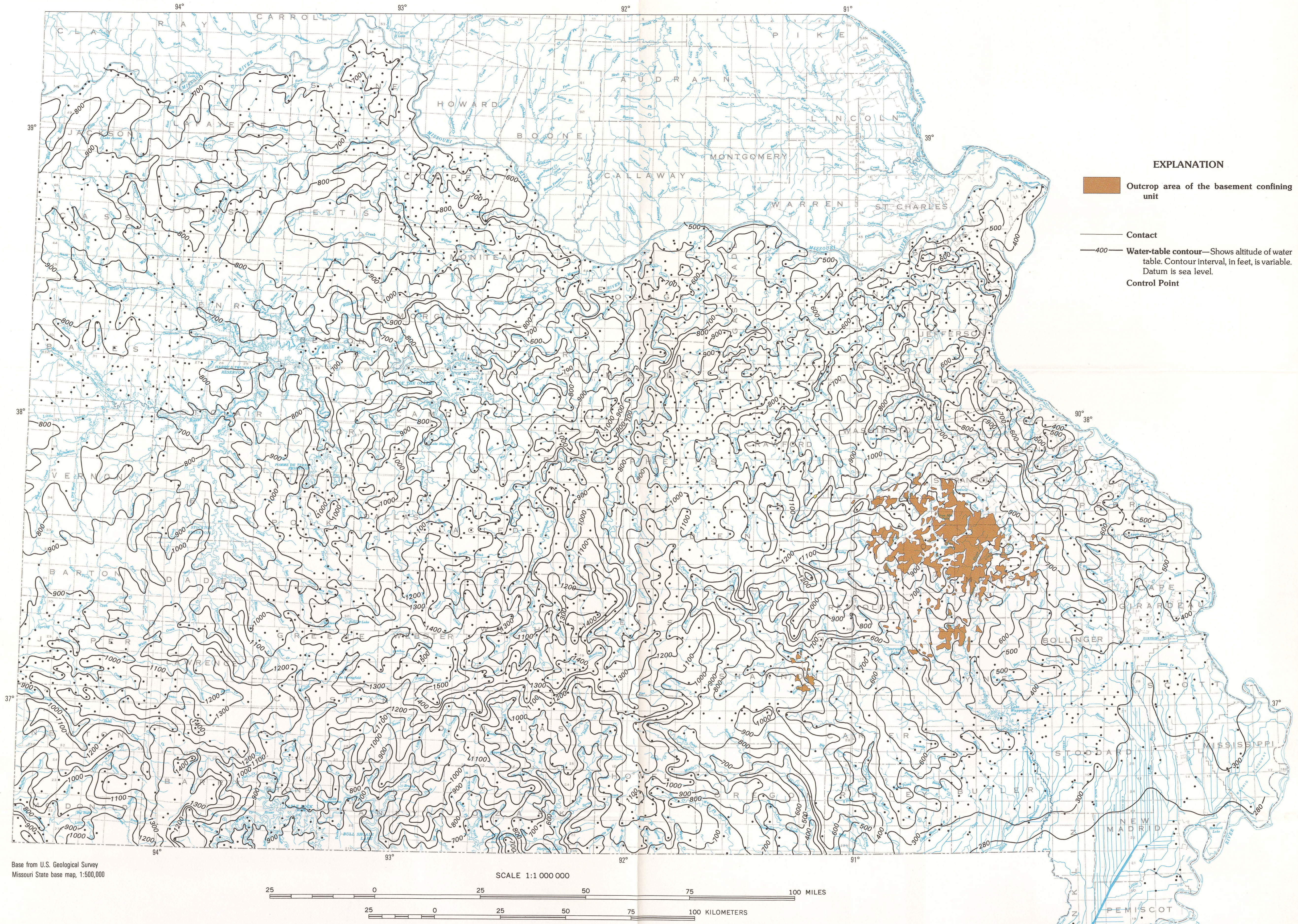

Figure 5.—Water table in the surficial geohydrologic units of southern Missouri (excluding the Basement confining unit).

