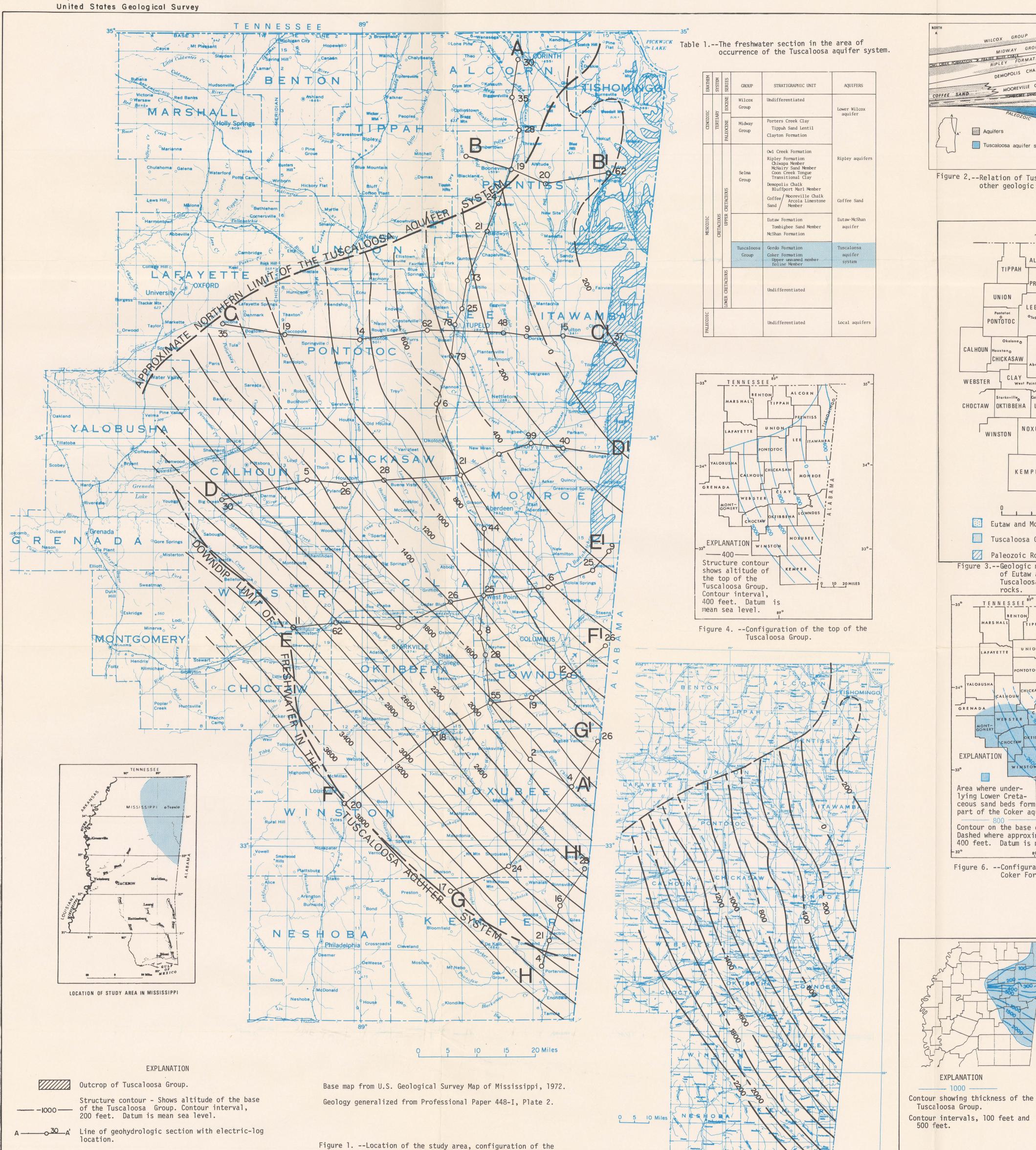
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WATER-RESOURCES INVESTIGATIONS 78-98



SHEET 1 OF 3 OPEN-FILE REPORT



Department of the Interior

OW CREEK FORMATION > PRAIRIE BLUE CHAIR FORMA MESHAN FORMATION Figure 2.--Relation of Tuscaloosa aquifer system to other geologic and hydrologic units.

