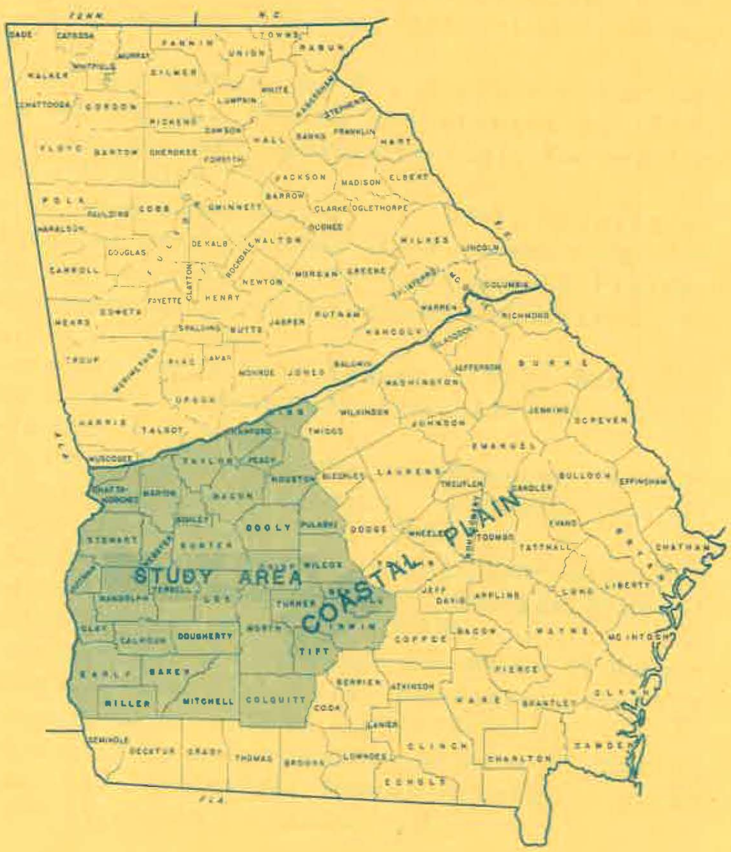
HYDROLOGIC ATLAS 11

HYDROGEOLOGY OF THE PROVIDENCE AQUIFER OF SOUTHWEST GEORGIA

John S. Clarke, Robert E. Faye and Rebekah Brooks



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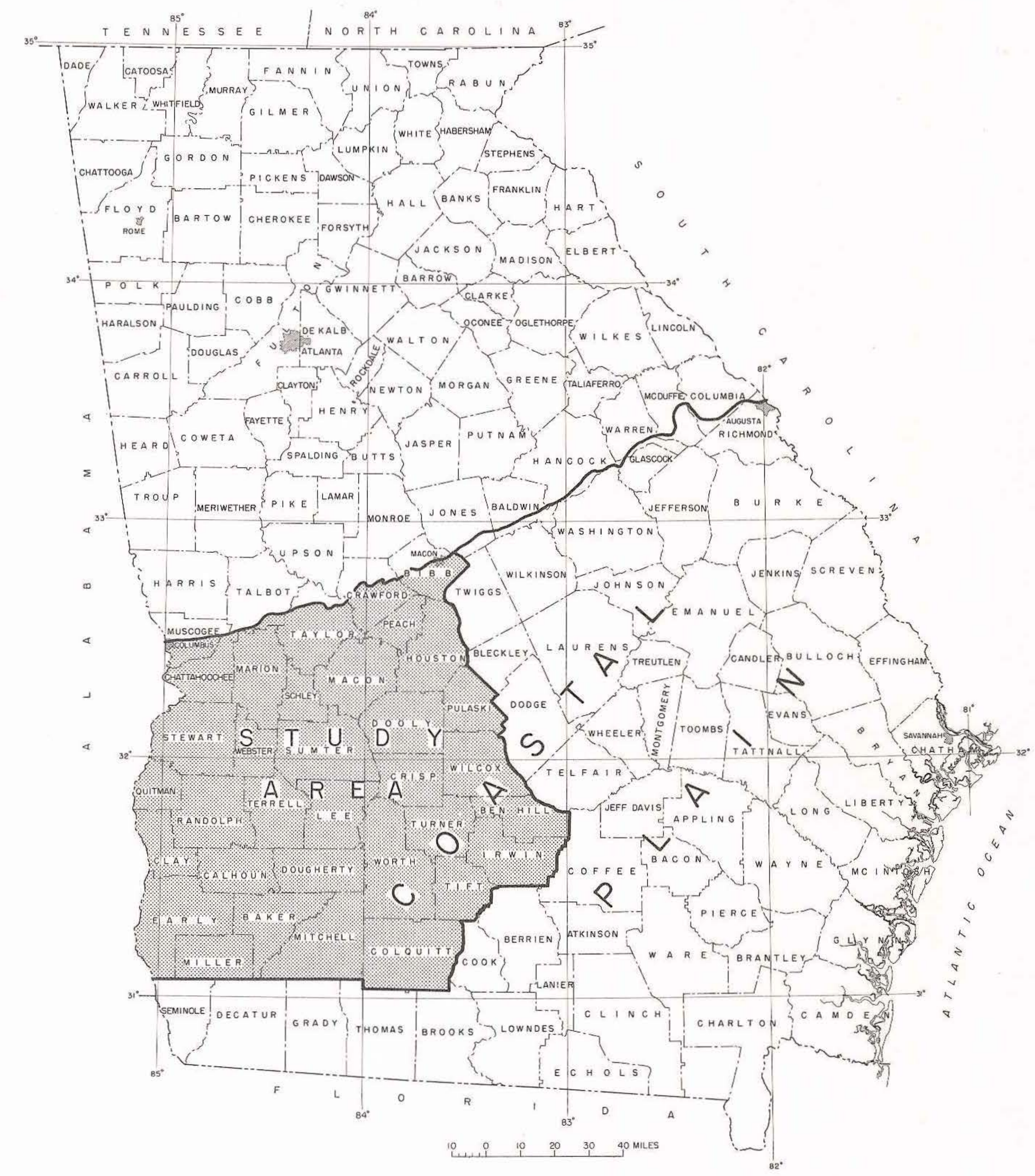

Figure 1.— Location of study area.

Table 1.--Generalized correlation of stratigraphic, lithologic, and aquifer units of Mesozoic and Cenozoic age in southwest Georgia

Era-them	System	Series	Gulf Coast stage	Group and formation Chattahoochee River area	Lithology	Aquifer (A) or confining zone (C) (Pollard and Vorhis, 1980)	Aquifer or confining zone this report	Thickness (feet)
Cenozoic	Quaternary	Holocene			Alternating layers of sand, clay, and limestone			
		Pleistocene						
	Tertiary	Miocene						
		Oligocene	Chickasawhayan					
			Vicksburgian					
		Eocene	Jacksonian	Ocala Limestone			Ocala aquifer	0 - 200
			Claibornian	Claiborne Group: Lisbon Formation			Lisbon confining zone	0 - 70
				Claiborne Group: Tallahatta Formation			Claiborne aquifer	0 - 270
			Sabinian	Wilcox Group: Hatchetigbee Formation			Wilcox confining zone. Sandy layers within this zone may yield sufficient quantities of water for domestic supply	0 - 260
		Paleocene		Wilcox Group: Tuscahoma Sand and Nanafalia Formation, undifferentiated				
			Midwayan	Midway Group: Clayton Formation (upper unit)	Sand, fine to medium; quartz, calcareous; inter-bedded thin limestone [1]			
				Midway Group: Clayton Formation (limestone unit)	Limestone, light-gray, massive, recrystallized; fossiliferous at the top [1]		Clayton aquifer. Forms single aquifer unit with the upper member of the Providence Sand updip	0 - 300
				Midway Group: Clayton Formation (lower unit)	Sand, fine to medium, arkosic; locally glauco-nitic and silty [1]		Clayton-Providence confining zone. Where absent, the upper member of the Providence Sand and the Clayton Formation form a single aquifer unit	0 - 130
Mesozoic	Cretaceous	Upper Cretaceous (Gulfian)	Navarroan	Providence Sand (upper unnamed sand member)	Sand; grades from a thickly bedded sand updip to a massive marine sand containing calcareous intervals downdip. [2] In Albany, Dougherty County, upper part is a dense clayey sand. Middle part is a slightly dolomitic coquina grading upward to a siltstone. Lower part is sand containing varying amounts of silt [1]	A2	Providence aquifer. Forms a single aquifer unit with the Clayton Formation updip and Cusseta Sand and Ripley Formation downdip	0 - 390
				Providence Sand (Perote member)	Silt or very fine sand, dark-gray; highly mica-ceous, carbonaceous. East of Schley County, merges with upper member through facies change to coarse sand [3]	C2	Providence-Ripley confining zone. Where absent, the Providence Sand and upper part of Cusseta Sand form a single aquifer unit termed the Providence-Cusseta aquifer	0 - 300
				Ripley Formation	Sand, fine, clayey, micaceous, fossiliferous; undergoes an eastward facies change to a clayey coarse sand between the Flint and Ocmulgee Rivers [4]			
			Tayloran	Cusseta Sand	Sand; coarse; increasing amounts of thinly bed-ded carbonaceous clay toward the upper contact. Size and amount of sand decreases downdip where micaceous silt and clay dominate [2]	A3	Cusseta aquifer. Upper part forms a single aquifer unit with the Providence Sand and the Ripley Formation downdip and eastward	0 - 150
				Blufftown Formation	Sand, fine, micaceous, calcareous; contains vary-ing amounts of silt and clay	C3 A4 C4 A5	Blufftown aquifer	0 - 700
			Austinian	Eutaw Formation	Alternating layers of sand, sandy clay, and clay	C5		
			Eaglefordian and Woodbinian	Tuscaloosa Formation		A6 C6		

1 Hicks and others, 1981, p. 4
2 Reinhardt and others, 1980, p. 388
3 Eargle, 1955, p. 70
4 Eargle, 1955, p. 56

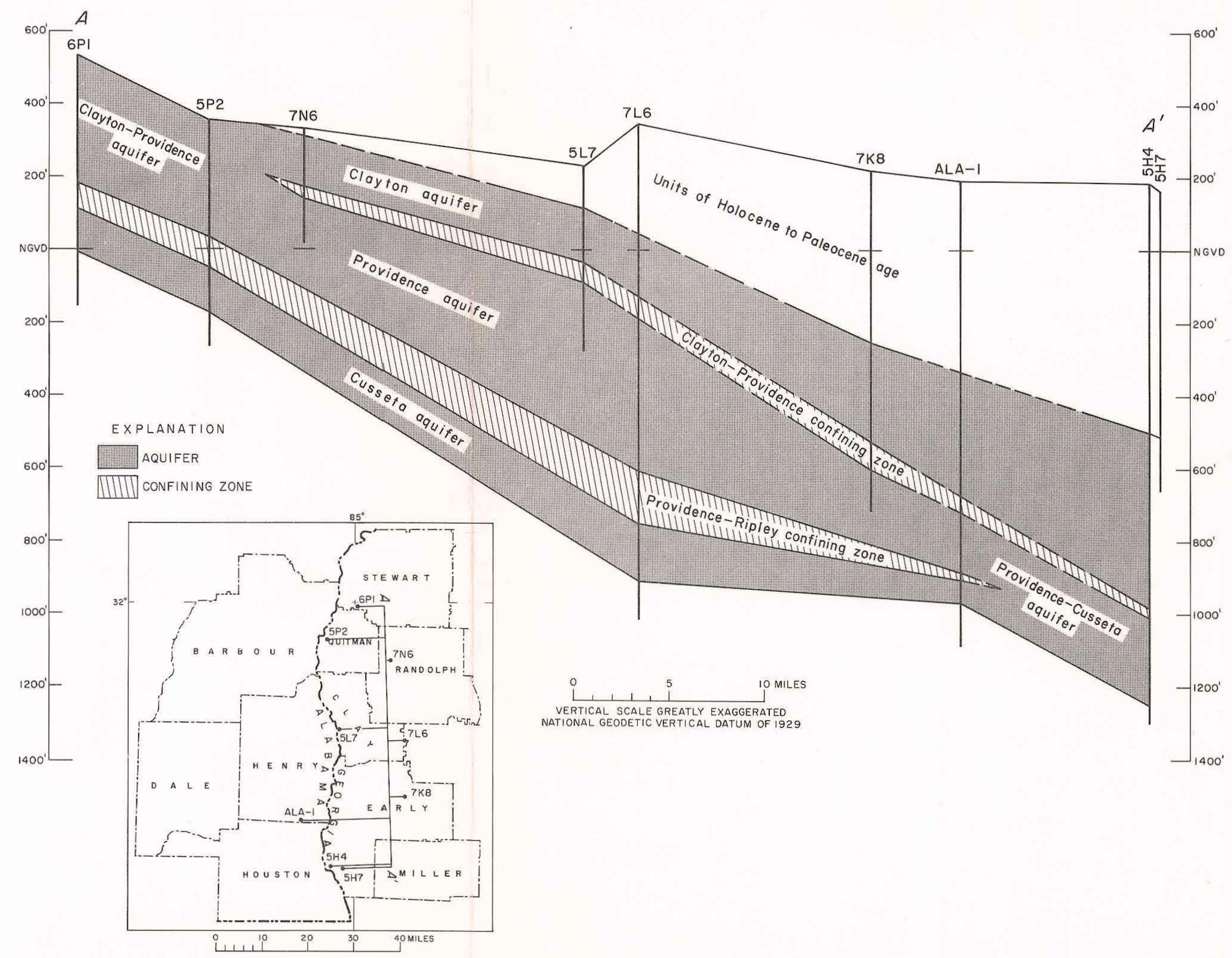

Figure 2.— Hydrogeologic section of southwest Georgia.

