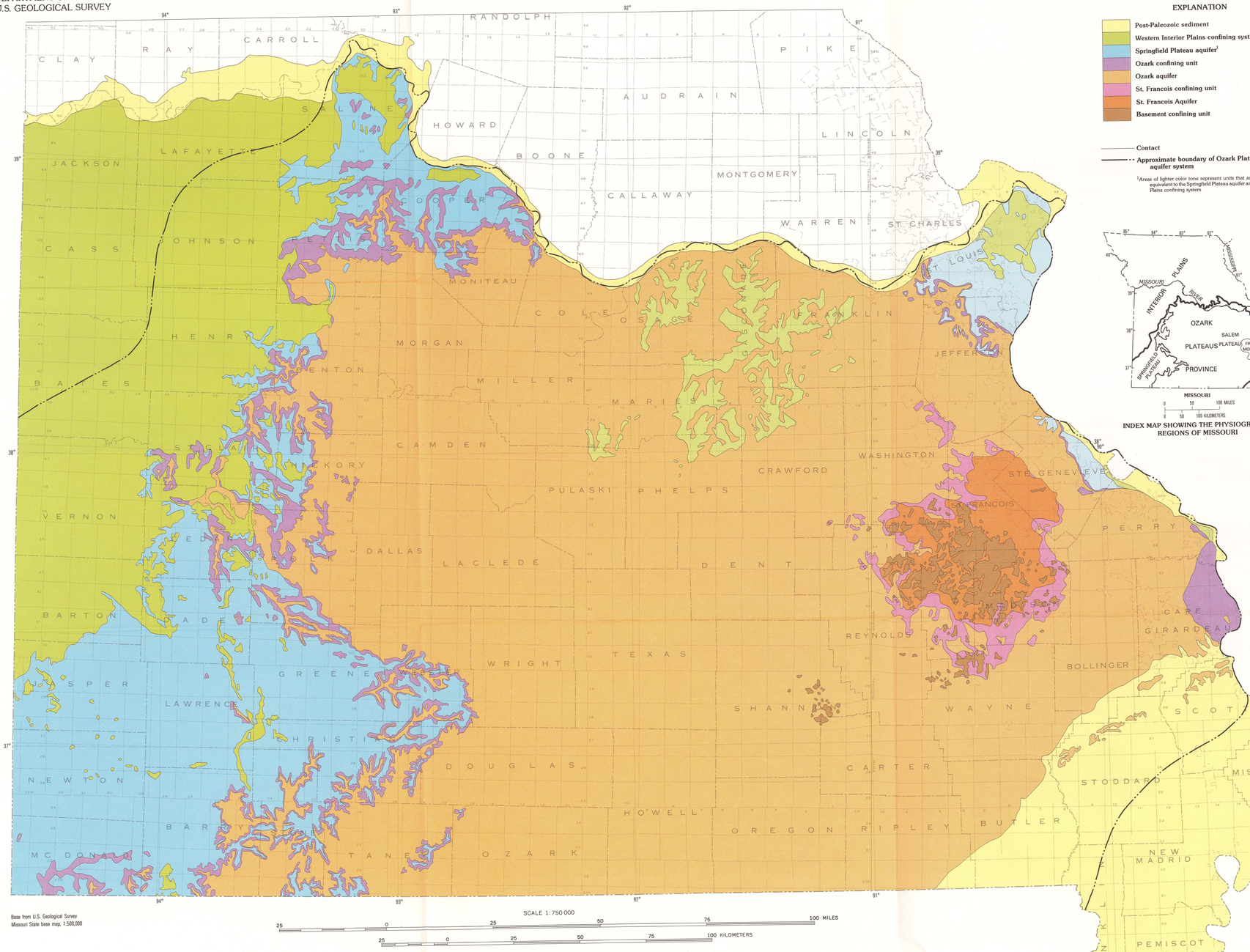


Base from U.S. Geological Survey
Missouri State base map, 1:500,000

SCALE 1:750 000

25 0 25 50 75 100 MILES

25 0 25 50 75 100 KILOMETERS

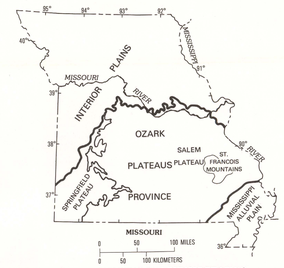
Figure 1.—Generalized outcrop of aquifers and confining units in southern Missouri.

