HYDROGEOLOGY OF THE GULF TROUGH- APALACHICOLA EMBAYMENT AREA, GEORGIA

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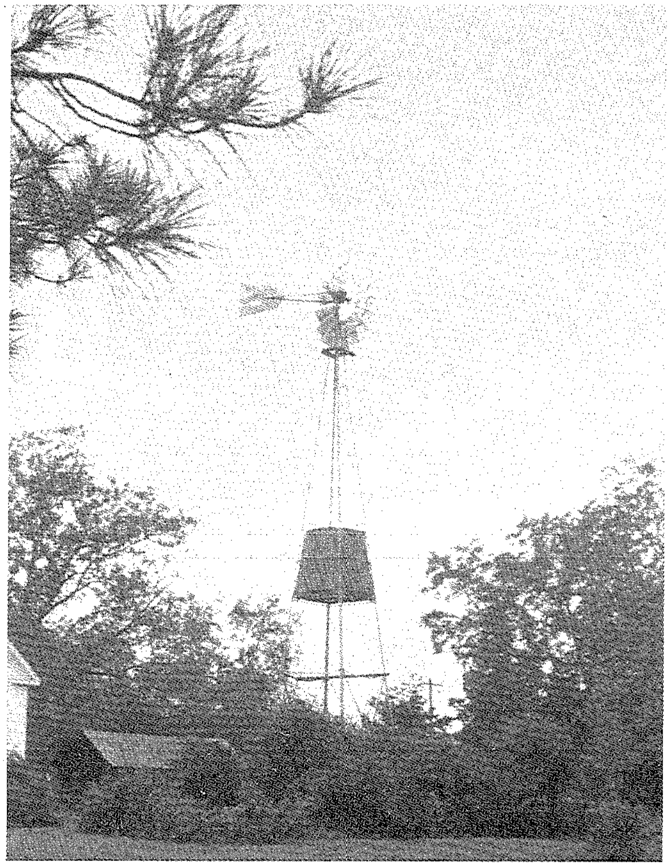

Georgia Department of Natural Resources
Environmental Protection Division
Georgia Geologic Survey

BULLETIN 94

Cover Photo: Windmill on a domestic well in Tarrytown, Montgomery County, Georgia.

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Atlanta
1990

BULLETIN 94

M. Wallace Holcombe

IN MEMORIAM

Wallace Holcombe, the Geologic Survey's Senior Environmental Technician for the last ten years, passed away on October 8, 1990. Wallace was always prepared to go the extra mile to see that the needs of the Geologic Survey staff were met. His diligence in maintaining the geological equipment and field vehicles in proper working condition allowed the staff to maintain their field and laboratory schedules. Wallace's contributions to the success of this report and numerous others over the last ten years will be greatly missed.

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ABSTRACT

The geologic make-up and hydrologic properties of the Floridan aquifer system in the study area are controlled by the presence of the Gulf Trough-Apalachicola Embayment. The Floridan aquifer system, within the trough-embayment, is composed of dense, deep-water limestones; and it is thickly overlain by Miocene and younger sediments.

Throughout the Gulf Trough, and in most of the Apalachicola Embayment, the permeability of the aquifer is lower than that typical of the Floridan system outside the trough-embayment. This is due to a combination of factors, including the low primary permeability of the deep-water limestones of the trough-embayment; limited development of secondary permeability due to thick overburden; and, possibly, a lack of joints or fractures to enhance movement of ground water. However, certain areas within the Apalachicola Embayment and along its south flank are exceptions to this trend. The contact between the Miocene and Oligocene sediments in these areas is a zone of enhanced permeability.

The quality of water from the Floridan aquifer system is reduced in certain parts of the study area. In the Colquitt-Thomas-Grady Counties area, sluggish ground-water flow through the lower parts of the aquifer has inhibited the dissolution of gypsum and the removal of sulfate from the aquifer, causing high sulfate levels. The source of elevated levels of barium in ground water from Ben Hill County is not understood. High concentrations of natural radioactivity (mainly as Radium-226) occur in ground water from the Wheeler-Montgomery and Tift-Berrien Counties areas. The ultimate source is Uranium-238, probably derived from weathered crystalline rocks of the Piedmont. The uranium was incorporated in the crystal structure of the abundant phosphate minerals of the Miocene confining sediments. Oxidizing recharge waters flowing through these sediments dissolved uranium and transported it into the aquifer. The uranium was deposited on the aquifer matrix in areas where reducing conditions were encountered. The pyrite content of the trough-embayment limestones provided such reducing conditions, as did decaying organic matter trapped in paleo-sinkholes within the top of the Oligocene strata. Radioactive decay now contributes Radium-226 to ground water in these areas.

INTRODUCTION

GENERAL

This investigation is the culmination of a multi-year study by the Georgia Geologic Survey of the geology and ground-water hydrology of the Gulf Trough and Apalachicola Embayment, which are part of a subsurface paleo-marine channel system in the Georgia Coastal Plain. The Floridan aquifer system, the most widely used aquifer in the Coastal Plain, is affected by the presence of the Apalachicola Embayment, and by its northeastward extension, the Gulf Trough. Both the quality and the availability of ground water in and near the trough-embayment are reduced. In view of the continuing water needs of municipal, agricultural, and industrial users of this aquifer, a comprehensive study of the geology and hydrogeology of this area was conducted in order to explain the causes of reduced well yields and water quality.

This study of the Gulf Trough-Apalachicola Embayment includes three reports. A data report (McFadden and others, 1986) presents lithologic logs and a table summarizing stratigraphic data on all wells used in the ensuing geologic and hydrologic investigations. The locations of these wells are displayed on a 1:500,000 scale base map. A geologic report (Huddlestun and others, in preparation) presents the stratigraphic framework for the hydrologic investigation of the Gulf Trough and Apalachicola Embayment. The geologic report contains lithologic and faunal descriptions of stratigraphic units, isopach and structure-contour maps, and discussions of the nature, origin, and geologic history of the trough-embayment. The present report, which was completed in 1988, describes the aquifers in the Gulf Trough-Apalachicola Embayment area, presents data on the availability and quality of ground water from the Floridan aquifer system, and makes recommendations for the future development of ground-water resources in the area.

PURPOSE

The Floridan aquifer system is the most widely used aquifer in Georgia. Potentiometric maps of the Floridan system in Georgia consistently show an anomalous steepening of the potentiometric surface trending northeastward across the Coastal Plain, from Grady County in the southwest, to Bulloch County in the northeast. This anomaly roughly parallels the trend of the Gulf Trough-Apalachicola Embayment. The Floridan aquifer system in the vicinity of this anomaly exhibits poor well yields and locally reduced water quality, including abnormally high concentrations of barium, sulfate, and natural radioactivity. The present study was designed primarily to examine the hydrogeology of the Floridan aquifer system in the Gulf Trough-Apalachicola Embayment area. The goal of this study was to assess the principal controls on the occurrence, availability, and quality of ground water from the Floridan system in the study area. Specifically, the following aspects were to be addressed:

1) the cause of the potentiometric anomaly;
2) ground-water occurrence and movement in the Upper Floridan aquifer; and;
3) water quality, particularly the mechanisms which produce the abnormally high barium, sulfate, and natural radioactivity levels which appear to be associated with the Gulf Trough-Apalachicola Embayment.

SCOPE

Prior studies of the ground-water hydrology of the Gulf Trough area were hampered by an incomplete understanding of its complex geology. This study used data from approximately 500 wells to define the stratigraphy of the Gulf Trough-Apalachicola Embayment area. The interpretation of the geology of the trough-embayment area which has emerged from this study allows a more comprehensive view of the hydrogeology of the trough-embayment area than had been possible previously. The hydrogeology phase of this study was designed (1) to describe the lithology and extent of aquifers in the vicinity of the trough-embayment; (2) to produce new data on the hydraulic characteristics of the Floridan aquifer system in the Gulf Trough and Apalachicola Embayment; (3) to discuss the hydraulic characteristics of the Floridan aquifer system in the area; and (4) to examine the possible causes of the reduced quality and availability of ground water from the Upper Floridan aquifer in and near the trough-embayment.

SOURCES OF DATA

Data for the hydrogeologic study were gathered from a variety of sources, both published and unpublished. Published sources of lithologic data and stratigraphic data include collections of well logs by Herrick (1961) and Applin and Applin (1964). A summary of petroleum exploration wells in Georgia (Swanson and Gernazian, 1979) provided stratigraphic and well location data. In addition to well logs from these sources, a number of additional wells were examined and five wells were cored and examined specifically for this project. These were all wells for which the Georgia Geologic Survey (GGS) retains cutting or core samples in its cuttings library or wells drilled (cored) specifically for this project. All are assigned a sequential registration number, known as a GGS number, and are available for inspection at the Georgia Geologic Survey in Atlanta. The stratigraphic data obtained from all the above sources have been published in Georgia Geologic Survey Information Circular 56 (McFadden and others, 1986).

Sources of unpublished geologic data include the files of the GGS in Atlanta and those of the U. S. Geological Survey (USGS), Water Resources Division office in Doraville, Georgia. These files include lithologic logs prepared by staff of the GGS and USGS and a small number of logs prepared by the staffs of petroleum exploration companies.

Hydrologic data for this study were obtained primarily from the files of the GGS, the USGS, and the Water Resources Management Branch of the Georgia Environmental Protection Division. These data include well-construction details, production-test data, and water-quality analyses. Published water-quality data were also included in this study (Grantham and Stokes, 1976). Permeability tests were conducted on cores collected during the project, and the results are summarized in Appendix D. The potentiometric maps of the Floridan aquifer used in this report were produced by the Water Resources Division of the USGS (Clarke and others, 1979; Bush and others, 1987).

METHODS OF INVESTIGATION

The wells chosen for inclusion in the study were those for which the most complete information was available in the form of lithologic logs or cuttings, well construction data, and verifiable locations. These locations were field checked wherever possible. Geophysical and paleontological logs were also available in some case. In addition, five wells were cored and geophysically logged, specifically, for this study.

The definition of the Floridan aquifer system in the study area was reexamined on the basis of the revised stratigraphic interpretation of the Gulf Trough-Apalachicola Embayment area. Using lithologic and geophysical logs of all wells from the stratigraphic data base, the top and base of the Floridan aquifer system in the study area were determined and its thickness was mapped. The depth to the top of the Upper Floridan aquifer was also calculated and mapped. Appendix A lists the wells used in mapping the aquifer and includes land surface elevations, depth to top of the aquifer, and elevations of its top and base. More complete information on these wells is presented by McFadden and others (1986).

Specific-capacity maps were constructed using data from well production tests. These tests varied greatly in duration, ranging from an hour or less to several days. Construction of the wells also varied widely in such details as diameter, depth, and length of open borehole. Specific-capacity indices were obtained by dividing the specific-capacity values by the length of open borehole of the well; thus, normalizing, in part, the varying well construction. Maps were constructed to show the range and distribution of specific-capacity indices. Appendix B summarizes construction data for these wells.

Time-drawdown data, needed to calculate transmissivity (T), storativity (S), and hydraulic conductivity, are very limited for the study area. However, an estimate of transmissivity can be obtained from the specific capacity (Q/s). Lohman (1979, p. 52) noted a relationship between specific capacity and transmissivity of confined aquifers which can be expressed as:

$$T = \frac{2.3(Q/s_w)}{4\pi} \quad . \quad \log\left(\frac{2.25Tt}{r^2_w S}\right)$$

where pumping rate (Q), drawdown (s), and duration of test (t) are measured during the well production test, and rw is the diameter of the well.This relationship was used to estimate the transmissivity of the aquifer at wells for which time-drawdown data is not available. Pertinent data on these wells is summarized in Appendix B.

Storage cooefficients (S) for the Floridan aquifer system in the study area were, also, not generally available. A S value typical for confined aquifers (0.0001) was used in the transmissivity estimations. The effect of changes in the S on the estimated transmissivity value is relatively small; an order of magnitude change in the S value, typically, produces only an 11 per cent change in the estimated transmissivity. Transmissivity estimates derived using this method agreed well with values obtained using time-drawdown data.

Tests of vertical hydraulic conductivity were conducted on 140 core samples from the five core holes drilled for this study and from two U. S. Gypsum cores. Test samples were selected at intervals of approximately 25 feet Sampling intervals varied, however, where sample gaps occurred or where the core was fragmented. The sides of core samples were sealed by wrapping them tightly with impermeable tape. Polyvinylchloride caps were fitted on the ends of the samples and sealed with silicone sealer. The samples were oriented vertically and saturated with water. Water was introduced from the bottom of the core sample to minimize the possiblity of trapping air in the sample.

Core samples varied greatly in permeabilty, making it neccessary to employ both constant head and falling head tests. Samples with relatively high vertical hydraulic conductivity values were tested using the constant head method. In this method, a constant head gradient was established across the sample while measuring the rate of flow. A constant head was maintained by the use of an overflow tube on the supply side of the sample. The flow rate was measured by noting the time required to fill a known volume. Head gradients used ranged up to approximately 2 feet.

Measurements were made at three or more different gradients for each sample. For each measurement, the flow rate was plotted against the head gradient. If the values plotted on a line that extended through the origin, then laminar flow conditions through the sample were assumed. A non-linear plot of values was assumed to indicate turbulent flow through the sample. These samples were retested at lower head gradients. In several instances, scatter of the head gradient versus flow rate plot could not be attributed to turbulent flow. Measurements repeated several hours later showed a linear plot, suggesting that the saturation of the sample may have caused swelling of clay minerals. A longer interval between saturation and testing eliminated this problem.

When flow through the core sample was too small to be measured readily by timing the filling of a known volume, falling head tests were used. Falling head tests measure the rate at which water enters the sample. Following saturation, a tube of known cross-sectional area, open to the sample, was filled with water. The rate at which the water level in the tube dropped was measured. The initial head gradient (the difference in height between the water level in the supply tube and the discharge point) ranged up to 5.5 feet. The head values were plotted against time to insure that there were no sudden changes in the rate of decline.

Samples of low permeability, typically, required several days to saturate. Those samples which did not saturate after four days or more could not be tested and are assumed to have a vertical hydraulic conductivity of 0.001 ft/day or less. This appears to be a conservative figure, as several samples which did saturate had vertical hydraulic conductivity values lower than 0.001 ft/day.

Hydraulic conductivity values were calculated using readily available equations derived from Darcy's Law (Freeze and Cherry, 1979, p. 335-336). Vertical hydraulic conductivity data are presented in Appendix D.

Water-quality maps were produced using a combination of published and unpublished data. Sequential identification numbers were assigned to the wells and municipal water systems used in the maps, keyed to appendices which list sources of data.

ACKNOWLEDGEMENTS

The authors would like to thank the many people whose assistance helped make this report possible. Sue Rodenbeck and Susan Mosteller collected and checked much of the data on which this study was based. Stephen McFadden participated in the early portion of this study and also provided information on research into the occurrence of radionuclides in ground water. John Fernstrom, now retired from the Georgia Environmental Protection Division's Ground-water Program, contributed data on the occurrence of natural radioactivity in the Gulf Trough/Apalachicola Embayment area. Wendell Pope, of Abner Pope and Sons Well Drilling, supplied well data and cooperated with geophysical logging of wells in the vicinity of Alapaha. Grady Thompson, of Bishop Pump and Well Service, provided well data and general observations on the nature of the Gulf Trough/Apalachicola Embayment. He also assisted in repairing a damaged inflatable packer. James Miller and Woody Hicks of the U.S. Geological Survey reviewed the manuscript and made many helpful comments.

DESCRIPTION OF STUDY AREA

LOCATION

The 27-county study area is located in the Coastal Plain Province of Georgia. The Coastal Plain covers approximately 60 percent of the state's total area and contains Georgia's major aquifers. The study area extends northeastward from the southwestern corner of the state to the Savannah River, an area of approximately 11,550 square miles (Figure 1). The study area takes in the Apalachicola Embayment and Gulf Trough (Figure 2), as well as adjacent portions of the Coastal Plain. The Apalachicola Embayment occupies the southwestern end of the study area, and the Gulf Trough occupies the central portion.

DEMOGRAPHY AND POPULATION

The total estimated population of the study area was 492,900 in 1985 (Bachtel, 1987), with a population density of approximately 43 people per square mile. The population is primarily rural, producing agricultural and forest products as the main economic activities. A number of small cities are located in the study area, eight of which have populations in excess of 10,000. These eight cities are: Bainbridge, Douglas, Fitzgerald, Moultrie, Statesboro, Thomasville, Tifton, and Vidalia. Only Moultrie (15,508) and Thomasville (18,352) contain populations greater than 15,000 (Bachtel,

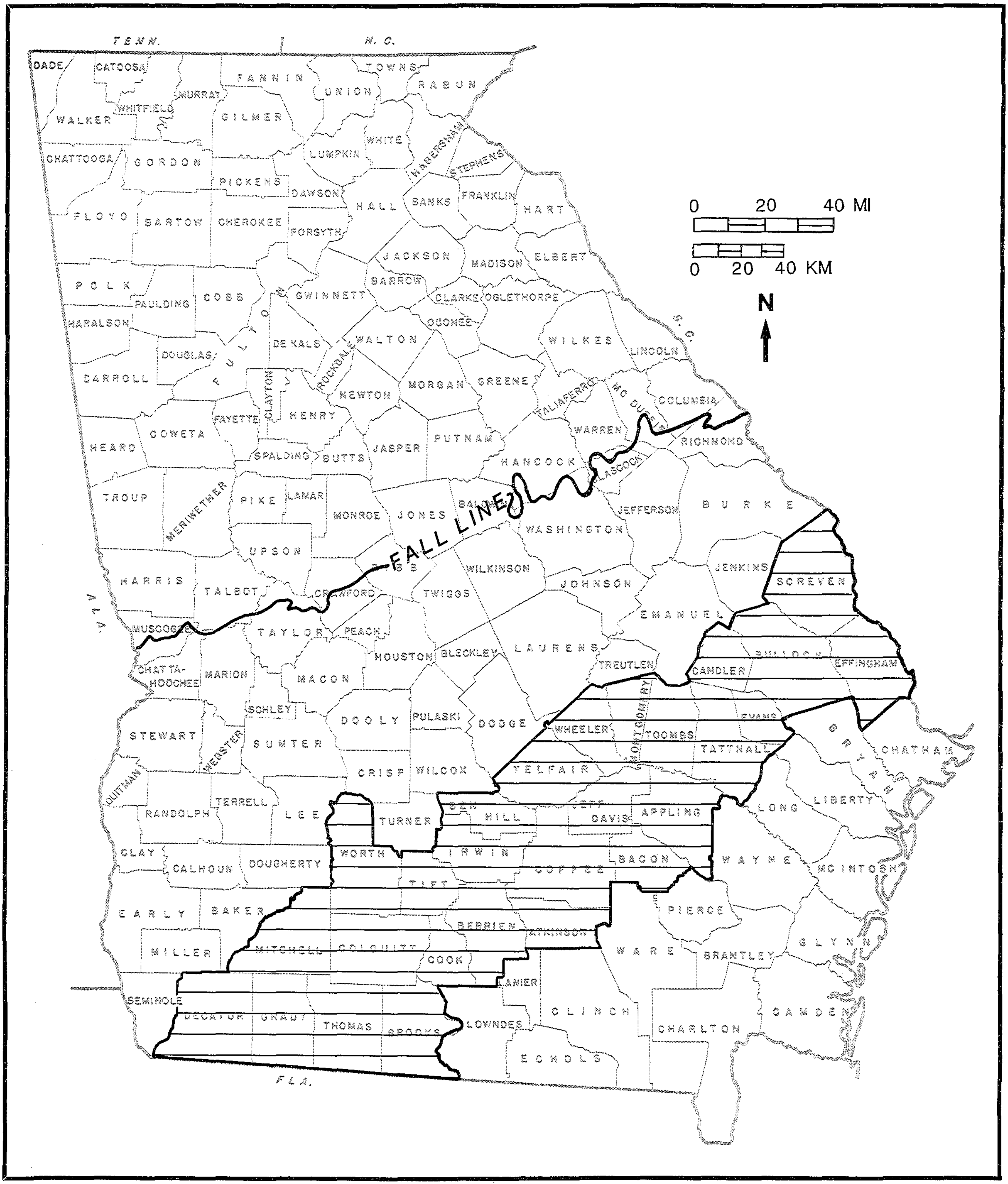

Figure 1. Location of the study area.

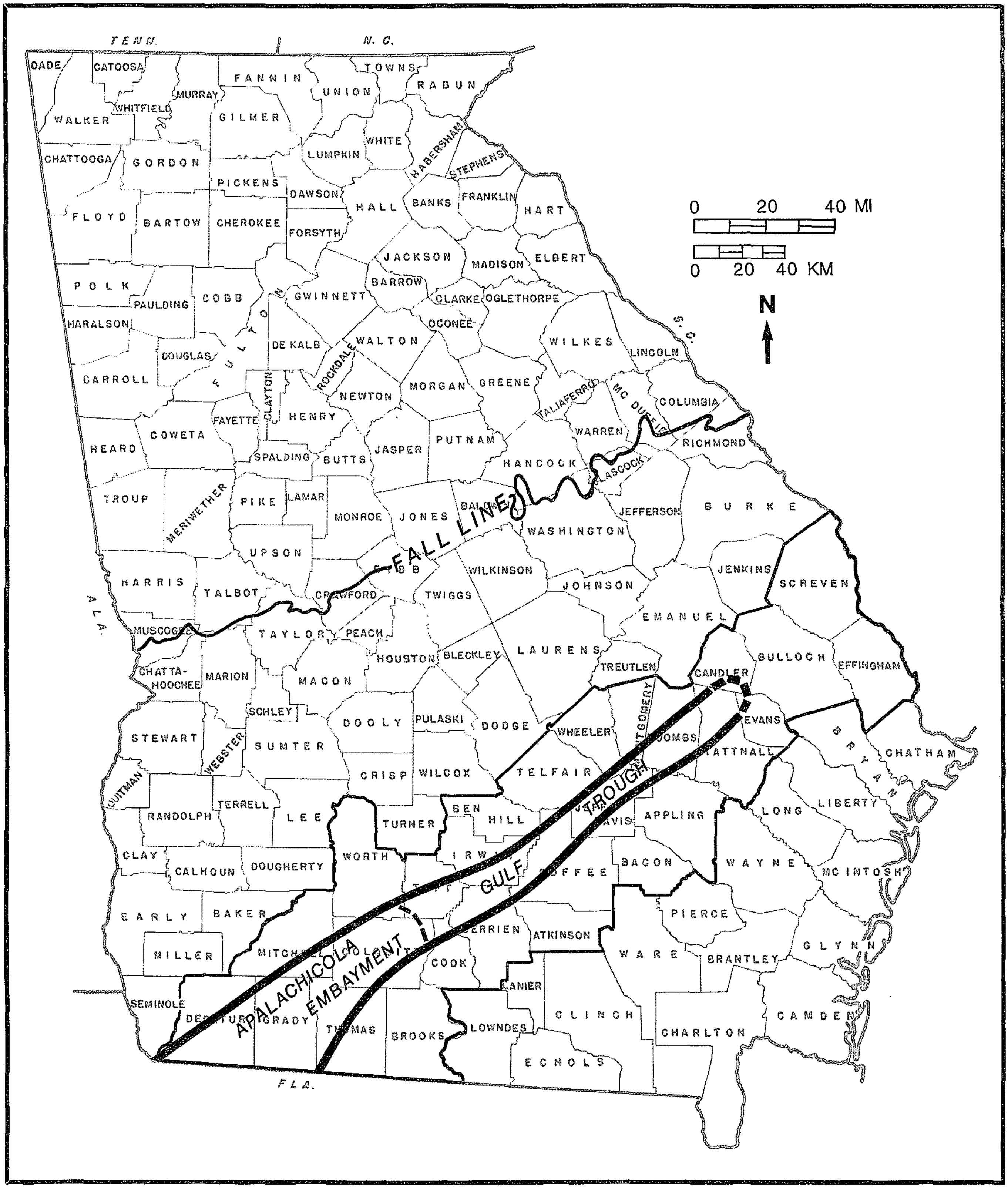

Figure 2. Approximate location of the Gulf Trough and Apalachicola Embayment. (After Huddlestun and others, in prep.)

1987).

PHYSIOGRAPHY AND DRAINAGE

Portions of five physiographic districts make up the study area: the Tifton Upland, Vidalia Upland, Dougherty Plain, Bacon Terraces, and Barrier Island Sequences Districts (Clark and Zisa, 1976). The Tifton and Vidalia Uplands comprise the majority of the study area (Figure 3). These two districts are topographically high areas, ranging in elevation from about 500 feet above sea level in the north and northeast to about 100 feet above sea level in the southeast. The regional slope is southeastward, towards the Atlantic coast. Drainage in these areas is well developed and dendritic.

The western edge of the study area, including portions of Decatur, Grady, Mitchell, and Worth Counties, lies in the Dougherty Plain, a gently-rolling karstic lowland. The regional slope of this district is southwestward, towards the Gulf of Mexico. Maximum elevations of about 300 feet above sea level occur in the northeast and a minimum elevation of about 77 feet above sea level in the southwest, at Lake Seminole. The Dougherty Plain contains few surface streams but many sinkhole lakes and marshes.

Portions of Appling, Atkinson, Bacon, Ben Hill, Coffee, Irwin, and Jeff Davis Counties lie in the Bacon Terraces District, an area of subtly dissected terraces, paralleling the present coastline. Terrace levels range in elevation from about 330 to about 160 feet above sea level. Drainage is southeast-trending, dendritic, and extended.

The easternmost end of the study area, including Effingham County and portions of Bulloch and Screven Counties, lies in the Barrier Island Sequence District, an area of abandoned shorelines parallel to the present coast. This area exhibits slight to moderate dissection, with marshes occupying poorly drained lowlands.

The study area is crossed by several of the state's major rivers. The Flint River forms the western boundary of the study area and flows through Decatur County in the extreme southwestern part of the study area. The Ocmulgee and Oconee Rivers join in the vicinity of Jeff Davis, Montgomery, and Toombs Counties to form the Altamaha River. The Savannah River forms the eastern boundary of the study area.

CLIMATE

The climate of the study area is influenced in the west by the Gulf of Mexico and in the east by the Atlantic Ocean. Winters are generally mild, and summers are hot and humid. The mean annual temperature for the period of record, 1951 to 1980, was 65.7° F at the Tifton experiment station of the National Oceanic and Atmospheric Administration (NOAA). Mean annual precipitation for the same period and location was 46.61 inches. March and July are, usually, the wettest months of the year in the study area; while October and November are the driest. Evapotranspiration rates are highest in the spring and summer.

PREVIOUS INVESTIGATIONS

The Floridan aquifer system has been known by a number of names, among them, the principal artesian aquifer, the Tertiary limestone aquifer, the Floridan aquifer, and most recently and formally, the Floridan aquifer system. The large geographic extent of the Floridan aquifer system in Georgia has, until recently, limited the detail of most investigations. Early reports on the hydrogeology of the Floridan in Georgia were of a reconnaissance nature, due to the incompletely understood geology of the Coastal Plain. More detailed work, on a single county or smaller scale, has added to the general understanding of the hydrogeology of the aquifer; and as more detail emerges from these small studies, a larger regional picture of the Floridan aquifer system is being developed. The influence of the Gulf Trough-Apalachicola Embayment on the Floridan aquifer system in Georgia has only recently been studied.

One of the earliest reconnaissance studies of ground water in Georgia was that of McCallie (1908), who described wells and springs throughout Georgia and included many driller's logs and water-quality analyses in his descriptions. He identified the upper Eocene limestone, which he called the Vicksburg-Jackson limestone, as the major water-bearing unit of the Coastal Plain. Stephenson and Veatch (1915) related ground water to stratigraphy, and summarized the geology and water resources of the Coastal Plain by county, including information on well construction, well yields, subsurface geology, and water quality. Meinzer (1923), in his summary of ground-water occurrence in the United States, identified the Eocene and Oligocene formations of Georgia as important water-bearing strata.

In view of the rapid rate at which ground-water resource development was occurring in the Southeast, Warren (1944) published results of investigations of limestone aquifers of the Coastal

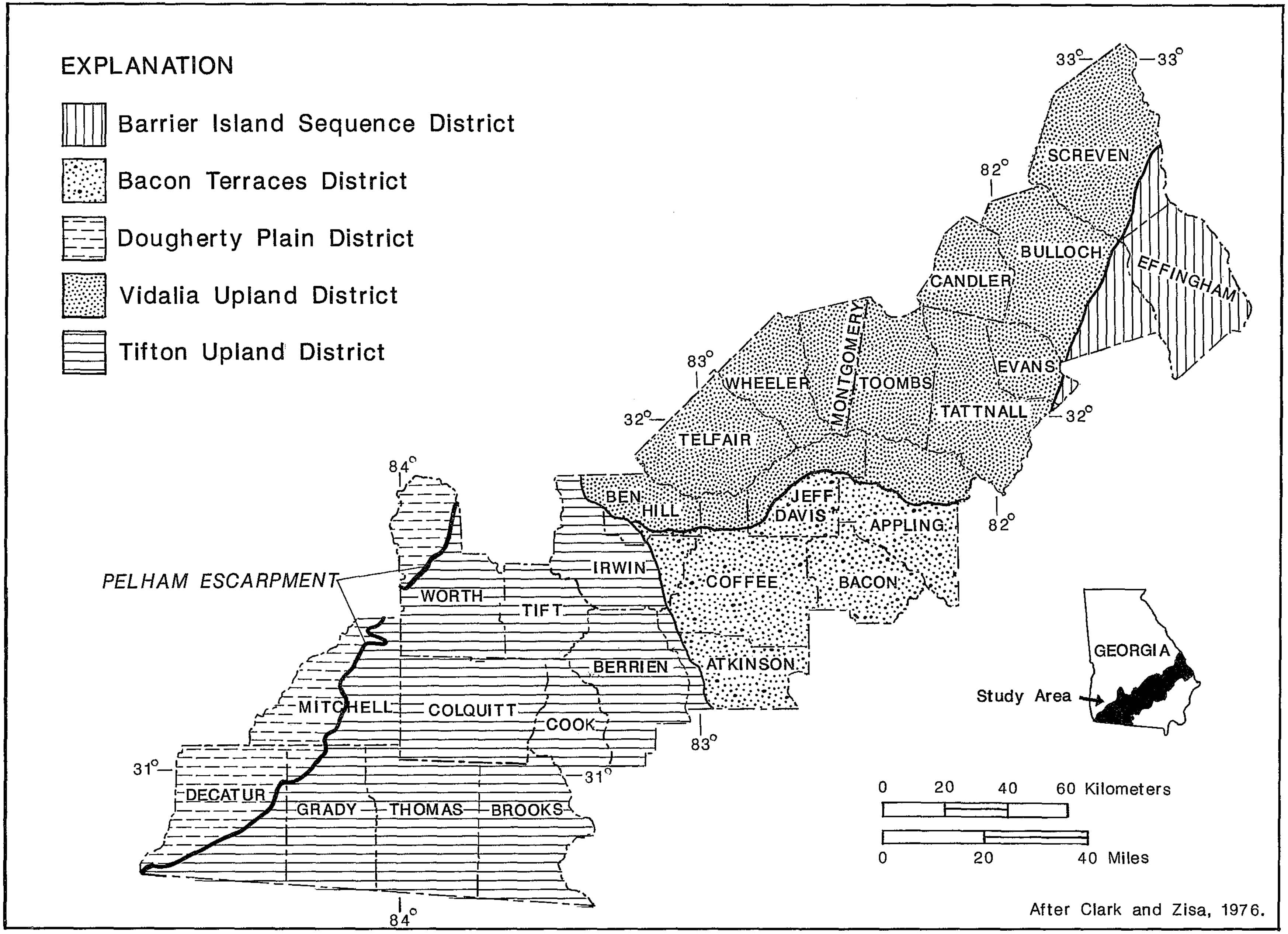

Figure 3. Physiographic districts of the study area.

Plain. Warren noted that the principal artesian aquifers in the Southeast are limestones of Eocene and Oligocene age, which crop out in a belt extending northeastward from the southwestern corner of Georgia, roughly paralleling the Fall Line. Recharge areas were identified in the area of outcrop, and also in the Valdosta area, where lime sinks allow direct access to the aquifer. Warren included the Oligocene Suwannee Limestone and the Eocene Ocala Limestone in the principal artesian aquifer, and identified the impervious clays and marls of the Miocene Hawthorne Formation as the upper confining unit. Transmissivity values for the principal artesian aquifer were calculated to range from 100,000 to 1,000,000 square feet per day (ft^2/d). Herrick and Wait (1956) characterized the availability and quality of ground water from Coastal Plain strata, including the middle Eocene to lower Miocene principal artesian aquifer. They cited dolomitization as the cause of reduced utility of the principal artesian aquifer in the vicinity of Grady, Thomas, and Colquitt Counties, and mentioned the presence of a "subsurface structural trough" in this area as the cause of decreased permeability of the aquifer and increased hardness of the ground water. In a 1960 study, Wait described ground-water quality in the Ocala Limestone, characterizing the water as moderately hard to hard, slightly alkaline, and of calcium bicarbonate type. He noted that in some areas of the Tifton Upland, water from the Ocala Limestone contained elevated levels of sulfate. The principal artesian aquifer was redefined to include limestones of Miocene age. Wait presented water-quality data for southwestern Georgia, and discussed the relationship of structural features and sinkholes to water-quality trends in the area.

In a study that has formed the basis for much of the subsequent geologic and hydrogeologic work in the Coastal Plain, Herrick (1961) published a collection of lithologic logs of wells in the Coastal Plain of Georgia. He described well cuttings from 354 wells, noting possible water-bearing units in each.

Among the reports detailing ground-water resources of single counties in the study area was that of Owen (1963) on the geology and ground-water resources of Mitchell County. Mitchell County was divided into three hydrologic zones, the Dougherty Plain, the solution escarpment, and the Tifton Upland. Mitchell County lies, for the most part, in the Dougherty Plain. In this karstic lowland, the Ocala Limestone is at the land surface, overlain by a blanket of residuum. Water in the Ocala Limestone is under unconfined conditions, except where the overburden of clayey residuum is sufficiently thick to confine it. Wells drilled in the Dougherty Plain often tap the middle Eocene Tallahatta Formation, in addition to the Ocala. Few wells have been drilled in the solution escarpment, probably due to the greater thickness of overburden in this area. In the Tifton Upland, the Ocala Limestone is deeply buried by thick Miocene and Oligocene deposits, which Owen interpreted as evidence of downwarping in the extreme southeastern part of the county. The term principal artesian aquifer was not used in this study because the Oligocene and Eocene limestone are unconfined over most of Mitchell County.

Callahan (1964) attempted to quantify the amount of water available from Coastal Plain aquifers, including the principal artesian aquifer. The principal artesian aquifer was redefined as an aquifer system made up of a number of interconnected water-bearing strata. Aquifer geometry, flow zones, water quality, and recharge were considered. An estimated maximum "safe yield" of the principal artesian aquifer system was calculated, and the probable effects of maximum pumpage on water levels in the aquifer and in streams were assessed. Using potentiometric maps of the principal artesian aquifer, Callahan noted an apparent decrease in transmissivity in the position now identified as the Gulf Trough-Apalachicola Embayment. Two northeast-trending faults, offsetting or constricting the permeable zones of the aquifer, were postulated as the cause of this anomaly.

Sever (1966), in another small-scale study, surveyed the ground water and geology of Thomas County. He identified the Eocene Ocala Limestone and Oligocene Suwannee Limestone as the principal aquifer in the county, excluding the middle Eocene Lisbon Formation due to its highly mineralized waters. Sever noted the wide range of well yields in Thomas County, from 60 gallons per minute (gal/min) in the northeast, to 3,000 gal/min in the southeast; and he postulated a fault, the Ochlockonee fault, to explain the steep gradient of the potentiometric surface of the principal artesian aquifer. In addition, certain water-quality anomalies were identified, including elevated levels of sodium chloride and sulfate.

In a paper on the Tertiary limestone aquifers of the southeastern states, Stringfield (1966) identified the Ocala Limestone and the Suwannee Limestone as the major water-bearing units in Georgia, and described the hydraulic properties, recharge, and water quality of these units. The steepening of the hydraulic gradient across the

Georgia Coastal Plain was discussed and a number of possible explanations were given. A written communication from H.E. LeGrand (in Stringfield, 1966, p. 123) attributed the anomaly to the proximity of the recharge area. LeGrand's theory was that there was upward leakage from the principal artesian aquifer to the overlying Miocene rocks, which diminished as the water moved under the confining Hawthorne Formation, and as the aquifer became thicker and more permeable. Stringfield (p.132) attributed the potentiometric anomaly to "recharge and discharge relationships and...changes in the permeability and thickness of the limestone."

Sever and Herrick (1967) discussed the origin of poor-quality ground water, high in sulfate, iron, flouride, and total dissolved solids, derived from wells in the Grady County area. They concluded that this water, formerly thought to be from the Ocala Limestone, was probably being obtained from a limestone of early Oligocene age, never before described in Georgia.

Sever (1969) reported the results of aquifer tests and water-quality analyses at the cities of Alapaha, Coolidge, Fitzgerald, and Thomasville. Transmissivity values calculated for wells tapping the Oligocene and Eocene limestones ranged from 16,000 ft^2/d at Fitzgerald to as large as 2,700,000 ft^2/d at Thomasville. The extremely high transmissivity value obtained from the Thomasville test was attributed to solution of the limestone along structurally-produced joints and fractures. In addition to calculations of transmissivity, storage coefficients were derived where possible, and the effects of future pumpage were estimated.

Zimmerman (1977) explained variations in the transmissivity of the principal artesian aquifer in Colquitt County as the result of facies changes across a paleogeographic feature which he identified with the Suwannee Strait. Reduced transmissivity was attributed to deposition of fine-grained clastic sediments within the strait, contrasted with deposition of more permeable carbonates outside the feature. The Ochlockonee fault of Sever (1966) was used to explain such water-quality anomalies as high concentrations of dissolved solids, especially sulfate.

Krause (1979), in a study of the geohydrology of Brooks, Lowndes, and western Echols Counties, described the principal artesian aquifer in Brooks County as containing rocks of the Claiborne Group, the Ocala Limestone, Suwannee Limestone, and limestone of the lower Hawthorne Formation. These limestones are jointed, enhancing solution of the limestone and allowing conduit flow of ground water. Recharge takes place through the area's many sinkholes and permeable lake bottoms and the bed of the Withlacoochee River.

Gelbaum (1978), in a paper on the geology and ground water of the Gulf Trough, extended the trough northeastward into Screven and Effingham Counties on the basis of potentiometric maps of the principal artesian aquifer. She discussed possible causes of low yields from wells in the vicinity of the trough, suggesting that many wells may not penetrate the aquifer very deeply, or at all, due to the greater depth to the top of the aquifer in the Gulf Trough. Another possibility mentioned was a thinning of Oligocene strata in the trough, making the aquifer thinner overall. Faulting parallel to the trough and facies changes across the trough were also considered as possible causes of low well yields. In later work on the Gulf Trough, Gelbaum and Howell (1982) used specific-capacity indices to characterize ground-water flow across different areas of the trough. The potentiometric anomaly which marks the trough was described as the result of a combination of structural and depositional factors. They attributed the reduced transmissivity of the aquifer in the trough to facies changes resulting in denser limestones deposited in the trough, with downfaulted blocks locally forming ground-water flow barriers.

Bush (1982) simulated the predevelopment flow in the Tertiary limestone aquifer. The model revealed that the majority of flow in the aquifer prior to development occurred in the unconfined and thinly confined portions of the aquifer. In these areas, high recharge and discharge produced an active shallow flow zone and a less active deeper zone. Transmissivity values for unconfined and shallowly confined areas commonly exceeded 1,000,000 square feet per day (ft2/d). The thickly confined areas of the aquifer had lower transmissivities, due to the retarded discharge and sluggish ground-water flow.

