GROUND WATER IN THE TATUM DOME AREA, LAMAR COUNTY, MISSISSIPPI

by

R. E. Taylor
Geologist, U.S. Geological Survey
Jackson, Mississippi

INTRODUCTION

In January 1961 the U.S. Atomic Energy Commission began supervision of Project Dribble activities at the Tatum salt dome in connection with the Advanced Research Project Agency's Vela Uniform program of detection of seismic signals from underground atomic tests. Exploratory activities were initiated to establish dome definition and characteristics and to define the geology and hydrology of the area. This report will consider the ground-water conditions that exist in the Tatum dome area as determined from the investigations by the U.S. Geological Survey. The area under consideration is approximately 4 square miles and includes the dome and a mile-wide border. The Tatum dome is located in the southwest quarter of Lamar County about 18 miles southwest of Hattiesburg, Miss., and about 16 miles southeast of Columbia, Miss. (fig. 1).

Previous dome investigations were begun in 1941 by various companies undertaking oil, gas, and sulfur explorations. Since 1961 the U.S. Government's activities have expanded the available data through the drilling of 34 test holes.

GEOLOGY

Geologic units encountered in the ground-water investigation range from Recent surficial material down to the Sparta Sand of Eocene age at a depth greater than 2,600 feet. Figure 2 shows a southwest to northeast cross section through the salt dome and depicts the relation of the salt dome to the surrounding sediments. The Tatum dome is a large subsurface salt stock that has risen through sedimentary deposits ranging in age from Early Cretaceous to middle Tertiary.

The sedimentary deposits have a regional strike of approximately N. 75° W. and a south-southwest dip of about 40 feet per mile. However, the dip has been locally modified by the dome. With one exception, all stratigraphic units average about 20 feet thicker in the southwest section than in the northeast section. The stratigraphic units range from 92 to 228 feet deeper at well Hydrologic Test No. 2 than at Hydrologic Test No. 1, the thickening generally increasing with depth. The sediments of Miocene age are deeper and thicker in the southwest section than in the northeast section, but vary in thickness and attitude over the dome because of the relationship of rate of deposition and subsidence of the sediments and rate of rise and subsidence of salt stock and residual caprock.

