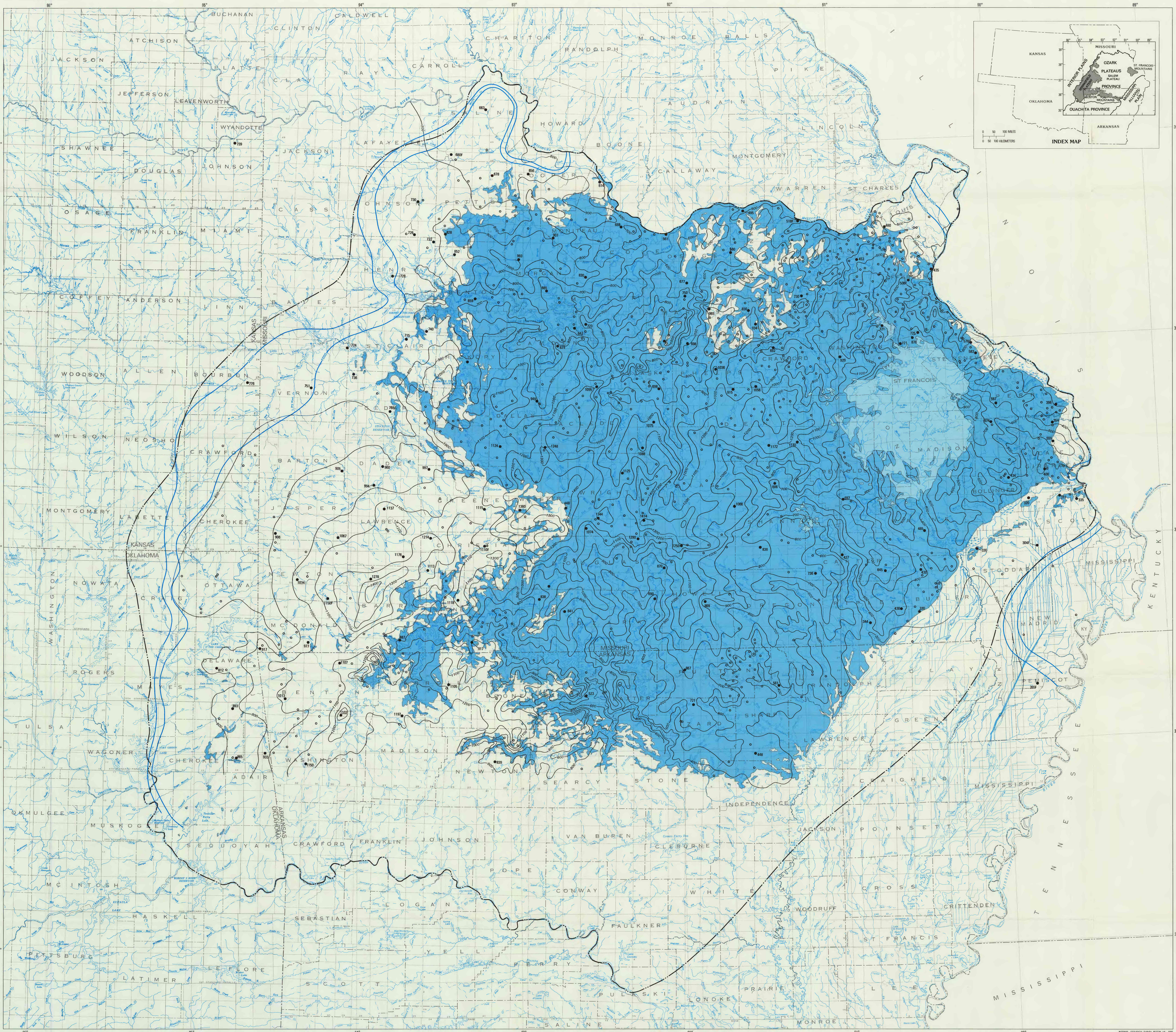
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

HYDROLOGIC INVESTIGATIONS
ATLAS HA–711–E (SHEET 3 OF 3)



Base from U.S. Geological Survey
State base maps, 1:500,000; Arkansas, 1967; Kansas, 1963; Missouri, 1973; Oklahoma, 1972