EXPLANATION

- Post-Paleozoic sediment
- Western Interior Plains confining system[1]
- Springfield Plateau aquifer[2]
- Ozark confining unit
- Ozark aquifer
- St. Francois confining unit
- St. Francois Aquifer
- Basement confining unit

- Contact
- Approximate boundary of Ozark Plateaus aquifer system

[1]Areas of lighter color tone represent units that are stratigraphically equivalent to the Springfield Plateau aquifer and Western Interior Plains confining system

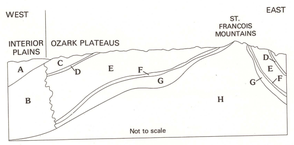


INDEX MAP SHOWING THE PHYSIOGRAPHIC REGIONS OF MISSOURI

STRATIGRAPHIC COLUMN WITH DESCRIPTIONS OF LITHOLOGIC AND GEOHYDROLOGIC PROPERTIES OF REGIONAL GEOHYDROLOGIC UNITS

ERATHEM	SYSTEM	LITHOLOGIC COLUMN	MAP COLOR	GEOLOGIC UNIT	LITHOLOGY	GEOHYDROLOGY
				POST-PALEOZOIC SEDIMENT		
					Unconsolidated sand, gravel, and clay of Cretaceous, Tertiary, and Quaternary age. Sediment thickens abruptly to the southeast from the Salem Plateau and exceeds 2,500 feet in thickness in Pemiscot County.	The unconsolidated sediment can yield large quantities of ground water from thick sand deposits. Yield can exceed 3,000 gallons per minute from the surficial alluvial material. The more permeable sediment is used extensively as a source of water for domestic and municipal supply and irrigation.
PALEOZOIC	Pennsylvanian			WESTERN INTERIOR PLAINS CONFINING SYSTEM		
				Kansas City Group Pleasanton Formation Marmaton Group Cherokee Shale Fayetteville Shale Batesville Sandstone Hindsville Limestone Carterville Formation	Shale, limestone, sandstone, and coal deposits. Confining system crops out in the western part of Missouri. Thickness of the confining system can exceed 800 feet in the extreme northwest. The confining system extends into the Interior Plains west of the Ozark Plateaus province, where it includes younger geologic formations and exceeds 20,000 feet in thickness. Stratigraphically equivalent rock units exist at isolated locations in the north-central part of the Salem Plateau, where Pennsylvanian shale is in contact with and confines the underlying Ozark aquifer, and in the extreme northeastern part of southern Missouri.	Excellent confining properties because of large shale content and large thickness of confining system. More permeable limestone and sandstone beds within the confining system and near-surface weathered layer can yield some water to wells. Yields commonly range from 1 to 15 gallons per minute, but may exceed 25 gallons per minute. Well depths generally range from 10 to 400 feet. Quality of water generally is inadequate for domestic consumption, and the unit is used for domestic and stock water supply only when better quality water is unavailable. Dissolved-solids concentrations locally can exceed 20,000 milligrams per liter.
	Mississippian			SPRINGFIELD PLATEAU AQUIFER		
				St. Louis Limestone Salem Limestone Warsaw Limestone Keokuk Limestone Burlington Limestone Elsey Formation[1] Reeds Spring Limestone[1] Pierson Formation[1]	Water bearing limestone and cherty limestone that contain small quantities of shale and sandstone. The aquifer crops out along the western and northwestern boundary of the Salem Plateau and in the southwestern corner of the State. The aquifer ranges from 0 to 400 feet thick in southwestern Missouri. It is absent in the Salem Plateau and the Mississippi Alluvial Plain. Units stratigraphically equivalent to Springfield Plateau aquifer are located along the eastern edge of the Ozark Plateaus. Equivalent units can be more than 1,500 feet thick.	The aquifer usually is an adequate source of water for domestic and stock wells. Yield of 5 to 20 gallons per minute is common. In a few areas yield may range from 300 to 400 gallons per minute. Well depths commonly range from 100 to 400 feet. Aquifer is unconfined in the outcrop area and confined where present beneath Pennsylvanian rocks. Karst topography at aquifer surface allows rapid recharge, creating a potentially extreme contamination hazard. Dissolved-solids concentration generally is less than 200 milligrams per liter in outcrop areas, but locally may exceed 1,000 milligrams per liter.
				OZARK CONFINING UNIT		
				Northview Shale[1] Hannibal Shale[1] Sedalia Limestone[1] Compton Limestone[1] Chouteau Limestone[2] Bachelor Formation[2,3] Bushberg Sandstone Glen Park Limestone Chattanooga Shale Calloway Formation[1] Fortune Formation[1,3] St. Laurent Limestone[2] Grand Tower Limestone[2] Clear Creek Chert[2] Little Saline Limestone[2] Bailey Limestone[2] Bainbridge Limestone[2] Sexton Creek Limestone[2,3] Girardeau Limestone[2] Orchard Creek Shale[2] Thebes Sandstone[2] Maquoketa Shale[2]	Thin limestone, shale, and sandstone unit that crops out in a narrow band that outlines the larger outcrop area of the Ozark aquifer. Thickness of the confining unit generally is less than 150 feet in southwestern part of the Ozark Plateaus, but may exceed 500 feet along the eastern edge of the plateau. The unit is absent in the north-central part of the Salem Plateau, where Pennsylvanian rocks are directly on the Ozark aquifer and in the Mississippi Alluvial Plain. The shale content of the unit ranges from 0 to 100 percent, generally increasing southward.	The confining unit is relatively impermeable because of large shale content and occurrence of massive, well-cemented limestone. Fracture systems are not extensive and secondary solution features are not well-developed in the limestone. Shale is entirely absent from the unit in several locations to the northwest of the Salem Plateau. Water-level measurements in the overlying Springfield Plateau aquifer and underlying Ozark aquifer indicate the confining unit is relatively permeable in these localities. The unit confines ground-water flow more effectively in extreme southwest Missouri where the shale content of the unit is much larger.
