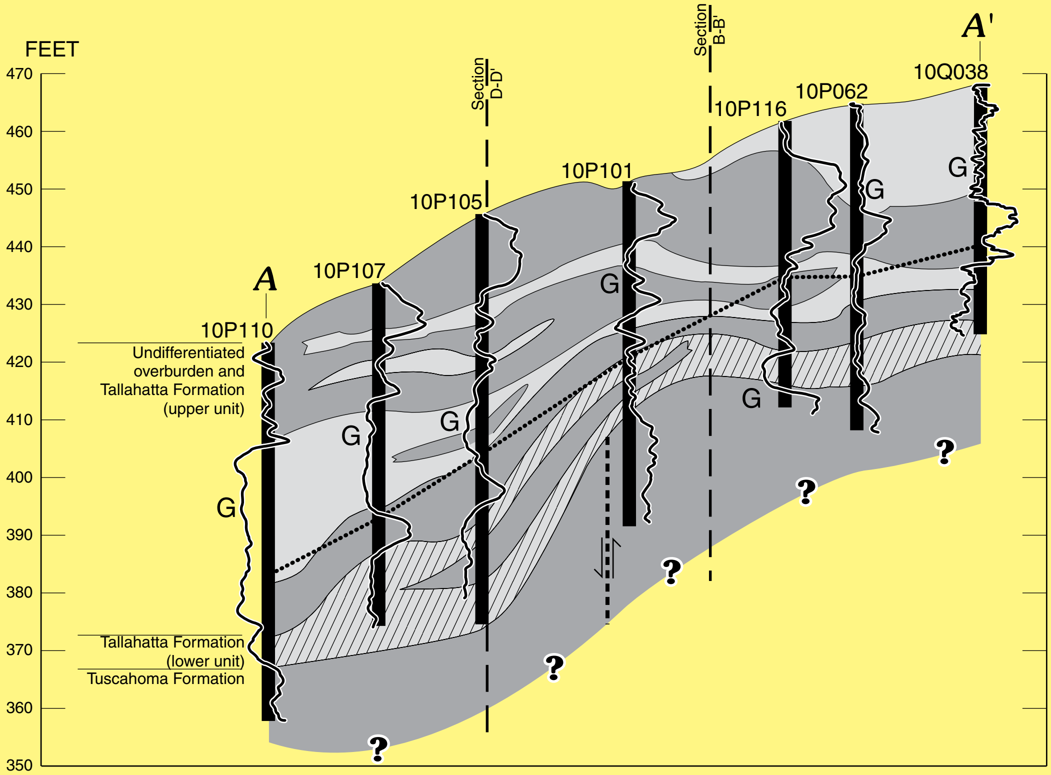
Hydrogeology of the Interstream Area Between Ty Ty Creek and Ty Ty Creek Tributary Near Plains, Georgia

U.S. Geological Survey



Prepared in cooperation with the

U.S. Department of Agriculture
Agricultural Research Service

Water-Resources Investigations Report 96-4052

HYDROGEOLOGY OF THE INTERSTREAM AREA BETWEEN TY TY CREEK AND TY TY CREEK TRIBUTARY NEAR PLAINS, GEORGIA

By Lisa M. Stewart and David W. Hicks

U.S. GEOLOGICAL SURVEY

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U.S. DEPARTMENT OF AGRICULTURE
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CONTENTS

ILLUSTRATIONS

TABLES

CONVERSION FACTORS, ACRONYMS, AND VERTICAL DATUM

CONVERSION FACTORS

Length

Multiply	by	to obtain
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer

Area

square mile (mi^2)	2.590	square kilometer
acre	0.004047	square kilometer

Volume

gallon (gal)	3.785	liter
million gallons (Mgal)	3,785	cubic meter

Transmissivity

foot squared per day (ft^2/d)	0.09290	meter squared per day

Hydraulic Conductivity

foot per day (ft/d)	0.3048	meter per day

HYDROGEOLOGY OF THE INTERSTREAM AREA BETWEEN TY TY CREEK AND TY TY CREEK TRIBUTARY NEAR PLAINS, GEORGIA

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ABSTRACT

This report is part of an interdisciplinary effort to identify and describe processes that control movement and fate of selected fertilizers and pesticides in the surface and subsurface environments in the Fall Line Hills district of the Georgia Coastal Plain physiographic province. This report describes the hydrogeology of the interstream area between Ty Ty Creek and its tributary near Plains, Sumter County, Georgia.

Geologic units of interest to this study are, in ascending order; (1) the Tuscahoma Formation, a bluish gray, silty clay; (2) the Tallahatta Formation, a fine-to-coarse, poorly sorted quartz sand that is divided into an upper and lower unit; and (3) the undifferentiated overburden, which consists of fine to medium poorly sorted sand, silt and clay. Continuous-core samples indicate that the unsaturated zone includes the undifferentiated overburden and the upper unit of the Tallahatta Formation, and attains a maximum thickness of about 52 feet (ft) in the southern part of the study area. The Claiborne aquifer in the study area consists of the lower unit of the Tallahatta Formation and ranges in thickness from 3 ft near Ty Ty Creek tributary to about 20 ft in the upland divide area. It is confined below by the clayey sediments of the Tuscahoma Formation.

The Claiborne aquifer in the study area generally is confined above by an extensive clay layer that is the base if the upper unit of the Tallahatta Formation. Fluctuations in the amount of vertical recharge to the aquifer result in areal and temporal changes in aquifer conditions from confined to unconfined in parts of the study area. Hydraulic conductivity of the aquifer ranges from 3.5 to 7 feet per day. The transmissivity of the aquifer is approximately 50 feet squared per day. Water-level data indicate the potentiometric surface slopes to the south, southeast, and southwest with a gradient of about 87 to 167 feet per mile. The shape of the potentiometric surface and the direction of ground-water flow remains relatively unchanged during high and low water-level periods.

Water levels in the Claiborne aquifer fluctuated by a maximum of 6 feet during the period from January to December 1991. Recharge to the Claiborne aquifer consists of a local and regional flow component. Lateral ground-water flow (regional flow) into the study area is dependent on regional hydraulic controls (pumpage, stream discharge, and rainfall). The rate of lateral movement of ground water is dependent on the hydraulic conductivity of the saturated zone, the hydraulic gradient, and other hydraulic factors, and is considered to be relatively constant. Local recharge enters the ground-water system as rainfall that percolates down to the water table. Annual water-level fluctuations in the Claiborne aquifer indicate that the majority of regional and local recharge occurs in the interstream area with recharge decreasing downslope to the streams. Ground water discharges to Ty Ty Creek and its tributary throughout the year during low and high water-level periods.

INTRODUCTION

Ground-water contamination by pesticides and herbicides used in agriculture (agrichemicals) is a potential problem in southwestern Georgia. Approximately 25 percent of all potable water used in the United States comes from ground-water sources (Solley and others, 1993). Therefore, understanding the fate and transport of surface-applied agrichemicals in the subsurface is necessary to develop solutions to prevent contamination of ground-water resources.

A cooperative research investigation was initiated in 1984 by the U.S Geological Survey (USGS) and the U.S. Department of Agriculture, Agricultural Research Service (ARS) to evaluate the effects of agrichemicals and management practices on ground-water quality. The objective of this cooperative investigation was to identify and describe the processes controlling the fate and transport of selected fertilizers and pesticides in the surface and subsurface environments. Understanding the hydrogeology of these environments, as they relate to these processes, is vital to the successful completion of this investigation.

Purpose and Scope

This report describes the hydrogeology of an interstream area between Ty Ty Creek and the Ty Ty Creek tributary near Plains, Ga. (figs. 1 and 2). The following geologic and hydrologic factors were evaluated: (1) lithology and thickness of the unsaturated zone; (2) lithology, thickness, and hydraulic properties of the shallow aquifer, which is the Claiborne aquifer in the study area; (3) lithology of the underlying confining unit; and (4) ground-water movement, including recharge to and discharge from the aquifer. The scope of this work included drilling and the examination of drill cores from test holes, the collection and analysis of hydraulic data using slug testing, the collection and analysis of water-level and well-construction data, and geophysical logs.

Description of Study Area

The study area is in Sumter County, near Plains, Ga., in the Fall Line Hills district of the Coastal Plain physiographic province (Clark and Zisa, 1976) (fig. 1), and consists of the interstream area between Ty Ty Creek and the Ty Ty Creek tributary (fig. 2). The study area includes the USGS/ARS research plot where the fate and transport of agrichemicals are being monitored within the recharge area of the Claiborne aquifer (Hicks and others, 1991b).

The study area encompasses about 0.5 square mile (mi^2) and is bounded by Ty Ty Creek on the west and an intermittent tributary to Ty Ty Creek on the east. The confluence of Ty Ty Creek and the tributary stream form the southern boundary. The northern boundary is coincident with the southern boundary of the study conducted by Hicks and others (1991a) in the Ty Ty Creek watershed. The topography of the interstream area is characterized by a relatively flat, broad upland divide between two deeply incised streams. Steep slopes lead from the interstream area to the streams. Land-surface altitudes range from 480 feet (ft) in the northern part of the upland divide to 360 ft at the confluence of the two streams (fig. 3).

Land Use

The study area consists of approximately 25 acres of farmland and 308 acres of adjacent woodlands. The fields are in the relatively level interstream area, and woodlands cover the steep-sided slopes that extend to the streams.

Rainfall, Evapotranspiration, and Runoff

Rainfall in the study area totaled 62 in. for the period January to December 1991 (David Bosch, ARS, written commun., 1994). From 1958 to 1991, annual rainfall totals averaged about 49 in/yr in the Plains area (Hicks and others, 1991a). In southwestern Georgia, rainfall totals during the periods January through March and June through August are about equal; however, the duration, intensity, and areal distribution of rainfall varies greatly. Rainfall data collected within the Ty Ty Creek watershed indicate that areal variability is most pronounced during the summer months because of intense thunderstorms (Hicks and others, 1991b). Evapotranspiration losses and runoff in the study area for the period January to December 1991 were calculated to be 44 in/yr and 9 in/yr, respectively (Bosch and Hicks, 1993).

Monitor-Well Numbering System

Wells described in this report are numbered according to a system based on the USGS index of topographic maps of Georgia. Each 7 1/2-minute topographic quadrangle in the state has been assigned a six-digit number and letter designation beginning in the southwestern corner of the State. Numbers increase sequentially eastward and letters advance alphabetically northward. Quadrangles in the northern part of the state are designated by double letters: AA follows Z, and so forth. The letters “I,” “O,” “II,” and “OO” are not used. Wells inventoried in each quadrangle are numbered consecutively, beginning with 01. Thus, the thirty-eighth well scheduled in 10Q quadrangle is designated 10Q038.

Acknowledgements

The authors wish to extend gratitude to Horizon Farms, Inc., for allowing wells to be drilled and monitoring equipment to be installed on their property near Plains.

Figure 1. Study area (from Hicks and others, 1991) and physiographic provinces of Georgia (from Clarke and Zisa, 1976).

