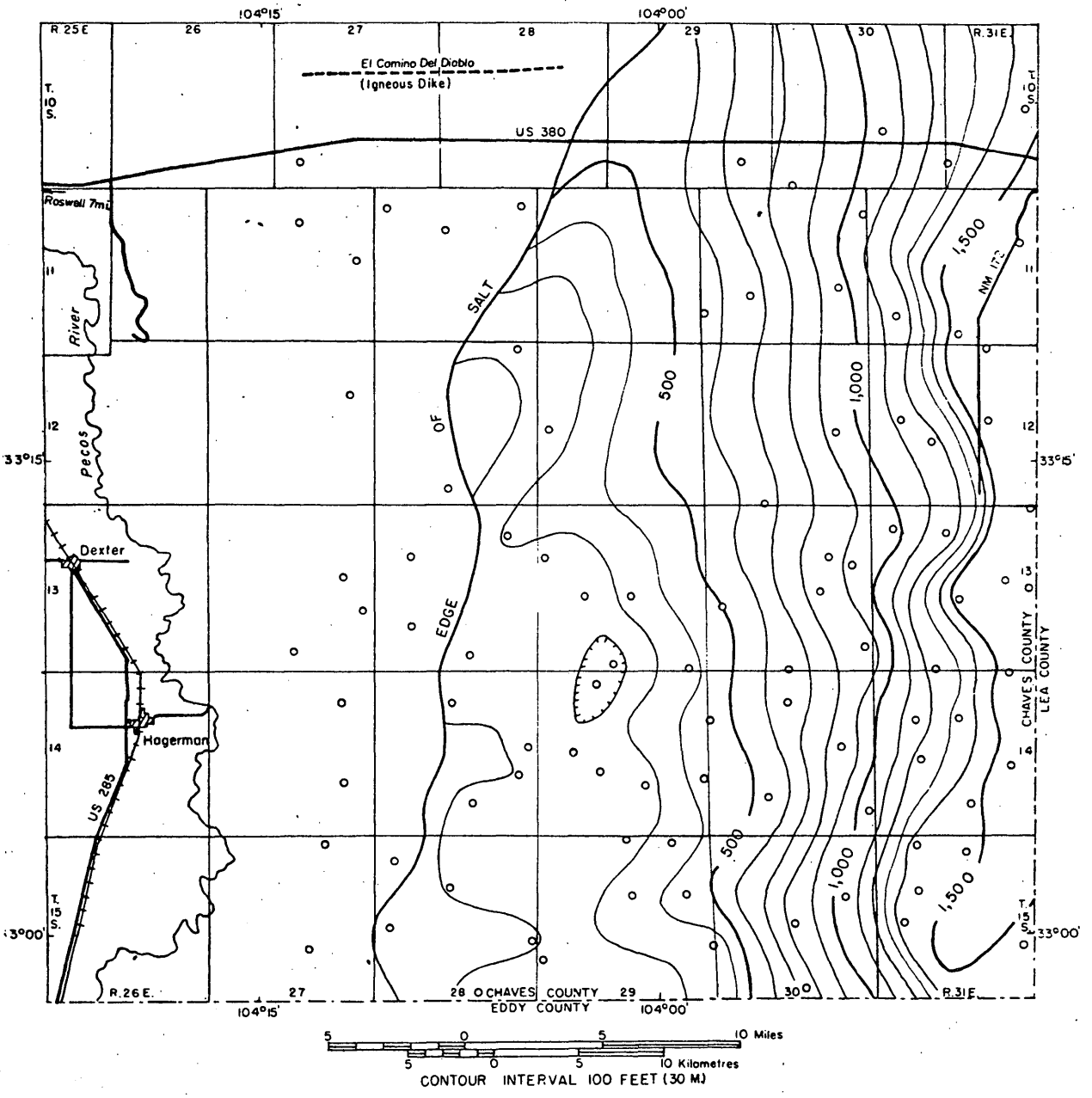


Figure 5.--Isopach map of overburden above salt in the Tansill and Salado Formations, Mescalero Plains area, Chaves County, New Mexico. Open circles are drill holes.

monoclinal flexures and small eastwardly plunging ridges and troughs, and there is a narrow eastwardly trending dike of diabase that cuts sharply through red beds and evaporites of the Artesia Group in the northern part of the area.

