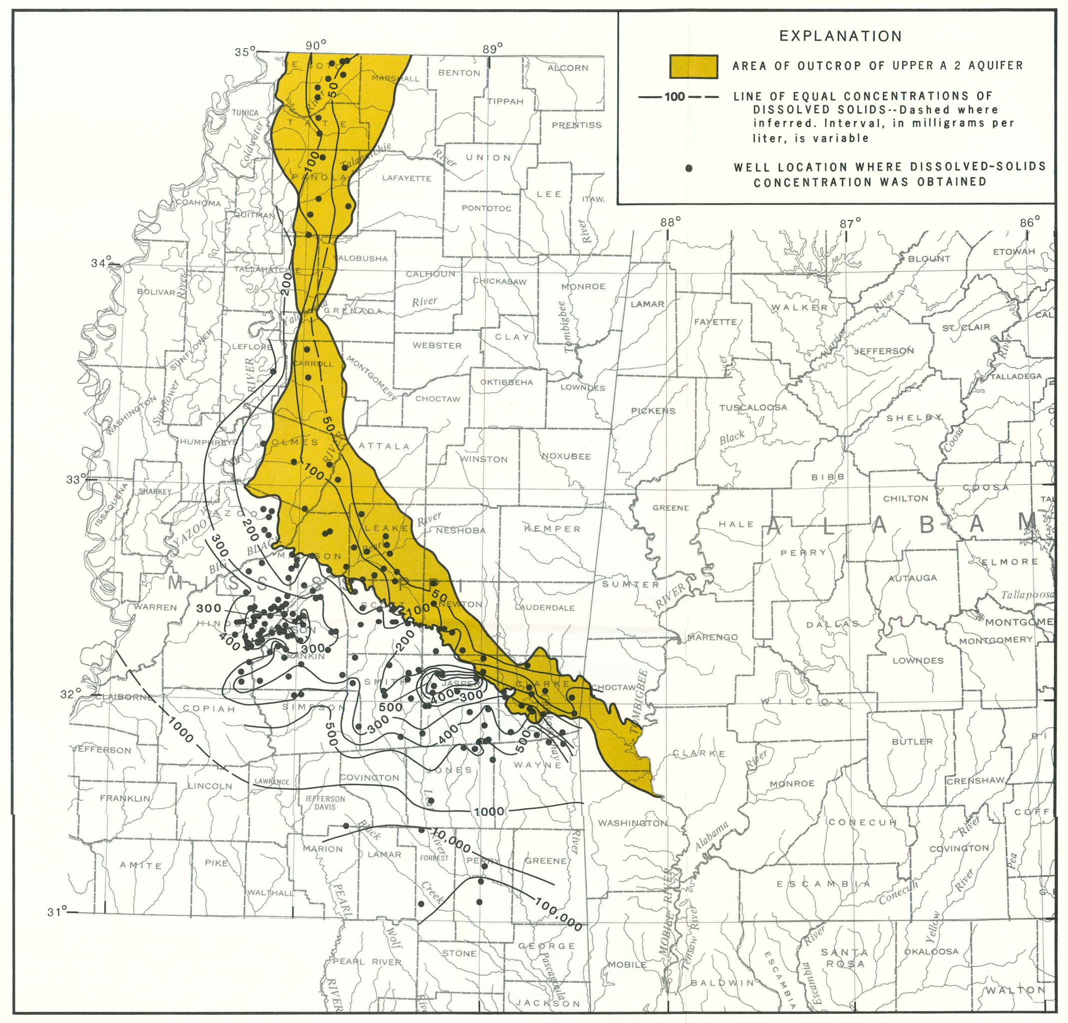
WATER-RESOURCES INVESTIGATIONS REPORT 86-4117
SHEET 1 OF 2



BASE FROM U.S. GEOLOGICAL SURVEY DIGITAL LINE GRAPHS FROM 1:2,000,000 - SCALE MAPS

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Figure 2.--Dissolved solids in the upper A2 aquifer.