EXPLANATION

- Outcrop area of the Ozark aquifer
- Outcrop area of rocks comprising geohydrologic units older than the Ozark aquifer
- Contact
- Approximate boundary of Ozark Plateaus aquifer system
- 800 — **Potentiometric contour**—Shows altitude at which water levels would have stood in tightly cased wells open to the Ozark aquifer. Contours in outcrop area are consistent with surface topography. Contour interval, in feet, is variable. National Geodetic Vertical Datum of 1929
- 2000 — **Line of equal dissolved-solids concentration**[1]—Data from which lines of equal dissolved-solids concentration are derived are not shown. Interval 1,000 milligrams per liter.
- 715 **Control data point**[1]—Part of Central Midwest Regional Aquifer-System Analysis data base. Number is altitude, in feet, of water level (F, flowing well). National Geodetic Vertical Datum of 1929
- **Auxiliary control data point**[1]

[1]Contours, lines and control points beyond the approximate boundary of the Ozark Plateaus aquifer system are for units stratigraphically equivalent to those that comprise the Ozark Plateaus aquifer system.

GROUND-WATER MOVEMENT

Movement of water within an aquifer, assuming isotropic conditions, is perpendicular to the lines of equal hydraulic head and proportional to the hydraulic gradient (change in hydraulic head with distance). The potentiometric surface of an aquifer is the altitude to which water would rise in fully penetrating wells cased to the top of the aquifer. The predevelopment potentiometric surface is the potentiometric surface that existed before large-scale withdrawal of water from the aquifer. It usually is assumed that hydraulic head within a specific aquifer does not vary with depth except in recharge and discharge areas. In an aquifer as thick and lithologically complex as the Ozark aquifer this assumption may be invalid locally. The map shown is believed to be representative of the regional predevelopment potentiometric-head distribution in the Ozark aquifer. Contours in areas where the Ozark aquifer crops out and is unconfined are drawn so that where a potentiometric contour crosses a trace of a perennial stream, the altitude of the ground-water potentiometric surface is approximately equal to the altitude of the stream. Contours primarily are drawn on the basis of historic water-level data, however, in areas lacking historic water-level data but with more recent water-level data, which are not shown on the map, the more recent water-level data are used to guide the contour construction. This assumes that the more recent water-levels are approximately equal to the predevelopment water levels. This assumption was checked with areas having both historic and more recent water level data. This method was not used in areas near the major pumping centers associated with the tri-State (Kansas, Oklahoma, and Missouri) and Viburnum (Iron and Reynolds County, Missouri) mining districts. Significant quantities of ground water were withdrawn from these areas as early as the late 1800's and few predevelopment water-level data are available. Elsewhere, ground-water pumpage has not significantly altered the predevelopment potentiometric surface.

Generally fresh water enters the Ozark aquifer by precipitation on the outcrop areas. Most of the water discharges into streams within relatively short distances, but some flows radially away from the Ozark Plateaus province toward surrounding regions containing saline ground water. The limit of fresh water to the west of the Ozark Plateaus province is depicted by the 1,000 and 2,000 milligram-per-liter dissolved-solids concentration lines (R. B., Leonard U.S. Geological Survey, written commun., 1984; and Imes, 1985) that approximately parallel the western limit of Ozark Plateaus aquifer systems. The chemical and physical interaction between the fresh-water and saline-water regions is not well understood at the present (1984).

Water in most of the Ozark aquifer is unconfined and its movement is strongly affected by topographic relief (Melton, 1976). Throughout the outcrop area, ground water moves toward the major rivers and their tributaries. In eastern Missouri, the Mississippi River is the major discharge area and to the north it is the Missouri River. West of Saline County, Missouri, at the east edge of Pennsylvanian rocks, the Ozark aquifer is confined and the Missouri River is no longer a major discharge area. Instead, most water in the Ozark aquifer flows eastward beneath the river. A prominent bend in the transition between salinewater and freshwater marks the beginning of an area from eastern Saline to northern Cooper Counties, Missouri, where saline water from the west and north converges with fresh water from the south and discharges into the Missouri River. Similarly, in west-central Missouri, saline water moving eastward from Kansas converges and discharges into the Osage River. This is indicated by a less prominent eastward extension of the 1,000 milligram-per-liter dissolved-solids concentration line in and near Henry County, Missouri. In southwestern Missouri, where the aquifer is confined, lateral ground-water flow to the west and northwest into southeastern Kansas has forced the transition zone much farther from the outcrop area of the aquifer. Although water-level data are sparse, evidence indicates that the more northerly flowing ground-water turns northeastward to the Osage River. The remainder turns southward and discharges through overlying deposits in the Neosho, Verdigris, and Arkansas River valleys in northeastern Oklahoma.

