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KARST AND SOLUTION PHENOMENA IN THE SANTA ROSA AREA, NEW MEXICO

by

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INTRODUCTION

The Pecos River basin has long been known for its solution phenomena, many types of which can be seen both in the Santa Rosa area and in the Roswell-Carlsbad district to the south. The northern part of the Pecos River basin in the neighborhood of Santa Rosa is an excellent example of a solution-subsidence or covered interstratal karst; the western and southern parts of the basin are an example of semi-arid bare karst.

The broad stratigraphic relationships in the Santa Rosa district show a thick series of soluble beds, mostly limestone and gypsum of Permian age; the series includes the San Andres Limestone and the Artesia Group, which are over 1000 ft thick. These beds dip southeast at about 50 ft per mile; they are overlain in the Santa Rosa and Fort Sumner areas by the Santa Rosa Sandstone of Triassic age. West of the Pecos River, the San Andres Limestone forms high-level plateau country, in a belt 25-60 miles wide, between the Glorieta Mesa in the north and the Guadalupe Mountains in the south.

The limestone or karst terrain in the Santa Rosa area can be divided into two main types: an area of semi-arid bare karst around the small town of Vaughn, and the area of covered interstratal karst immediately surrounding Santa Rosa.

THE HIGH-LEVEL SEMI-ARID KARST OF THE VAUGHN DISTRICT

The San Andres Limestone in the Vaughn district consists of gypsum and gypsiferous limestone. They form a plateau-like surface at about 5000 ft; the plateau is sometimes regarded as part of the High Plains or Sacramento surface. The rainfall averages about 13 ins. per year and is received from two main sources: from Pacific depressions, often in the form of snow, in winter, and from thunder storms associated with Gulf of Mexico depressions in summer.

The Vaughn district is slightly dissected by shallow dry valleys, or arroyos, but its chief karst features are shallow sink holes, or dolines. These are rounded solutional hollows 10-20 ft deep and 30 to 40 ft in diameter. They are of a classical solution type caused by the infiltration of water into joints and fissures in the soluble rocks. The sinks are often asymmetric in form, being steeper on the east (or west-facing) side. There are probably two reasons for this asymmetry. First, the general southeasterly dip would tend to make the updip side steeper. Second, the snow from the winter depressions tends to linger much longer on the eastern slopes of the sinks; thus on these slopes solution by snow and frost action is much greater and the slopes are steepened. In the writer's work in this region in 1964, no attempt was made to consider the distribution of the sink holes; it is possible that some statistical and spatial analysis might be profitable in this connection.

The soil cover is often discontinuous in the Vaughn area and bare limestone surfaces are scarred by rills caused by snow melt or rainwater solution; such rills are only a few millimeters wide, and a few centimeters long, and resemble those described from Texas. As is well known, the limestone surface is much affected by the development of the calcrete of the Ogallala Formation and a honeycombed weathering surface is often present.

THE COVERED OR INTERSTRATAL KARST OF THE SANTA ROSA DISTRICT

The San Andres Limestone dips to the east and becomes covered near Santa Rosa by the Santa Rosa Sandstone; the sandstone lies in a local structural basin, but the Pecos River lies west of the center of the basin. The river flows on the sandstones in a roughly SE direction towards Fort Sumner. Numerous dry arroyos feed into the Pecos from the west but most of the drainage reaching the river is underground. The rain which falls on the high limestone plateau to the west sinks into the rock via the sink holes described and flows down the dip of the rocks into the Pecos catchment. This water partly reappears in the Pecos, but much of it probably remains underground. Since this water is contained within the soluble limestones and gypsums, solution of these rocks takes place beneath the sandstone cover. The solution gives rise to subsidence on a large scale, a type of relief which was described by Lee as "solution and fill" relief.

The figures for the dissolved salts in the waters of the Pecos give much evidence for the effective solubility of the limestone and gypsum. Thus in the water of the Pecos above Santa Rosa, there are 131 ppm dissolved salts, (consisting mostly of calcium and sodium). But below Santa Rosa the concentration rises to 1642 ppm. In the southern part of New Mexico, towards Roswell and Carlsbad, water in the Pecos River contains 3444 ppm and at Malaga Bend near the Texas line it is 5120 ppm. There is thus ample evidence for the removal of limestone and gypsum from the beds below the Santa Rosa Sandstone. It has been calculated that 150 tons of material are removed each year from each square mile of the river's drainage basin north of the Texas border; in one million years this solution rate could lower the river's catchment by 56 ft.