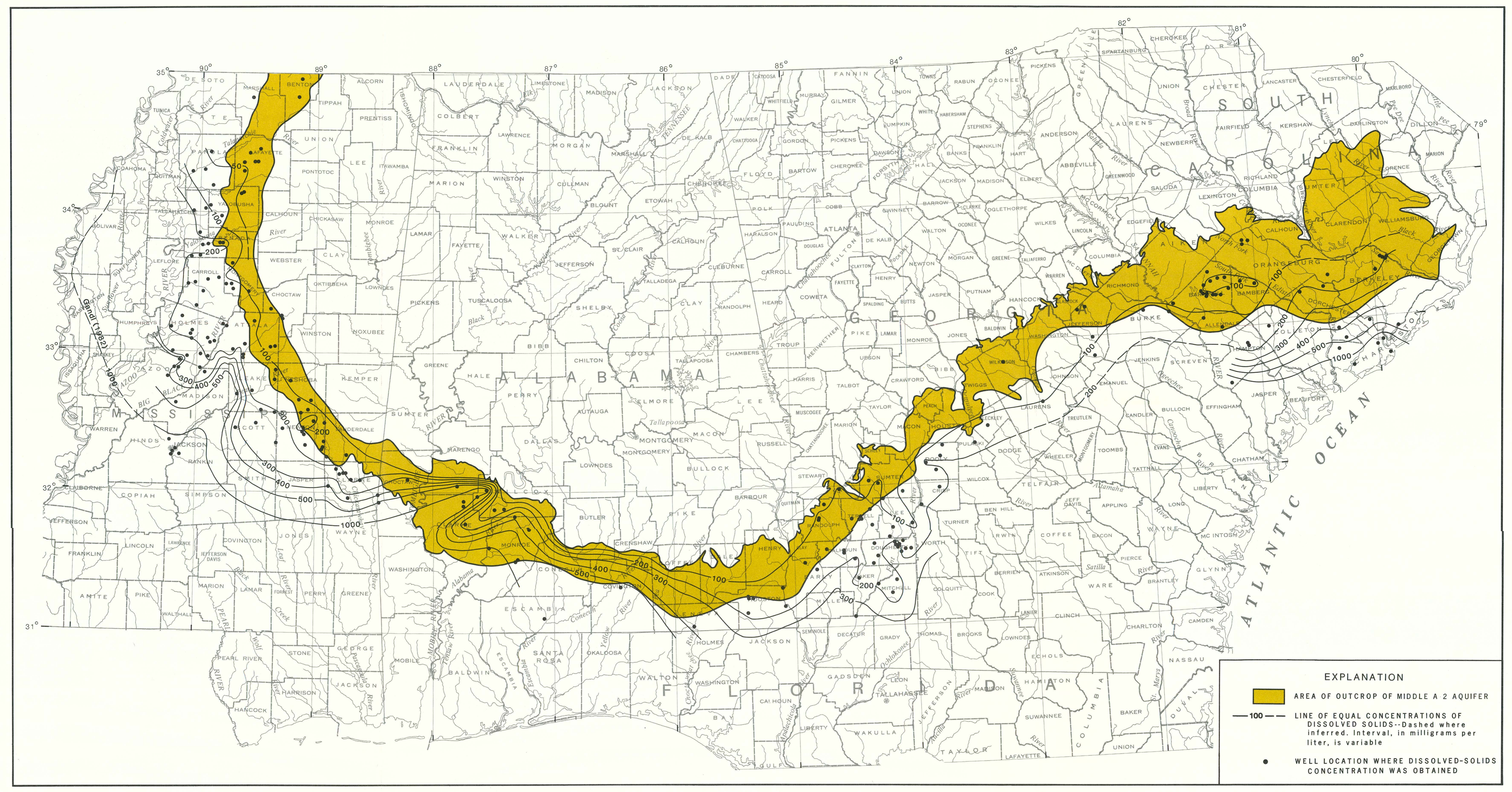

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Figure 3.--Dissolved solids in the middle A2 aquifer.

