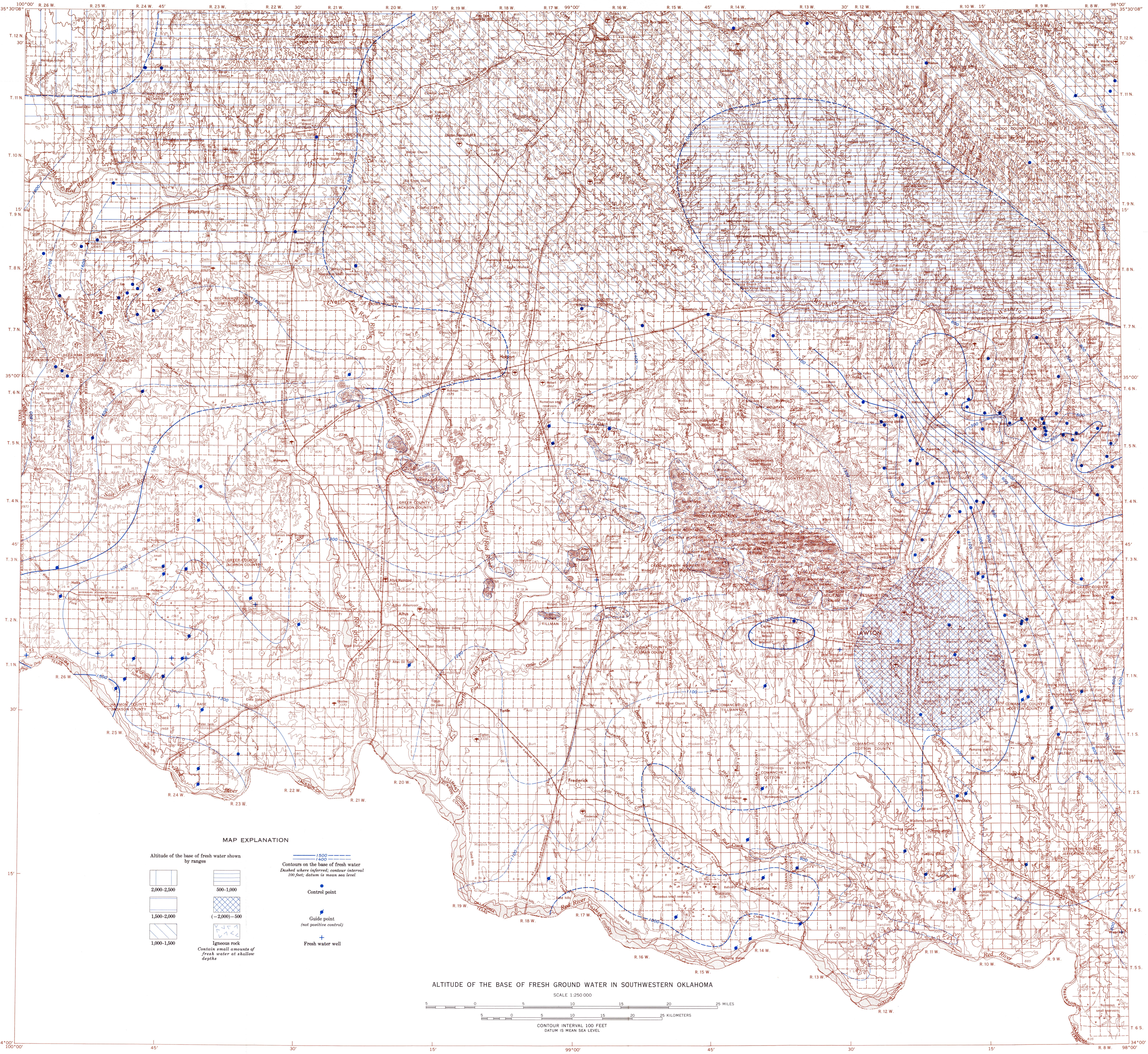
PREPARED IN COOPERATION WITH
THE OKLAHOMA CORPORATION COMMISSION
AND OKLAHOMA WATER RESOURCES BOARD