FACTORS FOR CONVERTING INCH-POUND UNITS TO INTERNATIONAL SYSTEM OF UNITS (SI)

Multiply	By	To obtain
feet (ft)	0.3048	meters (m)
inches (in.)	25.4	millimeters (mm)
miles (mi)	1.609	kilometers (km)
square miles (mi^2)	2.590	square kilometers (km^2)
gallons per minute (gal/min)	0.06309	liters per second (L/s)
million gallons per day (Mgal/d)	0.04381	cubic meters per second (m^3/s)
	43.81	liters per second (L/s)
cubic feet per second per square mile [ft^3/s/mi^2]	0.01093	cubic meters per second per square kilometer [m^3/s/km^2]
Transmissivity		
feet squared per day (ft^2/d)	0.0929	meters squared per day (m^2/d)

National Geodetic Vertical Datum of 1929 (NGVD of 1929). A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada. It was formerly called Sea Level Datum of 1929 or mean sea level in this series of reports. Although the datum was derived from the average sea level over a period of many years at 26 tide stations along the Atlantic, Gulf of Mexico, and Pacific Coasts, it does not necessarily represent local mean sea level at any particular place.

WELL—NUMBERING SYSTEM

Wells in this report are numbered according to a system based on 7-1/2 minute topographic quadrangle maps of the U.S. Geological Survey. Each quadrangle in the State has been given a number and a letter designated according to its location. The numbers begin in the southwest corner of the State and increase eastward. The letters begin in the same corner, but progress alphabetically to the north. Additional information regarding wells used in this report may be obtained by referring to the well identification number in any correspondence to the U.S. Geological Survey, Suite B, 6481 Peachtree Industrial Boulevard, Doraville, GA 30360.

INTRODUCTION

Since 1950, population growth and changes in farming practices in southwest Georgia have resulted in a significant increase in agricultural, industrial, and municipal ground-water use. From 1950-80, ground-water use increased 230 percent in Americus and 240 percent in Albany. Heavy pumping in these areas caused water levels in the Providence aquifer to decline more than 100 ft during this 30-year period.

The purpose of this study was to define the areal extent of the Providence aquifer and its hydrologic, geologic, and water-quality characteristics, and determine the water use and long-term trends of water levels in the aquifer. The location of the study area is outlined in figure 1.

Historical and modern water-level, water-quality, and water-use data were evaluated to gain an understanding of the effect of man on the ground-water flow system. During October 20-24, 1980, water-level measurements were made in wells distributed throughout the study area. These measurements, together with data listed by Stephenson and Veatch (1915); Wait (1963); Owen (1963); and from data files of the U.S. Geological Survey; the Georgia Geologic Survey, Environmental Protection Division; and numerous consulting and drilling firms, were used to construct the estimated 1951 and October 1980 potentiometric surface of the Providence aquifer. During 1980, a test well was drilled through Tertiary and Upper Cretaceous sediments in Pulaski County. Structure and thickness maps of the Providence aquifer were constructed from geophysical and lithologic data from the Pulaski test well, and other wells distributed throughout the study area.

This atlas is part of a series intended to present results of the lower Tertiary-Upper Cretaceous aquifer study being conducted as part of the Georgia Accelerated Ground-Water Program.

ACKNOWLEDGMENTS

This study was conducted by the U.S. Geological Survey in cooperation with the Georgia Department of Natural Resources, Environmental Protection Division, Geologic Survey.

The preparation of this report would not have been possible without the cooperation and assistance of well owners, drillers, and managers of town and industrial waterworks throughout the study area. The writers wish to thank Mr. Conway Mizelle of Insurance Services of Georgia for supplying historical records of municipal water use in the study area. Charles C. Smith and Norman F. Sohl, U.S. Geological Survey, provided paleontological correlations for test well 1 in Albany. Raymond A. Christopher, U.S. Geological Survey, provided palynological identifications and Lucy E. Edwards, U.S. Geological Survey, provided paleontological identifications for the Arrowhead test well in Pulaski County.

GEOLOGY

The study area lies within the southwestern part of the Coastal Plain physiographic province of Georgia. Sediments within the area consist primarily of alternating layers of sand, clay, shale, and limestone extending to a depth of at least 5,000 ft. Sediments are generally exposed in northeast trending outcrop belts and gently dip to the southeast, progressively thickening in that direction.

The Cretaceous formations of Georgia were divided by Pollard and Vorhis (1980) into a series of aquifers (A) and confining zones (C) (table 1). The Providence aquifer corresponds to the A2 aquifer of Pollard and Vorhis (1980) and consists primarily of the upper unnamed sand member of the Providence Sand. The Providence Sand is the youngest of the predominantly sand and clay Upper Cretaceous formations of southwest Georgia. In the Chattahoochee River valley, it consists of two units, the lower Perote Member and an upper unnamed sand member (Reinhardt and Gibson, 1980, p. 388). In updip areas along the Chattahoochee River, the Perote Member consists of silt or very fine sand and the upper unnamed member consists of fine to coarse sand (table 1).

The Providence Sand conformably overlies the Upper Cretaceous Ripley Formation and is unconformably overlain by the Clayton Formation of early Paleocene age, and younger units of Paleocene to Holocene age. The general stratigraphy and lithology of the Providence Sand and contiguous units are described in table 1.

Table 2.--Record of wells used in section A-A'

Aquifers (A): Pc, Clayton; Pc-Kp, Clayton-Providence; Kp, Providence; Kp-Kc, Providence-Cusseta; Kc, Cusseta
Confining zones (C): Pc-Kp, Clayton-Providence; Kp-Kr, Providence-Ripley

County	Well No.	Georgia Geologic Survey No.	Latitude-longitude	Owner or name	Altitude of land surface (ft)	Aquifers (A) and confining (C) zones	Altitude of top based on NGVD of 1929	Thickness (ft)	Remarks
Stewart	6P1	716	315933-0845910	H. S. Bradley, 1	535	Pc-Kp (A) Kp-Kr (C) Kc (A)	(?) 180 110	(?) 70 115	
Quitman	5P2	3117	315221-0850451	Georgetown, 2	355	Pc-Kp (A) Kp-Kr (C) Kc (A)	(?) 35 -53	(?) 88 118	
Randolph	7N6	3046	314905-0845220	Randolph, GGS [1] test well 1	340	Pc-Kp (C)	174	34	
Clay	5L7	--	313628-0850314	Ft. Gaines, 3	232	Pc (A) Pc-Kp (C) Kp (A)	114 -38 -92	152 54 (?)	See table 3 for well construction and water-level data.
Do.	7L6	192	313353-0844805	J. W. West, 1	352	Kp-Kr (C) Kc (A)	-608 -748	140 160	
Early	7K8	--	312342-0844846	McKnight, Luckey, and Tracey, 1	217	Pc (A) Pc-Kp (C)	-255 -525	270 78	
Henry-Alabama	ALA-1	--	312042-0851043	H. D. Granberry, 1	192	Kp-Kr (C) Kc (A)	-883 -908	25 60	Well located in Henry Co., Ala. Alabama Geological Survey No. 631.
Early	5H4	121	311019-0850439	A. C. Chandler, 1	185	Pc (A) Pc-Kp (C) Kp-Kc (A)	(?) -985 -1,015	(?) 30 240	
Do.	5H7	--	310942-0850224	Great Southern Paper Co. (Nursery well)	160	Pc (A)	-518	(?)	

1 Georgia Geologic Survey.

AQUIFER FRAMEWORK AND LITHOLOGY

The lithology of the Providence aquifer shows gradational changes both east and west of the Chattahoochee River valley and southward. Updip near the outcrop area (fig. 3), the aquifer sediments are primarily coarse fluvial sands. Downdip to the south, aquifer sediments are finer-grained and marine in origin. In the Albany-Dougherty County area, the Providence aquifer is a coquina, which grades upward to a siltstone (Hicks and others, 1981, p. 4).

The Providence aquifer is separated from the underlying Cusseta aquifer by the Providence-Ripley confining zone. This zone consists primarily of silts and fine sands of the Perote Member of the Providence Sand and the underlying Ripley Formation. Between the approximate midpoint of the Flint and Ocmulgee Rivers and eastward (fig. 3), the confining zone changes gradationally to a coarse sand and with the Providence and Cusseta aquifers, forms a single aquifer unit (Providence-Cusseta aquifer). Downdip and between the rivers the lower part of the Cusseta Sand changes gradationally to predominantly silt and clay (table 1) and is significantly less permeable than the Providence-Ripley confining zone (fig. 2, table 2). In this area the Providence-Cusseta aquifer consists of sediments of the upper part of the Cusseta Sand, the Ripley Formation, and the Providence Sand (table 1). The area in which the Providence and Cusseta aquifers are differentiated is outlined in figure 3.

The Providence aquifer is confined by overlying clays and fine sands of the Clayton-Providence confining zone (fig. 2; table 1). In updip areas, this confining zone may be absent and the Providence and Clayton aquifers form a single aquifer unit (Clayton-Providence aquifer). A similar condition exists in northern Houston County, where the Providence is overlain by sands of middle Eocene age (LeGrand, 1962, p. 45).

Cartography by Willis G. Hester

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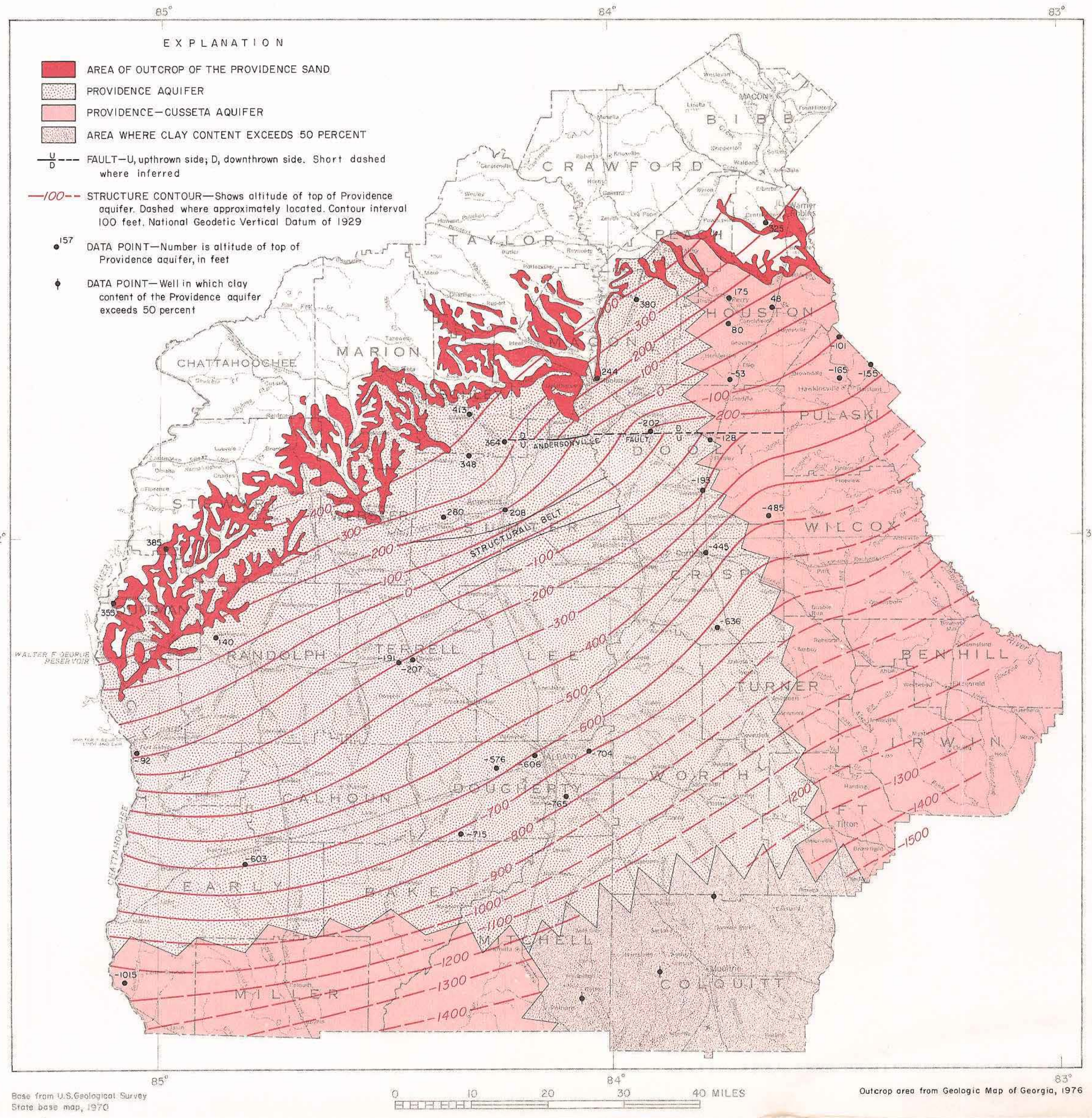

Figure 3.—Structural features, outcrop area, and approximate altitude of the top of the Providence aquifer.