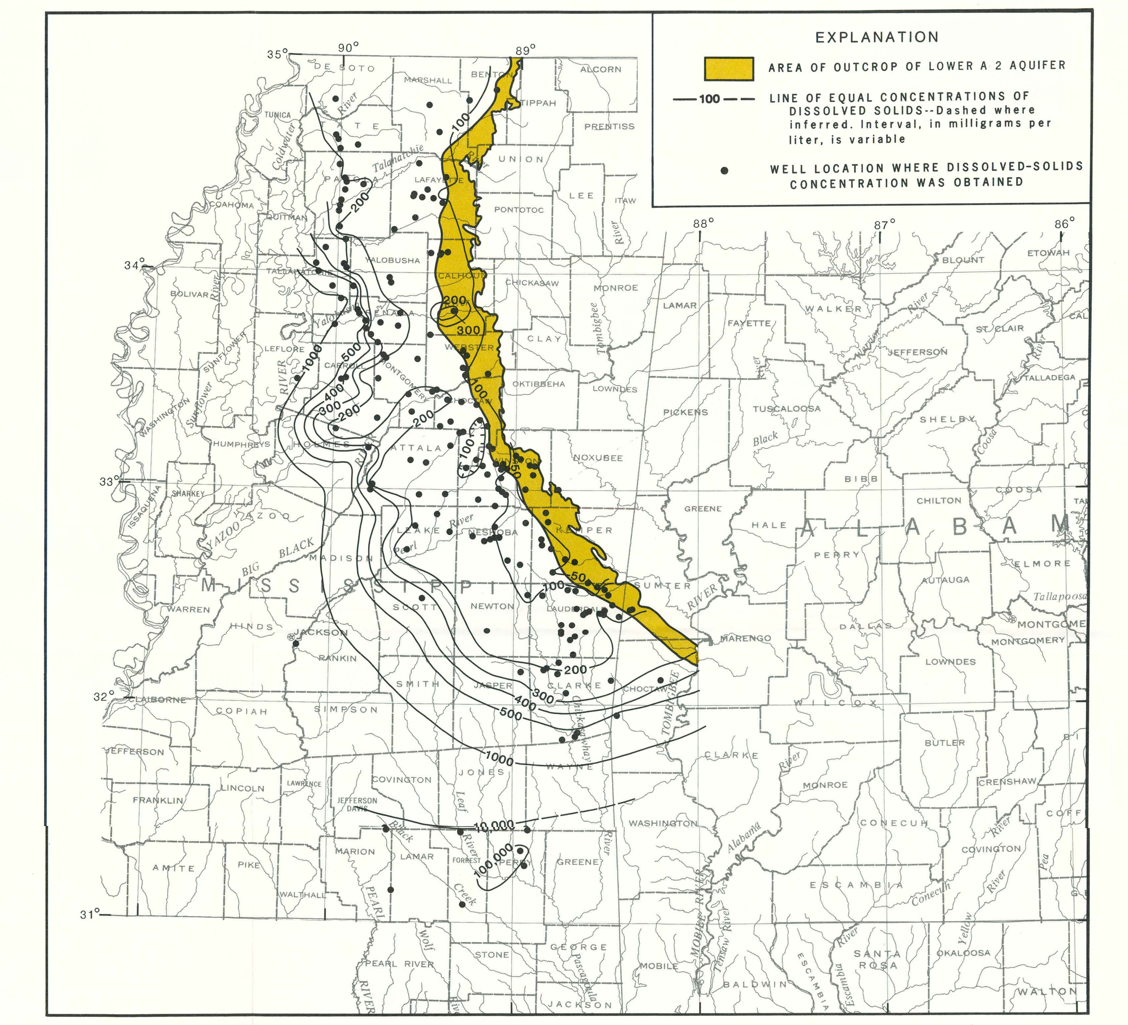

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Figure 4.--Dissolved solids in the lower A2 aquifer.

