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PURPOSE

C O L O R A D O

This map shows the distribution of the principal fresh-water aquifers in Oklahoma, the depth to water in wells penetrating them, and the yields that may be expected from these wells. Because of the limitations imposed by the scale of the map, the information shown here necessarily involves considerable approximation. It is to be regarded as "average," although use of this word is not meant to imply that mathematical averages have been calculated. Extremes of abundance and scarcity and of depth to water cannot be shown. Water-bearing formations capable of yielding more than 50 gallons per minute will be found in small areas here designated as capable of yielding less than 50 gallons per minute, and dry holes doubtless will be drilled in some areas where yields exceeding 1,000 gallons per minute are expected. The text describes the aquifers and outlines some fundamentals of the occurrence of ground water.

This map is not the first to show ground water in Oklahoma. Dott (1942, 1942a) showed the location of the principal water-bearing formations of the State in a series of small-scale State maps. The map entitled "Minerals of Oklahoma" (Oklahoma Geol. Survey, 1944), which now is out of print, showed essentially the same information on location of aquifers and indicated the approximate abundance of ground water and the pumping lift. Several publications of the Oklahoma Planning and Resources Board have included 1-page maps of the State outlining the principal aquifers. The latest of these is in "Oklahoma's Water Resources." U. S. Geological Survey Hydrologic Atlas 3, "General availability of ground water and depth to water level in the Arkansas, White, and Red River basins," published in 1953, covers all of Oklahoma and parts of adjacent states on a scale of about 1 inch to 40 miles. The map presented here gives details that could not be included in Hydrologic Atlas 3, together with additions and modifications based on field work done since the atlas was prepared. As investigations of ground water in Oklahoma disclose new facts other revisions and modifications will become apparent for incorporation in future maps.

ACKNOWLEDGMENTS

This map has been prepared under terms of a cooperative agreement between the U. S. Geological Survey and the Oklahoma Geological Survey. The agreement has been in effect and work has been in progress since mid-1937. Data used here have been drawn from investigations of ground water made under that agreement and under a similar agreement between the U. S. Geological Survey and the Oklahoma Planning and Resources Board, which has been in effect since late 1949. The writer's colleagues in the U. S. Geological Survey and members of the cooperating State agencies have supplied much unpublished information. A part of their contribution was, of course, furnished to them by city officials, industries, and private individuals too numerous to name here. For areas not covered by cooperative investigations of ground water, considerable use has been made of tabulations of wells inventoried in 1936 by the State Mineral Survey, a project of the Works Progress Administration sponsored and directed by the Oklahoma Geological Survey.

FEATURES SHOWN

The following paragraphs explain the terms ground-water reservoir, depth to water, and yield of wells as these have been interpreted in the preparation of this map.

GROUND-WATER RESERVOIR VERSUS OUTCROP AREA The areas shown on this map are only approximately the

outcrop areas of the water-bearing formations. Rock formations may be too thin near their edges to afford reservoir capacity for significant quantities of ground water, or they may have been cut through by a multitude of streams so that the water readily drains from them in springs and seeps. Accordingly, the boundaries on this map are drawn so as to include the areas where the aquifers are most likely to contain ground water, generally at a short distance from the geological edges of the formations. On the other hand, some formations contain potable ground water for miles down dip from their areas of outcrop, where wells must first penetrate overlying younger formations to reach them. Therefore some of the boundaries mark the limit not of the surface outcrop but that beyond which the ground water

DEPTH TO WATER

is likely not to be potable.