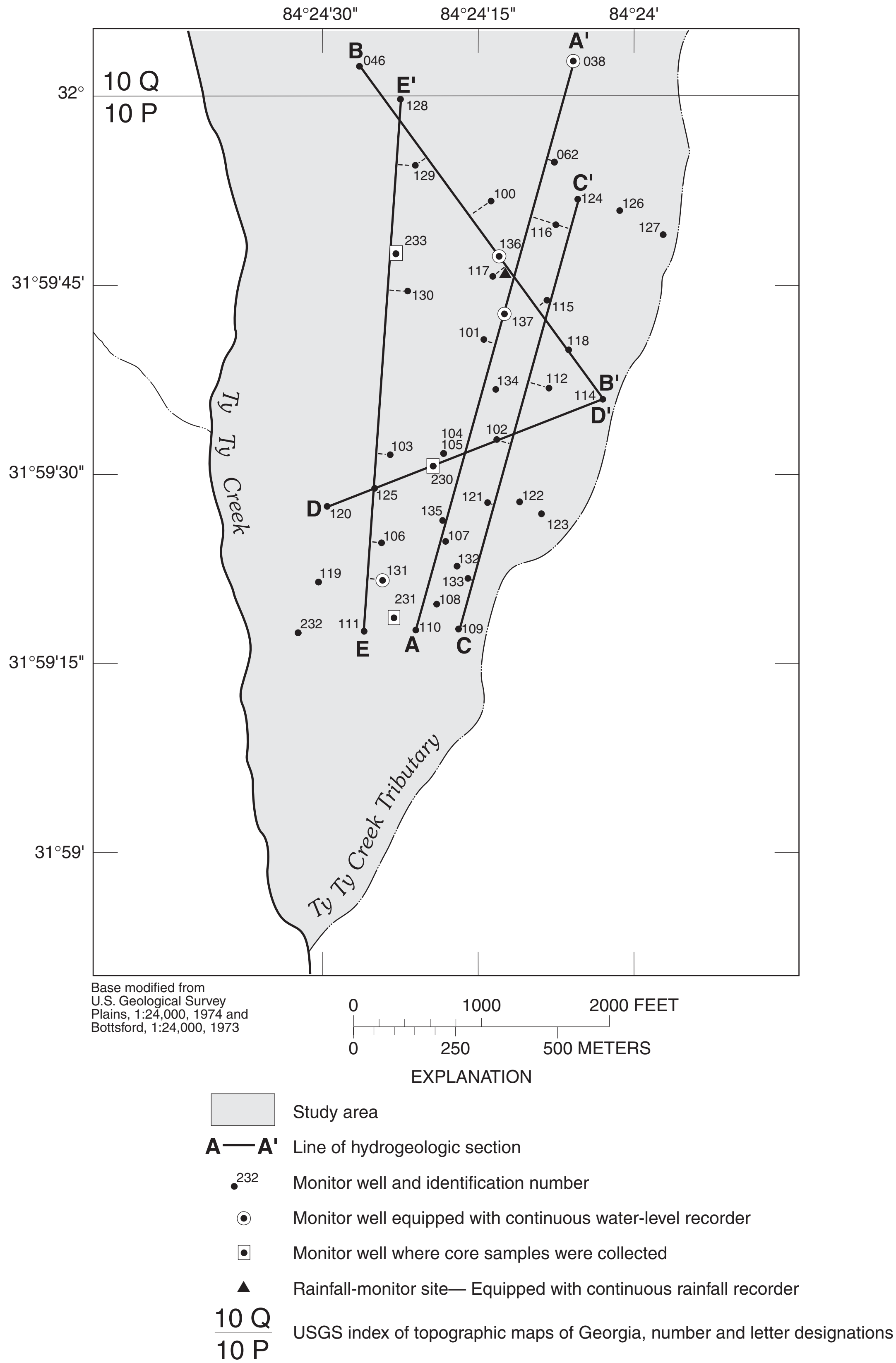


Figure 2. Study area, monitor-well sites, and lines of hydrogeologic sections A-A', B-B', C-C', D-D', and E-E'.

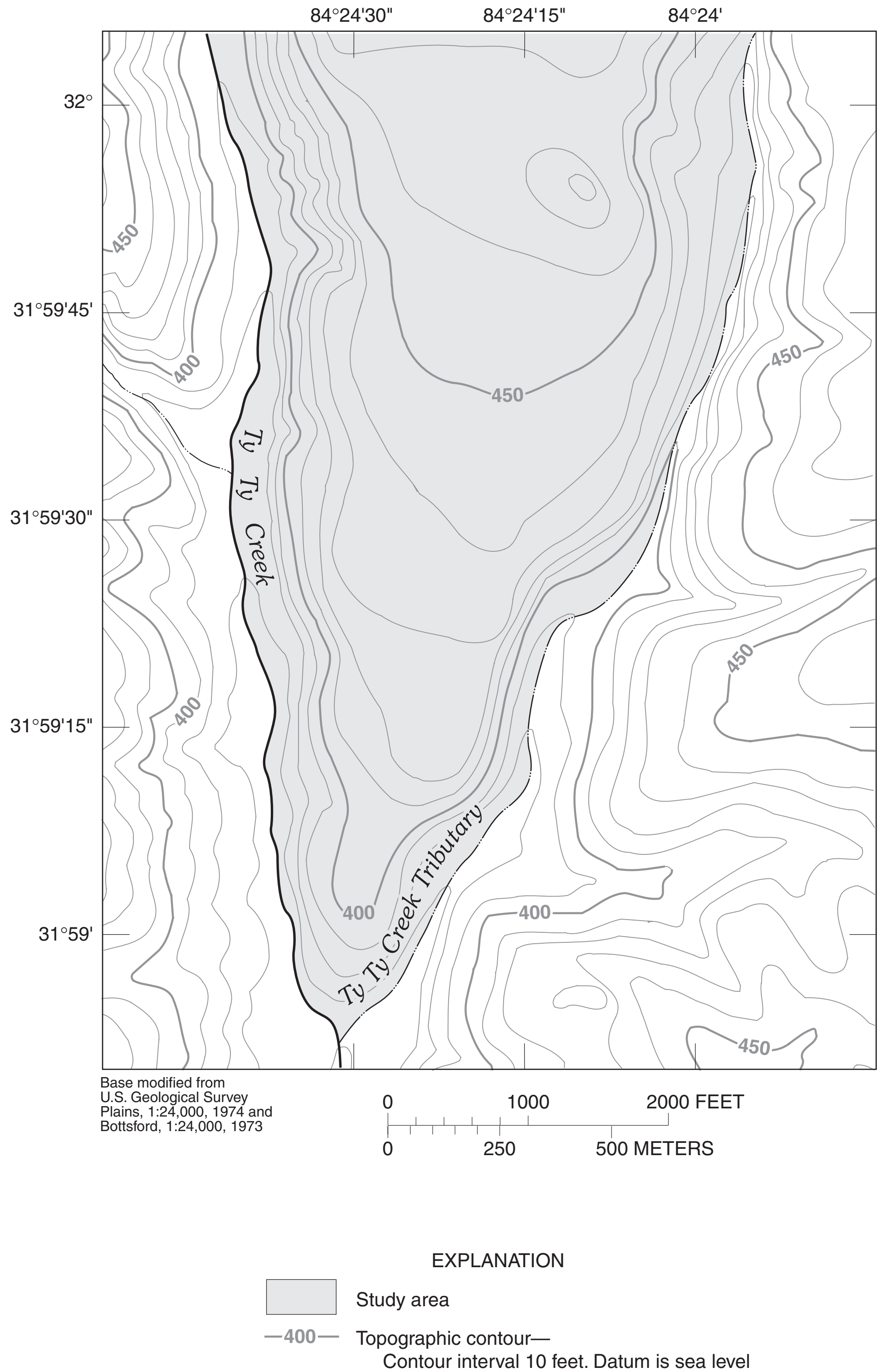


Figure 3. Study area and topography.

DATA COLLECTION

Data were collected from 44 monitor wells that include 3 test holes (table 1 and fig. 2) that were drilled jointly by the USGS and ARS from March 1986 through June 1994 using a hollow-stem auger. Monitor wells were constructed by inserting a 2- to 4-inch diameter, threaded-joint, polyvinylchloride (PVC) casing into the auger hole and packing the screened interval with washed, graded sand pack as the auger was withdrawn. A bentonite seal was placed above the screened interval to isolate the zone of interest. Native soil was used to pack the annular space from the bentonite seal to near land surface where an additional bentonite seal was installed. Monitor wells were developed by bailing, then airlifting using compressed air injected through a small-diameter pipe.

Core samples were collected from three test holes (10P230, 10P231, and 10P233) (fig. 2) and used to correlate with natural gamma geophysical logs from 28 wells to evaluate the stratigraphy and lithology of the study area. These data were used to construct structure-contour maps showing the top of the lower confining unit, thickness maps of the hydrogeologic units of interest, and hydrostratigraphic sections across the study area.

Aquifer testing was conducted in wells 10Q038 and 10P112 to determine the hydraulic conductivity of the Claiborne aquifer using the method described by Doss (1994). Rising-head tests were conducted by depressing the water table to the top of the well screen using compressed air. When equilibrium was reached, the air pressure was released which resulted in a rapid rise in water level in the well. Water-level recovery in the well was measured to 90 percent of the pretest level using an electronic pressure transducer and recorded on a data logger.

Altitudes of wells were determined to a one-hundredth of a foot using a Zeiss NI2 self-leveling instrument and a two-piece Philadelphia rod. Water-level data measured monthly to a one-hundredth of a foot using a graduated steel tape were used to construct detailed maps of the potentiometric surface of the Claiborne aquifer. Water-level and stratigraphic data were used to estimate the thickness of both the unsaturated zone and the aquifer. Continuous water-level data from recorders installed on wells 10Q038, 10P131, 10P136, and 10P137 (fig. 2) provided data on water-level fluctuations in the shallow aquifer.

HYDROGEOLOGY

Coastal Plain strata underlying the study area consist of alternating beds of limestone, sand, silt, shale, and clay that dip to the southeast by as much as 25 feet per mile (ft/mi), and progressively thicken in that direction (Hicks and others, 1991b). The upper-most geologic formations of these strata are discussed in this report. They are, in ascending order, (1) the Tuscahoma Formation of late Paleocene age, (2) the Tallahatta Formation of middle Eocene age, and (3) the undifferentiated overburden of Quaternary age (fig. 4).

The hydrogeologic units of interest in this study are, in descending order, the unsaturated zone and the Claiborne aquifer. The unsaturated zone consists of the undifferentiated overburden and the upper unit of the Tallahatta Formation. The Claiborne aquifer consists of the poorly sorted quartz sand of the lower unit of the Tallahatta Formation (fig. 4).

Ground-water flow in the Claiborne aquifer is to the south, southeast, and southwest at variable gradients that reflect the topographic relief and structural features in the geologic units underlying the study area. Recharge to the Claiborne aquifer is both regional and local. Discharge from the aquifer primarily is to Ty Ty Creek and its tributary.

Geologic Units

Tuscahoma Formation

The Tuscahoma Formation is divided into two lithologic units. The lower unit is a strongly transgressive unit (Gibson, 1982) and was described by Herrick (1961) as a light-brown to yellowish-brown, medium sand to granule gravel containing abundant glauconite and thin clay laminae. The upper unit consists of pale yellowish-brown and light-gray, very fine to fine, moderately sorted, carbonaceous, clayey sand of lagoonal origin (Gibson, 1982). Glauconite is randomly dispersed and is less abundant in the upper unit than in the lower unit. The upper unit is further subdivided as a result of an abrupt color change from olive gray (in the lower part) to pale yellowish brown (in the upper part). This lithology and color sequence is common in the Tuscahoma Formation in the Plains area, and is attributed to deep weathering and leaching (Hicks and others, 1991b). In the study area, the upper unit of the Tuscahoma Formation is characterized by yellowish-brown clayey sediments of the upper section and an abrupt color change to the bluish-gray, clayey sediments of the lower section.