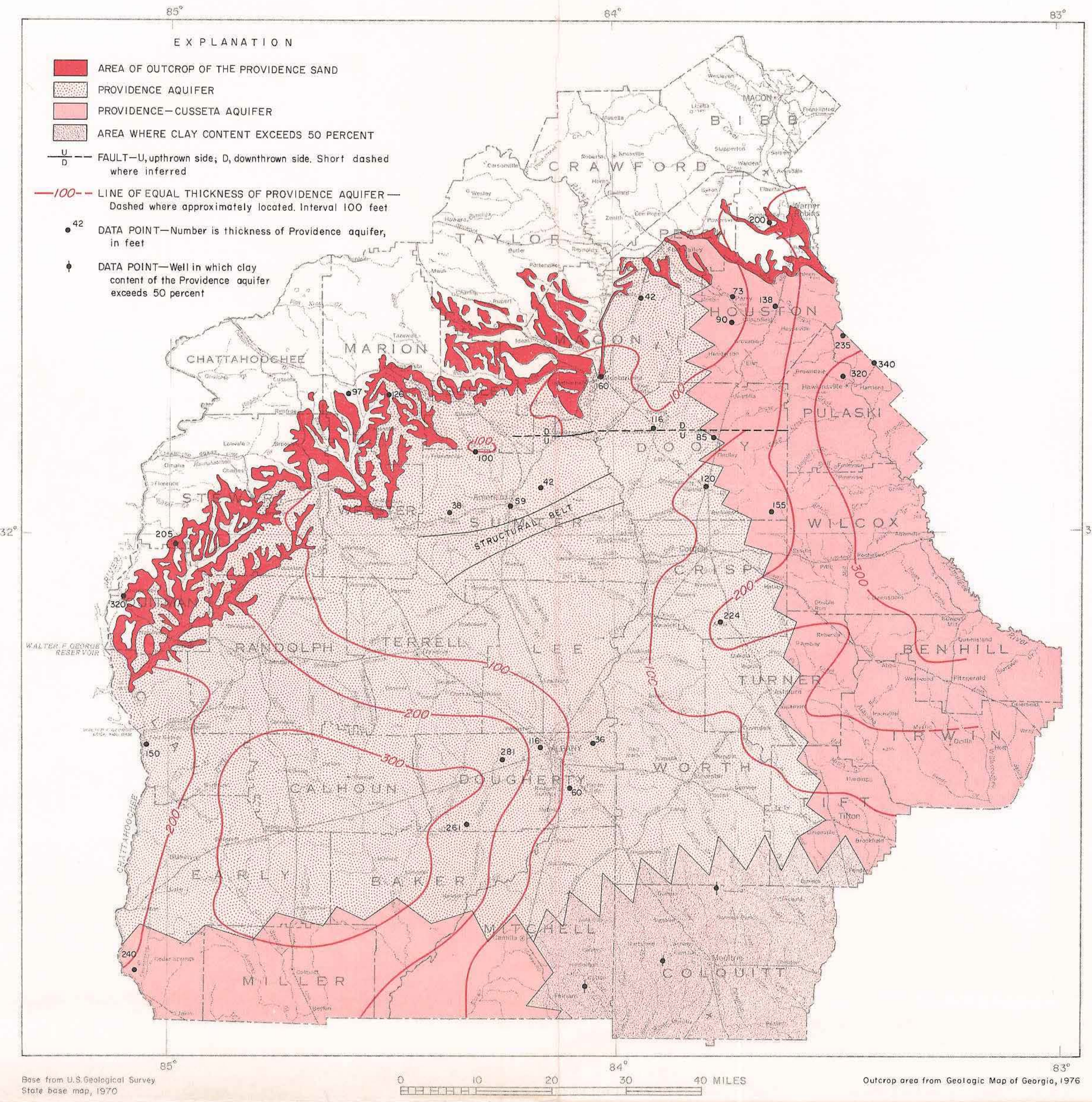

Figure 4.—Thickness of the Providence aquifer.

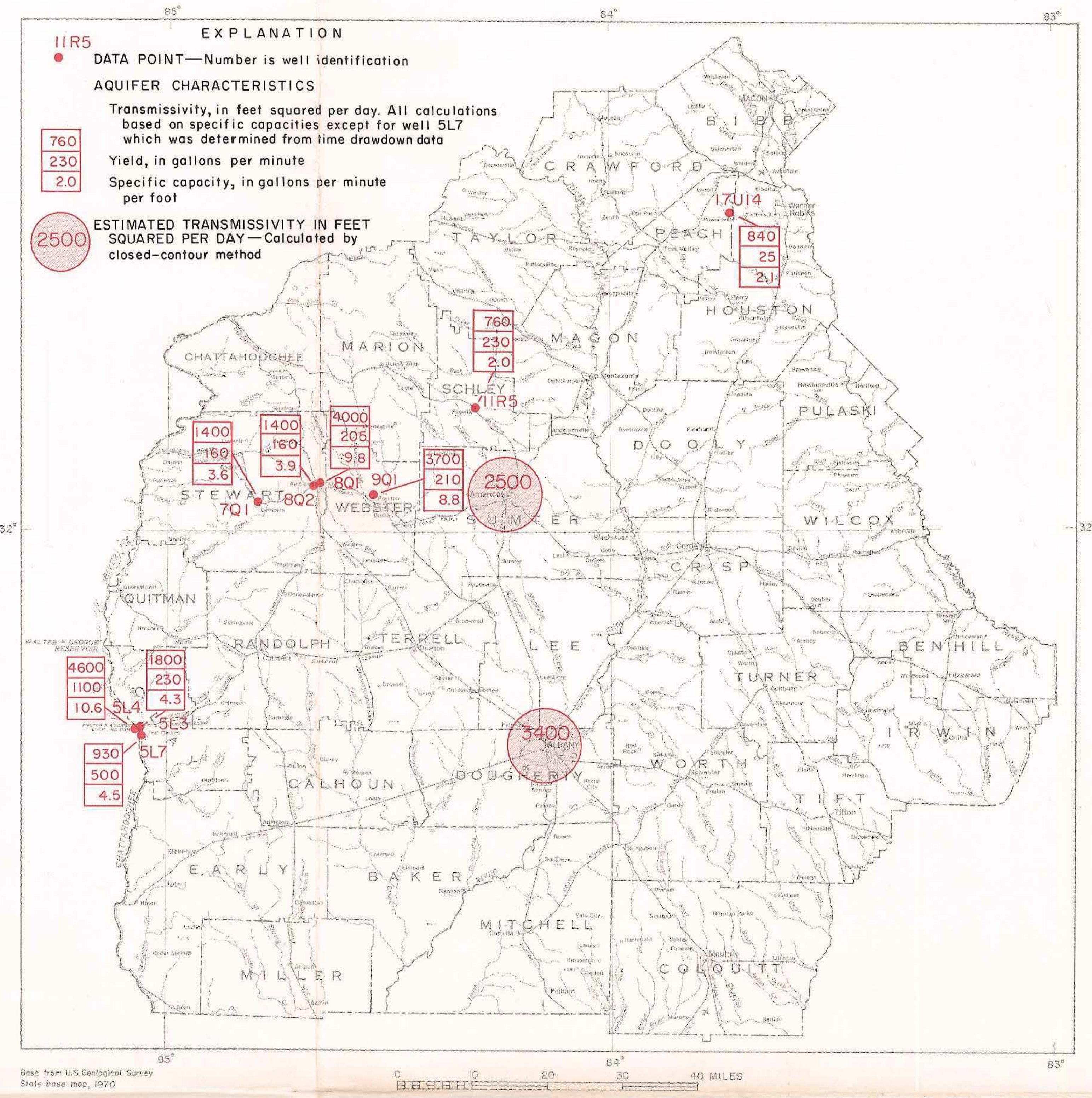

Figure 5.—Aquifer transmissivity, yield, and specific capacity of wells tapping the Providence aquifer.

STRUCTURE

The altitude of the top of the Providence aquifer is shown in figure 3. This map was constructed by using geophysical and lithologic logs from 37 wells throughout the study area. Depths to the top of the aquifer may be estimated from figure 3 by subtracting the altitude of the aquifer from the altitude of land surface. An average dip of 29 ft/mi to the southeast was computed for the top of the Providence aquifer.

The northeast trending structural belt of Sumter County (Owen, 1963, p. 38) and east-west trending Andersonville fault (Zapp, 1943) are major features that affect the geology of the Providence Sand (fig. 3). Within the Sumter County structural belt, the dip of the top of the Providence aquifer steepens. Owen (1963, p. 38) found that within this belt, the regional dip of Upper Cretaceous sediments, the lower Paleocene Midway Group, and the upper Paleocene Tuscahoma Sand is about twice as great as elsewhere and may be due to a monoclinal flexure, a fault, or a series of faults. In the vicinity of the Andersonville fault, structure contours of the top of the Providence aquifer are offset, indicating a maximum vertical displacement of about 200 ft along the fault. Owen (1963, p. 38) found that the top of the overlying Midway Group was offset 100 ft by the fault. It is, therefore, likely that the top of the Providence aquifer also is displaced 100 ft or more. In Dooly County, the low altitude of the top of the Providence aquifer at Byromville and high altitude at Pinehurst probably indicate that the Andersonville fault extends farther east than is shown on the Geologic Map of Georgia (1976), and that Byromville is on the downthrown side of the fault.

AQUIFER THICKNESS

The thickness of the Providence aquifer was determined from geophysical and lithologic logs of 32 wells distributed throughout the study area (fig. 4). The aquifer ranges in thickness from 38 ft in Sumter County and 36 ft in Dougherty County, to 386 ft in Pulaski County. Figure 4 shows two large areas where the thickness of the aquifer exceeds 300 ft: one to the southwest in Early, Calhoun, Baker, and Dougherty Counties and the other to the east in Pulaski and Wilcox Counties. The thickness of the Providence aquifer is less than 50 ft in parts of Sumter County and may be the result of faulting in the vicinity of the structural belt.

AQUIFER PROPERTIES

Aquifer transmissivity, well yields, and specific capacities of wells tapping the Providence aquifer are shown in figure 5. The specific capacity of a well is defined as the rate of yield per unit of drawdown, generally expressed in gallons per minute per foot [(gal/min)/ft]. Values for the Providence aquifer range from 2.0 (gal/min/ft) at well 11R5 in Schley County to 10.6 (gal/min)/ft at well 5L4 in Clay County.

The transmissivity of an aquifer is defined as the rate at which water will flow through a unit width of the aquifer under a unit hydraulic gradient (Lohman, 1972, p. 6). It is, thus, a measure of the aquifer's ability to transmit water, generally expressed in feet squared per day (ft^2/d). Transmissivities may be estimated from time-drawdown or specific-capacity data, and by the closed contour method. With the exception of values at Albany, Americus, and well 5L7 at Fort Gaines, transmissivities in this report were computed by applying Jacob's modified nonequilibrium formula to specific-capacity data (Ferris and others, 1962, p. 99). Unpublished data indicate that transmissivities estimated by this method are generally 2-4 times lower than values calculated from time-drawdown data for the same well. In order to account for this difference, values computed by this method were increased by about 50 percent to account for the effect of estimated energy losses near the well on measured drawdown. Transmissivities of 3,400 ft^2/d at Albany and 2,500 ft^2/d at Americus are probably most accurate and were estimated by using the closed contour method described by Lohman (1972, p. 46-47). The transmissivity for well 5L7 was computed from time-drawdown data. Computed transmissivities ranged from 760 ft^2/d at well 11R5 in Schley County to 4,600 ft^2/d at well 5L4 in Clay County.

Cartography by Willis G. Hester

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Table 3.--Record of selected wells

[Aquifers: To, Ocala; Tc, Claiborne; Pw, Wilcox; Pc, Clayton; Pc-Kp, Clayton-Providence; Kp, Providence; Kr, Ripley; Kp-Kc, Providence-Cusseta; Kc, Cusseta; Kb, Blufftown. Use of water: I, industrial; P, public supply; A, agricultural; D, domestic; O, observation. F, flowing. Water level: Reported levels are given in feet; measured levels are given in feet and tenths.]