> TENNESSEE ALCORN Pontotoc PONTOTOC CALHOUN Houstone WEBSTER West Pointo CHOCTAW OKTIBBEHA LOWNDES: NOXUBEE WINSTON SUMTER { Eutaw and McShan Formations Tuscaloosa Group Paleozoic Rocks Figure 3.--Geologic map showing outcrop areas of Eutaw and McShan Formations,

> > Tuscaloosa Group, and Paleozoic

ALCORN UNION Area where underlying Lower Cretaceous sand beds form part of the Coker aquifers. Contour on the base of the Coker Formation Dashed where approximate. Contour interval 400 feet. Datum is mean sea level.

Figure 6. -- Configuration of the base of the

Coker Formation.

EXPLANATION

Figure 7. -- Thickness of the Tuscaloosa

Figure 5. -- Base of the Gordo aquifer.

EXPLANATION Deepest freshwater is in the Gordo aquifer or in underlying rocks of Paleozoic age. Deepest freshwater is in the Coker aquifer. Deepest freshwater is in Lower Cretaceous rocks.

Figure 8.--Occurrence of freshwater

in the Tuscaloosa Group.

THE TUSCALOOSA AQUIFER SYSTEM IN MISSISSIPPI INTRODUCTION

This report, the eighth in a series of "atlas-type" reports, describes the character, extent, and development of the Tuscaloosa aquifer system in Mississippi. The large amount of unpublished data that are summarized in the report were collected by the U.S. Geological Survey during waterresources studies made in cooperation with the Mississippi Board of Water Commissioners and other local, State, and Federal agencies.

Previous reports in this series describe the Miocene (Newcome, 1975), lower Wilcox (Boswell, 1975), Sparta (Newcome, 1976), Meridian-upper Wilcox (Boswell, 1976), Eutaw-McShan (Boswell, 1977), Cockfield (Spiers, 1977a) and Winona-Tallahatta (Spiers, 1977b) aquifers or aquifer systems.

The Tuscaloosa aquifer system contains freshwater (less than 1,000 milligrams per liter of dissolved solids) in an area of about 9,000 mi2 in northeastern Mississippi (fig. 1). The aquifer system is now the primary source of ground water for public and industrial water supplies in about three-fourths of the study area. Wells developed in the Tuscaloosa aquifers are capable of much larger yields and have lesser pumping lifts than wells developed in the overlying Eutaw-McShan aquifer. In the past the Eutaw-McShan aquifer was the principal source of ground water in most of the study area because it is shallower and generally

contains water of good quality.

The Upper Cretaceous Tuscaloosa Group as reclassified by Drennen (1953) includes the Coker and Gordo Formations (table 1). The Coker is overlapped by the Gordo, which in turn extends farther north and is overlapped by the McShan and Eutaw Formations (fig. 2). The Tuscaloosa Group thickens southward in Calhoun, Chickasaw, and Monroe Counties. An example of this thickening is in the subsurface of Calhoun County where the Tuscaloosa increases from about 250 feet to more than 550 feet in 7.8 miles (Parks, 1961, fig. 23).

The Gordo Formation is exposed at the surface in small areas in Monroe, Itawamba, Prentiss, and Tishomingo Counties, Miss., and in northwestern Alabama (fig. 3). The top of the Gordo dips southwestward at a rate of about 30 feet per mile (fig. 4). The formation thins northward in the subsurface and it does not occur as a continuous unit northwest of an irregular line from southwestern Lafayette County to northeastern Alcorn County (fig. 1). In much of the study area the Gordo can be subdivided into an upper clay unit and a lower sand and gravel unit. The most distinctive boundary in the Tuscaloosa Group is at the bottom of the gravel unit of the Gordo (fig. 5). This boundary becomes less distinct northward.