The geology and configuration of the top of the Floridan aquifer system was mapped by Miller (1986). He followed Gelbaum in attributing the reduced transmissivity of the aquifer in the trough to faulting, stating that extensive graben faulting along the trend of the trough could have dropped low-permeability Miocene clastics into contact with permeable limestones of the aquifer, effectively damming ground-water flow across the trough. In 1986, Miller restated this conclusion in the context of a Regional Aquifer System Analysis (RASA). Although this work is the most complete and comprehensive report on the geology of the Floridan aquifer system to date, it employed relatively few data specific to the Gulf Trough-Apalachicola Embayment area.

An unpublished M. S. thesis by Korosy (1984) delineated ground-water flow patterns in the Ochlockonee River area of northwest Florida and southwest Georgia. Korosy used uranium isotope distributions to identify recharge areas and areas where the development of secondary permeability in the limestones of the Floridan aquifer is inhibited by retarded ground-water flow and thick overburden.

GEOLOGIC FRAMEWORK

The study area is located in the Coastal Plain geologic province. The Coastal Plain is underlain by a seaward thickening wedge of sediments ranging in age from late Cretaceous to Holocene, resting unconformably on a basement complex of Piedmont crystalline rocks; Triassic grabens filled with red-bed sediments and volcanic rocks; and Paleozoic sedimentary rocks. Coastal Plain sedimentary units generally dip to the southeast and exhibit an outcrop pattern that strikes northeast to southwest. The oldest outcropping sedimentary units of the Coastal Plain are exposed along the Fall Line in southwest Georgia, and the youngest crop out along the coast.

The Apalachicola Embayment along with the Gulf Trough, its narrow northeastward extension, is a linear, subsurface depression continuous with the Gulf of Mexico (Figure 2). The trough-embayment exhibits as much as 600 feet of buried relief and varies in width from 35 miles in the extreme southwestern corner of the state to approximately 6 miles at its narrowest in Jeff Davis County. The feature cannot be traced east of central Bulloch County.

The Gulf Trough-Apalachicola Embayment area is distinguished by radical changes in the geometry and lithology of stratigraphic units in the study area (Plate 1). The presence of the Gulf Trough is first apparent in Clabornian-age sediments, which show a facies boundary between clastic and carbonate sedimentation which approximates the position of the trough-embayment. Claibornian sediments are also anomalously thin in the vicinity of the feature. The Upper Eocene in the trough-embayment is represented by a dense, fine-grained, relatively deep-water limestone that is thinner than the adjacent Upper Eocene Ocala Limestone. The boundary between Eocene and Oligocene sediments is difficult to distinguish in well cuttings from the trough-embayment, due to their lithologic similarity. The Lower Oligocene Ochlockonee Formation of the trough-embayment is a dense, fine-grained limestone. There is no typical Suwannee Limestone in the trough-embayment. The Okapilco Member of the Suwannee, a coarser-grained, more variable, coralline limestone, occupies its stratigraphic position. In general, the Oligocene section in the trough-embayment is thicker than normal and contains a deeper-water faunal assemblage. Lower Miocene sediments in the trough-embayment are also unusually thick, particularly the Parachucla Formation of Aquitanian age.

The Apalachicola Embayment and Gulf Trough are interpreted to have been produced by the Suwannee Current which flowed from the Gulf of Mexico to the Atlantic Ocean and inhibited sedimentation in the trough-embayment during the middle and upper Eocene (Huddlestun and others, in preparation). Falling sea level during the Early Oligocene probably initiated the cessation of the current. The filling of the trough-embayment began, continuing into the lower Miocene.

Plate 1 shows generalized stratigraphic columns for representative parts of the study area. The stratigraphy and geologic history of the Gulf Trough and Apalachicola Embayment are complex, and this report addresses only those aspects pertinent to a discussion of the hydrogeology of the area. For a more thorough treatment of the geology of the Gulf Trough-Apalachicola Embayment area, the reader is referred to Huddlestun and others (in preparation).

HYDROLOGIC FRAMEWORK

GENERAL

Aquifers are rock units which store significant quantities of water and transmit that water to wells which tap the rock units. The amount of water considered to be significant varies with the water needs and water availability of an area. A confined, or artesian, aquifer is one which is overlain by a layer of relatively impermeable material. Pressure in the aquifer exceeds atmospheric pressure, causing water to rise above the level of the aquifer in tightly cased wells tapping the aquifer. The imaginary surface, coinciding with the level to which water from the aquifer will rise in artesian wells is called the potentiometric surface. An unconfined aquifer is one which contains water in contact with the atmosphere by way of the open spaces in the permeable material. The upper surface of water in an unconfined aquifer is called the water table. For this reason, unconfined aquifers are also called water-table aquifers. Water in unconfined aquifers is at atmospheric pressure at the water table. The configuration of the water table is usually a subdued replica of the land surface.

The Coastal Plain province of Georgia contains the State's major aquifers. Of these, the Upper Floridan aquifer, a confined carbonate aquifer of Middle Eocene to Oligocene age, is the most widely used. In much of the study area, the Floridan is overlain by sediments of Miocene and younger age, which are sufficiently permeable to form an unconfined surficial aquifer. The surficial aquifer in the study area locally yields quantities of water sufficient for domestic supply.

Other major aquifers which extend into the study area include the Clayton, Claiborne, and Providence aquifers and the Cretaceous aquifer system. All are confined aquifers. Because these aquifers are more deeply buried than the Floridan aquifer system, they are used extensively only in areas where the Floridan system is absent or yields insufficient water. Increased costs associated with the drilling of deep wells make use of the Floridan aquifer system the most practical in areas where it yields sufficient water.

SURFICIAL AQUIFER

Miller (1986) noted that the Floridan aquifer system in most places is overlain by an unconfined surficial aquifer (Figure 4). In the study area, the surficial aquifer is composed of sediments of Miocene to Holocene age, which vary greatly in thickness and permeability. In areas where the Upper Floridan aquifer or its upper confining unit crop out, such as the Dougherty Plain (Figure 4) no surficial aquifer is present.

The surficial aquifer in the majority of the study area is made up primarily of unconsolidated clastic sediments of the Miocene Hawthorne Group. Although the Hawthorne Group sediments are characteristically high in clay content and act as the upper confining unit for much of the Floridan aquifer, they vary greatly in lithology over the study area. Beds of coarser material locally yield supplies of water adequate for domestic supply. The Hawthorne Group also varies greatly in thickness in the study area, due to the presence of the Gulf Trough-Apalachicola Embayment. Deposition of the Hawthorne Group sediments completed the majority of infilling of the trough, primarily through deposition of the limestones of the lower Miocene Parachucla Formation.

Areal variations in lithology produce widely different well yields over the study area, even in wells drilled to the same depths, or in the same formations. Although the Parachucla Formation contains considerable amounts of dense dolomite, it may locally yield adequate amounts of water for domestic supply, particularly in areas where it contains beds of coquinoid limestone. Seasonal variations in water levels and well yields may also be extreme, as water-table aquifers respond quickly to fluctuations in precipitation. The surficial aquifer is used primarily for domestic supply because of its small and variable well yields. Locally, the surficial aquifer may yield adequate water for other purposes, but in drought years water supplies from this aquifer often prove to be unreliable. Even in areas where it is not used to supply water to wells, the surficial aquifer is important as a source of recharge to the Upper Floridan aquifer.

FLORIDAN AQUIFER SYSTEM

The Floridan aquifer system is a thick sequence of permeable carbonate rocks, ranging in age from Paleocene to Miocene, which are in some degree of hydraulic connection. The Floridan aquifer system blankets all of Florida, most of the Coastal Plain of Georgia (Figure 5), and adjacent portions of South Carolina and Alabama. The Floridan aquifer system consists of a single permeable zone in its updip regions, confined by less permeable sediments. Downdip, the aquifer system contains two permeable zones, the Upper and Lower Floridan aquifers, separated by one of a number of local confining units designated by Miller (1986) as middle confining units I-VIII. The Floridan aquifer system is represented only by the Upper Floridan aquifer throughout most of the study area. Although Miller (1986) and Bush (1982) mapped an intra-aquifer low permeability zone in the area southeast of the Apalachicola Embayment, this study did not divide the aquifer system into upper and lower permeable zones. The Floridan aquifer system is separated from the surficial aquifer by a relatively impermeable confining unit. This upper confining unit varies considerably in age, lithology, thickness, and permeability. The interbedded clays and sands of the Miocene Hawthorne Group form the confining unit for the Floridan aquifer system over most of the Coastal Plain of Georgia. Locally, however, the Miocene section also contains dense dolomites or other carbonate layers which form a portion of the confining unit. The Suwannee Limestone, a major component of the Upper Floridan aquifer, locally

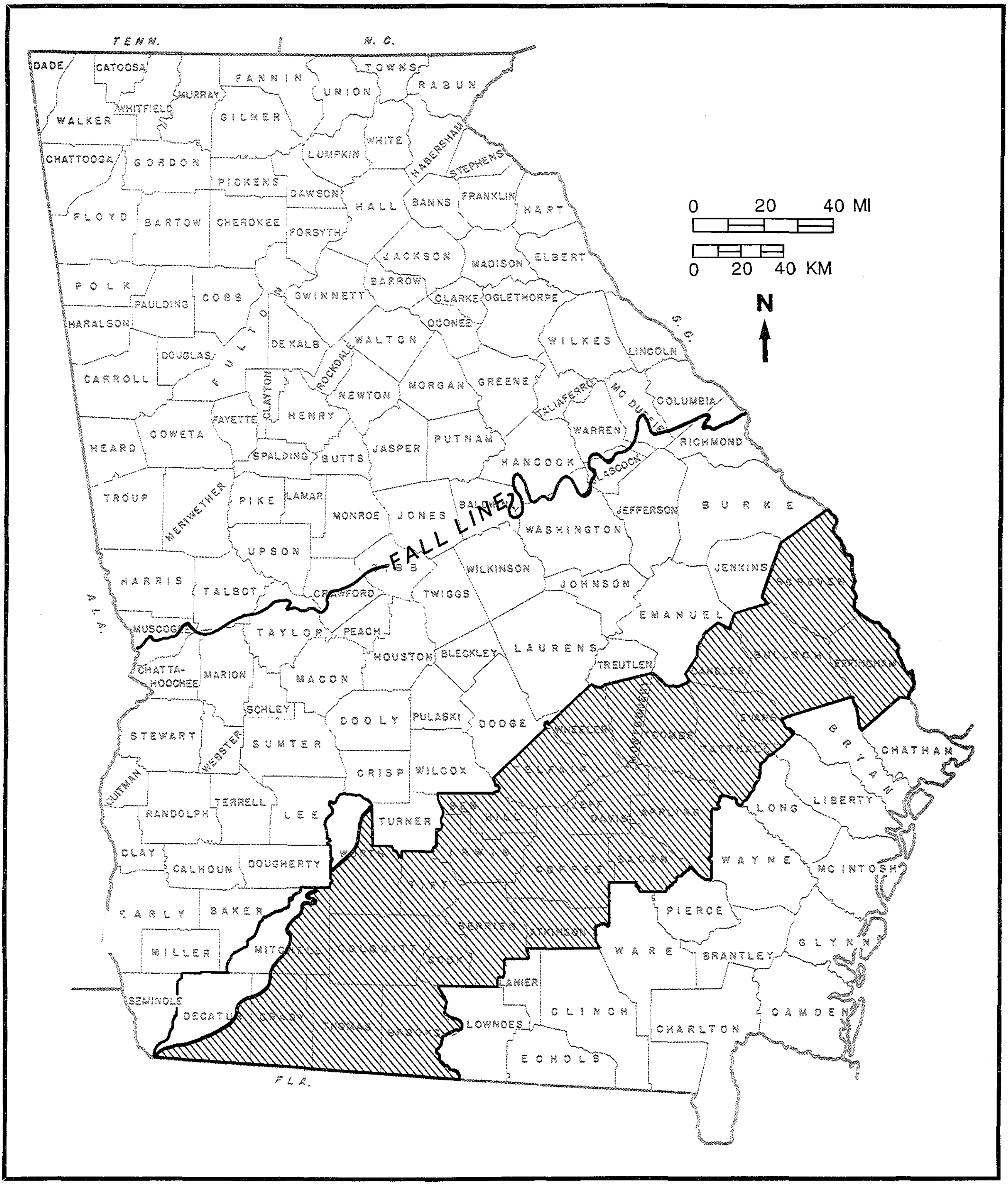

Figure 4. Geographic extent of the surficial aquifer in the study area. Shaded area indicates aquifer. (After Miller, 1986.)

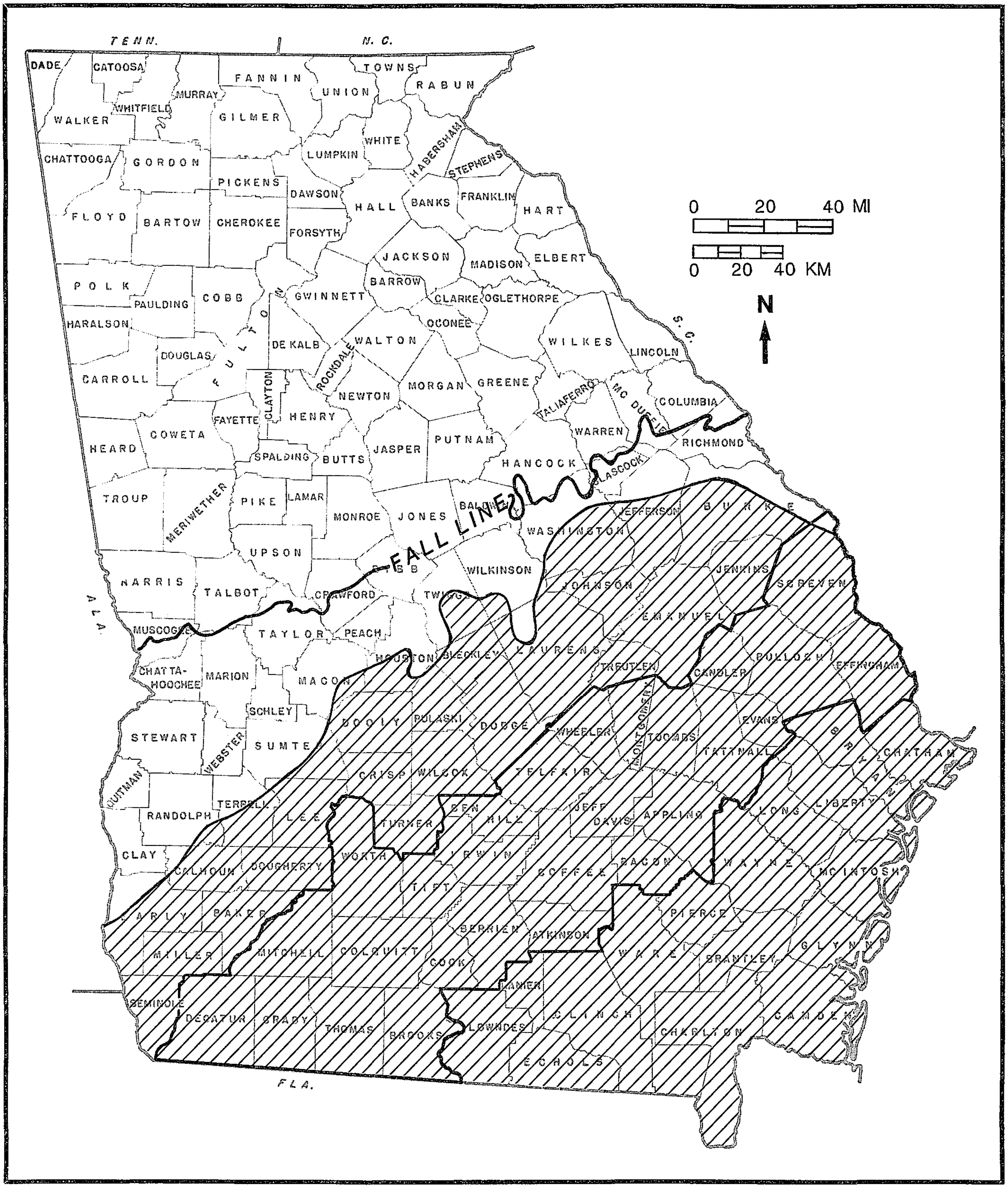

Figure 5. Geographic extent of the Floridan aquifer system. Shaded area indicates aquifer. (After Miller, 1986.)

forms a part of the confining layer.

The stratigraphic relationship between the Miocene and the Oligocene sediments in the study area is complex, and for this reason, the top and thickness of the upper confining unit of the Floridan system have not been mapped. Plate 2 shows the thickness of all sediments overlying the Floridan aquifer system, including both the surficial aquifer and the upper confining unit of the Floridan system.

The confining Miocene sediments have been removed by erosion in parts of the study area. The Pelham Escarpment, an erosional feature of the Coastal Plain, divides the Dougherty Plain in southwestern Georgia from the Tifton and Vidalia Uplands of the central Coastal Plain. West of this scarp, erosion has removed most of the Miocene sediments and all but a fringe of Oligocene sediments. The Upper Eocene Ocala Limestone, a major part of the Floridan aquifer system, is exposed at the surface, overlain only by clayey residuum. Locally, this residuum is sufficiently thick and impermeable to produce confined or semi-confined conditions in the Floridan. The upper confining unit has been breached by the Withlacoochee River and by numerous sinkholes in Brooks County, and in the Lowndes and western Echols Counties to the east. Recharge to the Floridan aquifer system takes place in this area from the river and through sinkholes and porous lakebeds (Krause, 1979).

The boundaries of the Floridan aquifer system cross both rock- and time-stratigraphic boundaries. Within the study area, the Upper Floridan aquifer is primarily Middle Eocene to Oligocene in age. Any of these units may be of low permeability locally and may be excluded from the aquifer as a result. The massive limestone of the lowermost Miocene may form a part of the aquifer in a few small areas.

Plates 3 through 5 illustrate the geology and geometry of the Floridan aquifer system in the study area. The geology and configuration of the top of the aquifer is shown in Plate 3, as determined by examination of well cuttings, cores and geophysical logs and by permeability testing of core samples. The top of the aquifer in the study area conforms most closely to the top of Oligocene sediments. Exceptions include areas such as the Dougherty Plain, where the Oligocene sediments have been removed by erosion, and the south-central part of the Apalachicola Embayment, where the lowermost Miocene limestones may be sufficiently permeable to form a portion of the aquifer.

The regional strike of the top of the Floridan aquifer system is southwest to northeast, but the direction of dip varies due to the presence of the Gulf Trough-Apalachicola Embayment. The top of the aquifer also varies in degree of dip, from a rate of 3.5 feet per mile southeast of the Apalachicola Embayment to 62 feet per mile on the south flank of the Gulf Trough. The subsurface relief of the top of the aquifer in the trough-embayment averages 350 feet, with a maximum of approximately 500 feet in the vicinity of southwestern Tift County.

Plate 4 shows the geology and configuration of the base of the Floridan aquifer system. This boundary is the base of the lowermost permeable limestone, as determined on the basis of well cuttings, cores, electric logs, and permeability tests. The lower confining unit varies in age and lithology, from the impermeable limestones of the upper Eocene in the Thomas-Brooks-southeastern Colquitt-southern Cook Counties area, to indurated sands of the middle Eocene southeast of the Gulf Trough.

Plate 5 shows the thickness of the Floridan aquifer system in the study area. At its thickest, near the central portion of the study area, the aquifer is 800-900 feet thick. The aquifer is thinnest in Screven and northern Effingham Counties where the Oligocene and upper Eocene limestones grade into clastic sediments. The aquifer is also thin in the Apalachicola Embayment and southwestern Gulf Trough, where impermeable limestones make up the lower portion of the Oligocene section.

The Gulf Trough-Apalachicola Embayment is an area of rapid and complex facies changes. The trough-embayment contains limestones of a deeper-water origin than those beyond the flanks of the feature (Huddlestun and others, in preparation). Thus, the flanks of the trough-embayment represent areas of rapid facies change. Additional facies changes mark the transition from the Apalachicola Embayment to the Gulf Trough, and also the northeastern termination of the Gulf Trough. The relationship of the Floridan aquifer system to the stratigraphic units in the study area is shown on Plate 1, using a series of stratigraphic columns keyed to various parts of the study area. Complete descriptions of these stratigraphic units can be found in Huddlestun and others (in preparation).

CLAIBORNE AQUIFER

The Claiborne aquifer extends into the western part of the study area (Figure 6), and it underlies the Floridan system in Mitchell, northern Worth, and extreme northwestern Colquitt Counties (McFadden and Perriello, 1983). The

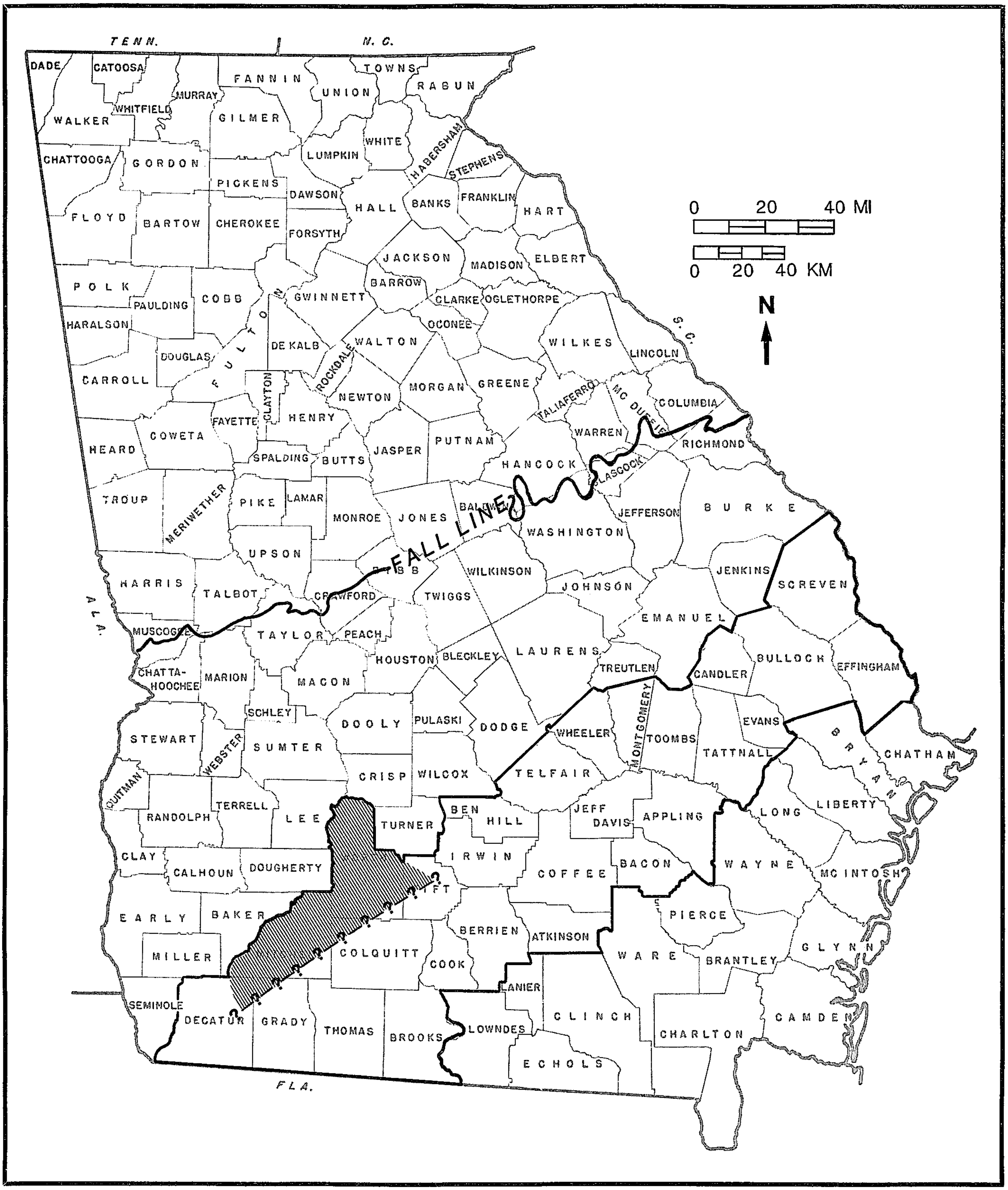

Figure 6. Approximate geographic extent of the Claiborne aquifer in the study area. Shaded area indicates aquifer. (After Arora, 1984.)

Claiborne aquifer is composed of Middle Eocene sands of the Tallahatta Formation in its updip portion, and in some areas it includes clastic sediments of the lower part of the overlying Lisbon Formation and the underlying Hatchetigbee Formation. The Claiborne is confined above by the clay-rich upper part of the Lisbon Formation. In the downdip region, where the Claiborne aquifer enters the study area, the distinctions between the Claiborne aquifer and the overlying Floridan aquifer system become less distinct due to facies changes in both aquifers. Although the Upper Eocene to Middle Eocene section is carbonate, the uppermost Claiborne sediments consist of relatively impermeable glauconitic limestones which serve to confine the Claiborne aquifer.

Recharge to the Claiborne aquifer is through its outcrop area in the northwestern part of the Coastal Plain and possibly through downward leakage from the Floridan aquifer system. Outside the study area, in the vicinity of Albany, declining head in the Claiborne aquifer may be causing such leakage (McFadden and Perriello, 1983). Potentiometric declines in the Albany area, and throughout the area occupied by the Claiborne aquifer, suggest that it is not a good candidate for extensive development in the study area.

CLAYTON AQUIFER

The Lower Paleocene Clayton aquifer extends into the study area in western Mitchell and northern Worth Counties (Figure 7). This aquifer underlies the Claiborne aquifer and is separated from it by a confining unit which consists of the Nanafalia Formation and the clay-rich upper Clayton Formation (McFadden and Perriello, 1983). The Clayton aquifer is made up of permeable limestone of the middle unit of the Clayton Formation. It locally includes permeable sands of the upper and lower parts of the Clayton Formation. The Clayton aquifer is confined below by clay layers in the lower Clayton Formation and upper Providence Sand. Recharge is by leakage from other aquifers and by infiltration in the area of outcrop. This aquifer has a relatively small outcrop area; thus recharge to it is limited (McFadden and Perriello, 1983).

The Clayton aquifer has been extensively developed in the area northwest of the Apalachicola Embayment. Large ground-water withdrawals, combined with the limited recharge to this aquifer, have resulted in dramatic head declines in the Clayton aquifer. Although a small portion of this aquifer extends into the study area, its future development potential is low. Because this aquifer underlies the more productive Floridan aquifer system, no wells tapping the Clayton exclusively are known in the study area.

CRETACEOUS AQUIFERS

The interbedded sands and clays of the Cretaceous stratigraphic units of the Coastal Plain form a number of aquifers and intervening confining units throughout the area. Pollard and Vorhis (1980) identified seven such Cretaceous aquifers in the Coastal Plain and designated them aquifers A_1 through A_7. These aquifers are rarely tapped in the study area, due to the ease of obtaining water from the shallower Floridan aquifer system.

Aquifer A_1 extends into Screven County, in the northeastern portion of the study area. In 1976, 1.5 million gallons of water were pumped from this aquifer for industrial use in Screven County (Pollard and Vorhis, 1980).

The Providence aquifer of southwestern Georgia, also called Aquifer A_2, is unconformably overlain by the Clayton Formation. It is composed of the the upper sand member of the Upper Cretaceous Providence Sand. Lithology of the aquifer is variable, ranging from a sand in the updip region to a coquina in the downdip region. The aquifer underlies a portion of Mitchell County, and the northern part of Worth County. Recharge to the Providence aquifer is through its area of outcrop. Discharge is to streams and also to the Clayton aquifer, through upward leakage. The declining head in the Clayton aquifer has increased the potential for such upward leakage.

Pollard and Vorhis (1980) also identified an aquifer, which they designated A_3 composed primarily of the Cretaceous Cusseta Sand. Where aquifer A_3 underlies the study area, it is not separated from the Providence aquifer (aquifer A_2) by a confining unit. Hence, Pollard and Vorhis called this aquifer $A_2C_2A_3$, also called the Providence-Cusseta aquifer. No wells are known in the study area which tap this aquifer exclusively.

The greatest development potential for the Cretaceous aquifers is north of the study area, in their updip regions, where they are closer to the surface and contain a greater percentage of sand. Due to the availability of water from the shallower Floridan aquifer system, the Cretaceous aquifers are rarely tapped in the study area. Northeast of the Gulf Trough, aquifer A_1 is used quite extensively, and the Providence aquifer is used in the vicinity of Albany and Americus. Potential for use of the Providence aquifer also exists in northern

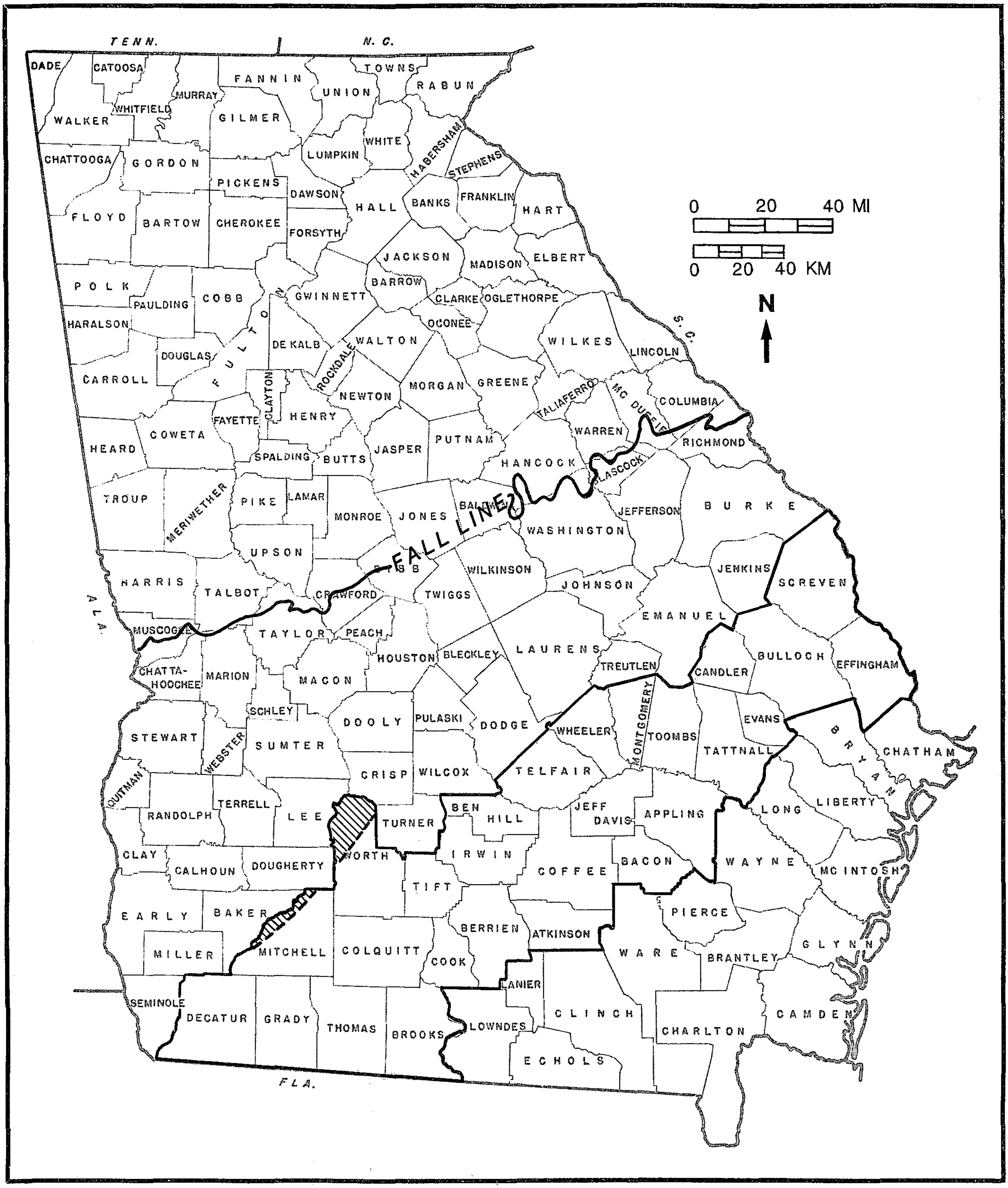

Figure 7. Approximate geographic extent of the Clayton aquifer in the study area. Shaded area indicates aquifer. (After Arora, 1984.)

Worth County. Although deeper Cretaceous aquifers cross the Gulf Trough study area, few wells are known which tap them exclusively, and development potential for these aquifers in the study area is quite low at present. The reader is referred to Pollard and Vorhis' (1980) study of the Cretaceous aquifers for a more complete treatment of their hydrology.

POTENTIOMETRIC TRENDS AND WATER USE

GENERAL

The potentiometric surface of a confined aquifer is an imaginary surface connecting the altitudes to which water will rise in tightly cased wells tapping the aquifer. Water rises in the wells due to hydraulic head. A potentiometric map is a contour map of this imaginary surface, constructed from water-level measurements made in wells completed in the aquifer. The varying altitudes on a potentiometric map represent hydraulic head values. The slope of the potentiometric surface is, therefore, the hydraulic gradient. Ground water flows downgradient, from areas of high hydraulic head to areas of low hydraulic head. Under isotropic conditions, flow directions are perpendicular to the potentiomentric contours, and for this reason, potentiometric maps reveal ground-water flow patterns.

POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER

Many factors influence the configuration of the potentiometric surface of a confined aquifer. Aquifer properties, recharge to the aquifer, and discharge from the aquifer interact to produce the ground-water conditions depicted by the potentiometric map. The potentiometric map of the Upper Floridan aquifer in Georgia shows highest head values at the northwestern limit of the aquifer, near its outcrop area (Figure 8). Head values generally decline southeastward, with the steepest hydraulic gradient perpendicular to the trend of the Gulf Trough. A "dome" or high area appears in the Brooks-Lowndes-Thomas-Cook Counties area. East of this high, the potentiometric surface is relatively flat, with head values declining eastward. This smooth eastward slope is broken by four significant lows in the potentiometric surface, caused by high water use at Savannah, Brunswick, St. Marys, and the Jesup-Doctortown area.

The physical properties of the aquifer, such as transmissivity and storage coefficient, can affect the steepness of the hydraulic gradient. For example, low transmissivity may produce a steep hydraulic gradient, visible on the potentiometric map as closely spaced contours. The potentiometric map of the Upper Floridan aquifer in Georgia illustrates this point (Figure 8). The highly permeable, locally cavernous limestones which make up the aquifer outside the Gulf Trough have very high transmissivity values, typically greater than 10,000 ft^2/d and commonly greater than 100,000 ft^2/d. The potentiomentric surface of the Floridan system in the Atkinson-southeastern Coffee-Bacon-Appling Counties area, where the Suwannee and Ocala Limestones form the bulk of the aquifer, is characterized by an extremely low hydraulic gradient. This contrasts with the northern Berrien-northwestern Coffee-northwestern Jeff Davis Counties area of the Gulf Trough, where the dense, micritic to dolomitic limestones of the trough have a much lower transmissivity, typically 10,000 ft^2/d or less. This is illustrated by the potentiometric contours, which are closely spaced across the trough. The Gulf Trough cannot be detected east of central Bulloch County. This is reflected by the potentiometric contours, which begin to diverge in this area.

Recharge to an aquifer and discharge from it also affect the configuration of the potentiometric surface. Recharge areas are characterized by high hydraulic head. On the potentiometric map, high head values can be observed in the Dougherty Plain, where recharge occurs by the direct infiltration of rainfall. Another recharge area appears as a potentiometric "dome" or high area in the vicinity of Lowndes, Brooks, eastern Thomas, and southern Cook Counties, where the upper confining unit is breached by numerous sinkholes and by the Withlacoochee River, allowing recharge to enter the system rapidly. Natural discharge from an aquifer occurs where a stream is in hydraulic connection with an aquifer and the hydraulic head of the stream is lower than that of the aquifer. The Floridan aquifer in the western portion of the study area discharges to the Flint River south of Albany.

Other types of natural discharge are possible. Leakage to other aquifers can occur, but it does not show on potentiometric maps because it is diffuse. This type of discharge can occur when an adjacent aquifer has suffered severe head declines as a result of pumping. Leakage between aquifers is sometimes apparent as an overall

EXPLANATION

——120—— **WATER-LEVEL CONTOUR – Shows altitude at which water level would have stood in tightly cased wells. Contour interval is 10 feet below 100-foot contour, 20 feet above 100- and below -60-foot contours. Datum is sea level. Contours based on 924 data points.**

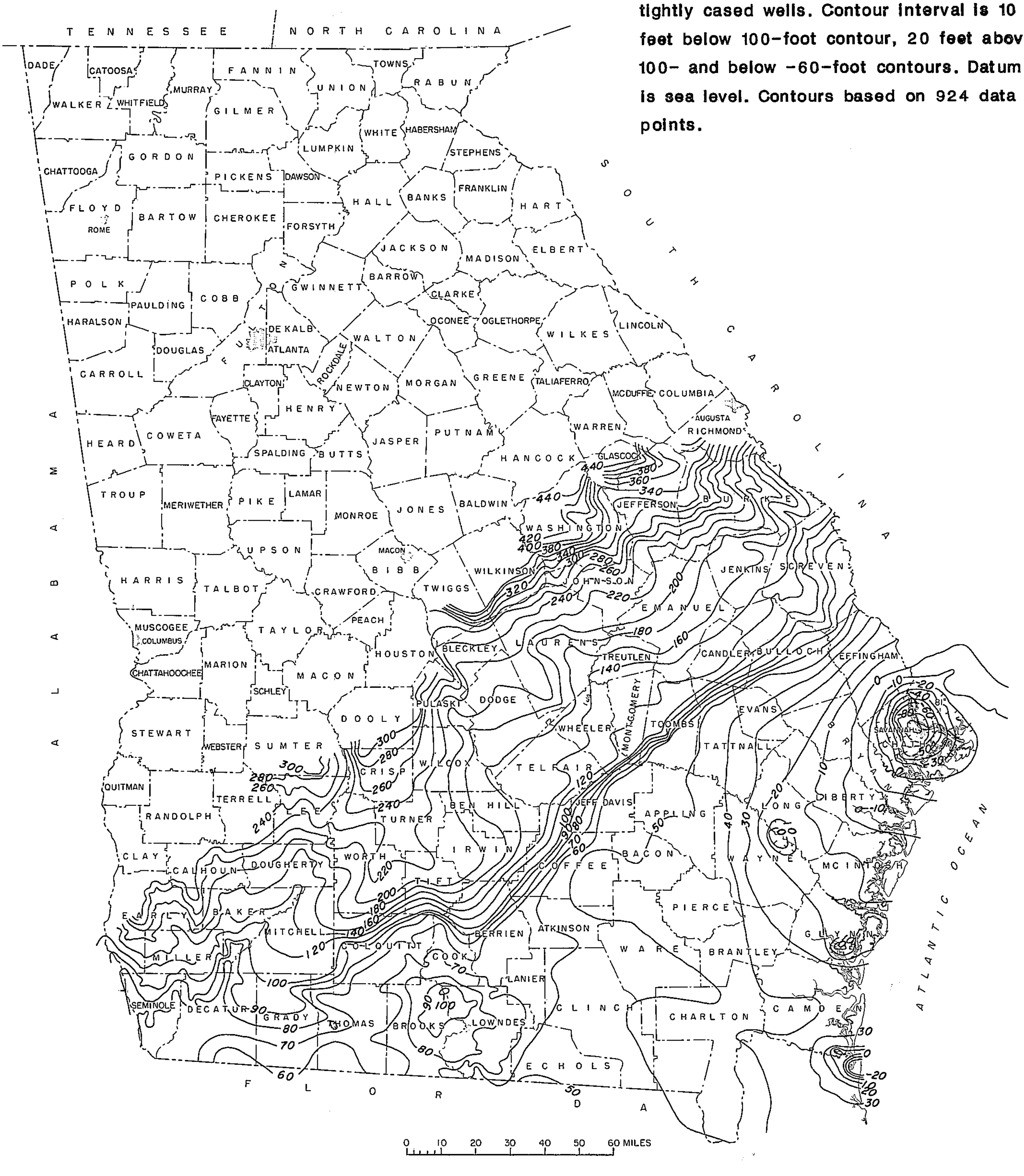

Figure 8. Water level in the Upper Floridan aquifer, May 1985 (Clarke, et. al., 1986).

lowering of head values over time in the affected area. Large quantities of water are also discharged offshore, beyond the scope of most potentiometric mapping.