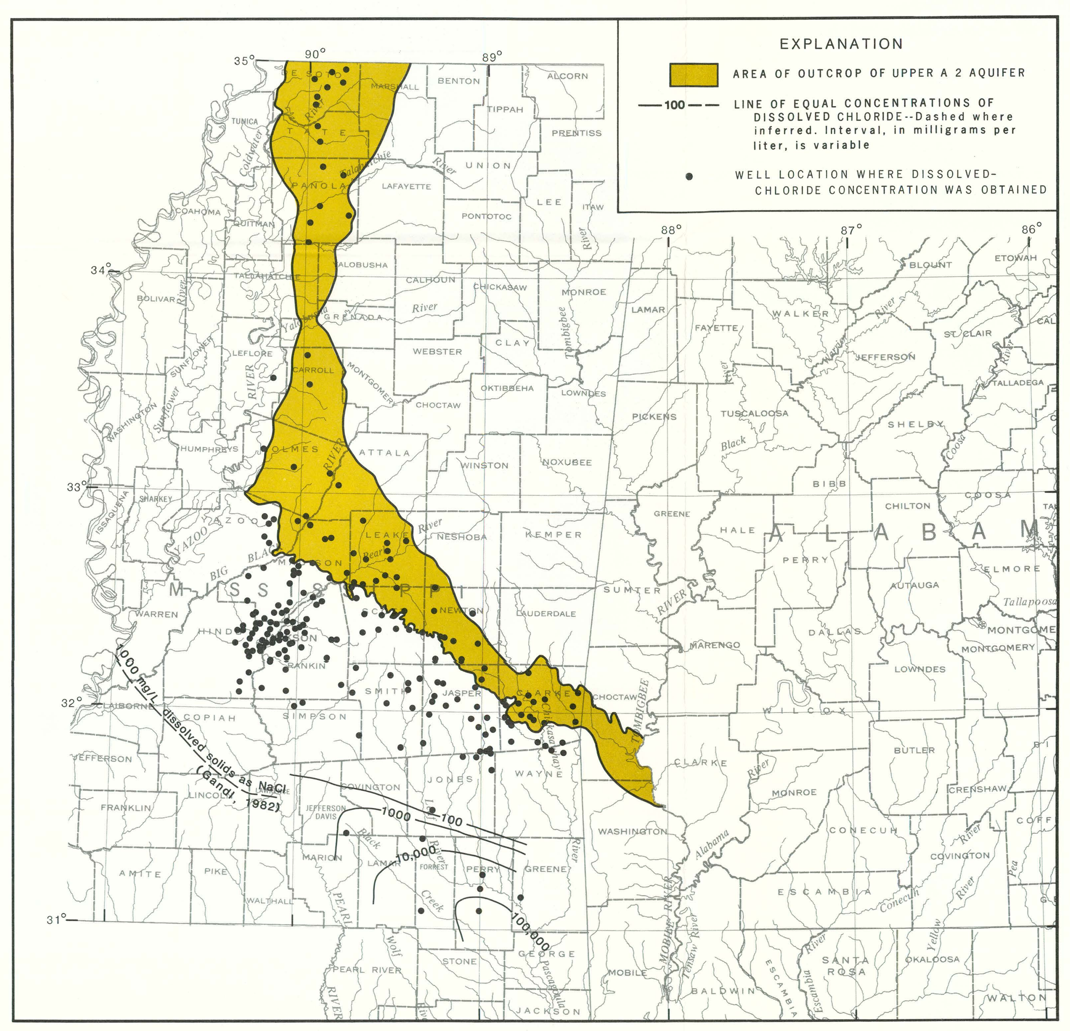

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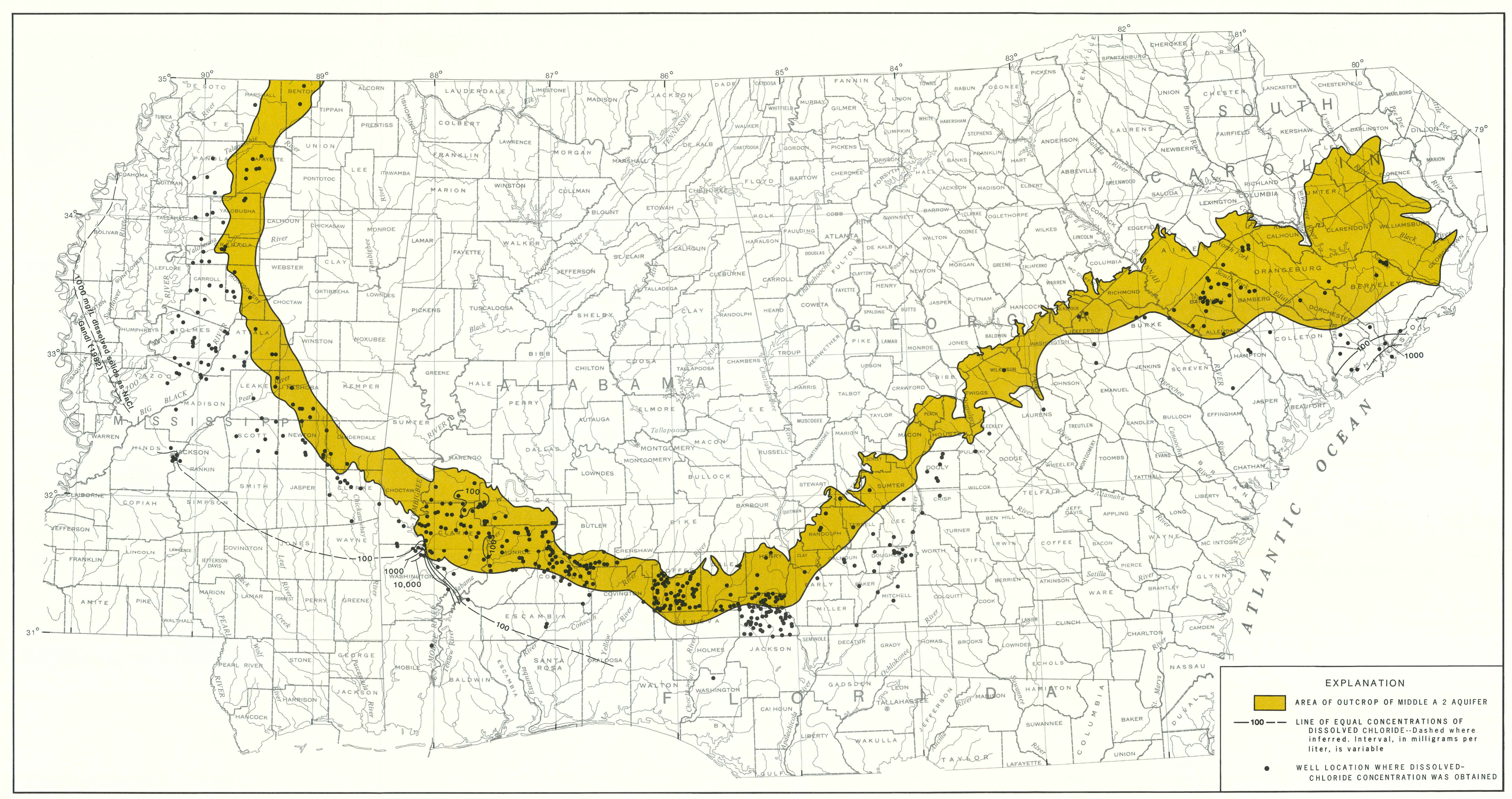
Figure 5.--Dissolved chloride in the upper A2 aquifer.