The Coker Formation overlies Paleozoic rocks and, farther to the south, Lower Cretaceous rocks (fig. 6). The Coker includes the 'upper unnamed member" and the Eoline Member (table 1). The upper unnamed member is composed of clay and irregular beds of sand, partly of marine origin. The Eoline Member, composed of clay, sand, and gravel, includes at the base the 'massive sand' of McGlothlin (1944, p. 40). The Coker Formation has not been subdivided in the outcrop north of Marion County, Ala. (fig. 3), and in the subsurface it is not distinguishable from the Gordo Formation in the northern part of the study area.

Undifferentiated Lower Cretaceous deposits, present in the subsurface in Mississippi and Alabama, underlie the Coker Formation southwest of a line extending through central Calhoun County to central Lowndes County (fig. 6). The deposits occur as a southwestward thickening wedge that exceeds 1,500 feet in thickness in Kemper, Neshoba, and Winston Counties (Nunnally and Fowler, 1954, plate 3). Some of the uppermost beds of the Lower Cretaceous in the area are very similar lithologically to the basal beds of the Coker Formation.

HYDROLOGY

Poland and others (1972, p. 2) define an aquifer system as "a heterogeneous body of intercalated permeable and poorly permeable material that functions regionally as a water-yielding hydraulic unit; it comprises two or more permeable beds separated at least locally by aquitards that impede ground-water movement but do not greatly affect the regional hydraulic continuity of the system." The term "Tuscaloosa aquifer system" includes the water-bearing sand and gravel beds in the Tuscaloosa Group and underlying hydraulically connected Lower Cretaceous beds in the study area. The system includes all beds in the Tuscaloosa Group that are water bearing and those relatively impermeable beds that form local or extensive separations between major or minor aquifers. The thickness of the aquifer system ranges from a few feet in the north to more than 2,000 feet in southern Kemper County (fig. 7). The base of the aquifer system is at the top of the Paleozoic rocks in the northern part of the area and within beds of the Lower Cretaceous in the southern part (figs. 8 and 9). In the extreme northern part of the area, the underlying Paleozoic rocks also contain freshwater; however, these aquifers have not been determined to be very productive in the study area except in localities in northern Tishomingo County.

In the northern part of the study area the Tuscaloosa Group comprises one principal aquifer (figs. 2 and 9). In the southern part of the area the system consists of two major aquifers -- (1) the Gordo aguifer (the lower sand-and-gravel unit of the Gordo Formation) and (2) the Coker aquifer (the basal 'massive sand' of the Coker Formation and hydraulically connected sand beds of the underlying Lower Cretaceous Series). Minor aquifers occur in irregular sand beds in the upper part of the Gordo and in the upper part of the Coker. The relation of the Tuscaloosa Group and the Gordo and Coker aquifers to other geologic and hydrologic units in the area is shown in figures 9 to 16.

Recharge to the Tuscaloosa aquifer system in Mississippi and extreme northwestern Alabama is primarily by precipitation on the outcrop (fig. 3). Water moves southwestward into the subsurface from the outcrop areas. In the northern part of the area in Mississippi some water moves downward into the Gordo from the overlying Eutaw-McShan aquifer. Recharge to the Coker Formation in the north in Mississippi occurs where the Gordo overlaps the eroded surface of the Coker and the water-bearing beds are connected. Sand beds in the Lower Cretaceous are in turn hydraulically connected to the Coker aquifer (table 1).

> Potentiometric maps resulting from earlier studies (Boswell and others, 1965 p. 12 and 15) indicated that the original southwestward regional movement of water in the Gordo aguifer is now toward a depression or trough that generally coincides with the valley of the Tombigbee River -- a lowland where uncontrolled flowing wells have been common for a hundred years.

> The increased pumpage for public, industrial, and military uses during and since World War II has greatly intensified the draft on the Gordo aquifer. Water level declines in the Coker aquifer have been small except in the vicinity of large withdrawals. The aquifer is used for several public, community, and industrial water supplies (table 2) but it does not have a long history of development.