County	Well No.	Georgia Geologic Survey No.	Latitude-longitude	Name or owner	Date drilled or modified	Depth of well (ft)	Depth of casing (ft)	Diameter of well (in.)	Altitude of land surface (ft)	Aquifer(s)	Water level: Above (+) or below (-) land surface (ft)	Water level: Date of measurement	Yield (gal/min)	Specific capacity [(gal/min)/ft]	Use	Remarks
Calhoun	8K3	—	312621-0844335	Arlington	—	1,173	—	—	303	Kp	-40	1909	—	—	P	—
Clay	5L3	556	313640-0850322	Ft. Gaines	1958	375	310	8	148	Kp	+20 +35.7	4/3/58 10/80	230 125F	4.34	P	8-in. screen set at 310-320, 350-360 ft, gravel packed. Water-quality analysis made 4/5/58 & 4/17/68
Do.	5L7	—	313628-0850314	Ft. Gaines, 3	1979	550	456	24,8	232	Kp	-70 -77.1	2/1/79 8/26/81	500	4.54	P	8-in. screen set at 330-340, 355-365, 370-385, 425-445 ft.
Do.	5L4	—	313727-0850355	W.F. George Lock and Dam Plant (powerhouse)	—	372	324	—	96	Kp	F	8/3/60	1,100 600F	10.58	I	Screen set at 324-354 ft. Well flowed 8/3/60. Well located on Alabama side of Chattahoochee River, at powerhouse.
Do.	5M2	—	313731-0850341	USA C. of E. Test well 3	—	343	316	8,6	135	Kp	+33	12/55	800F	—	O	Open hole, 316-343 ft. Observation well for dewatering operations. Water-quality analysis, 8/27/57.
Do.	5L2	—	313640-0850320	Ft. Gaines	1909	264	260	—	150	Kp	+30	1909	300F	—	P	—
Dooly	14R6	3393	321209-0835422	Byromville, 2	1979	610	260	26,8	358	Tc,Kp	-66 -78.5	6/13/79 10/23/80	402	6.09	P	8-in. screen set at 260-280, 330-340, 580-600 ft.
Do.	15R6	—	320338-0834800	J. Grady Jones	—	500	—	—	365	Pc,Kp	-21.7 -32.5	2/1/51 4/2/81	—	—	D	—
Do.	14R1	—	321241-0845806	J. D. Lester	—	582	582	—	385	Kp	-100 -79.9	1/30/51 4/2/81	—	—	D	—
Dougherty	12L21	3406	313534-0841030	U.S.G.S. Test well 10	1978	845	810	14, 6,5	198	Kp	-116.9 -136.3	12/19/78 10/80	—	—	O	8-in. screen set at 810-830 ft. Continuous water-level recorder installed 12/78. Water-quality analysis, 11/21/78.
Do.	11K1	183	312654-0842101	U.S.G.S. Sealy 2	1978	1,200	1,103	—	184	Kp-Kc	-13.4 -12.2	11/6/78 4/18/79	—	—	O	Unused oil-test well drilled 1942. Original total depth, 5,500 ft.
Do.	11L13	—	313011-0841859	St. Joe - Barnett	1941	795	540	6	180	Pc,Kp	+25.1	11/28/41	270F	—	D	6-in. open hole from 540-795 ft. Well caved to 540 ft in 1978.
Do.	12L29	—	313559-0841204	Lakeside Development	1950	823	620	—	220	To, Pc,Kp	-17	2/1/50	250	—	D	Water-level measurement made during testing of lower strata. Finished well taps To, Pc, and Kp aquifers.
Do.	12L20	—	313534-0841030	U.S.G.S. Test well 6	1978	690	619	6	198	Pc	-125.4	1/18/78	—	—	O	Open hole, 619-690 ft. Water-quality analysis, 3/7/78.
Early	6K1	321	312332-0845551	Blakely, 3 (Howell Ave.)	1952	960	—	12,10	310	Pc, Kp-Kc	-40	1952	500	—	P	Well caved, 1964.
Do.	6K5	—	312246-0845600	Blakely, 1	1931	809	650	8	240	Pc,Kp	-20	5/15/46	500	—	P	Open hole, 650-809 ft. Water-quality analysis, 5/16/46.
Houston	16T4	—	322652-0833736	Pabst Brewery	1973	700	300	26, 16,12	295	Kp-Kc, Kb	-4	6/5/73	1,560	24.0	I	Screen set at 300-325, 490-510, 560-620 ft.
Do.	16T2	1094	322619-0833812	Pabst Brewery, 4	1967	640	295	26, 16,12	300	Kp-Kc, Kb	-5 -12.4	12/18/67 10/22/80	1,557	67.70	I	12-in. screen set at 295-300, 310-330, 340-360, 438-443, 510-520, 560-565, 580-585, 600-630 ft.
Do.	16T9	2160	322640-0833719	Pabst Brewery, 2	1969	625	320	26, 16,12	320	Kp-Kc, Kb	-25 -35.6	7/23/69 10/22/80	1,585	66.04	I	12-in. screen set at 320-340, 390-410, 525-545, 580-620 ft.
Do.	16T3	2139	322629-0833801	Pabst Brewery, 3	1969	710	330	26, 16,12	315	Kp-Kc, Kb	-19	5/12/69	1,543	35.88	I	12-in. screen set at 300-350, 520-550, 610-640, 680-700 ft.
Do.	16T10	—	322607-0833813	Pabst Brewery, 5	1977	640	300	26, 16,12	292	Kp-Kc, Kb	-7	6/4/77	1,655	26.27	I	12-in. screen set at 300-350, 500-520, 580-610 ft.
Do.	17U14	—	323522-0834245	Gleaton's Mobile Home Park, 1	1969	95	90	4	450	Kp	-45	6/26/69	25	2.08	D	4-in. screen set at 90-95 ft.
Do.	15S1	1025	322027-0834708	Houston Co. Board of Commissioners, Henderson	1964	433	175	8	380	Tc, Kp-Kc	-152	10/64	272	2.78	P	8-in. screen set at 175-180, 315-320, 398-403, 425-430 ft.
Do.	16U6	—	323017-0833955	Mrs. C.L. Kersey	—	50	—	3	382	Kp-Kc	-40	—	—	—	D	—
Do.	16U7	—	323020-0833615	G. E. Perdue	—	65	—	2	340	Kp-Kc	-45	—	—	—	D	—
Do.	16U8	—	323056-0834008	Ethel Davis	—	116	116	2	300	Kp-Kc	+8	—	40F	—	D	—
Do.	16U9	—	323040-0834006	H. A. Merker	—	150	150	3	300	Kp-Kc	+8	—	65F	—	D	—
Do.	16U10	—	323025 0834003	J. H. Davis	—	200	200	3	300	Kp-Kc	+7	—	45F	—	D	—
Lee	12M5	—	314236-0841036	James Wingfield	1952	717	555	—	230	Pc,Kp	-7.0 -25.0	1952 7/10/79	200	—	A	Open hole from 555-717 ft.
Do.	13N2	—	314502-0820102	John Gates	—	700-800	—	—	236	Kp	+14.0	5/23/58	—	—	D	—
Macon	13R2	1061	321342-0840542	American Cyanamid Co., 1	1971	574	320	8	320	Kp, Kc,Kb	-9.2 -12.7	4/20/76 10/24/80	240	16.0	I	8-in. screen set at 320-340, 445-465, 475-485, 556-568 ft.
Do.	13S2	2161	321732-0840032	Southern Frozen Foods, 2A	1969	620	210	26, 12,10	330	Kp, Kc,Kb	-50 -53.1	7/10/69 12/1/76	1,050	19.81	I	10-in. screen set at 210-220, 440-450, 490-505, 572-582, 600-610 ft.
Do.	13S6	—	321734-0840034	Southern Frozen Foods, 1	1960	475	190	8	330	Kp,Kc	-38	5/4/60	525	6.82	I	Screen set at 190-210, 230-235, 450-465 ft.
Do.	13S9	1013	321735-0840037	Southern Frozen Foods, 2	1962	520	190	8	330	Kp,Kc	-52	8/3/62	800	14.29	I	Screen set at 190-200, 231-236, 440-450, 497-502, 510-520 ft. Water-quality analysis, 8/6/62, 1/10/69, and 4/24/74.
Do.	13S16	—	—	Joule Felton	—	348	220	4	290	Kp	+11.9	4/20/42	—	—	D	Open hole, 220-348 ft.
Do.	13S17	—	—	W. E. Wilburns	—	102	—	2	295	Kp	-10	2/22/42	—	—	D	—
Do.	13T2	—	—	J.A. Wardsworth	—	109.5	—	6	290	Kp	+8	4/22/42	100F	—	D	—
Do.	12S2	—	321813-0841405	Lester Souter	—	70	65	2	405	Kp	-33	—	—	—	D	—
Marion	9S3	329	321526-0843022	M. B. Wells	1963	398	—	—	645	Kp	-139 -179.7	1/14/63 10/80	—	—	D	—
Pulaski	18S3	—	321615-0832800	Old racetrack well, Hawkinsville	1959(?)	473	458	—	225	Kp-Kc	F F	1959 10/30/80	250F	—	P	Screen set at 458-470 ft.
Do.	18S11	—	321550-0832820	New racetrack well, Hawkinsville, 4	1976	552	171	—	260	To,Tc, Kp-Kc	-18	11/28/76	1,258	19.66	P	Screen set at 171-191, 220-240, 306-326, 376-386, 481-501, 535-545 ft.
Do.	18S10	—	321759-0832800	Portals Co.	1981	520	325	24,12	238	Tc, Kp-Kc	+1.2	4/22/81	1,080	22.43	I	12-in. screen set at 325-335, 345-355, 360-370, 400-445, 475-480, 502-510 ft.
Quitman	5P3	436	315310-0850454	Keglar School	1955	170	116	—	348	Kp	-64.0 -53.3	1/29/75 11/9/76	25P	—	P	Original total depth, 396 ft. Well caved to depth of 170 ft.
Do.	5N1	—	314906-0850415	R. Balkcom	1966	560	473	—	414	Kp	-183	1966	—	—	D	Screen set at 473-560 ft.
Randolph	7N1	—	314609-0844743	U.S.G.S., Cuthbert observation well	—	372	250	8	455	Pc	-134.1 -146.0	1/5/65 1/5/79	—	—	O	Open hole, 250-372 ft. Unused municipal well. Water-quality analysis, 6/22/78.
Schley	11R4	75	321413-0841823	Ellaville, 1	—	624	177	8	560	Kp, Kr,Kc	-140 -154.0	3/1/37 11/14/78	245	7.0	P	8-in. screen set at 177-183, 218-223, 258-263, 303-309, 487-493, 531-537, 568-578, 618-624 ft.
Do.	11R2	174	321413-0841819	Ellaville, 2	—	585	175	8	560	Kp,Kc	-63	7/48	250	1.97	P	8-in. screen set at 175-190, 520-525, 550-560 ft.
Do.	11R5	315	321435-0841850	Crossroad Enterprises	1952	195	73	8	566	Tc,Kp	-53 -61.4	8/15/52 10/27/80	230	2.05	I	Screen set at 73-83, 170-175, 185-195 ft.
Do.	12R4	312	321129-0841352	T. M. Childers	1952	246	242	4	520	Kp	-155	7/6/52	9.5	.34	D	Screen set at 242-246.5 ft. Well destroyed in 1969.
Do.	11S2	—	322032-0841539	Morris Hill	—	89	85	2	500	Kp	-70	—	—	—	D	—
Do.	11S3	—	321747-0841724	J. B. Teele	—	104	—	2	480	Kp	-44	—	—	—	D	—
Do.	11S4	—	321742-0841650	Chester Davis	—	125	—	2	525	Kp	-105	—	—	—	D	—
Do.	11S5	—	321738-0841722	B. S. Teele	—	96	91	2	443	Kp	-36	—	—	—	D	—
Do.	11S6	—	321613-0841819	J. W. Collins	—	120	115	2	500	Kp	-80	—	—	—	D	—
Stewart	7Q3	—	320306-0844742	Lumpkin, 1	1963(?)	165	125	8	525	Kp	-100 -96.1	8/8/63 10/80	137	3.7	P	8-in. screen set at 125-155 ft.
Do.	7Q1	—	320320-0844717	Lumpkin, 2A	1967	156	118	8	540	Kp	-100 -102.3	4/3/67 10/80	160	3.56	P	8-in. screen set at 118-123, 133-138, 143-153 ft.
Do.	7Q2	3098	320309-0844740	Lumpkin, 3 (or 1A)	1975	191	151	4	570	Kp	-143.7 -135.3	9/75 10/80	150	—	P	Screen set at 151-191 ft. Water-quality analysis, 6/25/74.
Do.	8Q2	—	320507-0843955	Richland, 1	1952(?)	220	107	18,8	590	Pc-Kp	105	7/11/52	364	3.83	P	8-in. screen set at 107-112, 145-155, 170-180, 195-210 ft.
Do.	8Q3	—	320508-0843955	Richland, 2	1963	215	160	26,8	585	Pc-Kp	-112 -122.0	4/12/63 10/80	205	3.66	P	8-in. screen set at 160-180, 185-205 ft.
Do.	8Q1	—	320525-0843914	Richland, 3	1968	215	135	26,8	560	Pc-Kp	-107 -104.9	1/10/68 10/80	205	9.76	P	8-in. screen set at 135-155, 175-205 ft. Water-quality analysis, 6/20/68 and 6/27/74.
Do.	8Q4	—	320241-0843908	Singer & Jones	—	300	160	—	545	Pc-Kp	-97.8	1/29/75	700	16.59	A	—
Sumter	12Q1	2163	320702-0841141	S. Georgia Vocational Technical School, 2	1969	720	285	—	469	Kp, Kr,Kc	-152 -169.6	7/25/69 10/24/80	510	9.27	P	Screen set at 285-315, 322-332, 380-390, 435-445, 482-492, 650-660, 672-677 ft.
Do.	12Q8	215	320702-0841141	A & S Development (Old Dayton Veneer Corp.)	1948	386	313	—	470	Kp	-142 -176.7	2/5/52 10/24/80	254	—	I	Screen set at 313-333 ft.
Do.	12Q23	—	320447-0841351	Americus	1952	300	—	6	345	Kp	-40	1952	—	—	O	Continuous water-level recorder installed 1952 to 1961. Original total depth, 400 ft. Well drilled, 1896. Reworked, 1952. Cased through limestone.
Do.	12Q6	147	320345-0841330	Americus, 3 (Elm Ave.)	1947	590	260	20,10	420	Kp,Kc	-74 -210.2	8/6/47 10/24/80	800	4.12	P	10-in. screen set at 260-290, 475-485, 495-515, 570-590 ft.
Do.	12Q4	333	320332-0841355	Americus, 4 (Harrold Ave.)	1947	800	205	20,10	385	Kp,Kr, Kc,Kb	-60 -150.3	2/17/53 10/24/80	935	8.82	P	10-in. screen set at 205-210, 220-225, 327-332, 342-347, 385-390, 400-405, 465-470, 600-605, 625-630, 685-690, 735-745, 765-785 ft.
Do.	12Q2	692	320321-0841212	Americus, 5 (Industrial Park)	1957	900	210	20,10	410	Pc, Kp,Kr, Kc,Kb	-60 -116.4	9/57 10/24/80	900	8.49	P	10-in. screen set at 210-220, 255-260, 275-280, 310-315, 370-375, 385-390, 428-433, 455-460, 520-525, 630-635, 668-673, 740-745, 775-780, 807-812, 885-890 ft.
Do.	12Q7	955	320336-0841409	Americus, 6 (Oak Ave.)	1964	926	194	24,10	375	Kp,Kr, Kc,Kb	-63 -116.9	4/24/64 11/16/78	1,627	18.08	P	10-in. screen set at 194-204, 216-221, 239-244, 452-457, 610-630, 692-697, 728-743, 766-786, 891-896, 904-914 ft.
Do.	10Q4	—	320240-0842237	U. of Ga. Experiment Sta.	1979	550	190	—	510	Pw,Pc, Kp,Kc	-118 -117.5	3/79 12/18/79	1,000	4.5	A	Screen set at 190-210, 230-270, 370-390, 430-470, 510-535 ft.
Terrell	10N1	213	314650-0842647	Dawson, 3	1978	575	342	20	350	Pc,Kp	-125	4/11/79	—	—	P	Backfill material removed in 1978, exposing Providence aquifer. Bottom of well plugged in 1979, sealing off Providence aquifer.
Webster	9Q1	—	320358-0843215	Preston, 1	1947	194	158	12,6	465	Kp	-86 -90.9	7/47 10/80	210	8.75	P	6-in. screen set at 158-163, 173-188 ft. Water-quality analysis, 12/14/48 and 3/31/72.
Do.	9Q2	947	320358-0843209	Preston, 2	1962	205	148	12,6	465	Kp	-94 -133.8	11/28/62 10/80	175	6.25	P	6-in. screen set at 148-158, 185-195 ft. Water-quality analysis, 12/3/62.
Do.	9Q5	—	320336-0843232	Preston, 3	1973	150	—	—	410	Kp	-48 -39.7	8/73 10/80	—	—	P	Water-quality analysis, 8/27/73.
Do.	9R3	—	321025-0843111	South River Farms	—	170	—	—	602	Kp	-130 -130.3	12/79 3/81	—	—	A	—