Pumpage from wells is a major type of ground-water discharge. During 1980, pumpage from the Floridan aquifer system in Georgia totaled more than 600 million gallons per day (Krause and Hayes, 1981). Sustained pumpage from an aquifer can result in water levels lower than predevelopment levels. The May 1985 potentiometric map of the Upper Floridan aquifer system (Figure 8) shows several areas where the water levels have been lowered as a result of pumpage. The cities of Savannah and Brunswick, on the Georgia Coast, are areas of such water-level declines. The concentric, hatchured contour lines centered on these cities delineate a type of feature called a cone of depression. A cone of depression can be produced around any pumping well; however, extensive, sustained pumpage is required to produce a regional cone of depression, such as those shown.

POTENTIOMETRIC TRENDS

The potentiometric surface of an aquifer is not static. Climatic variations cause changes in the water levels in an aquifer, through changes in precipitation and infiltration rates, evapotranspiration rate, and stream stages. All of these factors influence the amount of water available for recharge to the aquifer. These climatic changes, in turn, produce dramatic variations in water levels through pumpage. Ground-water levels in the Floridan aquifer system in Georgia are generally lowest in the late fall following the driest months of the year, when evapotranspiration rates are high and agricultural withdrawals are heavy. Water levels are generally highest in spring, following late winter and spring rains coupled with low evapotranspiration rates. These short-term fluctuations in water levels are best observed by studying hydrographs, or graphic records, of water levels in a single well or stream over time.

Long-term fluctuations also occur in the potentiometric surface of aquifers, and these changes are magnified when the aquifer is developed. Long-term fluctuations in the potentiometric surface occur when there are prolonged changes in recharge, discharge, or flow paths, such as those produced by drought or by increased pumpage from wells. These long-term changes can be observed by studying hydrographs or by constructing water-level change maps.

In northeastern Ben Hill County, in the updip portion of the aquifer, the Upper Floridan is thinly confined and close to a recharge area. Figure 9a clearly shows the seasonal variation, with water-level highs produced by peak recharge in the late winter and spring and lows occuring in the summer and fall. The drought years of 1981 and 1986 produced record low water levels, but water-level recovery was rapid. Little water-level decline was observed in this well during the period of record (1972-1987). A similar pattern can be observed in the record from the Mitchell County well (Figure 9b), which is also thinly confined and close to a recharge area, the Dougherty Plain. This hydrograph shows the 1981 drought to have been locally more severe than that of 1986.

The hydrograph of the city of Sylvester well, in Worth County, shows subdued seasonal peaks (Figure 10a). The Floridan system is more thickly confined in this area, which contributes to this effect. The drought years of 1981 and 1986 are clearly indicated. This hydrograph suggests a greater long-term decline in the potentiometric surface in the Sylvester area than in the less-thickly-confined areas to the north and northeast. The Toombs County well (Figure 10b), near the city of Vidalia, experienced a steady potentiometric decline for the period of record (1974-1987), with a more severe decline during the drought of 1986. The subdued peaks of the curve show that this well is located in an area where the aquifer is thickly confined.

Other types of water-level fluctuations are possible, including those caused by pumping, by atmospheric pressure changes, and by aquifer loading (Hendry and Sproul, 1966). Pumping a well causes a drop in water level in that well and produces a cone of depression in the potentiomentric surface around the well. Other wells located inside the radius of influence of the pumping well will also show declines in water levels. Atmospheric pressure changes also cause water-level fluctuations. When atmospheric pressure decreases, water levels rise, and when atmospheric pressure increases, water levels drop. Aquifer loading can also cause changes in water levels, and may be responsible for a portion of the water-level rise noted after periods of increased rainfall. The sediments overlying a confined aquifer become saturated with water and exert increased pressure on the aquifer, thus raising water levels. Changes in water levels caused by atmospheric pressure changes and aquifer loading are are minor.

Water-level change maps show the net change

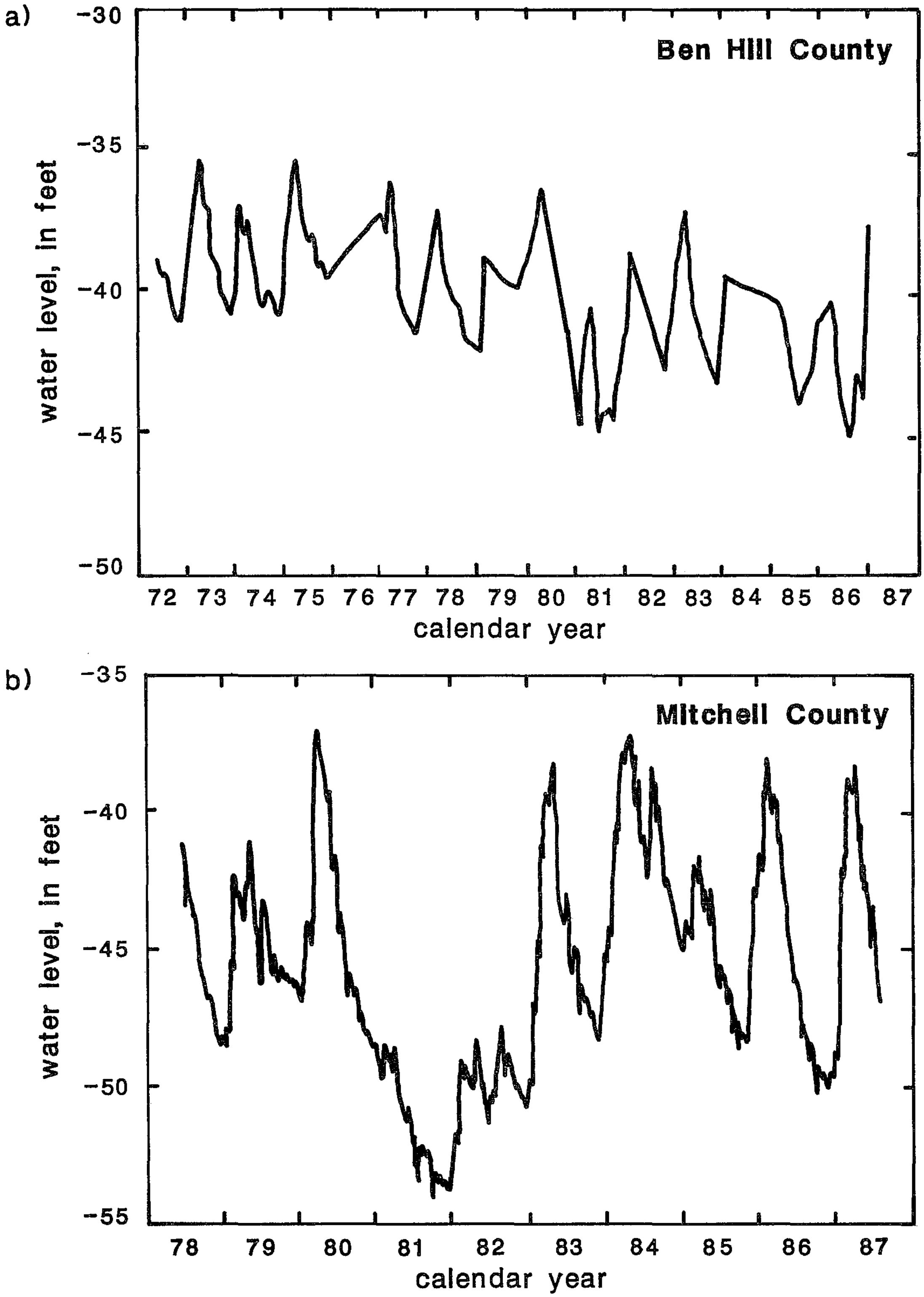

Figure 9. Water levels in Floridan aquifer wells. a). Trees Inc., northern Ben Hill County. b). Wright well, eastern Mitchell County.

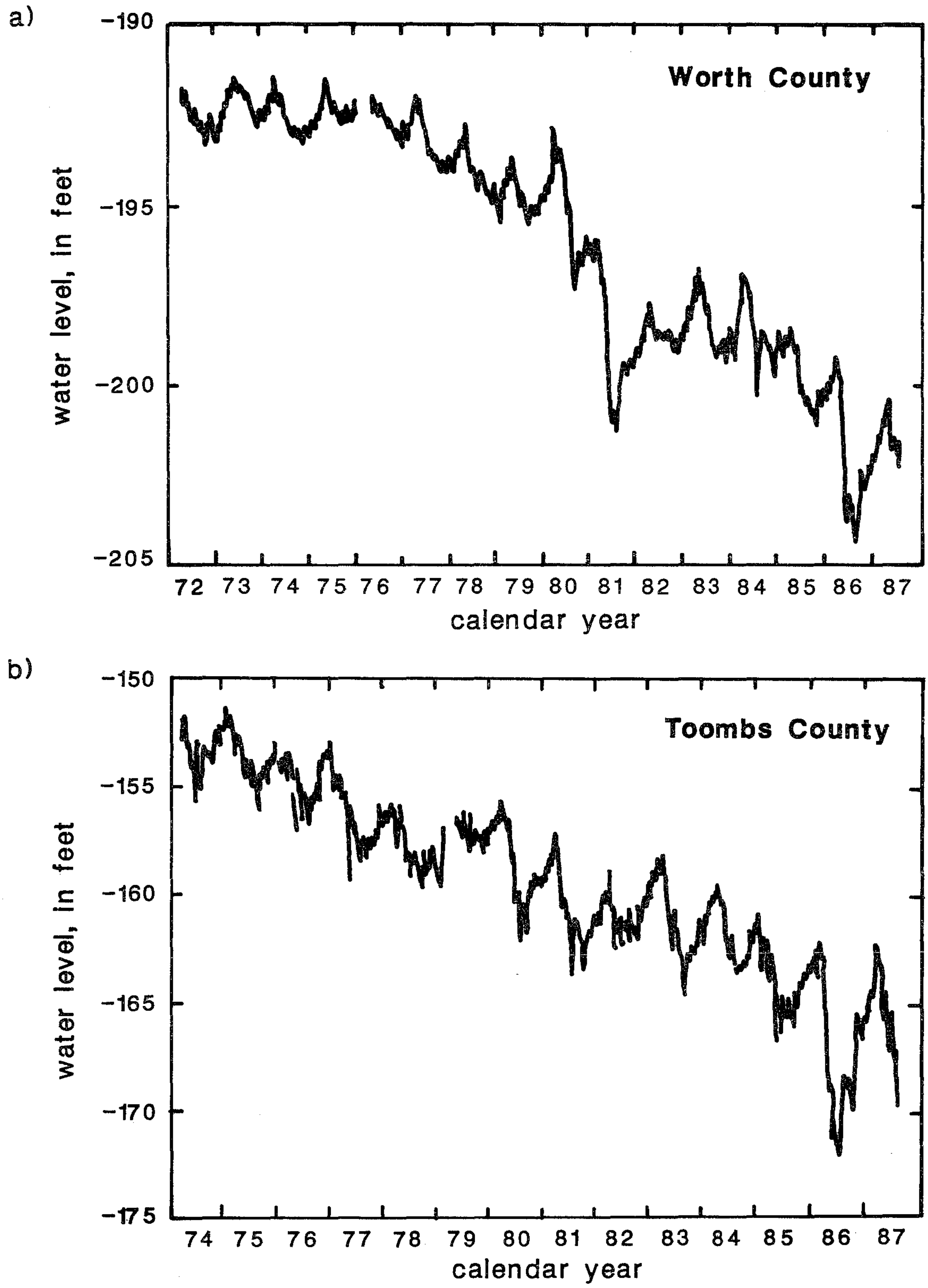

Figure 10. Water levels in Floridan aquifer wells. a). City of Sylvester, Worth County. b). City of Vidalia, Toombs County.

in water levels over large areas. Development of aquifers as water supplies produces changes in recharge and discharge relationships. Declines in water levels commonly result from large withdrawals of ground water. In the Floridan aquifer system, water levels over much of the Coastal Plain have declined (Figure 11). No decline is seen at the northwest extent of the aquifer near the outcrop area, and in the Brooks-Lowndes-Thomas-Cook Counties area, where the aquifer is recharged. The largest water-level declines appear at Savannah and in Wayne and Long Counties in the vicinity of Jesup and Doctortown. These declines are the result of large industrial withdrawals to supply the paper industries in these cities. Regional water-level declines resulting from these large withdrawals do not extend westward of the Gulf Trough, suggesting that the low transmissivity of the aquifer within the trough prevents the pumpage-produced pressure changes from extending further westward.

A comparison of the May 1980 (Krause and Hayes, 1981) and May 1985 (Bush and others, 1987) potentiometric maps of the upper permeable zone of the Floridan aquifer system (now called the upper Floridan aquifer) in Georgia shows that major water-level decline occurred in only one portion of the study area. The southwestern portion of the state, in and adjacent to the Dougherty Plain, showed a water-level decline of 10 to 30 feet. This decline was brought about by a combination of local drought conditions and resulting increased pumpage during this time.

WATER USE

Total reported ground-water use in the study area in 1985 was approximately 179.4 million gallons per day (Mgal/d) (Turlington and others, 1987). Most of this water was withdrawn from the Floridan aquifer system. Municipalities were once the main consumers of ground water in the Coastal Plain and still rely almost exclusively on wells to provide adequate water to meet public-supply needs. Agricultural withdrawals, however, account for an increasing percentage of ground-water use and in most counties have surpassed municipal use. Locally, industrial withdrawals form a growing segment of total ground-water use. Ground water is used for thermoelectric power generation in two counties of the study area.

The largest ground-water withdrawals in the study area are for agricultural purposes, including both irrigation and livestock use. Recent decades have seen phenomenal growth in the number of acres of irrigated farmland (Table 1, after Bachtel, 1987). With the advent in the seventies of sophisticated irrigation systems supplied by water wells, ground-water withdrawals have played an increasingly large role in crop irrigation. The largest agricultural withdrawals in 1985, an average of 32.94 million gallons per day (Mgal/d), were in Decatur County (Turlington and others, 1987). Four other counties reported agricultural withdrawals in excess of 5 Mgal/d: Mitchell, with 11.29 Mgal/d; Colquitt, with 7.54 Mgal/d; Tift, with 6.58 Mgal/d; and Screven, with 5.10 Mgal/d. Some of the withdrawals reported from Decatur and Mitchell Counties, which border the Dougherty Plain, may have been obtained from the Clayton or Claiborne aquifers. Total reported agricultural use in the study area in 1985 was 106.08 Mgal/d. These figures are average daily-use estimates which do not take into account the highly seasonal nature of irrigation withdrawals.

The city of Thomasville is the largest municipal user of ground water in the study area, withdrawing 4.51 million gallons per day for public supply purposes (Turlington and others, 1987). Three other cities in the study area reported withdrawals in excess of 3.00 Mgal/d. They were: Adel, with 3.71; Douglas, with 3.11; and Moultrie, with 3.08 Mgal/d. Total reported ground-water withdrawal for public supply in the study area for 1985 was 45.45 Mgal/d. Self-supplied domestic and commercial withdrawals locally form a large segment of county-wide ground-water use. Estimates of ground-water use in this category include all household water users not supplied by public water systems, as well as commercial users such as restaurants, hotels, stores and other businesses. These amounts also include withdrawals by military and recreational facilities, schools, hospitals, prisons, and other institutions (Turlington and other, 1987). Total withdrawals for these and other categories are presented in Table 2.

Industrial users locally account for significant ground-water withdrawals. Colquitt and Thomas Counties contain two of the largest population centers in the study area, and industrial withdrawals are correspondingly high. Significant withdrawals for industrial use in 1985 were reported for Colquitt County, 1.30 Mgal/d and Thomas County, 1.28 Mgal/d. Both Jeff Davis and Screven Counties have established textile industries which withdraw large quantities of ground water, 1.68 Mgal/d in Jeff Davis, and 1.36 Mgal/d in Screven County. Total industrial and mining use in 1985 was 9.78 Mgal/d. Thermoelectric power generation, a separate category of water

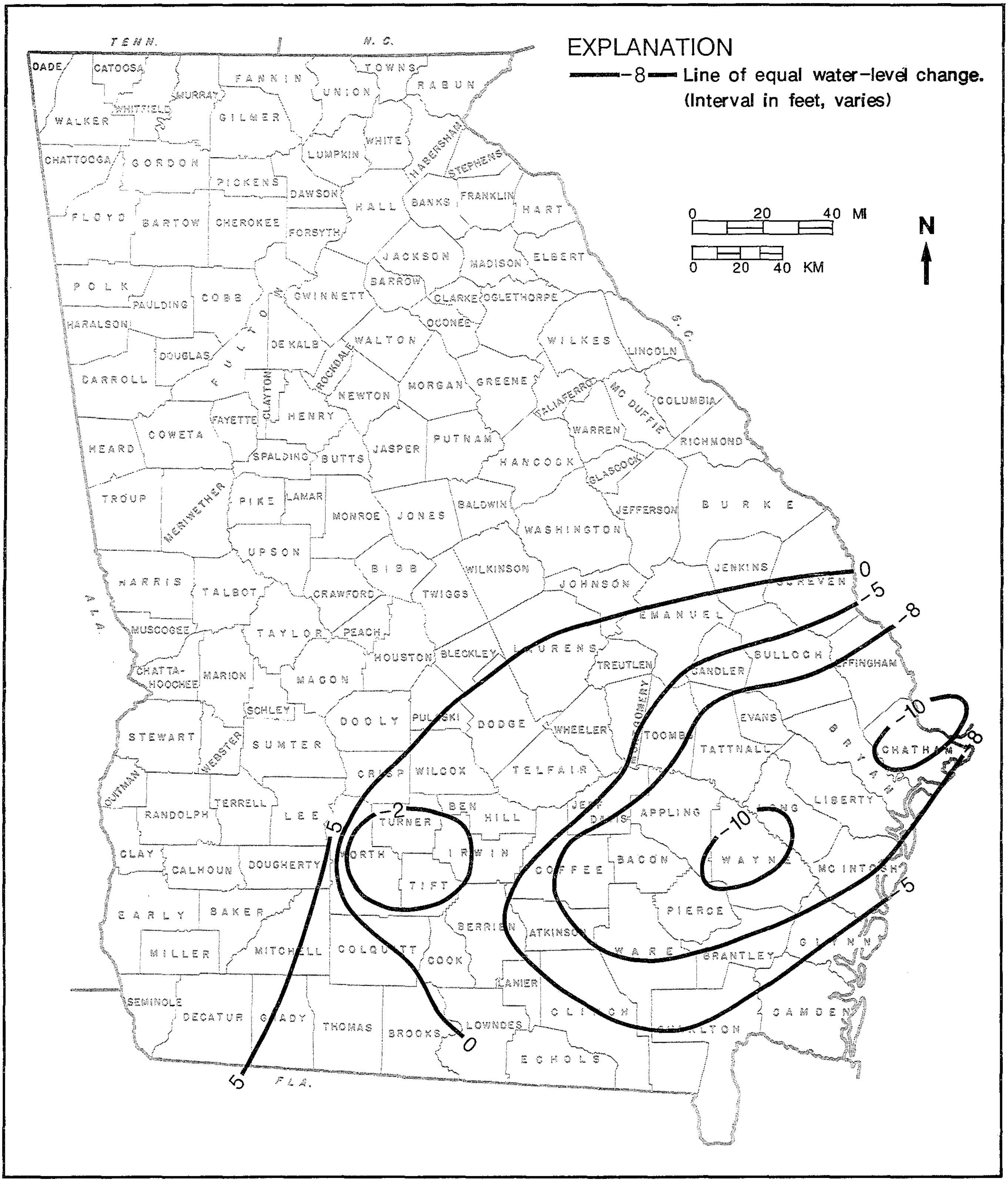

Figure 11. Water-level change, Floridan Aquifer System, 1969-78. (After Clarke et. al., 1978.)

Table 1. Number of acres irrigated, 1974 and 1984 (after Bachtel, 1987).

County	Year 1974	1984
Appling	609	3012
Atkinson	624	5365
Bacon	376	4475
Ben Hill	265	10625
Berrien	1904	11530
Brooks	1484	10056
Bulloch	559	14870
Candler	851	12010
Coffee	2430	21000
Colquitt	3623	28373
Cook	2074	8164
Decatur	9575	66872
Effingham	29	25885
Evans	564	2620
Grady	1840	12272
Irwin	1653	7034
Jeff Davis	217	19350
Mitchell	8353	54506
Montgomery	46	2341
Screven	276	14300
Tattnall	2246	7122
Telfair	406	10760
Thomas	632	7078
Tift	5262	39516
Toombs	1190	10149
Wheeler	147	2187
Worth	1363	19382

Table 2. **Water use in the study area, by county, in million gallons per day (Turlington and others, 1987).**

County	Public Supply	Domestic and Commercial	Industry and Mining	Agri-cultural	Thermo electric	Total
Appling	0.89	0.75	0.15	0.75	0.22	2.76
Atkinson	0.35	0.22	0.00	1.13	0.00	1.70
Bacon	0.56	0.41	0.48	1.01	0.00	2.46
Ben Hill	2.69	0.28	0.00	2.44	0.00	5.41
Berrien	0.36	0.51	0.71	3.87	0.00	5.45
Brooks	1.56	0.63	0.00	2.11	0.00	4.30
Bulloch	1.32	1.49	0.80	3.39	0.00	7.00
Candler	0.63	0.29	0.00	2.11	0.00	3.03
Coffee	3.51	0.93	0.00	4.52	0.00	8.96
Colquitt	3.65	0.65	1.30	7.54	0.00	13.14
Cook	3.84	0.45	0.00	1.13	0.00	5.42
Decatur	2.14	1.33	0.80	32.94	0.00	37.21
Effingham	0.73	1.08	0.00	0.44	0.27	2.52
Evans	0.45	0.22	0.72	0.21	0.00	1.60
Grady	2.17	0.90	0.08	1.57	0.00	4.72
Irwin	0.68	0.35	0.01	1.10	0.00	2.14
Jeff Davis	0.72	0.53	1.68	4.06	0.00	6.99
Mitchell	2.86	0.78	0.00	11.29	0.00	14.93
Montgomery	0.33	0.32	0.00	1.07	0.00	1.72
Screven	1.32	0.81	1.36	5.10	0.00	8.59
Tattnall	1.06	1.54	0.00	1.17	0.00	3.77
Telfair	1.54	0.27	0.16	3.47	0.00	5.44
Thomas	5.19	0.99	1.28	1.55	0.00	9.01
Tift	3.26	0.32	0.25	6.58	0.00	10.41
Toombs	2.16	0.58	0.00	1.59	0.00	4.33
Wheeler	0.23	0.18	0.00	0.56	0.00	0.97
Worth	1.25	0.79	0.00	3.38	0.00	5.42
Total	45.45	17.60	9.78	106.08	0.49	179.40

use, accounts for a portion of ground-water use in two counties in the study area. Total withdrawals for power generation in 1985 were 0.49 Mgal/d; 0.22 Mgal/d were reported from Appling County and 0.27 Mgal/d from Effingham County.

WELL CONSTRUCTION

Wells constructed in the Floridan aquifer system follow a fairly consistent pattern. The well is typically drilled to the top of the aquifer, usually the first major limestone unit encountered, and casing is installed. Drilling is then resumed; the aquifer is penetrated, and the bottom of the hole is left open. The massive limestones of the Floridan system require no well screens. The well is developed by pumping, airlift, or surging to remove drilling fluids, and a pump is installed. A diagram of the construction of a typical Floridan aquifer system well is shown in Figure 12. Within the Gulf Trough and Apalachicola Embayment, such construction methods may not produce a satisfactory well. Because the top of the Floridan aquifer system is deeper than normal, it may be necessary to geophysically log a well, or collect and examine well cuttings carefully, in order to ensure that the aquifer is actually penetrated. The lowermost Miocene unit in some areas within the the trough-embayment is a dense, massive limestone, which superficially resembles the limestone of the Floridan. The Miocene limestone is significantly less permeable than the Oligocene limestone which usually forms the top of the aquifer, but in most areas can be distinguished by the presence of sand in the Miocene limestone. For best yields, wells drilled in the vicinity of the Gulf Trough-Apalachicola Embayment should be completed in Oligocene and, where permeable, upper Eocene limestones. However, these limestones in the Gulf Trough and Apalachicola Embayment are, in general, less permeable than those outside. For this reason, it may be necessary to drill wells with a much longer open-hole interval, thus allowing flow into the borehole from a number of the most permeable zones, thereby maximizing yield. All of these factors may increase the cost of drilling wells in the vicinity of the trough-embayment.

Water quality may dictate well-construction practices in some parts of the study area. The lowermost Miocene sediments and uppermost portions of the Oligocene limestones may contain zones of naturally radioactive water which must be cased off if the well is to be used. This topic will be dealt with in greater detail in the water-quality section of this report.

GROUND WATER AVAILABILITY

GENERAL

The amount of ground water available from an aquifer is dependent on many interrelated factors, including the volume and hydraulic properties of the aquifer and the amount and distribution of recharge and discharge. In addition, the method of well construction can influence the ease with which water can be obtained from an aquifer. The Gulf Trough-Apalachicola Embayment has been noted as an area of reduced well yields from the Floridan aquifer system. A variety of theories have been advanced to explain this.

WELL CHARACTERISTICS AND AQUIFER PROPERTIES

In order to assess the availability of ground water from an aquifer it is necessary to attempt to quantify its hydraulic properties. Such properties include transmissivity, storage coefficient, and hydraulic conductivity. These quantities cannot be measured directly, but they can be derived using aquifer-test data and applying various formulae derived from Darcy's Law, a basic equation of ground-water flow. Well yields, which can be measured directly, are also useful for assessing ground-water availability; however, they are affected by factors other than those intrinsic to the aquifer. The locations of wells used to assess aquifer properties are displayed on Plate 6.

Specific capacity is a measure of the yield of a pumping well. It is the rate of ground-water withdrawal, expressed in gallons per minute, per unit of drawdown, expressed in feet (gpm/ft). The specific-capacity value of a well gives a rough estimate of ground-water availability, but reflects properties of the well in addition to properties of the aquifer. Factors which influence the efficiency of pumping wells, such as well diameter, degree of well development, and pumping rate affect the specific-capacity value. The length of open borehole or screen and the length of pumping time also affect specific capacity. When the specific-capacity value is divided by the length of open borehole, in feet, the result is an average yield per cross-sectional area of aquifer, known as the specific-capacity index. Specific-capacity indices can be compared more directly than specific capacity-values, but the indices do not allow for the varying efficiencies of wells of different construction. In fractured carbonate aquifers, specific capacity

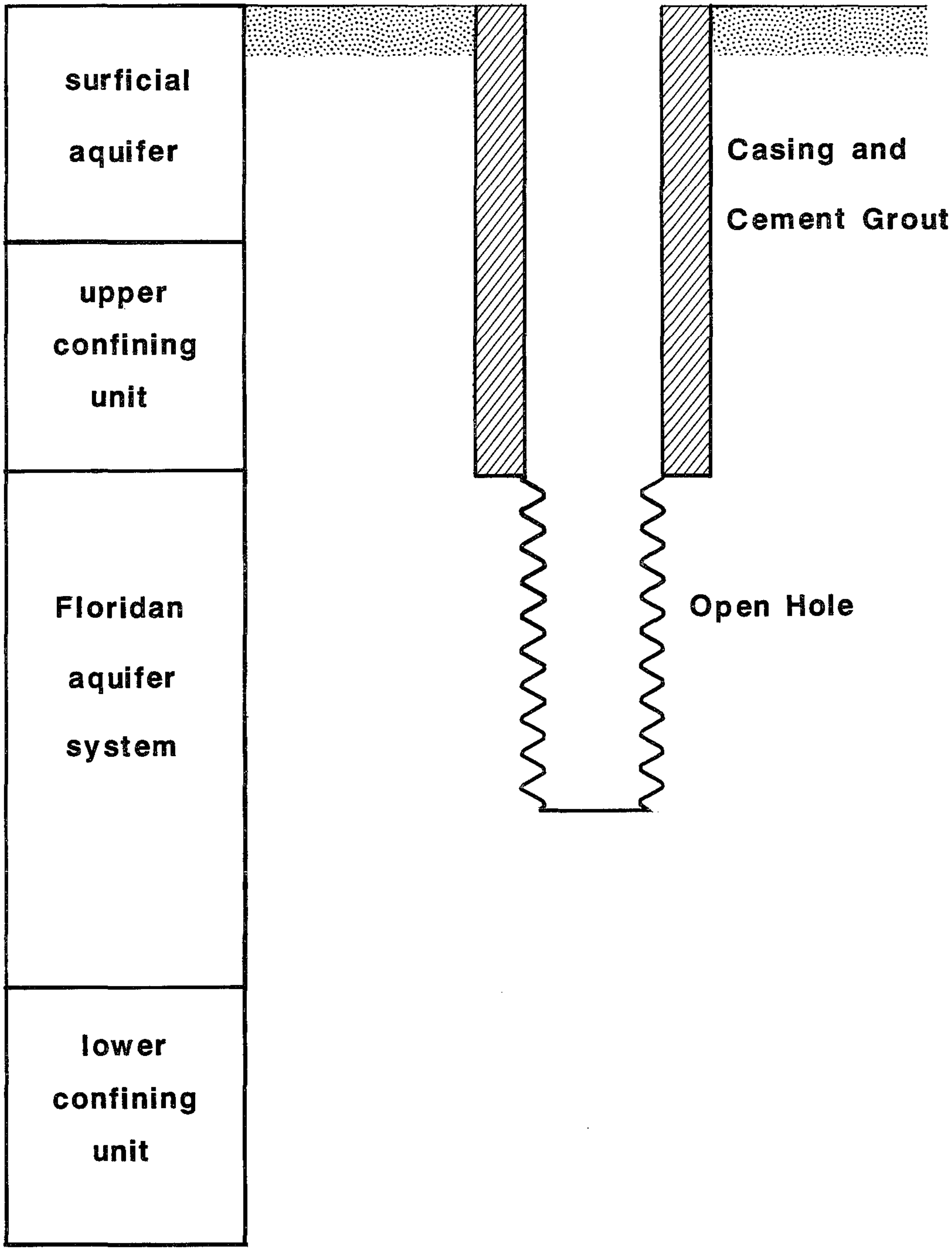

Figure 12. Typical well construction, Floridan aquifer system.

indices may be anomalously high.

Transmissivity (T) is a measure of the relative ease with which water moves through an aquifer. It is the rate at which water will move through a unit width of aquifer under a unit hydraulic gradient. Transmissivity is expressed in units of feet squared per day (ft^2/d). Transmissivity values reflect both the permeability of the aquifer and the thickness of the aquifer. Storage coefficient is the volume of water an aquifer releases from or takes into storage per unit surface area under a unit change in head. This dimensionless number is a measure of both the expandability of water and the compressability of the aquifer. The response of an aquifer to changes in the ground-water flow system is dependent in part on the storage coefficient and transmissivity.

Hydraulic conductivity is another relative measure of the permeability of an aquifer. It is the rate at which water moves through a unit area of aquifer under a unit hydraulic gradient, and it is expressed in feet per day (ft/d). The hydraulic conductivity (K) value is commonly obtained by dividing the transmissivity value by the thickness of the aquifer. This approach assumes that the transmissivity is homogeneous. Where this is not the case, the K value obtained represents an average value.

Specific Capacity

Although specific-capacity values are affected by the construction and development of a given well in addition to the physical properties of the aquifer, they are often useful as a gauge of the availability of ground water from an aquifer in a given area. Low specific-capacity values often indicate an area where aquifer permeability is reduced, making ground water difficult to obtain. The effects of differing well diameters and depths produce many exceptions to this general rule, however. Specific capacity values from the Floridan aquifer system in the study area are displayed on Plate 7. Examples of areas in the trough-embayment where wells exhibit low specific-capacity values include: the Hazelhurst area, in Jeff Davis County; the Lyons area, in Toombs County; and the vicinity of Meigs, in northern Thomas and southern Mitchell Counties. Northern Berrien County, in the vicinity of Enigma, is also characterized by low specific-capacity values, but data in this area are sparse. These areas may be contrasted with the city of Tifton, in Tift County, north of the Gulf Trough. Wells in the Tifton area have much higher specific capacity values than many wells within the trough-embayment, but allowances must be made for the much larger diameters of the Tifton city wells compared to those commonly drilled elsewhere in the study area.

Specific-Capacity Indices

In order to minimize the effect of varying well depths on specific-capacity values, specific-capacity indices were calculated. Like the specific-capacity values, the indices vary considerably, but generally they are lower in the the trough-embayment than outside it (Plate 8). Several observations can be made using specific-capacity indices which are not possible using specific-capacity values. The southwestern half of the study area, from Coffee County southwestward, exhibited generally higher specific-capacity indices than does the northeastern half. The specific-capacity indices in this area are also lower inside the trough-embayment than outside it. For example, in the Tift and Berrien Counties area, and southwestward, 17 of 22 wells with specific-capacity indices of 0.1 gallons per minute per square foot (gpm/ft^2) or less lie in the trough-embayment. This trend continues to the northeast, as far as and including Tattnall County. In this area, 39 of 45 wells with specific-capacity indices in excess of 0.1 gpm/ft^2 lie outside the Gulf Trough. The influence of the trough can be seen as far northeastward as Statesboro, in central Bulloch County. Wells on the north side of Statesboro have higher specific capacity indices than those on the south side, which lie near the probable terminus of the Gulf Trough.

Transmissivity

The range and distribution of estimated transmissivity values are shown on Plate 9. In the northeastern portion of the study area, from northern Berrien County to central Bulloch County, transmissivity values are lowest along the trend of the Gulf Trough. Low values also extend northward beyond the flank of the trough proper, into Wheeler, Montgomery, and southeastern Telfair Counties, and southward beyond the flank into Appling County. The southwestern part of the study area shows a more complex distribution of transmissivity values. Although low transmissivity values are observed within the trough-embayment, they also occur in scattered places to the north of the trough in Worth County and western Tift County. Low values are observed within the the trough-embayment as far southward as northern Grady and Thomas Counties, whereas the southern portions of these counties exhibit some of the highest estimated transmissivity values in the study area. The Cairo East-Side Water Plant well exhibits a transmissivity value of 430,000 ft²/d, probably a result of a large void encountered during drilling (Dan Wells, pers. comm.). On the southeastern side of the trough-embayment, high transmissivity values (100,000 ft²/d or greater) can be observed in southern Thomas, southern Cook and Berrien Counties, and central Coffee County.

Hydraulic Conductivity

The distribution and range of estimated hydraulic-conductivity values (Plate 10) in the study area is broadly similar to that of transmissivity values. The lowest values cluster along the trend of the trough-embayment. The highest values in the study area appear in the Dougherty Plain, along the northern edge of the Apalachicola Embayment and along the southern flank of the trough-embayment from central Coffee County southwestward into Berrien, Cook, and Thomas Counties. A Cairo city well within the embayment, in Grady County, has an estimated hydraulic conductivity value of 5800 ft/d.

RECHARGE

Recharge patterns are an important factor in ground-water availability. The Floridan aquifer system receives recharge from a variety of sources. One primary recharge area is the Dougherty Plain, where the upper Eocene Ocala Limestone crops out or is covered by a thin veneer of residuum. Topographic slopes in this area are low and infiltration rates high. Rainfall infiltrates the aquifer directly, at an estimated rate of 10 inches per year over an area of 4000 square miles (Bush, 1982). Limestones of the Floridan system also crop out northeast of the Dougherty Plain as far as Wilkinson and Laurens Counties, but recharge in this area is reduced by the smaller outcrop area and steeper topographic slope. Further to the northeast, Oligocene and Eocene rocks are primarily clastic in the outcrop area, but grade downdip into limestones. Recharge to the Floridan in this area is through the clastic Jacksonian aquifer (Vincent, 1982), which is continuous with, and stratigraphically equivalent to, a portion of the downdip carbonate Floridan aquifer system.

The upper confining unit of the Floridan is thin in the Brooks and Lowndes Counties area, and it is breached by numerous sinkholes as well as by the Withlacoochee River. Krause (1979) estimated that, on the average, the Withlacoochee River loses 112 cubic feet of water per second (ft³/s) to the aquifer. Sinkholes along the stream will accept all the water from the river when flow rates do not exceed 40 ft³/s.

A third important source of recharge to the Floridan aquifer system is diffuse leakage of water from overlying clastic sediments. Although clay layers of very low permeability separate the Floridan from these overlying sediments, small amounts of water are able to move across the confining layers and enter the aquifer. Areas where the potentiometric surface has been lowered by pumping of the aquifer are particularly subject to leakage of this type. The amount of water which crosses the confining layer in any given area is small, but taken over the entire extent of the aquifer, the amount of recharge by leakage is significant (Bush, 1982).

GROUND-WATER FLOW

The potentiometric map of the Floridan aquifer system shows the effects of the Gulf Trough on ground-water flow (Figure 8). Water entering the aquifer system northwest of the Gulf Trough flows laterally downgradient towards discharge points to the southeast. The hydraulic gradient north of the trough is fairly uniform, but it steepens abrubtly across the trough. The low-permeability limestones of the Gulf Trough exert a damming effect on ground water in the aquifer. Northeast of the Gulf Trough, in Bulloch County and northeastward, the direction of ground-water flow is southeast, under a uniform hydraulic gradient. Southeast of the Gulf Trough, ground-water flow is sluggish, despite the high transmissivity of the aquifer in this area (Bush, 1982).

Ground-water flow in the southwestern half of the study area shows a more complex pattern. Water entering the aquifer where it is unconfined and thinly confined in the Dougherty Plain area flows laterally downgradient both to the southeast and southwest. Water entering the aquifer in the recharge area near Valdosta flows downgradient in all directions, away from the potentiometric high. It is important to note that certain areas in and near the Apalachicola Embayment, such as the southern Cook and Berrien Counties area, receive ground-water flow from two directions, across the Gulf Trough from the north and from the Valdosta area in the south.

ANALYSIS OF GROUND-WATER AVAILABILITY

The availability of ground water from the

Floridan aquifer system in the study area is determined by a complex interaction of 1) the lithology of the rocks which compose the aquifer, 2) the morphology of the Gulf Trough and Apalachicola Embayment, and 3) the recharge, discharge, and flow relationships within the trough-embayment. These factors combine to reduce the permeability of the Floridan system in this area and hence affect the availability of ground water from the aquifer.

Lithologic Factors and Availability of Ground Water

The Gulf Trough and Apalachicola Embayment appear to have existed as bathymetric depressions from middle Eocene through early Miocene time. Because the trough and embayment were different environments, in terms of water depth and energy conditions, than the surrounding shallow shelf, stratigraphic units change in lithology as they cross the trough-embayment. The rocks which were deposited in the trough-embayment are fine-grained, relatively deep-water limestones (Huddlestun and others, in preparation) Permeability tests show these limestones to be lower in average primary premeability than those found outside. Some stratigraphic units are confined to the trough-embayment and show abrupt facies changes from rocks of the same age outside the trough. For example, the Lower Oligocene Ochlockonee Formation and its Pridgen Limestone Member are both relatively deep-water limestones and are confined to the trough or embayment, whereas the more permeable, shallow-water Bridgeboro Limestone occupies the flanks. A similar situation occurs in the Upper Eocene; the permeable, shallow-water Ocala Limestone is present outside the trough-embayment, and a dense, deeper-water limestone (undifferentiated Upper Eocene limestone) is present inside it.

Another possible cause of reduced permeability of the Floridan aquifer system in the trough-embayment may be the presence of small amounts of swelling clay within the limestone. Visual and microscopic examinations commonly do not reveal the presence of any clay. However, its presence is suggested by the fact that limestones in the trough, the Ochlockonee Limestone for example, often produce core samples which are longer than the coring run. For example, a fifteen-foot coring run may yield sixteen feet of core when removed from the core barrel. Also, during permeability testing, some newly saturated samples produce hydraulic conductivity values that decrease with time. Samples that are allowed to "rest" after saturation yield values that plot linearly. This effect is interpreted to be the result of swelling of clays during saturation.