Most of the observation wells (fig. 17) that monitor the Tuscaloosa aquifer system are located in areas proximate to large withdrawals for public and industrial water supplies. Although the present regional waterlevel decline is less than 2 feet per year, wells tapping the Gordo aquifer in areas of withdrawal show larger declines (fig. 18). The very steep decline for well Itawamba G24 (fig. 18), caused by large withdrawals from nearby wells, has now reversed as a result of redistribution of pumping. Tha water level in well Tishomingo F1 has recovered since the City of Iuka began using wells made in an underlying Paleozoic aquifer about 1965. By 1975 the water level in the Gordo aquifer at Iuka had recovered to near the level of the 1920's when the first wells were made in the aquifer.

Water levels in the Coker aquifer are monitored in only a few places. Two observation wells (fig. 19) are in locations where large withdrawals are made. The third observation well, Monroe Q12, is in an area where the Coker aquifer is very thin and the effects of pumping are pronounced.

AQUIFER AND WELL CHARACTERISTICS

The median hydraulic conductivity (the rate of flow through a 1-foot square section of the aquifer under unit hydraulic gradient) for 13 aquifer tests using wells in the Gordo aquifer was 42.8 (ft3/d)/ft2 Transmissivity, the product of hydraulic conductivity and aquifer thickness, ranged from 535 (ft^3/d)/ft to 21,400 (ft^3/d)/ft (Newcome, 1971).

Most wells recently developed in the Gordo aquifer are designed to produce 500 to 1,000 gal/min. The largest reported yield is 1,200 gal/min from a well in Monroe County. The deepest well developed in the aquifer is a 2,410-foot well in Webster County. Wells deeper than 1,500 feet are common in the western and southern parts of the study area.

Only a few wells have been available for testing the Coker aquifer. Four tests resulted in transmissivity values ranging from 762 (ft³/d)/ft to 80,200 (ft³/d)/ft (Newcome, 1971). Most large wells developed in the aquifer produce 1,500 to 1,800 gal/min. Water levels in the aquifer are high enough that wells developed at low altitudes flow--one well completed about 1960 flowed at a reported rate of 2,300 gal/min. A well completed in 1977 at Columbus flowed at a reported rate of 1,000 gal/min. The deepest well in the Coker aquifer is a 2,369-foot well in Kemper County.

Determinations of aquifer hydraulic characteristics are useful in designing wells and for estimating the predicted effects of pumping on the pumped well or nearby wells. Pumping rates and well spacing can be planned by using time-distance-drawdown graphs (fig. 20) prepared using methods described by Lohman (1972). Specific capacity graphs (fig. 21) can be used for planning pump settings and discharge.

WATER USE

The Tuscaloosa aquifer system was not used extensively in the past because the overlying Eutaw-McShan aquifer yielded enough water to meet most of the requirements for public and industrial water users. Also, in most of the area water from the Eutaw-McShan was suitable for most uses without treatment. Utilization of water from the Tuscaloosa aquifer system was limited to areas in the south and west where the shallower aquifers contained excessive concentrations of dissolved solids or were too thin to yield the needed quantities of water. The principal deterrent to the utilization of the aquifer in the past where it occurs at shallow depths is the excess of iron in solution. Many wells were drilled in the Tombigbee River Valley where natural flows were obtained. Some of the flowing wells were for watering livestock and other minor uses but most of the water was allowed to flow unregulated.

Since World War II the accelerating demand for water has resulted in a rapid increase in withdrawal from the Tuscaloosa aquifer system. In most of the study area the Tuscaloosa is capable of much higher yields than are available from the Eutaw-McShan aquifer, and in the western and southern parts of the area the Tuscaloosa contains the best quality water available. Although the largest increases in water use have been in industrial supplies, the increase in municipal production of water has been appreciable. The rapid proliferation of community water systems during the last decade is a significant factor in the development of the aquifer. Two interesting changes are now underway -- the city of Columbus is changing the source of its municipal water supply from Luxapallila Creek to the Coker aquifer and the source of the Tishomingo municipal water supply is being changed from springs to wells. At West Point the Eutaw-McShan aquifer is developed to near its potential yield and work is underway to produce water from the Gordo aquifer.