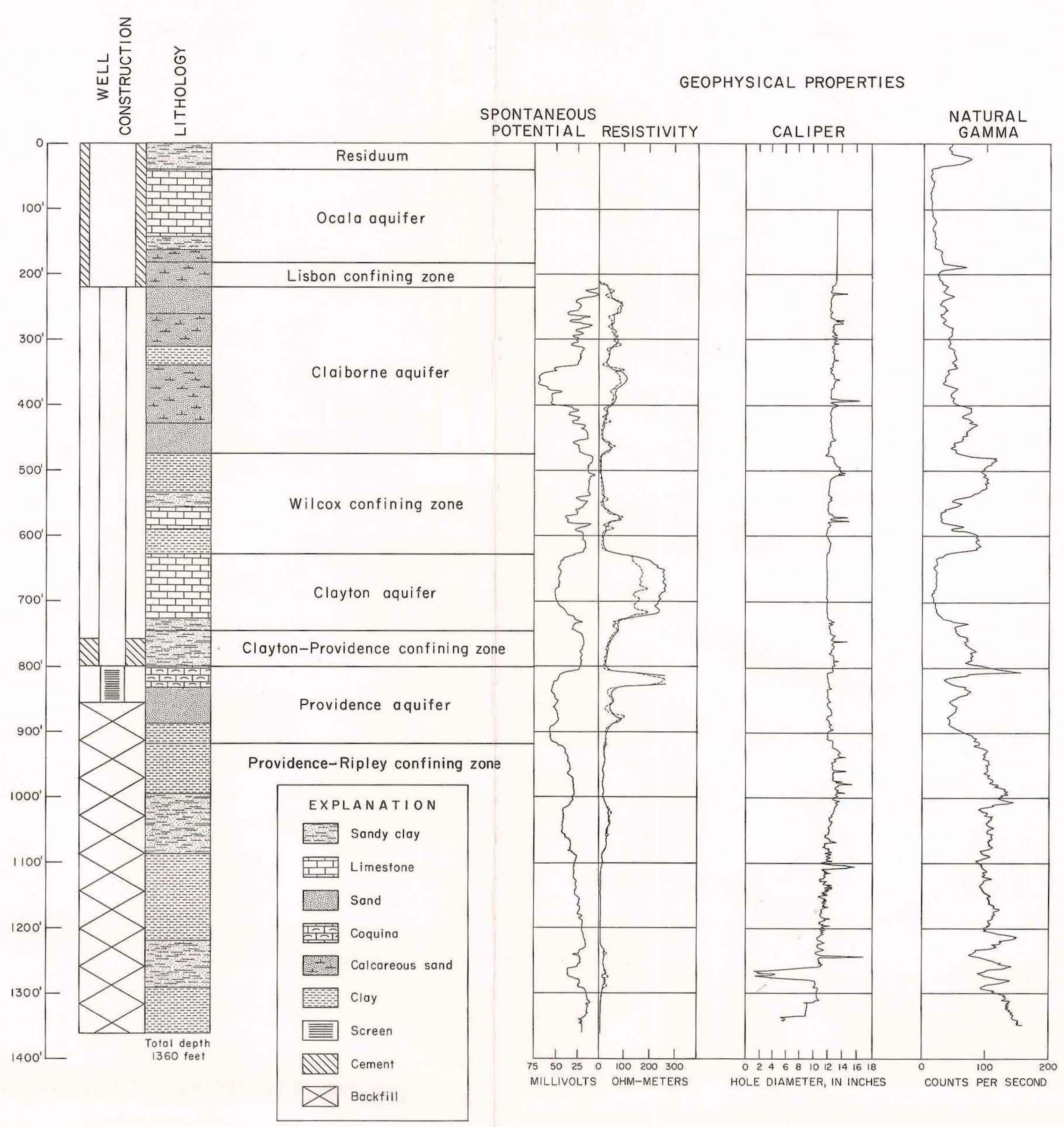

Figure 6.—Well construction and lithologic and geophysical properties of sediments at well 12L21 at Albany.

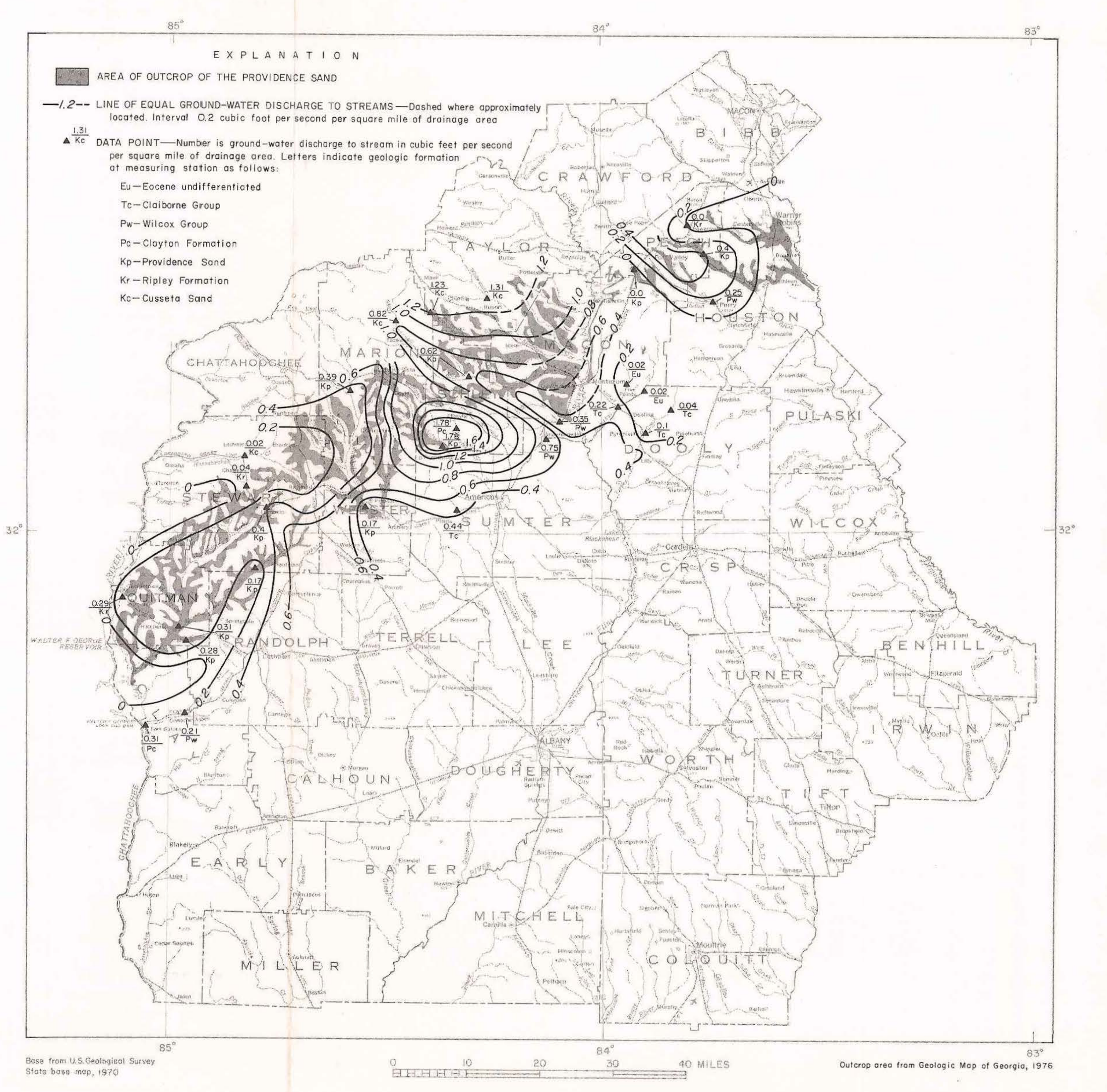

Figure 7.—Estimated discharge to streams from the Providence and other aquifers, September-October 1954.

WELL CONSTRUCTION

Wells tapping the Providence aquifer typically use multi-screen construction. The well construction and lithologic and geophysical properties of sediments at well 12L21 at Albany are shown in figure 6. Screens generally are placed opposite water-bearing zones that contain the highest percentage of coarse sand. During drilling, cuttings are collected at 10-foot intervals to determine the grain size and lithologic character of the material being penetrated. After the borehole is completed to the desired depth, a series of geophysical logs may be run to evaluate further the lithologic properties of the sediments. These logs, together with the drill cuttings, are used to determine the depth intervals of water-bearing zones. A screen line then is assembled above ground by welding alternating sections of blank casing and well screen at intervals that correspond to the depths of designated water-bearing zones. The assembled screen line is then positioned in the hole and the space between the well screen and the borehole wall is packed with coarse sand or gravel (Hicks and others, 1981, p. 19).

In some areas, the Providence aquifer supplies insufficient quantities of water and is used in combination with other aquifers. In Americus, multiaquifer wells tap combinations of the Clayton, Providence, Cusseta, and Blufftown aquifers. Albany municipal wells tap the Providence aquifer in combination with the Clayton and Claiborne aquifers. Construction information, water levels, and yields of wells tapping the Providence and other aquifers are listed in table 3.

RECHARGE

The Providence aquifer is recharged by precipitation along a 600-square mile outcrop belt that extends from the Chattahoochee River valley in Clay and Quitman Counties northeastward to the Flint River valley in Macon and Peach Counties (fig. 7). Additional recharge by precipitation is received between the Flint and Ocmulgee Rivers where the aquifer is near land surface and is overlain by permeable sand units. The aquifer also may receive recharge south of the outcrop area through leakage from underlying units. Declining water levels in the Providence aquifer have increased naturally occurring hydraulic head differentials, and therefore the potential for upward leakage of poor-quality water from underlying units has been increased.

DISCHARGE

The Providence aquifer discharges significant quantities of water to surface streams both in the outcrop area and downdip through overlying units. Much of this discharge probably represents rejected aquifer recharge due to low transmissivity (fig. 5). Estimated discharges of ground water to streams in the outcrop area during September-October 1954 (fig. 7) indicate that even during a period of extreme drought, water was available to recharge the aquifer. During this period, discharges exceeding 0.8 $(ft^3/s)/mi^2$ were observed in parts of Macon, Taylor, Schley, and Marion Counties (Thomson and Carter, 1954).

South of the outcrop area, discharge may occur where water from the Providence aquifer, under greater hydraulic pressure than water in the overlying Clayton aquifer, leaks upward through the Clayton-Providence confining zone into the Clayton aquifer. Declining water levels in the Clayton aquifer since the early 1900's have increased this naturally occurring head differential, thereby increasing the potential for upward leakage from the Providence aquifer. Water-quality analyses from the Clayton aquifer indicate that water may be leaking from the Providence aquifer into the Clayton aquifer in the Albany area (Hicks and others, 1981, p. 16).

DISCHARGE THROUGH IDLE MULTIAQUIFER WELLS

Idle multiaquifer wells in Albany and Dawson also provide conduits for the discharge of water from the Providence aquifer into the Clayton aquifer. Tests made in an idle Albany city well in 1979 showed that the Providence aquifer was discharging water through the well into the Clayton aquifer at a rate of 12 gal/min (Hicks and others, 1981, p. 20). A similar test conducted in an idle Dawson city well in 1981 showed that the Providence aquifer was discharging water through the well into the Clayton aquifer at a rate of 178 gal/min (D. W. Hicks, U.S. Geological Survey, oral commun., 1982). The higher discharge rate at Dawson probably is due to a greater head difference between the Providence and Clayton aquifers in that area. This head difference may be due to greater water-level declines in the Clayton aquifer than in the Providence aquifer.

SEASONAL WATER-LEVEL FLUCTUATIONS

Water-level fluctuations in the Providence aquifer are related to seasonal changes in precipitation, evapotranspiration, and rates of pumping. Owing to low transmissivity (fig. 5), most of the water-level fluctuations in the aquifer south of the outcrop area are caused by changes in pumping rates. The water level in observation well 12Q23 about 10 miles south of the outcrop area in Americus, fluctuated 13.8 ft between the lowest observed level in November 1958 and the highest level in January 1959. This fluctuation was due primarily to heavy seasonal pumping from nearby city wells (Owen, 1963, p. 42).

The water level in test well 12L21 about 40 miles south of the outcrop area at Albany, fluctuated 23.8 ft during 1980. A comparison of the water-level records for this well with the estimated pumping from the Providence aquifer by the city of Albany, shows the seasonal variation in rates of pumping and their effect on water levels (fig. 8).

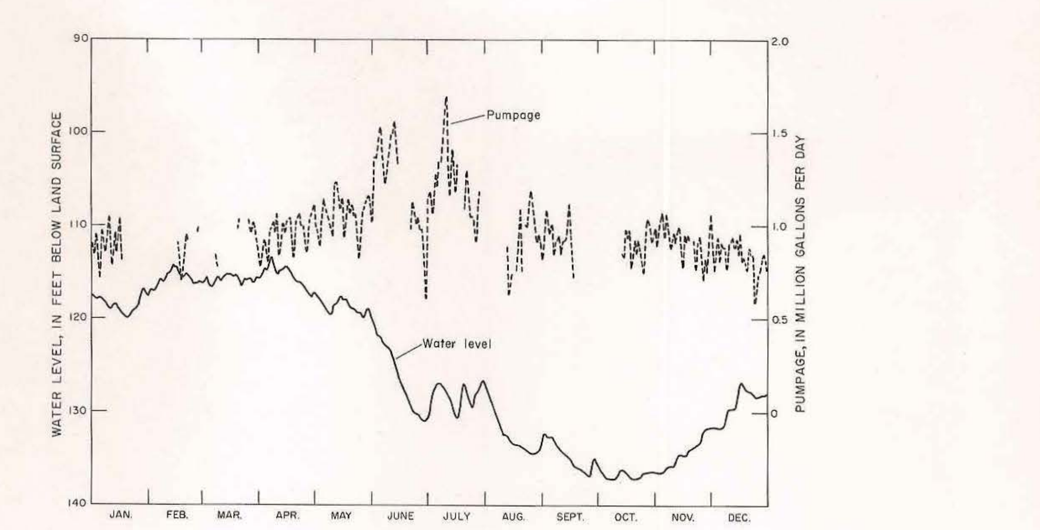

Figure 8.—Estimated mean daily pumpage from the Providence aquifer by the city of Albany and mean daily water levels in the Providence aquifer at well 12L21 at Albany, 1980.

