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SALINE GROUND WATER IN EAST-CENTRAL NEW MEXICO*

by

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INTRODUCTION

Mother nature has been harsh to east-central New Mexico combining most of the forces at her disposal to form an ideal environment for the occurrence of saline ground water. She has formed the rocks containing the major aquifers of impermeable for slightly permeable materials, thus making it difficult for water to move into, through, or out of these rocks. She has emplaced evaporite minerals at many places forming a barrier to underground water movement, and at the same time effectively deteriorating the quality of any water that has somehow invaded or moved to the proximity of these rocks. She has imposed the conditions of low rainfall, high evaporation rates, and moderately large stream gradients. She has dispersed certain clay minerals, mostly where the evaporite minerals are absent, that increase the salinity of ground water. Whether by accident or by a further refinement of this grand design, saline ground water is under artesian pressure at many places, hence upward leakage of very saline water and brines into lesser saline aquifers must be commonplace. Man, though he may not appreciate the effect of this system, cannot fail to marvel at its efficiency.

SALINE GROUND WATER

The amount of saline ground water in storage in east-central New Mexico is estimated as sufficient to cover the area of its occurrence to an average depth of about 1,000 feet. It is believed that most, perhaps more than 70 percent, of this water is brine, or saltier than ocean water. Fresh water is scarce in many areas of east-central New Mexico. The largest deposits are in aquifers within the Ogallala Formation and alluvial aquifers in Torrance County. Elsewhere its occurrence is sporadic (see paper by Fred D. Trauger this guidebook).

One of the most ambiguous terms in hydrology is "saline water" because the saline water of one area may be considered fresh water in another. Many papers discussing saline water now use a classification proposed by Winslow and Kister (1956, p. 5) that is based on the concentration of dissolved solids. Concentrations are given in mg/l (milligrams per liter) which is approximately equal to concentrations in parts per million. The following table gives the ranges of dissolved solids for fresh water and for each class of saline water.

Class	Concentration range (mg/l)
Fresh	less than 1,000
Slightly saline	1,000-3,000
Moderately saline	3,000-10,000
Very saline	10,000-35,000
Brine	greater than 35,000

Hydrologists bent toward theoretical and mathematical treatment of ground-water hydrology may find fault with references to so many aquifers in this paper. Lest it be misunderstood, these references carry no connotations of hydrologic disconnection. Aquifers are separated herein according to the salinity of their water, and they may have excellent hydrologic connections at places.

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Slightly saline and moderately saline ground water is present in most parts of San Miguel, Torrance, Guadalupe, Quay, and De Baca Counties. Very saline water and brine probably underlie all these areas at various depths. The writer believes that the aquifers containing slightly saline water do not exceed 500 feet in thickness, and that aquifers containing moderately aline water are about the same thickness, but may exceed 1,000 feet in a few places.

There is little information on the areal extent or thickness of aquifers containing very saline water; however, it is assumed that these aquifers overlie all brine aquifers and from various pieces of evidence it is assumed that the brine aquifers underlie most of east-central New Mexico. The evaporites contain little or no water, but all other rocks of Paleozoic age lying beneath the evaporites probably contain brine aquifers. There is some evidence, from comments in driller's reports, that brine aquifers are present in Triassic rocks in Quay County, hence the total thickness of brine aquifers in parts of Quay County may be many thousands of feet. To the west the brine aquifers are much thinner and may be absent or only a few feet thick in most of Torrance County.

It is conjectured that the maximum potential yields of properly constructed wells tapping slightly saline aquifers are generally less than 25 gallons per minute. Yields may be much greater for wells tapping solution channels or collapsed breccia. A few wells in De Baca County are reported to yield more than 500 gallons per minute (Mourant and Shomaker, 1970, p. 24) and wells with comparable yields possibly could be developed near Santa Rosa. Many wells in the Estancia Valley yield more than 500 gallons per minute, but most pump fresh water (Smith, R. E., 1967).

Little information is available on the yield of wells tapping the more saline aquifers, but Berkstresser and Mourant (1966, p. 11) report an artesian flow of 1,000 gallons per minute from an oil test that tapped a moderately saline aquifer in sec. 30, T. 11 N., R. 28 E. Such yields from moderately saline aquifers probably are uncommon.

The U.S. Public Health Service (1962, p. 7) recommends that drinking water contains less than 500 mg/l dissolved solids. Few areas of the State have substantial supplies of water meeting this quality criterion, and as a necessity some communities use slightly saline water. The dissolved-solid concentrations of public water supplies in New Mexico range widely. One of the better supplies containing about 50 to 70 mg/l dissolved solids is a surface-water supply for Santa Fe. Probably the poorest supply was furnished to one of the communities in eastern New Mexico; a former municipal well in Santa Rosa yielded water with a dissolved-solid concentration of 2,380 mg/l (Dinwiddie, 1963, p. 71).