BASE FROM U.S. GEOLOGICAL SURVEY DIGITAL LINE GRAPHS FROM 1:2,000,000 - SCALE MAPS

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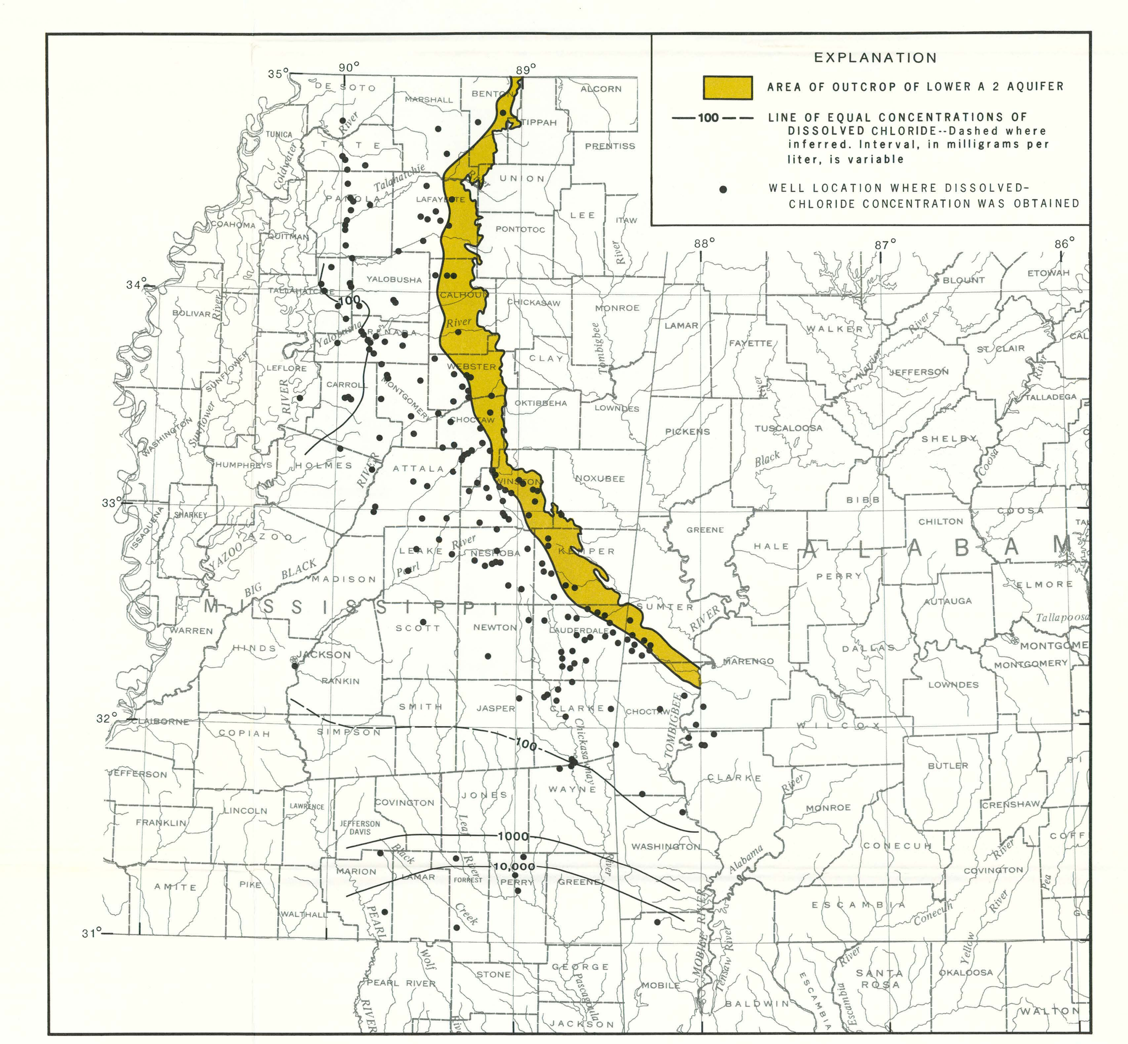
Figure 6.--Dissolved chloride in the middle A2 aquifer.



BASE FROM U.S. GEOLOGICAL SURVEY DIGITAL LINE GRAPHS FROM 1:2,000,000 - SCALE MAPS

0 20 40 60 MILES
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Figure 7.--Dissolved chloride in the lower A2 aquifer.

