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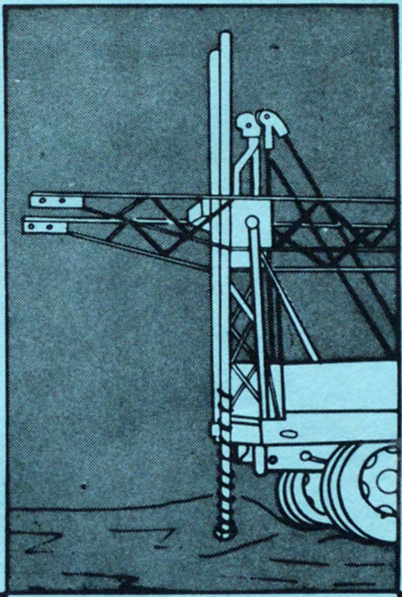
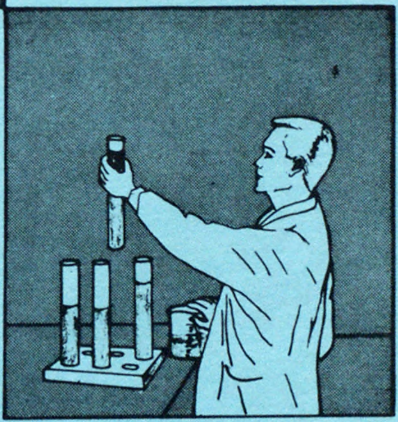
GROUND-WATER RESOURCES OF COLQUITT COUNTY, GEORGIA





Prepared in cooperation with
Georgia Department of Natural Resources,
Geologic and Water Resources Division

Open-file Report 77-56

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GROUND-WATER RESOURCES OF COLQUITT COUNTY, GEORGIA

By E. A. Zimmerman

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Prepared in cooperation with the
Georgia Department of Natural Resources,
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Doraville, Georgia

June 1977

UNITED STATES DEPARTMENT OF THE INTERIOR

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GEOLOGICAL SURVEY

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FACTORS FOR CONVERTING ENGLISH UNITS TO INTERNATIONAL SYSTEM (SI) UNITS

The following factors may be used to convert the English units published herein to the International System of Units (SI).

Multiply English units	By	To obtain SI units
Inches (in)	25.4	millimeters (mm)
	2.54	centimeters (cm)
Feet (ft)	0.3048	meters (m)
Miles (mi)	1.609	kilometers (km)
Square miles (mi^2)	2.590	square kilometers (km^2)
Feet per mile (ft/mi)	0.189	meters per kilometer (m/km)
Gallons per minute (gal/min)	5.450	cubic meters per day (m^3/d)
Gallons per minute per foot of drawdown [(gal/min)/ft]	17.9	cubic meters per day per meter [(m^3/d)/m], simplified to m^2/d
Cubic feet per day per foot [(ft^3/d)/ft] simplified to ft^2/d	0.134	cubic meters per day per meter [(m^3/d)/m] simplified to m^2/d
Degrees Fahrenheit (°F) -32	5/9	degrees Celsius (°C)

GROUND WATER RESOURCES OF COLQUITT COUNTY, GEORGIA

By Everett A. Zimmerman

ABSTRACT

Limestone beds of Eocene, Oligocene, and lower Miocene age, called the principal artesian aquifer, are the chief source of ground water for Colquitt County. Because streams are small, undependable and relatively inaccessible to most users, ground water is the most important source for increased industrial and agricultural water use.

Southeast of Moultrie the principal artesian aquifer is very productive, and has transmissivity in excess of 145,000 feet squared per day (13,500 meters squared per day). A structural or paleogeographic feature called the Suwannee strait traverses the county from near the southwest corner to the northeast corner. In this strait, limestone in the principal artesian aquifer is partly replaced by fine-grained clastic sediment, impairing transmissivity and making wells hard to construct. Transmissivity is much lower northwest of the strait than it is southeast, probably because of facies changes in the aquifer.

In the belt of the hypothesized Ochlockonee fault, water containing greater-than-usual concentrations of dissolved solids is produced. This anomaly could be the result of the fault having acted as a conduit when the vertical hydraulic gradient was upward from a deeper aquifer, or be the result of the movement of ground water from a sulfate-rich source in the sediments of the Suwannee strait. In south-central Colquitt County, clay-capped permeable beds extending above potentiometric surfaces create conditions favorable for breathing wells.

Predominantly clastic beds of Miocene age overlie the Suwannee Limestone. These beds have a transmissivity of about 2,280 feet squared per day (215 meters squared per day), but they are of comparatively little importance because larger yields can be obtained from the underlying principal artesian aquifer. Moreover, wells are difficult to construct in the poorly consolidated clastic sediments, and water from these shallow beds is likely to be depleted during droughts.

The ground water is generally hard, but is otherwise of good quality. One exception is near the hypothesized Ochlockonee fault where water contains higher-than-usual concentrations of various ions, especially sulfate. Another exception occurs along the axis of the Suwannee strait where clay minerals in the channel facies may soften the water by ion exchange.

INTRODUCTION

Colquitt County, Ga., largely depends on ground water for domestic and industrial use. Water-well drillers, however, have experienced difficulty in obtaining adequate supplies in some parts of the county. The drillers noted anomalous ground-water heads and water-quality problems. Studies in other counties in southwestern Georgia suggested that these anomalies might be related to poorly defined structural features. These were among the reasons that Colquitt County was selected for study in 1967.

Location and Extent of the Area

Colquitt County (fig. 1) includes an area of 536 mi^2 (1,458 km^2) in south-central Georgia. The county lies in the lower Coastal Plain physiographic province. The principal towns include the county seat, Moultrie (1970 population, 14,302); Doerun (1,157); Norman Park (912); Berlin (422); Ellenton (337); Funston (293); and Crosland (158). Colquitt County is bordered on the north by Worth and Tift Counties, on the east by Cook County, on the south by Brooks and Thomas Counties, and on the west by Mitchell County.

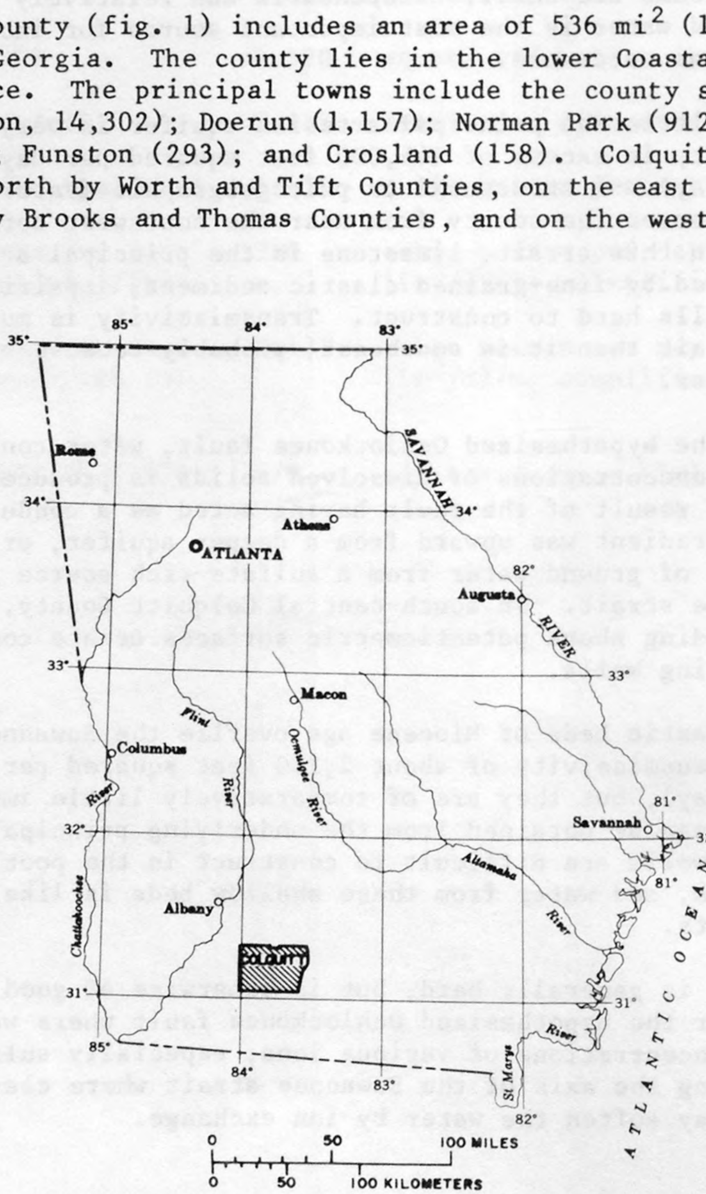

FIGURE 1.—LOCATION OF COLQUITT COUNTY

Purpose and Scope of the Investigation

Although surface water is still the main source of irrigation water, ground water is the principal source of domestic, industrial, and stock water in Colquitt County. Responsible governmental and service organizations in Colquitt County hope for and expect continued economic expansion in industry and agriculture. This expansion will almost certainly be accompanied by a greatly increased demand for water. The only source likely to meet this demand is ground water. It is necessary to evaluate the magnitude of this resource in order to properly plan for continued development. To aid in this evaluation, the Georgia Department of Natural Resources, Geologic and Water Resources Division, maintains a statewide cooperative program with the U.S. Geological Survey to appraise Georgia's water resources.

The objectives of this investigation were:

1. To map and study the subsurface formations that constitute the principal artesian aquifer and its water-bearing zones, and to determine their hydrologic properties.

2. To map and study the beds making up lesser aquifer systems and to determine their hydrologic properties.

3. To determine geologic structure and its hydrologic significance.

4. To determine the sustained yield of wells and the quality of the water available in the various aquifer systems.

Previous Investigations

Colquitt County, as a part of the Coastal Plain of Georgia, has been discussed in a number of reports covering south Georgia or the Southeast. These include, "Artesian water in Tertiary limestone in the southeastern States" (Stringfield, 1966) and "Subsurface geology of the Georgia Coastal Plain" (Herrick and Vorhis, 1963). Chen (1965) analyzed the stratigraphy of Paleocene and Eocene rocks of Florida and southern Georgia and included a discussion of the stratigraphic and structural problems in southern Georgia. Patterson and Herrick (1971) discussed the arguments for and against previously proposed structural features in southern Georgia. They show that many structural names have been proposed, based on unproven hypotheses. One such feature, the Ochlockonee fault, has been extended into Colquitt County but as yet, its existence has not been proved. This fault is hypothesized as one explanation to account for some otherwise anomalous data.

Ground-water geology has also been studied in several adjoining counties. Owen (1963) reported on Mitchell County, which adjoins Colquitt County on the west. Sever (1966a, b) investigated Thomas County to the south and Cook County (1972) to the east. These papers deal with conditions similar to those in Colquitt County, and many of the findings were extended into the project area.

Methods of Investigation

Drillers provided data on well depth, amount of casing, initial water level in wells, and furnished drill cuttings. In addition, municipal and industrial wells were inventoried and measured. City and industrial officials supplied estimates of water use.