ALTITUDE OF THE BASE OF FRESH GROUND WATER IN SOUTHWESTERN OKLAHOMA

Base from Army Map Service 1:250,000 Series:
Clinton and Lawton, 1955

BASE OF FRESH GROUND WATER IN SOUTHERN OKLAHOMA

INTRODUCTION

In 1960 the Oklahoma Corporation Commission requested the Ground Water Branch of the U.S. Geological Survey to prepare a reconnaissance report outlining areas in Oklahoma where appreciable quantities of fresh ground water occur. Maps delineating the base of the fresh-water body were planned as an important part of the report. By mutual agreement, the U.S. Geological Survey would map the southern part of Oklahoma and at the same time the Corporation Commission would prepare similar maps for the northern part.

This report, which covers the southern part of the State, as shown on the index map, contains: (1) a general description of the fresh ground-water body; (2) maps showing contours drawn on the base of the fresh-water body; (3) maps showing the depth of the fresh-water body in the bedrock formations; and (4) maps showing areas where fresh water is found in particular formations, or groups of formations.

The information should be useful in planning, conserving, and developing the State's ground-water resources and in establishing depths at which casings in oil wells and waste-disposal wells should be set to prevent contamination of fresh ground water. The terms "fresh water" and "fresh-water body" are used in this report in a broad sense to include water suitable for human and stock consumption and for irrigation. It includes the slightly brackish water that may be of economic importance in the future. The slightly brackish water referred to may contain approximately 2,000 to 5,000 ppm (parts per million) dissolved solids. For instance, in southwestern Oklahoma, water derived from the Permian Blaine Gypsum contains large amounts of calcium sulfate and though generally unsuitable for domestic use, is satisfactory for irrigation. The base of the fresh-water body was determined from electric logs of deep wells, drillers' records of water wells and test holes, and information contained in geologic and hydrologic reports.

The most important source of information was electric logs of wells drilled for oil. Because of the areal extent of the project and the complexity of the geology the electric logs were interpreted by inspection. No attempt was made to compute the sodium-chloride content or hypothetical chemical combinations that might occur in the water.

The interpretations of the electric logs were based on the comparative values of three curves, as shown on the idealized electric log: the spontaneous-potential curve and two resistivity curves. The spontaneous-potential curve measures the differences in electrical potential across formation boundaries and is of little value in the fresh-water section. However, as the "formation water" (as opposed to water introduced during drilling) becomes more highly mineralized, the curve becomes more indicative of the quality of the water and is a valuable aid in determining the transition zone between fresh and salt water.

The first resistivity curve is called the short normal and is a shallow penetration curve based on an electrode spacing of 10 to 20 inches. It records the resistivity of the formation and the contained fluid for only a short distance from the wall of the hole and is, therefore, influenced by the drilling fluid, which invades the formation during drilling of the hole. The second resistivity curve, or long normal, is based on an electrode spacing of five or more feet and is a deep penetration curve recording the apparent resistivity of the formation and its fluid. A comparison of the short- and long-normal curves gives an indication of the quality of the water in a formation. As the water in the formation becomes more highly mineralized the resistance values decrease.

This decrease in resistance (shown on the long-normal curve) and the corresponding increase in the spontaneous potential can be used to identify approximately the depth where ground water becomes salty.

FRESH GROUND-WATER BODY

The body of fresh ground water in the southern part of Oklahoma is contained in sedimentary, igneous, and metamorphic rocks of several ages. The water may occur in unconsolidated deposits of silt, sand, and gravel; in sandstone; in crevices and solution cavities in beds of limestone or gypsum; in fractures developed in shale and tightly cemented rocks; or in crevices formed in igneous and metamorphic rocks. Knowing the lowest formation or zone in which fresh water exists should be helpful in establishing the depth of surface casing for oil wells necessary to prevent contamination. This should also be helpful in estimating the quantity and quality of fresh water available in the area.