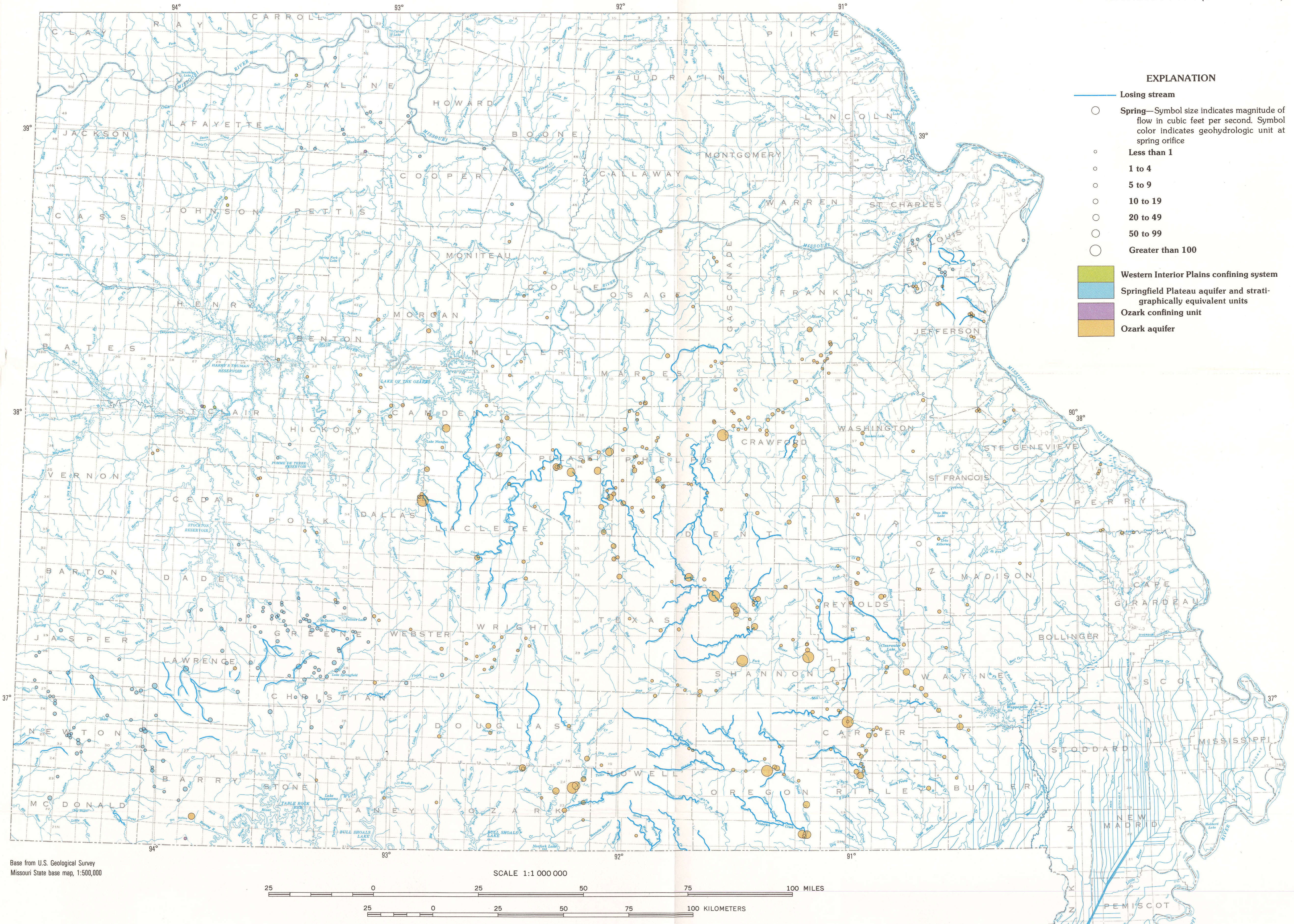

Figure 6.—Distribution of principal springs and losing streams in southern Missouri.

SHALLOW SUBSURFACE HYDROLOGY

The water table is that surface in rocks containing ground water at which the water pressure is one atmosphere. The water table is defined by the level at which water stands in a shallow well completed in the surrounding rocks. Water levels from wells generally 300 feet or less in depth were used to construct the water-table surface map (fig. 5). The altitude of the water table can vary as much as a few tens of feet because of seasonal variations in rainfall. If several measurements were available at one location, a representative measurement was chosen. Although the water table is mapped for the whole of southern Missouri, the meaning and validity of the contours and their accuracy differ among the four primary physiographic subdivisions of the map area.

In the Interior Plains (index map, sheet 1) surficial geologic materials predominately are sandstone, shale, and limestone. Because the Pennsylvanian sandstone and shale virtually are insoluble, the hydraulic properties of these strata are relatively uniform. Secondary permeability is minimal and does not significantly affect the movement of ground water through the limestone units. Karst development is nonexistent in this region. The more uniform hydraulic properties in this region create a geohydrologic condition that supports a water table, controlled by the general topographic features of the area. Contours of the altitude of the water table usually parallel rivers and streams and reflect the movement of shallow ground water from the highlands to adjacent valleys.