HYDROGEOLOGY OF THE PROVIDENCE AQUIFER OF SOUTHWEST GEORGIA.

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Cartography by Willis G. Hester

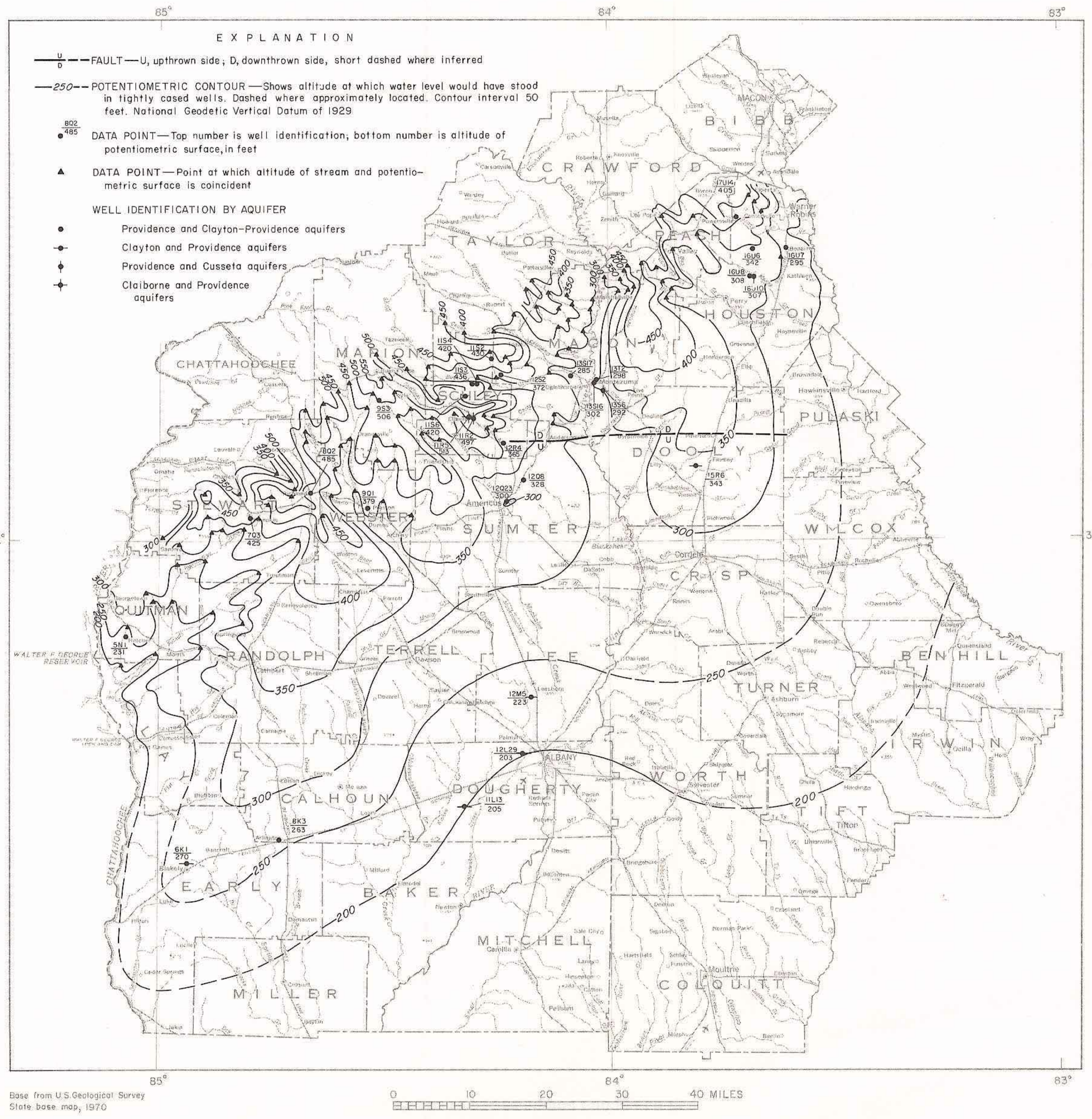

Figure 9.—Estimated potentiometric surface of the Providence aquifer, 1951.

POTENTIOMETRIC SURFACE

The potentiometric surface of an aquifer is an imaginary surface representing the altitude to which water would rise in tightly cased wells that penetrate the aquifer (Lohman, 1972, p. 8). The potentiometric surface is highest in areas of recharge and lowest in areas of discharge, indicating that ground water flows from areas of recharge toward areas of discharge. Where discharge exceeds recharge, the potentiometric surface is lowered, forming a cone of depression.

ESTIMATED 1951 POTENTIOMETRIC SURFACE

The predevelopment potentiometric surface of an aquifer represents natural conditions before man-induced stresses, such as pumping, were applied. Because ground-water withdrawals from the Providence aquifer prior to 1951 were limited mainly to pumping centers at Albany and Americus, the 1951 potentiometric surface over most of the study area closely resembles the predevelopment potentiometric surface. Declines between the predevelopment potentiometric surface and the 1951 surface were about 43 ft at Americus, and 12 ft at Albany.

The estimated potentiometric surface of the Providence aquifer for 1951 is shown in figure 9 and was constructed from potentiometric data collected during 1941-69.

Flow directions within the Providence aquifer in 1951 generally were from the outcrop area southward and toward major rivers and streams. Two major discharge areas--the Chattahoochee River in the west and the Ocmulgee River in the east--acted as boundaries to the ground-water flow system. This naturally occurring discharge is indicated by potentiometric contours that bend upstream in an inverted "V" pattern, showing that the hydraulic gradient is toward the stream. Potentiometric contours also indicate that two major ground-water divides--one to the southwest between the Chattahoochee and Flint Rivers, and the other to the southeast between the Flint and Ocmulgee Rivers--generally corresponded to interstream drainage divides. In the outcrop area, these ground-water divides were areas of significant aquifer recharge.

In the vicinity of Americus, the primary flow direction in 1951 was toward the center of a cone of depression that had formed as a result of many years of heavy ground-water withdrawals. The bending of the contour lines northwest of Albany may be an indication of a developing cone of depression at Albany.

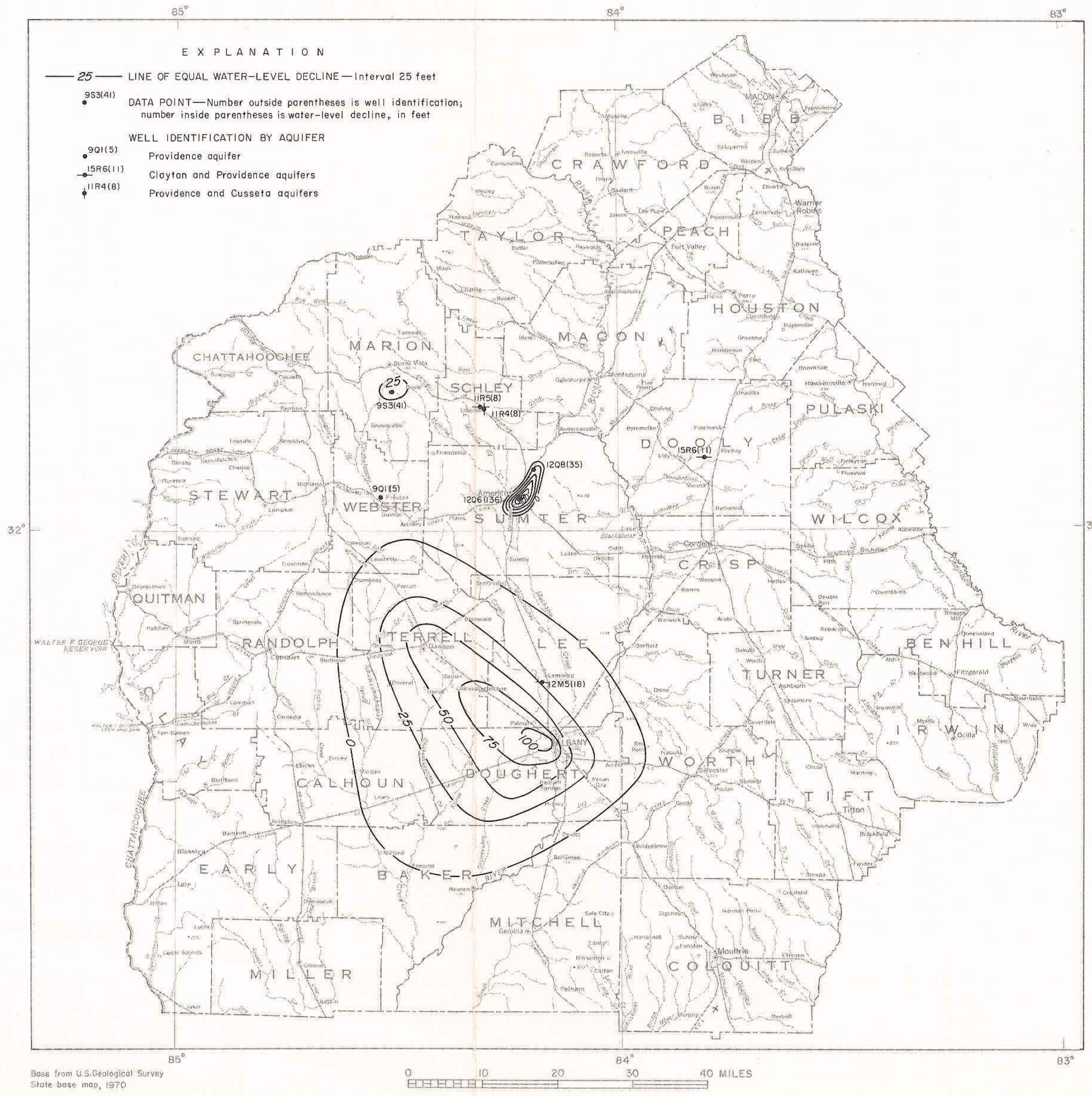

Figure 11.— Water-level declines in the Providence aquifer, 1951-80.

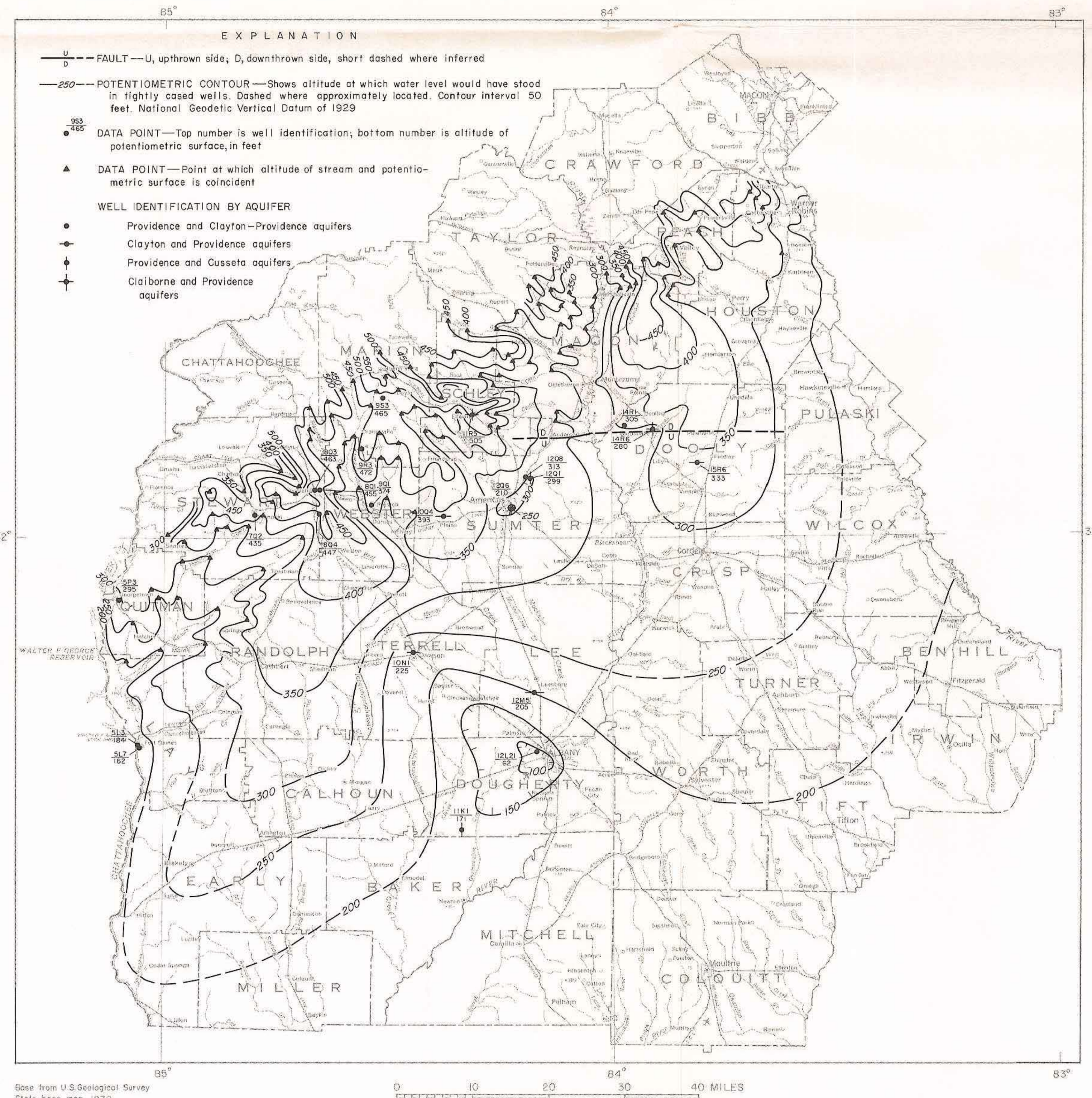

Figure 10.—Potentiometric surface of the Providence aquifer, October 1980.