The depth to water is the depth below the land surface to the static (nonpumping) water level in wells. Where ground-water investigations have been or are being made, this depth generally has been measured in many water wells by means of a graduated steel tape. For other areas, the depth to water is based on reports from various sources, including well owners and drillers. On the scale of this map, the inaccuracies inherent in the reported information probably are of small consequence. The depth to water as shown is not the same as the pumping lift. The latter is the depth to water in a well that is being pumped, and it depends on the depth to static water level, the hydraulic properties of the aquifer, the construction of the well, and the pumping rate. The depth to water closely approximates the depth at which water will be found in wells where water-table conditions prevail, although this is not necessarily the depth of the most prolific part of the aquifer. In alluvium, especially, the water level in a well is likely to stand opposite finegrained sediments capable of low yields at best, whereas the bulk of the water reaches the well through coarse gravel near the bottom of the deposit. Where artesian conditions prevail, the static water level may range from a few feet to hundreds of feet above the top of the water-bearing formation. Where the land surface is nearly flat, the depths to water as measured in a few wells are sufficient for drawing lines representing equal depth to water. Such lines are used to depict the depth conditions in the Oklahoma Panhandle and some adjacent parts of Oklahoma. Where the land surface is hilly or rough the drawing of such lines becomes highly complicated; also, for rather large areas the required information is not available. The best that can be done is to scan the records, eliminate a few of the extremely deep or extremely shallow water levels, and give the range in depth of the rest. For example, the figures 10 to 100 appear on a rather large ground-water area centering in Delaware County, and mean that the depth to water in most wells is between 10 and 100 feet from the land surface. A single figure within a bracket means an isolated record of depth to water, and is used only where information is so scanty that a reasonable range in depth cannot be given. The figure [100] adjacent to Seminole is an example. It is applicable to the local area only, and does not mean that the depth to water is 100 feet in all parts of the ground-water basin. The depth to static water level in alluvium along major streams is generally less than 25 feet, and accordingly the figure <25 is used to express the idea "less than 25 feet." Actually, the depth is between 5 and 15 feet in the greater part of the bottom lands and may be practically zero at the channel. Static water levels in the vicinity of Miami, Ottawa County, show the effect of half a century of ground-water withdrawal. Wells here once overflowed at the surface, but nonpumping water levels are now hundreds of feet below the surface.

YIELDS OF WELLS

Yields of existing wells are the basis for the expectable yields wherever such information is available; where it is not, comparison has been made with aquifers having similar lithologic characteristics. Adjacent wells may yield quantities of water that differ widely for a variety of reasons, and it is therefore difficult to estimate with certainty how much normally may be expected. In general, the extremely prolific well and the dry hole have been ignored. Because many wells and pumps are not designed or even intended to extract the maximum quantity from aquifers, the expectable yields shown here may be less than the capabilities of some aquifers and therefore may be regarded as conservative. On the other hand, the discharges reported by well drillers and by well owners commonly are higher than the discharges measured in the survey, and expectable yields based on such reports may be too optimistic. Incomplete data on ground water in western Caddo County suggest that no more than 500 gallons per minute may be expected, but some reports from well owners and others imply substantially higher yields. Accordingly, two small areas are designated on this map as having yields between 500 and 1,000 gallons per minute. These are shown near Alfalfa and Weatherford, but they are diagrammatic, not geographically precise. They are intended to show that yields exceeding 500 gallons per minute may be obtainable locally. It is impossible to single out the individual wells having the higher yields.

GENERAL GEOLOGY OF OKLAHOMA

The rocks underlying the surface of the State of Oklahoma are of sedimentary origin except in parts of the mountains and a few small areas elsewhere, where they are of igneous origin. The igneous rocks, however, crop out in but a small fraction of the total area of the State. Of the sedimentary rock types, shale predominates as to both area of outcrop and thickness, but other kinds of sediments are well represented. Sandstone, limestone, dolomite, sand, and gravel at many places constitute thick geologic units and underlie large areas. Gypsum, anhydrite, and rock salt are of widespread occurrence in the western half of the State and have special bearing on the quality of both surface and ground water. The oldest rocks exposed at the surface are the igneous rocks along the axis of the Wichita and Arbuckle Mountains. These are surrounded by outcrops of sedimentary rocks, successively younger rocks cropping out at progressively greater distances from the mountains. Aside from the mountains, which after all are only a small fraction of the whole area. the oldest rocks occur in the eastern and the youngest in the western parts In a general way, the sedimentary rock formations dip west-

ward at low angles ranging from a few tens of feet to a few hundred feet per mile. Several major structural features interrupt this general westward dip, and in and near them the rocks dip at steep angles. The principal uplifted structures are the Wichita, Arbuckle, and Ouachita Mountains and the Criner Hills. In these areas the rocks are extensively and, in places, intricately folded and faulted. The Ozark dome is an uplift that centers outside the State, but several eastern Oklahoma counties are on its flanks.

The Ardmore basin is a large downfolded structure lying south of the Arbuckle Mountains. Within it the rocks are closely folded and

dip at steep angles, being overturned at places.

The dominant structural feature of northwestern Oklahoma north of the Wichita Mountains is the Anadarko basin, which is a great asymmetric trough whose axis extends northwestward from southwestern Garvin County into the northwestern part of the Panhandle of Texas. According to Freie (1939, p. 75) the rock formations along the north flank of the Wichita Mountains (south flank of the basin) dip north and northeast toward the axis of the basin at an average rate of 250 feet to the mile; at the southeastern end of the basin they dip west about 50 feet to the mile; and along the extreme north flank they dip southwest at an average rate of about 10 feet to the mile.

(Continued on Reverse Side)