Yields of wells obtaining water from the fresh-water body range from less than a gallon a minute to more than 3,000 gpm (gallons per minute), depending upon the thickness, permeability, and areal extent of the water-bearing zone tapped.

In a few isolated areas the body of fresh water is too thin to provide a dependable source of water. In other areas fresh water may be found to depths as great as 3,000 feet below land surface.

Beneath the fresh-water body, the rocks are so poorly permeable that they contain little or no water, or contain saline water that is unsuitable for most uses.

In some areas the rocks are shown as containing fresh water but they may be poorly permeable and the fresh-water body may not have sufficient thickness to yield water to wells economically, especially where the depth to water is great.

At the time of writing (1964), the permeability (ability of a rock to transmit water under pressure) and the transmissibility (quantity of water that can be transmitted through saturated rocks at a hydraulic gradient of 1 foot to the mile) of the rocks containing the fresh-water body are not well known; hence, in most areas, it is not possible to determine the volume of water available for use.

The depth to which fresh water extends in a particular formation depends upon the dip of the beds, the permeability and solubility of the rocks, the extent of the outcrop and recharge areas; the source of recharge, and possibly contamination from local sources. The interrelation and variability of these factors account for the irregularity of depths at which fresh water occurs in large areas and locally within a particular bedrock formation. Areas of deepest fresh water occur in moderately to steeply dipping permeable rocks having large recharge capabilities.

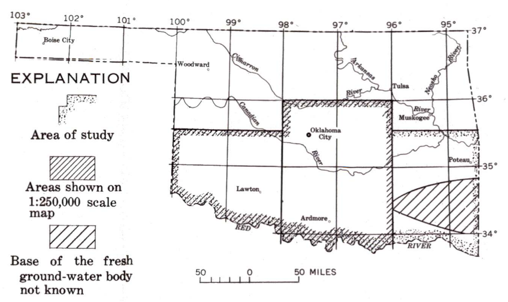
Where the fresh-water body is underlain by poorly permeable rocks, the boundary on the base of the fresh water is quite distinct. Where the rocks are relatively permeable, however, the contact between fresh and saline water may grade from fresh to brackish to saline through an interval of several hundred feet. In these areas, the base of the fresh-water body was marked at the point where the resistivity curves on electric logs of wells indicated salt water (in excess of 5,000 ppm dissolved solids). In a few places, fresh water was found below bodies of saline water. These intermediate, or perched(?), saline-water bodies were not shown on the maps because data were not adequate to map their areal extent and thickness.

In a general way the contours drawn on the base of the fresh-water body reflect structural features that influence the occurrence and availability of ground water.

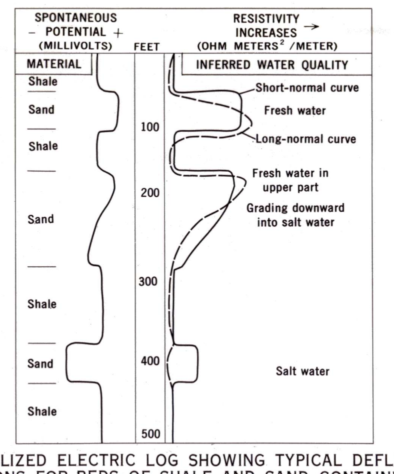
Some of the many irregularities of the base of the fresh-water body may be due to the method used to determine the base. The bottom of the lowermost fresh-water sand at any one location was mapped as the base of the fresh-water section as shown on the generalized sections. However, if that sand grades laterally into a shale, an overlying sand, possibly several hundred feet higher, would have been chosen as the base of the fresh-water section in an adjacent well. Other irregularities of the base in and around oil fields may result from oil-field contamination.