The Springfield and Salem Plateaus differ geologically from the Interior Plains in that they are underlain by predominately soluble limestone and dolostone. The cyclical emergence and submergence of the Ozark Plateaus province throughout millions of years have exposed the carbonate bedrock to periods of weathering and erosion. Solution of the carbonate rocks, at least in the initial phase, usually is controlled by bedding planes and fractures and can produce complex and irregular surface and subsurface drainage patterns. Differential solution results in abrupt changes in geohydrologic properties throughout short distances within the different geologic formations. Carbonate rocks that contain a well-developed system of solution channels or karst may not have a well-defined water table.

The Springfield Plateau aquifer in southwest Missouri is composed of a water-bearing cherty limestone that increases in thickness from its eastern terminus where it pinches out atop the Ozark aquifer to about 400 feet where it dips into the subsurface below the Western Interior Plains confining system. The aquifer is deeply weathered and contains a near-surface karst terrane. The water-table surface generally is stable in this aquifer, and the water levels reflect the surface topography. Most streams in the area are gaining; that is, ground water discharges from the aquifer into the streams throughout their length. However, an occasional water level is measured that does not conform to the water levels in nearby wells, but seems more consistent with water levels in wells downstream from, or in an area of lower altitude than, the well in question. Probably these wells are completed in a solution-channel or conduit system that hydrologically links the well, along a path of larger permeability, with another region.

An extensive, well-developed, and deep karst system is in the thick dolostone and limestone that crop out in the Salem Plateau. The large thickness of the carbonate rocks and extensive network of bedding-plane fractures and joints they contain have allowed freshwater to percolate through the aquifer for millions of years, dissolving enormous quantities of the soluble rocks in the process. Caverns and large springs are numerous in this part of the Ozark aquifer. Large conduit systems are scattered throughout the upper few hundred feet of the aquifer. Consequently, in many areas of the Salem Plateau the water table is not solely determined by the surficial topographic relief. Recharge that enters one basin as infiltrated precipitation or capture of stream water through a near-surface zone of large permeability can discharge at seeps or springs many miles away. Water-table gradients may direct water away from a stream in one area and return the water to the stream at a downstream point. Two or more near-surface, ground-water-flow systems can cross each other, as determined by dye-tracer data in the southernmost parts of the Salem Plateau. Because of these complexities, the water-table surface is not as well-defined in this region as it is in the Interior Plains, and the entire concept may not be applicable to certain areas.

The uppermost geologic unit in the Mississippi Alluvial Plain in southeastern Missouri is a 100 to 200 feet thick layer of permeable sand, silty sand, and clay. Topographic relief in the alluvial plain is minimal, and the gradient of the water table is small. Before the extensive development of manmade drainage channels and irrigation, most of the plain was submerged by several feet of water. Swamp conditions were prevalent because the small gradient did not allow ground water that discharged upward from the Paleozoic and Cretaceous rocks beneath the alluvium or surface water that infiltrated to the water table to rapidly move to the Mississippi River or smaller streams.

SPRINGS AND LOSING STREAMS

Southern Missouri contains one of the largest concentrations of springs in the United States. With few exceptions, the springs are confined to the Ozark Plateaus province. The thousands of springs yield freshwater at a rate less than 1 gallon of water per day to millions of gallons per day. The springs are significant for recreational purposes and commercial fish hatcheries.

Many of the larger springs in the Ozark Plateaus of southern Missouri are shown in figure 6. Nine springs have a discharge larger than 100 cubic feet per second (Beckman and Hinchey, 1944; Vineyard and Feder, 1974). Discharge values used in figure 6 are from selected sources and range from single measurements to averages of multiple measurements obtained during several years.

The geohydrologic unit from which the spring issues, indicated by color-coded symbols, also is shown in figure 6. However, some or all of the water can come from a lower geohydrologic unit than that indicated if the surficial unit is thin and the spring is supplied by a deep circulation system. Tubular conduits that connect the rise pool of a spring to the underlying ground-water system have been discovered at a number of the larger springs. These conduits may be several feet wide and may exceed 100 feet in length (Vineyard and Feder, 1974).