	Devonian					
	Silurian					
	Ordovician			OZARK AQUIFER		
				Cape Limestone[2,3] Kimmswick Limestone Decorah Formation[2] Plattin Limestone Rock Levee Formation[2,3] Joachim Dolomite Dutchtown Formation[2,3] St. Peter Sandstone Everton Formation Smithville Formation Powell Dolomite Cotter Dolomite Jefferson City Dolomite Roubidoux Formation Gasconade Dolomite Van Buren Formation[2] Eminence Dolomite Potosi Dolomite	Water-bearing dolostone with some sandstone, limestone, chert, and small quantities of shale. Cambrian formations and Lower Ordovician formations younger than the Everton Formation are predominately dolostone. Limestone and sandstone are prevalent throughout the remaining Ordovician formations. Older dolostone is exposed throughout most of the outcrop area. Younger sandstone and limestone crop out in a narrow band along the eastern edge of the State. In the north-central part of the Ozark Plateaus province, Pennsylvanian clay directly lies on the Ozark aquifer. Thickness of the unit in the outcrop area is as much as 3,000 feet and averages about 700 feet thick. Numerous faults and fracture systems are present, especially in the vicinity of the St. Francois Mountains. Dissolution of carbonate along fractures and bedding planes has greatly increased the permeability of the unit. In southwestern Missouri, as much as 400 feet of Mississippian and Devonian rocks cover the aquifer. In western Missouri the aquifer is buried beneath more than 800 feet of Devonian through Pennsylvanian rocks. Thick deposits of post-Paleozoic sediment lie directly on the aquifer in the Mississippi Alluvial Plain.	The aquifer is the primary source of ground water in southern Missouri, excluding post-Paleozoic sediment, and is the source of many large springs. Most public supplies obtain water from this aquifer. Well depths range from 200 to 1,700 feet. Yields range from 15 to 700 gallons per minute, but may exceed 1,000 gallons per minute. The aquifer is confined in western and extreme eastern Missouri. Water levels are controlled by topography in outcrop area. Current (1987) water levels in much of southern Missouri slightly differ from predevelopment conditions. Ground water withdrawal in the Springfield area has decreased water levels by more than 150 feet. Dissolved-solids concentration in outcrop area ranges from 300 to 500 milligrams per liter, but exceeds 1,000 milligrams per liter beneath Pennsylvanian rocks in the northwest, extreme northeast, and beneath the Mississippi Alluvial Plain. Of the individual formations comprising the aquifer, the Potosi Dolomite is the most permeable and reliable for public-water supply and municipal use. The shallower Gasconade Dolomite and Roubidoux Formation especially are significant in the southwest and southern part of the State. The St. Peter Sandstone yields adequate supplies of ground water for domestic and municipal use. Recharge to the Ozark aquifer in its outcrop area is rapid because of the presence of karst.
	Cambrian			ST. FRANCOIS CONFINING UNIT		
				Doe Run and Derby Dolomites Davis Formation	Shale and shaly dolostone, siltstone, and limestone conglomerate that range in thickness from 0 to more than 500 feet, averaging about 300 feet. Shale is present both as distinct beds and disseminated throughout dolomite matrix. Shale content is 0 to 40 percent, averaging about 20 percent. Davis Formation generally has larger shale content. Net shale thickness of the unit is larger in east.	Permeability is minimal to moderate. Minimal permeability in east near St. Francois Mountains is because of larger shale content. Moderate permeability in west where shale content is less. Unit is more permeable where transected by fault and fracture zones and where Davis Formation is absent along paleoreef zone in Douglas and Wright Counties.
				ST. FRANCOIS AQUIFER		
				Bonneterre Dolomite Reagan Sandstone Lamotte Sandstone	Water-bearing sandstone and dolostone, lower part sandstone with basal arkosic conglomerate, grading to dolostone and limestone in upper part. Aquifer crops out in and around the St. Francois Mountains. Reagan Sandstone, a facies equivalent of the Lamotte Sandstone, Bonneterre Dolomite, and Davis Formation, is present only in western one-third of State. Thickness exceeds 1,300 feet beneath the Mississippi Alluvial Plain. In western Missouri the unit locally is missing in the subsurface.	Aquifer is source of water in outcrop areas for domestic and public-supply wells. Well depths range from 100 to 500 feet. Wells completed in Bonneterre generally yield less than 50 gallons per minute. Wells completed in Lamotte yield 100 to 500 gallons per minute. Few data are available for Reagan Sandstone in western Missouri because of depth to formation. Potentiometric surface near St. Francois Mountains is controlled by topography. The limited water-level declines are because of mining operations around St. Francois Mountains. Dissolved-solids concentration ranges from 220 to 450 milligrams per liter.
	Precambrian			BASEMENT CONFINING UNIT		
				St. Francois Mountains intrusive and volcanic rocks	Igneous and contact metamorphic rocks. Unit crops out in the St. Francois Mountains as predominately rhyolitic ashflow tuff and granite. Metamorphic rocks are limited to contacts between intruded plutons and host rock. The unit is buried beneath more than 4,000 feet of sediment in the Mississippi Alluvial Plain.	The virtually impermeable igneous and metamorphic rocks from the lower boundary of the Ozark Plateaus aquifer system. Unit is extensively faulted and fractured near the St. Francois Mountains and may locally yield water to wells at 10 to 70 gallons per minute. Well yield in excess of 10 gallons per minute is uncommon.