USE OF MAPS

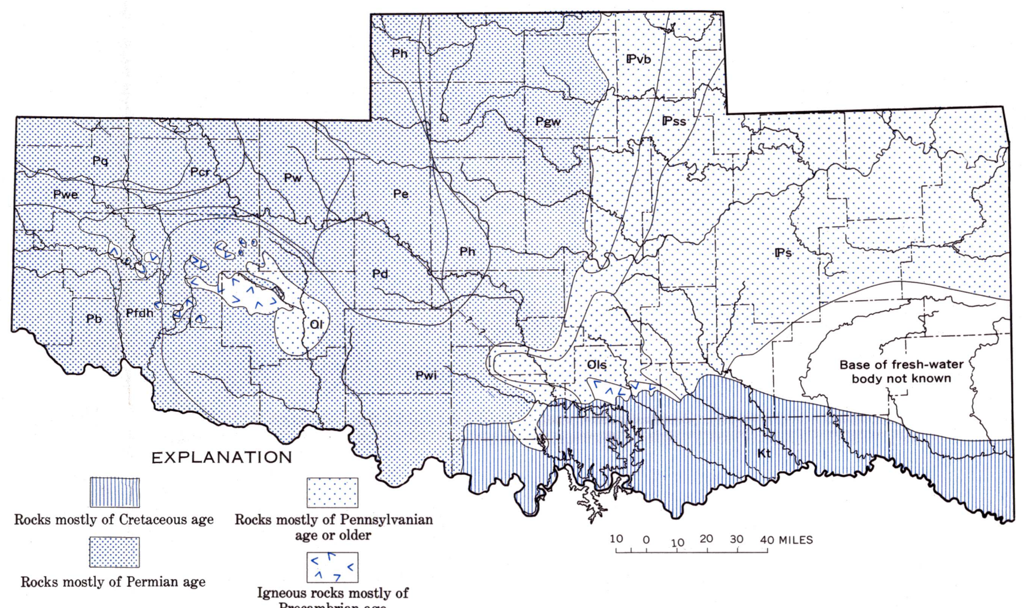
The maps show by patterns and contours what is known of the base of fresh water in the southern part of the state. Generalized maps show information frequently required by individuals and industries, such as the depth of the fresh-water body and the lowest geologic units that contain fresh water. More detailed maps show information on the base of the fresh-water body by contours and by patterns. By use of the contour maps one can obtain information on the altitude of the base of fresh water, its configuration, and its thickness at particular locations. The contour maps were prepared by plotting and contouring altitudes of the base of fresh water, as determined from electric logs of wells and other data. In areas where control data were too widely spaced for contouring, patterns are used to show altitudes by ranges. Depth of the fresh water at a particular place may be approximated by comparing the altitude of the land surface from the topographic contours with the altitude of the base of the fresh-water body.