Natural gamma log data were used to identify the top of the Tuscahoma Formation, which has a highly variable and irregular dip throughout the study area (figs. 5-10). The irregular surface of the top of the Tuscahoma Formation may be attributed to post-depositional erosion of this surface. The abrupt change in dip of this surface in the central part of the study area was characterized by a southeast-northwest trending inferred fault zone affecting the Tuscahoma Formation and underlying units. Cenozoic-age faults displacing Paleocene and Eocene age sediments, including the Tuscahoma Formation, have been mapped in the Georgia Coastal Plain Province (Cofer and Manker,

Table 1: Well-construction information of selected monitor-well sites completed in the Claiborne aquifer, near Plains, Georgia

[Well casings are polyvinylchloride (PVC); wells are screened; depths are in feet below ground surface]

Well number	Latitude	Longitude	Altitude (in feet)	Well depth (in feet)	Casing diameter (in inches)	Depth to top of well-screen opening (in feet)	Depth to bottom of well-screen opening (in feet)
10Q038	32°00'03"	84°24'05"	467.92	43	2	38	43
10Q046	33°00'03"	84°24'25"	469.49	47	2	42	47
10P062	31°59'55"	84°24'07"	464.66	56	2	31	36
10P100	31°59'52"	84°24'13"	464.58	48	2	43	48
10P101	31°59'41"	84°24'13"	451.30	61	2	56	61
10P102	31°59'33"	84°24'13"	442.16	91	2	86	91
10P103	31°59'32"	84°24'23"	435.36	54	2	49	54
10P104	31°59'32"	84°24'18"	444.35	48	4	43	48
10P105	31°59'32"	84°24'18"	444.03	67	2	62	67
10P106	31°59'26"	84°24'24"	431.38	61	2	56	61
10P107	31°59'25"	84°24'18"	432.80	60	2	55	60
10P108	31°59'20"	84°24'19"	425.70	46	4	41	46
10P109	31°59'18"	84°24'17"	415.20	39	2	34	39
10P110	31°59'18"	84°24'21"	423.35	66	2	61	66
10P111	31°59'18"	84°24'26"	421.38	45	2	40	45
10P112	31°59'37"	84°24'08"	444.59	43	2	38	43
10P114	31°59'36"	84°24'03"	404.71	16	2	11	16
10P115	31°59'44"	84°24'08"	454.65	55	2	50	55
10P116	31°59'50"	84°24'07"	461.37	48	2	43	48
10P117	31°59'46"	84°24'13"	455.36	43	2	38	43
10P118	31°59'40"	84°24'06"	443.27	34	2	29	34
10P119	31°59'22"	84°24'30"	418.04	44	2	39	44
10P120	31°59'28"	84°24'28"	430.82	55	2	50	55
10P121	31°59'28"	84°24'14"	439.17	54	2	49	54
10P122	31°59'28"	84°24'11"	430.59	49	2	44	49
10P123	31°59'27"	84°24'09"	407.76	28	2	23	28
10P124	31° 59'51"	84°24'05"	463.79	37	2	32	37
10P125	31°59'29"	84°24'23"	434.04	50	2	45	50
10P126	31°59'51"	84°24'01"	434.02	15	2	10	15
10P127	31°59'49"	84°23'57"	411.16	6	2	1	6
10P128	32°00'00"	84°24'22"	465.04	33	2	28	33
10P129	31°59'55"	84°24'21"	461.58	41	2	36	41
10P130	31°59'46"	84°24'22"	453.68	35	2	30	35
10P131	31°59'22"	84° 24'23"	427.61	55	4	50	55
10P132	31°59'23"	84°24'17"	433.31	54	2	49	54
10P133	31° 59'22"	84°24'16"	428.25	50	2	45	50
10P134	31°59'37"	84°24'13"	449.40	49	2	44	49
10P135	31°59'27"	84°24'18"	437.35	60	2	55	60
10P136	31°59'47"	84°24'12"	462.60	37	4	32	37
10P137	31°59'43"	84°24'12"	459.30	38	4	33	38
10P230	31°59'31"	84°24'19"	443.34	64	2	49	64
10P231	31°59'19"	84°24'23"	423.35	53	2	43	53
10P232	31°59'18"	84°24'32"	411.77	45	2	40	45
10P233	31°59'48"	84°24'22"	453.77	27	2	22	27

<table>
<tr><th colspan="2">Geologic Age</th><th>Stratigraphic Unit</th><th>Description</th><th>Hydrologic Unit</th></tr>
<tr><td colspan="2">Quaternary</td><td>Undifferentiated overburden</td><td>Reddish-brown, fine to medium sand interlayered with red-orange-white mottled clay lenses</td><td rowspan="2">Unsaturated zone</td></tr>
<tr><td rowspan="3">Tertiary</td><td rowspan="2">Middle Eocene</td><td>Tallahata Formation (upper unit)</td><td>Pale yellowish-orange to grayish-brown, fine to medium poorly sorted, cross bedded, clear to milky quartz sand grading to a yellow-brown, sandy clay</td></tr>
<tr><td>Tallahata Formation (lower unit)</td><td>Pale yellowish-brown, to pale-orange, to lavender,and consists of very fine to gravelly, poorly sorted, clear to milky quartz sand</td><td>Claiborne aquifer</td></tr>
<tr><td>Late Paleocene</td><td>Tuscahoma Formation</td><td>Yellowish-brown clayey sediments abruptly transitioning to bluish-gray, clayey sediments</td><td>Confining unit</td></tr>
</table>

Figure 4. Stratigraphic and hydrologic unit correlation chart for the study area.

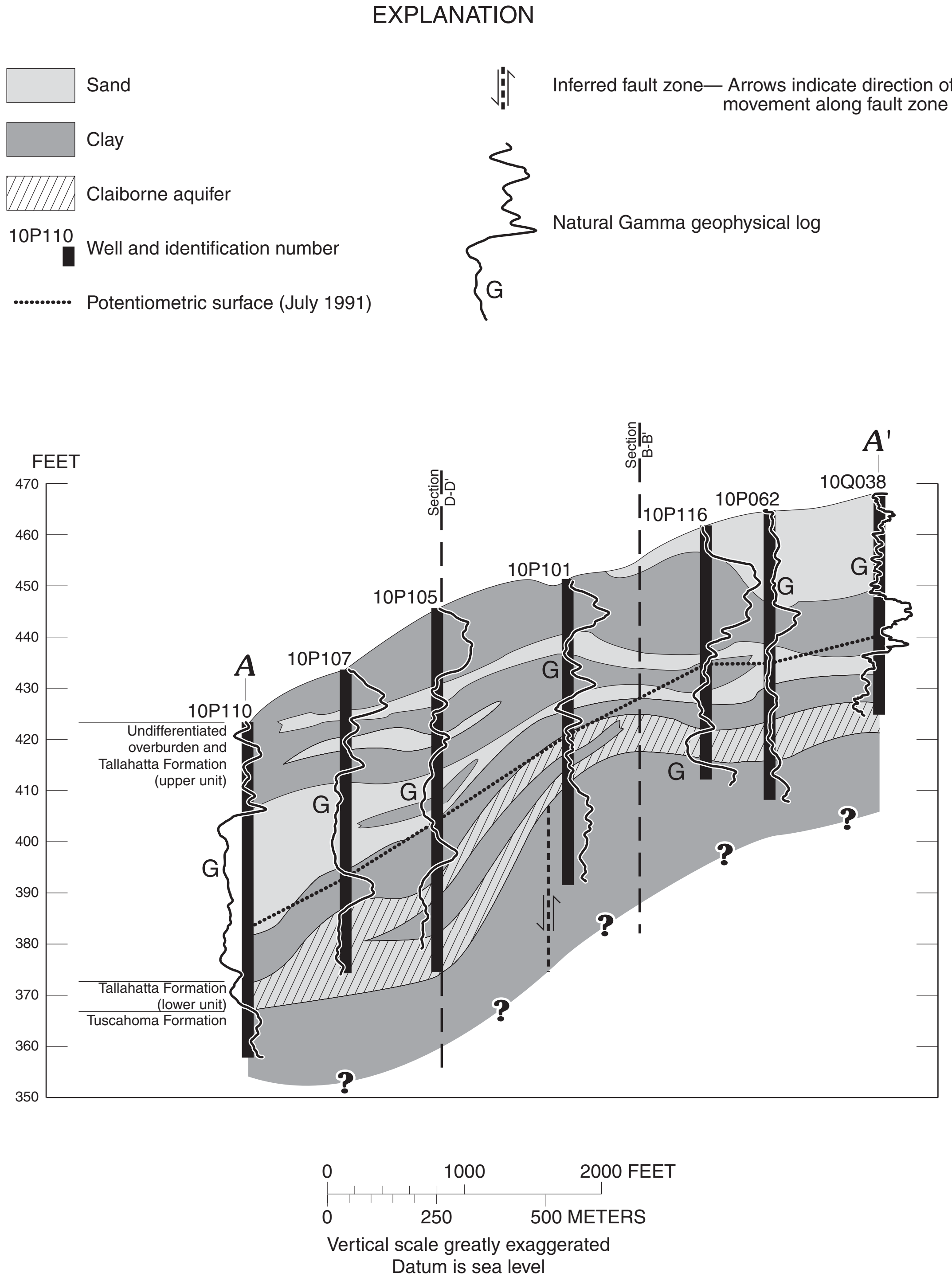


Figure 5. Generalized hydrogeologic section A-A'.

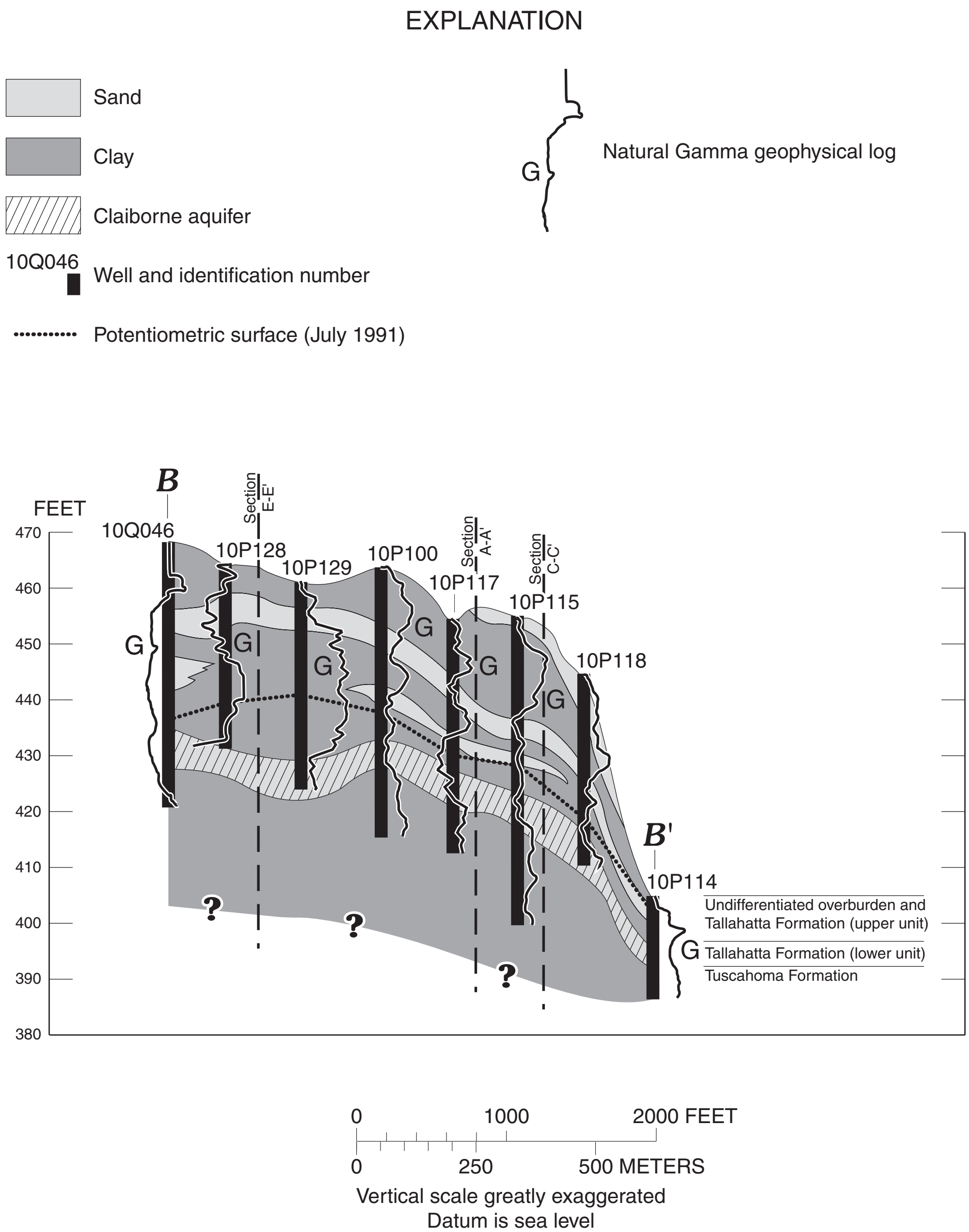


Figure 6. Generalized hydrogeologic section B-B'.