The author examined drill cuttings from 20 wells and the resulting lithologic logs were used with those previously available. S. M. Herrick provided information on stratigraphic tops for 16 wells in Colquitt County. The Ocala Fla., laboratory of the U.S. Geological Survey chemically analyzed 31 water samples. Geophysical (electric and gamma-ray) logs were made of seven newly-drilled wells to supplement the 26 existing logs previously available. Tests were conducted on two wells to determine the transmissivity and storage coefficient of the aquifer. Two continuous water-level recorders monitored water-level fluctuations. Depth to water was periodically measured in 18 wells to observe the water-level trends. Locations of wells are shown in figure 2.

Acknowledgments

Data for this report came from a number of sources. Much of it was in the files of the U.S. Geological Survey, which had been gathered from well drillers and owners. Messrs. Cecil Bishop, Hoyt Tyson, Lawrence Dean, John Carr, Dayton Everett, and John Flatt are among the drillers who provided drill cuttings and information from wells in or near Colquitt County. Well owners cooperated by providing information about their wells and by permitting water-level measurements. Some well owners provided water samples for analysis and permitted hydrologic testing and geophysical logging of their wells. Messrs. Collins and Roberts, of the Moultrie Water Department, provided much information about the city wells. Mr. Lester Norman, superintendent of the Spence Field Industrial Park, assisted in setting up an aquifer test of the Spence Field wells. Municipal officials of Doerun, Funston, Ellenton, and Berlin freely provided information about their water systems and permitted access to their wells.

GEOGRAPHY

Climate

Colquitt County has a warm humid climate. Normal precipitation at Moultrie is 48.61 in (1,235 mm) per year. Median precipitation is about 47 in (1,190 mm). Normal annual temperature is 68.2°F (Fahrenheit) (20.1°C - Celsius). Temperatures of 90°F (32.2°C) or more occur about 94 days per year; temperatures of 32°F (0°C) or below occur about 21 days per year. The growing season is longer than 200 days. This climate permits the growing of crops without irrigation. Supplemental irrigation, however, has proved to be beneficial in improving yields-- especially in dry years and for certain crops.

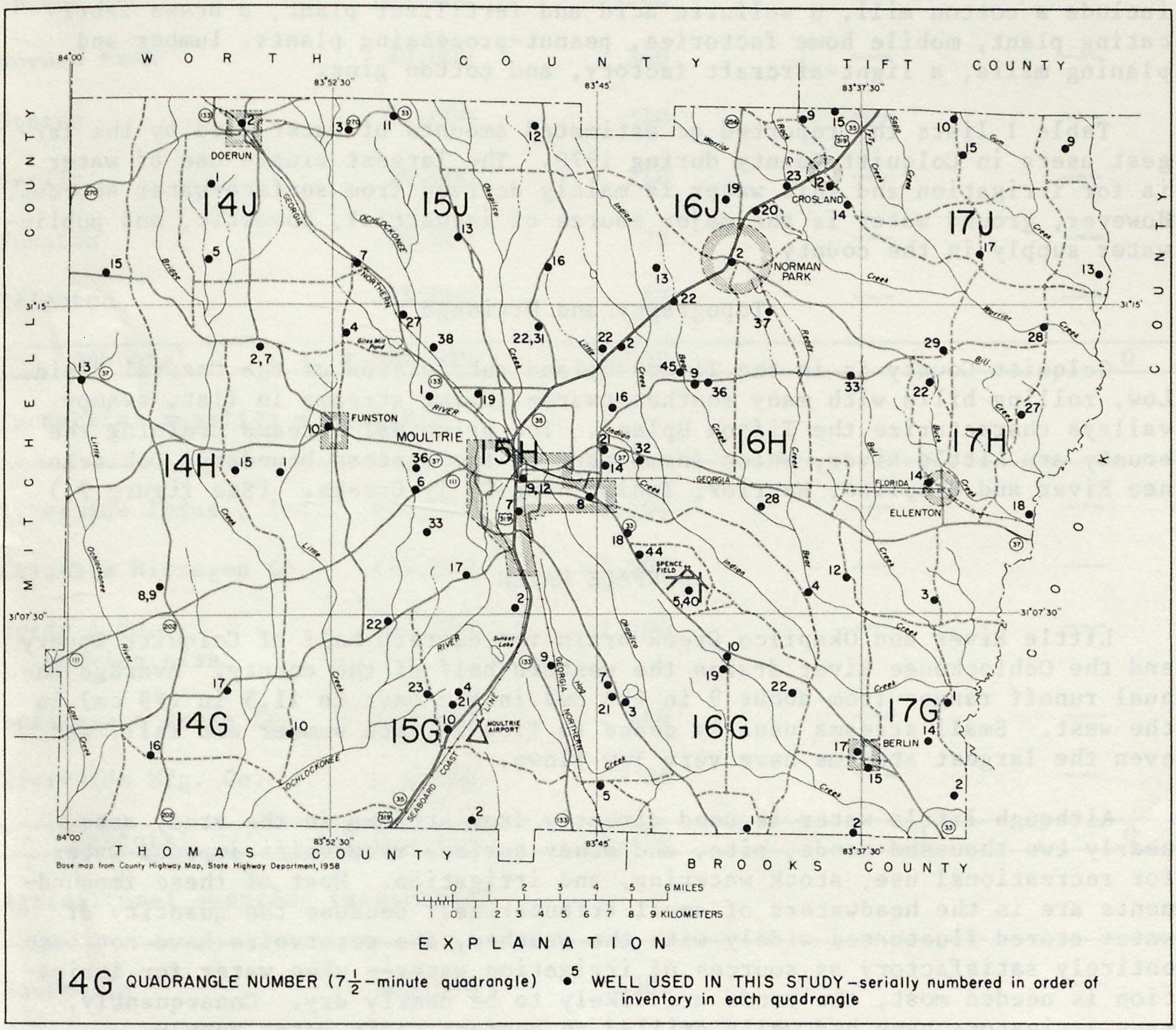

FIGURE 2.—LOCATION OF WELLS AND WELL-NUMBERING SYSTEM.

Economic Development and Water Use

Colquitt County is predominantly agricultural. Corn, cotton, peanuts, and tobacco are the principal crops, including livestock, but a wide variety of other crops are grown including vegetables, pecans, lawn sod, and peaches.

Most industries in the county are categorized as light. A meat-packing plant that employs over 400 people is the largest industry. Other industries include a cotton mill, a sulfuric acid and fertilizer plant, a brass fabricating plant, mobile home factories, peanut-processing plants, lumber and planing mills, a light-aircraft factory, and cotton gins.

Table 1 lists the reported or estimated amounts of water used by the largest users in Colquitt County during 1970. The largest single use of water is for irrigation and this water is mainly derived from surface-water sources. However, ground water is the major source of industrial, domestic, and public-water supply in the county.

Topography and Drainage

Colquitt County is in the Tifton Upland subdivision of the Coastal Plain. Low, rolling hills with many southeastward-flowing streams in flat, swampy valleys characterize the Tifton Upland. The principal streams draining the county are Little River, which forms part of the eastern boundary; Ochlockonee River and Okapilco, Warrior, Indian, and Ty Ty Creeks. (See figure 2.)

SURFACE WATER

Little River and Okapilco Creek drain the eastern half of Colquitt County and the Ochlockonee River drains the western half of the county. Average annual runoff ranges from about 9 in (23 cm) in the east to 11.5 in (29 cm) in the west. Small streams usually cease to flow in late summer and fall, and even the largest streams have very low flows.

Although little water is used directly from streams in the study area, nearly two thousand ponds, pits, and other surface reservoirs impound water for recreational use, stock watering, and irrigation. Most of these impoundments are in the headwaters of small tributaries. Because the quantity of water stored fluctuates widely with the weather, the reservoirs have not been entirely satisfactory as sources of irrigation water-- when water for irrigation is needed most, the ponds are likely to be nearly dry. Consequently, many irrigators have had wells drilled to augment their water supply.

GEOLOGIC UNITS AND THEIR WATER-BEARING CHARACTERISTICS

Rocks of pre-Cretaceous, Cretaceous, Tertiary, and Quaternary ages underlie Colquitt County. Only rocks of middle and late Tertiary age and younger are discussed in this report because older, deeper formations are not considered economically feasible as sources of water. The cost of drilling to the deeper formations is prohibitive and the water to be obtained is probably of poor quality.

Table 1.--Water use during 1970

Public supplies	Ground water (Gallons per day)	Ground water (Meters ^{3}/day)	Surface water (Gallons per day)	Surface water (Meters ^{3}/day)
Moultrie	2,300,000	8,700	---	---
Spence Field	100,000	380	---	---
Norman Park	90,000	340	---	---
Doerun	83,000	310	---	---
Berlin	56,000	210	---	---
Funston	20,000	76	---	---
Ellenton	15,000	57	---	---
Subtotal	2,664,000	10,000	0	0
Industrial supplies - Moultrie				
Riverside Indus., Inc.	670,000	2,500	---	---
Columbia Nitrogen Co.	670,000	2,500	---	---
Swift & Co. packing plant	570,000	2,200	---	---
Bridgeport Brass Co.	117,000	440	---	---
Riverside Mfg. Co.	6,700	25	---	---
Subtotal	2,033,700	7,700	0	0
Agricultural supplies (estimated)				
Household	500,000	1,900	---	---
Livestock	250,000	950	250,000	950
Irrigation	400,000	1,500	3,700,000	14,000
Subtotal	1,150,000	4,400	3,950,000	15,000
Total water use	5,847,700	22,000	3,950,000	15,000

Table 2 summarizes the geology and water-bearing characteristics of the rocks underlying the county.

The geologic map (fig. 3) shows the distribution of surficial deposits: the Tampa Limestone equivalent, the Alum Bluff Group, and flood-plain deposits. Sand dunes and gravel deposits of small areal extent were not mapped. Structure contours on the top of the Suwannee Limestone of Oligocene age, the position of the hypothesized Ochlockonee fault, and the axis of the Suwannee strait are included on the map.

The well table (table 3) lists data for the principal wells. The "GGS numbers" shown under "remarks" refer to the file numbers of samples from these wells in the sample library of the Department of Natural Resources, Geologic and Water Resources Division, Atlanta, Ga. These samples are available for public inspection. The locations of the wells in table are shown in figure 2.

Eocene Series

Tallahatta Formation

A deep formation underlying Colquitt County that may contain water of good quality and adequate quantity is the Tallahatta Formation. Only one drill hole in the county has penetrated the Tallahatta and it produces no water. Thus, in Colquitt County, the Tallahatta is untested as an aquifer. To the west in Mitchell County, it is a very productive sand aquifer; some wells yield more than 1,000 gal/min (5,450 m^3/d) of good water (Owen, 1963, p. 13). However, to the south in adjoining Thomas County, the formation produces poor-quality water under greater artesian head than that in overlying aquifers (Sever, 1966a, p. 2). As the Tallahatta is more than 700 ft (213 m) deep in most of Colquitt County, and overlying aquifers are capable of supplying abundant water, little inducement exists to test this formation as a source of water.