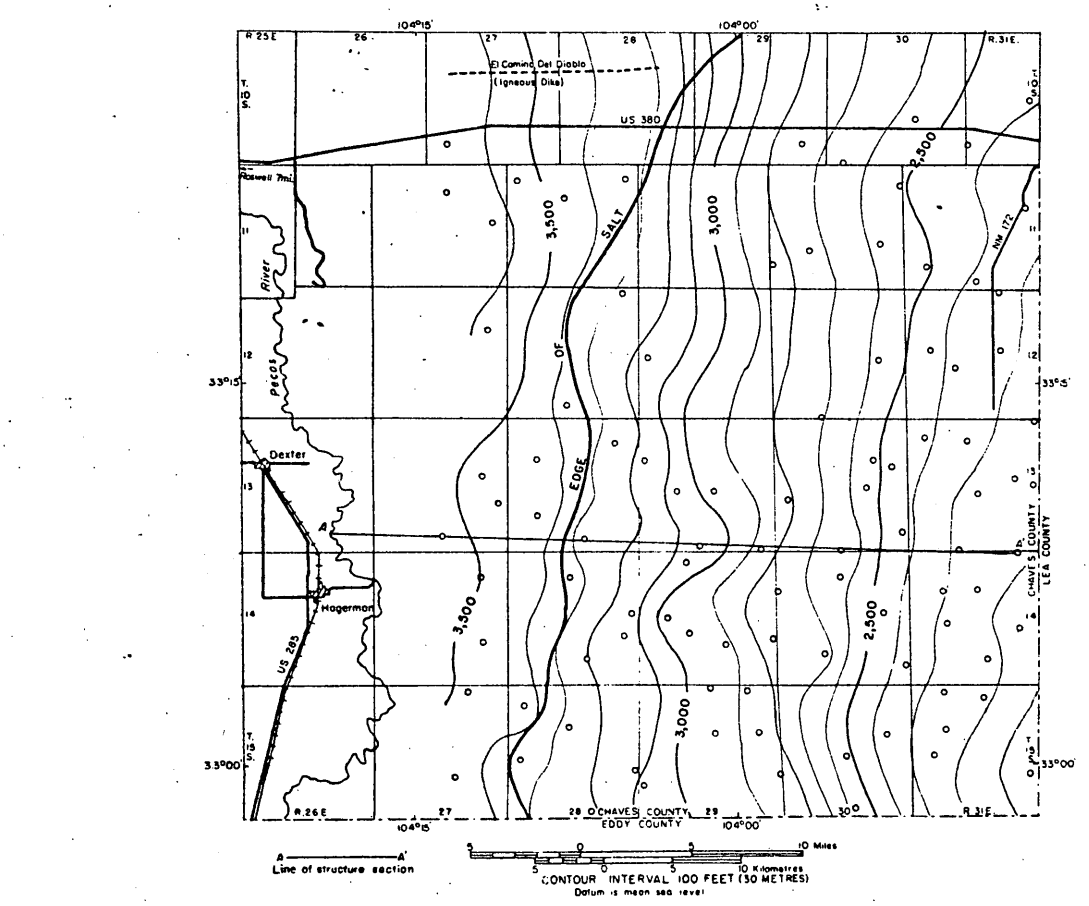
The structure of the salt in the Salado and Tansill Formations in the central and eastern parts of the area is shown on figure 6 by a structure section and a map with structure contours drawn at intervals of 100 feet (30 m) on the top of the Ocotillo Silt Member of the Tansill Formation. As may be seen, the structure is simple; there is no evidence of deformation involving compressional forces or tectonic stresses of appreciable regional or local importance.

MINERAL RESOURCES

Oil and gas are produced in the Mescalero Plains area, and there are occurrences of potassium salts in nearly all sections underlain by salt in the Salado Formation. The locations of the oil and gas fields and the area of potassium-bearing salt are shown on figure 7.