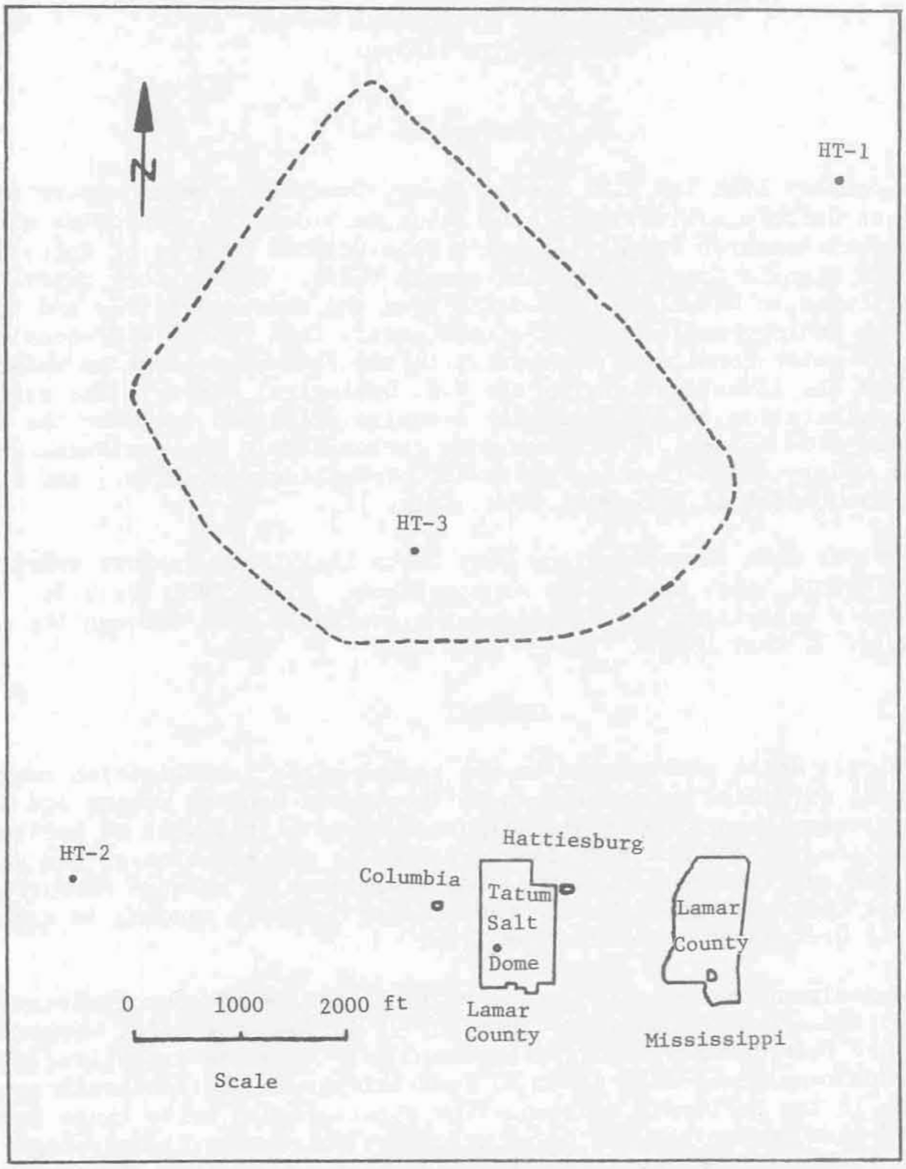

Figure 1.--Map showing location of the Tatum dome and hydrologic test wells.

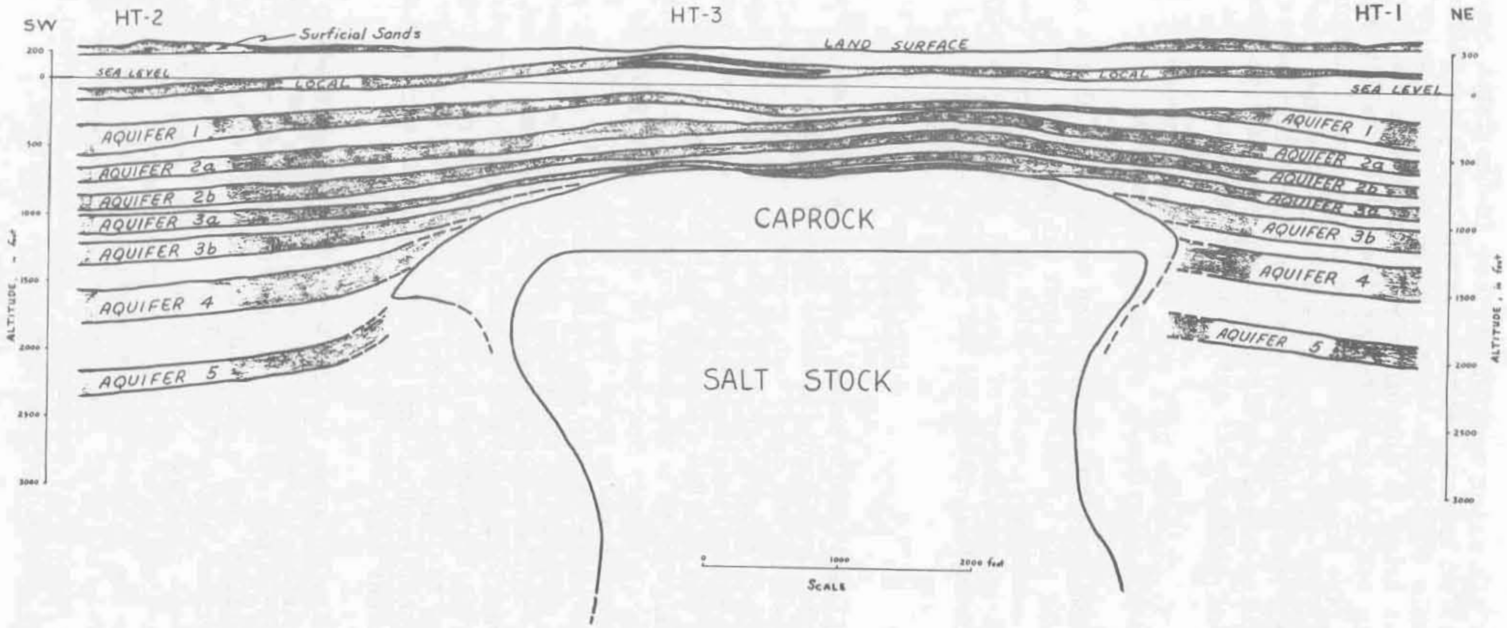

Figure 2.--Southwest to northeast cross section through the Tatum dome.

HYDROLOGY

There are six major aquifer systems in the Tatum dome area. The shallowest aquifer system comprises irregular water-bearing sands in which water-table conditions exist in the surficial material, and artesian conditions exist in the underlying local aquifer. Most domestic water supply in the area is obtained from this shallow aquifer system. The remaining five aquifer systems are designated 1 through 5 from the top down. Aquifers 1, 2, and 3 have fresh water under artesian conditions and supply the industrial and municipal ground-water withdrawal in the surrounding area. Aquifer 4 has brackish water and aquifer 5 has saline water, both under artesian conditions.