The largest springs of the State discharge from the Ozark aquifer, which crops out in the Salem Plateau. The Cambrian and Ordovician carbonate rocks that comprise this aquifer constitute the main water-bearing rocks of southern Missouri. Springs generally are more numerous and larger where the Gasconade, Eminence, and Potosi Dolomites crop out. The springs commonly are in or near large river valleys where they receive water from both the local and regional ground-water flow systems. The large size of the springs is directly related to the deep karst terrane that is prevalent throughout much of the Salem Plateau. Many of the springs have a rapid increase in discharge after storms within the boundary of their catchment areas (Feder, 1970), which indicates the large size of the subterranean channels that link the catchment areas with the spring orifices.

In the Springfield Plateau, springs issue from cherty Mississippian limestone that forms the Springfield Plateau aquifer. Springs are numerous in this region of subdued topography, but are not as large as those of the more rugged Salem Plateau because karst development is less pronounced and more shallow than in the Ozark aquifer. Some of the springs that issue from the Springfield Plateau aquifer in and near Saline County, from the upper Ozark confining unit and from the Western Interior Plains confining system, receive part or most of their water from underlying geohydrologic units. These springs usually can be recognized by the large dissolved-solids concentration of the spring water. Springs that receive most or all their water from the surficial geohydrologic unit usually are less mineralized.

The catchment areas of many of the larger springs may cover tens of square miles and do not necessarily coincide with surface-water drainage basins. In many cases a spring catchment area can be identified by the presence of sinkholes in the land surface and losing streams. Losing streams (fig. 6) are defined, for purposes of this report, as those streams or stream reaches that lose 30 percent or more of their flow through natural processes, such as drainage through permeable soil or karstic bedrock into the underlying aquifer.

Although not as apparent as sinkholes, losing streams also are common throughout most of the Ozarks. Surface water that moves into sinkholes or is lost through a streambed can enter a system of solution channels and caverns and be directed to a spring located downstream in the same basin, or appear as springflow in another drainage basin, or become part of the deeper ground-water-flow system. Because of the large hydraulic conductivity of solution-channel networks, springflow can rapidly respond to precipitation in the catchment basins. During periods of dry weather, long-term, or base flow is provided by the regional ground-water flow system, which has more water-storage capacity than the local system (Feder, 1970).

The quality of spring water in the Ozarks generally is adequate; however, because of the link between springs and the surface provided by the karst terrane, springs are especially susceptible to contamination. Contaminants, as well as water, can rapidly move through the spring drainage system. Sources of contamination include diffuse sources, such as agricultural pesticides, or point sources, such as septic tanks and hazardous chemical spills. Because the catchment-area boundaries of many springs are not exactly known and can extend miles from the spring orifice, contamination can originate from unexpected sources. Sometimes a locality is not recognized as part of a catchment basin until residue from a contaminated spill is identified at a spring. Therefore, most spring water in southern Missouri is not considered safe for drinking water purposes without testing for contamination.

MARAMEC SPRING

Maramec Spring in Phelps County (fig. 7) provides an example of ground-water movement to springs and their susceptibility to damage by contaminants released miles from the spring outlet. This spring issues from beneath a bluff of Gasconade Dolomite, one of the most permeable and cavernous formations in the Ozark aquifer. The rise pool of the spring is several feet wide and descends more than 190 feet below the spring orifice into the Eminence Dolomite (fig. 8). Thus, the spring receives water from local flow systems by solution channels in the Gasconade Dolomite and from larger, intermediate flow systems that are controlled by the regional topography and penetrate into the deeper geologic formations. The sustained, large-volume, base flow provided by the spring is a result of the discharge of deep ground water. Because the catchment area of the spring is not limited to the uplands adjacent to the spring orifice, the discharge volume of the spring is large. Maramec Spring is one of the largest springs in southern Missouri, having an average flow rate of 144 cubic feet per second (93 million gallons per day). During intense rainfall in the catchment area, the spring discharge can exceed 600 cubic feet per second (Vineyard and Feder, 1974).

The catchment area includes the Dry Fork and Norman Creek valleys and the uplands between and adjacent to the valleys (fig. 7). Bedrock in the catchment area generally is the Roubidoux Formation in the uplands and the Gasconade Dolomite along the large river valleys. The Roubidoux Formation is a permeable sandy dolostone through which precipitation can rapidly infiltrate. Ground water that enters the Gasconade Dolomite quickly moves through the extensive network of solution channels toward the spring outlet. The spring responds to storm-induced changes in hydraulic pressure in a few hours, but the actual rate of flow of ground water from the catchment area to the spring is a few days.

The susceptibility of springs, such as Maramec Spring, to damage by contamination was illustrated during 1981 when a liquid-fertilizer pipeline ruptured 13 miles west of the spring in the Dry Fork valley. Eight days later, rare cave fauna and thousands of trout were killed at the orifice of the spring when dissolved-oxygen concentrations at the spring began decreasing and could not support the aquatic population (Vandike, 1981).