Oil and gas

Oil and gas are produced at more than 50 fields in and near the Mescalero Plains area, and their presence elsewhere in the area is a geologic possibility. Production is from the Queen, Grayburg, San Andres, and Wolfcamp Formations of Permian age, and from other formations of Pennsylvanian, Mississippian, Devonian, Silurian, and Ordovician age (Roswell Geological Society, 1967, p. 28-30). The type of trap for the



EXPLANATION

- Qd Quaternary deposits
- To Ogallala Formation
- Trc Chinle Formation
- Trsr Santa Rosa Sandstone
- Pr Rustler Formation
- Ps Salado Formation
- Pt Tansill Formation
- Py Yates Formation
- Psr Seven Rivers Formation
- Drill hole

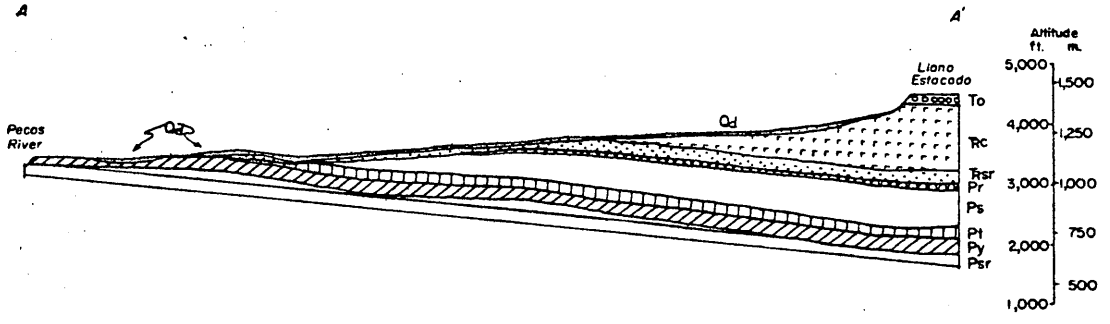


Figure 6.--Structure contour map of the salt in the Tansill and Salado Formations, Mescalero Plains area, Chaves County, New Mexico. Structure contours drawn on top of the Ocotillo Silt Member of the Tansill Formation. Open circles are drill holes.