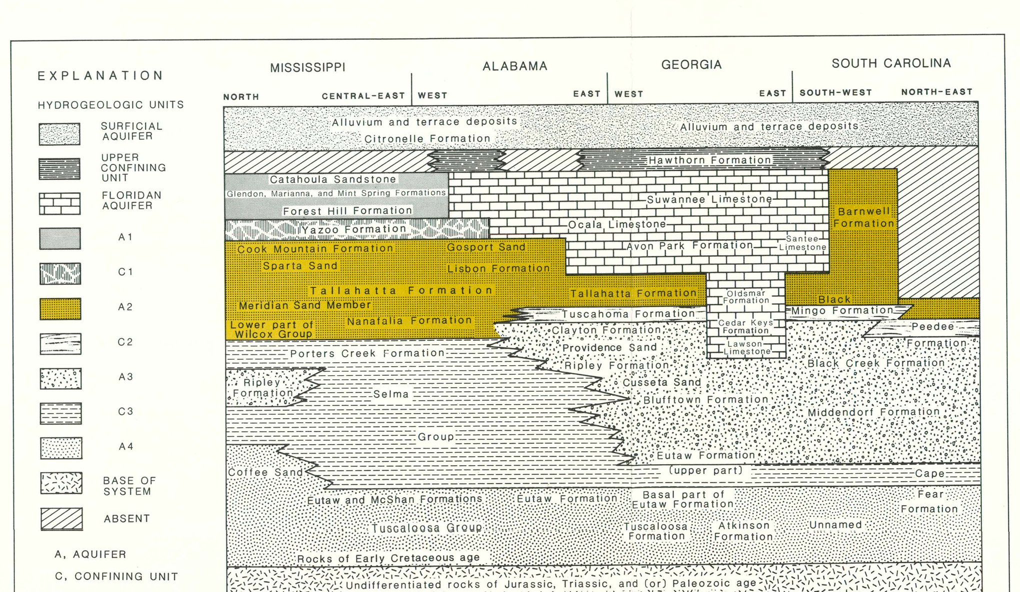

Figure 1.--Schematic diagram of regional hydrogeologic units and selected rock-stratigraphic units in the Southeastern U.S. Coastal Plain. (Modified from Renken, (1984)

INTRODUCTION

In the Coastal Plain of Mississippi, Alabama, Georgia, and South Carolina, water-bearing zones comprise major hydrogeologic units of an extensive sand aquifer system that are characterized by regional ground-water flow (Barker, 1985). The aquifer system is being studied as part of the U.S. Geological Survey's Sand Aquifer Regional Aquifer-System Analysis (RASA) program. This system has been delineated by Renken (1984; fig. 1) into regional aquifers and confining beds that correlate with major permeable and impermeable zones in each State within the study area (fig. 1). A series of preliminary reports developed by the RASA program depict the ground-water geology and water chemistry of the sand aquifers in the Southeastern Coastal Plain.

This report contains maps that depict the spatial distributions of concentrations of dissolved solids, dissolved chloride, dissolved iron, and hydrochemical facies (Back, 1961) for three water-bearing zones in the A2 aquifer: (1) an upper zone consisting mostly of sands in the Sparta Sand and the Cockfield Formation in Mississippi; (2) a middle zone consisting of sands in the upper part of the Wilcox Group combined with the Meridian Sand Member of the Tallahatta Formation in Mississippi and all the pertinent Tertiary sands and limestones in Alabama, Georgia, and South Carolina; and (3) a lower zone consisting mostly of sands in the lower part of the Wilcox Group in Mississippi.

Chemical data used in this study were obtained from the U.S. Geological Survey data base (WATSTORE). Chemical data used for the maps were collected by state and federal agencies during the last half century and have been published in county or state reports in each state within the project area. Data for the maps of the project area were selected by the following criteria: well location, geologic unit, and pertinent chemical analyses. A complete chemical analysis including major cations and anions with a cation-anion balance of less than ± 10 percent error was required for data used in constructing the hydrochemical-facies maps. Several hundred partial and complete chemical analyses were selected for mapping from geologic units corresponding to the A2 aquifer. An abundance of data was available in Mississippi; however, fewer data were available in Alabama, Georgia, and South Carolina. The nomenclature of the A2 aquifer is provisional and should be interchanged with more appropriate regional aquifer names for the Southeastern Coastal Plain when more conventional names are selected.

HYDROGEOLOGY

The hydrogeology of the South Atlantic-Gulf region has been generally described by Cederstrom and others (1979). More detailed descriptions of the geology and hydrology of the Southeastern Coastal Plain may be found in county or multiple county reports in each state. The hydrogeologic framework provides the basis for detailed studies of the regional ground-water flow and supports digital simulations of ground-water flow in the Southeastern Coastal Plain.

The Southeastern Coastal Plain aquifer system has been divided into four regionally extensive aquifers that are separated by confining units consisting of clay, chalk, or other low-permeability materials (Renken, 1984). Each of these regional aquifers can be subdivided into zones and, based upon vertical head differences or vertical differences in water chemistry within the aquifer, these differences may be small, or, as occur in the A2 aquifer they may be significant. The differences in head and chemistry may be mutually supportive, or they may not.

The regionally extensive A2 aquifer is comprised of sand and shale of Tertiary age which were deposited in deltaic and associated near-shore environments. The aquifer consists of massive to thinly laminated, very fine to coarse, glauconitic, calcareous, quartz sand of late Eocene to middle Paleocene age. In Mississippi, the geology and hydrology of the Tertiary sediments have been previously studied and detailed subsurface information and appropriate water-quality data are available (Boswell, 1976a, 1976b; Newcome, 1976; Spiers, 1977a, 1977b; Wasson, 1980; Gandl, 1982). To better understand the complex water chemistry, the A2 aquifer has been subdivided in Mississippi and western Alabama into three water-bearing zones, the upper, middle, and lower zones. Few vertical chemical differences exist in the water chemistry of the A2 aquifer in Alabama, Georgia, and South Carolina. These data closely resemble those from the middle zone in Mississippi and are accordingly mapped as an extension of the zone. The upper and lower zones are mapped separately in Mississippi and western Alabama.