Aquifers 5, 4, and a part of 3 have been pierced by the dome; the other aquifers are continuous throughout the area.

Three hydrologic data-collection sites were chosen along the general regional dip of the formations in the dome area. One site is up dip to the northeast; another site is on the dome; the third site is down dip to the southwest of the dome. The discussion of the aquifers will be from the oldest to the youngest.

Aquifer 5

The shallowest saline-water aquifer in the dome area is the limestone within the Cook Mountain Formation of Eocene age. This aquifer has been pierced by the dome, but probably is hydraulically connected with the residual caprock or salt stock of the dome. There is no withdrawal of water from this aquifer in the general area but brine has been injected into the aquifer for more than 13 years in the vicinity of the Baxterville oil field, a few miles southwest of the Tatum dome. The injection over the years has been of sufficient quantity to raise the head in observation wells more than 5 feet since 1961. The normal movement of ground water toward the south-southwest has been reversed in the dome area because of the brine injection; the movement is about 3 feet per year to the north-northeast. The thickness and nature of the overlying formations precludes water from aquifer 5 moving upward into aquifer 4 in the surrounding area, although there is possible communication between the aquifers along the flanks of the salt dome. Aquifer 5 has the highest head of any artesian aquifer explored in the dome area. Generally, deeper aquifers have more pressure.

The quality of water in the Cook Mountain Formation varies in well HT-1 in the northeast section and well HT-2 in the southwest section. At HT-1 the water has a dissolved-solids content of about 18,000 ppm (parts per million) and a chloride content of about 11,000 ppm. At HT-2 the water has a dissolved-solids content of about 30,000 ppm and a chloride content of about 18,000 ppm. This excessive increase results from the salt dome intercepting the ground-water flow, thus the water down dip from the dome is more mineralized. The expected change in water quality at HT-1, owing to the reversal of ground-water movement caused by the brine injection, has not yet occurred. This can be attributed to the short time and slow rate of movement involved.

Aquifer 4

Limestone beds of the Vicksburg Group contain brackish water in the dome area and have been designated aquifer 4. The aquifer is not continuous throughout the area, as it has been pierced by the dome and is now positioned adjacent to the residual caprock. Water is not withdrawn from aquifer 4 in the surrounding area.

The head of aquifer 4 is intermediate between the head of the underlying aquifer 5 and the overlying aquifers 1, 2, and 3. The pressure is also greater than that of the caprock fluid, so that some ground water moves from aquifer 4 into the caprock and then into the overlying aquifer 3. The direction of ground-water movement in aquifer 4 is to the south-southwest at a rate of about 1 foot a year. Water level has declined less than 1 foot a year since 1963.

At HT-1 the water in this aquifer has a dissolved-solids content of about 1,200 ppm and a chloride content of about 400 ppm; down dip at HT-2 the water has a dissolved-solids content of about 1,400 ppm and a chloride content of about 450 ppm.

Aquifer 3

Aquifer 3, which contains the deepest fresh water in the dome area, has been separated into two distinct units within the Catahoula Sandstone. The upper part of the formation, composed of sand, has been designated aquifer 3a. It is a continuous aquifer throughout the area, although thinner across the top of the dome. The lower part, the Tatum Limestone Member of the Catahoula Sandstone, has been designated aquifer 3b. The dome has interrupted aquifer 3b, but lithologically the aquifer may probably be transitional into the caprock of the dome. No ground-water data have been obtained for aquifer 3b; therefore, the following discussion will be concerned only with aquifer 3a.

ıhe direction of ground-water movement throughout the region for aquifer 3 is to the south-southwest. Because of water withdrawal to the east and northeast the hydraulic gradient in the Tatum dome area is to the northeast. The rate of water movement is about 13 feet per year. The water-level decline is about 1 foot per year.

At HT-1 the water has a dissolved-solids content of 420 ppm and a chloride content of 21 ppm. At HT-3 the water has a dissolved-solids content of 1,730 ppm and a chloride content of 438 ppm. At HT-2 the water has a dissolved-solids content of 1,420 ppm and a chloride content of 503 ppm. This sequence of water-quality changes across the dome suggests that normal fresh water is being mineralized by upward migrating water because of the differential head pressure between the caprock aquifer and aquifer 3a. At HT-2 the water is less mineralized because of the dispersion of the mineralized water moving off the dome and mixing with the normal aquifer water moving around the dome. Thus, the dome has an effect on the water quality for some unknown distance away from the dome. Pumping tests of wells in both the caprock aquifer and aquifer 3a indicate communication between them.

Aquifer 2

Aquifer 2 is in the Pascagoula and Hattiesburg Formations, undifferentiated. Within the Tatum dome area, aquifer 2 has been separated into two distinct sand units, the upper unit designated 2a and the lower unit 2b. Aquifer 2 is a major source of ground water for industrial and municipal use in the surrounding areas.