OCTOBER 1980 POTENTIOMETRIC SURFACE

The October 1980 potentiometric surface of the Providence aquifer is shown in figure 10. This surface is similar to the 1951 potentiometric surface, with the exception of the development of a major cone of depression at Albany, in Dougherty County, and expansion of the existing cone at Americus, in Sumter County. In these areas, discharge from the aquifer exceeds recharge, which causes a reduction in compressive aquifer storage and a corresponding depression in the potentiometric surface.

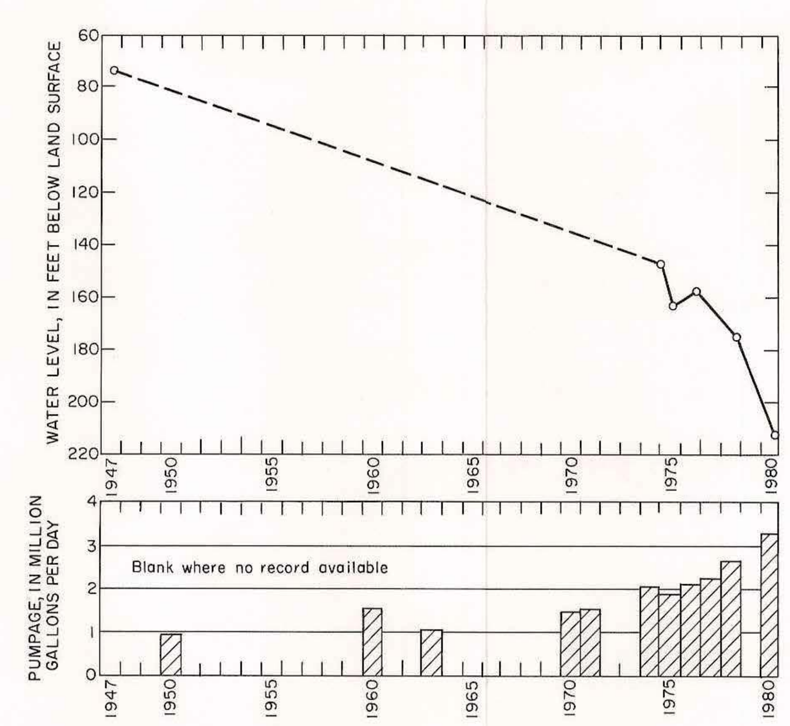

Figure 12.—Water level in well 12Q6 at Americus and average daily ground-water withdrawals by the city of Americus.

LONG-TERM WATER-LEVEL DECLINES

Long-term water-level declines in the Providence aquifer occurred during the period 1951-80 and are shown in figure 11. Declines in excess of 50 ft occurred in parts of Sumter, Lee, Dougherty, and Terrell Counties. Because the aquifer has low transmissivity and is recharged by precipitation 15 to 45 miles north of these areas, most of the decline may be attributed to increases in regional pumpage and the inability of the aquifer to transmit sufficient quantities of water to the areas of use. It is likely that increases in pumpage and the resulting water-level declines in the Clayton aquifer have increased the potential for upward leakage from the Providence and, therefore, contributed to the water-level decline.

Americus.--Heavy pumpage from municipal and industrial wells caused water levels in the Providence aquifer at Americus to decline 136 ft from 1947-80 (fig. 12). Water-level measurements of an Americus city well (12Q6), which taps the Providence and Cusseta aquifers, show that water levels declined 90 ft from 1947-75, rose 3 ft from 1975-76, and dropped 49 ft from 1976-80 (fig. 14). These declines correspond to a general increase in ground-water withdrawals in Americus since 1950 (fig. 12).

Albany.--Heavy pumpage from municipal wells in Albany caused water levels in the Providence aquifer to decline more than 100 ft from 1950-78 (fig. 11). Mean monthly water levels in test well 12L21, near the center of pumpage, showed a decline of 12.1 ft from December 1979 to December 1980 (fig. 13). This decline corresponded to an increase in municipal pumpage.

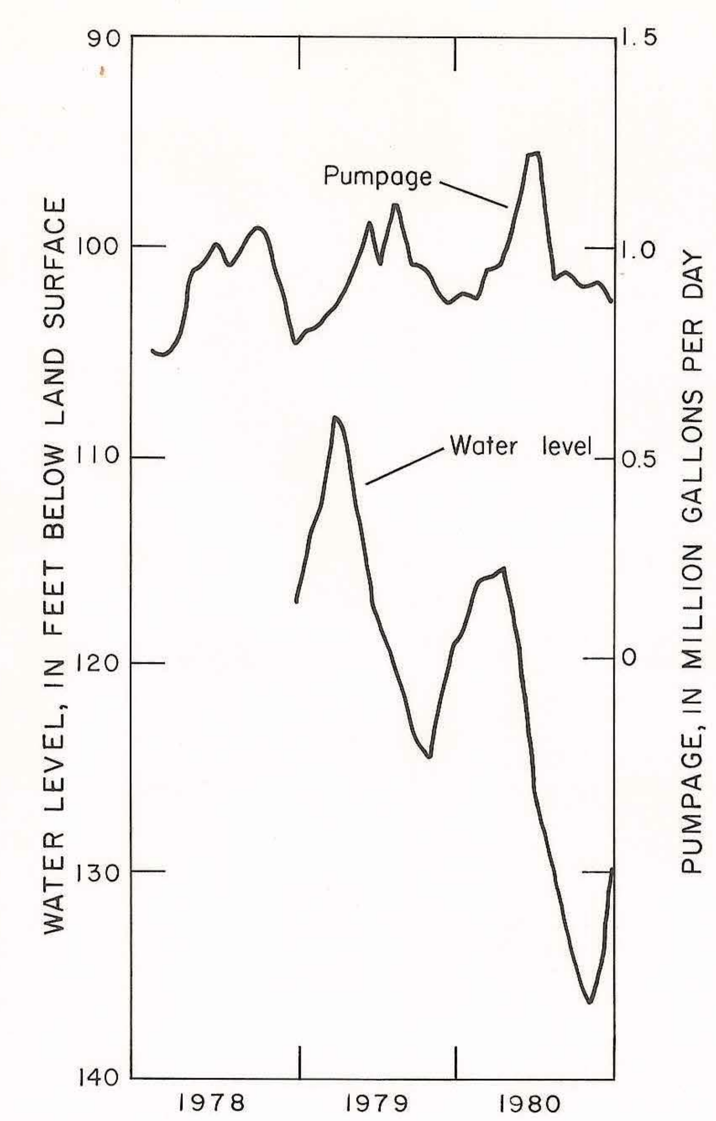

Figure 13.—Estimated mean monthly pumpage from the Providence aquifer by the city of Albany, 1978-80, and mean monthly water-levels in the Providence aquifer at well 12L21 at Albany, 1979-80.

Cartography by Willis G. Hester

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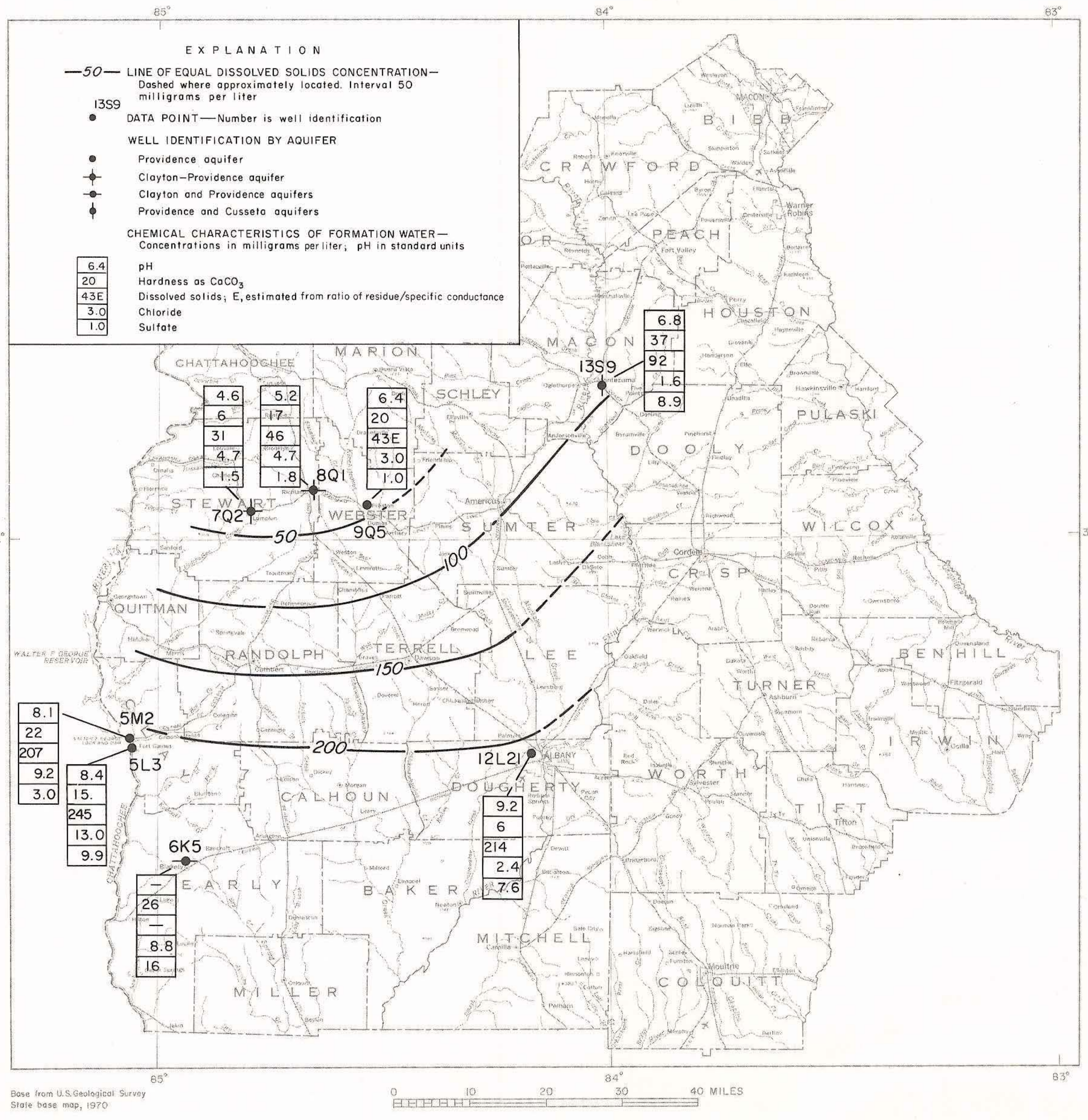

Figure 14.—Significant chemical characteristics of ground-water from the Providence aquifer.

WATER QUALITY

Analyses of water samples obtained from the Clayton and Providence aquifers are listed in table 4. Water obtained from the Providence aquifer is soft and has a relatively high sodium content. In most areas the water contains no constituent concentrations that exceed the Georgia Environmental Protection Division (1977) or U.S. Environmental Protection Agency (1977) standards for safe drinking water (table 4).

Although the few water-quality analyses available are unevenly distributed within the study area, the data indicate that dissolved solids and most other constituent concentrations increase from the outcrop area southward (fig. 14, table 4). Values of pH also increase southward and range from a low of 4.6 at well 7Q2, near the outcrop area, to a high of 9.2 at well 12L21, in Albany.

A diagram showing the chemical classification of ground water according to type is given in figure 15. The plots represent the percentage concentrations in milliequivalents per liter of the two groups of major cations and anions in the water.

A comparison of samples obtained from the Clayton and Providence aquifers indicates that water from each aquifer has distinct chemical characteristics. Water from the Providence aquifer generally is a soft sodium bicarbonate type (well 12L21), whereas water from the Clayton aquifer generally is a hard calcium bicarbonate type (well 7N1). Wells tapping both aquifers yield water that is a mixture of the two types (well 6K5).

In the Albany area, the chemical characteristics of water from the Clayton aquifer are similar to those of water from the Providence aquifer. Well 12L20 taps the Clayton aquifer and yields a sodium bicarbonate type water. Such similarity of water quality probably indicates that significant quantities of water leak upward from the Providence aquifer into the Clayton aquifer (Hicks and others, 1981, p. 13).

WATER USE

The Providence aquifer supplied more than 8.8 Mgal/d to municipalities, industries, and agriculture during 1980 (table 5). Major users of the Providence include the cities of Americus and Albany; industries in Houston, Clay, and Pulaski Counties; and agricultural users in Macon, Lee, Houston, and Randolph Counties.

Americus.--The city of Americus is supplied by a system of five multiaquifer wells which produced an average of 3.2 Mgal/d in 1980. The Providence aquifer supplied an estimated 0.7 Mgal/d, or about 22 percent of the total yield. Records indicate that water use in Americus increased about 230 percent since 1950. Most of the increase occurred during 1970-80 (fig. 12).

Albany.--A system of 23 multiaquifer wells supplied an average of 16.1 Mgal/d to the city of Albany during 1980. The Providence aquifer supplied an estimated 1.0 Mgal/d, or 6 percent of the total yield. Records indicate that Albany municipal use increased about 11.2 Mgal/d or 240 percent from 1950-80 (fig. 16).