[1]Unit present only in west-central or southwestern Missouri.
[2]Unit present only in east-central or southeastern Missouri.
[3]Unit follows usage of the Missouri Division of Geology and Land Survey.



EXPLANATION

- A Western Interior Plains confining system
- B Western Interior Plains aquifer system
- C Springfield Plateau aquifer
- D Ozark confining unit
- E Ozark aquifer
- F St. Francois confining unit
- G St. Francois aquifer
- H Basement confining unit

(C–G: Ozark Plateaus aquifer system)

Figure 2.—Relative stratigraphic position of geohydrologic units.

DESCRIPTION OF REGIONAL GEOHYDROLOGIC UNITS

Consolidated rocks in southern Missouri can be grouped into eight regional geohydrologic units on the basis of relative rock permeability and well yields (Imes, in press). Geohydrologic-unit boundaries do not necessarily coincide with geologic unit boundaries or geologic time lines, but are determined by regional hydrologic properties, which may vary from one area to another. Geohydrologic units have been named on the basis of the physiographic province in which the unit crops out or on the stratigraphic relation of the unit with adjacent units. Five of the geohydrologic units comprise the Ozark Plateaus aquifer system (Imes, in press; figs. 1 and 2), the principal source of fresh ground water in southern Missouri. The Ozark Plateaus aquifer system is bounded on the north and east by the Missouri and Mississippi River alluvial valleys and on the west by a large ground-water valley (Jorgensen and others, in press) that separates freshwater (less than 1,000 milligrams-per-liter dissolved-solids concentration) in the aquifer system from surrounding regional salinewater (fig. 1). The southern boundary is the Arkansas River alluvial valley (not shown).