use in Lowndes County where both the Coker and Gordo aquifers are used and in Monroe County where most large water supplies are obtained from the Gordo aquifer (fig. 22). The total withdrawal of water from the Tuscaloosa aquifer system in 1975 was about 63 Mgal/d by about 90 water systems (table 2) and numerous industries. Water use by aquifer is summarized in the following table. Withdrawals (million gallons per day)

The largest withdrawal of water from the Tuscaloosa is for industrial

	WICHUI awais (IIIIII	
Aquifer	Public supplies	Industrial supplies
Gordo Coker	15.1 .7	34.5 12.4
Totals	15.8	46.9
	WATER QUALITY	

The dissolved-solids concentration in water in the Tuscaloosa aquifer system increases with distance from the outcrop area as the water moves down the dip (figs. 23, 24, and 25 and table 2). Near the outcrop at shallow depths the water is acidic, generally soft to slightly hard, and very low in dissolved solids. As depth to the aquifer increases, the pH and the dissolved-solids concentration increase. Most of the increase is caused by the dissolution of sodium, bicarbonate, and chloride from the aquifer materials. The water changes from the calcium and sodium bicarbonate type to a mixture of the sodium bicarbonate and sodium chloride type. Most constituents occur in acceptable concentrations and excessive color is rare.

The iron concentration, generally low in and near the recharge area (see table 2, Tishomingo County), increases as the water moves to depths of several hundred feet and then diminishes as depth continues to increase. Although water produced by many wells does not require treatment, iron is nearly always present.

Fluoride commonly occurs in concentrations of less than 0.5 mg/L; however, anomolous occurrences of concentrations of 1.1 to a maximum of 3.8 mg/L were found in water from the Gordo aquifer (table 2).

Some public water-supply wells in the southern and western parts of the area produce water having a dissolved-solids concentration higher than 500 mg/L. The water is used because the Tuscaloosa is the deepest aquifer that contains freshwater, and all shallower aquifers contain more highly mineralized water or do not yield enough water to meet the needs.

The temperature of water in the Tuscaloosa aquifer system increases about 0.6°C (Celsius) or 1.4°F to 1.1°C (2.0°F) for each 100 feet of depth increase (Geothermal Survey of North America subcommittee of the AAPG Research Committee, 1976). Representative temperatures for the Gordo aguifer range from 17°C (63°F) at Fulton to 18°C (65°F) at Tupelo; 19°C (66°F) at Aberdeen; and 23°C (73°F) at Pontotoc. The highest temperature recorded is 36°C (96°F) for water from a 2,369-foot well developed in the Coker aquifer in Kemper County.

At locations in the central and southern parts of the area water in the Coker aguifer commonly is less mineralized than water in the Gordo aquifer. This condition is attributed to the faster movement of water in the highly permeable beds of the Coker aquifer.

POTENTIAL FOR FUTURE DEVELOPMENT

The Tuscaloosa aquifer system is the principal source of ground water for future development in its area of occurrence in northeastern Mississippi. The most favorable areas for development are in the central part of the area where both the Gordo and Coker aquifers are thick, highly permeable, and contain water of good quality. Several municipalities (Aberdeen, Houston, Okolona, and West Point, for example) that now obtain water from the Eutaw-McShan aquifer can obtain much larger quantities of water from the Tuscaloosa aquifer system. Opportunities for development of water supplies may be more limited in the north where only the Gordo occurs and in the west and south where the dissolvedsolids concentration is high. On an areal basis, high water levels, large specific capacities for wells, favorable recharge conditions, and excellent aquifer hydraulic characteristics will contribute to maximum production of ground water for a minimum expenditure of energy.

The largest withdrawal of water from the Tuscaloosa is for industrial use in Lowndes County where both the Coker and Gordo aquifers are used and in Monroe County where most large water supplies are obtained from the Gordo aquifer (fig. 22). The total withdrawal of water from the Tuscaloosa aquifer system in 1975 was about 63 Mgal/d by about 90 water systems (table 2) and numerous industries. Water use by aquifer is summarized in the following table.

THE TUSCALOOSA AQUIFER SYSTEM IN MISSISSIPPI

geohydrologic sections.

base of the Tuscaloosa Group, and location of

E. H. Boswell