The Tallahatta is 130 ft (40 m) thick in the only hole (14H1, an oil test) deep enough to penetrate the formation (Herrick, 1961, p. 129) in Colquitt County. The formation is 200 to 400 ft (61 to 122 m) thick in Thomas County (Sever, 1966a, p. 4) and 275 to 390 ft (84 to 119 m) thick in Mitchell County (Owen, 1963, p. 13).

The Tallahatta Formation undergoes a facies change in western Colquitt and eastern Mitchell Counties. The updip facies noted in counties west of Colquitt is predominantly sand; the downdip facies (found in 14H1) is predominantly limestone. Glauconite pellets characterize both facies.

Lisbon Formation

The hydraulic properties of the Lisbon Formation, like the Tallahatta, are untested in Colquitt County. Elsewhere, however, it is a poor aquifer or a confining bed.

Table 2. – Geologic Units (Generalized section of stratigraphic units underlying Colquitt County, Ga., and their water-bearing properties).

System	Series	Stratigraphic Unit	Maximum Thickness (feet)	Lithology	Water-bearing Properties
Quaternary	Holocene	Flood-plain deposits	40	Unconsolidated sand and fine gravel along streams.	Contain abundant water. Little developed because deposits underlie low areas subject to flooding.
	Pleistocene	Dune sand	30?	Fine, unconsolidated sand in isolated patches east of major streams (not mapped).	Generally above water table, hence drained. Absorbs rain readily and thus aids recharge of underlying beds.
Tertiary	Pliocene	Citronelle Formation	90	Fine gravel and coarse sand in small isolated patches. (not mapped)	Usually above the water table but may contribute some water to shallow dug or bored wells.
	Miocene	Alum Bluff Group	300	Interbedded sand, clay, and silt. Limestone and chert occur locally. Some of the clay is highly absorbent and is mined as fuller's earth in nearby counties.	Yields small amounts of water to many dug or bored wells. Water levels fluctuate markedly in response to rainfall or drought.
		Tampa Limestone equivalent	160	Limestone; calcareous sand and clay.	Can yield up to 22 gpm, but caving of sand makes well construction difficult.
	Oligocene	Suwannee Limestone	100	Limestone, cream-colored, nodular, recrystallized, and fossiliferous and local tongues of partly dolomitized limestone.	Very good aquifer. Yields up to 1,000 gpm obtainable.
		Byram Formation	230	Dolomitic limestone.	A good aquifer but yields poor-quality water in some places.
		Marianna Limestone equivalent	300	Granular limestone intertongued with marl. Marl predominates in the Suwannee strait.	Not favorable as a source of water in the Suwannee strait, but the limestone may be productive outside the strait.
	Eocene	Ocala Limestone	300	Limestone, granular, partly recrystallized, fossiliferous.	A very productive aquifer. Yields of more than 1,000 gpm obtainable in many parts of the county. However, the formation thins in the Suwannee strait and is probably unproductive.
		Lisbon Formation	380	Limestone, crystalline, nodular containing chert zones.	A poor aquifer.
		Tallahatta Formation	130	Glauconitic dolomitized limestone grading westward into glauconitic sand and clay.	A good aquifer in adjoining counties but at excessive depth in Colquitt County.
	Older than Eocene		More than 4,000	Varied sand, limestone, clay, marl.	No data available.

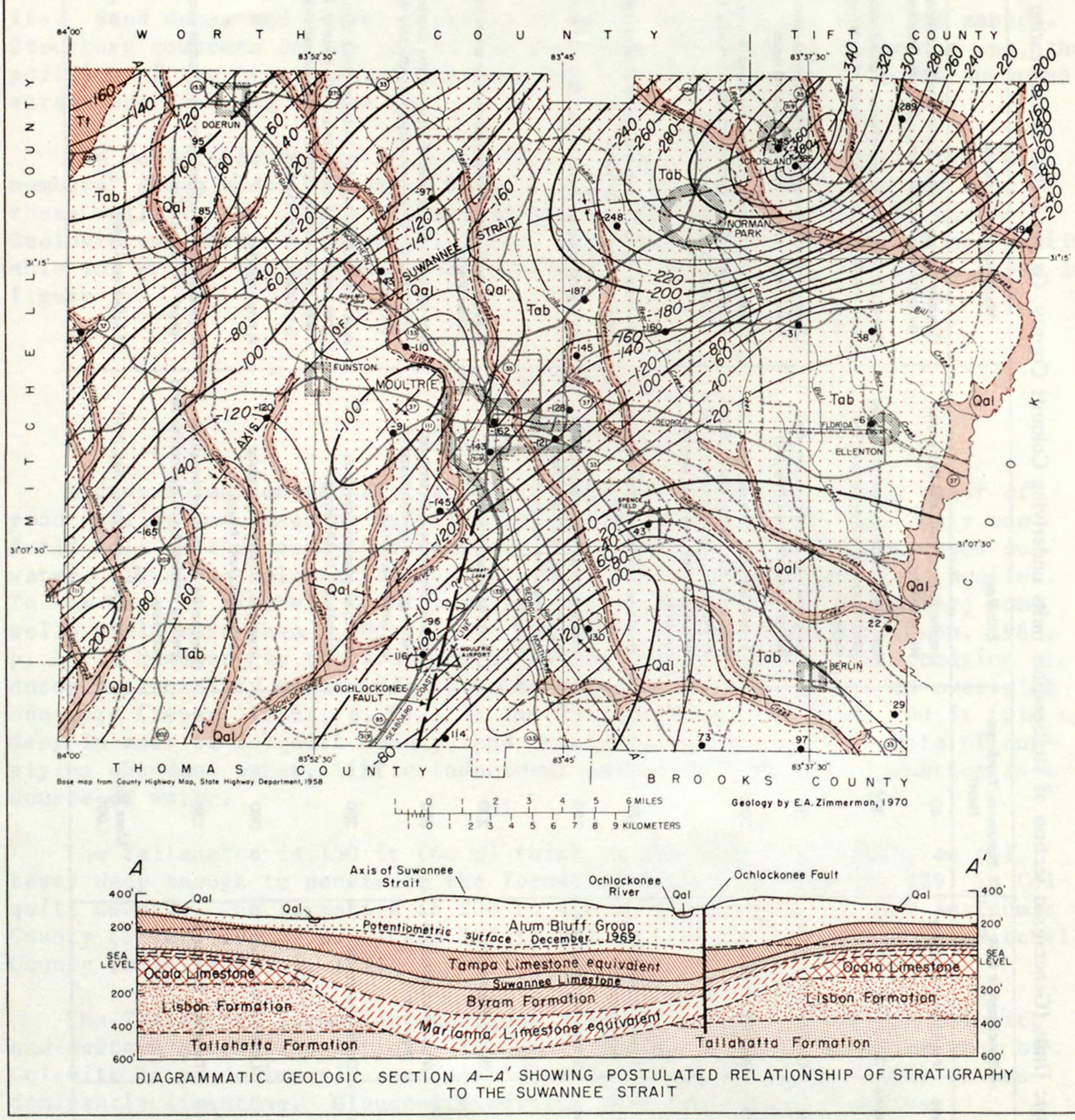

FIGURE 3.—SURFACE GEOLOGY AND STRUCTURE CONTOURS OF TOP OF THE SUWANNEE LIMESTONE.

EXPLANATION

Qal	ALLUVIUM—Flood plain deposits	Holocene	QUATERNARY
Tab	ALUM BLUFF GROUP	Miocene	TERTIARY
Tt	TAMPA LIMESTONE EQUIVALENT SHOWN ON SECTION ONLY	Miocene	TERTIARY
Ts	SUWANNEE LIMESTONE	Oligocene	TERTIARY
Tb	BYRAM FORMATION	Oligocene	TERTIARY
Tm	MARIANNA LIMESTONE EQUIVALENT	Oligocene	TERTIARY
To	OCALA LIMESTONE	Eocene	TERTIARY
Tl	LISBON FORMATION EQUIVALENT	Eocene	TERTIARY
Ttf	TALLAHATTA FORMATION EQUIVALENT	Eocene	TERTIARY

- -------- CONTACT—Approximately located
- ——?—? FAULT—Approximately located; queried where probable. U, upthrown side; D, downthrown side
- ANTICLINE—Approximately located; showing trace of crestal plane
- SYNCLINE—Approximately located; showing trace of trough plane
- —20— STRUCTURE CONTOUR—Shows altitude of Suwannee Limestone. Approximately located. Contour interval 20 feet (6.1 meters). Datum is mean sea level
- •-120 DATA POINT—Number indicates altitude of top of Suwannee Limestone

Table 3. - Record of selected wells in Colquitt County, Georgia

Well No.	Owner or Name	Driller	Date Completed	Altitude Above Sea Level	Depth Of Well (feet)	Diameter Of Well (inches)	Character Of Material	Depth to Which Well Is Cased (feet)	Water Level		Remarks E log – Electric log G/R log – Gamma-ray log
									Below surface or bench Mark (feet) (R) reported	Date of Measurement	
14G10	Myron J. Hart	Carr Drilling Co.	1962	274.00	400	4	Limestone	393	203.62	3/62	GGS1241; Chemical Analysis (CA)
14G16	Troy Lindley	Tyson & Dean	1968	303	385	4	Limestone	250	191	5/68	GGS1973
14G17	Crosby	Tyson & Dean	1969	294	370	4	Limestone		212.47	12/69	
14H1	D.G.Arrington	R.T. Adams	1948	270	4,916						GGS170; plugged, abandoned; E log, 75'-4,904; oil test described in GGS Bull. 70.
14H7	W.H.Summerlain	Rowe Bros.	1963	337	740	4	Limestone	500	182.09	12/69	CA
14H8	R.L. Millings	Tyson & Dean	1965	310	850	4	Limestone	310	190	5/65	GGS1419; well caved & abandoned
14H9	R.L. Millings	Tyson & Dean	1965	310	403	4	Limestone	285	199.11	12/69	GGS1417; E&G/R logs before well completed; CA
14H10	Funston Gin Co.	Rowe Bros.	1965	354	1,078	10	Limestone	589	276.22	12/69	
14H13	Eugene Gay	Tyson & Dean	1964	284	426	4	Limestone	256	133.33	12/69	GGS1242; CA; E & G/R logs.
14H15	J.A. Faison	Tyson & Dean	1967	338	810	4	Limestone	630	225.05	12/69	GGS1910; CA
14J1	D.E. Smith	Tyson & Dean	1964	362	350	4	Limestone	260	182.08	12/69	GGS1243; CA
14J2	City of Doerun,2	Rowe Bros.	1956	385	555	10	Limestone	266	191.70	12/69	CA
14J5	J.Q. Davis	Tyson & Dean	1966	340	365	4	Limestone		167.05	12/69	
14J15	Donald Simmons	Rowe Bros.	1968	358	320	4	Limestone	245	191.42	12/69	
15G2	Mrs. D.A. Lanier	Carr Drilling Co.	1962	278.5	254	4	Limestone	189	190(R)		GGS786
15G4	Ed Lewis	Carr Drilling Co.	1962	274.4	494	4	Limestone	394	207(R)	7/62	GGS848
15G9	C.O. Smith	John Watson		294.8			Limestone		224.86	12/69	GGS863
15G10	Leslie Smith	John Carr	1963	281	431	4	Limestone		212.12	12/69	GGS885; CA; cavity at 395'
15G21	Norman Saunders	Bishop Drilling Co.	1967		470	4	Limestone	442	198(R)	8/67	GGS1795
15G22	Charles A. Smith	Tyson & Dean	1967	249	400	4	Limestone	316	163.07	10/69	E & G/R logs.
15G23	Mack Dekle	Watson	1968	240	440	4	Limestone		181.6	12/69	
15H1	Grady Mathews	John Carr	1961	312	554.6	4	Limestone	294	336(R)		GGS1244
15H2	H. Tomlinson	John Carr		300	474.4	4	Limestone	426	230.69	12/69	GGS1245; CA
15H4	W.M. Brooks	John Watson		354	930		Limestone		214.98	12/69	GGS877; CA
15H6	Ennon Flowers	Carr Drilling Co.	1963	299	567	4	Limestone	397	221(R)	5/61	GGS852; very hard flint at 567'; pump set at 252'