INDEX MAP OF OKLAHOMA SHOWING AREA OF THIS INVESTIGATION AND AREAS SHOWN ON CONTOUR MAPS

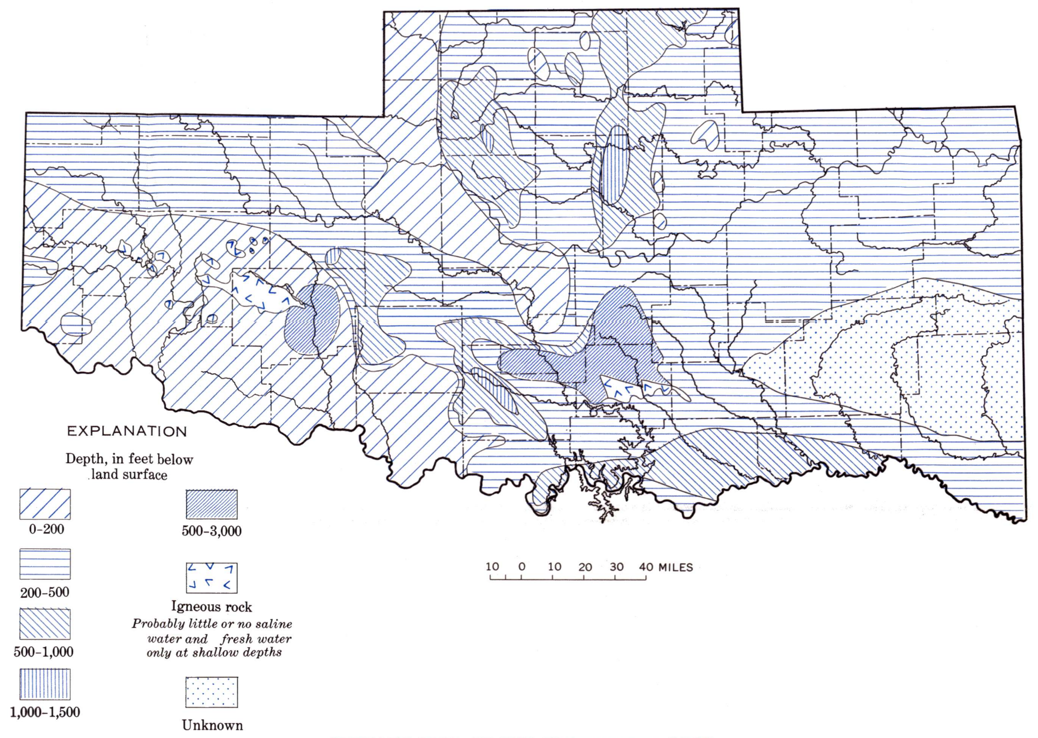


IDEALIZED ELECTRIC LOG SHOWING TYPICAL DEFLECTIONS FOR BEDS OF SHALE AND SAND CONTAINING WATER OF DIFFERENT QUALITY

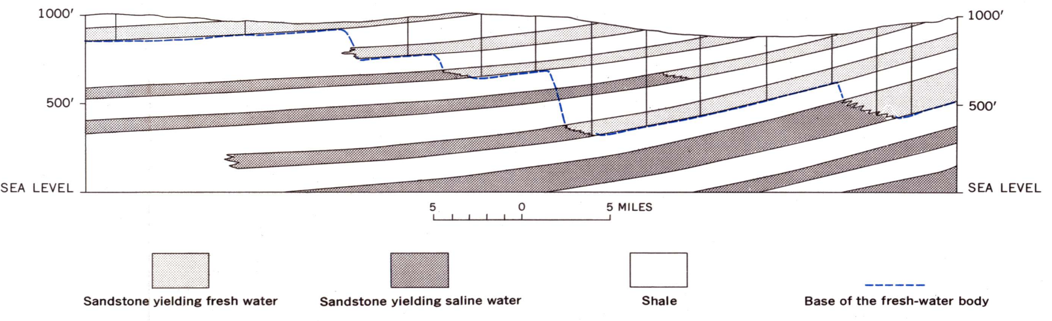


Kt, Trinity Group of Early Cretaceous age; Pq, Quartermaster Formation of Late Permian age; Pcr, Cloud Chief Formation and Rush Springs Sandstone; Pwe, Whitehorse and El Reno Groups, Pw, Whitehorse Group, Pe, El Reno Group, Pb, Blaine Gypsum, Pfdh, Flowerpot Shale, Duncan Sandstone, and Hennessey Shale, Pd, Duncan Sandstone, Ph, Hennessey Shale, and Pgw, Garber Sandstone of Permian age, and Wellington Formation of Early Permian age; Pwi, Wichita Formation of Early Permian age; IPvb, Vamoosa and Barnsdall Formation of Late Pennsylvanian age; IPss, sandstone of Middle Pennsylvanian age; and IPs, sedimentary rocks of Early Pennsylvanian age; and Ol, limestone, and Ols, limestone and sandstone of Ordovician age

AREAL DISTRIBUTION OF THE LOWEST BEDROCK UNITS CONTAINING FRESH WATER



DEPTH TO BASE OF THE FRESH-WATER BODY



DIAGRAMMATIC SECTION SHOWING BASE OF THE FRESH-WATER BODY IN GENTLY DIPPING SANDSTONE BEDS

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—1966—W66144

BASE OF FRESH GROUND WATER IN SOUTHERN OKLAHOMA

By
Donald L. Hart, Jr.
1966

For sale by U.S. Geological Survey, price $1.25 per set