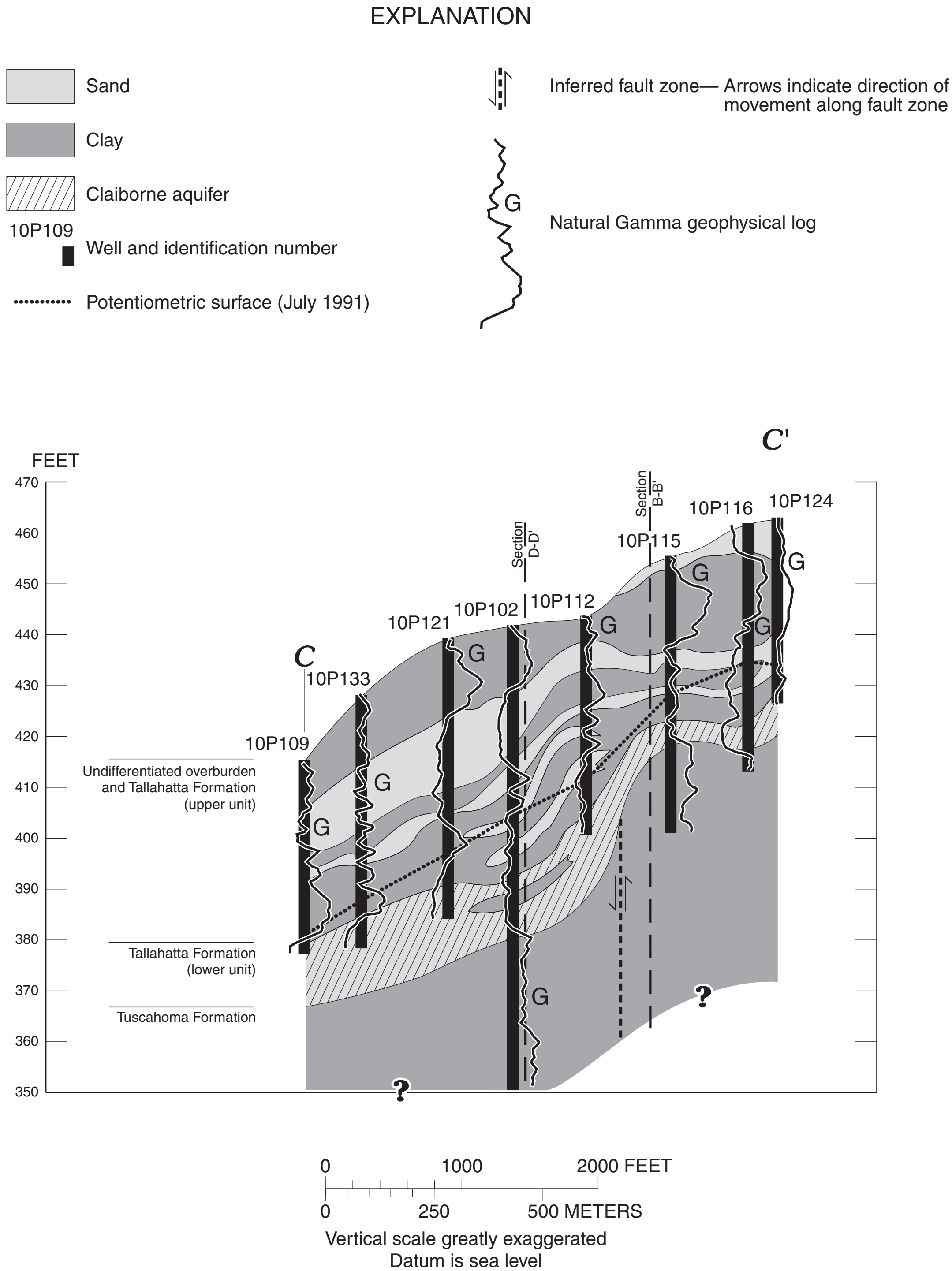


Figure 7. Generalized hydrogeologic section C-C'.

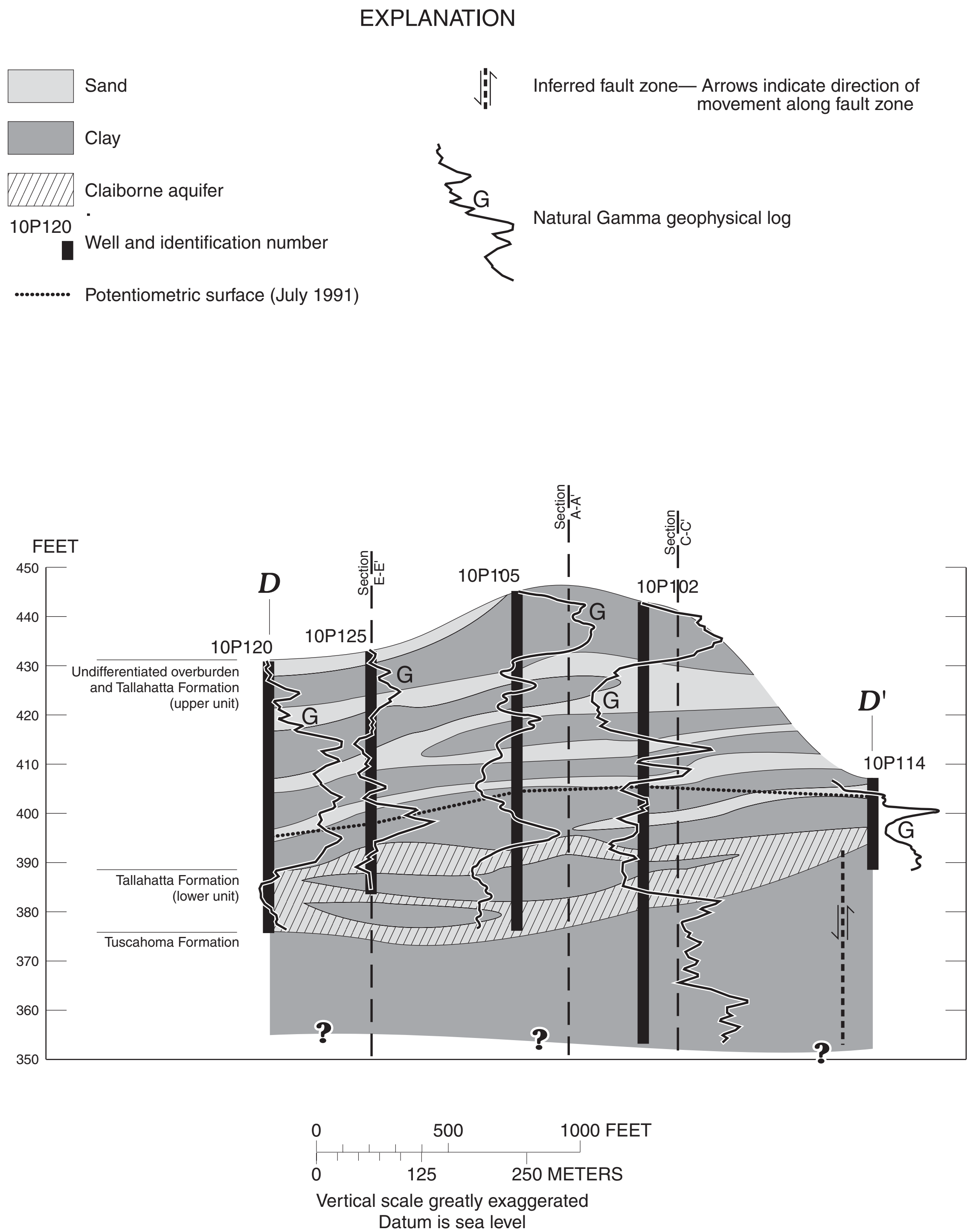


Figure 8. Generalized hydrogeologic section D-D'.

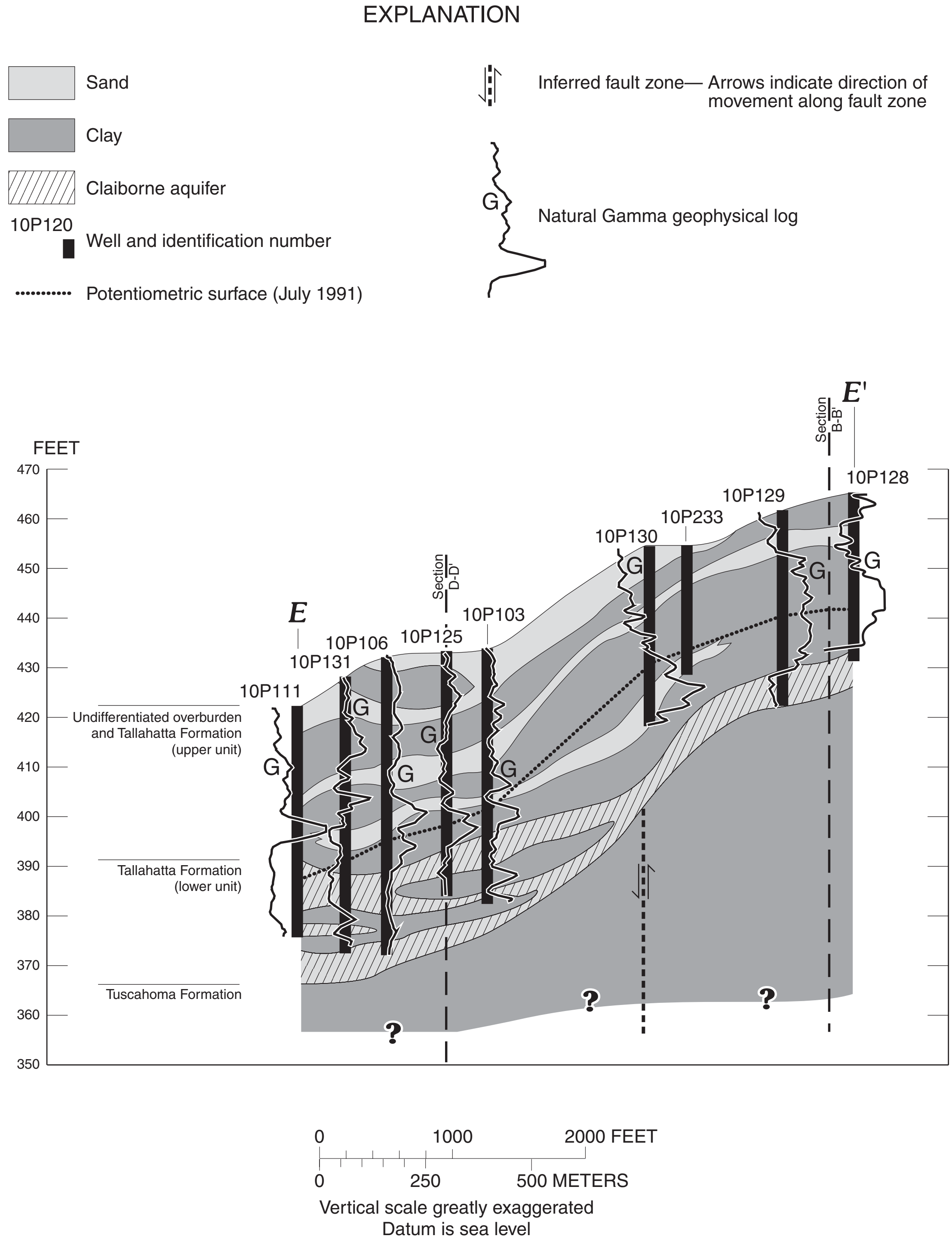


Figure 9. Generalized hydrogeologic section E-E'.