Table 3. - Record of selected wells in Colquitt County, Georgia--Continued

Well No.	Owner or Name	Driller	Date Completed	Altitude Above Sea Level	Depth Of Well (feet)	Diameter Of Well (inches)	Character Of Material	Depth to Which Well Is Cased (feet)	Water Level		Remarks E log – Electric log G/R log – Gamma-ray log
									Below surface or bench Mark (feet) (R) reported	Date of Measurement	
15H7	City of Moultrie(3)	Steven & Southern & Layne-Atlantic	1949	328	752	16	Limestone	425	273.90	3/70	GGS175; well drilled to 1,000′; plugged back to 752′
15H8	City of Moultrie(4)	Steven & Southern,	1959	298	808	10	Limestone	425	267	4/74	
15H9	City of Moultrie(2)	Steven & Southern	1943	308	825	20-12	Limestone	469	238(R)	3/70	GGS22; CA; driller's log. Ga. Bull. 70.
15H12	City of Moultrie(1)	Steven & Southern	1936	309	750	12	Limestone	470	270.25		Well drilled 1,000′ deep; plugged back to 750′
15H17	Griffin	Tyson & Dean	1964	295	495	4-2½	Limestone	485	225.18	12/69	GGS1246
15H19	O.C. Causey	Tyson & Dean	1964	320	625	4	Limestone	458	247.25	12/69	GGS1248; CA; cuttings collected; E & G/R logs.
15H22	N.D. Gunn	Tyson & Dean	1965	340	480	4	Limestone	396	223.14	12/69	GGS1367; CA
15H27	Frank Mashburn	Tyson & Dean	1966	327	530	4	Limestone	360	190(R)	5/66	GGS1614
15H33	Lawrence Funderburke	Rowe Bros.	1968	320	780	4	Limestone	457	242.04	12/69	GGS1968; CA
15H36	K.V. Cope	Tyson & Dean	1968	336	725	6	Limestone	396	255.79	12/69	E & G/R log
15H38	James Kirk II	Tyson & Dean	1968	306	840	4	Limestone	4″-400′ 2½-840′	220.63	12/69	CA; E & G/R log
15J3	D.C. Smith	Tyson & Dean	1965	340	380	4	Limestone	300	148.62	12/69	CA; GGS1455
15J7	I.J. Sikes	Tyson & Dean	1966	374	620	4	Limestone	475	198.55	12/69	GGS1617
15J11	Mrs. Westberry			376	235	5	Limestone	195	162.83	12/69	Observation well; E & G/R log
15J12	J.B. Price	Bishop Drilling Co.	1969	367	582	4	Limestone	417	185.94	12/69	
15J13	G.W. Holloway	International Res. Dev. Corp.	1969	373	640	4	Limestone	536	188.45	12/69	GGS2043
15J16	Oakdale Church	Bishop Drilling Co.	1967	380	950	4	Limestone	422	267.79	12/69	
16G1	Cecil Lawrence	John Carr	1961	278	307	4	Limestone	215	196.95	12/69	GGS758; CA
16G2	Wesley Chapel	John Carr		242	235	4	Limestone	206	163(R)	2/62	GGS813
16G3	Vera Gray	John Carr		289	260	4	Limestone	191	197(R)	2/62	GGS814
16G5	F.E. Kilgore	John Carr	1962	264.7	222	4	Limestone	177	173.59	12/69	GGS1018
16G7	David Bell	Rowe Bros.	1963	265	210		Limestone	182			CA; E& G/R log
16G10	Hubert Martin	Tyson & Dean	1964		160	4		90	none		GGS1251; abandoned
16G17	City of Berlin		1946	256	400	6	Limestone	200	150(R)	46	CA
16G19	Oscar Wilder	Tyson & Dean	1965	257	200	4	Limestone	195	187.35	12/69	GGS1494
16G21	Stripling	Tyson & Dean	1967	296	247	4	Limestone	189	199.19	12/69	E & G/R log
16G22	Graham Cole	Rowe Bros.	1968	267	320	10	Limestone	205	188.07	12/69	CA; E & G/R log
16H2	Tammy Martin	John Carr	1962	305	533	4	Limestone	414	231(R)		GGS1000; pump set at 262′
16H4	W.B. Allman	Bowman Stewart	1963	257	200	4	Limestone	188	177.5	3/63	E & G/R log

Table 3. - Record of selected wells in Colquitt County, Georgia--Continued

Well No.	Owner or Name	Driller	Date Completed	Altitude Above Sea Level	Depth Of Well (feet)	Diameter Of Well (inches)	Character Of Material	Depth to Which Well Is Cased (feet)	Water Level: Below surface or bench Mark (feet) (R) reported	Water Level: Date of Measurement	Remarks E log—Electric log G/R log—Gamma-ray log
16H5	City of Moultrie (Spence Field)	Stevens Southern	1941	288	760	12	Limestone	253	212(R)	11/41	GGS188; CA
16H9	J.F. Pinkard	Tyson & Dean	1964	290	545	4	Limestone	316	223.90	12/69	GGS1256
16H12	Bud Williams	Tyson & Dean	1964	265	247	4	Limestone	197	194.00	12/69	GGS1259
16H14	Bridgeport Brass	Rowe Bros.	1964	305	579	16	Limestone	423	232	1/65	GGS1260; CA; E & G/R log
16H16	J.C. Boyd	Tyson & Dean	1965	315	540	4	Limestone	433	235	5/65	GGS1268
16H18	Tyson & Dean	Tyson & Dean	1965	312	400	4	Limestone	294	233.03	12/69	
16H21	Holman Store	Tyson & Dean	1965	296	550		Limestone		224.97	12/69	GGS1467; CA
16H22	So. Ga. Water Co.	Layne-Atlantic	1958	334	700	8	Limestone	515	251.90	12/69	GGS688; CA
16H28	N.S. Johnson	Tyson & Dean	1966	273	300	4	Limestone	245	198.74	12/69	GGS1643 E & G/R log
16H32	Mt. Olive Baptist Church	Bishop Drilling Co.	1967	279	500	4	Limestone	310	207(R)	11/67	GGS1915; CA
16H33	J.E. Bragg	Bishop Drilling Co.	1967	321	374	4	Limestone	338	240.47	12/69	GGS1916; E & G/R log
16H36	Mrs. Pearl Clark	Bishop Drilling Co.	1968		502	4	Limestone	409	227(R)	3/68	GGS1954
16H37	W.L. Gibbs	Bishop Drilling Co.	1968	324	522	4	Limestone	404	243.27	12/69	GGS1964
16H40	City of Moultrie (Spence Field)	Stevens Southern	1941	288	741	10	Limestone	254	213.20	12/69	CA
16H44	Moultrie Manufact.			301	37	12	Sand	37	7.08	10/69	CA
16H45	Carl Hamm	Bishop Drilling Co.	1968	319	200	3	Sand	93	86(R)	12/68	CA
16J2	City of Norman Park	Gray & Co.	1941	333	817	8	Limestone	499	253.2(R)	5/41	CA; driller's log
16J9	J.R. Vaughn	Bishop Drilling Co.	1967	317	630	4	Limestone	531	180.91	12/69	GGS1784; CA
16J12	C.H. Hobby	Bishop Drilling Co.	1967	285	660	4	Limestone	540	191(R)	9/67	GGS1799
16J13	W.H. Sinclair	Bishop Drilling Co.	1967	334	702	4	Limestone	419	294.06	12/69	GGS1918
16J14	G.E. Clark	Bishop Drilling Co.	1968	299	722	4	Limestone	427			GGS1937
16J15	Southern Turf	Bishop Drilling Co.	1962		104	6	Sand	93	13.53	3/68	pH 7.29
16J19	T. Williams	Bishop Drilling Co.	1968	313	684	4	Limestone	386	197.36	12/69	GGS1978; CA
16J20	H.T. Dorsey	Bishop Drilling Co.	1968	274	485	4	Limestone	320	169.44	12/69	
16J22	Billy Paramore	Bishop Drilling Co.	1969	336	29.9	12	Sand	30	4.36	10/69	CA
16J23	Sam Wood	Bishop Drilling Co.		289	160	3	Sand	109	42(R)		CA
17G1	Edgar Walden	Bishop Drilling Co.	1963	231	318	4	Limestone	202	156.39	12/69	GGS869; CA; G/R & E log
17G2	Earl Moore	John Carr	1963	214	261	4	Limestone	231	150(R)	5/63	GGS853
17G14	K.G. Cardin, 1	Tyson & Dean	1968	220	310	6	Limestone	201	155	3/68	CA; E & G/R log
17G15	K.G. Cardin, 2	Tyson & Dean	1969	226	315	6	Limestone	206	160.20	12/69	CA

Table 3. - Record of selected wells in Colquitt County, Georgia--Continued

Well No.	Owner or Name	Driller	Date Completed	Altitude Above Sea Level	Depth Of Well (feet)	Diameter Of Well (inches)	Character Of Material	Depth to Which Well Is Cased (feet)	Water Level: Below surface or bench Mark (feet) (R) reported	Water Level: Date of Measurement	Remarks E log—Electric log G/R log—Gamma-ray log
17H3	Williams	Tyson & Dean	1964	234	240	4	Limestone	182	161.55	12/69	GGS1261
17H14	Mrs. Roy Baker	Tyson & Dean	1965	277	298	4	Limestone	218	202.07	12/69	GGS1266; CA
17H18	Reed Bingham Park	Creasey Drilling Co.	1965	202	190	4	Limestone	182	123.42	1/66	GGS1374
17H22	N.C. Brannon	Bishop Drilling Co.	1967	292	350	4	Limestone	310	219.99	12/69	GGS1900; CA
17H27	E.L. Waites	Bishop Drilling Co.	1969	263	305	4	Limestone	275	188.23	12/69	GGS2015
17H28	A.D. Conger	Bishop Drilling Co.	1969	318	30	2	Sand	26'-4" screen	9(R)	9/69	CA
17H29	Kenny Roberts	Bishop Drilling Co.	1969	312	150	3	Sand	64	8(R)	7/69	CA
17J9	Alton Stone	Bishop Drilling Co.	1967	258	422	4	Limestone	340	175.79	12/69	GGS1696; CA
17J10	J.E. Bush	Bishop Drilling Co.	1967	314	170	4	Sand	136	60(R)	5/67	GGS1771; CA
17J13	Sim Rentz	Bishop Drilling Co.	1967	231	267	4	Limestone	252	158.82	12/69	GGS1922
17J15	Glenn Powell	Bishop Drilling Co.	1968	333	1,017	6	Limestone	726	248.62	12/69	GGS1952; CA; E & G/R log
17J17	Felix Roberson	Bishop Drilling Co.	1968	282	440	4	Limestone	312	208.07	10/68	

The Lisbon is a cream-colored, nodular, partly recrystallized, granular, rather loosely consolidated limestone containing several cherty zones. It is as much as 380 ft (116 m) thick.