The upper water-bearing zone of the A2 aquifer is limited to Mississippi and western Alabama, and consists of sands in the Sparta Sand, the Cockfield Formation, and the Cook Mountain Formation. The latter formation is less extensive as an aquifer than the previous two, but available chemical data on water from Cook Mountain sediments have been included with the upper water-bearing zone. The Sparta Sand and Cockfield Formation have been previously reported as separate aquifers throughout Mississippi (Newcome, 1976; Spiers, 1977a). They are known, however, to be interconnected hydrologically in many places, especially north of Jackson, Mississippi, where the Cook Mountain Formation is sandy and acts as a hydraulic connection between the two aquifers. Some areas of vertical chemical difference are present locally, but on a regional basis, the chemical data may be combined for these three units.

The middle water-bearing zone consists of a combination of several aquifers in Mississippi that are grouped with Tertiary sands and limestones in Alabama, Georgia, and South Carolina which were determined by Renken (1984) to be part of the A2 aquifer. In Mississippi, chemical data from the Winona-Tallahatta aquifer including the Basic City Shale Member (Spiers, 1977b), the Meridian-upper Wilcox aquifer (Boswell, 1976b), and the Neshoba Sand Member of the Tallahatta Formation have been combined as the middle zone. In Alabama, chemical data for the middle zone are from the Gosport Sand, the Lisbon Formation, the Tallahatta Formation, the Tuscahoma Formation, the Nanafalia Formation, and the Naheola Formation shown as a confining unit in figure 1. In Georgia, chemical data for the middle zone are from the Barnwell Formation, the McBean Formation, the Lisbon Formation, the Tallahatta Formation, the Tuscahoma Formation, and the Nanafalia Formation. In South Carolina, chemical data for the middle zone are from the Barnwell Formation, the McBean Formation, and the Black Mingo Formation. Other geologic units are present in the middle zone in these states, but available ground-water chemical data are generally limited to these named formations.

The lower water-bearing zone is confined to the state of Mississippi and is differentiated primarily on the basis of water-quality data from the lower Wilcox aquifer (Boswell, 1976a). Additional chemical data from the Tuscahoma Formation has been combined with the lower zone map.

Regional ground-water flow patterns are similar in all three water-bearing zones. Recharge to the A2 aquifer occurs in the outcrop areas and flows along the hydraulic gradient, which generally correlates with the seaward dip of the geologic units. Most of the Tertiary formations crop out seaward of the Fall Line. Ground-water flow is generally toward the Mississippi River in central Mississippi; toward the Gulf of Mexico in southern Mississippi, Alabama, and western Georgia; and toward the Atlantic Ocean in eastern Georgia and South Carolina (Cederstrom and others, 1979; Stricker and others, 1985).

GENERAL WATER CHEMISTRY

The quality of ground water from sand aquifers in the Southeastern Coastal Plain is within U.S. Environmental Protection Agency drinking water standards (U.S. Environmental Protection Agency, 1977) in many places. Concentrations of dissolved solids in excess of 500 mg/L may occur as a result of mineral-water interactions in the aquifers, or mixing of fresh ground waters with seawater or brines present in the deeper parts of the water-bearing zones. Most of the waters are sodium and bicarbonate dominated (Lee, 1985) when concentrations of dissolved solids are less than about 500 mg/L. In deeper parts of the aquifers, dissolved sodium and chloride ions dominate (Cederstrom and others, 1979) and concentrations of dissolved solids may exceed 10,000 mg/L. Concentrations of dissolved iron may reach 20,000 μg/L in freshwater areas in noncalcareous sands and are usually treated before the water is used.

Maps of concentrations of dissolved solids, dissolved iron, dissolved chloride, and hydrochemical facies illustrate spatial distributions of these principal water-quality parameters in the A2 aquifer of the Southeastern Coastal Plain.

Dissolved Solids

Maps of concentrations of dissolved solids in the A2 (figs. 2 to 4) aquifer were prepared using values of residue on evaporation at 180 °C, where available, or calculated dissolved solids if no residue on evaporation was recorded. Concentrations of dissolved solids in ground water generally increase with distance from the area of outcrop where recharge occurs. In recharge areas, concentrations of dissolved solids in ground water may be less than 50 mg/L and near that of dissolved solids observed in rainfall (Junge and Werby, 1958). Waters that have dissolved-solids concentrations of less than 500 mg/L usually result from water-rock interactions (Lee, 1985). If concentrations of dissolved solids are greater than 500 mg/L, it is generally the result of the combined effects of water-rock interactions and mixing of saline water. This mixing produces concentrations of dissolved solids greater than 10,000 mg/L in places. Near Hattiesburg, south-central Mississippi, known salt domes have locally caused elevated concentrations of dissolved solids in ground water (Spiers and Gandl, 1980).

In Southern Georgia and parts of South Carolina, ground-water supplies are plentiful and of good quality in the Floridan aquifer system. As a result, water wells generally do not penetrate the deeper sand aquifers and data are not available for the aquifer in this part of the Southeastern Coastal Plain. In Mississippi, contour lines showing the location of 1,000 mg/L dissolved solids as sodium chloride for each water-bearing zone, derived from geophysical data of Gandl (1982), have been used to supplement chemical distribution on the maps.