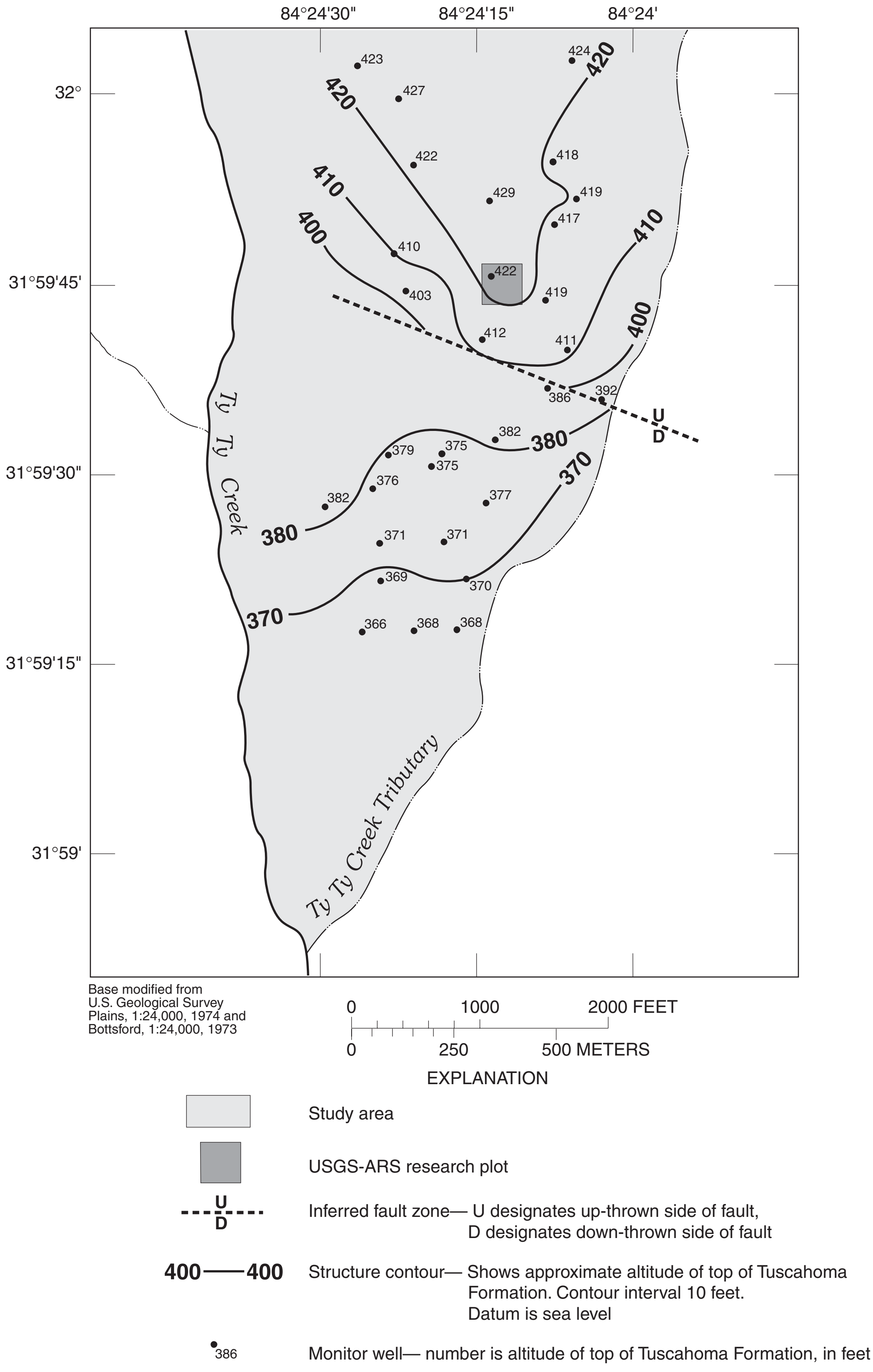


Figure 10. Approximate altitude of the top of the Tuscahoma Formation.

1983; Wentworth and Mergner-Keefer, 1983; Reinhardt and others, 1984; and Prowell, 1988). The nature of the tectonic displacements in the Tuscahoma Formation result in flexure of the soft sediments (figs. 5 and 7–10) rather than abrupt offsets that normally occur in consolidated material (D.C. Prowell, U.S. Geological Survey, oral commun., 1994). North of the USGS-ARS research plot, the thickness of the Tuscahoma Formation was determined to be approximately 115 ft at well location 10P136.

Tallahatta Formation

The Tallahatta Formation consists of non-marine deposits described by Hicks and others (1991b) as divided into two lithologic units in the study area. The lower unit varies in color from pale yellowish-brown, to pale orange, to lavender, and consists of very fine-to-gravelly, poorly sorted, clear to milky, sub-angular quartz sand. Clay laminae and cross bedding are common. Natural gamma log data indicate that the thickness of the lower unit ranges from 3 ft near the Ty Ty Creek tributary to 25 ft in the upland divide area (figs. 5–9).

The upper unit consists of pale yellowish-orange to grayish-brown, fine to medium poorly sorted, cross bedded, clear to milky quartz sand. Natural gamma log data for the upper unit were indistinguishable from natural gamma log data for the undifferentiated overburden described below. Therefore, the thickness of the upper unit includes the thickness of the undifferentiated overburden. Natural gamma log data indicate that a laterally extensive clay layer at the bottom of the upper unit separates the upper and lower units of the Tallahatta Formation.

Undifferentiated Overburden

The undifferentiated overburden consists of reddish-brown, fine-to-medium sand interlayered with red-orange-white mottled clay lenses, probably derived from sediments younger than the Tallahatta Formation. The thickness of the undifferentiated overburden including the upper unit of the Tallahatta Formation ranges from less than 10 ft near the Ty Ty Creek tributary to about 52 ft in the upland divide (figs. 5–9).

Hydrologic Units

Unsaturated Zone

The unsaturated zone is within the undifferentiated overburden and the upper unit of the Tallahatta Formation (figs. 5–9). The top of the unsaturated zone is land surface. The base of the unsaturated zone is the water table where the Claiborne aquifer is unconfined, and the top of the lower unit of the Tallahatta Formation where the Claiborne aquifer is confined. The altitude of the base of the unsaturated zone in the unconfined parts of the aquifer fluctuates with changes in precipitation and infiltration rates to the potentiometric surface. During July 1991, the minimum thickness of unsaturated zone was less than 10 ft along Ty Ty Creek tributary, and the maximum thickness was about 52 ft in the upland divide area (figs. 5–9 and 11). During periods of increased precipitation, and hence recharge to the ground-water flow system, the thickness of the unsaturated zone decreases. During periods of extended drought little or no recharge to the ground-water system occurs, therefore water levels in the unconfined parts of the Claiborne aquifer decline and the thickness of the overlying unsaturated zone increases.

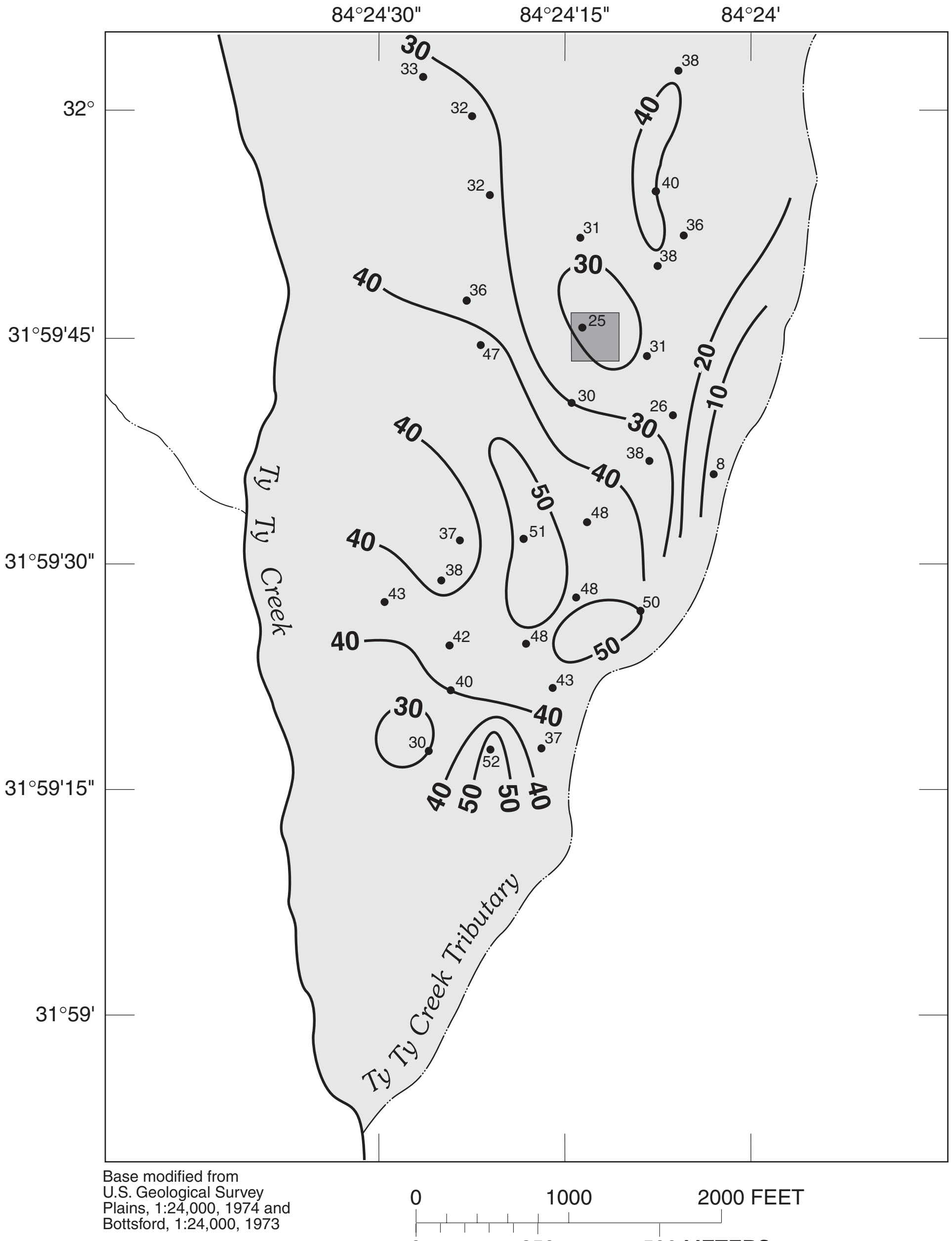
Claiborne Aquifer

The Claiborne aquifer is restricted to the poorly sorted quartz sands of the lower unit of the Tallahatta Formation (figs. 5–9). The clayey sediments of the Tuscahoma Formation form the base of the Claiborne aquifer and act as a confining unit.