As a result of solution taking place in the limestones and gypsums, and the formation of caverns within the limestones, the sandstone has collapsed in large masses and subsided, and a subsidence relief has been formed. This is well seen in the neighborhood of the Pecos River itself, and in particular between the banks of the river near the town of Santa Rosa.

The subsidence relief can be divided into the following three different parts more or less differentiated by their topographic position:

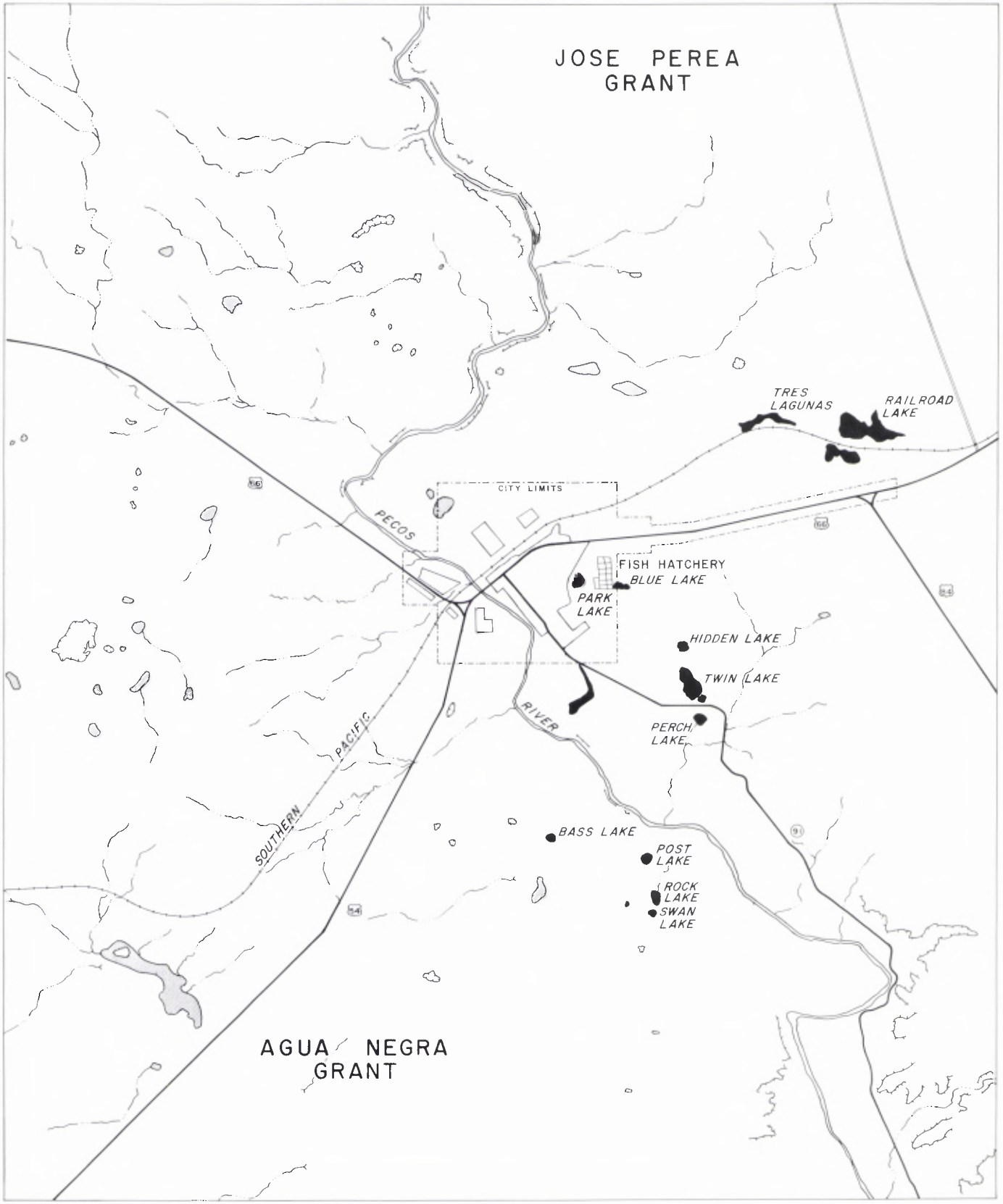

Figure 1. Index map of the Santa Rosa area.