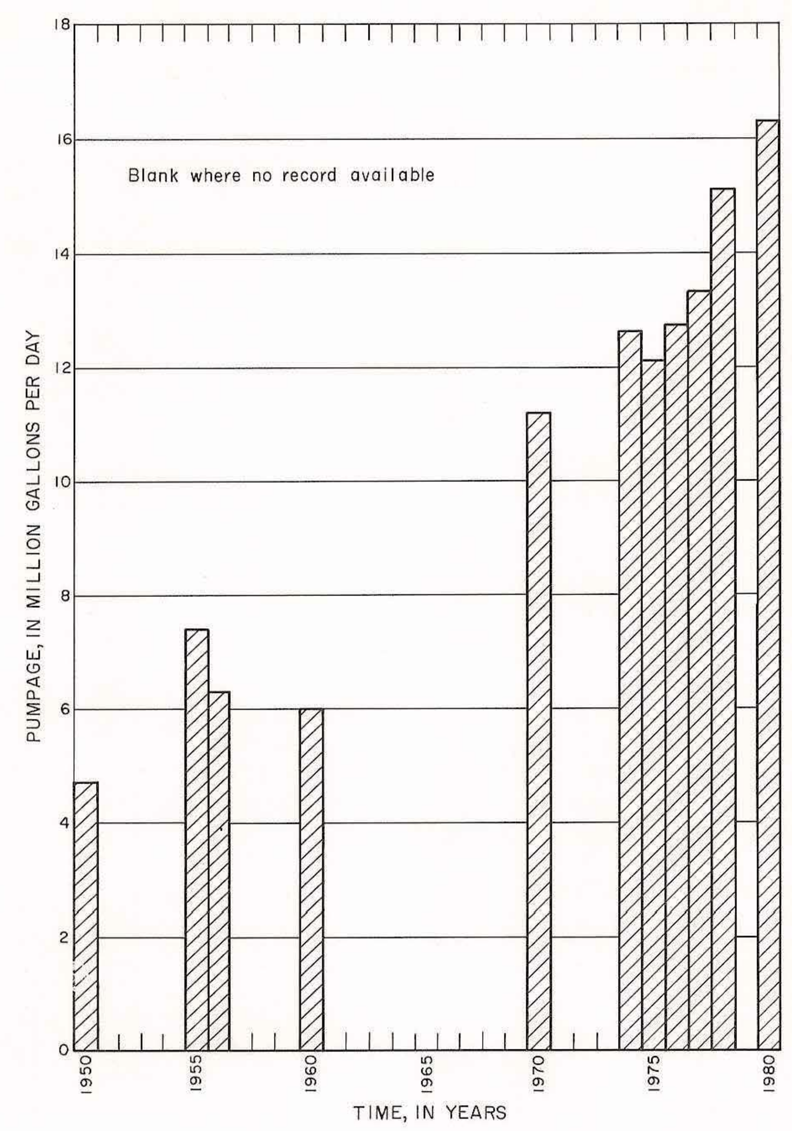

Figure 16.—Average daily ground-water withdrawals by the city of Albany.

Table 5.--Estimated ground-water use from the Providence aquifer, 1980

County	Ground-water use (Mgal/d)			
	Agricultural[1]	Industrial	Municipal	Total
Clay	—	1.11	0.19	1.30
Dooly	0.01	—	.03	.04
Dougherty	—	—	.97	.97
Houston	.44	1.42	.02	1.88
Lee	.69	—	—	.69
Macon	.82	.13	—	.95
Pulaski[2/]	—	.68	.31	.99
Randolph	.38	—	—	.38
Schley	.07	.07	—	.14
Stewart	—	—	.15	.15
Sumter	.14	.07	.68	.89
Terrell	—	—	.10	.10
Webster	—	—	.30	.30
Total	2.55	3.48	2.75	8.78

1 Values are estimated growing-season withdrawals averaged over a 365-day period.
2 Providence-Cusseta aquifer.

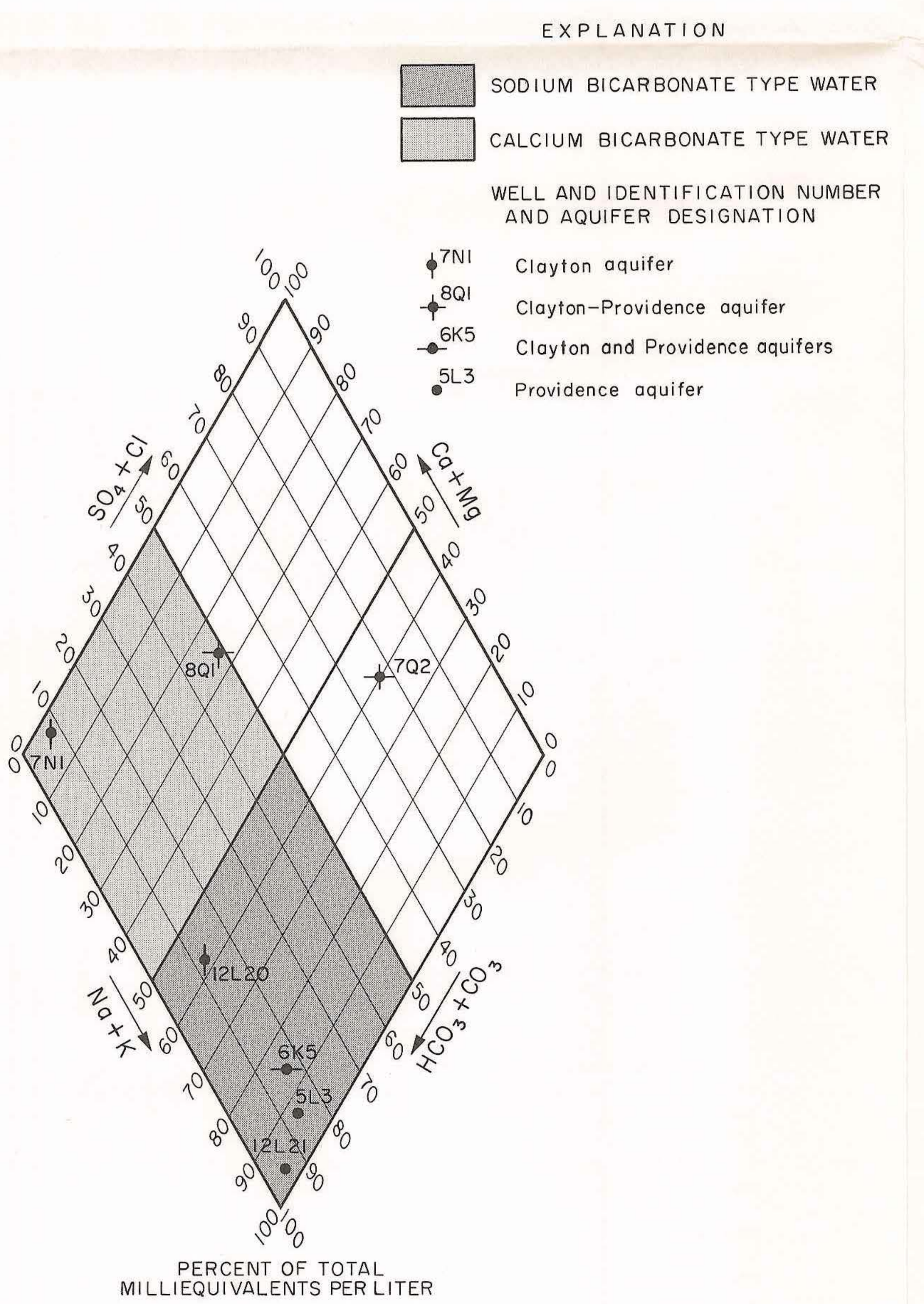

Figure 15.—Chemical classification of ground water according to type.

Table 4.--Chemical analyses of well water from the Providence and Clayton aquifers

[Analyses by U.S. Geological Survey, except as noted. Aquifer(s): Pc, Clayton; Pc-Kp, Clayton-Providence; Kp, Providence; Kc, Cusseta. <, less than]

Well No.	Owner or name	Aquifer(s)	Date sampled	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Alkalinity as $CaCO_3$	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Nitrite (NO_2)
				Milligrams per liter											
Georgia Environmental Protection Division standards for safe drinking water, 1977											250	250	2/		
5L3	Ft. Gaines	Kp	4-8-58	16	5.6	1.5	90	1.7	226	185	12	15	1.0	0.00	--
			4-17-67	14	4.4	1.0	87	1.4	218	185	9.9	13	.8	.00	--
5M2	USA Corps of Engrs. test well 3	Kp	8-27-57	16	6.8	1.2	70	1.4	198	--	3.0	9.2	.6	.0	--
12L21	USGS test well 10	Kp	11-21-78	12	1.7	.4	85	1.6	200	190	7.6	2.4	.6	.090	0.0
12L20	USGS test well 6	Pc	3-7-78	20	12	6.0	33	2.8	140	110	13	1.5	.2	.03	.00
6K5	Blakely, 1	Pc,Kp	5-16-46	16	5.8	2.7	74	--	191	157	16	8.8	.4	.5	--
13S9	Southern Frozen Foods, 2	Kp,Kc	4/8-6-62	--	--	--	--	--	35	35	3.0	3.0	1.0	--	--
			5/10-1-69	--	--	--	--	--	--	32	--	--	--	--	--
			4-24-74	49	12	1.6	1.6	.5	44	36	8.9	1.6	.4	.00	.00
7N1	USGS, Cuthbert observation well	Pc	6-22-78	20	56	3.7	1.8	1.5	170	140	8.0	2.1	.0	.00	.00
7Q2	Lumpkin, 3 (1A)	Kp	6-25-74	7.8	1.3	.6	3.5	.8	3	2	1.5	4.7	.0	6.6	.00
8Q1	Richland, 3	Pc-Kp	6-20-68	8.3	7.9	.5	3.3	.4	18	15	.0	4.0	.1	11	--
			6-27-74	9.7	6.0	.4	2.3	.6	11	9	1.8	4.7	.0	9.7	.00
9Q1	Preston, 1	Kp	6/12-14-48	11	7.5	.7	--	--	--	--	--	--	--	--	--
			5/3-31-72	--	--	--	--	--	--	16	--	--	--	--	--
9Q2	Preston, 2	Kp	7/12-3-62	11	--	.4	0.0	--	--	19	0.0	.7	.0	--	--
9Q5	Preston, 3	Kp	4/8-27-73	10	8.0	.0	--	--	27	22	1.0	3.0	.0	--	--
Average values for Providence aquifer				11.6	5.5	0.7	42.6	1.1	113	71	4.1	6.3	0.3	4.3	0.00

Well No.	Dissolved solids: Residue at 180° C	Dissolved solids: Sum of constituents	Hardness: Calcium, magnesium	Hardness: Noncarbonate	Specific conductance, in micromhos at 25°C	Field pH	Temperature, in degrees Celsius	Color, in platinum-cobalt units	Carbon dioxide, mg/L as $CO_2$1/	Aluminum (Al)	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	Mercury (Hg)	Selenium (Se)	Strontium (Sr)	Zinc (Zn)
										Micrograms per liter											
Standards, 1977	500	500	3/					15			50	10	50	1,000	300	50	50	2.0	10		5,000
5L3	251	254	20	0	403	8.3	--	4	--	--	--	--	--	--	--	--	--	--	--	--	--
	245	243	15	0	395	8.4	21.0	0	--	--	--	--	--	--	--	--	--	--	--	130	--
5M2	207	--	22	0	328	8.1	20.0	--	--	--	--	--	--	--	30	--	--	--	--	--	--
12L21	214	223	6	0	358	9.2	24.0	[illegible]	0.2	40	0	3	1	0	50	10	0	0.6	0	--	0
12L20	160	158	55	0	231	7.2	22.8	10	14	20	0	0	0	0	180	11	10	<.5	0	360	0
6K5	218	--	26	0	--	--	25.0	[illegible]	--	--	--	--	--	--	60	--	--	--	--	--	--
13S9	--	--	37	8	--	6.3	--	15	.0	--	--	--	--	--	3	--	--	--	--	--	--
	--	--	32	--	--	6.7	--	--	13	--	--	--	--	--	1	--	--	--	--	--	--
	92	98	37	0	96	6.8	21.0	[illegible]	11	20	2	--	10	3	560	4	25	.1	0	--	9
7N1	200	178	160	16	270	6.8	22.0	[illegible]	43	20	1	0	0	0	530	3	40	<.5	0	170	10
7Q2	31	28	6	3	28	4.6	19.0	[illegible]	121	30	4	3	0	20	0	36	17	<.5	3	--	8
8Q1	55	44	22	6	67	6.3	--	[illegible]	14	--	--	--	--	--	--	--	--	--	--	0	--
	46	41	17	8	42	5.2	20.0	[illegible]	111	30	0	4	0	2	10	19	0	<.5	3	--	8
9Q1	--	--	22	--	--	6.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	--	--	16	--	--	6.7	--	--	6.3	--	--	--	--	--	<100	--	<50	--	--	--	--
9Q2	--	--	20	--	--	6.2	--	--	24	--	--	--	--	--	699	--	0	--	--	--	--
9Q5	--	--	20	0	60	6.4	--	[illegible]	.0	--	--	--	--	--	10	--	0	--	--	--	--
Average values for Providence aquifer	150	139	17	2	210	--	20.8	[illegible]	39.5	33	1	3	0.5	7	--	22	3	--	2	65	5

1/ Carbon dioxide concentration calculated from measured values of pH and bicarbonate ion.
2/ State standards for flouride are set according to temperature.
3/ Water having a $CaCO_3$ hardness of 0 to 60 mg/L is classified "soft"; 61 to 120 mg/L, "moderately hard"; 121 to 180 mg/L, "hard"; and more than 181 mg/L, "very hard."
4/ Parker Laboratory, Inc., Charleston, S.C.
5/ Georgia Dept. of Public Health.
6/ Black Laboratories, Gainesville, Fla.
7/ Law and Co., Atlanta, Ga.

SUMMARY

The predominantly sand Providence aquifer lies within the Coastal Plain physiographic province of southwest Georgia and ranges in thickness from 38 to 386 feet. Estimated transmissivities range from 760 feet squared per day in Schley County to 4,600 feet squared per day in Clay County.

Recharge water enters the aquifer in the northeastward-trending outcrop belt and flows southward, bounded by the Ocmulgee River on the east and the Chattahoochee River on the west. Additional recharge is received through leakage from underlying units. Discharge from the aquifer to streams occurs both in the outcrop area and downdip through overlying units. Idle multiaquifer wells in Albany and Dawson provide conduits for upward discharge of water from the Providence aquifer.

During 1980, an estimated 8.8 million gallons per day was pumped from the Providence aquifer. From 1950-80, ground-water use increased 230 percent in Americus and 240 percent in Albany, causing water levels in the aquifer to decline more than 100 feet.

Water from the Providence is a soft, sodium bicarbonate type which generally contains no constituent concentrations that exceed the Georgia Environmental Protection Division and U.S. Environmental Protection Agency standards for safe drinking water.

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Cartography by Willis G. Hester

HYDROGEOLOGY OF THE PROVIDENCE AQUIFER OF SOUTHWEST GEORGIA.

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