Ocala Limestone

The Ocala Limestone of late Eocene age overlies the Lisbon Formation and underlies rocks of Oligocene age. In conjunction with overlying beds, the limestone constitutes a very productive aquifer called the principal artesian aquifer. The Ocala can yield more than 1,000 gal/min (5,450 m^3/d) to properly constructed wells where it attains its full thickness of 300 ft (91 m). However, it pinches out along the trend of the Suwannee strait, a subsurface feature discussed later in this report. The greatest thickness, and consequently the greatest yields, can be expected near the southeast and northwest corners of the county as far from the strait as possible.

The Ocala is a cream-colored, granular, partly recrystallized, fossiliferous limestone locally interbedded with dolomite.

Oligocene Series

Marianna Limestone equivalent

The Marianna Limestone equivalent of middle Oligocene age attains a thickness in excess of 300 ft (91 m). The thickness is greatest in the deeper parts of the Suwannee strait, and the formation may pinch out along the flanks of the strait.

The Marianna Limestone, at its type section in Florida, is a cream to white-colored, uniformly granular, massive limestone (Puri and Vernon, 1959, p. 85). At Cairo, Ga., 16 mi (26 km) southwest of Colquitt County, the incomplete section of the Marianna penetrated by a test well included almost 40 percent marl, in addition to interbedded limestone and dolomite. Several wells in Colquitt County penetrated as much as 200 ft (61 m) of predominantly marl bed in the Marianna. Perhaps the lithology of the Marianna in the county is transitional between that of typical Marianna in Florida and that of the equivalent Cooper Marl in eastern Georgia and South Carolina. Where the formation thins along the edges of the Suwannee strait, the rocks are mainly limestone, but in the deep parts of the strait they grade into marl.

The Marianna, especially where it is predominantly marl, is not favorable as a source of water. In the parts of Colquitt County where wells penetrate thick units of marl or clay, drillers have experienced difficulty obtaining adequate water. Outside the strait, the Marianna equivalent may be an aquifer. Sever (1972) noted a water-bearing zone at the top of the Marianna Limestone and at the bottom of the overlying Byram Formation in Cook County.

Byram Formation

The Byram Formation of middle Oligocene age overlies the Marianna Limestone equivalent and underlies the Suwannee Limestone. It is as much as 230 ft (70 m) thick in Colquitt County. Like the Marianna, the Byram seems to be developed most fully in the Suwannee strait and pinches out along its margins.

The Byram is mainly brown, saccharoidal, dolomitic limestone. This limestone was considered to be part of the Ocala Limestone before Sever and Herrick (1967, p. B50) established the probable correlation of similar beds at Cairo, Ga., with the Byram Formation cropping out in the Florida panhandle.

The Byram contributes substantial amounts of water to wells. A yield of more than 100 gal/min (545 m^3/d) was indicated by a test at Adel, Ga. However, water from the formation is of poor quality in a number of wells in southwestern Georgia.

Suwannee Limestone

The Suwannee Limestone of late Oligocene age is the main unit of the principal artesian aquifer in southwestern Georgia. Most of the deep wells in Colquitt County penetrate only 40 to 60 ft (12 to 18 m) into the Suwannee. They are drilled by the hydraulic-rotary method, and fluid circulation is commonly lost in that interval. The circulation loss generally indicates that the well is deep enough to yield ample water.

The Suwannee Limestone ranges from 50 to more than 100 ft (15 m to more than 30 m) in thickness in Colquitt County. It consists mainly of cream-colored, nodular, recrystallized, fossiliferous limestone, but partly-dolomitized limestone has been noted in some wells. The formation contains some zones so abundantly fossiliferous that they form a coquina. Chert is commonly present at the top of the limestone and in the southeastern part of Colquitt County, chert beds make drilling difficult.

The Suwannee, as the main unit in the principal artesian aquifer in Colquitt County, is highly productive. A current-meter test of a well at Adel in Cook County showed that an 8-ft (2.4 m) thick zone in the Suwannee produced 38 percent of the water from the well, and could yield 1,100 gal/min (6,000 m^3/d) with a drawdown of 36 ft (11 m) (Sever, 1972). The remainder of the water came from two distinct zones in the underlying Marianna and Ocala Limestones. Another water-bearing zone in the Suwannee, indicated by a loss in circulation during drilling, was cased out and thus, not tested. During injection of water, a current-meter test of well 16H14 in Colquitt County indicated that the Suwannee probably produces a similar percentage of the water from this well, but the rate of injection was not determined.

Miocene Series

Tampa Limestone equivalent

The Tampa Limestone equivalent of early Miocene age overlies the Suwannee Limestone. Because its lithology seems rather inconsistent, correlation and identification of the Tampa equivalent is difficult in Colquitt County. Sand and calcareous material seem to be common to all observed or reported occurrences. In this investigation, the presence of calcareous material as indicated by effervescence in dilute hydrochloric acid, whether in sandy limestone or in limey sand, was taken as indicative of the Tampa equivalent. Because the formation in Colquitt County contains much sand, silt, and marl, it is referred to here as Tampa Limestone equivalent rather than as Tampa Limestone.

The beds assigned to the Tampa in Colquitt County range from about 20 ft (6 m) to 160 ft (49 m) in thickness. The maximum thickness seems to be in or near the Suwannee strait.

The Tampa equivalent is a fair aquifer in its own right, but its easy recognition may be of most value to drillers as an indication that the drill is approaching the much more productive Suwannee. A pumping test on a well near Laconte in Cook County revealed a maximum yield for the well of 22 gal/min (120 m^3/d). Many wells have been completed in the Tampa equivalent (called "semi-deep" wells by local drillers) for domestic and stock-water supplies.

Some wells have proved successful over many years. However, wells in southwestern Georgia are generally completed as open-hole type wells. These wells are cased to the top of the aquifer and drilled through it with no screen being set. This type of construction works admirably in the Suwannee Limestone and underlying formation, but the abundance of silt and sand in the Tampa equivalent commonly causes problems of caving and sand pumping. Installation of well screens might prevent some of the problems. However, the main reason for trying to complete wells in the Tampa equivalent is to save the cost of deeper drilling; the expense of installing a screen might negate this saving. Local drillers, plagued by callbacks, are reluctant to drill "semi-deep" wells in the Tampa equivalent.

The yields obtainable from wells tapping the Tampa differ from place to place, depending upon its saturated thickness or depth below the water table. Thus, yields from the Tampa equivalent can be expected to be greater near the Suwannee strait where the aquifer is deepest in relation to the water level. The Tampa equivalent is an artesian aquifer in most of the county, but becomes a water-table aquifer in much of the southern part. In the extreme southeastern part of the county the Tampa equivalent is above the water table.

Alum Bluff Group

The Alum Bluff Group of Miocene age overlies the Tampa Limestone equivalent and crops out at the surface in most of Colquitt County. The beds designated here as Alum Bluff have been variously mapped as Miocene undifferentiated or Hawthorn Formation, as well as Alum Bluff Group. The name Alum Bluff is used here to avoid implying a correlation with the Hawthorn, which some have questioned, and to differentiate these beds from the Tampa equivalent, which is also of Miocene age. Further subdivision of the group has been attempted (Sever, 1966a, p. 5), but the basis for the subdivision seems neither clear-cut nor widespread enough to use in this report.

In Colquitt County, the Alum Bluff Group attains a maximum thickness of about 300 ft (91 m) in or near the Suwannee strait, but it has been eroded to less than 100 ft (30 m) in the southeast part of the county and to a featheredge in the northwest.

The Alum Bluff Group consists mainly of sand, clay, and silt. The lower 100 ft (30 m) is mainly clay and silt, but includes some scattered tongues of limestone and chert. Sandy beds predominate in the upper part of the group. Subdivision based on the general lithologic changes may be possible; but changes from bed to bed are generally gradual, reliable marker beds are lacking, and correlation of beds is consequently poor.

Highly absorbent clay, attapulgite or montmorillonite, is commonly found in cuttings from wells drilled through the Alum Bluff and is mined as fuller's earth southwest of Colquitt County. Sever (1964, p. B166) noted that commercially-mined fuller's earth deposits tend to occur near the axis of a trough that seems to be the southwestward extension of the Suwannee strait, and he inferred that deposition of the fuller's earth was controlled by the trough.

The Alum Bluff yields water to many dug or bored wells in Colquitt County. These wells are generally less than 50 ft (15 m) deep and most supply water for domestic and stock use. Because the Alum Bluff is exposed at the surface and obtains recharge rather directly from rainfall, water levels in the wells fluctuate markedly in response to rainfall or drought. Thus, wells in the Alum Bluff are considered unreliable and, when droughts occur or demand increases with the installation of modern plumbing, more and more of the wells in the Alum Bluff fail and are replaced by deep wells. Of those wells remaining in use, many produce small amounts of water for homes that have minimal facilities. A manufacturing company in Moultrie has a 37-ft (11 m) well (16H4) that provides about 20 gal/min (109 m^3/d) of water (intermittently) for a plating and anodizing operation. The company has been pleased with the yield of the well, and the quality of the water is superior to that obtainable from deeper limestone aquifers.

Pliocene Series

Sever (1966a, p. 5) described a deposit of gravel and coarse sand up to 90 ft (27 m) thick in Thomas County, which he called the Citronelle Formation of Pliocene age. Remnants of this formation are probably present in Colquitt County but aside from isolated patches of gravel, none were noted. This deposit does not contrast sharply enough with the underlying Alum Bluff Group to make mapping feasible within the scope of this study.

One would expect the Citronelle to be favorable as a source of water to shallow wells, but its major hydrologic importance may be to facilitate natural recharge of rainfall. The hydrologic properties of the formation should be essentially the same as those of the upper part of the Alum Bluff.

Pleistocene Series

Dune sand

Two small patches of dune sand were noted during this study. One is on the east side of the Ochlockonee Valley, southeast of Doerun; the other is east of Little River, adjacent to the study area. As these are neither areally extensive nor particularly significant hydrologically, they are not shown on the geologic map. The dunes attain a height of about 30 ft (9 m) and consist of fine to medium, angular to subangular white sand.

As the dunes are above the water table, they are not potential sources of ground water, but the unconsolidated, permeable material may absorb and retain water to retard runoff and increase recharge to underlying beds. The dunes are not actively growing or moving, because vegetation has stabilized them fairly well.