The head of aquifer 2a is about 3 feet higher than that of aquifer 2b. The direction of ground-water movement throughout the region for aquifer 2 is to the south-southwest. The rate of movement and direction for aquifer 2b cannot be ascertained, because there is only one well finished exclusively in this sand unit. In the Tatum dome area the direction of ground-water movement for aquifer 2a is to the northeast, because of water withdrawal in the surrounding area, and is at a rate of 58 feet per year. The water-level decline of aquifer 2 is about 1 foot per year.

Aquifer 2 water at HT-1 has a dissolved-solids content of 71 ppm and a chloride content of 4.1 ppm. At HT-2 the water has a dissolved-solids content of 67 ppm and a chloride content of 4.5 ppm. Thus, there is no appreciable difference in the chemical quality of the water away from the dome. However, over the dome water in aquifer 2b has a dissolved-solids content of 909 ppm and a chloride content of 102 ppm; water in the overlying aquifer 2a has a dissolved-solids content of 106 ppm and a chloride content of 19 ppm. Thus, some mineralization of aquifer 2 water occurs above the dome and decreases with an increase in height above the caprock.

Pumping tests indicate that hydraulic communication exists between aquifers 2a and 2b. Pumping tests also indicate hydraulic communication between aquifers 2b and 3a.

Aquifer 1

Aquifer 1, the shallowest major water-bearing sand in the region, is found within the Pascagoula and Hattiesburg Formations, undifferentiated.

The head of aquifer 1 is about 15 feet higher than that of aquifer 2a. Ground water aquifer 1 moves southwest at a rate of about 3 feet per year. The water level declines less than 1 foot per year, as indicated by a single well completed in the aquifer.

Water at HT-1 has a dissolved-solids content of 164 ppm and a chloride content of 4.5 ppm. At HT-2 the water has a dissolved-solids content of 117 ppm and a chloride content of 4.6 ppm. The analysis of a water sample from a well on the dome indicates greater mineralization. Thus, there is no appreciable difference in the chemical quality of the water away from the dome. However, the water-quality variations that occur over the dome are probably because of vertical mineralization from the caprock.

Pumping tests indicate that hydraulic communication exists between aquifers 1 and 2a.

Shallow Aquifers

The shallow aquifers consist of irregular water-bearing sands in the Pascagoula and Hattiesburg Formations, undifferentiated, the designated local aquifer in which artesian conditions prevail, and the surficial sands younger than Miocene in age in which water-table conditions prevail. These aquifers are the source of almost all the domestic water in the area.

The surficial sands are in the alluvium, terrace deposits, and the Citronelle Formation of Pliocene age. Most streams have eroded down to the clays of Miocene age, therefore, this aquifer is not a continuous unit throughout the area. The surficial sands supply the base flow of the streams. Water-table conditions prevail in these sands. Thus, the amount of available water is the excess precipitation recharge over discharge losses to streams and the atmosphere. Water is in sufficient quantity to supply the small domestic requirements. Some of the shallow water is affected by surface contamination. The main problem in the use of water from the surficial sands is the quality, iron content in particular.

In localities where the quantity of water in surficial sands is insufficient or the iron content is too high, domestic wells are completed in the underlying and minor water-bearing sands of the upper part of the Pascagoula and Hattiesburg Formations, undifferentiated. The quantity of water available from this source is more than sufficient to meet domestic needs. As to the quality of the water, the dissolved-solids content is higher, but the iron content is lower than in the water from the overlying surficial sand.

SUMMARY

The Tatum dome influences the chemical quality of ground water by two means: (1) the position of the dome in relation to the surrounding aquifers is such that ground water moves from one aquifer to another; (2) the complex chemistry of the dome itself is contributing mineralization to the contiguous aquifers.

There are probably no effects of the dome on the waters of the surficial or local aquifers. Changes in the quality of water for aquifers 1, 2, or 3 do not impose any consequential water-use problem outside the Tatum dome area, because of dilution and the slow rate of ground-water movement. The water quality of aquifer 4 is affected by the dome, but the water may never be utilized because of the availability of fresher water. The water quality of aquifer 5 is greatly affected by the dome, but it is already a brine solution and its use would be limited.

Name: R. E. Taylor

Title: Geologist

Organization: U.S. Geological Survey, Water Resources Division

Home State: Pennsylvania

Education: B.S. degree in geology and mineralogy from the Pennsylvania State University.

Experience: Began work in 1956 with USGS in South Carolina. After a tour of duty with U.S. Navy resumed work with USGS at the Hydrologic Laboratory in Denver, Colo. Also assigned to projects at Atomic Energy Commission's National Reactor Testing Station in Idaho and their Nevada Test Site. Came to Mississippi in 1961 and presently is doing areal and interpretive studies.