Northeast of the Gulf Trough, in portions of Bulloch and Screven Counties, the Oligocene sediments contain a higher percentage of clastic material than do those to the southwest. The Oligocene section in Bulloch County may locally be represented by a sandy limestone or even a sand, and the Upper Eocene limestones grade laterally updip into clastic rocks of the Barnwell Group. The Floridan aquifer system in this area exhibits reduced permeability as a result.

Ground-water Flow Factors and Availability of Ground Water

All of the above factors relate, for the most part, to the primary permeability of the limestone. Secondary permeability is produced by dissolution of the limestone as ground water flows through joints, fractures, and other openings in the rock, and it is the major source of permeability in most limestone aquifers. Both the lithology of the limestones and the morphology of the Gulf Trough-Apalachicola Embayment may affect the secondary permeability of the Floridan aquifer system in the study area.

The development of secondary permeability in limestone aquifers follows a common pattern. Massive limestones, which may have little primary permeability, are prone to develop networks of joints, which then provide a path for ground-water flow. Dissolution of the limestone occurs along the joints. The degree to which dissolution occurs along a given ground-water flow path is dependant on the length of the flow path and the saturation of the water with respect to carbon dioxide. Short, shallow flow paths traversed by water relatively high in carbon dioxide concentration will undergo the most dissolution per unit volume of limestone. In this way, shallow flow zones are developed at the expense of the deeper flow zones (Rhoades and Sinacori, 1941).

Bush (1982), in his model of pre-development flow in the Tertiary (Floridan) aquifer system, showed that the greatest degree of secondary permeability was produced in the unconfined and thinly confined portions of the aquifer, where the most active flow was taking place. These areas had the greatest inflow and outflow of ground water, and hence experienced the greatest degree of dissolution.

The Floridan aquifer system within the study area conforms to the pattern of highest permeability in the unconfined or thinly confined areas. Permeability is low in areas such as the Gulf Trough, where the aquifer is overlain by a thick overburden. This is also true for the thickly confined Wheeler and Montgomery Counties area, for the Appling and Bacon Counties area within the Southeast Georgia Embayment, and for the thickly confined portions of the Apalachicola Embayment. The Apalachicola Embayment in Colquitt County is an example of thick overburden coupled with low permeability; however, thinly confined portions of the embayment show much higher permeability. This is true in southeastern Grady County, where thinner overburden and proximity to recharge from the Valdosta area produce a more active flow system. The southern Cook and Berrien Counties area receives ground-water flow from across the Gulf Trough as well as recharge from the Valdosta area. Transmissivity of the shallow zone of the Floridan system in this area reaches 360,000 ft^2/d, one of the highest values reported from the study area.

Development of secondary permeability, and, hence, the availability of ground water in the Gulf Trough and Apalachicola Embayment area is dependant on such lithologic factors as the density of the deep-water limestones in the area, their susceptibility to fractures, and possibly, the presence of swelling clays within the limestones. The morphology of the Gulf Trough and Apalachicola Embayment exerts a profound influence on ground-water availability by determining the thickness of sediments overlying the aquifer and by its effects on regional ground-water flow patterns.

GROUND-WATER QUALITY

GENERAL

All ground water is ultimately derived from precipitation. Precipitation contains almost no impurities; however, the soil and rocks which this water infiltrates contribute various chemical constituents to the water. The chemical species present in ground water, and their concentrations, reflect all of the chemical processes that have affected the water since it fell as precipitation. The elements present in the rocks along the flow path of the water, the solubility of the rocks, the pH of the water, and the sequence in which that water contacts the various minerals along its flow path, are some of the factors which will affect the chemical makeup of ground water (Freeze and Cherry, 1979). As water moves through the ground its chemical constituents and their concentrations may change. Ground water in a limestone aquifer typically becomes higher in dissolved solids and in pH with longer residence time.

The quality of ground water from the Floridan aquifer system in the study area is, in general, quite good. The Georgia Rules for Safe Drinking Water establish primary Maximum Contaminant Levels (MCLs) for potentially harmful substances in drinking water, and secondary MCLs for substances that affect the sight, taste, or smell of drinking water. Water from the majority of wells in the area falls below the specified MCLs. Elevated levels of sulfate, barium, and natural radioactivity are, however, associated with the Gulf Trough and Apalachicola Embayment, and reduce water quality in some areas.

Ground-water chemistry may be characterized by examining the abundance of the major cations, including calcium, magnesium, sodium, and potassium, and the major anions, including bicarbonate, sulfate, and chloride. The relative percentages of these ions in a water sample may be illustrated by using Piper diagrams (Piper, 1944). Plots of the concentration of the major ions (in milliequivalents per liter) are known as Stiff diagrams (Stiff, 1951).

GROUND-WATER QUALITY IN THE GULF TROUGH AND APALACHICOLA EMBAYMENT

The dominant anion in ground water from the Floridan aquifer is bicarbonate (Plate 11). Most of the samples which showed greater than 15 percent sulfate anions were from wells located in the Apalachicola Embayment. Cation percentages were more variable, but calcium was the most prevalent cation. Ground-water samples taken from near recharge areas typically contained a high ratio of calcium to other cations. Most of the samples which had significant percentages of sodium or potassium were taken from wells located in the Gulf Trough-Apalachicola Embayment.

Because ground water typically increases in dissolved solids content as it progresses downgradient through the flow system, dissolved-solids concentration is a useful indication of flow path length or residence time. Water from the Floridan aquifer system in the study area contains total dissolved solids (TDS) concentrations ranging from 26 milligrams per liter (mg/l) to 761 mg/l; however, most values fall between 130 and 250 mg/l. High TDS values are present within the Apalachicola Embayment in Grady County and in southern Colquitt County, where the thick overburden retards ground-water flow and increases residence time. Most TDS values reported for ground water from Thomas County are high, although some fall within the typical range of the study area. Slightly elevated values are reported for water from scattered wells in Brooks and Appling County, in the thickly confined Southeast Georgia Embayment. The Georgia Rules for Safe Drinking Water establish a secondary MCL of 500 mg/l dissolved solids. Elevated levels of sulfate, barium, and natural radioactivity have been reported from the study area. The close geographic association of such water-quality anomalies with the Gulf Trough and Apalachicola Embayment suggests a possible relationship.

SULFATE IN GROUND WATER

The secondary MCL for sulfate in drinking water has been established not to exceed 250 mg/l. Sulfate may produce a detectable taste at 300 to 400 mg/l, and at 500 mg/l it will produce a medicinal taste and, possibly, a laxative effect (Lehr and others, 1980).

Distribution of Sulfate

Elevated levels of sulfate have been reported from wells tapping the Floridan aquifer system in the Gulf Trough-Apalachicola Embayment area. Plate 13 shows the range and distribution of sulfate levels in the study area. Sulfate concentrations exceeding 100 mg/l are restricted to the Gulf Trough-Apalachicola Embayment, with the exception of water from one USGS test well in Cook County. A number of counties southeast of the trough-embayment contain wells that produce water with sulfate concentrations of 50 to 100 mg/l. They include Appling, Atkinson, Bacon, southern Berrien, Evans, and southern Tattnall Counties.

Sulfate levels vary widely with depth. For example, water samples from the USGS test well at Adel in Cook County, varied from 256 mg/l at a depth of 227 to 243 feet, to 610 mg/l at 452 to 468 feet (Grantham and Stokes, 1976). Nearby municipal wells in Adel do not exceed 400 feet in depth, and sulfate concentrations in water from these wells are less than 100 mg/l. Water samples from the USGS test well at Cairo, in Grady County, contained concentrations of sulfate that ranged from 5.6 mg/l to as high as 1000 mg/l, depending on the depth sampled (Grantham and Stokes, 1976). The lowest concentrations were from samples obtained from sediments overlying the Floridan aquifer, whereas the highest concentrations were from the base of the Floridan aquifer.

Source of Sulfate

The most common source of sulfate in ground water is gypsum. Within and southeast of the Apalachicola Embayment, the lowermost portions of the Floridan aquifer system contains significant amounts of interstitial gypsum. Southeast of the Apalachicola Embayment, the lower part of the Upper Eocene Ocala Limestone contains sufficient amounts of interstitial gypsum to exclude it from the aquifer.

The presence of the Gulf Trough and Apalachicola Embayment inhibits the development of secondary permeability in the lower parts of the Floridan aquifer system. Reduced permeability in turn inhibits the dissolution of gypsum and the removal of sulphate from the aquifer. Relatively high concentrations of gypsum thus remain in the aquifer matrix in its lower parts. Sluggish ground-water flow through these zones and correspondingly longer residence time contribute to the elevated levels of sulfate in ground water.

BARIUM IN GROUND WATER

The Georgia Environmental Protection Division samples water from public-supply systems for barium content. The majority of these analyses were conducted on treated water; however, barium concentrations are not affected by most types of water treatments. The established primary MCL for barium in drinking water is 1000 micrograms per liter (ug/l). Barium concentrations in ground water from the Floridan aquifer system are generally low. Most of the water samples analyzed between January 1976, and June 1982, had concentrations of barium that were at or below the 200 ug/l detection limit.

Distribution of Barium

Plate 14 shows the concentration of barium for those samples that exceeded the detection limit and also shows the total number of municipal water systems in each county whose samples fell below the detection limit for barium. The Floridan aquifer system is assumed to be the source for most public-supply systems in the study area; however, this could not be confirmed in all cases due to a lack of well construction data. Samples from specific wells known to tap the Floridan aquifer system are distinguished on the map from those taken from public-supply systems, which may use more than one well, or from wells of unknown construction.

Detectable concentrations of barium are generally restricted to wells north of the axis of the Gulf Trough-Apalachicola Embayment. Concentrations of barium in excess of the drinking water standards are found at Fitzgerald, in Ben Hill County (Plate 14). Fitzgerald municipal wells A, B, C, D, and E consistently produce water with barium concentrations in the range of 1300 to 2260 ug/l. Water samples from city wells F and G, which are shallower than wells A through E, contain concentrations at or below the detection limit. Shallow domestic wells tapping the Floridan system in the vicinity of Fitgerald also produce water with lower concentrations of barium, ranging from 250 to 350 ug/l. High barium concentrations thus appear to be confined to the lower portions of the aquifer. Water samples collected from discrete depth intervals in municipal wells C and E failed to pinpoint zones of barium concentration, possibly due to mixing of water in the borehole.

Source of Barium

The source of barium in the Fitzgerald area is not understood. Mineral sources of barium in ground water include such common minerals as barite and such rare ones as gorceixite (Milton and others, 1958; Michel and others, 1982). Barite is one of the most common barium-containing minerals; however, its solubility is such that water would typically be saturated with respect to barium at concentrations that fall below the limits of detection. The presence of sulfate, even at relatively moderate concentrations, will cause the precipitation of barite, thus removing barium from the ground water. Sulfate levels in ground water must be relatively low in order for levels of barium to reach detection limits. This most often occurs where bacterial activity removes sulfate from the ground water (Gilkeson and others, 1983) and may be the case in the Fitzgerald area. This study found no evidence of a causal relationship between elevated barium levels and the presence of the trough-embayment.

NATURAL RADIOACTIVITY IN GROUND WATER

Elevated activity of radioactive elements is closely associated with the Gulf Trough-Apalachicola Embayment. Several public-supply wells have yielded water that exceeds drinking water standards for natural radioactivity and have been plugged or reconstructed as a result. In other cases, water from affected and unaffected wells is combined in the municipal water system, and the mixed water then meets drinking water standards.

Radioactivity is a product of the unstable decay of a number of different naturally occurring radioactive isotopes. The Georgia Rules for Safe Drinking Water specify MCLs for several specific isotopes as well as for total particle activity. Within the study area, the only two parameters known to exceed the MCLs are gross alpha activity and Radium-226. All municipal water systems are tested for gross alpha activity, for which the MCL is 15 picocuries per liter (piC/l), excluding radon and uranium. Water samples which exceed 5 piC/l gross alpha activity are then tested for the combined level of Radium-226 and Radium-228. The MCL for this parameter is 5 piC/l. Radium-226 and 228 are of concern from a health standpoint because they can be ingested and can accumulate in the bones. The daughter products of the nuclides are short-lived alpha-emitters, which are particularly harmful to the body (Gilkeson and others, 1983).

Laboratory results indicate that Radium-226 is the dominant alpha emitter in the study area, and that Radium-228 activity is negligible. Because of the greater availability of data on gross alpha activity, and because the majority of that activity can be attributed to Radium-226, only gross alpha activity was mapped in this study.

Distribution of Radioactivity

Plate 15 shows the known values of gross alpha activity in the study area. Most of the values included are from samples collected from the distribution lines of municipal water systems. If a system uses multiple wells, the values often cannot be assigned to water from any particular well. Two types of map symbols are used to distinguish these values from those of water from specific wells. The majority of samples tested had gross alpha activities of 4 piC/l or less. Many of the samples that exceeded this level were taken from wells in the Gulf Trough or Apalachicola Embayment. The two areas that show the highest gross alpha activity are the Tift-Berrien Counties area, and the Wheeler-Montgomery Counties area. The occurrence of radioactivity in these areas indicates two separate patterns.

High gross alpha levels in ground water are associated with high gamma-ray activity. Gamma-ray logs of water wells can help identify zones which will produce water with high gross alpha levels. In the Wheeler-Montgomery Counties area, two distinct zones of gamma radiation can be identified on gamma-ray logs. The upper zone appears above the Floridan aquifer in the Miocene section, where it appears to be associated with voids in the limestone (John Fernstrom, EPD, personal communication). The lower zone of high gamma radiation is located at the top of the Floridan aquifer system. Several public supply wells in the area contained water which exceeded drinking water standards for radiation. The cities of Ailey, Alamo, Mount Vernon, and Tarrytown drilled new wells to replace those that yielded water with high radiation levels. The new wells were cased to greater depths in an attempt to exclude the radioactive zones. Most of these wells subsequently produced water which met standards, with one exception. The replacement well at Alamo was cased to four feet above the base of the gamma-ray anomaly. Water from the well met drinking water standards for five years before the radiation again exceeded standards. In 1987, a third well was drilled and logged, and casing was installed to a depth below the zones of radiation. This well now produces water free from significant amounts of radiation.

High radiation levels in ground water from the Tift and Berrien Counties area are restricted to wells that are in or near the Gulf Trough; however, high gross alpha activity is not found in all of the wells within the trough. Highest levels are found in the vicinity of Tifton, in Tift County, and Alapaha, in Berrien County.

The city of Tifton, on the north flank of the Gulf Trough, has removed municipal well 5 from production due to high radioactivity levels. The gamma log of this well shows large gamma anomalies at depths of 350 feet (cased), 495 feet, and 525 feet. The city replaced this well with municipal well 7, located 3400 feet to the northwest, farther from the trough. The gamma log of well 7 shows moderate gamma-ray activity at 190 feet (cased) and at 290 feet. The gross alpha activity of the water from this well is at or below background levels. Gross alpha activity of water from nearby municipal well number 4 has declined from 7 ± 2 piC/l to 4 ± 1 piC/l since well 5 was taken off line. The city of Alapaha, which lies in the Gulf Trough, has two production wells, both of which produce water with higher than normal amounts of radioactivity. Gamma-ray logs of these wells show high gamma-ray activity between depths of 380 and 400 feet. A test well (GGS 3555) was drilled, logged, and sampled in an attempt to develop a new well to supply water to the city of Alapaha. An inflatable packer was used to isolate and sample discrete depth intervals. The packer was set at depths of 360, 375, and 381 feet. Tests of water samples collected from beneath the packer for each of these depths indicated gross alpha activities of 12 ± 2, 12 ± 2, and 10 ± 2 piC/l, respectively. A gamma-ray log showed no discrete zones of high radiation. A nearby domestic well, located 800 feet to the east, produces water which meets drinking water standards, but this well is significantly shallower than the city of Alapaha test well. Although at the same land elevation, the domestic well is cased to 272 feet, while the test well is cased to 358 feet.

Assuming that both wells are cased to the top of the aquifer, this means that there is a significant amount of relief on the top of the aquifer. Logs of the city of Tifton municipal wells also indicate that the top of the aquifer is irregular, and wells number 4 and 5, which produce water with higher than normal gross alpha activity, are located in areas where the top of the aquifer is low. Drillers in the Berrien County area also report that high radioactivity seems to be associated with low areas of the top of the aquifer.

Source of Radioactivity

Radioactivity in the study area is dominated by the decay of Radium-226. Radium-226 is a part of the Uranium-238 decay series that follows, in order, Uranium-238, Thorium-234, Proactinium-234, Uranium-234, Thorium-230, and Radium-226. Radium-226 in turn decays to form Radon-222, and a succcession of short-lived daughter products. The activity levels of these isotopes vary. Some, like Uranium-238, have low alpha particle activity, while others, such as Radium-226, are shorter-lived and have high activity levels.

In order to define the controls on the occurrence of Radium-226 in ground water, it is necessary to determine the activity of the other isotopes in the decay series (Gilkeson and others, 1984). These data are not available for the study area; however, certain hypotheses can be made as to the source of the radioactivity.

Uranium-bearing minerals are the ultimate source of the Radium-226 in ground water in the study area. Elevated radioactivity levels are geographically widespread, indicating that the source of the parent isotopes is also widespread. The Miocene and younger sediments in the Coastal Plain contain clastic sediments derived from the crystalline rocks of the Piedmont, which contain uranium-bearing minerals such as monazite. Portions of the Miocene sediments in Georgia are rich in radioactive phosphate minerals, which contain inclusions of Piedmont-derived quartz, microcline, and opaque minerals. Additionally, the dark phosphate pellets contain pyrite and carbonaceous organic matter (Simmons, 1968). Uranium is soluble under oxidizing conditions and precipitates under reducing conditions. Uranium was incorporated in the phosphate minerals due to the reducing conditions produced by the decay of organic matter and the presence of pyrite. Under proper conditions the uranium contained in these minerals can be leached and can enter the ground water.

Typically, ground water in recharge areas is oxidizing and has relatively high levels of uranium, which has a low activity level (Korosy, 1984). As ground water enters reducing conditions, the uranium is deposited on the aquifer matrix, lowering concentrations of uranium in ground water. The uranium then decays, producing daughter products with high activity levels, such as Radium-226. Through the alpha recoil process, the Radium-226 is thrown off the aquifer matrix, and it enters the ground water (Gilkeson and others, 1983).

Reducing conditions in an aquifer can be produced where ground-water flow is sluggish, or where reducing agents such as pyrite or organic matter are present in the aquifer. The Gulf Trough and Apalachicola Embayment provide these conditions. The thick sediments overlying the Floridan aquifer system in the Gulf Trough and parts of the Apalachicola Embayment retard the inflow of oxygen-rich water. In addition, the limestones which comprise the Floridan system in the trough and embayment are less permeable and contain more pyrite than their counterparts outside the feature. Finally, the top of the Oligocene section was exposed and eroded. The paleo-karst developed on this surface trapped fine-grained sediments, rich in organic debris.

High radioactivity levels follow the trend of the Gulf Trough and Apalachicola Embayment, appearing most often in water from the lower Miocene section and the upper portion of the Floridan aquifer system. It is probable that reducing conditions produced in the Lower Miocene sediments and the Oligocene limestones of the Floridan system caused the precipitation of uranium on the aquifer matrix and overlying sediments. The Floridan aquifer system in the Wheeler-Montgomery-Toombs Counties area, though outside the Gulf Trough, is thickly confined and its upper surface karstic and irregular. Therefore, it would also provide the reducing conditions necessary for the precipitation of uranium. Radioactive decay of the uranium would then contribute Radium-226 to the ground water.

Gilkeson and others (1984) and Michel and others (1982) demonstrated the importance of analyzing data on all isotopes in the decay series in order to develop a comprehensive model of the distribution of radioactivity in ground water. Thus, further delineation of the controls on the occurrence of Radium-226 will require more data on the distribution of the parent and daughter isotopes. However, the available information is useful in understanding the mechanism by which Radium-226 enters the ground water, and in identifying areas where high levels of natural radioactivity are likely to be encountered.

SUMMARY

The hydrogeology of the study area is dominated by the presence of a subsurface geologic feature known as the Apalachicola Embayment and by its narrow, northeastward extension, the Gulf Trough. The Gulf Trough-Apalachicola Embayment extends, in Georgia, from the extreme southwest corner of the State northeastward to central Bulloch County. The feature is sinuous and trough-shaped, widest at the southwest and narrowing northeastward. It was produced by a marine current, the Suwannee Current, which was active in the study area from the middle Eocene through the early Oligocene. This current flowed northeastward from the Gulf of Mexico to the Atlantic, inhibiting sedimentation in the Apalachicola Embayment and Gulf Trough during the late Eocene. Rising sea level during the late Oligocene and Miocene caused the cessation of the current. Filling of the trough-embayment occurred during the Oligocene and early Miocene (Aquitanian).The Suwannee Current controlled sedimentation in the trough-embayment from late Eocene through early Miocene. The Gulf Trough and Apalachicola Embayment are characterized by dense, low-permeability, deeper-water limestones. Upper Eocene sediments in the trough-embayment are uncharacteristically thin, whereas those on the north and south flanks are much thicker. Oligocene sediments thicken as they cross the trough-embayment, as do the lower Miocene sediments.

The Floridan aquifer system is the most widely used aquifer in the Coastal Plain of Georgia. It is composed of a thick sequence of permeable limestones, ranging in age from Paleocene to early Miocene. The Floridan aquifer system in its updip region is composed of a single permeable zone, whereas downdip one of several regional middle confining units divides the system into an Upper and a Lower Floridan aquifer. The lower confining unit of the system is highly variable in age and lithology. Throughout most of its extent in Georgia, the aquifer is confined above by clastic and carbonate rocks, mostly Miocene in age. Locally, the upper confining unit has been breached by sinkholes or streams, and in some areas it has been removed entirely by erosion. Thus, water in the Floridan aquifer system may be under semiconfined or unconfined conditions in these areas.

The Floridan aquifer system in the study area yields ground water for agricultural, domestic, municipal, and industrial uses. Total water use in the study area in 1985 was 179.4 Mgal/d. Dramatic increases in ground-water withdrawals for irrigation in recent years have produced water-level declines in some areas; nevertheless, the Floridan aquifer system continues to yield adequate quantities of water to support these withdrawals.

Within the Gulf Trough and parts of the Apalachicola Embayment, the availability of ground water from the Floridan aquifer system is less than in surrounding areas. The permeability of the aquifer is reduced by a combination of factors: the low primary permeability of the deeper-water limestones of the trough-embayment; the greater thickness of overburden which limits development of secondary permeability, and possibly, a lack of joints or fractures to enhance movement of ground water. Certain areas within the Apalachicola Embayment and along its south flank are exceptions to this trend, however. The contact between the Miocene and Oligocene sediments in these areas is a zone of enhanced secondary permeability, capable of supplying large quantities of water to wells.

The quality of ground water from the Floridan aquifer system is reduced in certain parts of the study area. Elevated levels of sulfate, barium, and natural radioactivity are associated with the Gulf Trough and Apalachicola Embayment. High levels of sulfate are reported from the trough-embayment and from the Colquitt-Thomas-Grady Counties area. The most probable source of sulfate in ground water from the Floridan aquifer system in and southeast of the trough-embayment is interstitial gypsum contained in the limestones of the system. The sluggish ground-water flow through the lower parts of the aquifer system has inhibited the dissolution of gypsum and the removal of sulphate from the aquifer. The long residence time of ground water in these lower parts produces high concentrations of sulphate.

Elevated levels of barium in ground water from the Floridan aquifer system are reported from the vicinity of Fitzgerald in Ben Hill County. The source of the barium is not understood. High levels of barium in ground water are usually the result of bacterial activity which lowers the concentration of sulfate in the water. This prevents the precipitation of barite and allows the concentration of barium in ground water to rise. Bacterial activity may be the cause of elevated barium concentrations in the Fitzgerald area.

High levels of natural radioactivity are also associated with the Gulf Trough and Apalachicola Embayment. The highest levels are found in the Wheeler-Montgomery Counties area, and in the Tift-Berrien Counties area, but elevated radioactivity levels are reported from water samples at other locations throughout the trough and embayment. The ultimate source of radioactivity in the ground water from this area is Uranium-238, probably derived from natural sources in or near the study area. The crystalline rocks of the Piedmont Province contain such uranium-bearing minerals as monazite, which were weathered and transported into the Coastal Plain. Also, the phosphate minerals of the Miocene sediments incorporate uranium in their crystal structure, and, hence, are another potential source. Uranium is soluble under oxidizing conditions and precipitates under reducing conditions. Oxidizing waters in recharge areas dissolve uranium from these sources and transport it until reducing conditions are encountered. Uranium is then deposited on the aquifer matrix. Reducing conditions are provided by the limestones of the trough-embayment because of their pyrite content and thick overburden. Paleo-sinkholes could also have provided reducing conditions, due to the decay of trapped organic matter. Through decay of the uranium, Radium 226 is thrown off the aquifer matrix and carried in ground water.

RECOMMENDATIONS

The following recommendations are intended to provide suggestions for maximizing water quality and yield for wells in the study area.

1) Wells should be located as far from the axis of the Gulf Trough and Apalachicola Embayment as possible, in areas with the thinnest overburden.

2) Whenever practical, wells should be geophysically logged to locate permeable zones and facilitate design of efficient wells.

3) Water samples should be collected from wells drilled in the areas of high radioactivity (Figure 13). These samples should be analyzed for gross alpha levels.

4) Municipalities located in the area of high radioactivity should run gamma-ray logs of new wells so that radioactive zones may be cased.

5) Municipalities which already have wells producing radioactive water may wish to consider drilling small-diameter test wells when choosing sites for new wells. These wells could be drilled at less expense than large-diameter wells, and could then be enlarged if conditions were found to be favorable.

6) The Miocene sediments in the Gulf Trough and Apalachicola Embayment area should be investigated as an alternative source of groundwater supply.

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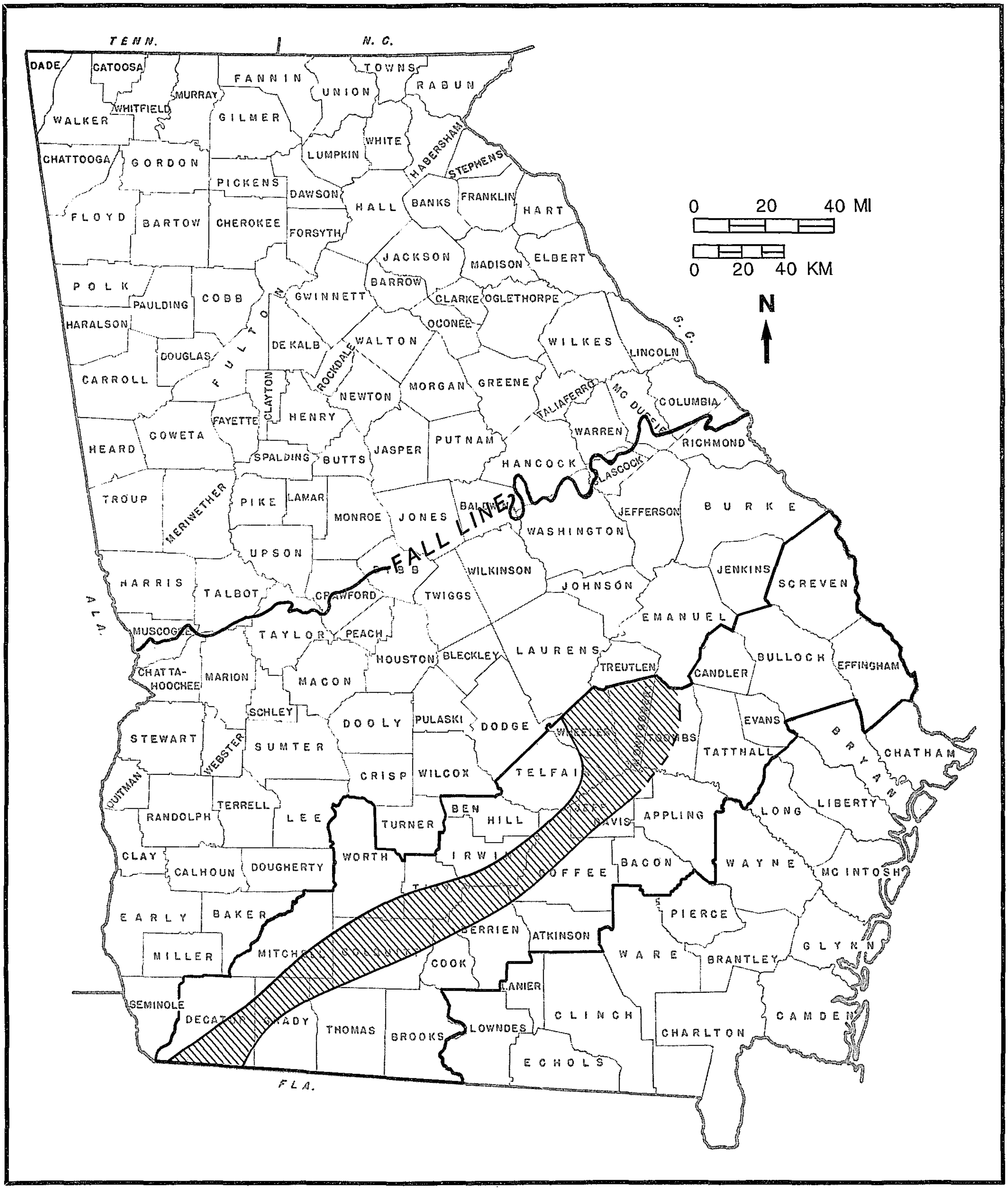

Figure 13. Areas at greatest risk for elevated levels of natural radioactivity in ground water.

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APPENDICES

APPENDIX A: DEPTH TO THE TOP AND BOTTOM OF THE FLORIDAN AQUIFER

WELL NUMBER	LAND SURFACE ELEVATION (FEET)	DEPTH TO TOP OF AQUIFER (FEET)	DEPTH TO BOTTOM OF AQUIFER (FEET)	USED ON BASE OF AQUIFER MAP	USED ON ISOPACH MAP
** APPLING					
50	204	515	b 840	B	I
148	225	520	1325	B	I
161	242e	550	b 640	B	
1059	203	b 520			
1701	144	610			
28L005	130	540			
** ATKINSON					
107	214	260	780	B	I
410	295	274	b 425	B	I
425	199	290	b 460	B	I
918	243	270	b 445	B	I
1548	171	340	b 380		
1549	189	270	b 300		
1557	206	290	b 360		
1714	193	300	b 330		
1715	195	270	b 335		
1716	212	310	b 350		
1717	150	350	b 390		
1848	164	340	b 420		
1855	154	360	b 370		
1877	166	360	b 400		
2122	186	350	b 430		
2164	162	360	b 410		
** BACON					
58	201	450	b 625	B	I
** BEN HILL					
154	353	256	b 739	B	I
160	355	260	b 380	B	I
355	363	243	b 295		
1738	359	260	b 410	B	I
1830	368	240	b 310		
1832	354	240	b 370	B	I
1838	248	130	b 232	B	I
1842	335	200	b 310	B	I
1858	362	260	b 382	B	I
1863	372	210	b 215		
1867	352	264	b 330		
1868	365	180	b 240		

APPENDIX A: DEPTH TO THE TOP AND BOTTOM OF THE FLORIDAN AQUIFER (CONTINUED)

WELL NUMBER	LAND SURFACE ELEVATION (FEET)	DEPTH TO TOP OF AQUIFER (FEET)	DEPTH TO BOTTOM OF AQUIFER (FEET)	USED ON BASE OF AQUIFER MAP	USED ON ISOPACH MAP
1869	378	190	b 270		
1872	334	230	b 240	B	I
1883	350	270	b 368		
1884	356	300	b 410	B	I
1898	335	240	b 706	B	I
2111	260	130	b 218		
3037	197	100	b 390	B	I
** BERRIEN					
159	250	b 317			
1368	291	380	b 550	B	I
1815	235	260	b 485	B	I
1843	244	270	b 298		
1856	249	270	b 290		
1860	243	260	b 285		
1875	215	320	b 350		
1881	272	a 300	b 335		
1960	210	240	b 300		
2039	307	440	b 575	B	I
2040	220	250	b 278		
2049	214	230	b 310		
2082	308		b 500		
2083	217	230	b 320		
2104	226	270	b 320		
2105	222	240	b 340		
2128	216	420	b 430		
2146	223	275	b 350		
2167	220	230	b 244		
3542	320	604	1016	B	I
3555	278	440	b 540		
** BROOKS					
3	165	60	b 200	B	I
21	195	175	b 310	B	I
77	200	120	b 160		
87	245	b 220			
469	210	150	b 304	B	I
723	191	210	b 240		
759	235	110	b 231	B	I
840	189	105	b 205		
846	219	175	b 296	B	I
888	150	100	b 200		
889	184	120	b 156		

APPENDIX A: DEPTH TO THE TOP AND BOTTOM OF THE FLORIDAN AQUIFER (CONTINUED)

WELL NUMBER	LAND SURFACE ELEVATION (FEET)	DEPTH TO TOP OF AQUIFER (FEET)	DEPTH TO BOTTOM OF AQUIFER (FEET)	USED ON BASE OF AQUIFER MAP	USED ON ISOPACH MAP
892	212	190	b 240		
893	228	150	b 250		
894	127	90	b 190		
895	228	120	b 240	B	I
896	223	100	b 200		
897	205	160	b 250		
898	127	100	b 209	B	I
899	219	90	b 220	B	I
900	201	100	b 186		
901	225	110	b 210		
902	218	120	b 226	B	I
911	215	170	b 218		
912	155	80	b 200	B	I
1005	213	190	b 230		
1006	183	120	b 220		
1106	185	115	b 205		
1387	235	150	b 300	B	I
1390	165	100	b 180		
1436	185	90	b 182		
3189	220	143	b 335	B	I
3208	160	a 61			
3209	200	a 223	627	B	I
3211	260	a 186	472	B	I
** BULLOCH					
81	162	300	430	B	I
378	223	365	585	B	I
393	193	475	b 577	B	I
430	305	348	b 456	B	I
432	185	380	b 460		
439	241	470	b 560		
553	155	310	b 515	B	I
571	290	383	505	B	I
576	252	351	b 450		
580	228	363	b 512	B	I
586	230	360	b 410		
666	222	330	b 670	B	I
929	242	286	b 360		
1044	190	334	524	B	I
1707	187	450	b 520		
1709	215	430	b 480		
3210	200	302	556	B	I
3520	198	270	605	B	I

APPENDIX A: DEPTH TO THE TOP AND BOTTOM OF THE FLORIDAN AQUIFER (CONTINUED)

WELL NUMBER	LAND SURFACE ELEVATION (FEET)	DEPTH TO TOP OF AQUIFER (FEET)	DEPTH TO BOTTOM OF AQUIFER (FEET)	USED ON BASE OF AQUIFER MAP	USED ON ISOPACH MAP
3522	118	450	770	B	I
** CANDLER					
429	193e	320	b 577	B	I
574	255	345	b 471	B	I
575	218	413	b 533	B	I
581	273	296	b 430	B	I
582	285	389	b 450		
591	215	327	b 450	B	I
592	249	307	b 450	B	I
636	278	329	b 371		
740	230	327	b 431	B	I
963	232	524	b 635	B	I
1702	268	440	b 530		
** COFFEE					
434	198e	400	b 600	B	I
445	165	290	1010	B	I
446	270	495	1085	B	I
468	312	530	1250	B	I
508	265	540	1350	B	I
509	309	520	1370	B	I
510	280	440	1280	B	I
1538	257	b 400			
1825	315	620	b1120	B	I
3033	215	340	b 600	B	I
3034	200	290	b 600	B	I
3041	251	400	b 650	B	I
3127	275	a 420	1300	B	I
3541	290	567	b1026	B	I
** COLQUITT					
170	287	470	820	B	I
175	317	460	640	B	I
188	282	245	570	B	I
688	330	b 523		B	
767	312	415	b 555		I
785	280	210	b 267		
786	266	165	b 254	B	
848	282	350	b 485	B	I
870	238	400	b 500		
877	352	515	b 850	B	I
1018	235	145	b 155		

APPENDIX A: DEPTH TO THE TOP AND BOTTOM OF THE FLORIDAN AQUIFER (CONTINUED)

WELL NUMBER	LAND SURFACE ELEVATION (FEET)	DEPTH TO TOP OF AQUIFER (FEET)	DEPTH TO BOTTOM OF AQUIFER (FEET)	USED ON BASE OF AQUIFER MAP	USED ON ISOPACH MAP
1242	279	240	b 270		
1243	365	290	b 300		
1246	291	440	b 495		
1248	310	430			
1256	299	450	b 545		
1260	305	440	b 560	B	I
1268	305	460	b 540		
1416	270	270	b 300		
1419	307	475			
1455	355	280	b 380		
1467	290	440	b 500		
1614	330	480	b 530		
1617	355	460	b 620	B	I
1620	328	280	b 365		
1649	328	440	b 540		
1910	332	b 760			
1911	235	a 130	b 190		
1918	338	582	b 702	B	I
1922	239	250	b 267		
1943	358	176	b 240		
1952	332	622	b1017	B	I
1964	324	482	b 522		
1965	359	b 482			
1968	318	480	670	B	I
1975	350	230	b 250		
2043	365	470	b 640	B	I
2094	338	260	b 285		
3179	350	b 705			
3195	330	470	830	B	I
3196	245		620	B	
3199	290	396			
3212	225	a 170	590	B	I
3213	270	a 195			
3214	245	149	500	B	I
3456	348	500			
3535	290	396	700	B	I
3544	255	175	b 240		
3545	350	316	791	B	I
14H10	357	440	885	B	I
** COOK					
25	293	358	b 491	B	I
39	240	209	b 270		

APPENDIX A: DEPTH TO THE TOP AND BOTTOM OF THE FLORIDAN AQUIFER (CONTINUED)

WELL NUMBER	LAND SURFACE ELEVATION (FEET)	DEPTH TO TOP OF AQUIFER (FEET)	DEPTH TO BOTTOM OF AQUIFER (FEET)	USED ON BASE OF AQUIFER MAP	USED ON ISOPACH MAP
105	272	b 280			
114	235	b 220			
118	228	190	b 280		
122	239	200	b 270		
682	236	240	b 260		
684	295	260	b 500	B	I
966	241	195	444	B	I
1423	245	215	b 275		
1497	231	200	b 230		
1576	295	b 370			
1638	268	290	b 320		
1927	290	b 581			
1969	222	240	b 300		
3350	205	170	b 440	B	I
** DECATUR					
10	130	82	373	B	I
49	133	a 190	390	B	I
57	135	a 115	400	B	I
168	88	a 138	530	B	I
206	270		930	B	
228	131	75	375	B	I
805	316	598	b 904	B	I
1359	299	340	b 442	B	I
3359	118	56	b 185	B	I
3360	119	50	b 145		
3434	140	85	b 160		
** EFFINGHAM					
211	75	195	b 400	B	I
457	102	277	b 360		
458	70	250	b 360	B	I
569	48	319	b 400		
1035	17	220			
1704	34	240			
2179	95	165	b 175		
3107	120	180	b 345	B	I
3108	112	146	b 198		
3109	113	168	b 188		
3110	109	158	b 210		
3140	57	281	b 315		
3155	68	233	b 276		

APPENDIX A: DEPTH TO THE TOP AND BOTTOM OF THE FLORIDAN AQUIFER (CONTINUED)