Holocene Series

Flood-plain deposits

The flood plains of major streams in Colquitt County are underlain by as much as 40 ft (12 m) of water-sorted sand and gravel. Although these deposits are well situated to receive abundant recharge from the streams, they are almost untested as aquifers because the flood plains are swampy in many places, subject to flooding, and hence, nearly uninhabited.

One well (17H28), drilled 30 ft (9 m) into flood-plain deposits underlying Warrior Creek valley, has a screen set opposite a 4-ft (1.2 m) bed at the bottom of the well. The maximum yield of the well is unknown, as it is equipped with a small-capacity pump; but when the well was inventoried, the owners were satisfied with the 10 gal/min (55 m^3/d) it supplied.

Flood-plain deposits can probably produce substantial amounts of water. The water is exceptionally low in dissolved solids, which might make it attractive to certain users, but the low-lying land underlain by the deposits is generally unattractive as building sites.

STRUCTURAL GEOLOGY AND ITS RELATION TO THE OCCURRENCE OF GROUND WATER

The structure-contour map (fig. 3) shows the configuration of the upper surface of the Suwannee Limestone, as noted in well logs. The contours indicate the altitude of the top of the formation with respect to sea level; positive above, or negative if below. Because the map is based on more data than were available to compilers of earlier maps, it does not necessarily agree with previous structure maps. The map represents the current interpretation as to nature of the structure based on the data available.

The map may be used to estimate how deep a proposed well should be drilled to reach the top of the Suwannee. If the altitude of the land surface at the proposed well site is known, the depth to the top of the Suwannee can be estimated by subtracting the altitude of the top of the Suwannee from that of the site (if the contours are positive), or by adding the negative altitude to that of the well site.

A northeast-trending trough, the Suwannee strait, crosses Colquitt County. This feature has been given a variety of names by previous authors. Dall (Dall and Harris, 1892, p. 111, 121-122) defined the Suwannee strait as a Cretaceous feature extending along the Suwannee River in Florida and through the Okefenokee Swamp in Georgia. Applin and Applin (1944) suggested, on the basis of subsurface stratigraphy, that a channel or saddle extended southwestward across Georgia through the Tallahassee area of Florida to the Gulf of Mexico, and Jordan (1954) applied the name Suwannee strait. These two uses of the same term would seem to conflict; however, Chen (1965, p. 10) recognized the continuous existence of the Suwannee "channel" (as he preferred to call it), in his analysis of Paleocene and Eocene rocks of Florida, at least through early Tertiary time. The trend of this channel moved northwestward from the approximate location described by Dall during Paleocene deposition to approximately the location shown in this paper by the time of late Eocene deposition (Chen, 1965, figs. 41-44). Herrick and Vorhis (1963, p. 55) proposed the name "Gulf Trough of Georgia" for what seems to be the same feature and Sever (1966b, p. C12) introduced the name "Meigs basin" for what may be a depression in the much larger trough.

Several different opinions as to the nature and origin of the Suwannee strait have been expressed by previous investigators. Patterson and Herrick (1971, p. 11-12) present a recapitulation of these differing views. The principal hypotheses are:

1. That the feature represents a buried submarine valley or strait analogous to the present-day straits of Florida.

2. That it is a graben.

3. That it is a syncline.

4. That it is a buried solution valley analogous to the Flint River valley where solution of carbonate rocks has reduced Oligocene limestone to a residuum of greatly reduced thickness.

The author prefers the first hypothesis. The arguments for the differing ideas are voluminous and beyond the scope of this report.

The Ochlockonee fault was postulated, mapped on indirect evidence, and named by Sever (1966a, p. 6) in his Thomas County study. He also projected it into Colquitt County. The validity of his mapping has been questioned by several geologists on the grounds that the density of control points does not permit proof of displacement-- the data could be explained by changes in dip (Patterson and Herrick, 1971, p. 13). Apparent dips without the fault in Thomas County, however, are locally more than 100 ft/mi (19 m/km) in contrast with the average dip of about 15 ft/mi (2.8 m/km). Abrupt changes in dip are recognized by most geologists as strongly indicative of faulting. Structural control in Colquitt County is also inadequate to prove the existence of the fault. However, the fault as projected into the county provides some explanation of the head distribution in the Suwannee Limestone and the pattern of water quality in the southern part of Colquitt County. Alternative hypotheses to explain the changes in dip offer no explanation for those features. Thus, the water-quality distribution may be considered suggestive, though not conclusive evidence of the fault.

Sever (1966a, p. 3) mapped a linear depression in the potentiometric surface of the Suwannee Limestone in Thomas County that extends northeastward to Moultrie in Colquitt County. He interpreted the depression to mean that ground water was discharging from the Suwannee, down the fault, into the underlying Ocala. This writer believes that enhanced transmissivity along the fault may possibly account for the depression, but that natural upward vertical leakage may have occurred and accounted for the water-quality anomalies noted in this investigation and by Sever (1966b, p. 9).

Present local increases in sulfate may be the result of upward leakage from an underlying source under a pumping stress.

In part of southern Colquitt County the Suwannee Limestone is in a structurally high position that puts its top above the potentiometric surface, changing it from an artesian (confined) aquifer to a water-table (unconfined) aquifer. This change in confinement may account for the rather high storage coefficient determined from an aquifer test on well 16H5 at Spence Field, which is near an area where part of the permeable beds of the Suwannee are above the potentiometric surface.

The position of permeable beds of the Suwannee above the water table creates conditions favorable for the breathing wells that are common in southern Colquitt County. This rather curious phenomenon results when the casing of wells is set at the top of permeable limestone above the water table, leaving a porous permeable interval filled with air below the casing and above the water table. When the barometric pressure exceeds the air pressure in the limestone, air flows into the well and wells suck--often very audibly. When the barometric pressure is less than the air pressure in the limestone, the wells blow. The wells also respond to changes in water level--when the water level is dropping, the wells suck; when it rises, the wells blow. The part of the county where these breathing wells are common is shown in figure 5.

GROUND WATER

Because of its abundance and wide distribution, ground water is of great economic importance in Colquitt County. Through the years, as demand has increased, many of the low-yielding dug or bored wells have been replaced by deep (more than 200 ft or 61 m), comparatively high-yielding wells.

Hydrologic characteristics of the water-bearing material and the extent and magnitude of recharge govern the availability of ground water. These factors are, in turn, controlled by geologic characteristics of the materials.

Hydrology of the Principal Artesian Aquifer

Aquifer tests have been made on several wells penetrating the principal artesian aquifer in southwestern Georgia. The principal hydrologic characteristics determined by aquifer tests are transmissivity and storage coefficient. Transmissivity is the rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient. It is expressed in cubic feet of water per day per foot of aquifer width (ft^3 per day per foot), which simplifies to feet squared per day (ft^2/d) or as cubic meters per day per meter, simplifying to meters squared per day (m^2/d).

The storage coefficient is the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head.

Table 4 lists the results of some of the aquifer tests conducted in Colquitt County and at other sites in southwestern Georgia. Figure 4 is a map showing the location of the wells tested and the transmissivities determined. The construction of the various wells differ so that the results may not be truly comparable, but a pattern emerges that seems meaningful.

The 3 high transmissivity values of more than 150,000 ft^2/d (14,000 m^2/d) are on the south side of the Suwannee strait, and 2 of the 3 low values of less than 32,000 ft^2/d (3,000 m^2/d) are on the north side. This suggests that there is a substantial difference in the hydrologic properties on opposite sides of the strait. Although differences in well construction could explain this disparity, a facies change in the water-producing rocks is more likely the cause. The comparatively low transmissivity at Alapaha of 32,000 ft^2/d (3,000 m^2/d) south of the Swuannee strait (as projected) may be due to sinuosity of the strait. On the basis of the above aquifer tests, the greatest potential for high-yielding wells is southeast of the Suwannee strait.

The storage coefficients determined in the aquifer tests also differ substantially. Very low storage coefficients (less than 0.001) characterize artesian (confined) aquifers, whereas storage coefficients in water-table (unconfined) aquifers generally range from about 0.05 to 0.30. The fact that the storage coefficients for the Spence Field, Adel, and Fitzgerald wells are larger than would be expected for artesian aquifers, yet lower than expected for water-table aquifers, suggests that these wells are situated near boundaries between artesian and water-table conditions.

Table 4.--Aquifer constants of the principal artesian aquifer in southwestern Georgia, determined by aquifer tests

Well No.	Location	Transmissivity (ft^2 day^{-1})	(m^2 day^{-1})	Coefficient of storage
14J2	Doerun (Colquitt County)[1/]	13,000	1,200	Not determined
15G7	Coolidge (Thomas County)[2/]	170,000	16,000	0.00002
16H5	Spence Field near Moultrie (Colquitt County)[1/]	150,000	14,000	.007
18H5,33	Adel (Cook County)[3/]	210,000	20,000	.002
20K2	Alapaha (Berrien County)[2/]	32,000	3,000	Not determined
20M1,2,3	Fitzgerald (Ben Hill County)[2/]	16,000	1,500	.002

1/ Test run as part of this study.
2/ From Sever (1969, p. 6).
3/ From Sever (1972).

The transmissivity and storage coefficients determined by the aquifer tests can be used to estimate the probable yield of wells drilled into the principal artesian aquifer. The specific capacity of a well is the yield in gallons per minute per foot of drawdown. The well yield is, thus, the specific capacity multiplied by the drawdown.

The specific capacity of a hypothetical well of 100 percent efficiency can be approximated by the following equation:

$$\text{Specific capacity} = \frac{Q}{s_w} \simeq \frac{4\pi T}{2.30 \log_{10} 2.25\, Tt/r_w{}^2 S}$$

where Q is the quantity of water discharged, or yield, in ft^3/day
s_w is the drawdown, in ft
T is the transmissivity, in ft^2/d
t is the time pumped, in days
r_w is the radius of the well, in ft, and
S is the storage coefficient.