The direction of ground-water flow in northern Arkansas is more difficult to establish because data are very sparse south of the northernmost tier of counties (Lamonds, 1972). The probable direction of ground-water flow in this area can be assessed from topographic and geologic conditions, the altitude of major rivers, and available water-quality and hydraulic-conductivity data. It is probable that a ground-water divide exists in the Boston Mountains between the Arkansas River to the south and the White and Buffalo Rivers to the north. The divide approximately coincides with the transition zone between saline water and fresh water in northern Arkansas. The divide and transition zone approximately parallel the northern limit of the Western Interior Plains confining system, a shale and sandstone confining unit that is thicker than 6,000 feet at the Arkansas River (Chapter H). North of the ground-water divide, water recharges the Ozark aquifer primarily via the overlying Mississippian limestone rocks and from precipitation in outcrop areas and flows towards the White and Buffalo Rivers. South of the divide, recharge to the aquifer is small due to the thick surficial confining system and movement of the ground water southward is sluggish due to the greatly decreased hydraulic conductivity. Because of the enormous thickness of the Western Interior Plains confining system near the Arkansas River, it is likely that ground water in the Ozark aquifer moves south, then southeast and discharges into post-Paleozoic sedimentary rocks along the western edge of the Mississippi Alluvial Plain. This concept is supported by the presence of saline springs along the alluvial plain. The saline water in this southernmost part of an otherwise freshwater aquifer probably is connate sea water.

REFERENCES

Amsden, T. W., 1980, Hunton Group (Late Ordovician, Silurian, and Early Devonian) in the Arkoma Basin of Oklahoma: Oklahoma Geological Survey Bulletin 129, 136 p.
Fenneman, N. M., 1938, Physiography of eastern United States: New York, McGraw-Hill, 714 p.
Imes, J. L., 1985, The ground-water flow system in northern Missouri with emphasis on the Cambrian-Ordovician aquifer: U.S. Geological Survey Professional Paper 1305 (in press).
Jorgensen, D. G., and Signor, D. C., 1981, Plan of study for the Central Midwest Regional Aquifer-System Analysis in parts of Arkansas, Colorado, Kansas, Missouri, Nebraska, New Mexico, Oklahoma, South Dakota, and Texas: U.S. Geological Survey Water-Resources Investigations Open-File Report 81-206, 28 p.
Lamonds, A. G., 1972, Water-resources reconnaissance of the Ozark Plateaus province, northern Arkansas: U.S. Geological Survey Hydrologic Investigations Atlas HA–383.
McCracken, M. H., 1966, Structural features of Missouri: Missouri Geological Survey and Water Resources Report of Investigations 49, 99 p.
Melton, R. W., 1976, The regional geohydrology of the Roubidoux and Gasconade Formations, Arkansas and Missouri: Fayetteville, University of Arkansas, 160 p.
Merriam, D. F., 1960, Preliminary regional structural contour map on top of "Hunton" (Silurian-Devonian) rocks in Kansas: Kansas Geological Survey Oil and Gas Investigations 23, scale 1:633,600.
Merriam, D. F. and Smith, P., 1961, Preliminary regional structural contour map on top of Arbuckle rocks (Cambrian-Ordovician) in Kansas: Kansas Geological Survey Oil and Gas Investigations 25, scale 1:633,600.

CONVERSION FACTORS

Multiply inch-pound unit	By	To obtain SI unit
foot	0.3048	meter
mile	1.609	kilometer
foot per mile	0.1894	meter per kilometer
foot per second	0.3048	meter per second

Predevelopment potentiometric surface of Ozark aquifer

MAJOR GEOHYDROLOGIC UNITS IN AND ADJACENT TO THE OZARK PLATEAUS PROVINCE, MISSOURI, ARKANSAS, KANSAS, AND OKLAHOMA—OZARK AQUIFER

By
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1990