WELL NUMBER	LAND SURFACE ELEVATION (FEET)	DEPTH TO TOP OF AQUIFER (FEET)	DEPTH TO BOTTOM OF AQUIFER (FEET)	USED ON BASE OF AQUIFER MAP	USED ON ISOPACH MAP
** EVANS					
635	105	368			
773	193	445	b 700	B	I
1547	143	440			
** GRADY					
140	265e	368	b 495	B	I
141	235	402	b 434		
196	209	365	587	B	I
205	245	477	b 587	B	I
493	308	340	b 550	B	I
801	163	190	b 215		
883	238	460	b 482		
884	239	472	b 550		
916	233	70	b 205	B	I
962	205	471	670	B	I
1446	242	300	b 353		
** IRWIN					
274	331	230	b 630	B	I
1551	292	570	b 620		
1552	315	320	b 340		
1712	350	250			
1713	378	250	b 300		
1847	344	250	b 310		
1847	344	250	b 310		
1865	340	154	b 352	B	I
1873	330e	270	b 350		
1961	330	220	b 352	B	I
1979	328	180	b 320	B	I
2017	325	220	b 501	B	I
2114	355	210	b 330	B	I
2134	322	170	b 233		
2154	317	255	b 365	B	I
3103	353	260	b 696	B	I
** JEFF DAVIS					
157	250	557	b 840	B	I
1165	252	580			
1749	280	b 520			
1826	220	580			
3128	272	a 440	b1250	B	I
3384	202	425	b 760	B	I

APPENDIX A: DEPTH TO THE TOP AND BOTTOM OF THE FLORIDAN AQUIFER (CONTINUED)

WELL NUMBER	LAND SURFACE ELEVATION (FEET)	DEPTH TO TOP OF AQUIFER (FEET)	DEPTH TO BOTTOM OF AQUIFER (FEET)	USED ON BASE OF AQUIFER MAP	USED ON ISOPACH MAP
3457	287	450	1270	B	I
** MITCHELL					
89	335	305	b 337		
100	371	a 315	b 500	B	I
109	318	370	850	B	I
218	177	90	b 310	B	I
400	318	b 316			
417	160	63	b 84		I
564	164e	50	340	B	I
620	265	0	b 171	B	I
1397	272		b 648	B	I
1539	153	a 50			
1459	322	240			
3081	340	234	b 822	B	I
** MONTGOMERY					
190	260	370			
319	133	220	b 240		
450	221	330	b 500	B	I
514	190	430	b 547	B	I
515	170	315	b 512	B	I
600	258	283	b 645	B	I
1520	291	390			
3153	222	471	b 700	B	I
25R002	239	b 400			
** SCREVEN					
295	212	134	268	B	I
413	192	91	b 216	B	I
462	220	220	b 300		
578	165	177	b 207		
590	111	123	143	B	I
979	160	180	637	B	I
1007	261	180	b 325	B	I
1170	41	60	b 123	B	I
1175	90	30	116	B	I
B31	71	a 30	61	B	I
B32	75	a 33	114	B	I
B36	49	a 37	113	B	I
B37	102	118	213	B	I

APPENDIX A: DEPTH TO THE TOP AND BOTTOM OF THE FLORIDAN AQUIFER (CONTINUED)

WELL NUMBER	LAND SURFACE ELEVATION (FEET)	DEPTH TO TOP OF AQUIFER (FEET)	DEPTH TO BOTTOM OF AQUIFER (FEET)	USED ON BASE OF AQUIFER MAP	USED ON ISOPACH MAP
** TATTNALL					
180	182	480	b 820	B	I
522	187	505	b 678	B	I
572	172	510	b 950	B	I
583	250	634	b 675		
593	190	412			
662	213	391			
1509	228	415	b 465		
1530	210	380	b 480		
1531	165	350			
1545	97	590	b 710	B	I
1731	153	500	b 550	B	
1741	130	460			
1742	205	490			
1743	224	520	b 630	B	I
1744	217	600			
1745	212	500			
3026	210	460	b 744	B	I
** TELFAIR					
375	249	225	1145	B	I
507	250	170	b 515	B	I
1053	263	208			
** THOMAS					
19	235	155	b 300	B	I
132	258	170	b 505	B	I
401	285	180	b 400	B	I
495	305	516	b 905	B	I
603	201	b 240			
747	200	165	b 240		
748	189	58	b 80		
768	230	130	b 175		
771	272	a 210	b 295		
778	255	190	b 200		
779	245	125	b 269	B	I
784	170	85	b 115		
787	230	125	b 225		
807	178	95	b 205	B	I
808	225	115	b 180		
810	265	170	b 195		
811	268	205	b 245		
814	229	a 140	b 250	B	I

APPENDIX A: DEPTH TO THE TOP AND BOTTOM OF THE FLORIDAN AQUIFER (CONTINUED)

WELL NUMBER	LAND SURFACE ELEVATION (FEET)	DEPTH TO TOP OF AQUIFER (FEET)	DEPTH TO BOTTOM OF AQUIFER (FEET)	USED ON BASE OF AQUIFER MAP	USED ON ISOPACH MAP
817	195	45	b 250	B	I
826	261	195	b 210		
830	210	330	b 360		
854	232	165	b 270	B	I
866	180	105	b 190		
886	262	395	b 410		
914	285	195	b 220		
915	275	b 395			
924	305	500	b 530		
925	248	356	b 380		
934	198	130	b 240	B	I
995	255	140	b 170		
996	260	160	b 180		
1022	191	a 110	b 240	B	I
3186	327	470	b 810	B	I
3188	200	a 96	740	B	I
3207	238	130	701	B	I
3215	248	157	565	B	I
3534	330	444	892	B	I
** TIFT					
82	328	256	b 501	B	I
292	355	270	b 585	B	I
419	338	170	b 350	B	I
1465	370	200	b 260		
1632	325	b 540			
1687	321	b 700			
1692	329	870			
1782	335	278	b 580	B	I
1903	250	580	b 670		
1912	269	365			
1914	295	400			
1930	295	308	b 352		
1977	311	b 95	b 280	B	I
1989	324	450	b 490		
1993	392	254	b 294		
2027	330	575			
2034	600	470			
2067	300	195	b 220		
2088	390	185			
2095	395	200			
16J005	295	865	1050	B	I
16J030	280	860	b1046	B	I

APPENDIX A: DEPTH TO THE TOP AND BOTTOM OF THE FLORIDAN AQUIFER (CONTINUED)

WELL NUMBER	LAND SURFACE ELEVATION (FEET)	DEPTH TO TOP OF AQUIFER (FEET)	DEPTH TO BOTTOM OF AQUIFER (FEET)	USED ON BASE OF AQUIFER MAP	USED ON ISOPACH MAP
** TOOMBS					
95	198	448	1180	B	I
146	205	645			
640	217	460	b 560		
650	290	420	b 808	B	I
652	231	b 715	b 715		
667	194	600	b 885	B	I
1090	292	460			
1521	176	370			
1540	212	510	b 530		
1542	230	640	b 820	B	I
1546	220	370			
1700	252	390			
1732	247	640			
1740	208	680	b 740		
1753	236	480			
1754	255	b 600	b 600		
1800	188	630			
1801	240	500	b 609	B	I
1802	188	630			
1803	169	b 575			
** WHEELER					
92	225	254	b 288		
336	180	360	1100	B	I
337	141	345	b 610	B	I
340	235	295	b 340		
1045	195	170			
3080	172	260	900	B	I
3084	161	250	1050	B	I
23Q002	205	240			
** WORTH					
232	260	a 50	b 80		
420	355	65	b 180	B	I
456	410	280	b 300		
1231	425	190	b 460	B	I
1235	350	225	b 300		
1265	407	220	b 235		
1405	372	240	b 405	B	I
1644	412	210			
1762	340	410	b 430		

APPENDIX A: DEPTH TO THE TOP AND BOTTOM OF THE FLORIDAN AQUIFER (CONTINUED)

WELL NUMBER	LAND SURFACE ELEVATION (FEET)	DEPTH TO TOP OF AQUIFER (FEET)	DEPTH TO BOTTOM OF AQUIFER (FEET)	USED ON BASE OF AQUIFER MAP	USED ON ISOPACH MAP
1939	360	360	b 620	B	I
1999	370	374	b 610	B	I
2023	389	240			
2024	378	180			
2045	340	90	b 210	B	I
2066	395	300	b 320		
2080	338	275			
2093	296	110			
3154	322	550	820	B	I

Notes:

a maximum depth to top of aquifer

b minimum depth to top or bottom of aquifer

e land surface elevation is estimated

B indicates that the well was used on the bottom of aquifer structure-contour map

I indicates that the well was used on the isopach map

APPENDIX B: WELLS USED IN HYDRAULIC PARAMETER AND INORGANIC CHEMISTRY PLATES

MAP NUMBER	OWNER/WELL NAME	OTHER ID# GGS, USGS GRID	DIAMETER (IN)	CASING LENGTH (FT)	TOTAL DEPTH (FT)	DISCHARGE (GPM)	DRAW DOWN (FT)	LENGTH OF TEST	SAMPLE DATE	PLATES	DATA SOURCE
** APPLING											
B001	CITY OF BAXLEY	1059 27N001	12	500	764	1000	13.3	24HRS	04/28/71	H,T,S	1,4
B002	FILTERED ROSIN PROD. CO.	27N004	8	525	625	100	3.0	20MIN	/ /	H	1
B003	GEORGIA POWER #1	27P001	12	455	680	750	5.0	8HRS	/ /	H	1
B004	GEORGIA POWER #2	27P002	12	490	711	750	8.0	8HRS	/ /	H	1
B005	CITY OF BAXLEY	27N003	12	564	849	704	10.0	24HRS	04/18/67	H,T,S	2,4
B006	ALTAMAHA MHP		6	470	600	200	4.0	?	08/27/80	H,S	3
B007	GA BAPTIST CHILDRENS HOME		4	578	650	300	10.0	1HR	05/15/84	H,S	3
B008	R. PEARCE	28N001	0	580	700	0	0.0		03/12/63	T,S	4
B009	TOWN OF SURRENCY		0	553	651	0	0.0		05/11/66	T,S	4
** ATKINSON											
B010	CITY OF WILLACOOCHEE #2	918 21J003	0	289	445	0	0.0		05/09/66	H,T,S	4
B011	CITY OF WILLACOOCHEE #1	21J001	0	380	408	0	0.0		05/09/46	H,T,S	4
B012	CITY OF PEARSON	23J003	0	361	471	0	0.0		12/01/59	H,T,S	4
** BACON											
B013	CITY OF ALMA	58 26L001	10	363	626	360	1.6	5HRS	12/02/59	H,T,S	1,4
B014	CITY OF ALMA #3	26L004	12	501	840	1000	15.0	12HRS	/ /	H	1
B015	DEERING MILLIKEN SER. #2		16	397	795	2250	25.0	10HRS	/ /	H	2
** BEN HILL											
B016	CITY OF FITZGERALD C	154 20M003	12	260	750	1000	23.0	8HRS	/ /	H	2
B017	CITY OF FITZGERALD D	355 19M001	12	283	612	1016	16.0	24HRS	12/03/51	H	2,4
B018	CITY OF FITZGERALD E	1898	12	250	663	1192	17.0	12HRS	/ /	H	1
B019	CITY OF FITZGERALD F		12	295	453	1200	19.0	8HRS	/ /	H	1
B020	CITY OF FITZGERALD G		12	318	450	1212	32.0	24HRS	/ /	H	2
B021	TREES, INC.	3037 20N002	6	272	390	0	0.0		/ /	T,S	1
B022	CITY OF FITZGERALD A	20M002	10	260	825	0	0.0		04/22/71	T,S	4
B023	H. COWAN	21N001	0	189	299	0	0.0		04/20/67	T,S	4
** BERRIEN											
B024	CITY OF ALAPAHA	1368 20K002	8	368	550	999999	999.9	999999	/ /	H	5,1
B025	CITY OF RAY CITY #2		10	208	396	750	1.5	?	11/30/78	H,T,S	3
B026	CITY OF NASHVILLE #4	1815 20H003	16	283	485	1000	1.0	24HRS	06/18/70	H,T,S	2,4
B027	CITY OF NASHVILLE #5		16	280	505	1000	1.0	24HRS	/ /	H	2
B028	CITY OF ENIGMA #2	19K005	6	386	620	225	40.0	24HRS	03/09/82	H,T,S	3,4
B029	J.C. TYSON	18J022	0	380	540	0	0.0		05/09/66	T,S	4
B030	CITY OF NASHVILLE #2	19H026	0	265	450	0	0.0		08/02/61	T,S	4
B031	CITY OF RAY CITY #1	20G009	0	200	350	0	0.0		05/26/43	T,S	4
** BROOKS											
B032	C.L. WILLAFORD	900 17F007	4	158	186	0	0.0		06/20/74	T,S	1
B033	J.M. TYSON #1	1005 16F009	4	185	230	0	0.0		06/20/74	T,S	1
B034	CITY OF MORVEN #3		8	160	315	285	5.0	24HRS	11/04/82	H,T,S	3
B035	FAWN HIGHTS S/D		4	180	220	56	10.0	24HRS	10/22/84	H,T,S	3
B036	FERNWOOD MHP #1		4	99	126	56	2.0	1HR	10/10/84	H,T,S	3
B037	CITY OF QUITMAN #3	17E012	0	120	304	0	0.0		08/03/61	T,S	4
** BULLOCH											
B038	STATESBORO AIR FIELD #2	81	10	275	475	500	28.0	?	/ /	H	1

APPENDIX B: WELLS USED IN HYDRAULIC PARAMETER AND INORGANIC CHEMISTRY PLATES (CONTINUED)

MAP NUMBER	OWNER/WELL NAME	OTHER ID# GGS, USGS GRID	DIAMETER (IN)	CASING LENGTH (FT)	TOTAL DEPTH (FT)	DISCHARGE (GPM)	DRAW DOWN (FT)	LENGTH OF TEST	SAMPLE DATE	PLATES	DATA SOURCE
B039	CITY OF STATESBORO #4	378	18	400	555	1040	92.0	?	/ /	H	2,1
B040	WILLOW HILL SCHOOL	430	6	386	450	36	12.5	8HRS	/ /	H	1
B041	CITY OF BROOKLET #1	32T13	8	302	510	0	0.0		06/10/43	T,S	4
B042	BULLOCH CO. GROWERS ASSN.	666	6	357	670	350	9.0	?	/ /	H	1
B043	CITY OF STATESBORO #7		20	360	490	1400	133.0	24HRS	/ /	H	1
B044	CITY OF BROOKLET #1	553	8	346	525	175	13.0	3HRS	/ /	H	2
B045	ITT GRINNELL #1		10	320	430	500	80.0	8HRS	/ /	H	2
B046	COOPER WISS #1		8	315	420	400	40.0	24HRS	/ /	H	2
B047	GA. SOUTHERN COLLEGE #1		8	420	550	225	90.0	8HRS	/ /	H	2
B048	GA. SOUTHERN COLLEGE #2		8	420	610	610	90.0	8HRS	/ /	H	2
B049	CITY OF STATESBORO #2	31T010	8	320	555	305	5.0	?	01/06/60	H,T,S	2
B050	COUNTRY CLUB HILLS S/D		6	375	480	220	15.0	24HRS	12/30/80	H,T,S	3
B051	GEORGIAN WALK WATER CO.		6	296	420	210	4.0	6HRS	/ /	H	3
B052	LAKESIDE ESTATES S/D		8	281	355	500	10.0	?	/ /	H	3
B053	NEVILS WATER ASSOCIATION		8	475	600	385	4.0	9HRS	/ /	H	3
B054	CITY OF PORTAL	30U002	0	395	596	0	0.0		04/11/63	T,S	4
B055	A. DORMAN	32U002	0	150	516	0	0.0		06/11/43	T,S	4
**	CANDLER										
B056	CITY OF METTER #2 SOUTH	29T010	10	386	616	626	14.0	24HRS	09/12/79	H,T,S	1,2
B057	CITY OF METTER #2 NORTH	29T011	12	321	540	1000	4.0	12HRS	/ /	H	1
B058	CITY OF METTER #2	29T006	0	308	520	0	0.0		08/07/61	T,S	4
B059	L. RUSHTON	29U001	0	350	389	0	0.0		03/31/66	T,S	4
**	COFFEE										
B060	CITY OF AMBROSE	1825	8	442	1120	385	5.0	8HRS	/ /	H	1
B061	CITY OF DOUGLAS #5	23L004	16	514	684	1800	1.1	33HRS	/ /	H	2
B062	CITY OF DOUGLAS #4	23L002	14	506	728	1250	1.8	36HRS	04/17/67	H,T,S	1,2
B063	CITY OF NICHOLLS #3		10	506	760	800	8.0	24HRS	07/07/81	H,T,S	2
B064	PARKVIEW VILLAGE MHP		4	370	380	50	2.0	?	/ /	H	3
B065	CITY OF DOUGLAS #3	23L003	0	395	590	0	0.0		08/02/61	T,S	4
**	COLQUITT										
B066	CITY OF MOULTRIE #3	175 15H007	16	425	752	1040	31.0	24HRS	04/09/58	H,T,S	1
B067	CITY OF NORMAN PARK	3195	8	490	1220	305	28.0	24HRS	/ /	H	1,2
B068	SWIFT & CO #4	15H011	18	380	800	500	120.0	?	/ /	H	1
B069	CITY OF MOULTRIE #5	15H040	18	422	580	2150	8.0	?	09/01/76	H,T,S	3
B070	CRESTWOOD S/D		4	324	480	40	3.0	24HRS	11/19/82	H,T,S	3
B071	COLQUITT COUNTY HOSPITAL	15H032	10	438	564	500	2.0	48HRS	/ /	H	3
B072	CITY OF ELLENTON #2		8	246	410	150	20.0	48HRS	/ /	H	3
B073	D.E. SMITH	14J001	0	260	350	0	0.0		04/28/69	T,S	4
B074	D.C. SMITH	15J003	0	300	380	0	0.0		04/28/69	T,S	4
B075	T. WILLIAMS	16J019	0	386	684	0	0.0		04/28/69	T,S	4
B076	G. POWELL	17J015	0	726	1008	0	0.0		04/29/69	T,S	4
B077	N.C. BRANNON	17H022	0	215	350	0	0.0		04/29/69	T,S	4
B078	R. BAKER	17H014	0	218	298	0	0.0		05/25/65	T,S	4
B079	MT. OLIVE BAPTIST CHURCH	16H032	0	310	500	0	0.0		04/29/69	T,S	4
B080	BRIDGEPORT BRASS CO.	16H014	0	425	579	0	0.0		05/25/65	T,S	4

APPENDIX B: WELLS USED IN HYDRAULIC
PARAMETER AND INORGANIC CHEMISTRY
PLATES (CONTINUED)

MAP NUMBER	OWNER/WELL NAME	OTHER ID# GGS, USGS GRID	DIAMETER (IN)	CASING LENGTH (FT)	TOTAL DEPTH (FT)	DISCHARGE (GPM)	DRAW DOWN (FT)	LENGTH OF TEST	SAMPLE DATE	PLATES	DATA SOURCE
B081	SOUTH GEORGIA WATER CO.	16H022	0	515	700	0	0.0		10/08/69	T,S	4
B082	N.D. GUNN	15H022	0	396	480	0	0.0		04/28/69	T,S	4
B083	J. KIRK II	15H030	0	840	840	0	0.0		04/28/69	T,S	4
B084	O.C. CAUSEY	15H019	0	458	625	0	0.0		05/12/65	T,S	4
B085	W.M. BROOKS	15H004	0	485	930	0	0.0		05/12/65	T,S	4
B086	W.H. SUMMERLAIN	15H002	0	44	740	0	0.0		05/12/65	T,S	4
B087	J.A. FAISON	14H015	0	630	810	0	0.0		04/30/69	T,S	4
B088	R.L. MILLINGS #2	14H009	0	285	403	0	0.0		04/30/69	T,S	4
B089	L. FUNDERBURKE	15H033	0	457	780	0	0.0		04/30/69	T,S	4
B090	H. TOMLINSON	15H002	0	426	474	0	0.0		04/21/64	T,S	4
B091	E. LEWIS	15G004	0	394	494	0	0.0		05/11/65	T,S	4
B092	L. SMITH	15G010	0	372	431	0	0.0		04/30/69	T,S	4
B093	D. BELL	16G007	0	182	210	0	0.0		05/11/65	T,S	4
B094	K.G. CARDIN	17G014	0	155	310	0	0.0		10/07/69	T,S	4
B095	C. LAWRENCE	16G001	0	215	307	0	0.0		04/30/69	T,S	4
B096	E. WALDEN	17G001	0	202	318	0	0.0		05/11/65	T,S	4
B097	TYSON & DEAN DRILLING	16H018	0	294	400	0	0.0		04/29/69	T,S	4
B098	G. COLE	16G022	0	205	320	0	0.0		04/29/69	T,S	4
B099	CITY OF BERLIN #1	16G017	0	200	400	0	0.0		05/11/65	T,S	4
B100	K.G. CARDIN #2	17G015	0	206	315	0	0.0		10/07/69	T,S	4
B101	J.B.VAUGHN	16J009	0	531	630	0	0.0		04/28/69	T,S	4
B102	CITY OF NORMAN PARK	16J002	0	499	817	0	0.0		06/12/65	T,S	4
B103	J.B. PRICE	15J012	0	417	528	0	0.0		04/28/69	T,S	4
B104	CITY OF DOERUN #2	14J002	0	266	555	0	0.0		05/12/65	T,S	4
B105	E.T. GAY		0	256	426	0	0.0		04/19/67	T,S	4
**	COOK										
B106	CITY OF ADEL #3	122 18H002	12	231	386	500	10.0	8HRS	/ /	H	2
B107	CITY OF ADEL #1	39 18H005	12	213	375	1200	20.0	8HRS	04/19/67	H,T,S	2,4
B108	CITY OF ADEL #4	682 18H008	12	253	335	1200	6.0	10HRS	/ /	H	1,2
B109	CITY OF LENOX #2	684 18J012	8	266	501	308	3.0	10HRS	/ /	H	1
B110	CITY OF ADEL #5	1218 18H033	18	200	393	1571	5.0	8HRS	11/28/78	H,T,S	1,2
B111	CITY OF CECIL	1423 18G018	8	214	308	53	12.8	5HRS	03/17/65	H,T,S	1,4
B112	CITY OF ADEL #2B		12	221	359	1120	30.0	8HRS	/ /	H	2
B113	CITY OF ADEL #6		16	229	405	1865	4.0	24HRS	11/17/65	H,T,S	2,4
B114	SUNSHINE TRAILER COURT		4	256	300	60	21.0	24HRS	08/15/85	H,T,S	3
B115	CITY OF SPARKS	18H015	0	400	407	0	0.0		04/29/65	T,S	4
B116	USGS ADEL TEST WELL	18H016	0	207	865	0	0.0		12/01/64	T,S	4
**	DECATUR										
B117	CITY OF BAINBRIDGE #3	228 9F486	12	109	464	1260	58.0	20MIN	02/05/38	H,T,S	1
B118	CITY OF BAINBRIDGE #2	804 9F519	12	122	351	1700	0.5	22HRS	05/02/67	H,T,S	1
B119	J. CAMPBELL CO.	1412 10E199	4	285	329	15	1.0	?	/ /	H	1
B120	CITY OF BAINBRIDGE #5		14	230	375	1700	47.0	6HRS	/ /	H	1,2
B121	AMOCO FABRICS CO. #1	8F008	12	127	222	800	4.0	?	/ /	H	2
B122	AMOCO FABRICS CO. #2	9F003	12	100	240	800	4.0	?	/ /	H	2
B123	CITY OF BAINBRIDGE #1		20	147	445	1650	62.0	12HRS	/ /	H	2

APPENDIX B: WELLS USED IN HYDRAULIC PARAMETER AND INORGANIC CHEMISTRY PLATES (CONTINUED)

MAP NUMBER	OWNER/WELL NAME	OTHER ID# GGS, USGS GRID	DIAMETER (IN)	CASING LENGTH (FT)	TOTAL DEPTH (FT)	DISCHARGE (GPM)	DRAW DOWN (FT)	LENGTH OF TEST	SAMPLE DATE	PLATES	DATA SOURCE
B124	DECATUR COUNTY AIR PARK	8F494	10	240	408	607	8.0	?	/ /	H	2
B125	C.W. WHITE	8F004	0	78	83	0	0.0		09/07/61	T,S	4
B126	H.M. WHITLEY	9F001	0	82	88	0	0.0		08/08/61	T,S	4
B127	CITY OF BAINBRIDGE #4	9F488	0	147	485	0	0.0		08/09/61	T,S	4
B128	A.J. NEWTON	9F002	0	83	105	0	0.0		03/30/62	T,S	4
B129	RED BARN MHP		4	200	220	40	5.0	24HRS	/ /	H	3
**	EFFINGHAM										
B130	CITY OF SPRINGFIELD #2	211	10	180	400	400	20.0	?	/ /	H	2
B131	WESTWOOD HEIGHTS S/D	961 36S004	11	303	565	900	9.0	4HRS	/ /	H	1
B132	CITY OF SAVANNAH	1035 36S021	8	234	454	600	9.3	?	/ /	H	1
B133	DAWES SILICA COMPANY	1527 34R043	12	320	689	2600	17.0	?	/ /	H	1,2
B134	DAWES SILICA COMPANY	1704 34R044	8	312	520	500	6.0	?	/ /	H	1
B135	CITY OF RINCON #2	36S022	10	281	500	700	72.0	12HRS	/ /	H	2
B136	FORT HOWARD PAPER CO. #1	36S025	14	280	500	750	7.8	10HRS	/ /	H	2
B137	FORT HOWARD PAPER CO. #2	36S026	14	280	520	750	14.0	24HRS	/ /	H	2
B138	FORT HOWARD PAPER CO. #3	36S027	8	282	500	300	16.0	1HR	04/11/86	H,T,S	2
B139	LAKESIDE WATER CO. #2		8	300	500	400	4.0	3HRS	/ /	H	2
B140	SEPCO #1		10	240	500	525	6.0	12HRS	/ /	H	2
B141	SEPCO #2		10	242	500	800	8.0	12HRS	/ /	H	2
B142	FOXBOW NORTH S/D #2		8	320	460	600	17.0	24HRS	/ /	H	3
B143	FOXBOW NORTH S/D #1		8	317	440	500	15.0	8HRS	11/02/82	H,T,S	3
B144	LAKESIDE FARMS S/D #3		8	340	450	500	10.0	8HRS	/ /	H	3
B145	MEADOWWOOD S/D		4	340	440	90	2.0	24HRS	12/12/83	H,T,S	3
B146	PECAN GROVE S/D		6	323	420	300	7.0	24HRS	/ /	H	3
B147	SILVERWOOD PLANTATION		14	292	500	1001	16.4	24HRS	09/23/86	H,T,S	3
B148	TARA MHP		4	284	355	50	12.0	8HRS	01/18/84	H,T,S	3
B149	GOSHEN VILLAS		8	295	410	360	70.0	24HRS	/ /	H	3
B150	COASTAL PUBLIC SERVICE CO		0	280	425	0	0.0		01/29/41	T,S	4
B151	CENTRAL OF GEORGIA RR	34R036	0	273	431	0	0.0		03/12/40	T,S	4
**	EVANS										
B152	CITY OF CLAXTON	773 30R002	10	452	805	510	2.7	1HR	04/28/71	H,T,S	1
B153	CITY OF CLAXTON #2	30R001	12	401	701	780	7.0	?	/ /	H	1,2
B154	CLAXTON POULTRY CO. #1		10	420	620	600	5.0	24HRS	/ /	H	2
B155	CLAXTON POULTRY CO. #3		10	380	600	1000	10.0	4HRS	/ /	H	2
B156	CITY OF DAISEY #2		8	491	705	400	6.0	24HRS	10/26/83	H,T,S	3
B157	P.H. JONES	30S002	0	440	480	0	0.0		11/14/63	T,S	4
B158	CITY OF CLAXTON	30R003	0	600	662	0	0.0		08/04/66	T,S	4
B159	G. TIPPENS	31Q001	0	460	515	0	0.0		04/01/66	T,S	4
**	GRADY										
B160	CITY OF CAIRO #8		16	390	465	2500	2.0	11HRS	/ /	H	3
B161	CITY OF WHIGHAM		8	426	604	160	48.0	36HRS	10/18/77	H,T,S	3
B162	GRADY CO. CHILD DEV. CTR.		4	286	425	30	20.0	2HRS	/ /	H	1
B163	CITY OF CAIRO #1	12F030	0	492	671	0	0.0		10/02/62	T,S	4
B164	USGS CAIRO TEST WELL	12F036	0	560	740	0	0.0		06/23/64	T,S	4

APPENDIX B: WELLS USED IN HYDRAULIC PARAMETER AND INORGANIC CHEMISTRY PLATES (CONTINUED)

MAP NUMBER	OWNER/WELL NAME	OTHER ID# GGS, USGS GRID		DIAMETER (IN)	CASING LENGTH (FT)	TOTAL DEPTH (FT)	DISCHARGE (GPM)	DRAW DOWN (FT)	LENGTH OF TEST	SAMPLE DATE	PLATES	DATA SOURCE
**	IRWIN											
B165	CITY OF OCILLA #3	274	20L003	12	266	645	1000	30.0	?	08/02/61	H,T,S	1,4
B166	CITY OF OCILLA #4	3103		12	303	696	1200	20.0	12HRS	/ /	H	1
B167	CITY OF OCILLA #2			12	266	672	1200	20.0	12HRS	/ /	H	2
B168	J.W. PAULK	21L001		0	432	620	0	0.0		04/20/67	T,S	4
B169	J. MCDUFFIE	18M001		0	195	230	0	0.0		05/04/66	T,S	4
**	JEFF DAVIS											
B170	CITY OF HAZELHURST #3	1165		12	600	950	1052	37.0	24HRS	/ /	H	3
B171	HAZELHURST MILLS #5			6	595	800	450	8.0	24HRS	/ /	H	2
B172	CITY OF DENTON			8	430	475	250	10.0	?	/ /	H	3
B173	LAKE OWL HEAD S/D			6	435	500	235	17.0	30HRS	03/21/86	H,T,S	3
B174	S. STOKES & C.W. CAIN #1	24M001		0	435	450	0	0.0		03/06/63	T,S	4
B175	CITY OF HAZELHURST #2	25N004		0	450	648	0	0.0		01/05/60	T,S	4
**	MITCHELL											
B176	CITY OF CAMILLA #3	218		12	155	341	2000	4.0	6HRS	/ /	H	2
B177	GRAVEL HILL PLANTATION	1062	13K001	10	116	386	732	2.0	5HRS	/ /	H	1
B178	CITY OF PELHAM #4	3081		12	240	822	856	72.0	24HRS	/ /	H	1,2
B179	BOWEN MOBILE ESTATES			4	300	465	41	5.0	1HR	/ /	H	3
B180	HINSONTON COM WATER ASSN			6	300	345	145	10.0	8HRS	/ /	H	3
B181	CITY OF SALE CITY #2			10	242	575	503	40.0	8HRS	/ /	H	3
B182	CITY OF CAMILLA #1	12H004		0	120	396	0	0.0		03/29/63	T,S	4
B183	CITY OF CAMILLA #4			0	150	335	0	0.0		05/08/58	T,S	4
B184	L. BATEMAN	12M006		0	142	287	0	0.0		02/11/60	T,S	4
B185	CITY OF COTTON	13H006		0	300	305	0	0.0		02/10/60	T,S	4
B186	CITY OF PELHAM #1	12G001		0	190	720	0	0.0		02/10/60	T,S	4
B187	G.W. HENDLEY	11H001		0	100	110	0	0.0		05/02/67	T,S	4
B188	E. VANN, JR.	12J001		0	382	460	0	0.0		02/11/60	T,S	4
**	MONTGOMERY											
B189	CITY OF UVALDA #2	3153		8	501	700	250	83.0	20HRS	08/08/75	H,T,S	1
B190	CITY OF MT VERNON #1			8	400	700	480	27.0	20HRS	02/18/81	H,T,S	2
B191	CITY OF AILEY #2			4	516	700	340	160.0	36HRS	06/04/81	H,T,S	3
B192	CITY OF ALSTON #1			8	522	700	183	4.0	22HRS	08/28/72	H,T,S	3
B193	MONTGOMERY CORR. INST. #2			6	450	570	380	15.0	24HRS	02/02/70	H,T,S	3
B194	CITY OF TARRYTOWN #2			4	474	580	165	44.0	?	/ /	H	3
B195	WILDWOOD MHP			4	415	504	45	3.0	24HRS	08/31/76	H,T,S	3
B196	T.A. BLOCKER	25S001		0	373	452	0	0.0		04/18/67	T,S	4
B197	CITY OF AILEY #1	25R001		0	345	403	0	0.0		08/04/61	T,S	4
B198	CITY OF MT VERNON	25R002		0	347	400	0	0.0		03/05/43	T,S	4
B199	CITY OF UVALDA #1	25Q002		0	430	700	0	0.0		03/06/63	T,S	4
**	SCREVEN											
B200	J.P. KING #2	32U018		24	253	670	1815	36.0	?	/ /	H	1
B201	INDIGO MOBILE ESTATES			4	173	220	50	29.0	2HRS	/ /	H	3
B202	CITY OF HILLTONIA	32X034		0	178	400	0	0.0		05/04/64	T,S	4
B203	P.H. JOHNSTON	31X017		0	160	249	0	0.0		09/17/63	T,S	4
B204	MEAD INVESTMENT CORP.	33X020		0	205	369	0	0.0		08/12/63	T,S	4

APPENDIX B: WELLS USED IN HYDRAULIC PARAMETER AND INORGANIC CHEMISTRY PLATES (CONTINUED)

MAP NUMBER	OWNER/WELL NAME	OTHER ID# GGS, USGS GRID	DIAMETER (IN)	CASING LENGTH (FT)	TOTAL DEPTH (FT)	DISCHARGE (GPM)	DRAW DOWN (FT)	LENGTH OF TEST	SAMPLE DATE	PLATES	DATA SOURCE
B205	GA. DEPT. OF TRANS.	34W004	0	220	434	0	0.0		03/16/70	T,S	4
B206	CITY OF SYLVANIA #2	32W015	0	150	301	0	0.0		05/21/43	T,S	4
B207	CITY OF SYLVANIA #1	32W013	0	190	490	0	0.0		11/17/59	T,S	4
B208	CITY OF SYLVANIA #4	32W070	0	197	257	0	0.0		06/17/70	T,S	4
B209	H.I. CONNER & C. FARMER	31W010	0	212	275	0	0.0		03/16/70	T,S	4
B210	CITY OF NEWINGTON	33U009	0	200	280	0	0.0		09/18/63	T,S	4
B211	CITY OF OLIVER	33U019	0	270	290	0	0.0		09/18/63	T,S	4
**	TATTNALL										
B212	GEORGIA STATE PRISON #3	879	12	556	855	1270	24.0	12HRS	/ /	H	1,2
B213	CITY OF MANASSAS	3026	8	555	744	305	12.3	4HRS	/ /	H	3
B214	CITY OF REIDSVILLE #1	29Q001	8	560	713	400	15.0	?	08/04/61	H,T,S	1,4
B215	GEORGIA STATE PRISON #1	28Q002	8	500	810	550	20.0	30MIN	03/04/36	H,T,S	1,2,4
B216	GEORGIA STATE PRISON #2		10	460	818	700	19.0	30MIN	/ /	H	2
B217	GA. STATE PRISON UNIT C		14	551	940	1016	10.0	8HRS	02/17/82	H,T,S	2
B218	CITY OF GLENNVILLE #2		8	520	729	300	3.0	24HRS	/ /	H	2
B219	CITY OF GLENNVILLE #3		12	560	800	750	6.0	24HRS	12/22/86	H,T,S	3
B220	GEORGIA FORRESTRY COMM.	28P001	0	508	955	0	0.0		04/14/67	T,S	4
B221	CITY OF GLENNVILLE #1	30P001	0	344	714	0	0.0		05/12/66	T,S	4
**	TELFAIR										
B222	CITY OF LUMBER CITY #1	24P006	6	350	450	132	5.5	?	/ /	H	1
B223	CITY OF MCRAE #1	22Q001	14	120	640	1200	5.0	7HRS	/ /	H	1
B224	CITY OF NCRAE #3	1053 22Q003	12	235	545	750	6.0	18HRS	/ /	H	1
B225	CITY OF LUMBER CITY		10	375	868	900	35.0	1HR	/ /	H	2
B226	CITY OF JACKSONVILLE #2		6	242	343	170	15.0	120HRS	08/09/83	H,T,S	3
B227	CITY OF SCOTLAND		10	266	600	1700	65.0	?	03/25/77	H,T,S	3
B228	N.S. WHEELER	24P008	0	400	778	0	0.0		03/06/63	T,S	4
B229	J.E. DOBSON	22N001	0	270	415	0	0.0		05/05/66	T,S	4
**	THOMAS										
B230	THOMASVILLE ARMY AIR BASE	19 14F012	10	180	300	425	5.6	1HR	01/06/64	H,T,S	1,4
B231	CITY OF THOMASVILLE #4	56 14E010	16	112	305	960	1.3	?	12/02/51	H,T,S	2,4
B232	CITY OF THOMASVILLE #3	186 14E011	16	108	550	1000	2.0	3HRS	12/02/51	H,T,S	1,4
B233	CITY OF THOMASVILLE #6	401 14E013	20	157	400	3200	9.0	23HRS	/ /	H	1,2
B234	WAVERLY MINERAL PROD. #1	495 13G003	8	605	905	280	85.0	?	01/24/64	H,T,S	1,2,4
B235	O. NESMITH	769 13F003	4	168	261	30	4.0	1HR	/ /	H	1
B236	CITY OF MEIGS	3186	10	460	1004	160	80.0	2HRS	/ /	H	3
B237	CIRCLE C MHP #3		4	228	288	45	5.0	18HRS	10/15/84	H,T,S	3
B238	HIDDEN ACRES S/D		6	134	240	200	2.0	6HRS	/ /	H	3
B239	LAKE LILLIQUIN S/D		10	196	294	500	1.0	12HRS	12/18/84	H,T,S	3
B240	LAKE RIVERSIDE S/D		6	226	360	150	15.0	24HRS	01/16/84	H,T,S	3
B241	RIVERWOOD ESTATES #2		6	181	340	175	16.0	24HRS	09/19/83	H,T,S	3
B242	SUGARWOOD ESTATES MHP		4	261	300	50	5.0	18HRS	/ /	H	3
B243	CITY OF THOMASVILLE #5	14E012	0	230	400	0	0.0		08/01/61	T,S	4
B244	CITY OF COOLIDGE	15G011	0	237	383	0	0.0		01/06/64	T,S	4
B245	D.O. MIMMS	15E002	0	155	210	0	0.0		01/07/64	T,S	4
B246	CITY OF BOSTON	15E005	0	150	235	0	0.0		01/07/64	T,S	4

APPENDIX B: WELLS USED IN HYDRAULIC PARAMETER AND INORGANIC CHEMISTRY PLATES (CONTINUED)