Aquifer conditions vary areally and temporally in the study area. Unconfined aquifer conditions exist where the altitude of the potentiometric surface is below clayey sediments that define the base of the undifferentiated overburden and upper unit of the Tallahatta Formation. The thickness of the aquifer under unconfined conditions is dependent on the altitude of the potentiometric surface and the altitude of the top of the Tuscahoma Formation. Confined aquifer conditions exist where the potentiometric surface is above the base of the clayey sediments of the overburden and upper unit of the Tallahatta Formation. Aquifer thickness under confined conditions is dependent on the thickness of the lower unit of the Tallahatta Formation. Water-level data collected July 1991 indicate that aquifer thickness ranged from 3 ft near the Ty Ty Creek tributary to 20 ft in the upland divide area (figs. 5–9, and 12). Aquifer conditions can vary at a given well location depending on the altitude of the potentiometric surface. For example, water-level data collected in July 1989, 1990, and 1991 indicate that the lateral extent and location of regions of the Claiborne aquifer under unconfined conditions vary with time (fig. 13).

Hydraulic conductivity, which is a measure of the ability of an aquifer to transmit water (Anderson and Woessner, 1992), was determined using single-well response tests as previously described at wells 10Q038 and 10P112. The time-drawdown data were analyzed using the curve-matching method described by Cooper and others (1967). Hydraulic-conductivity values range from 3.5 to 7 feet per day (ft/d) (table 2).

Transmissivity is the rate at which water is transmitted through a unit width of aquifer under a unit-hydraulic gradient and is calculated by multiplying the hydraulic conductivity times the aquifer thickness (Lohman, 1979). Transmissivity of the Claiborne aquifer in the study area is approximately 50 feet squared per day (ft^2/d) at wells 10Q038 and 10P112 (table 2).



EXPLANATION

Study area

USGS-ARS research plot

40——40 Approximate line of equal thickness of the unsaturated zone— Contour interval 10 feet

•37 Monitor well— Number is approximate thickness of the unsaturaterd zone, in feet

Figure 11. Approximate thickness of the unsaturated zone in the undifferentiated overburden and the upper unit of the Tallahatta Formation, July 1991.

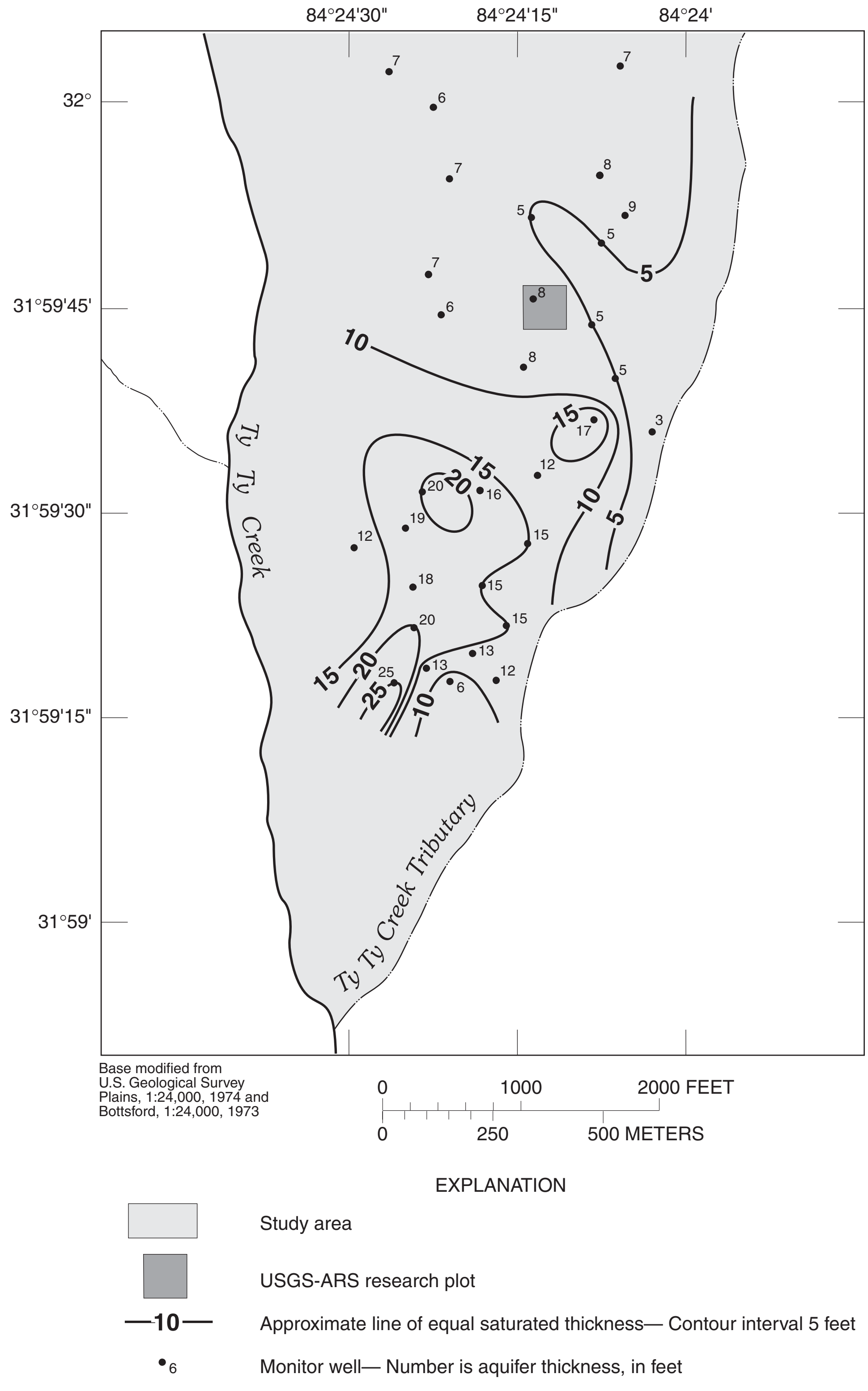


Figure 12. Approximate saturated thickness of the Claiborne aquifer, July 1991.

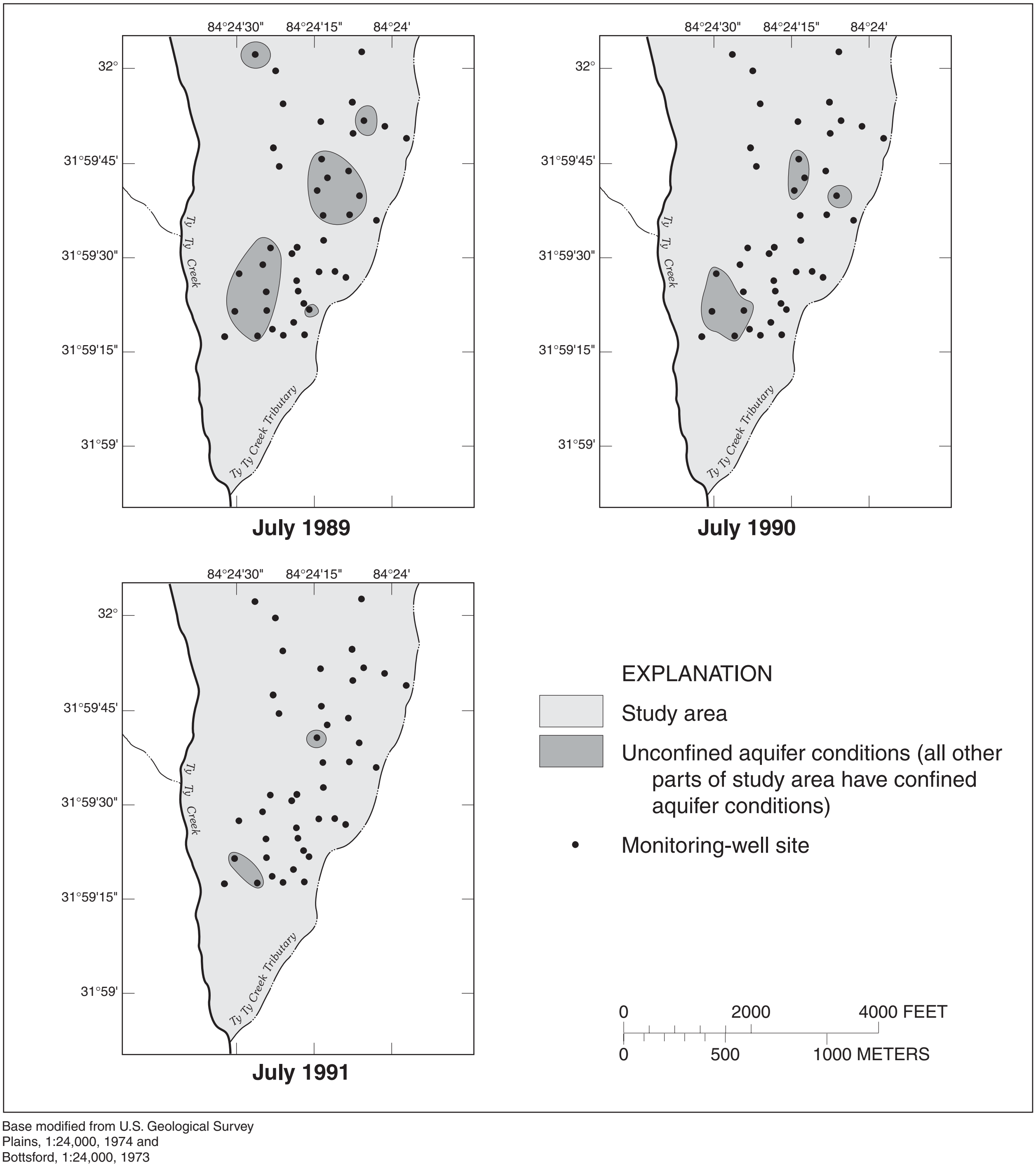


Figure 13. Aquifer conditions in the Claiborne aquifer, July 1989, July 1990, and July 1991.

Table 2: Summary of hydraulic properties of the Claiborne aquifer in the study area near Plains, Georgia

Well number	Hydraulic conductivity (in feet per day)	Aquifer thickness (in feet)	Transmissivity (in feet squared per day)
10P112	3.5	14	50
10Q038	7.0	7.0	50

Ground-Water Movement

Potentiometric Surface

The potentiometric surface is the altitude at which the ground-water level would stand in a tightly cased well (Lohman, 1979). Continuous water-level data collected during 1991 at four wells (fig. 14) show that maximum altitude of the potentiometric surface typically occurs during the summer months of June, July and August, with the minimum potentiometric-surface altitude occurring during January and February. Rainfall records for the study area (fig. 15) indicate that the majority of rainfall occurs during the late spring and early summer, and that the annual maximum altitude of the potentiometric surface occurs as a result of greater recharge to the aquifer during this time period. The maximum change in the potentiometric surface of the aquifer determined from water level data collected monthly from January through December 1991 was about 6 ft (fig. 16).

Ground-Water Flow, Recharge, and Discharge

Generally, ground-water flow is to the south, southeast, and southwest from the upland divide toward Ty Ty Creek and its tributary (figs. 17 and 18). The gradient of the potentiometric surface varies across the site and ranges from about 87 to 166 ft/mi. The gradient is steepest in the northern part of the study area and becomes less steep in the southern part of the study area. The change in gradient is attributed to the topographic relief of the area and the inferred structural deformity of the Tuscahoma Formation. The direction and gradient of ground-water flow remained nearly unchanged between the January and July 1991 measurement periods (figs. 17 and 18).