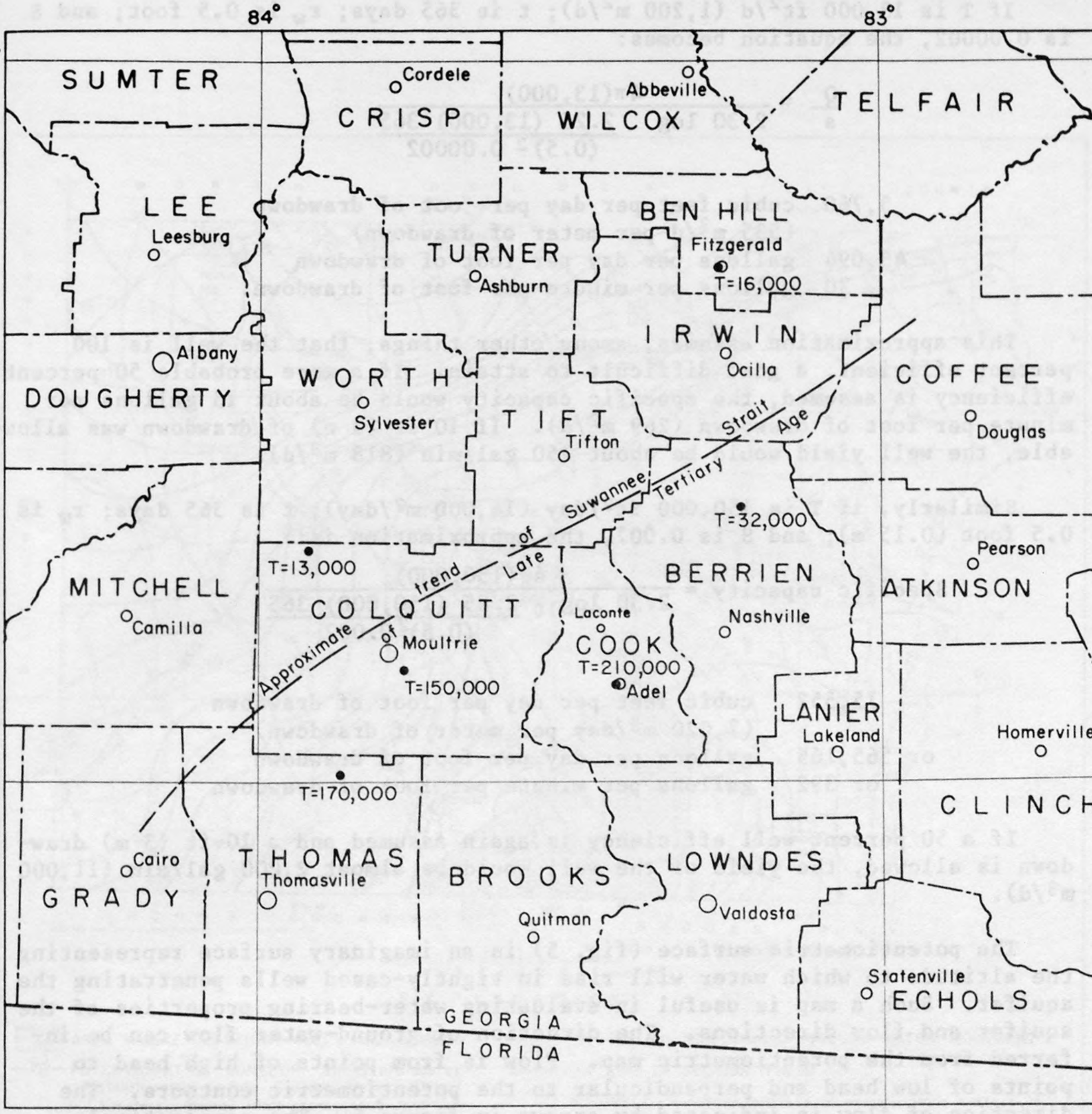

FIGURE 4. TRANSMISSIVITY OF THE PRINCIPAL ARTESIAN AQUIFER IN RELATION TO THE SUWANNEE STRAIT.

If T is 13,000 ft^2/d (1,200 m^2/d); t is 365 days; r_w is 0.5 foot; and S is 0.00002, the equation becomes:

$$\frac{Q}{s} \approx \frac{4\pi(13,000)}{2.30 \log \dfrac{2.25\ (13,000)\ 365}{(0.5)^2\ 0.00002}}$$

5,760	cubic feet per day per foot of drawdown
	(535 m^3/d per meter of drawdown)
43,094	gallons per day per foot of drawdown
30	gallons per minute per foot of drawdown.

This approximation assumes, among other things, that the well is 100 percent efficient, a goal difficult to attain. If a more probable 50 percent efficiency is assumed, the specific capacity would be about 15 gallons per minute per foot of drawdown (269 m^2/d). If 10 ft (3 m) of drawdown was allowable, the well yield would be about 150 gal/min (818 m^3/d).

Similarly, if T is 150,000 ft^2/day (14,000 m^2/day); t is 365 days; r_w is 0.5 foot (0.15 m); and S is 0.007, the approximation is:

$$\text{Specific capacity} = \frac{4\pi(150,000)}{2.30 \log_{10} \dfrac{2.25\ (150,000)\ 365}{(0.5)^2 0.007}}$$

75,552	cubic feet per day per foot of drawdown
	(7,020 m^3/day per meter of drawdown)
or 565,165	gallons per day per foot of drawdown
or 392	gallons per minute per foot of drawdown

If a 50 percent well efficiency is again assumed and a 10-ft (3 m) drawdown is allowed, the yield of the well would be almost 2,000 gal/min (11,000 m^3/d).

The potentiometric surface (fig. 5) is an imaginary surface representing the altitude to which water will rise in tightly-cased wells penetrating the aquifer. Such a map is useful in evaluating water-bearing properties of the aquifer and flow directions. The direction of ground-water flow can be inferred from the potentiometric map. Flow is from points of high head to points of low head and perpendicular to the potentiometric contours. The direction of flow is indicated by arrows in figure 5. The comparatively close spacing of the contours in the belt that extends from near Funston to the northeast corner of Colquitt County suggests reduced transmissivity.

The hachured contours around Moultrie represent a depression in the potentiometric surface caused by relatively heavy pumping. The irregular pattern of this depression may be caused by anisotropic transmissivity: that is, the aquifer can transmit water more freely along the trend of the depression (in a general northeast-southwest direction) than it can normal to this trend. The anisotropic transmissivity may be the result of enhanced permeability in a particular facies, along a structural feature, or both.

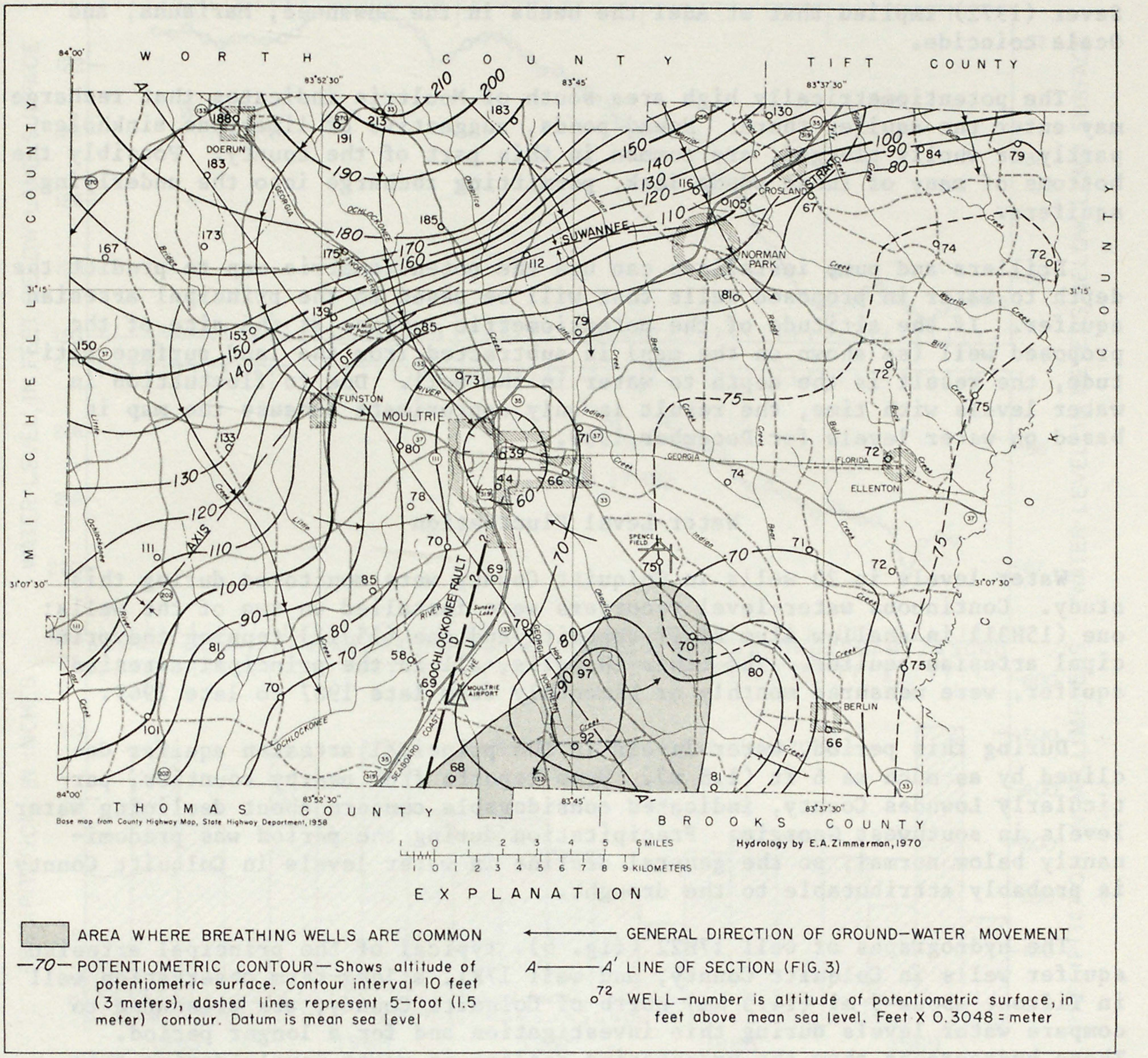

FIGURE 5.— POTENTIOMETRIC SURFACE OF THE PRINCIPAL ARTESIAN AQUIFER, DECEMBER 1969.

Sever (1966a, fig. 1) noted a depression in the potentiometric surface in Thomas County that seems to be a southwesterly continuation of the one in Colquitt County. In Thomas County, however, the depression did not coincide with areas of heavy pumping; Sever attributed it to the drainage of water from the Suwannee into underlying beds that have lower artesian heads. Information about the heads in aquifers below the Suwannee is lacking in Colquitt County. Sever (1972) implied that at Adel the heads in the Suwannee, Marianna, and Ocala coincide.

The potentiometrically high area south of Moultrie indicates that recharge may enter the aquifer there. Round ponds, suggestive of limestone sinkholes partly or wholly plugged, are common in this part of the county. Possibly the bottoms of many of these ponds leak, permitting recharge into the underlying aquifers.

Drillers and pump installers can use the potentiometric map to predict the depth to water in proposed wells that will be cased to the principal artesian aquifer. If the altitude of the potentiometric surface at the site of the proposed well (as shown on the map) is subtracted from the land surface altitude, the result is the depth to water in the well. Due to fluctuation in water levels with time, the result is only approximate because the map is based on water levels for December 1969.

Water-Level Fluctuation

Water levels in 20 wells in Colquitt County were monitored during this study. Continuous water-level recorders were installed on two of the wells: one (15H31) in shallow Alum Bluff deposits and one (15J11) tapping the principal artesian aquifer. The other 18 wells, all in the principal artesian aquifer, were measured monthly or bimonthly from late 1967 to late 1969.

During this period, water levels in the principal artesian aquifer declined by as much as 6 ft (1.8 m). News reports from nearby counties, particularly Lowndes County, indicated considerable concern about declining water levels in southwest Georgia. Precipitation during the period was predominantly below normal, so the general decline in water levels in Colquitt County is probably attributable to the drought.