Slightly saline and moderately saline water is widely used for most purposes in east-central New Mexico. Moderately saline water is not used for a public water supply, but it is probably consumed by humans in some rural areas. Livestock are watered with both classes of saline water.

At places very saline water is probably used for watering livestock. It is believed, however, that livestock will generally avoid drinking such water if a better supply is available within a reasonable distance. Very saline water is used to some extent for irrigation, but several reports from farmers indicate its value is marginal.

The economic importance of a given water supply in general varies inversely with the dissolved-solid concentration, is related to its availability compared to the availability of a better supply, and is related to the chemical composition of the dissolved solids. However, if the concentration of dissolved solids is great enough, the value of the water may be enhanced.

Some brines are mined for their mineral constituents such as sodium chloride, sodium sulfate, and sodium carbonate. Others including sea water are mined for magnesium, iodine, and bromine. The salt lakes of Torrance County have been mined for common salt since Spanish Colonial times, and brines from several wells in Eddy County (T. 24, 26 S., R. 25, 27 E.) have been processed for sodium sulfate (Alto, Fulton, and Haigler, 1965, p. 304). A well in sec. 26, T. 25 S., R. 26 E., has yielded brine with a boron concentration greater than 1,300 mg/l (files of U.S. Geological Survey, Albuquerque).

Several studies have been made of the brines and evaporite deposits in west Texas and southeastern New Mexico, but insofar as known these studies have never been extended to east-central New Mexico. A "deep boring" drilled near Amarillo, Tex., prior to 1912 apparently yielded no potash. In 1921 potash was discovered in the borings from a well in Midland County, Texas (Hoots, 1926, p. 34). This and subsequent potash discoveries in the same area apparently shifted potash exploration to the south where it has remained for more than 40 years. A report of later potash exploration (Schaller and Henderson, 1932) indicates no interest in the brines or evaporite deposits of east-central New Mexico.

A few memoranda in the files of the U.S. Geological Survey are the only known testaments to an investigation of the brine and evaporite deposits of eastern New Mexico during World War II. The search was primarily for magnesium-rich brines and was centered, if not confined, to Red Bluff Draw in Eddy County (C. V. Theis, oral commun. 1972).

A search for information on subsurface brines in east-central New Mexico has yielded only one water analysis from a well in sec. 31, T.20 N., R.31 E. The major constituents of the brine are given in the following table:

Constituent	Concentration (mg/1)	Constituent	Concentration (mg/1)
Calcium	200	Sulfate	5,240
Magnesium	1,310	Chloride	26,000
Sodium and potassium	17,700	Dissolved solids	51,800

Numerous analyses of brines from Paleozoic rocks in southeastern New Mexico have been published by the Roswell Geological Society (1956, 1960, 1967), and are probably representative of brines in the same rocks of east-central New Mexico. These analyses are incomplete, showing only concentrations of boron, iodine, and bromine. A perusal of 34 of these analyses, selected at random, shows that 15 contain greater concentrations of magnesium than sea water, which is about 1,270 parts per million (Rankama and Sahama, 1950, p. 287). The greatest magnesium concentration is 18,000 parts per million in a brine from Roosevelt County (Roswell Geol. Soc., 1967, p. 170).

Demineralization of saline water is sometimes cited as the panacea for arid areas containing large volumes of such water. The optimistic advocates see demineralization as the means to obtain unlimited water supplies that will cause "the desert to bloom." The pessimists view demineralization as another technological blight, citing its many problems, such as the disposal of the large accumulation of salt byproduct, the undesirable changes of ground-water movement due to pumpage from saline aquifers, and the possibility of land subsidence.

The value of demineralization lies somewhere between these opposing viewpoints. If the need for a good water supply is great and demineralization is economically feasible, it may be possible to practice it on a limited basis. It is likely that demineralization would be practiced more widely, were it not for its high cost. When the cost of this process is reduced, demineralization of saline ground water may become a commonly used process for the utilization of saline-water resources.

It is possible that the greatest value of a paper in a Geological Conference Guidebook is the list of references. The reader seeking more reference material than is given below will be helped by a special publication of the New Mexico State Engineer entitled "Bibliography of ground-water studies in New Mexico," by R. L. Borton, 1972. A more complete bibliography is available for consultation at the offices of the U.S. Geological Survey in Albuquerque.

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