MAP NUMBER	OWNER/WELL NAME	OTHER ID# GGS, USGS GRID	DIAMETER (IN)	CASING LENGTH (FT)	TOTAL DEPTH (FT)	DISCHARGE (GPM)	DRAW DOWN (FT)	LENGTH OF TEST	SAMPLE DATE	PLATES	DATA SOURCE
B247	CITY OF PAVO	16F004	0	104	305	0	0.0		01/06/64	T,S	4
**	TIFT										
B248	CITY OF TIFTON #6	3125	24	280	652	2360	5.0	12HRS	/ /	H	1
B249	CITY OF TIFTON #2	17K062	12	275	501	1000	5.5	30MIN	04/28/58	H,T,S	1,4
B250	CITY OF TIFTON #5		20	360	610	1500	13.4	7HRS	/ /	H	1
B251	ABAC #1		10	263	500	700	47.0	?	12/22/78	H,T,S	3
B252	ABAC #2		10	260	514	800	10.0	10HRS	/ /	H	2
B253	CITY OF TIFTON #4		20	398	612	1500	63.0	8HRS	/ /	H	2
B254	WENDELL HOBBS S/D #1		4	147	220	70	5.0	1HR	01/04/79	H,T,S	3
B255	NORTHGATE LAKE S/D #2		0	253	340	50	20.0	24HRS	/ /	H	3
B256	PEBBLE BROOK MEADOWS #1		6	201	400	150	5.0	?	03/20/78	H,T,S	3
B257	PINE HILL MHP		4	407	600	20	30.0	24HRS	10/19/82	H,T,S	3
B258	SPRING HILL PROPERTIES		6	192	320	150	10.0	24HRS	/ /	H	3
B259	CITY OF TIFTON #7		14	350	750	2335	4.5	24HRS	11/24/86	H,T,S	3
B260	TOWN & COUNTRY MHP		6	190	300	20	5.0	24HRS	/ /	H	3
B261	WHISPERING PINES ESTATES		4	400	480	150	20.0	24HRS	/ /	H	3
B262	CITY OF TIFTON	18K001	0	390	610	0	0.0		06/19/70	T,S	4
**	TOOMBS										
B263	VIDALIA AIR FIELD	85	10	470	864	235	8.0	?	/ /	H	1
B264	CITY OF VIDALIA #1	650	16	430	808	1600	18.0	24HRS	/ /	H	1,2
B265	CITY OF VIDALIA	26R003	16	442	800	1200	27.0	24HRS	/ /	H	1
B266	CITY OF VIDALIA #2	26R001	8	720	1000	200	6.0	6HRS	08/04/61	H,T,S	1,4
B267	CITY OF LYONS #1		17	500	698	500	33.0	8HRS	08/15/80	H,T,S	2
B268	CITY OF LYONS #2		19	487	764	1043	41.0	?	06/06/68	H,T,S	2
B269	CITY OF VIDALIA #3		16	442	761	1200	28.0	24HRS	08/22/73	H,T,S	2
B270	MCNATT FALLS S/D #1		4	475	605	35	35.0	?	/ /	H	3
B271	T.C. TALLEY	28R001	0	511	714	0	0.0		04/14/67	T,S	4
B272	TOOMBS CO. BD. OF ED.	27Q001	0	654	885	0	0.0		03/12/63	T,S	4
**	WHEELER										
B273	LITTLE OCMULGEE ST. PK.	1045	10	165	266	500	20.0	24HRS	/ /	H	1
B274	CITY OF ALAMO #2	23R001	0	352	600	800	75.0	24HRS	/ /	H	1
B275	LITTLE OCMULGEE ST. PK.	22Q004	10	194	248	500	18.3	12HRS	/ /	H	1
B276	F. JOYCE	24P001	0	400	610	0	0.0		05/06/66	T,S	4
B277	T.B. CLARK	22R001	0	220	253	0	0.0		03/07/63	T,S	4
B278	CITY OF GLENWOOD	24R001	0	300	380	0	0.0		01/05/60	T,S	4
**	WORTH										
B279	C.E. BUCK FARM #1	420 14L007	6	73	180	146	7.0	8HRS	/ /	H	1
B280	CITY OF SYLVESTER #3	15L021	18	146	536	1018	131.0	6HRS	02/05/72	H,T,S	1
B281	CITY OF WARWICK #2		10	200	350	1100	5.0	36HRS	06/15/82	H,T,S	3
B282	WORTHY MANOR S/D		10	60	185	465	14.0	8HRS	04/07/72	H,T,S	3
B283	L.L. LEVERETTE	14M002	0	206	240	0	0.0		05/10/65	T,S	4
B284	G.W. STROM	14M001	0	160	215	0	0.0		05/10/65	T,S	4
B285	W.J. PATE	14L002	0	260	430	0	0.0		05/10/65	T,S	4
B286	CITY OF SUMNER	16L001	0	160	410	0	0.0		05/10/65	T,S	4
B287	H.APPERSON	14K003	0	195	370	0	0.0		05/10/65	T,S	4

APPENDIX B: WELLS USED IN HYDRAULIC PARAMETER AND INORGANIC CHEMISTRY PLATES (CONTINUED)

MAP NUM-BER	OWNER/WELL NAME	OTHER ID# GGS, USGS GRID	DIAM-ETER (IN)	CASING LENGTH (FT)	TOTAL DEPTH (FT)	DIS-CHARGE (GPM)	DRAW DOWN (FT)	LENGTH OF TEST	SAMPLE DATE	PLATES	DATA SOURCE
B288	I.J. WHITE	15K003	0	206	240	0	0.0		05/10/65	T,S	4
B289	F. BROWN	14K005	0	240	280	0	0.0		05/04/66	T,S	4
B290	CITY OF WARWICK	14N001	0	160	325	0	0.0		04/20/67	T,S	4

PLATES CODES:

H	Hydraulic Parameters, Plates 7-10
T	Total Dissolved Solids, Plate 12
S	Sulfates, Plate 13

DATA SOURCE CODES:

1	Georgia Geologic Survey files
2	Water Resources Management Branch files
3	Ground-Water Program files
4	Grantham and Stokes (1976)
5	Sever (1969)

APPENDIX C: WELLS USED IN BARIUM AND GROSS ALPHA PLATES

MAP NUM.	SUPPLY NAME		WELL NUM.	OTHER ID #	BARIUM SAMPLE DATE	BARIUM CONC. (ug/l)	RAD. SAMPLE DATE	GROSS ALPHA ACT. (piC/l)	RA226 ACTIV-ITY (piC/l)	RA228 ACTIV-ITY (piC/l)
**	APPLING									
C001	ALTAMAHA MHP			B006	07/21/78	<200.	04/21/83	<2		
C002	BASS S/D EAST				05/12/82	<200.	/ /			
C003	CITY OF BAXLEY				05/12/82	<200.	05/12/82	2+2		
C004	COOPER TRAVEL TRAILER PK.				11/15/78	<200.	/ /			
C005	GA BAPTIST CHILDRENS HOME			B007	09/08/81	<200.	07/26/83	2+2		
C006	THE VILLAGE MHP				07/21/78	<200.	/ /			
C007	TOWN OF SURRENCY				08/20/81	<200.	09/08/81	<2		
**	ATKINSON									
C008	CITY OF PEARSON				04/07/82	<200.	04/07/82	<4		
C009	CITY OF WILLACOOCHEE				04/07/82	<200.	04/07/82	4+-2	4.4	<1.0
**	BACON									
C010	BACON APPERAL				06/12/80	<200.	/ /			
C011	CITY OF ALMA				03/31/82	<200.	05/10/84	2+-2		
C012	HIGHLAND PARK S/D				09/17/81	<200.	/ /			
C013	LEE MHP				09/17/81	<200.	/ /			
**	BEN HILL									
C014	CITY OF FITZGERALD	a	A	B022	/ /	1300.	/ /			
C015	CITY OF FITZGERALD	a	B		/ /	2300.	/ /			
C016	CITY OF FITZGERALD	a	C	B016	/ /	2000.	/ /			
C017	CITY OF FITZGERALD	a	D	B017	/ /	1600.	/ /			
C018	CITY OF FITZGERALD	a	E	B018	/ /	2100.	/ /			
C019	CITY OF FITZGERALD	b	F	B019	/ /	200.	/ /			
C020	CITY OF FITZGERALD	b	G	B020	/ /	100.	/ /			
C021	CITY OF FITZGERALD				/ /		12/31/80	3+-2	1.2	
C022	FOWLER (domestic)	c			/ /	250.	/ /			
C023	GLADDEN (domestic)	c			/ /	350.	/ /			
C024	GAINES (domestic)	c			/ /	300.	/ /			
C025	MERRITT (domestic)	c			/ /	350.	/ /			
C026	NETTLES (domestic)	c			/ /	350.	/ /			
C027	MCDUFFIE (domestic)	c			/ /	300.	/ /			
C028	BAGLEY (domestic)	c			/ /	250.	/ /			
C029	GRANTHAM (domestic)	c			/ /	350.	/ /			
C030	GIBBONS (domestic)	c			/ /	250.	/ /			
C031	ANDERSON (domestic)	c			/ /	250.	/ /			
**	BERRIEN									
C032	CITY OF ALAPAHA				08/28/79	230.	/ /			
C033	CITY OF ALAPAHA		1		/ /		08/02/83	7+-2	6.9	<1.0
C034	CITY OF ALAPAHA		2		/ /		08/02/83	7+-2	6.5	<1.0
C035	CITY OF ALAPAHA		T1		/ /		06/10/77	11+-2	4.4	<1.0
C036	BENNETTS MHP		2		01/28/82	<200.	/ /			
C037	CITY OF ENIGMA		1		08/28/79	<200.	02/19/79	6+-2	6.2	0.2
C038	CITY OF ENIGMA		2	B028	/ /		12/27/83	2+-2		
C039	CITY OF NASHVILLE				03/22/82	<200.	05/29/84	<2		
C040	SOUTHWOOD MHP				07/23/81	<200.	/ /			
C041	CITY OF RAY CITY				07/22/81	<200.	02/19/79	5+-2	1.2	

APPENDIX C: WELLS USED IN BARIUM AND GROSS ALPHA PLATES (CONTINUED)

MAP NUM.	SUPPLY NAME	WELL NUM.	OTHER ID #	BARIUM SAMPLE DATE	BARIUM CONC. (ug/l)	RAD. SAMPLE DATE	GROSS ALPHA ACT. (piC/l)	RA226 ACTIVITY (piC/l)	RA228 ACTIVITY (piC/l)
C042	CITY OF RAY CITY	1	B031	/ /		02/02/84	<3		
C043	WALKER TRAILER PARK			07/24/79	<200.	/ /			
**	BROOKS								
C044	CITY OF BARWICK			07/29/81	<200.	/ /			
C045	CITY OF QUITMAN			11/20/79	<200.	02/24/82	<3		
C046	JA MAR S/D			12/18/78	<200.	/ /			
C047	CITY OF MORVEN			08/03/81	<200.	/ /			
C048	SHADY ACRES S/D			08/04/81	<200.	/ /			
C049	TROUPVILLE MOBILE ESTATES			08/03/81	<200.	/ /			
**	BULLOCH								
C050	301 TRAILER PARK			02/08/82	<200.	/ /			
C051	BULLOCH CO. CORR. INST.			05/21/80	<200.	/ /			
C052	CITY OF BROOKLET			03/24/82	<200.	03/24/82	<3		
C053	CITY OF PORTAL			12/10/81	<200.	/ /			
C054	CITY OF STATESBORO			02/08/82	<200.	08/13/82	<4		
C055	CITY OF STATESBORO AIRPT.			01/05/78	<200.	/ /			
C056	CLARK'S MOBILE HOME VILL.			10/19/78	<200.	/ /			
C057	COACH HOUSE ESTATES MHP			12/09/81	<200.	/ /			
C058	COLONIAL HEIGHTS S/D			06/22/78	<200.	/ /			
C059	COUNTRY CLUB HILLS		B054	12/09/81	<200.	/ /			
C060	COUNTRY LAKES S/D			08/26/81	<200.	/ /			
C061	CYPRESS LAKE MHP			03/15/79	<200.	/ /			
C062	FOREST HEIGHTS S/D			12/10/81	<200.	/ /			
C063	FOREST HILLS S/D			06/15/82	<200.	/ /			
C064	FRANKVILLE WATER ASSN.			09/17/81	<200.	/ /			
C065	FRANK'S TRAILER PARK			08/27/81	<200.	/ /			
C066	GEORGIA SOUTHERN COLLEGE			01/19/82	<200.	01/19/82	<4		
C067	GROVE LAKES S/D			01/19/82	<200.	/ /			
C068	HAZELWOOD S/D			01/19/82	<200.	/ /			
C069	JANE BEAVER S/D			01/03/79	<200.	/ /			
C070	JOHNSON MHP			10/20/81	<200.	/ /			
C071	LAKE COLLINS ESTATES			10/19/78	<200.	/ /			
C072	LAKESIDE ESTATES			06/15/82	<200.	/ /			
C073	LANIER TRAILER PARK			10/05/78	<200.	/ /			
C074	LEE'S RIVERSIDE ESTATES			06/15/82	<200.	/ /			
C075	LEEFIELD WATER ASSN.			03/23/82	<200.	/ /			
C076	MILL CREEK ESTATES			08/26/81	<200.	/ /			
C077	MELSON LAW WATER SYSTEM			09/17/81	<200.	/ /			
C078	NEVILS WATER ASSOCIATION		B053	09/17/81	<200.	05/12/82	<4		
C079	NEWTON'S MH VILLAGE			02/08/82	<200.	/ /			
C080	REGISTER WATER ASSN.			09/16/81	<200.	/ /			
C081	RIDGEVIEW APARTMENTS			08/26/81	<200.	/ /			
C082	TANKERSLEY S/D			06/15/82	<200.	/ /			
C083	BARN MHP			08/26/81	<200.	/ /			
C084	THOMAS TRAILER PARK			02/07/79	<200.	/ /			
C085	WESTCHESTER S/D			07/27/78	<200.	/ /			

APPENDIX C: WELLS USED IN BARIUM AND GROSS ALPHA PLATES (CONTINUED)

MAP NUM.	SUPPLY NAME	WELL NUM.	OTHER ID #	BARIUM SAMPLE DATE	BARIUM CONC. (ug/l)	RAD. SAMPLE DATE	GROSS ALPHA ACT. (piC/l)	RA226 ACTIV-ITY (piC/l)	RA228 ACTIV-ITY (piC/l)
C086	WINDFIELD S/D			06/15/82	<200.	/ /			
C087	WOODLAND MOBILE ESTATES			04/16/79	<200.	/ /			
C088	YOUNGBLOOD MHP			12/10/81	<200.	/ /			
C089	ZETTEROWER MHP			12/09/81	<200.	/ /			
**	CANDLER								
C090	CITY OF METTER			03/22/78	<200.	03/22/78	3+-2		
C091	CITY OF PULASKI			08/27/81	<200.	08/27/81	<2		
**	COFFEE								
C092	BITTAKER TRAILER PARK			02/16/82	<200.	/ /			
C093	CITY OF AMBROSE		B060	12/20/77	280.	05/10/84	<3		
C094	CITY OF BROXTON			03/30/82	<200.	03/30/82	7+-2	5.4	<1.0
C095	CITY OF DOUGLAS			02/16/82	<200.	02/15/82	2+-2		
C096	CITY OF NICHOLLS			03/30/82	<200.	01/01/00			
C097	CITY OF NICHOLLS	2		/ /		12/07/83	3+-2	2.4	
C098	EVANS TRAILER PARK	2		11/18/81	<200.	/ /			
C099	GENERAL COFFEE STATE PK.			04/10/79	<200.	/ /			
C100	HARPER'S MHP			09/27/78	<200.	/ /			
C101	HEAD S/D			09/29/78	<200.	/ /			
C102	HILLSIDE TRAILER PARK			03/30/82	<200.	/ /			
C103	LITTLE ACRES TAILER PARK			04/09/79	<200.	/ /			
C104	NORTH SIDE MHP			03/07/78	<200.	/ /			
C105	PARKVIEW MOBILE HOME VIL.		B064	10/08/81	<200.	07/22/82	4+-3	2.6	
C106	SOUTHERN WATER INC.			01/04/82	<200.	/ /			
C107	TOWN & COUNTRY TRAILER PK			09/14/78	<200.	/ /			
**	COLQUITT								
C108	BEAR CREEK S/D			08/03/81	<200.	/ /			
C109	CITY OF BERLIN			05/26/78	<200.	02/17/83	2+-2		
C110	COLQUITT CO. MEM. HOSP.		B071	07/21/78	<200.	10/05/82	<4		
C111	CRESTWOOD S/D		B070	01/01/00		12/27/81	2+-2		
C112	CITY OF DOERUN			08/03/81	385.	09/26/83	2+-1		
C113	CITY OF ELLENTON			07/23/81	<200.	03/24/83	2+-2		
C114	CITY OF FUNSTON			05/26/78	<200.	09/14/82	2+-2		
C115	HARTSFIELD COMMUNITY			02/04/82	340.	02/20/84	6+-2	4.9	<1.0
C116	CITY OF MOULTRIE			12/22/81	<200.	01/09/84	2+-2		
C117	CITY OF NORMAN PARK			07/23/81	<200.	02/20/84	<2		
C118	CLUBVIEW S/D			08/03/81	<200.	/ /			
C119	COUNTRY CIRCLE S/D			07/06/79	<200.	/ /			
C120	DEMOTT S/D			09/14/81	<200.	/ /			
C121	GREEN ACRES ESTATES			01/22/79	<200.	/ /			
C122	INDIAN LAKES S/D			09/14/81	<200.	/ /			
C123	PINEY GROVE S/D			10/24/79	<200.	/ /			
C124	RIVERSIDE MANUFACTURING			08/22/78	<200.	/ /			
C125	RIVERWOOD SD			10/27/81	<200.	/ /			
C126	RUFUS MHP			11/14/78	<200.	/ /			
C127	SANDS MHP			05/02/79	<200.	/ /			
C128	SHADY GROVE S/D			10/27/81	<200.	/ /			

APPENDIX C: WELLS USED IN BARIUM AND GROSS ALPHA PLATES (CONTINUED)

MAP NUM.	SUPPLY NAME	WELL NUM.	OTHER ID #	BARIUM SAMPLE DATE	BARIUM CONC. (ug/l)	RAD. SAMPLE DATE	GROSS ALPHA ACT. (piC/l)	RA226 ACTIV-ITY (piC/l)	RA228 ACTIV-ITY (piC/l)
C129	SPENCEFIELD AIRPORT			01/21/82	<200.	/ /			
C130	SPENCETON S/D 1			08/20/81	<200.	/ /			
C131	SPENCETON S/D 2			08/20/81	<200.	/ /			
C132	TALOKAS CIRCLE S/D			08/20/81	<200.	/ /			
C133	YANCEY TRAILER RENTALS			03/16/79	<200.	/ /			
**	COOK								
C134	CITY OF ADEL			02/19/81	<200.	03/03/83	<2		
C135	CITY OF CECIL			02/19/81	<200.	09/13/82	<4		
C136	CITY OF LENOX			04/14/81	<200.	02/01/83	<2		
C137	CITY OF SPARKS			08/18/81	<200.	09/08/83	<4		
C138	GIDDENS TRAILER PARK			08/18/81	<200.	/ /			
C139	TILLMANS TRAILER PARK			06/28/79	<200.	/ /			
**	DECATUR								
C140	CITY OF ATTAPULGUS	1		/ /		08/09/83	8+-2	4.6	<1.0
C141	CITY OF ATTAPULGUS	2		/ /		06/07/84	14+-2	11.2	<1.0
C142	CITY OF ATTAPULGUS			02/10/81	250.	/ /			
C143	CITY OF BAINBRIDGE			05/14/80	<200.	10/19/82	<3		
C144	CITY OF CLIMAX			04/15/82	<200.	04/17/84	<1		
C145	DECATUR CO. CORR. INST.			12/05/78	<200.	/ /			
C146	DECATUR CO. IND. PARK			05/21/79	<200.	/ /			
C147	DOLLAR COMMUNITY APTS.			06/21/79	<200.	/ /			
C148	ENGELHARDS M&C			06/21/79	<200.	/ /			
C149	FLINTWOOD S/D			04/03/79	<200.	/ /			
C150	JAMES TRAILER PARK			02/22/79	<200.	/ /			
C151	MEADOWBROOK S/D			11/19/79	<200.	/ /			
C152	REDBARN NHP		B129	06/02/81	<200.	08/19/82	<3		
C153	ROBINWOOD ESTATES			08/14/80	<200.	/ /			
C154	SANDY ACRES MHP			08/05/81	<200.	/ /			
C155	TOWN OF BRINSON			09/10/81	<200.	09/20/83	<2		
**	EFFINGHAM								
C156	BLOOMINGDALE S/D			03/18/82	<200.	/ /			
C157	CITY OF GUYTON			01/13/82	<200.	01/13/81	<3		
C158	CITY OF RINCON			04/20/82	<200.	09/20/78	1+-2		
C159	CITY OF SPRINGFIELD			12/05/77	<200.	01/04/83	<3		
C160	GLEN LEE TRAILER PARK			01/13/82	<200.	/ /			
C161	GOSHEN TERRACE		B149	03/11/82	<200.	03/19/82	<2		
C162	HAGIN WATER WORKS			04/19/79	<200.	/ /			
C163	LAKE CHERIE MHP			10/16/79	<200.	/ /			
C164	LAKESIDE FARMS S/D			05/06/82	<200.	/ /			
C165	MELDRIM LAKES			09/18/78	<200.	/ /			
C166	REDGATE MHP			12/15/81	<200.	/ /			
C167	WESTWOOD HEIGHTS S/D			04/20/82	<200.	/ /			
**	EVANS								
C168	CITY OF BELLVILLE			04/15/82	<200.	04/15/82	<3		
C169	CITY OF CLAXTON			05/05/82	<200.	05/05/82	<2		
C170	CITY OF DAISY			04/15/82	<200.	03/23/84	<2		

APPENDIX C: WELLS USED IN BARIUM AND GROSS ALPHA PLATES (CONTINUED)

MAP NUM.	SUPPLY NAME	WELL NUM.	OTHER ID #	BARIUM SAMPLE DATE	BARIUM CONC. (ug/l)	RAD. SAMPLE DATE	GROSS ALPHA ACT. (piC/l)	RA226 ACTIV-ITY (piC/l)	RA228 ACTIV-ITY (piC/l)
C171	CITY OF HAGAN			05/05/82	<200.	05/05/82	<2		
C172	EVANS MEMORIAL HOSPITAL			04/15/82	<200.	/ /			
**	GRADY								
C173	CITY OF CAIRO			09/14/78	<200.	10/26/81	3+-2	2.3	
C174	CITY OF WHIGHAM		B161	06/28/82	200.	04/10/84	2+-2		
C175	DOLLAR MHP			12/03/80	270.	01/31/83	<2		
C176	GAY'S MHP			11/14/78	<200.	/ /			
C177	MAXWELL COMMUNITY			02/14/79	<200.	/ /			
C178	PINE TERRACE ESTATES			08/25/81	<200.	/ /			
C179	RENO WATER SYSTEM			02/14/79	200.	04/10/84	1+-1		
C180	SOUTHERN TERRACE MHP			09/24/81	<200.	/ /			
C181	WALDEN TRAILER PARK #1			04/09/81	<200.	/ /			
**	IRWIN								
C182	CITY OF MYSTIC			01/11/82	<200.	01/31/84	<2		
C183	CITY OF OCILLA			09/11/80	<200.	12/07/82	<2		
C184	FOREST ESTATE S/D			10/30/78	485.	/ /			
C185	IRWINVILLE WATER WORKS CO			01/11/82	<200.	/ /			
C186	KITCHENS MHP			02/06/79	310.	/ /			
C187	SIZLAND TRAILER PARK			08/27/79	340.	/ /			
**	JEFF DAVIS								
C188	B & B TRAILER PARK			02/08/82	<200.	/ /			
C189	CITY OF DENTON		B172	04/12/78	<200.	08/30/82	<4		
C190	CITY OF HAZELHURST			04/06/78	300.	02/09/83	4+-2	3.9	<1.0
C191	EDGEWOOD TRAILER PARK			11/19/81	223.	/ /			
C192	DENDERSON TRAILER PARK			02/08/82	<200.	/ /			
**	MITCHELL								
C193	BOWEN MOBILE ESTATES		B179	04/24/79	<200.	11/30/82	<3		
C194	CITY OF BACONTON			02/25/82	<200.	07/27/83	<3		
C195	CITY OF CAMILLA			11/19/79	<200.	09/28/82	<3		
C196	CITY OF PELHAM			12/16/80	<200.	11/16/82	<4		
C197	CITY OF SALE CITY			06/22/82	<200.	09/28/82	<4		
C198	HINSONTON WATER ASSN.		B180	06/22/82	285.	06/12/84	2+-2		
C199	SHADY GROVE TRAILER PARK			03/29/82	<200.	/ /			
C200	WACO COMMUNITY			10/23/80	<200.	/ /			
**	MONTGOMERY								
C201	ALLMONDS TRAILER PARK			01/18/79	<200.	/ /			
C202	CHARLOTTE WATER ASSN.			04/02/82	220.	/ /			
C203	CITY OF AILEY		B191	02/02/82	<200.	01/04/78	21+-3	20.7	0.2
C204	CITY OF AILEY (MODIFIED)		B191	/ /		09/22/82	<3		
C205	CITY OF ALSTON		B192	02/24/82	<200.	02/24/82	<3		
C206	CITY OF MOUNT VERNON	1	B190	05/24/78	<200.	02/28/78	29+-5	25.5	0.5
C207	CITY OF MOUNT VERNON	2		09/15/81	<200.	08/05/82	<3		
C208	CITY OF TARRYTOWN	1		03/21/78	400.	03/21/78	30+-5	51.0	1.2
C209	CITY OF TARRYTOWN	2	B194	01/06/82	410.	03/15/82	2+-2		
C210	CITY OF UVALDA			04/02/82	<200.	04/02/82	<4		
C211	MONTGOMERY CO CORR INST			05/10/82	<200.	10/25/83	<3		

APPENDIX C: WELLS USED IN BARIUM
AND GROSS ALPHA PLATES (CONTINUED)

MAP NUM.	SUPPLY NAME	WELL NUM.	OTHER ID #	BARIUM SAMPLE DATE	BARIUM CONC. (ug/l)	RAD. SAMPLE DATE	GROSS ALPHA ACT. (piC/l)	RA226 ACTIV-ITY (piC/l)	RA228 ACTIV-ITY (piC/l)
C212	WILDWOOD MHP		B195	/ /		08/05/82	5+-2	4.8	<1.0
**	SCREVEN								
C213	BRINSONS TRAILER PARK			12/20/78	<200.	/ /			
C214	CITY OF HILTONIA			06/20/78	<200.	09/30/82	<4		
C215	CITY OF NEWINGTON			08/25/81	<200.	08/25/81	<2		
C216	CITY OF OLIVER			08/25/81	<200.	08/25/81	<2		
C217	CITY OF SYLVANIA			06/07/78	<200.	11/18/82	<3		
C218	GREEN ACRES MHP			12/21/78	<200.	/ /			
C219	INDIAN BRANCH TRAILER PK.			12/20/78	<200.	/ /			
C220	INDIGO MOBILE ESTATES		B201	12/21/78	<200.	07/27/83	<2		
C221	PO-ROBIN MHP			12/21/78	<200.	/ /			
**	TATTNALL								
C222	BEARDS CREEK TRAILER PARK			01/06/82	<200.	/ /			
C223	CITY OF COBBTOWN			01/06/82	<200.	01/06/82	<3		
C224	CITY OF COLLINS			09/18/78	<200.	05/17/82	<4		
C225	CITY OF GLENNVILLE			11/09/77	<200.	09/14/82	<2		
C226	CITY OF MANASSAS		B213	01/06/82	<200.	01/02/82	<4		
C227	CITY OF REIDSVILLE			09/19/78	<200.	09/14/83	<3		
C228	GEORGIA STATE PRISON			06/16/82	<200.	06/16/82	<2		
**	TELFAIR								
C229	CITY OF HELENA			02/04/82	<200.	01/26/84	2+-2		
C230	CITY OF JACKSONVILLE			01/18/82	<200.	01/12/84	3+-1		
C231	CITY OF JACKSONVILLE	2	B226	/ /		04/26/83	5+-2	4.5	<1.0
C232	CITY OF LUMBER CITY			12/01/81	330.	12/02/81	3+-1		
C233	CITY OF LUMBER CITY	1	B222	01/01/00		12/01/83	3+-1		
C234	CITY OF MCRAE			01/08/82	270.	03/08/84	3+-1		
C235	CITY OF MILAN			12/22/81	<200.	08/26/82	4+-2		
C236	CITY OF SCOTLAND			12/08/81	245.	08/23/83	<3		
**	THOMAS								
C237	CINDY LANE S/D			02/12/81	<200.	/ /			
C238	CIRCLE C MOBILE ESTATES			02/02/82	<200.	04/19/84	3+-1		
C239	CITY OF BOSTON			08/02/78	<200.	01/25/83	<2		
C240	CITY OF COOLIDGE			07/18/79	<200.	11/09/82	2+-2		
C241	CITY OF MEIGS			12/18/80	210.	03/08/79	2+-2		
C242	CITY OF OCHLOCKNEE			06/23/82	<200.	06/05/84	<3		
C243	CITY OF PAVO			07/18/79	<200.	08/30/82	<3		
C244	CITY OF THOMASVILLE			03/25/82	<200.	09/29/83	<3		
C245	CRABAPPLE HILLS			02/12/81	<200.	/ /			
C246	CRESTWOOD MHP 1			09/09/81	<200.	/ /			
C247	CRESTWOODMHP 2			09/09/81	<200.	/ /			
C248	FOREST PARK MHP			01/18/79	<200.	/ /			
C249	FOXCROFT S/D			01/18/79	<200.	/ /			
C250	LITTLE ACRES ESTATES			09/17/81	<200.	/ /			
C251	OAKLAND S/D			03/23/82	<200.	/ /			
C252	PEBBLE HILL PLANTATION			05/10/79	<200.	/ /			
C253	PINE LAKE ESTATES MHP			09/17/81	<200.	/ /			

APPENDIX C: WELLS USED IN BARIUM AND GROSS ALPHA PLATES (CONTINUED)

MAP NUM.	SUPPLY NAME	WELL NUM.	OTHER ID #	BARIUM SAMPLE DATE	BARIUM CONC. (ug/l)	RAD. SAMPLE DATE	GROSS ALPHA ACT. (piC/l)	RA226 ACTIV- ITY (piC/l)	RA228 ACTIV- ITY (piC/l)
C254	ROSE CITY ESTATES			12/23/80	<200.	/ /			
C255	SHADY REST MHP			03/23/82	<200.	/ /			
C256	SUGARWOOD ESTATES MHP		B242	05/02/82	<200.	04/25/84	2+-1		
C257	SUNNY BELLE ACRES WA ASSN			04/02/81	<200.	/ /			
C258	THOMAS CO. CORR. INST.			09/23/80	<200.	/ /			
C259	TINY ACRES MHP			03/09/82	<200.	/ /			
C260	TOWN & COUNTRY ESTATES			10/09/80	<200.	/ /			
C261	TWIN ACRES S/D			11/19/81	<200.	/ /			
**	TIFT								
C262	ABRAHAM BALDWIN AG. COL.			12/16/80	210.	09/02/82	3+-2	2.3	
C263	BAILEYS TRAILER PARK			02/15/79	<200.	/ /			
C264	BAR W MHP			06/23/81	<200.	/ /			
C265	BOWEN-WRIGHT S/D			10/16/78	<200.	/ /			
C266	CHURCH OF GOD CAMPGROUND			09/29/81	<200.	/ /			
C267	CITY OF OMEGA			06/22/82	355.	05/22/84	<3		
C268	CITY OF TIFTON			03/09/82	225.	/ /			
C269	CITY OF TIFTON	4	B253	/ /		02/10/83	7+-2	4.8	<1.0
C270	CITY OF TIFTON	5	B250	/ /		02/10/83	15+-3	16.9	<1.0
C271	CITY OF TIFTON	7	B259	/ /		11/26/86	3+-1		
C272	CITY OF TYTY			12/16/80	<200.	10/07/82	<4		
C273	COUNTRY HAVEN TRAILER PK.			02/02/82	<200.	/ /			
C274	FERRY LAKE TRAILER PARK			08/24/81	<200.	/ /			
C275	FOREST LAKE ESTATES			02/15/79	<200.	/ /			
C276	GREEN ACRES MHP			04/16/79	240.	/ /			
C277	HIDE A WAY TRAILER PARK			09/26/79	<200.	/ /			
C278	HOBBS S/D			11/21/78	<200.	/ /			
C279	KEENS TRAILER PARK 1			01/08/81	<200.	/ /			
C280	OAK RIDGE TRAILER PARK			09/10/80	220.	/ /			
C281	PEBBLE BROOK MEADOWS S/D			06/21/82	<200.	06/21/82	<3		
C282	PINE HILL MHP		B257	06/28/82	215.	03/29/84	20+-2	25.9	<1.0
C283	PITTS TRAILER PARK			12/08/80	<200.	/ /			
C284	SEABROOK TRAILER PARK			02/15/79	<200.	/ /			
C285	SELPH TRAILER PARK			06/01/82	<200.	/ /			
C286	SPRING HILL PROPERTIES		B258	10/13/81	<200.	/ /			
C287	TIFT AREA MHP			06/28/79	<200.	/ /			
C288	TOWN & COUNTRY ESTATES		B260	06/28/82	225.	05/31/84	<2		
C289	VEAZEY TRAILER PARK			05/06/82	400.	/ /			
C290	WILSONS MHP			10/16/78	<200.	/ /			
C291	WHISPERING PINES MHP		B261	06/14/82	270.	02/21/84	11+-2	8.6	<1.0
C292	YANCEY TRAILER PARK			02/09/82	<200.	/ /			
**	TOOMBS								
C293	CATO'S TRAILER PARK			11/04/81	<200.	/ /			
C294	CENTER HILL MHP			02/08/82	<200.	/ /			
C295	CITY OF LYONS			02/09/82	<200.	12/08/82	2+-2		
C296	CITY OF SANTA CLAUS			03/30/78	<200.	02/08/82	<4		
C297	CITY OF VIDALIA			02/09/82	<200.	02/08/82	<4		

APPENDIX C: WELLS USED IN BARIUM AND GROSS ALPHA PLATES (CONTINUED)

MAP NUM.	SUPPLY NAME	WELL NUM.	OTHER ID #	BARIUM SAMPLE DATE	BARIUM CONC. (ug/l)	RAD. SAMPLE DATE	GROSS ALPHA ACT. (piC/l)	RA226 ACTIVITY (piC/l)	RA228 ACTIVITY (piC/l)
C298	M & T WATER WORKS			03/09/82	<200.	/ /			
C299	MCNATT FALLS S/D		B270	03/09/82	200.	03/01/82	4+-2	3.3	<1.0
C300	PETROSS WATER SYSTEM			11/04/81	<200.	/ /			
C301	SHADY ACRES TRAILER PARK			11/02/78	<200.	/ /			
**	WHEELER								
C302	CITY OF ALAMO	1		11/07/79	500.	01/24/78	188+-	196	0.4
C303	CITY OF ALAMO	2	B274	10/21/81	<200.	04/24/80	11+-2	4.8	<1.0
C304	CITY OF ALAMO	3		/ /		09/01/87	<2		
C305	CITY OF GLENWOOD		B278	11/08/77	285.	12/15/81	3+-2	2.1	
**	WORTH								
C306	CITY OF POULAN			04/21/82	250.	05/01/84	3+-2		
C307	CITY OF SUMNER			06/15/81	215.	12/09/82	2+-2		
C308	CITY OF SYLVESTER			06/10/81	<200.	11/18/82	2+-2		
C309	CITY OF WARWICK		B281	05/25/82	<200.	04/24/84	<3		
C310	CONGER MHP			06/10/81	<200.	/ /			
C311	ISABELLA WATER SYSTEM			05/13/82	200.	/ /			
C312	NETHER MHP			04/20/81	210.	/ /			
C313	PINE NEEDLE LANE TR. PK.			04/22/82	<200.	/ /			
C314	PLEASANT HILLS MHP			02/09/81	<200.	/ /			
C315	SOWEGA YOUTH HOME			05/14/79	<200.	/ /			
C316	WORTHY MANOR S/D		B282	08/12/81	<200.	08/11/83	<2		

Notes:

a Barium concentration data from memorandum of 9/17/74 on file at the Georgia Geologic Survey, no sample date given

b Barium concentration data from memorandum of 9/2/80 on file at the Georgia Geologic Survey, no sample date given

c Barium concentration data from file notes dated 7/31/78 on file at the Georgia Geologic Survey, no sample date given

APPENDIX D: PERMEABILITY TEST RESULTS

SAMPLE NUMBER	SAMPLE DEPTH (FEET)	VERTICAL HYDRAULIC CONDUCTIVITY (FT/D)
** GGS 3199		
137	276	0.048
139	305	0.056
138	330	0.027
140	360	D N S
120	385	0.081
121	403- 410	2.2
122	434- 436	25.
123	462- 468	12.
124	488	0.034
125	518	0.098
126	545	0.52
127	569	0.58
128	596	0.44
129	622	0.17
130	647	0.23
131	671	0.017
132	695	0.066
133	725	0.0022
134	748	0.0026
135	770	0.022
136	787	0.0083
** GGS 3213		
106	226	47.
107	244- 261	13.
108	271- 275	6.8
109	293- 297	0.31
110	367- 390	0.097
111	439- 443	3.2
112	466	48.
113	501	9.8
114	527	0.53
115	547	0.024
116	575	0.27
117	597	0.17
118	629	0.00083
119	651	0.033
96	674	0.0011
97	725	0.092
98	748	4.2
99	776	5.3
100	800	0.023

APPENDIX D: PERMEABILITY TEST RESULTS (CONTINUED)

SAMPLE NUMBER	SAMPLE DEPTH (FEET)	VERTICAL HYDRAULIC CONDUCTIVITY (FT/D)
101	826	0.032
102	853	0.0099
103	887	0.020
104	899- 903	0.062
105	198	0.13
** GGS 3535		
91	797	0.0055
90	822- 838	0.0034
89	848	0.0050
88	873	0.0068
87	899	0.0086
86	925	0.00048
85	948- 951	0.0020
84	977- 980	0.0091
83	1005	0.00057
82	1023-1028	0.0042
81	1057	0.0056
80	1081	0.0044
79	1106	0.00084
78	1128	0.0016
77	1150	0.0032
76	1173-1177	0.00044
** GGS 3541		
75	422	0.067
74	443	1.0
73	464	DNS
72	491	DNS
71	520- 521	DNS
70	545	0.00037
69	575	0.0011
68	592- 600	0.00049
67	625- 633	0.75
66	643- 661	0.18
65	673- 675	0.036
64	698- 701	0.011
63	718- 720	0.018
62	744- 748	0.048
61	769	0.0076
60	794	0.022
59	817- 818	0.00044
58	845- 849	0.0099
57	875	0.078

APPENDIX D: PERMEABILITY TEST RESULTS (CONTINUED)

SAMPLE NUMBER	SAMPLE DEPTH (FEET)	VERTICAL HYDRAULIC CONDUCTIVITY (FT/D)
56	901	0.0094
55	924	D N S
54	957	0.047
53A	979	0.25
52	1002	0.0029
51	1024	0.078
50	1051	0.16
** GGS 3542		
94	609	0.26
93	642	1.6
92	651- 662	2.1
2	722	11.
3	729	99.
4	744	23.
5	749	1.8
6	761	0.020
7	764	0.0038
8	786	0.21
9	796	0.030
10	806	0.0066
11	810	0.88
12	824	0.71
13	850	2.1
14	874	0.030
15	901	0.018
16	936	0.040
17	952	0.016
18	974	0.44
19	1008	3.7
20	1033	0.0088
21	1058-1062	0.0063
22	1086	D N S
23	1107-1121	0.018
24	1145-1146	0.029
25	1170	0.027
26	1225-1238	0.0037
27	1246-1255	0.0028
28	1265-1267	0.0041
** GGS 3544		
29	150- 154	0.0024
30	170- 171	D N S
31	192	0.0071

APPENDIX D: PERMEABILITY TEST RESULTS (CONTINUED)

SAMPLE NUMBER	SAMPLE DEPTH (FEET)	VERTICAL HYDRAULIC CONDUCTIVITY (FT/D)
32	204- 215	4.6
** GGS 3545		
33	312- 317	D N S
34	337- 339	D N S
35	363	3.9
36	423	0.17
37	456	0.20
38	483	1.5
39	506	0.0098
40	525- 536	0.013
41	546- 560	0.019
42	583	0.016
43	610- 619	0.0050
44	642	0.021
45	667	0.0042
46	704	0.046
47	729	0.00080
48	755- 759	0.099
49	783	0.023

Notes:

D N S denotes samples that did not saturate

Sample depth is listed as a range where core recovery was poor

**See separate envelope
for Plates 1 - 15**

For convenience in selecting our reports from your bookshelves, they will be color-keyed across the spine by subject as follows:

Red	Valley and Ridge mapping and structural geology
Dk. Purple	Piedmont and Blue Ridge mapping and structural geology
Maroon	Coastal Plain mapping and stratigraphy
Lt. Green	Paleontology
Lt. Blue	Coastal Zone studies
Dk. Green	Geochemical and geophysical studies
Dk. Blue	Hydrology
Olive	Economic geology Mining directory
Yellow	Environmental studies Engineering studies
Dk. Orange	Bibliographies and lists of publications
Brown	Petroleum and natural gas
Black	Field trip guidebooks
Dk. Brown	Collections of papers

Colors have been selected at random, and will be augmented as new subjects are published.