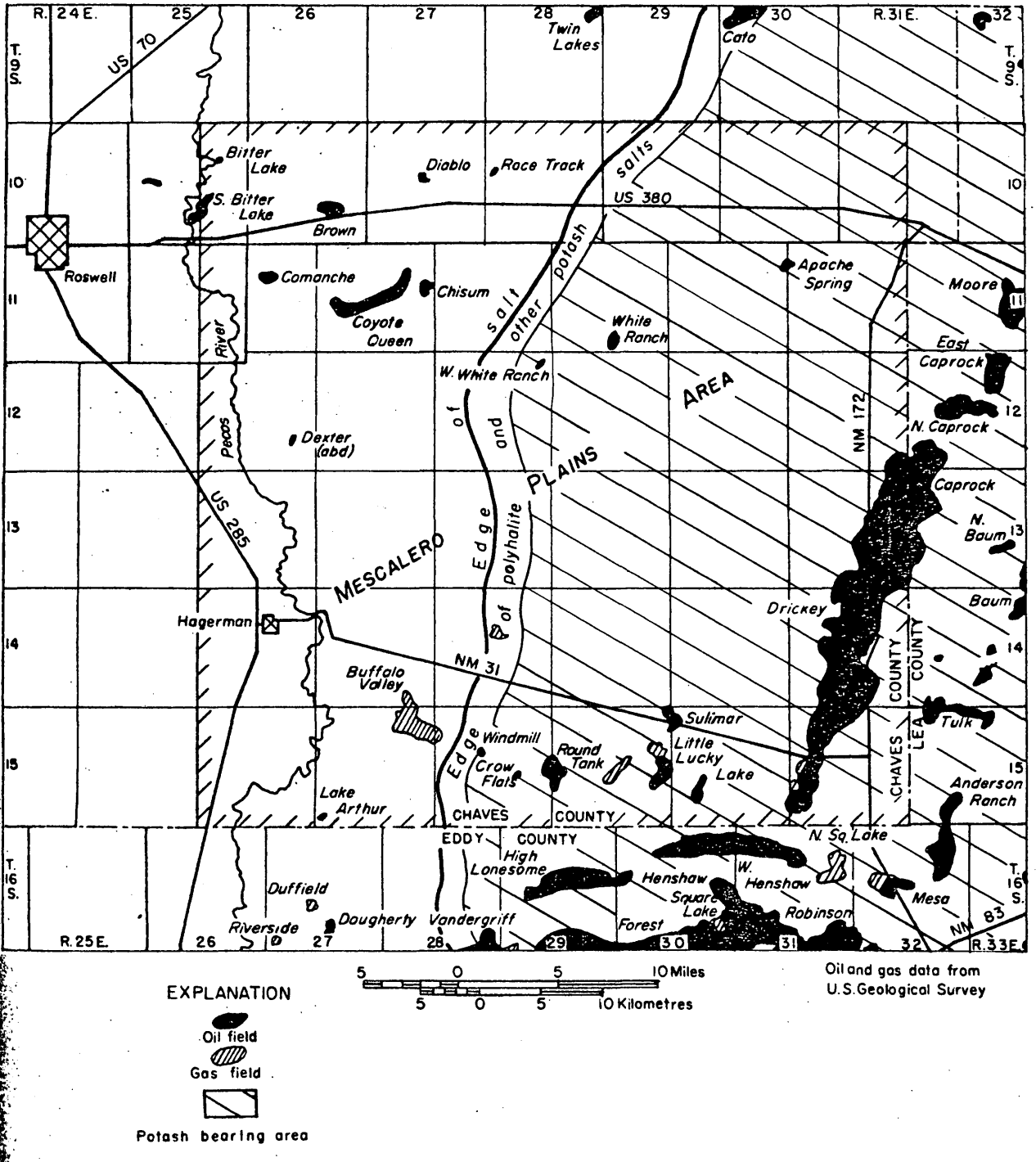


Figure 7.--Energy and mineral resources of Mescalero Plains area, Chaves County, N. Mex.

oil and gas accumulation in this area ranges from closure on flexures and faulted anticlines to diverse types of stratigraphic traps and updip pinchout of porosity and permeability.

Potassium salts

Occurrences of potassium salts involving sylvite, polyhalite, and carnallite are present in nearly all parts of the Mescalero Plains area underlain by salt in the Salado Formation. Several occurrences of sylvite in the southern part of the area have been prospected in the past but there are no indications of significant resources. Polyhalite and carnallite have no economic value.

CONCLUSIONS

The study has revealed that (1) thick and relatively high purity beds of rock salt underlie large portions of the Mescalero Plains area; (2) the thickness of rocks overlying the salt ranges from less than 200 feet (61 m) along the western boundary to more than 1,500 feet (457 m) on the east; (3) the western edge of salt has experienced a long history of dissolutioning, and subrosion forces are probably(?) active today in that area; (4) oil and gas deposits are known to underlie some but not all of the study area; and (5) minor amounts of potash-bearing minerals are distributed in the salt throughout the study area but are believed to be inferior in quality and quantity to those farther to the south near Carlsbad.

REFERENCES CITED

Brokaw, A. L., Jones, C. L., Cooley, M. E., and Hays, W. H., 1972, Geology and hydrology of the Carlsbad potash area, Eddy and Lea Counties, New Mexico: U.S. Geol. Survey open-file report, 86 p.

DeFord, R. K., and Riggs, G. D., 1941, Tansill Formation, west Texas and southeastern New Mexico: Am. Assoc. Petroleum Geologists Bull., v. 25, no. 9, p. 1713-1728.

Jones, C. L., 1973, Salt deposits of Los Medaños area, Eddy and Lea Counties, New Mexico, with sections on Ground water hydrology, by M. E. Cooley and Surficial geology, by G. O. Bachman: U.S. Geol. Survey open-file report, 67 p.

_____ 1974, Salt deposits of the Clovis-Portales area, east-central New Mexico: U.S. Geol. Survey open-file report 74-60, 22 p.

Kelley, V. C., 1971, Geology of the Pecos Country, southeastern New Mexico: New Mexico Bur. Mines and Mineral Resources Mem. 24, 75 p.

Roswell Geological Society, 1967, The oil and gas fields of southeastern New Mexico, 1966 supplement: Roswell, N. Mex., 185 p.

Semmes, D. R., 1920, Notes on the Tertiary intrusive of the lower Pecos valley, New Mexico: Am. Jour. Sci., 4th ser., v. 50, p. 415-430.

Tait, D. B., Ahlen, J. L., Gordon, A., Scott, G. L., Motts, W. S., and Spitler, M. E., 1962, Artesia Group of New Mexico and West Texas: Am. Assoc. Petroleum Geologists Bull., v. 46, no. 4, p. 504-517.