Recharge to the Claiborne aquifer consists of a regional and local component and for comparative purposes is assumed to be represented by the seasonal ground-water-level response to precipitation. Regional recharge enters the ground-water system upgradient, outside the study area, and is dependent on regional hydrologic controls such as pumpage, stream discharge, and rainfall) (Hicks and others, 1991b). The rate of lateral movement of regional recharge into the study area is dependent on aquifer continuity, hydraulic conductivity, hydraulic gradient, and other hydraulic factors, and is considered to be constant (Hicks and others, 1991b).

Local recharge enters the ground-water system as rainfall or irrigation water that percolates to the Claiborne aquifer. Irrigation in the study area is limited to two, one-acre plots and is not considered to greatly affect the ground-water levels. The distribution of annual water-level fluctuations in the Claiborne aquifer (fig. 16) indicate that the majority of regional and local recharge occurs in the interstream area and decreases downslope to both creeks.

Ground-water discharge from the Claiborne aquifer in the study area primarily is to Ty Ty Creek and its tributary. Discharge from evapotranspiration may be present in the study area.

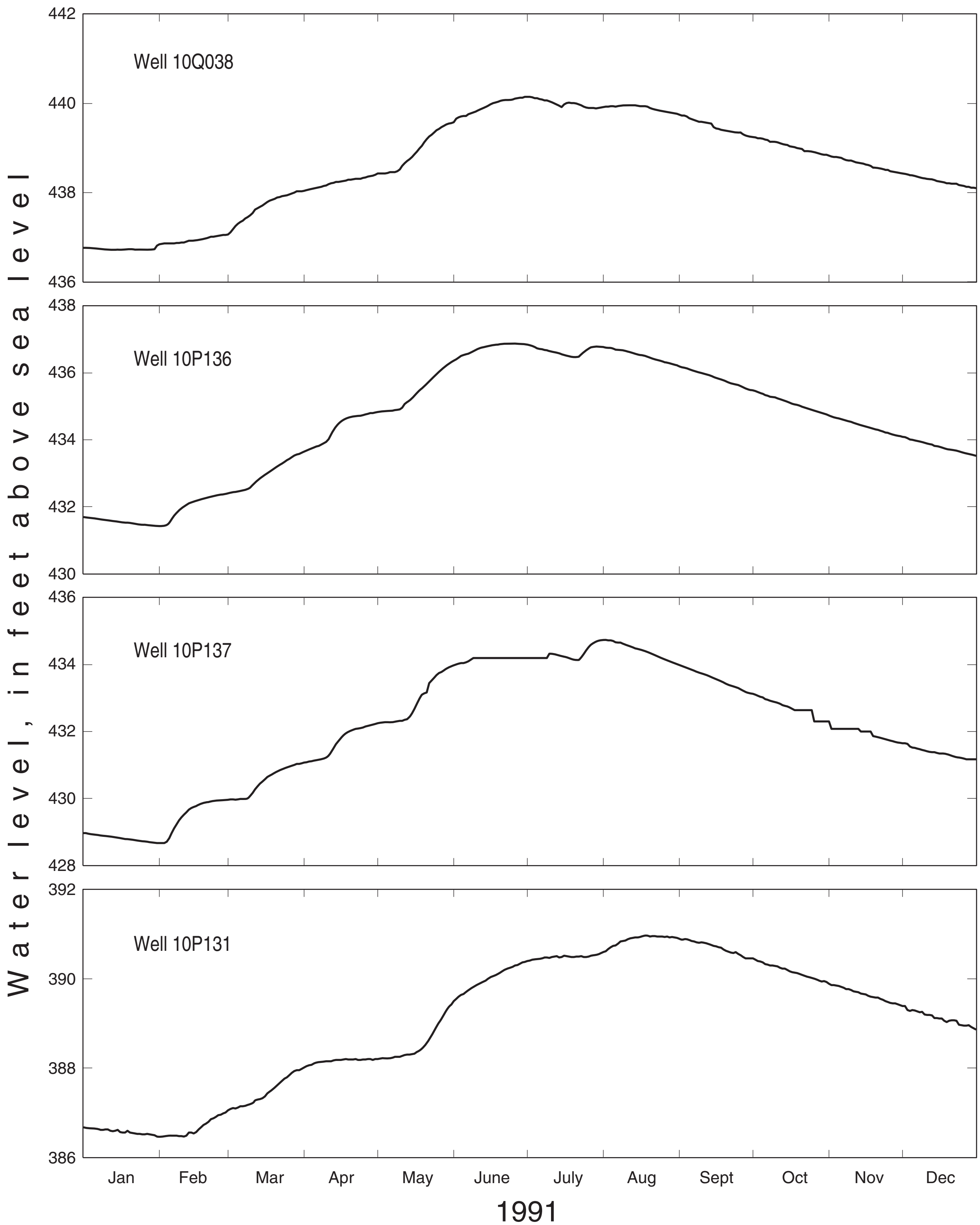


Figure 14. Daily water-level fluctuations in wells 10Q038, 10P136, 10P137, and 10P131.

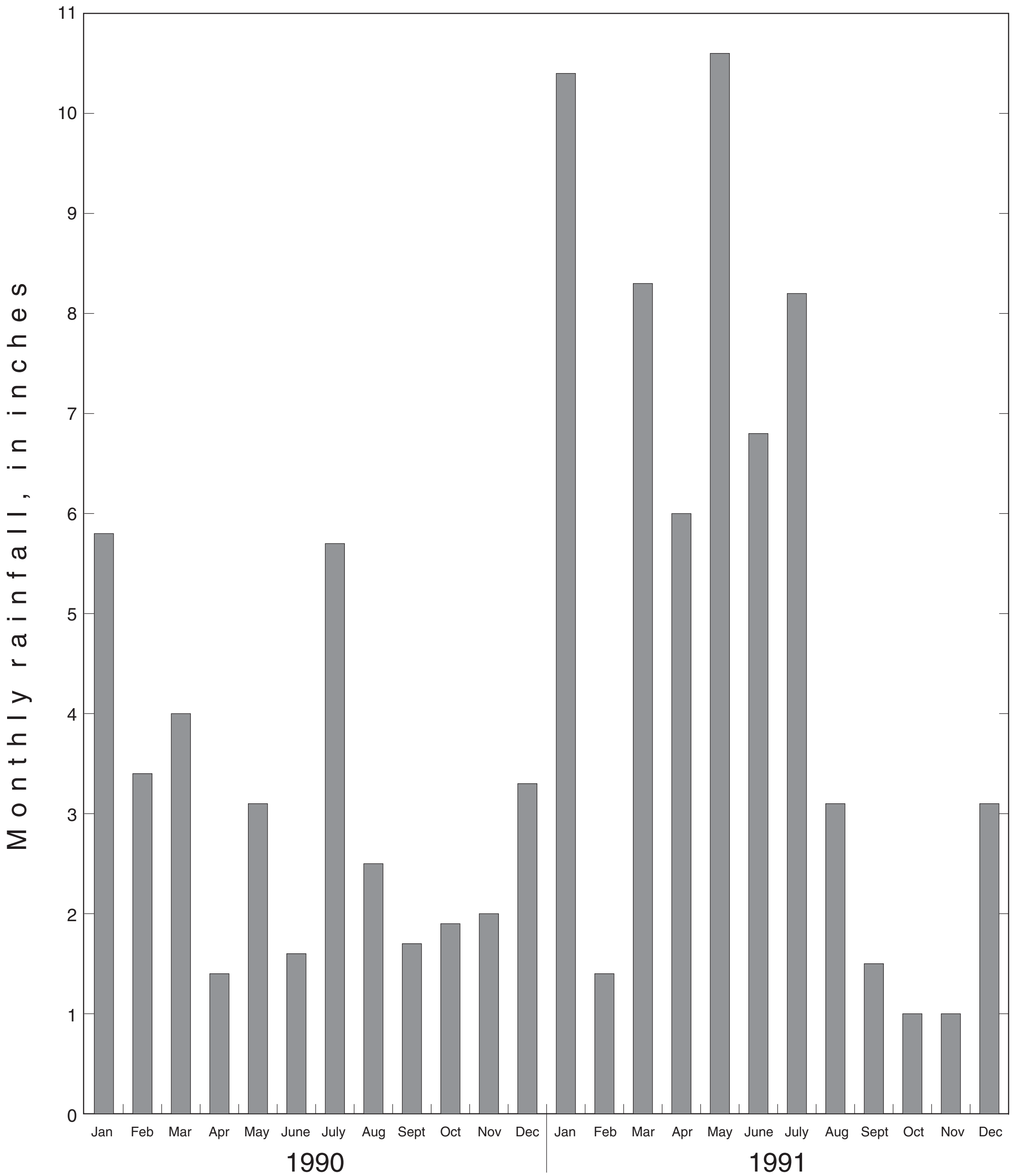
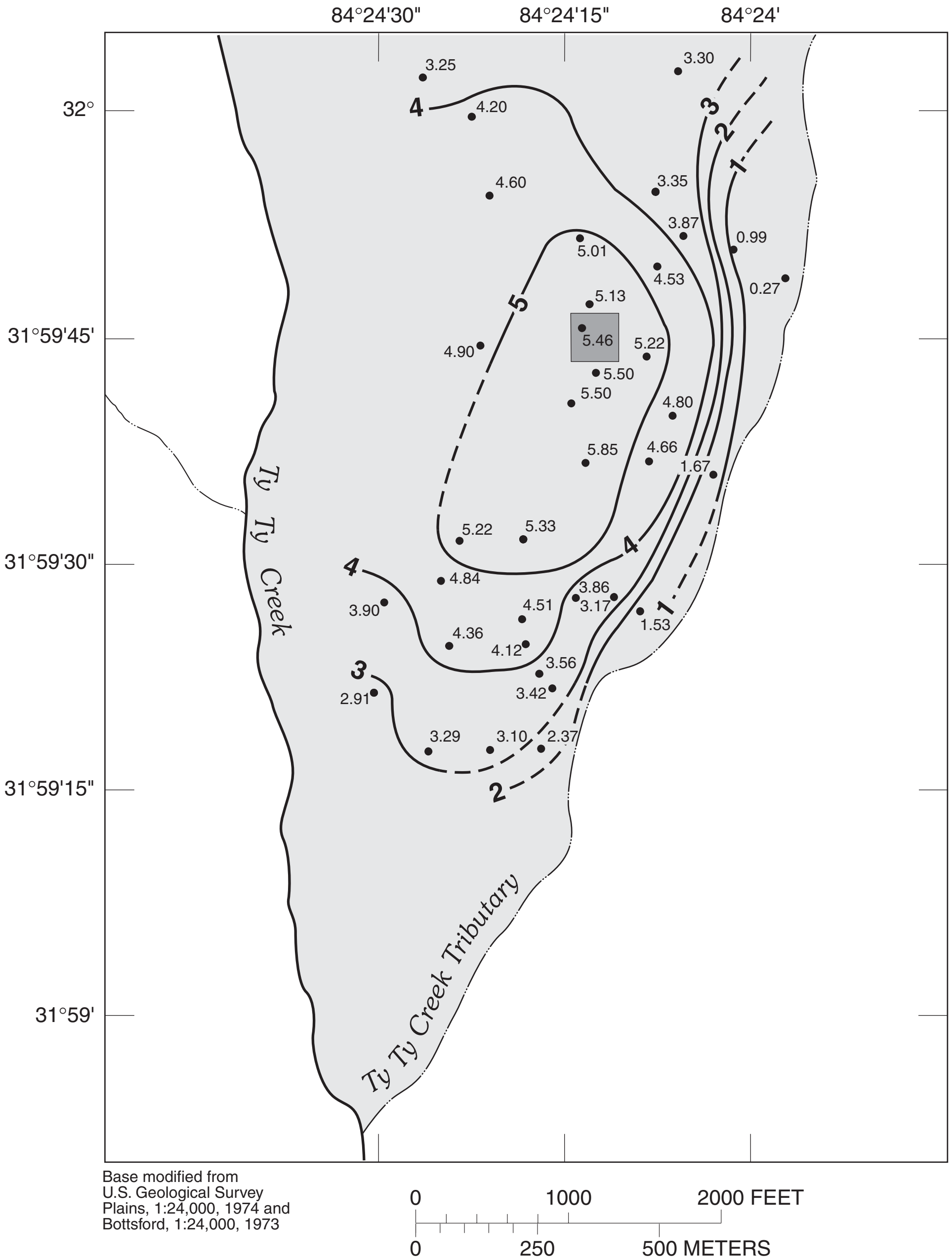


Figure 15. Monthly cumulative rainfall, January 1990 to December 1991.



