Aquifers in Ottawa County, Oklahoma[1]

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INTRODUCTION

Ottawa County, in the northeastern corner of Oklahoma, is nearly square, has an area of 504 square miles, and has a population of about 32,000 (1950).

The mining and milling of lead and zinc ores ranked as the most important industry in the county until 1944, when the B. F. Goodrich Co. established a tire-manufacturing plant at Miami. This industry is about equal in importance to mining and milling, and its large requirement for cooling water emphasized the need for an appraisal of the county's ground-water resources.

AQUIFERS

The principal aquifers are the Arbuckle group, of Cambian and Ordovician age, and the Boone limestone of Mississippian age. The alluvium and low-level terrace deposits along the main streams may contain substantial quantities of ground water in places, but they are an unproved reservoir thus far tapped only in a few places and only for small amounts of water. The other formations yield meager supplies of ground water, generally adequate only for rural, domestic, and stock use and not every where of good quality.

GROUND WATER IN THE ARBUCKLE GROUP

The Arbuckle group is the source of all municipal water supplies in the county. It does not crop out within the county and has its intake area many miles to the east in the Ozarks. Wells tapping it are generally 1,000 to 1,300 feet deep and are cased and cemented to exclude water from all overlying rocks. Of the water-bearing beds in the Arbuckle, the Roubidoux formation is the most prolific. The Roubidoux consists principally of dolomite, but contains two or three sandy zones in which sand makes up as much as 80 percent of the rock. The total thickness of the Roubidoux in Ottawa County, as indicated by microscopic examination of insoluble residues

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of drill cuttings from 13 wells, ranges from 105 to 180 feet, and its top has been reached at depths ranging from 880 to 1,020 feet. Most of the water of the Roubidoux comes from the sandy zones, and wells in the formation yield up to 600 gallons per minute. Although rather hard, the water has a relatively low mineral content.

When deep wells first tapped the water in the Arbuckle group, shortly after 1900, the artesian pressure was sufficient to make them flow, but as the withdrawals increased the artesian head declined. By 1918 most wells had stopped flowing, and by 1947 the water was being lifted more than 500 feet in some wells. The greatest decline in water levels has occurred near Miami, but water levels also have dropped alarmingly elsewhere in the county and in adjacent parts of Kansas and Missouri.

Three controlled pumping tests on wells of the B. F. Goodrich Co. were analyzed according to the Theis nonequilibrium formula to determine values of the coefficients of transmissibility and storage. The coefficient of transmissibility is a measure of the ability of the aquifer to transmit water and the coefficient of storage is a measure of its ability to release water when the artesian head is lowered. These coefficients, together with the discharge and boundary conditions, determine the position of the piezometric surface. From the tests, the coefficient of transmissibility was determined to be about 40,000 gallons per day per foot and the coefficient of storage to be about 1×10^{-4}.

The tests showed that the Miami syncline acted as an impermeable barrier to the flow of ground water in the area within the cone of depression caused by the pumping. The syncline is believed to be an impermeable barrier throughout most of its length and the same may be true of the Seneca fault. This, in part, would account for the larger decline in water level in the Miami area than elsewhere. For example, assume that a well in the Miami area, 0.5 mile from the Miami syncline, is pumped continuously for 5 years at a rate of 400 gallons per minute and has a specific capacity of 2 gallons per minute per foot of drawdown after 25 hours of pumping. At the end of this 5-year period, the drawdown in this well due to its own pumping would be about 260 feet. If no barriers were present, the drawdown would have been about 210 feet. If a second well, 0.5 mile from the first well and also 0.5 mile from the Miami syncline, were pumped at the same rate for the same period of time, the drawdown in the first well would be about 320 feet, an increase of 60 feet. If no boundaries were present, the increase in drawdown would have been less than 12 feet. Any additional pumping of wells in the area would increase the drawdown in the first well. The amount of such increase would depend on the distance from the first well, the distance from the Miami syncline and the Seneca fault, and the rate and duration of pumping.

From the geology and the analysis of the pumping tests it appears that the rocks of the Arbuckle group in Ottawa County function mainly as a huge reservoir, and water levels will decline as long as pumping continues. The rate of decline will diminish as time passes if the pumping rate remains unchanged, but will increase if the pumping rate is materially increased. If present rates of withdrawal are to be maintained, pump bowls ultimately will have to be lowered. The reservoir still should furnish many millions of gallons of water, although at increasing cost occasioned by increasing lift. If an economical and practical method could be found to recharge the reservoir artifically, the trend might be reversed.

Ground Water in the Boone Limestone

The Boone limestone contains water where it has been fractured or has been made porous by the dissolving action of circulating ground water. Whether wells in the Boone succeed or fail depends largely on the number, size, and interconnection of the openings encountered. Large quantities of

water have been pumped from the Boone limestone in dewatering the lead and zinc mines of the northern part of the county. Elsewhere in the county, the Boone is tapped only for relatively small rural needs, the water level remains high, and springs, some very large, are abundant, suggesting that considerably more water could be withdrawn without danger of overdraft. A serious drawback to using the water of the Boone is that polluted surface waters may enter the formation through cracks and sinkholes. Furthermore, the Boone, like limestones generally, effects little or no filtration of the water passing through it. The water is relatively high in calcium bicarbonate, is moderately hard, low in chloride, and relatively low in dissolved solids.