Upper Water-Bearing Zone

Ground water in the upper water-bearing zone of the A2 aquifer in Mississippi (fig. 2) increases in concentration of dissolved solids downgradient, reaching concentrations of greater than 500 mg/L as a result of dissolution of aquifer minerals (Lee, 1985). A closed area of low concentrations of dissolved solids (less than 100 mg/L) is found near the city of Jackson, in central Mississippi, and probably reflects vertical differences in concentrations of dissolved solids in the aquifer with most of the low values representing water wells completed in the Cockfield Formation. Dissolved-solids concentrations become greater than 11,000 mg/L south of Jones and Wayne Counties in southeastern Mississippi. Concentrations of dissolved solids exceed 100,000 mg/L in southwestern Alabama.

Middle Water-Bearing Zone

Dissolved-solids concentrations in the middle water-bearing zone are generally less than 500 mg/L and increase from outcrop areas in a downgradient direction (fig. 3). Concentrations of dissolved solids are greater than 1,000 mg/L in Hinds and Rankin Counties in central Mississippi, and Clarke and Marengo Counties in southwestern Alabama, and in southern South Carolina. Concentrations of dissolved solids greater than 1,000 mg/L in Clarke and Marengo Counties, southwestern Alabama, represent water from the lower part of the middle water-bearing zone. Concentrations of dissolved solids in Dougherty County, southwestern Georgia, may have become slightly elevated because of upward leakage from underlying aquifers. The slight increase in concentrations of dissolved solids in Barnwell and Bamberg Counties, in South Carolina, may represent local vertical chemical variations in discrete sands of the McBean Formation or the Barnwell Formation. Generally, the paucity of data in southeastern Georgia required extrapolation of the dissolved-solids contours in order to provide areal descriptions.

Lower Water-Bearing Zone

Dissolved-solids concentrations in the lower water-bearing zone are less than 100 mg/L near outcrop areas and increase to greater than 100,000 mg/L downgradient (fig. 4). A narrow band of slightly elevated dissolved-solids concentrations (greater than 200 mg/L) occurs in Montgomery and Choctaw Counties in central Mississippi. An area of low concentrations occurs in southern Choctaw and Winston Counties in central Mississippi and may represent vertical chemical differences in different sands, or may be indicative of recharge to the lower water-bearing zone. The elevated dissolved-solids concentrations (as much as 100,000 mg/L) in northern Perry County in southeastern Mississippi are probably related to salt domes.

Dissolved Chloride

The distribution of dissolved chloride in the three water-bearing zones shows the extent of freshwater flushing of brines or relict seawater. In southern Mississippi, elevated chloride concentrations reflect the influence of known salt domes. Mixing of meteoric ground water with saline water is indicated by the pronounced increase in chloride concentrations. Farther downgradient, beyond the mixing zone, sparse chemical data show that sodium-chloride brines are present in the deeper parts of the aquifer. Maps of dissolved-chloride concentrations (figs. 5 to 7) show similar trends of increasing concentrations as do dissolved solids where dissolved solids exceed about 500 mg/L.

Upper Water-Bearing Zone

Concentrations of dissolved chloride in water in the upper zone (fig. 5) are less than 100 mg/L in most areas and are less than 10 mg/L in many places. Concentrations of dissolved chloride exceed 100 mg/L in southeastern Mississippi and increase to greater than 100,000 mg/L in Perry County in southeastern Mississippi.

Middle Water-Bearing Zone

Concentrations of dissolved chloride generally are less than 10 mg/L in waters of the middle zone (fig. 6). Near Jackson in central Mississippi, dissolved-chloride concentrations exceed 500 mg/L. Concentrations of dissolved chloride greater than 200 mg/L occur locally in western Wilcox County, Alabama. South of Charleston, South Carolina, dissolved-chloride concentrations exceed 1,000 mg/L, probably as a result of incomplete flushing of seawater from the aquifer. In southwestern Alabama, dissolved-chloride concentrations that exceed 10,000 mg/L may be due to mixing of freshwater with brines present in the aquifer, or may result from upward leakage of saline ground water from deeper aquifers.

Lower Water-Bearing Zone

Dissolved-chloride concentrations in waters of the lower zone generally are less than 10 mg/L in the upgradient part of the study area (fig. 7). Concentrations increase west and south to greater than 100 mg/L in Grenada and Carroll Counties in northern Mississippi and in Wayne County in southeastern Mississippi. In Forrest and Perry Counties in southern Mississippi, dissolved-chloride concentrations exceed 10,000 mg/L due to salt domes in the area.

WATER-QUALITY MAPS FOR THE MIDDLE TERTIARY AQUIFER IN THE SOUTHEASTERN COASTAL PLAIN OF MISSISSIPPI, ALABAMA, GEORGIA, AND SOUTH CAROLINA

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