EXPLANATION

Study area

USGS-ARS research plot

—1– – Line of equal change in altitude of the potentiometric surface of the Claiborne aquifer—Contour interval 1 foot. Dashed where approximately located

0.99 Monitor well— Number is maximum change in the altitude of the potentiometric surface of the Claiborne aquifer, in feet

Figure 16. Maximum change in the altitude of the potentiometric surface of the Claiborne aquifer, January through December 1991.

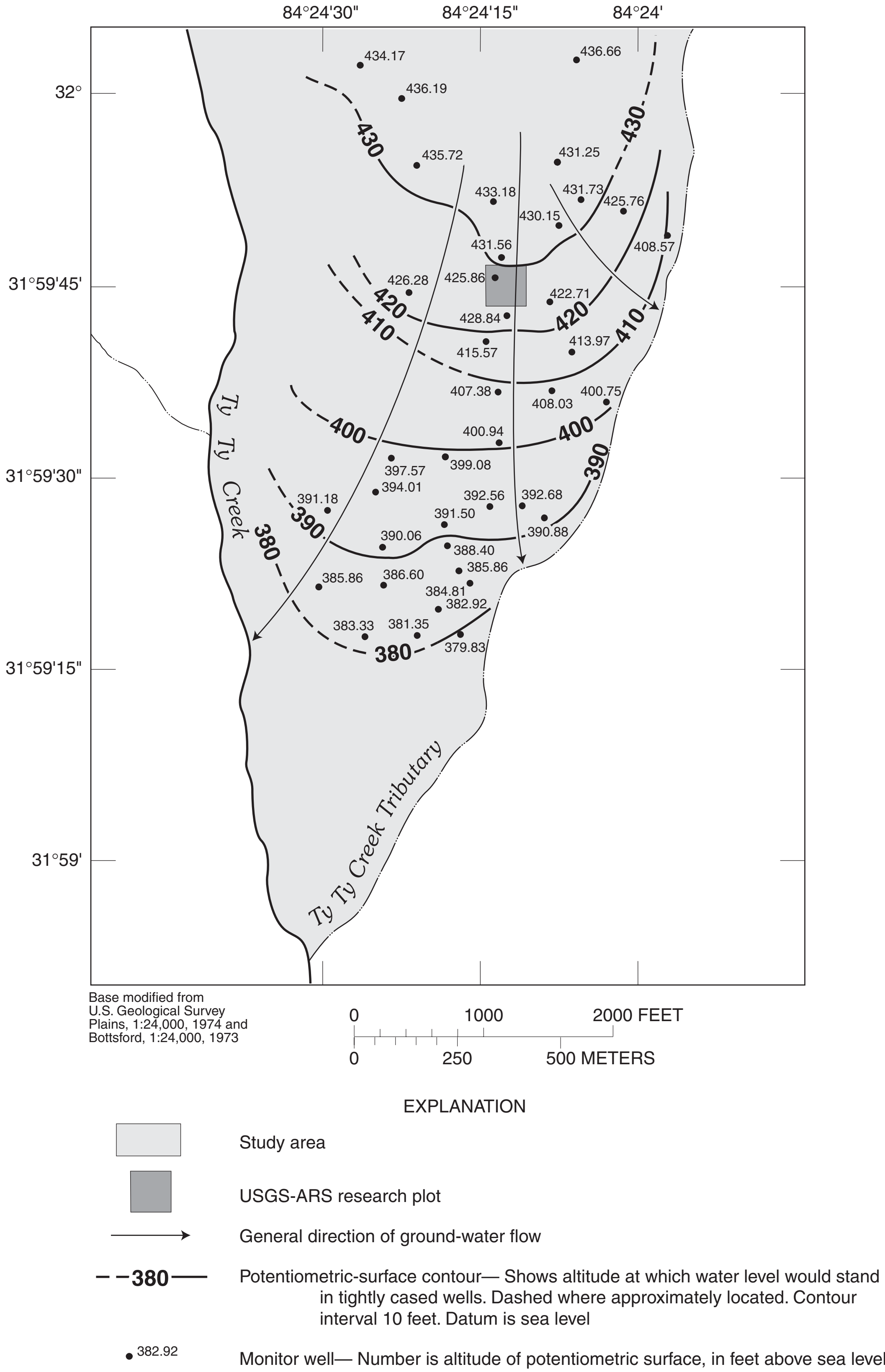


Figure 17. Potentiometric surface and general direction of ground-water flow in the Claiborne aquifer, January 1991.

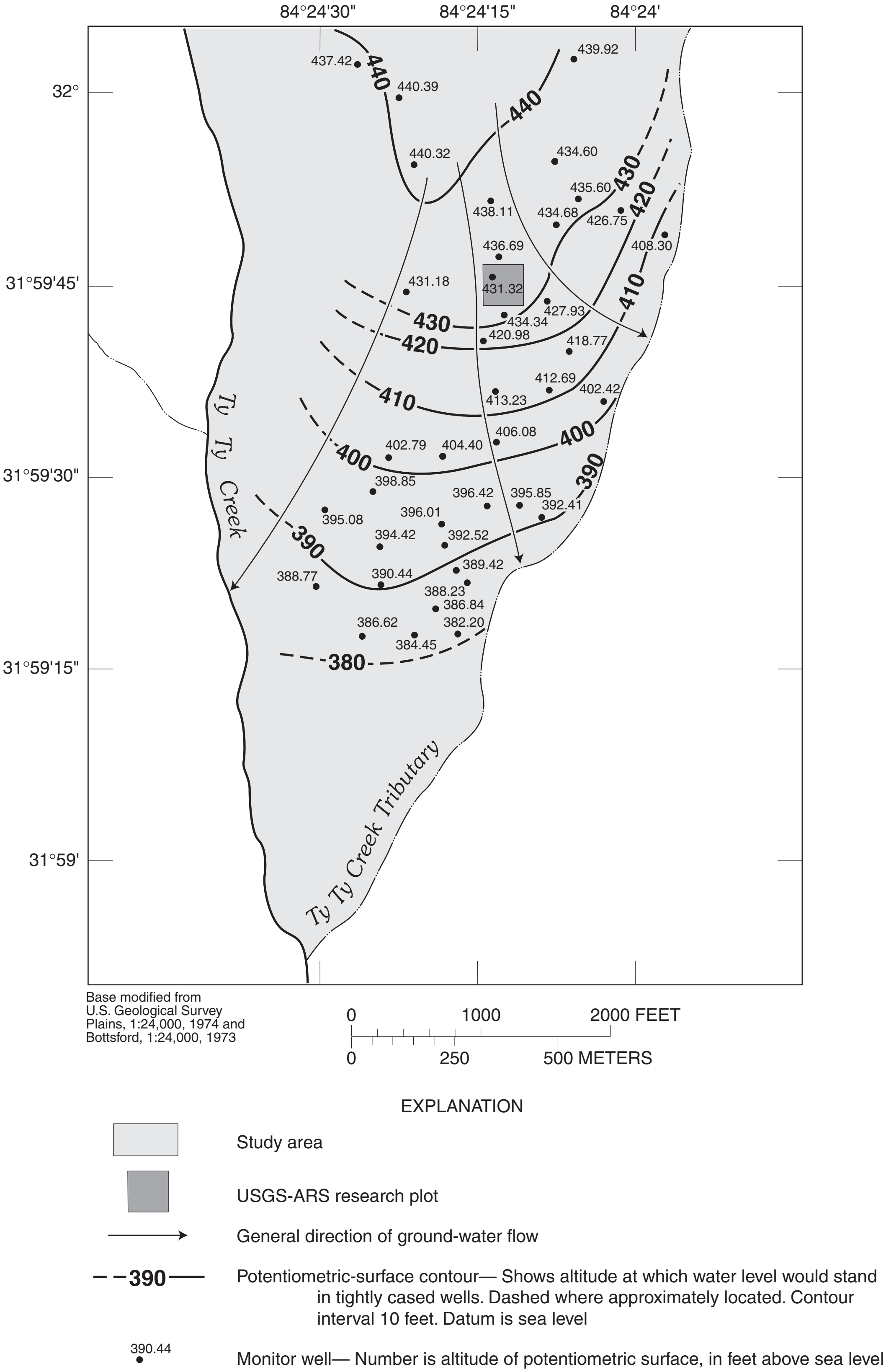


Figure 18. Potentiometric surface and general direction of ground-water flow in the Claiborne aquifer, July 1991.

SUMMARY

Geologic units of importance to the shallow ground-water system in the study area are, in ascending order, (1) the Tuscahoma Formation, a bluish gray, silty clay; (2) the Tallahatta Formation, a fine-to-coarse, poorly sorted quartz sand that is divided into an upper and lower unit; and (3) the undifferentiated overburden, a fine-to-medium poorly sorted sand interlayered with thin clay layers.

The unsaturated zone includes the undifferentiated overburden and the upper unit of the Tallahatta Formation which includes a laterally extensive clay layer that separates the upper and lower units of the Tallahatta Formation in most of the study area. The maximum thickness of the unsaturated zone is about 52 ft in the upland divide area.

The Claiborne aquifer is restricted to the lower unit of the Tallahatta Formation. The base of the Claiborne aquifer is the clayey sediments of the Tuscahoma Formation. Locally, the Claiborne aquifer may be confined by the clayey sediments of the undifferentiated overburden and the upper unit of the Tallahatta Formation. Water-level data indicate that regions of the Claiborne aquifer can change from confined to unconfined conditions if the potentiometric surface drops below the bottom of the clay layer that separates the upper and lower units of the Tallahatta Formation.

The Claiborne aquifer ranges in saturated thickness from about 3 ft near the Ty Ty Creek tributary to 25 ft in the upland divide area. Hydraulic conductivity ranges from 3.5 to 7 ft/d, and transmissivity was estimated at 50 ft^2/d.

The Claiborne aquifer potentiometric surface is typically at maximum altitude in July and August with minimum altitudes of the potentiometric surface occurring during January. The slope of the average potentiometric surface ranges from 87 to 167 feet per mile due to the topographic relief and structural deformity of the underlying Tuscahoma Formation. From January to December 1991, the change in the potentiometric surface was a maximum of 6 ft.

The direction of ground-water flow in the aquifer is generally to the south, southeast, and southwest and remains nearly unchanged during low and high water-level periods. Recharge to the Claiborne aquifer consists of a lateral ground-water-flow component (regional flow) having an assumed constant rate. Local recharge to the aquifer enters the ground-water system as rainfall that percolates down to the aquifer. Annual water-level fluctuations in the Claiborne aquifer indicate that the majority of regional and local recharge occurs in the interstream area with recharge decreasing downslope to the streams.

Ground water discharge from the Claiborne aquifer to Ty Ty Creek and its tributary during low and high ground-water-level periods. Discharge from evapotranspiration may be present.

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