The areal distribution of each geohydrologic unit at land surface in southern Missouri is shown in figure 1. The relative stratigraphic position of the units is shown in figure 2. Lithologic and geohydrologic characteristics of each geohydrologic unit are shown in the accompanying stratigraphic column. The units crop out in approximately concentric bands centered in southeastern Missouri. Three geohydrologic units crop out in the St. Francois Mountains of southeast Missouri, which are characterized by rugged topography and isolated Precambrian knobs. The units are: the Basement confining unit, the St. Francois aquifer, and the St. Francois confining unit.

The Basement confining unit consists of virtually impermeable igneous and contact metamorphic rocks that constitute the lower hydraulic boundary of the Ozark Plateaus aquifer system. The St. Francois aquifer crops out adjacent to the outcrop of the Basement confining unit. The aquifer is surrounded by a narrow outcrop of rocks comprising the St. Francois confining unit, except to the northeast where the St. Francois aquifer is in direct contact with the stratigraphically higher Ozark aquifer.

The Salem Plateau (Index map), an upland area of moderate relief dissected by steep-walled river valleys and entrenched river meanders, surrounds the St. Francois Mountains and is nearly coincident with the outcrop area of the Ozark aquifer. Excluding the unconsolidated post-Paleozoic deposits, the thick and areally extensive Ozark aquifer is the source of most ground water in southern Missouri. The overlying Ozark confining unit, a relatively thin unit, crops out along the eastern and western boundaries of the Ozark aquifer.

The Springfield Plateau aquifer crops out west of the Ozark aquifer in the Springfield Plateau. This aquifer also contains only freshwater in southern Missouri. Stratigraphic units equivalent to those that form the Springfield Plateau aquifer also crop out in small areas adjacent to the Mississippi River. Although the hydraulic properties of these stratigraphic units are similar to those of the Springfield Plateau aquifer, the rocks do not belong to the same hydrologic system as those in the western part of the province and constitute an independent, unnamed aquifer.

The Western Interior Plains confining system, a thick sequence of sandstone, shale, and limestone, extends across the Interior Plains west of the Ozark Plateaus (Jorgensen and others, in press). The designation "system" is used because the Western Interior Plains confining system impedes the vertical flow of ground water on a regional scale, but certain geologic units in the confining system locally are used as sources of water. Geohydrologic units that are stratigraphically equivalent to the Western Interior Plains confining system also are present in and near Maries, Gasconade, and St. Louis Counties (fig. 1). These isolated deposits are not considered part of the Western Interior Plains confining system.

The Western Interior Plains aquifer system (Jorgensen and others, in press) lies beneath and is confined by the Western Interior Plains confining system (fig. 2). The Western Interior Plains aquifer system is comprised of geohydrologic units stratigraphically equivalent to the Ozark Plateaus aquifer system, but contains a different regional ground-water flow system. The Western Interior Plains aquifer system, which does not crop out in southern Missouri, contains saline ground water. Eastward-flowing salinewater in the Western Interior Plains aquifer system and westward-flowing freshwater in the Ozark Plateaus aquifer system mix at the common border between the two systems.

Post-Paleozoic sediment in southern Missouri includes unconsolidated sediment of Cretaceous, Tertiary, and Quaternary age beneath the Mississippi Alluvial Plain. The geohydrologic properties of these deposits have been studied in detail, and individual aquifers and confining units have been identified and named (Luckey, 1985; Mesko, in press). Rocks that, if present, usually comprise the Ozark confining unit, the Springfield Plateau aquifer, and the Western Interior Plains confining system have been eroded from the alluvial plain. Thus, in this area, the Ozark aquifer is in direct contact with water-bearing post-Paleozoic sediment.

EXPLANATION

- Sand or sandstone
- Shale
- Gravel
- Limestone
- Dolomite
- Chert
- Coal
- Underclay
- Igneous

AREAL EXTENT, STRATIGRAPHIC RELATION, AND GEOHYDROLOGIC PROPERTIES OF REGIONAL GEOHYDROLOGIC UNITS IN SOUTHERN MISSOURI

By
J. L. Imes and B. J. Smith
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