1) In the river valley itself, there is the clearest indication of collapsed relief. Approaching the Pecos Valley from the west on Highway 66, the Santa Rosa Sandstone can be seen to be cracked and disturbed, with many landslips. Just west of the town the river cuts into the sandstone which is being undermined, not only by fluvial action, but also by solution sapping. The river here forms a local base level and a number of water-table springs are associated with it. In addition, lakes occur at this water level. Such lakes are formed by water which has percolated through both the limestones and the sandstones. Much collapse of sandstones can be seen.

A number of springs and lakes occur on the east side of the Pecos River near Santa Rosa. One of the most easily accessible is the spring at the fish hatchery in the east part of the town; this is an artesian spring, welling up through the sandstone through widened joints. To the S.E. of Santa Rosa are several water-table lakes and springs, for example the two known variously as Hidden Lake and Club Lake. In the Pecos River valley collapsed sandstone material occurs right down to the river level. The level in which the springs are developed may correspond to the Lakewood or Late Wisconsin terrace.

2) Above the valley bluffs for 2 to 3 miles from the river valley, the Santa Rosa Sandstone contains many circular, or nearly circular, enclosed hollows. These vary from a few feet wide to over 300 feet, and may be as much as 20 feet deep. They are often quite flat floored but have steeply cliffed sides, often with collapsed blocks. These are now well above the local water level and are usually dry, but can become lakes after rain. Debris is brought in by small arroyos, as is shown in the map, Figure 1. Hollows such as these seem to occur on a surface above the main river valley and may be associated with an early Wisconsin level of the Pecos River, as described by Leonard and Frye (1962), or the Orchard Park surface of Morgan and Sayre (1942). One or two big collapsed hollows occur at this level, as at Railroad Lake. It is possible that some of the arroyos draining to the river; have been initiated and aligned by the integration of a series of these collapsed sink holes.

3) At this higher level more gentle hollows occur; the steep sides have become smoothed over and much debris and alluvium have filled in the base of the hollows. Some parallel retreat of the sides has taken place and the depressions tend to be of a much larger area than those at lower levels. They can be up to several hundred yards long and wide and very flat floored. They resemble the poljes of Yugoslavia, though their origin may be quite different. The hollows on this level may belong to the Illinoian stage of the Pecos, or the Blackdom level. Associated with these hollows are solution-subsidence troughs, described by Olive in 1957; these are narrow linear depressions, varying in width from a few hundred feet to a mile and in length from 2 to 10 miles.

Above the third or upper level the hollows become obliterated on the sandstones and merge into the shallow valleys of the high plain. To the east these valleys are on sandstones, whereas to the west the small dolines and dry valleys of the Vaughn area become prominent.

The relief therefore of the Santa Rosa district shows a particularly good type of solution-subsidence relief. A few miles east of the town the sandstone cover becomes too thick for the subsidence features to be of any importance. Such subsidence relief is only important when the sandstone is of a certain thickness, probably up to about 500 to 550 feet. When the sandstone becomes thicker than this, subsidence relief does not occur. Solution-subsidence relief has been described from S. Wales in Great Britain by T. M. Thomas, where it is excellently portrayed.

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REFERENCES

Bretz, H., and L. Horberg, 1949, Caliche in southeastern New Mexico: Jour. Geology, v. 57, p. 491-511.

Harrington, E. R., 1957, Sinkholes, bottomless lakes and the Pecos River: Sci. Monthly, v.84, no. 6 p.302-308.

Lee, W. T., 1925, Erosion by solution and fill: U.S. Geol. Survey Bull. 760, p. 107-121.

Leonard, A. B., and J. C. Frye, 1962, Pleistocene molluscan faunas and physiographical history of the Pecos Valley: Bur. Econ. Geol. Univ. Texas. Rept. Invest. 45, 42 p.

Morgan, A. M., 1942, Solution phenomena in New Mexico: Am. Geophys. Union Trans., pt. I., p. 27-35.

Morgan, A. M., and A. N. Sayre, 1942, Geology and ground water in the Pecos River: Joint Investigation Nat. Res. Planning Board, p. 28-38.

Olive, W. W., 1957, Solution-subsidence troughs, Castile Formation of Gypsum Plain, Texas and New Mexico: Geol. Soc. America Bull., v. 68, p. 351-358.

Thomas, T. M., 1963, Solution subsidence in South Carmarthenshire and S.W. Breconshire: Trans. Inst. Brit. Geog. No. 33, p. 45-60.