$5598/500

Editor: Patricia A. Allgood

Cartographer: Don Shellenberger

DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

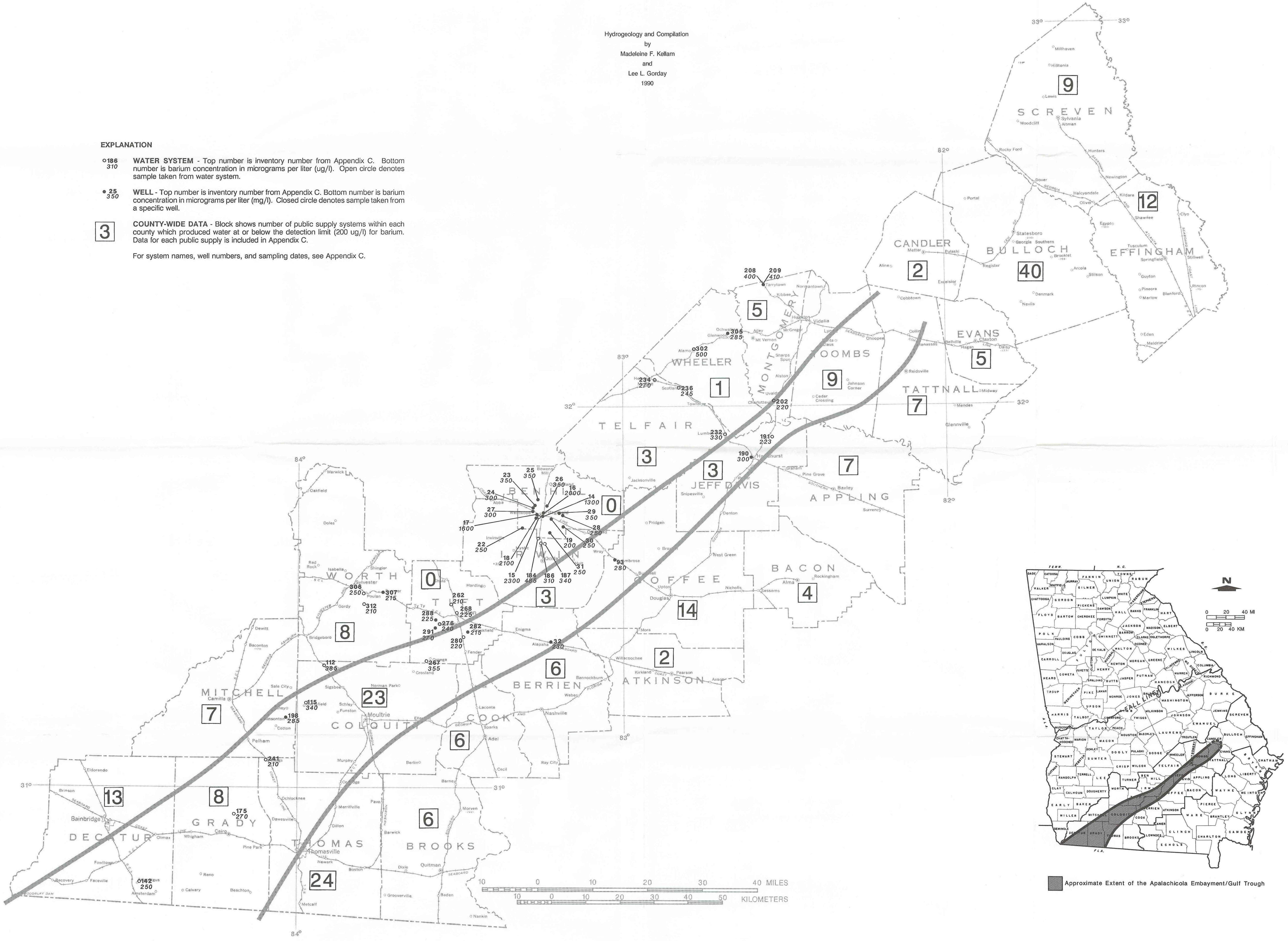
DISTRIBUTION OF BARIUM IN GROUND WATER FROM THE FLORIDAN AQUIFER SYSTEM IN THE GULF TROUGH/APALACHICOLA EMBAYMENT AREA

Hydrogeology and Compilation
by
Madeleine F. Kellam
and
Lee L. Gorday
1990

EXPLANATION

○186 *310*	**WATER SYSTEM** - Top number is inventory number from Appendix C. Bottom number is barium concentration in micrograms per liter (ug/l). Open circle denotes sample taken from water system.
● 25 *350*	**WELL** - Top number is inventory number from Appendix C. Bottom number is barium concentration in micrograms per liter (mg/l). Closed circle denotes sample taken from a specific well.
3	**COUNTY-WIDE DATA** - Block shows number of public supply systems within each county which produced water at or below the detection limit (200 ug/l) for barium. Data for each public supply is included in Appendix C.

For system names, well numbers, and sampling dates, see Appendix C.



Base map from U.S. Geological Survey 1:500,000 map of Georgia, 1970.

DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
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DISTRIBUTION OF SULFATE IN GROUND WATER FROM THE FLORIDAN AQUIFER SYSTEM IN THE GULF TROUGH/APALACHICOLA EMBAYMENT AREA

Hydrogeology and Compilation
by
Madeleine F. Kellam
and
Lee L. Gorday
1990

EXPLANATION

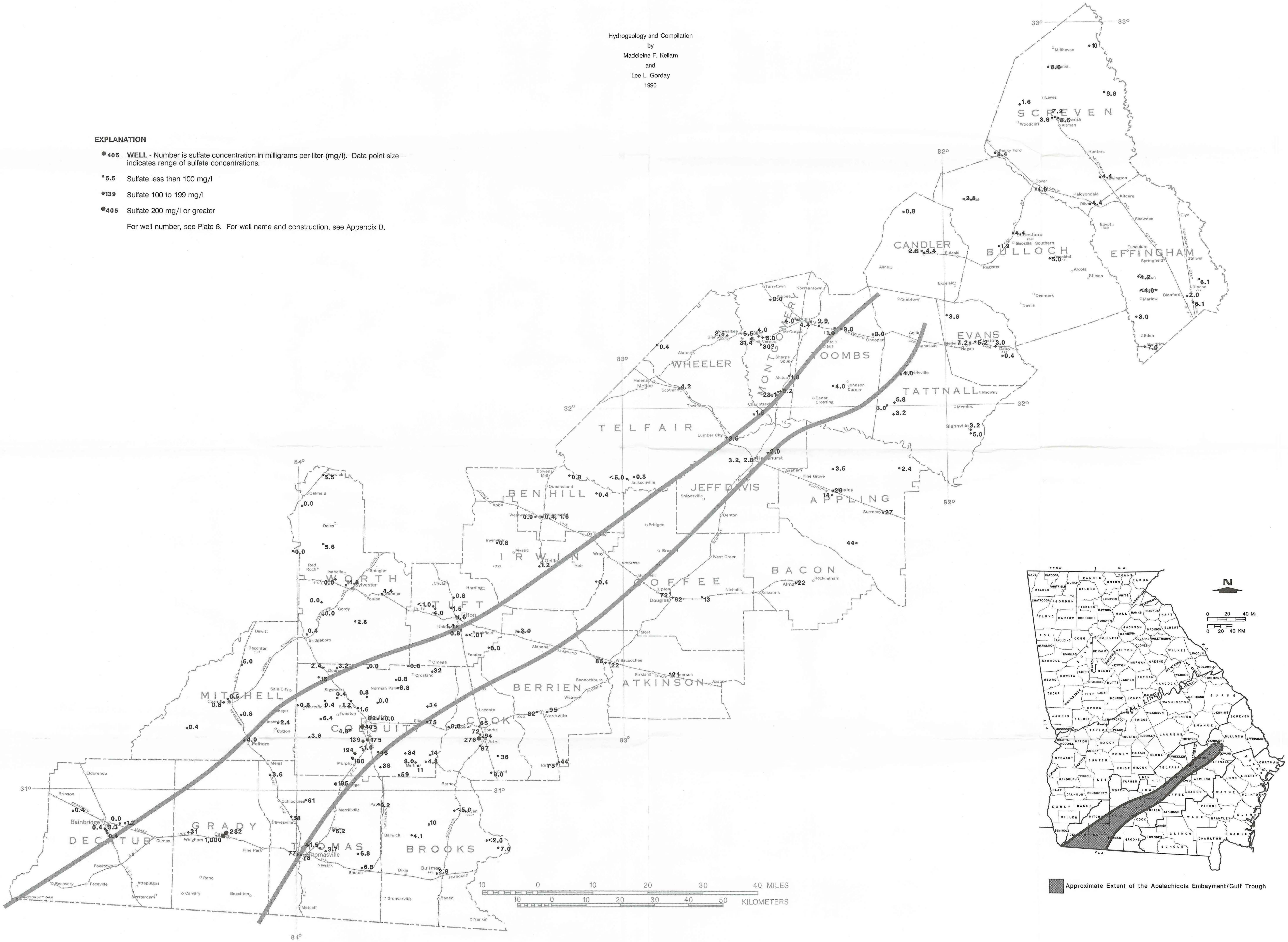
● 405 **WELL** - Number is sulfate concentration in milligrams per liter (mg/l). Data point size indicates range of sulfate concentrations.

• 5.5 Sulfate less than 100 mg/l

● 139 Sulfate 100 to 199 mg/l

● 405 Sulfate 200 mg/l or greater

For well number, see Plate 6. For well name and construction, see Appendix B.



▨ Approximate Extent of the Apalachicola Embayment/Gulf Trough

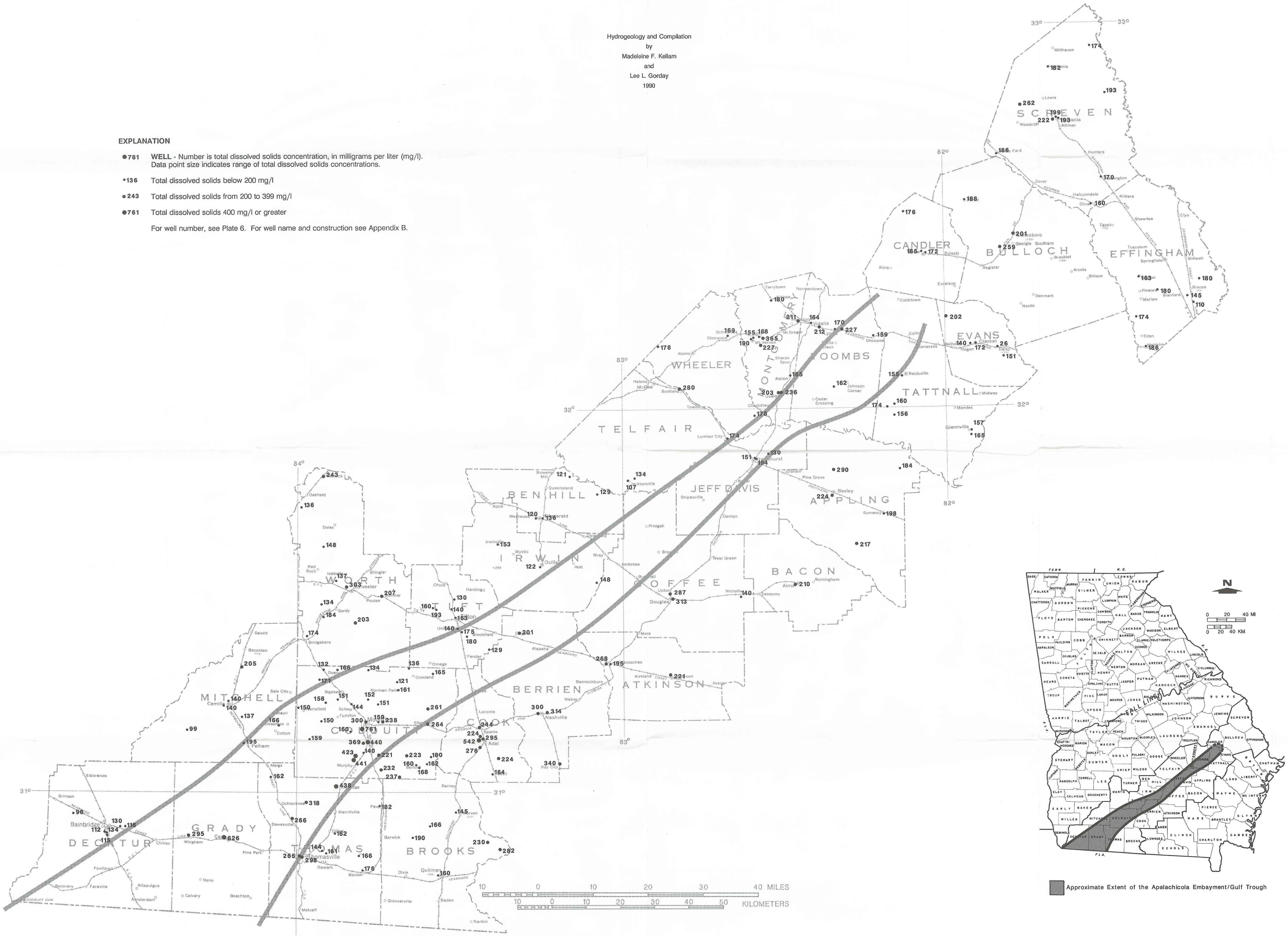
Base map from U.S. Geological Survey 1:500,000 map of Georgia, 1970.

TOTAL DISSOLVED SOLIDS IN GROUND WATER FROM THE FLORIDAN AQUIFER SYSTEM IN THE GULF TROUGH/APALACHICOLA EMBAYMENT AREA

Hydrogeology and Compilation
by
Madeleine F. Kellam
and
Lee L. Gorday
1990

EXPLANATION

●761	**WELL** - Number is total dissolved solids concentration, in milligrams per liter (mg/l). Data point size indicates range of total dissolved solids concentrations.
•136	Total dissolved solids below 200 mg/l
●243	Total dissolved solids from 200 to 399 mg/l
●761	Total dissolved solids 400 mg/l or greater
	For well number, see Plate 6. For well name and construction see Appendix B.



▨ Approximate Extent of the Apalachicola Embayment/Gulf Trough

Base map from U.S. Geological Survey 1:500,000 map of Georgia, 1970.

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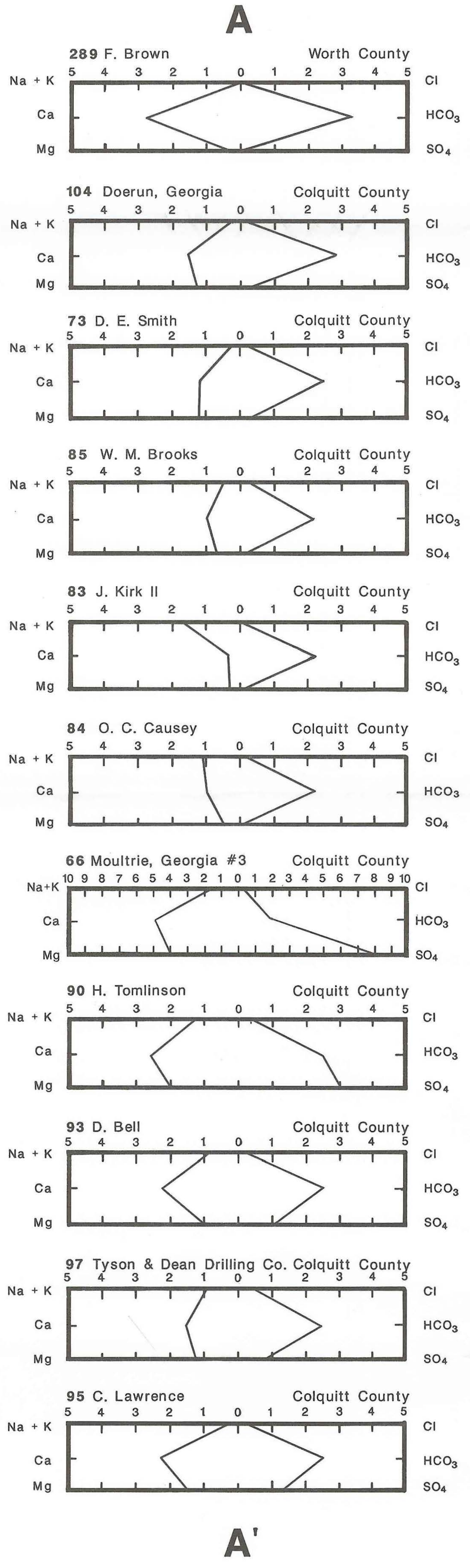
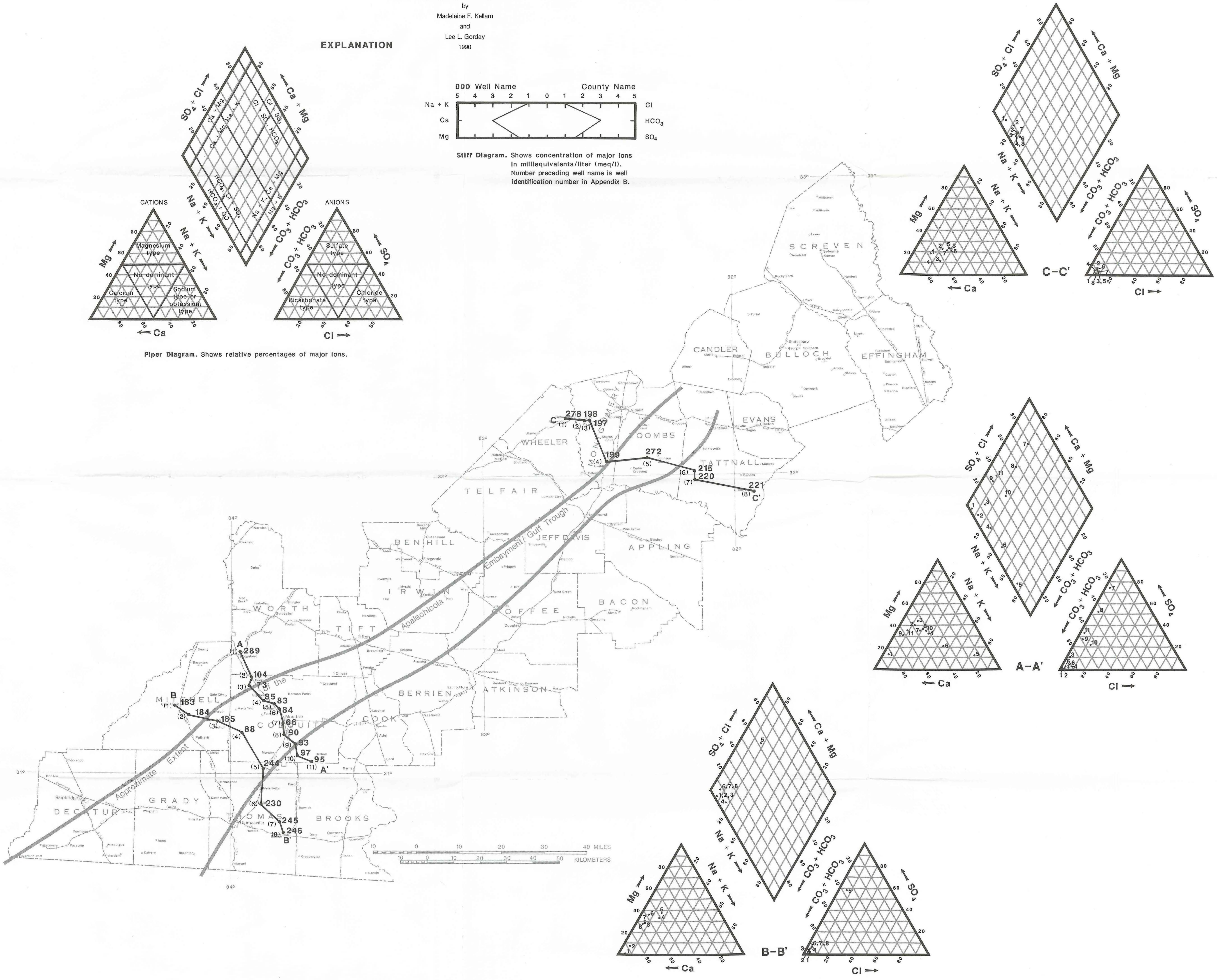
MAJOR ION GEOCHEMISTRY OF THE FLORIDAN AQUIFER SYSTEM

Hydrogeology and Compilation
by
Madeleine F. Kellam
and
Lee L. Gorday
1990





Piper Diagram. Shows relative percentages of major ions.

Stiff Diagram. Shows concentration of major ions in milliequivalents/liter (meq/l). Number preceding well name is well identification number in Appendix B.

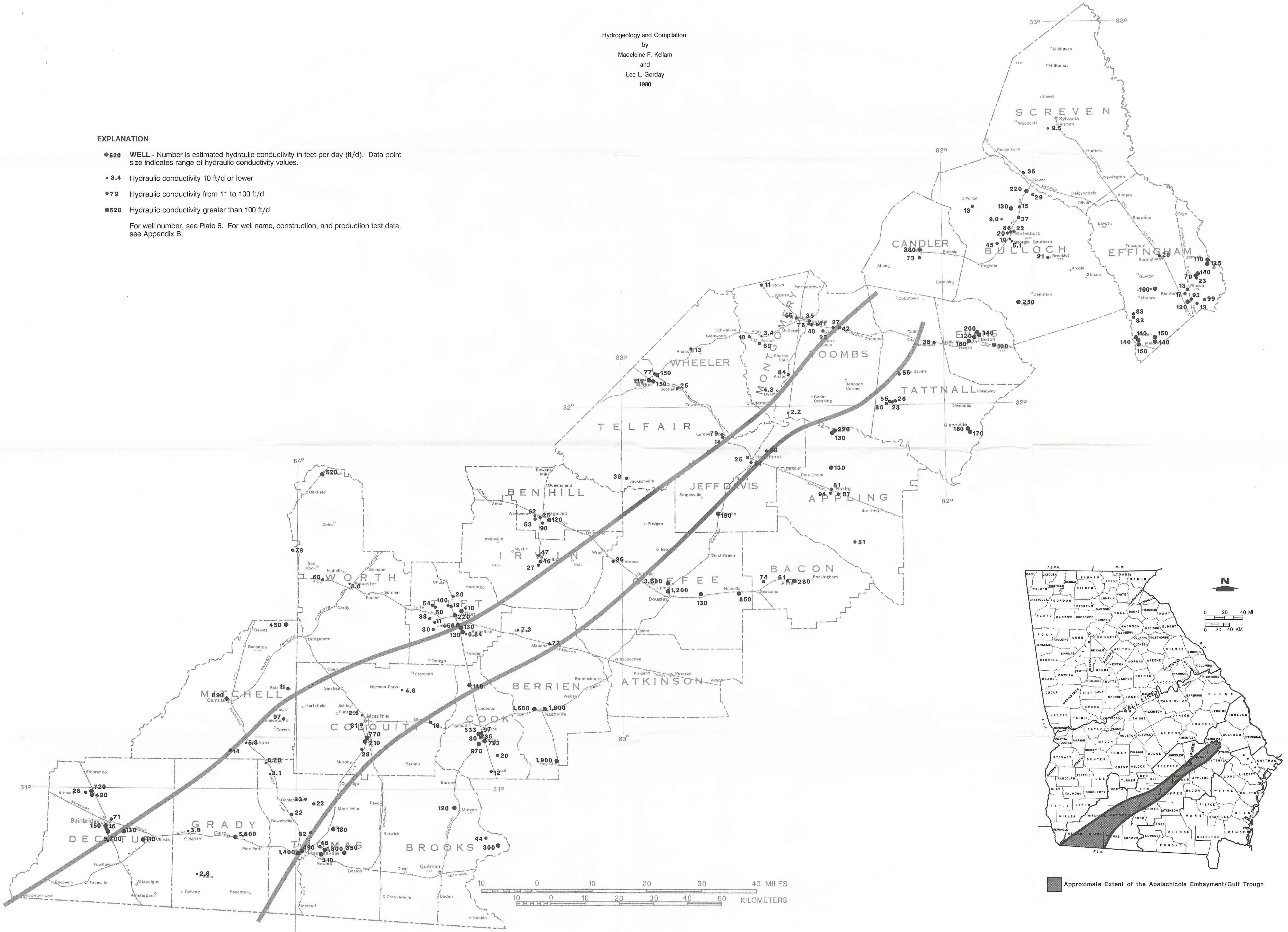
ESTIMATED HYDRAULIC CONDUCTIVITY VALUES FOR WELLS TAPPING THE FLORIDAN AQUIFER SYSTEM IN THE GULF TROUGH/APALACHICOLA EMBAYMENT AREA

Hydrogeology and Compilation
by
Madeleine F. Kellam
and
Lee L. Gorday
1990

EXPLANATION

●520	**WELL** - Number is estimated hydraulic conductivity in feet per day (ft/d). Data point size indicates range of hydraulic conductivity values.
• 3.4	Hydraulic conductivity 10 ft/d or lower
●79	Hydraulic conductivity from 11 to 100 ft/d
●520	Hydraulic conductivity greater than 100 ft/d

For well number, see Plate 6. For well name, construction, and production test data, see Appendix B.



Base map from U.S. Geological Survey 1:500,000 map of Georgia, 1970.

ESTIMATED TRANSMISSIVITY VALUES FOR WELLS TAPPING THE FLORIDAN AQUIFER SYSTEM

IN THE GULF TROUGH/APALACHICOLA EMBAYMENT AREA

Hydrogeology and Compilation
by
Madeleine F. Kellam
and
Lee L. Gorday
1990

EXPLANATION

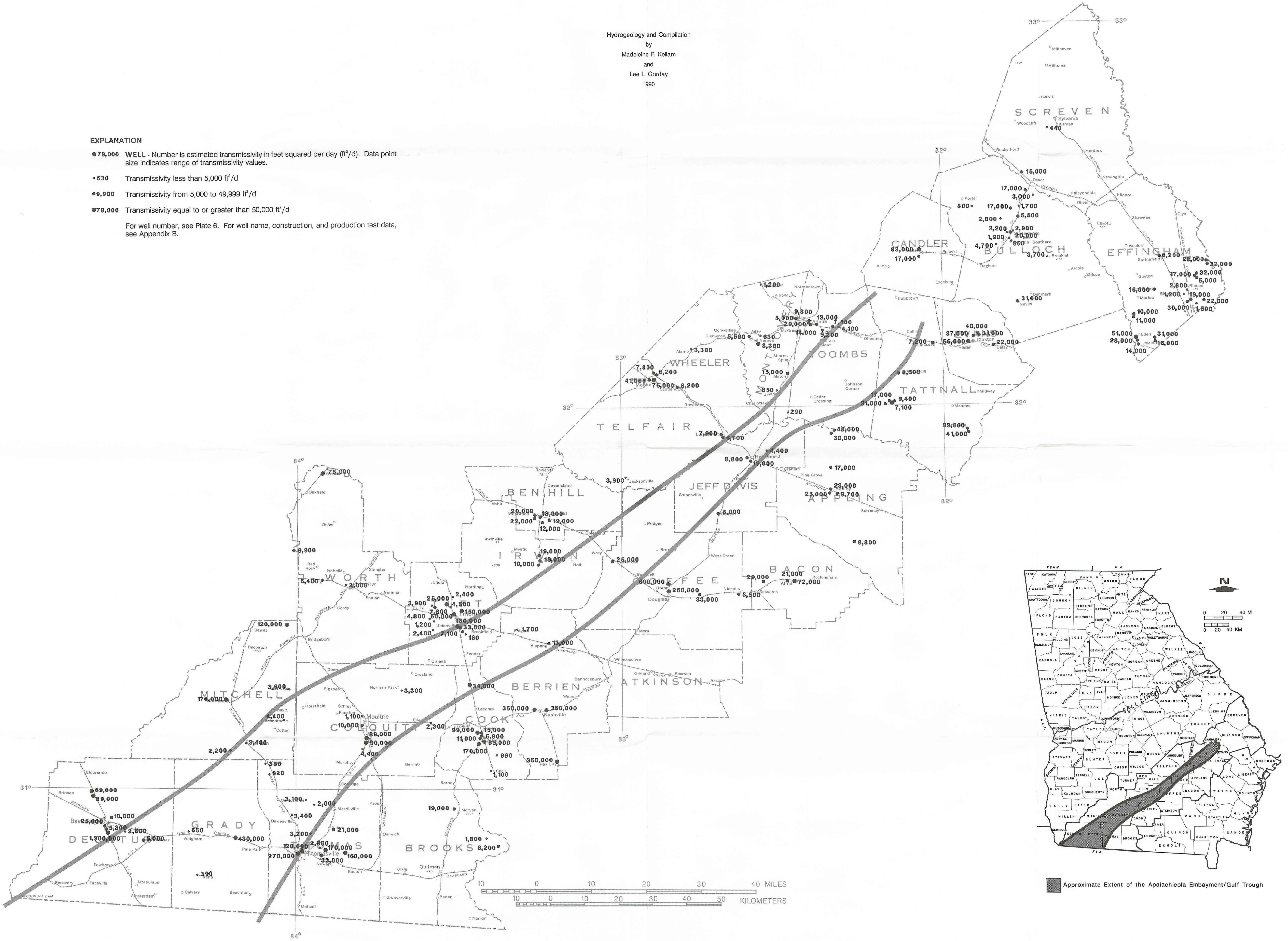
●78,000 **WELL** - Number is estimated transmissivity in feet squared per day (ft²/d). Data point size indicates range of transmissivity values.

•630 Transmissivity less than 5,000 ft²/d

●9,900 Transmissivity from 5,000 to 49,999 ft²/d

●78,000 Transmissivity equal to or greater than 50,000 ft²/d

For well number, see Plate 6. For well name, construction, and production test data, see Appendix B.



Base map from U.S. Geological Survey 1:500,000 map of Georgia, 1970.

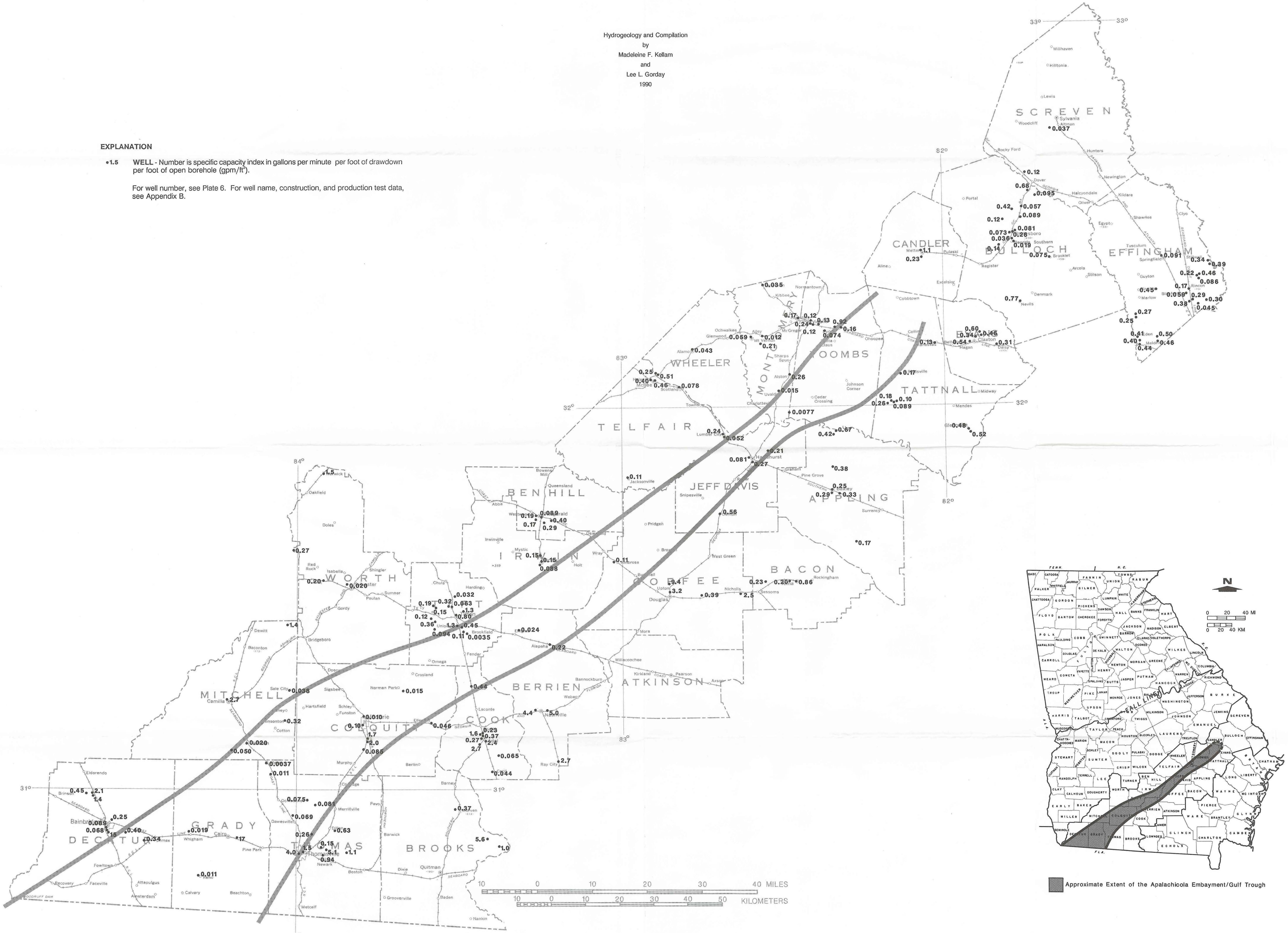
SPECIFIC CAPACITY INDICES FOR WELLS TAPPING THE FLORIDAN AQUIFER SYSTEM IN THE GULF TROUGH/APALACHICOLA EMBAYMENT AREA

Hydrogeology and Compilation
by
Madeleine F. Kellam
and
Lee L. Gorday
1990

EXPLANATION

•1.5 **WELL** - Number is specific capacity index in gallons per minute per foot of drawdown per foot of open borehole (gpm/ft²).

For well number, see Plate 6. For well name, construction, and production test data, see Appendix B.



▨ Approximate Extent of the Apalachicola Embayment/Gulf Trough

Base map from U.S. Geological Survey 1:500,000 map of Georgia, 1970.

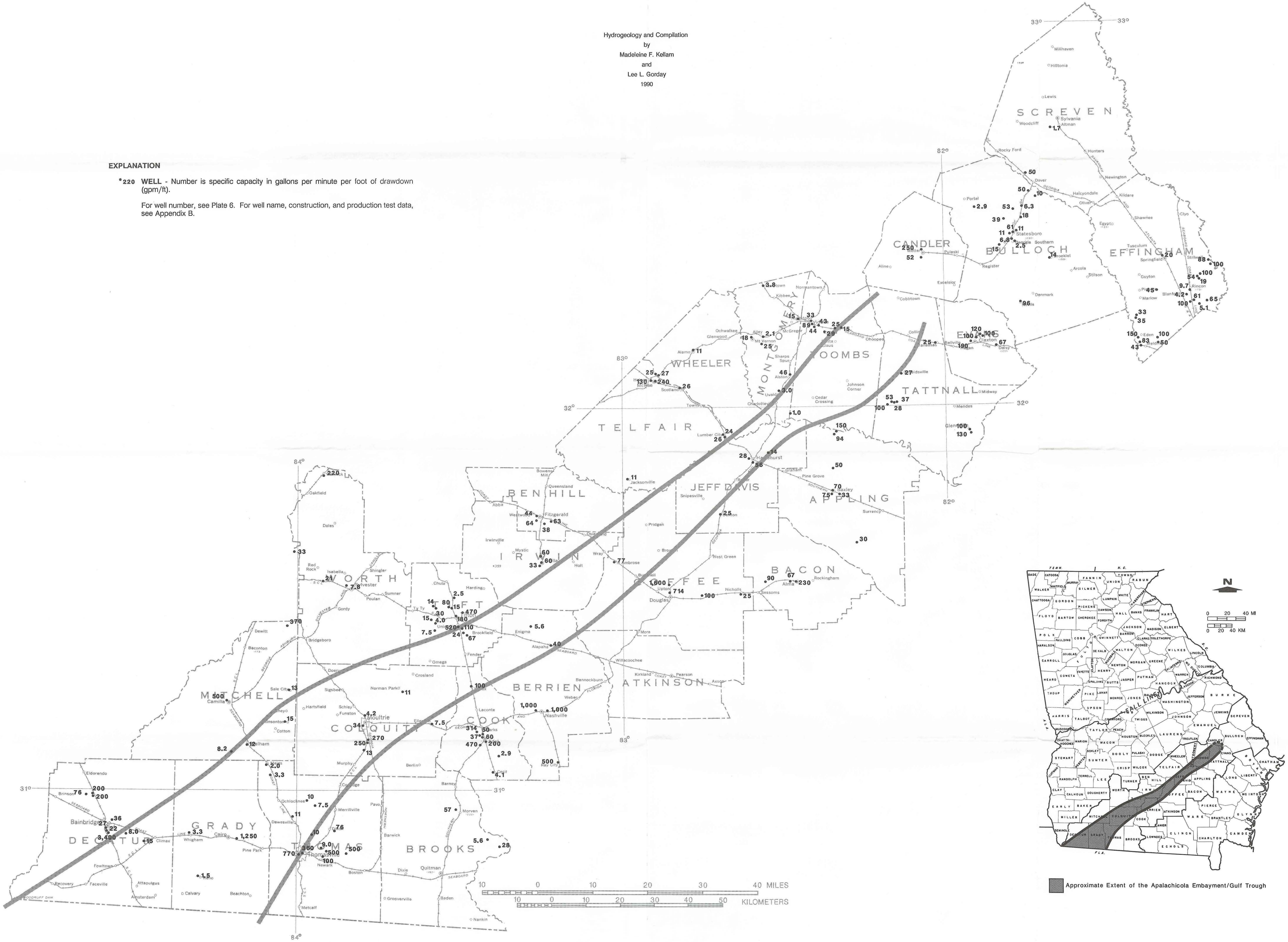
SPECIFIC CAPACITY VALUES FOR WELLS TAPPING THE FLORIDAN AQUIFER SYSTEM IN THE GULF TROUGH/APALACHICOLA EMBAYMENT AREA

Hydrogeology and Compilation
by
Madeleine F. Kellam
and
Lee L. Gorday
1990

EXPLANATION

•220 WELL - Number is specific capacity in gallons per minute per foot of drawdown (gpm/ft).

For well number, see Plate 6. For well name, construction, and production test data, see Appendix B.



Approximate Extent of the Apalachicola Embayment/Gulf Trough

Base map from U.S. Geological Survey 1:500,000 map of Georgia, 1970.