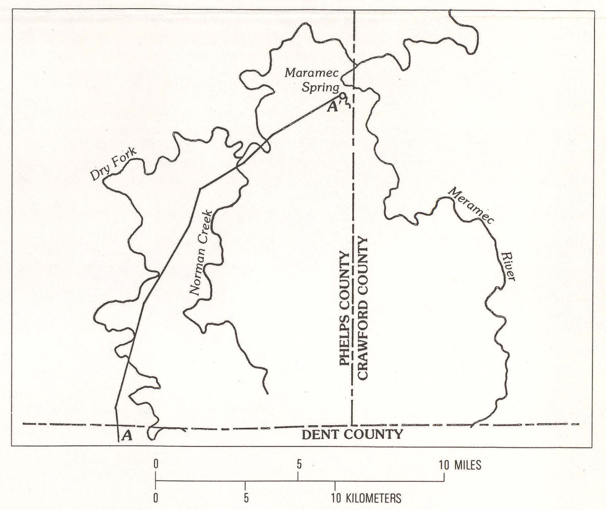

Figure 7.—Location of geohydrologic section A-A'.

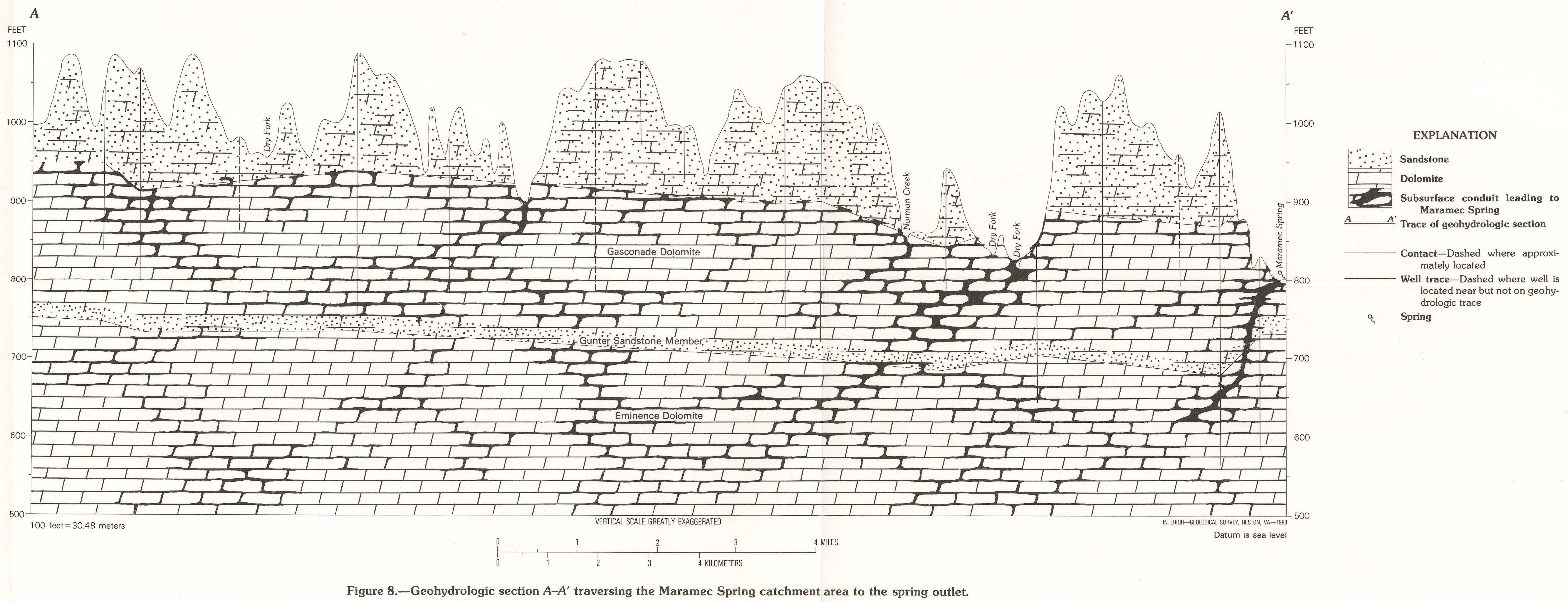

Figure 8.—Geohydrologic section A-A' traversing the Maramec Spring catchment area to the spring outlet.

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

By
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