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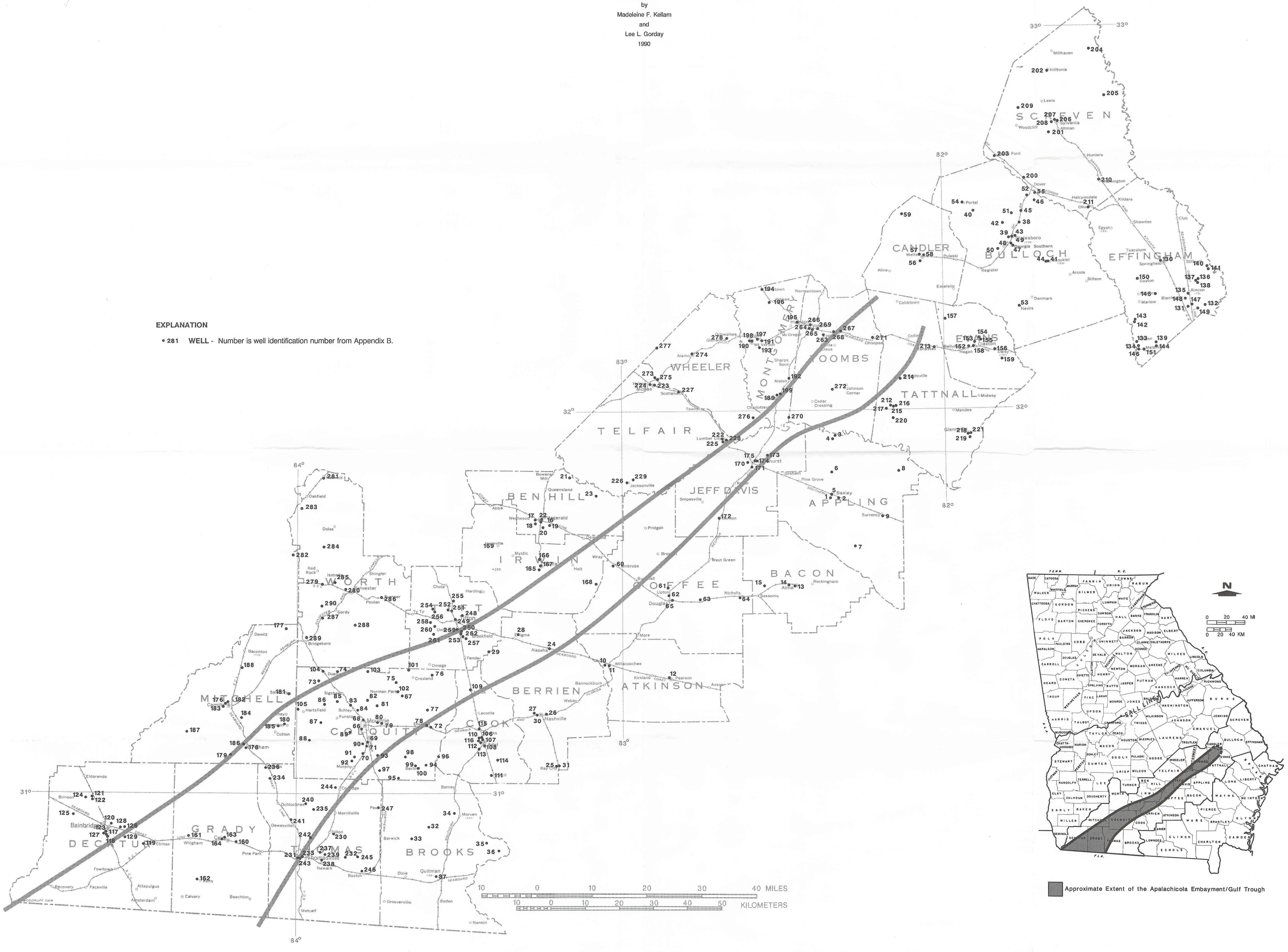
LOCATIONS OF WELLS USED IN MAPPING AQUIFER PROPERTIES AND WATER QUALITY

Hydrogeology and Compilation
by
Madeleine F. Kellam
and
Lee L. Gorday
1990



EXPLANATION

• 281 WELL - Number is well identification number from Appendix B.

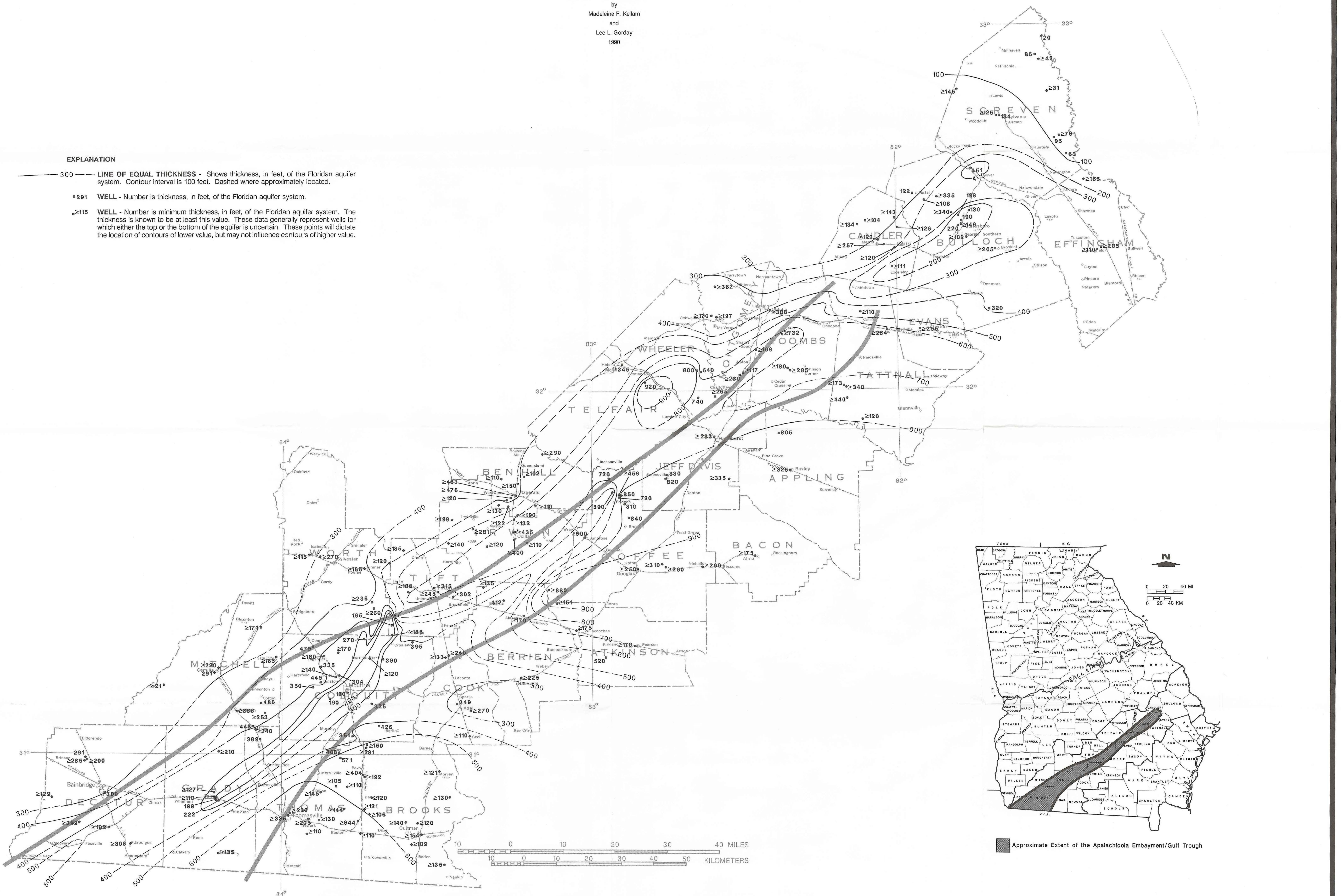
▨ Approximate Extent of the Apalachicola Embayment/Gulf Trough

Base map from U.S. Geological Survey 1:500,000 map of Georgia, 1970.

DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

THICKNESS OF THE FLORIDAN AQUIFER SYSTEM IN THE GULF TROUGH/APALACHICOLA EMBAYMENT AREA

Hydrogeology and Compilation
by
Madeleine F. Kellam
and
Lee L. Gorday
1990



EXPLANATION

—— 300 —— **LINE OF EQUAL THICKNESS** - Shows thickness, in feet, of the Floridan aquifer system. Contour interval is 100 feet. Dashed where approximately located.

•291 **WELL** - Number is thickness, in feet, of the Floridan aquifer system.

•≥115 **WELL** - Number is minimum thickness, in feet, of the Floridan aquifer system. The thickness is known to be at least this value. These data generally represent wells for which either the top or the bottom of the aquifer is uncertain. These points will dictate the location of contours of lower value, but may not influence contours of higher value.

▨ Approximate Extent of the Apalachicola Embayment/Gulf Trough

Base map from U.S. Geological Survey 1:500,000 map of Georgia, 1970.

GEOLOGY AND CONFIGURATION OF THE BASE OF THE FLORIDAN AQUIFER SYSTEM IN THE GULF TROUGH/APALACHICOLA EMBAYMENT AREA

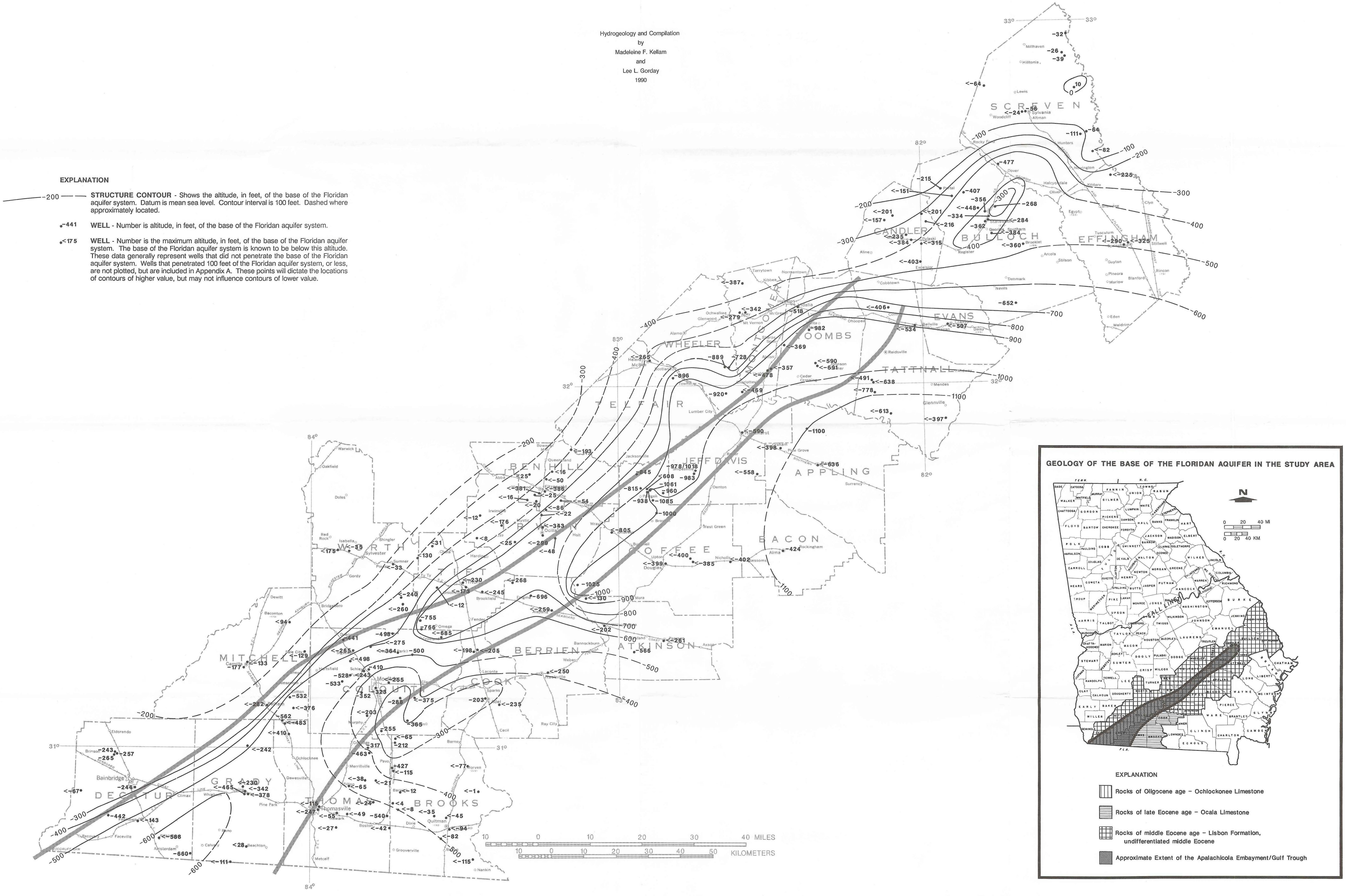
Hydrogeology and Compilation
by
Madeleine F. Kellam
and
Lee L. Gorday
1990

EXPLANATION

—— -200 — — **STRUCTURE CONTOUR** - Shows the altitude, in feet, of the base of the Floridan aquifer system. Datum is mean sea level. Contour interval is 100 feet. Dashed where approximately located.

•-441 **WELL** - Number is altitude, in feet, of the base of the Floridan aquifer system.

•<175 **WELL** - Number is the maximum altitude, in feet, of the base of the Floridan aquifer system. The base of the Floridan aquifer system is known to be below this altitude. These data generally represent wells that did not penetrate the base of the Floridan aquifer system. Wells that penetrated 100 feet of the Floridan aquifer system, or less, are not plotted, but are included in Appendix A. These points will dictate the locations of contours of higher value, but may not influence contours of lower value.



GEOLOGY OF THE BASE OF THE FLORIDAN AQUIFER IN THE STUDY AREA

EXPLANATION

- ▥ Rocks of Oligocene age – Ochlockonee Limestone
- ▤ Rocks of late Eocene age – Ocala Limestone
- ▦ Rocks of middle Eocene age – Lisbon Formation, undifferentiated middle Eocene
- ■ Approximate Extent of the Apalachicola Embayment/Gulf Trough

Base map from U.S. Geological Survey 1:500,000 map of Georgia, 1970.

DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

BULLETIN 94
PLATE 3

GEOLOGY AND CONFIGURATION OF THE TOP OF THE FLORIDAN AQUIFER SYSTEM IN THE GULF TROUGH/APALACHICOLA EMBAYMENT AREA

Hydrogeology and Compilation
by
Madeleine F. Kellam
and
Lee L. Gorday
1990

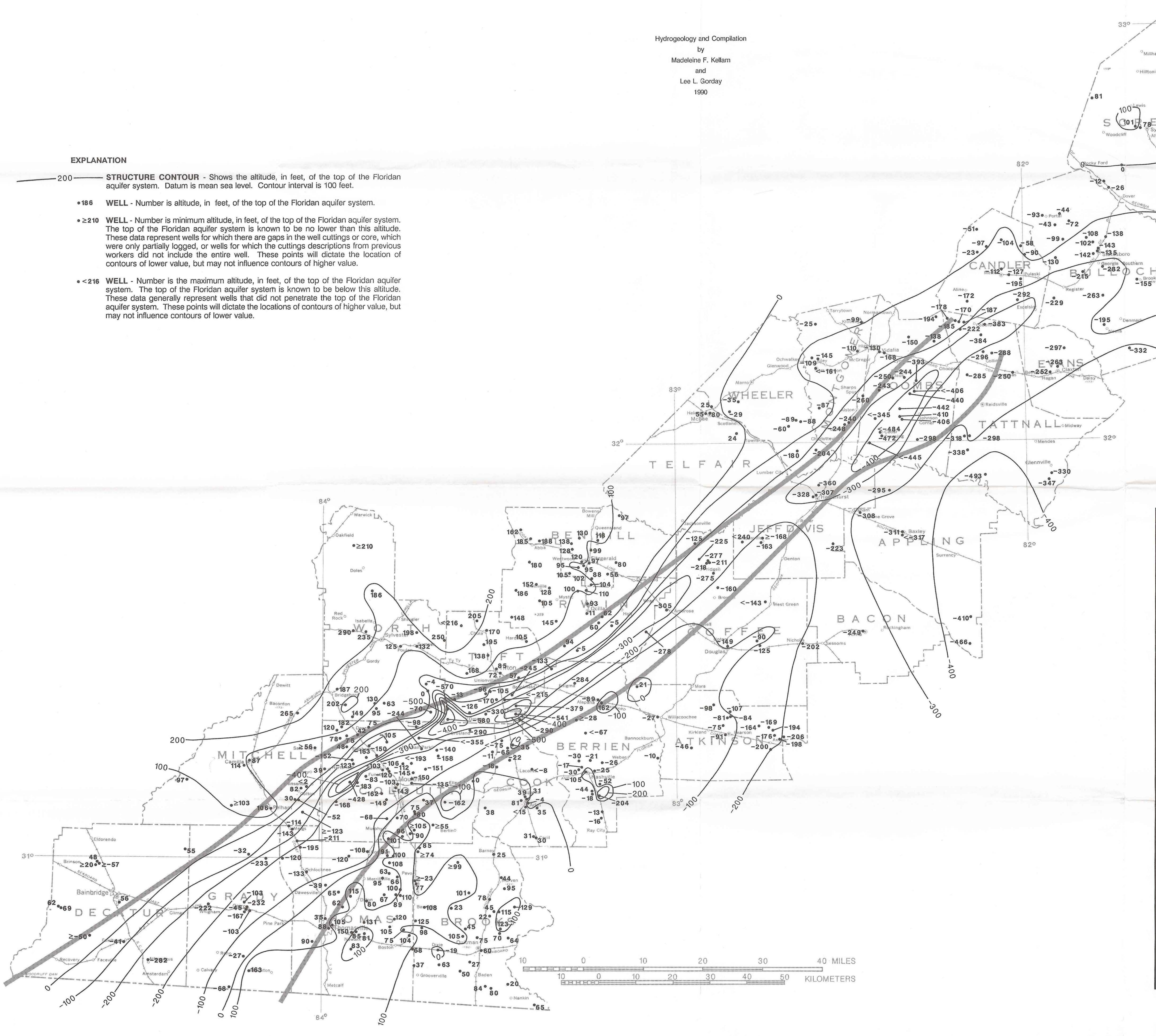
EXPLANATION

——200—— **STRUCTURE CONTOUR** - Shows the altitude, in feet, of the top of the Floridan aquifer system. Datum is mean sea level. Contour interval is 100 feet.

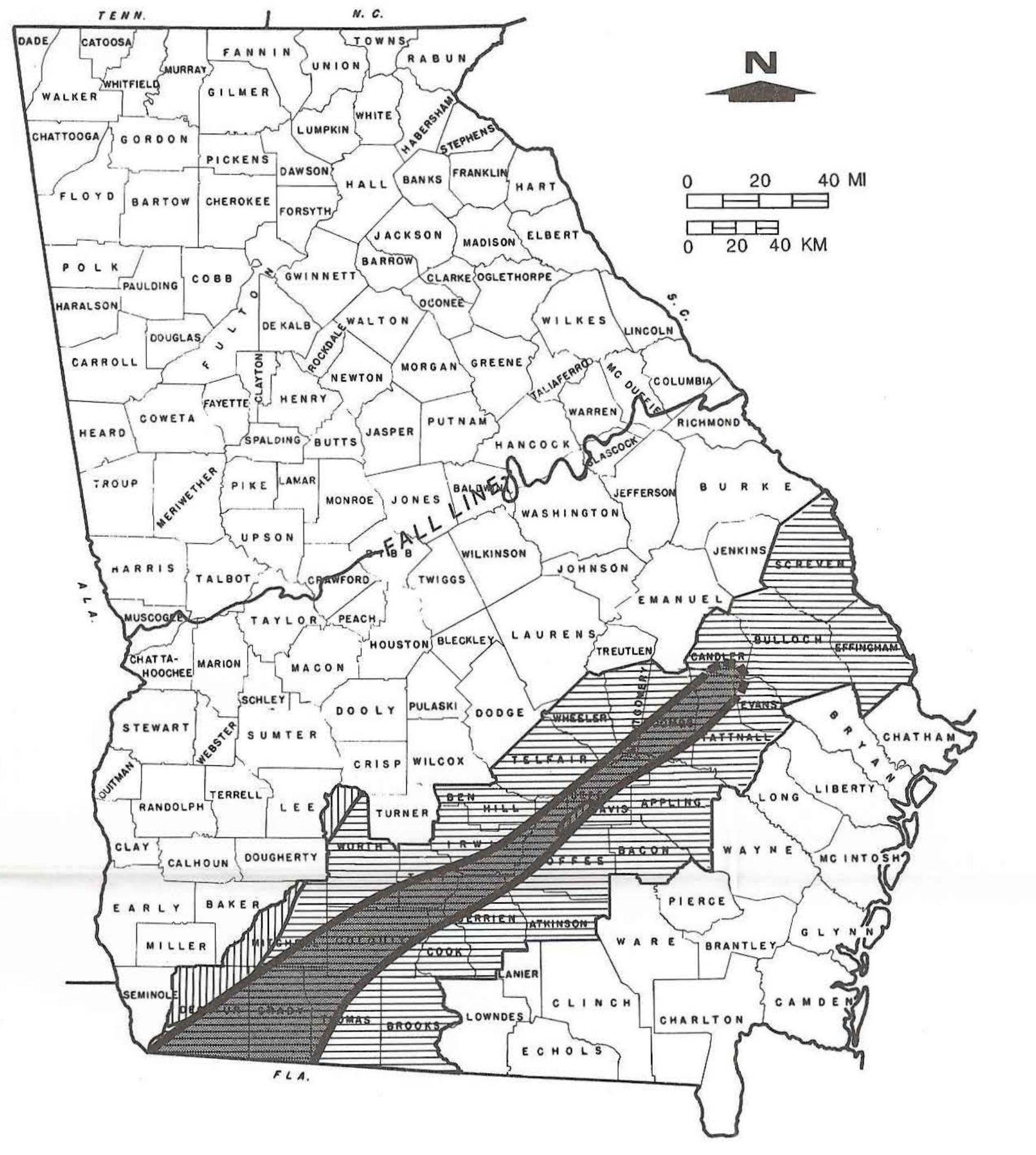
•186 **WELL** - Number is altitude, in feet, of the top of the Floridan aquifer system.

•≥210 **WELL** - Number is minimum altitude, in feet, of the top of the Floridan aquifer system. The top of the Floridan aquifer system is known to be no lower than this altitude. These data represent wells for which there are gaps in the well cuttings or core, which were only partially logged, or wells for which the cuttings descriptions from previous workers did not include the entire well. These points will dictate the location of contours of lower value, but may not influence contours of higher value.

•<216 **WELL** - Number is the maximum altitude, in feet, of the top of the Floridan aquifer system. The top of the Floridan aquifer system is known to be below this altitude. These data generally represent wells that did not penetrate the top of the Floridan aquifer system. These points will dictate the locations of contours of higher value, but may not influence contours of lower value.



GEOLOGY OF THE TOP OF THE FLORIDAN AQUIFER IN THE STUDY AREA



EXPLANATION

▤ Rocks of Oligocene age – Suwannee Limestone, Okapilco Limestone member and undifferentiated Oligocene limestone

▥ Rocks of late Eocene age – Ocala Limestone and equivalents

▩ Approximate Extent of the Apalachicola Embayment/Gulf Trough

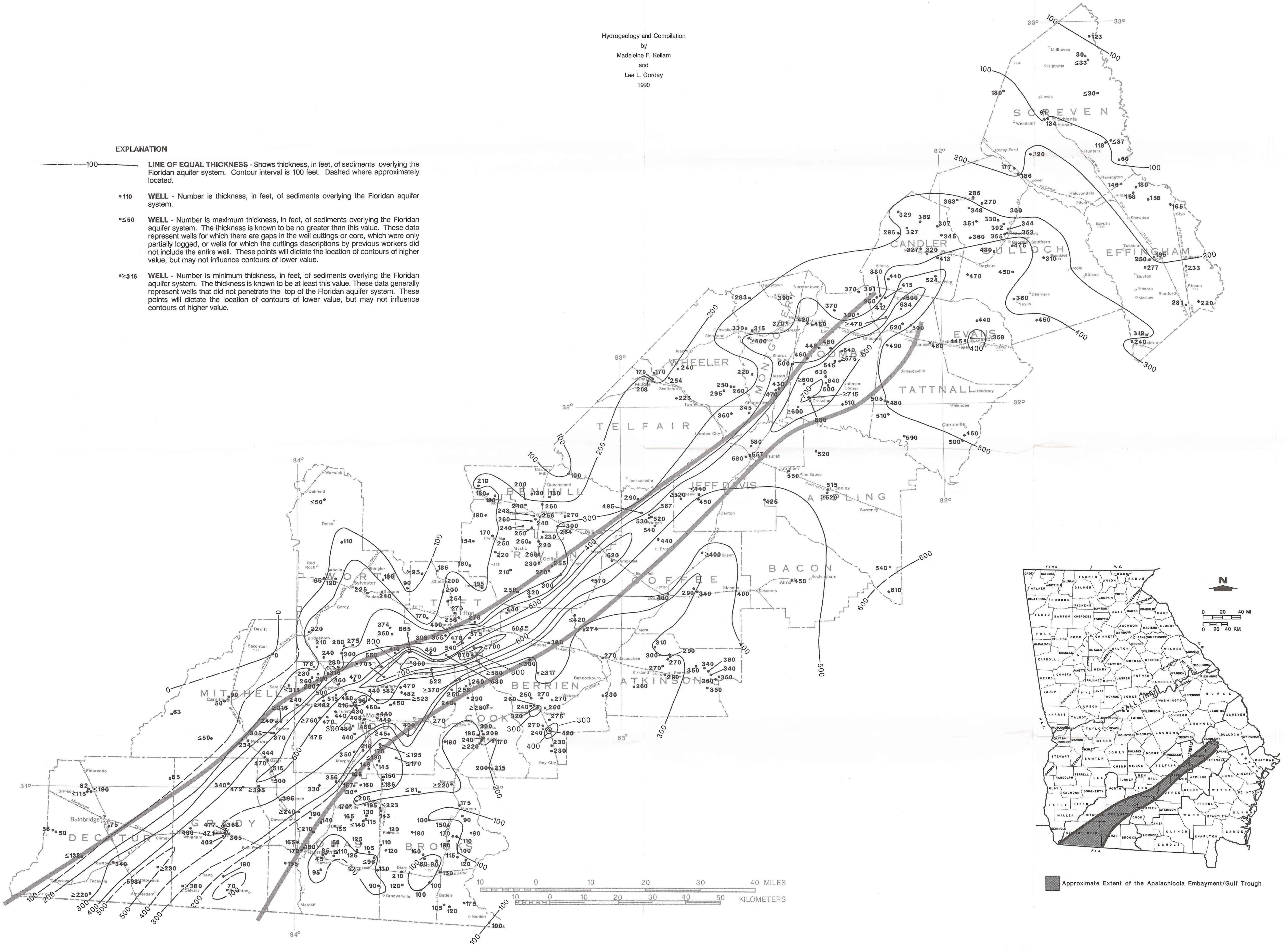
Base map from U.S. Geological Survey 1:500,000 map of Georgia, 1970.

THICKNESS OF SEDIMENTS OVERLYING THE FLORIDAN AQUIFER SYSTEM IN THE GULF TROUGH/APALACHICOLA EMBAYMENT AREA

Hydrogeology and Compilation
by
Madeleine F. Kellam
and
Lee L. Gorday
1990

EXPLANATION

——100——	**LINE OF EQUAL THICKNESS** - Shows thickness, in feet, of sediments overlying the Floridan aquifer system. Contour interval is 100 feet. Dashed where approximately located.
•110	**WELL** - Number is thickness, in feet, of sediments overlying the Floridan aquifer system.
•≤50	**WELL** - Number is maximum thickness, in feet, of sediments overlying the Floridan aquifer system. The thickness is known to be no greater than this value. These data represent wells for which there are gaps in the well cuttings or core, which were only partially logged, or wells for which the cuttings descriptions by previous workers did not include the entire well. These points will dictate the location of contours of higher value, but may not influence contours of lower value.
•≥316	**WELL** - Number is minimum thickness, in feet, of sediments overlying the Floridan aquifer system. The thickness is known to be at least this value. These data generally represent wells that did not penetrate the top of the Floridan aquifer system. These points will dictate the location of contours of lower value, but may not influence contours of higher value.



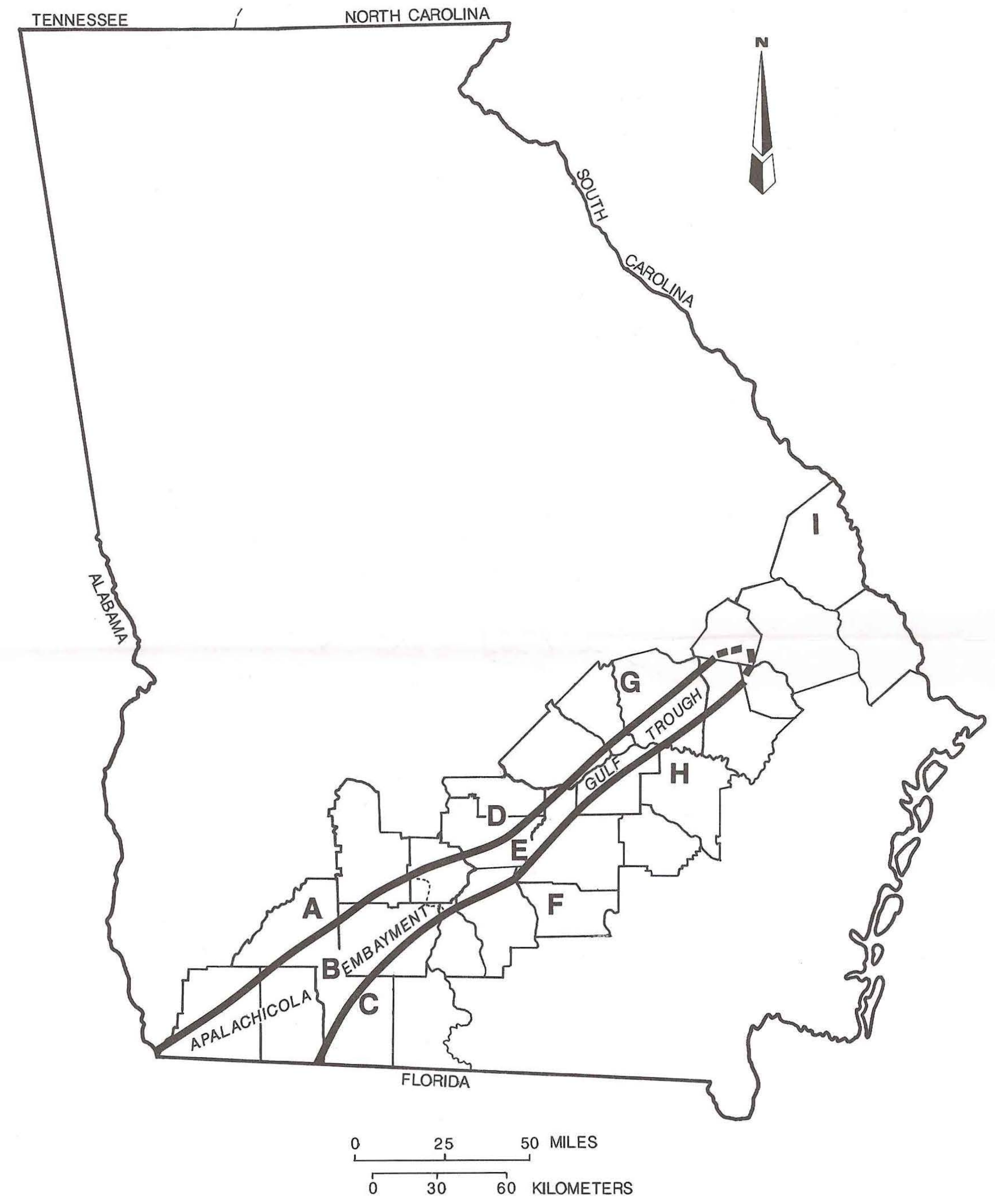
Base map from U.S. Geological Survey 1:500,000 map of Georgia, 1970.

DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

BULLETIN 94
PLATE 1

STRATIGRAPHIC UNITS IN THE GULF TROUGH/APALACHICOLA EMBAYMENT AREA AND THEIR RELATIONSHIP TO THE FLORIDAN AQUIFER SYSTEM

Hydrogeology and Compilation
by
Madeleine F. Kellam
and
Lee L. Gorday
1990



EXPLANATION

▒ Floridan Aquifer System

▩ Not Present

PERIOD	EPOCH	STAGE	A	B	C	D	E	F	G	H	I
TERTIARY	PLIOCENE		▩	Miccosukee Formation	Miccosukee Formation	▩	▩	▩	▩	▩	▩
	MIOCENE		▩	Hawthorne Group: Coosa-whatchie Formation Meigs Member	Hawthorne Group: undifferentiated	Altamaha Formation	Altamaha Formation	Altamaha Formation	Altamaha Formation	Altamaha Formation	▩
			▩	undifferentiated sand and clay		Hawthorne Group: no data	Hawthorne Group: Coosa-whatchie Formation Meigs Member undifferentiated sand and clay	Hawthorne Group: no data	Hawthorne Group: Coosa-whatchie Formation Meigs Member no data	Hawthorne Group: Coosa-whatchie Formation Marks Head Formation	▩
			▩	Parachucla Formation	Chattahoochee Formation	Parachucla Formation	Parachucla Formation	Parachucla Formation	Parachucla Formation	Parachucla Formation	Altamaha Formation
	OLIGOCENE	VICKSBURGIAN	▩	undifferentiated Oligocene limestone	▩	no data	Suwannee Limestone Okapilco Member	▩	▩	▩	▩
			▩	Ochlockonee Formation	Suwannee Limestone		Ochlockonee Formation	Suwannee Limestone	undifferentiated Oligocene limestone	Suwannee Limestone	Suwannee Limestone
			Bridgeboro Limestone		Bridgeboro Limestone	Bridgeboro Limestone	Pridgen Limestone Member	▩	▩	▩	▩
	EOCENE UPPER	JACKSONIAN	Ocala Group	undifferentiated Upper Eocene limestone	Ocala Group	Ocala Group	undifferentiated Upper Eocene limestone	Ocala Group	Ocala Group	Ocala Group	Barnwell Group
	EOCENE MIDDLE	CLAIBORNIAN	Lisbon Formation	undifferentiated Middle Eocene limestone	unnamed Middle Eocene limestone	Lisbon Formation	undifferentiated Middle Eocene limestone	unnamed Middle Eocene limestone	Lisbon Formation	unnamed Middle Eocene limestone	Lisbon Formation
			"Tallahatta" Formation	"Tallahatta" Formation		"Tallahatta" Formation	"Tallahatta" Formation		"Tallahatta" Formation		undifferentiated sand
	EOCENE LOWER	SABINIAN	Midway/Wilcox Groups undifferentiated	Midway/Wilcox Groups undifferentiated	undifferentiated Sabinian sediments	Midway/Wilcox Groups undifferentiated	Midway/Wilcox Groups undifferentiated	Midway/Wilcox Groups undifferentiated	Midway/Wilcox Groups undifferentiated	Midway/Wilcox Groups undifferentiated	Midway/Wilcox Groups undifferentiated
	PALEOCENE	MIDWAYAN			▩						
CRETACEOUS		NAVARROAN	undifferentiated Cretaceous sediments	undifferentiated Cretaceous sediments	▩	undifferentiated Cretaceous sediments	undifferentiated Cretaceous sediments	undifferentiated Cretaceous sediments	undifferentiated Cretaceous sediments	undifferentiated Cretaceous sediments	undifferentiated Cretaceous sediments
		TAYLORAN			undifferentiated Cretaceous sediments						

DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

BULLETIN 94
PLATE 15

DISTRIBUTION OF GROSS ALPHA ACTIVITY IN GROUND WATER FROM THE FLORIDAN AQUIFER SYSTEM IN THE GULF TROUGH/APALACHICOLA EMBAYMENT AREA

Hydrogeology and Compilation
by
Madeleine F. Kellam
and
Lee L. Gorday
1990

EXPLANATION

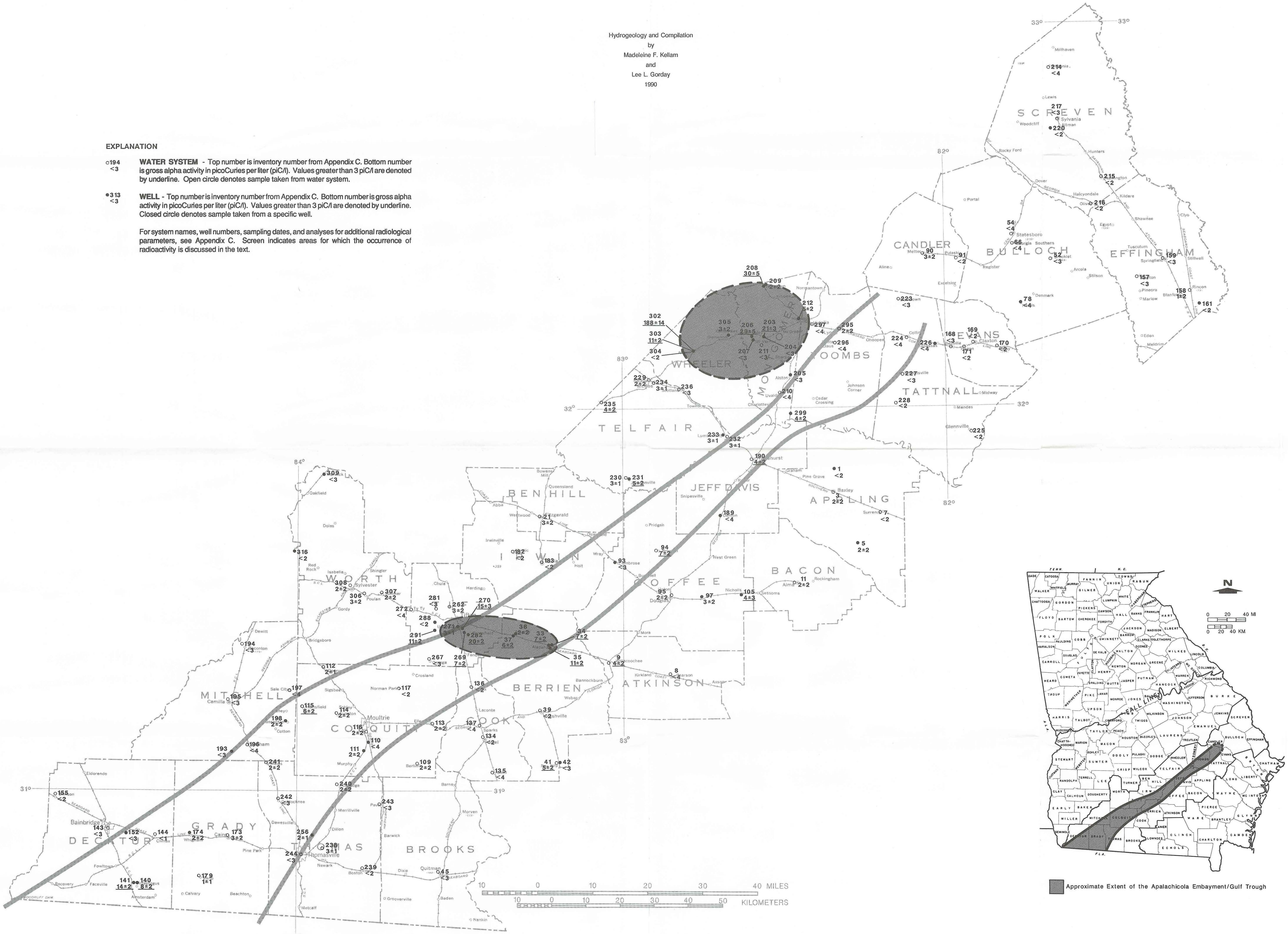
○194
<3

WATER SYSTEM - Top number is inventory number from Appendix C. Bottom number is gross alpha activity in picoCuries per liter (piC/l). Values greater than 3 piC/l are denoted by underline. Open circle denotes sample taken from water system.

●313
<3

WELL - Top number is inventory number from Appendix C. Bottom number is gross alpha activity in picoCuries per liter (piC/l). Values greater than 3 piC/l are denoted by underline. Closed circle denotes sample taken from a specific well.

For system names, well numbers, sampling dates, and analyses for additional radiological parameters, see Appendix C. Screen indicates areas for which the occurrence of radioactivity is discussed in the text.



▨ Approximate Extent of the Apalachicola Embayment/Gulf Trough

Base map from U.S. Geological Survey 1:500,000 map of Georgia, 1970.