The hydrographs of well 17H22 (fig. 6). typical of the principal artesian aquifer wells in Colquitt County, and well 17K1, a long-term observation well in Tifton, about 9 mi (14.5 km) north of Colquitt County, are presented to compare water levels during this investigation and for a longer period. These hydrographs show the progressive decline in water levels during this investigation.

The continuous water-level recorder on well 15J11 showed a progressive decline in the principal artesian aquifer similar to that indicated by the periodically measured wells. However, the recorder also showed short-term fluctuations that could not be detected by periodic measurements. A barograph was installed at the well; comparison of the record of barometric changes with the water-level record suggested that the short-term water-level fluctuations were in response to barometric changes (fig. 7).

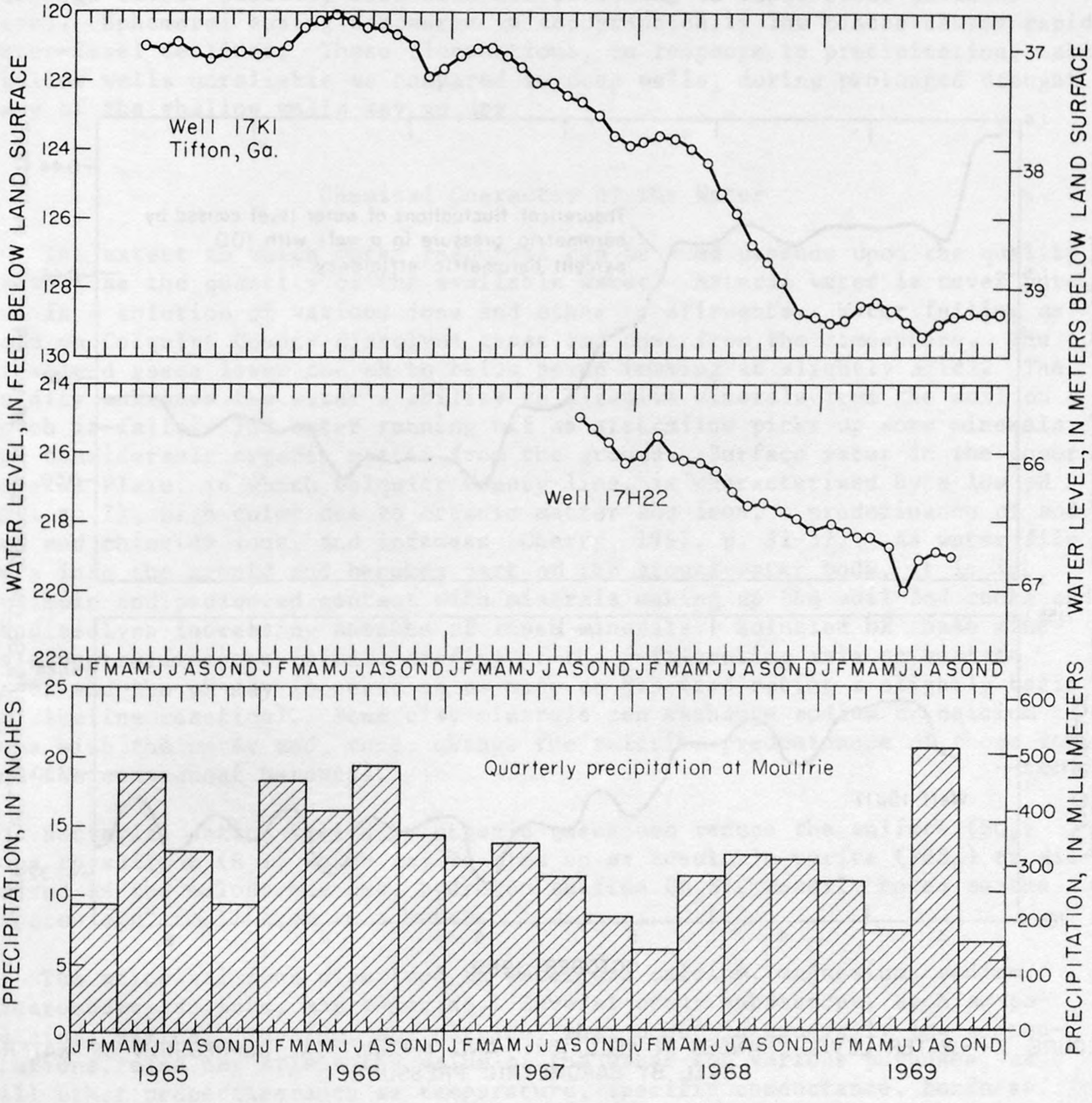

FIGURE 6.—WATER LEVEL CHANGES IN WELLS 17H22 and 17K1.

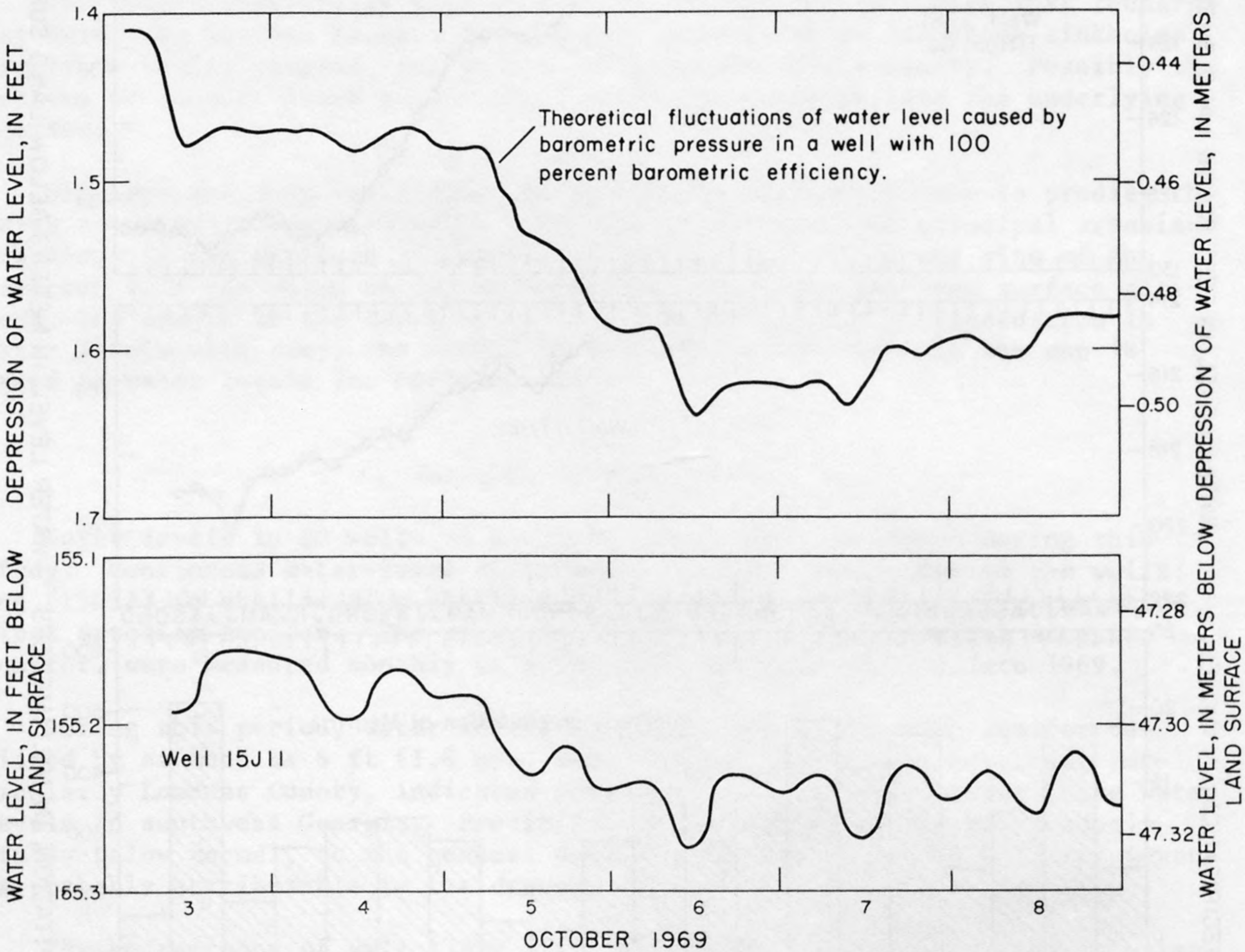

FIGURE 7.—WATER LEVEL CHANGES IN WELL 15J11 AND THEORETICAL DEPRESSION OF WATER LEVEL BY BAROMETRIC PRESSURE.

The continuous water-level recorder on well 15H31 in shallow Alum Bluff deposits showed prompt and marked response to local precipitation. The water level often rose 3 or 4 ft (0.9 or 1.2 m) within a day or so after heavy rains and declined almost as quickly (fig. 8). These deposits can receive recharge rather directly from rainfall resulting in rapid rises in water level. Ephemeral spring discharge in topographically low places causes rapid water-level declines. These fluctuations, in response to precipitation, make shallow wells unreliable as compared to deep wells; during prolonged drought many of the shallow wells may go dry.

Chemical Character of the Water

The extent to which water resources can be used depends upon the quality as well as the quantity of the available water. Natural water is never pure, but is a solution of various ions and other constituents. Water falling as rain on Colquitt County dissolves gases and dust from the atmosphere. The dissolved gases lower the pH to below seven (making it slightly acid). The acidity enhances the water's ability to dissolve minerals from the soil on which it falls. The water running off as streamflow picks up some minerals and considerable organic matter from the ground. Surface water in the lower Coastal Plain, in which Colquitt County lies, is characterized by a low pH (5.1 to 7), high color due to organic matter and iron, a predominance of sodium and chloride ions, and softness (Cherry, 1961, p. 31-32). As water filters into the ground and becomes part of the ground-water body, it is in intimate and prolonged contact with minerals making up the soil and rocks and it dissolves increasing amounts of these minerals. Solution of these minerals neutralizes the initial acidity of the infiltrating rain or surface water and the pH may increase to as much as 8.3 (indicating a slightly basic or alkaline reaction). Some clay minerals can exchange sodium or calcium ions with the water and, thus, change the relative predominance of those ions and the consequent hardness.

Bacterial action fueled by organic gases can reduce the sulfate (SO_4) ions to sulfide (S_2), which may be tied up as insoluble pyrite (FeS_2) or dissolved as the malodorous gas, hydrogen sulfide (H_2S), readily noted as the "rotten egg" smell from some water.

The principal ions dissolved in water are calcium, magnesium, sodium, bicarbonate, sulfate, and chloride. Several other substances, such as potassium, silica, fluoride, and nitrate, that occur in generally low concentrations, also may affect the value of the water for various purposes, as will other properties such as temperature, specific conductance, hardness, and pH. The major chemical constituents in natural water, their probable sources, their effects on water use, and their recommended limits in drinking water (U.S. Public Health Service, 1962), are tabulated in table 5.

Table 6 shows the chemical analyses of 31 water samples collected during this study, along with 20 others collected in previous years. These analyses are grouped according to the aquifer system from which the water is derived.

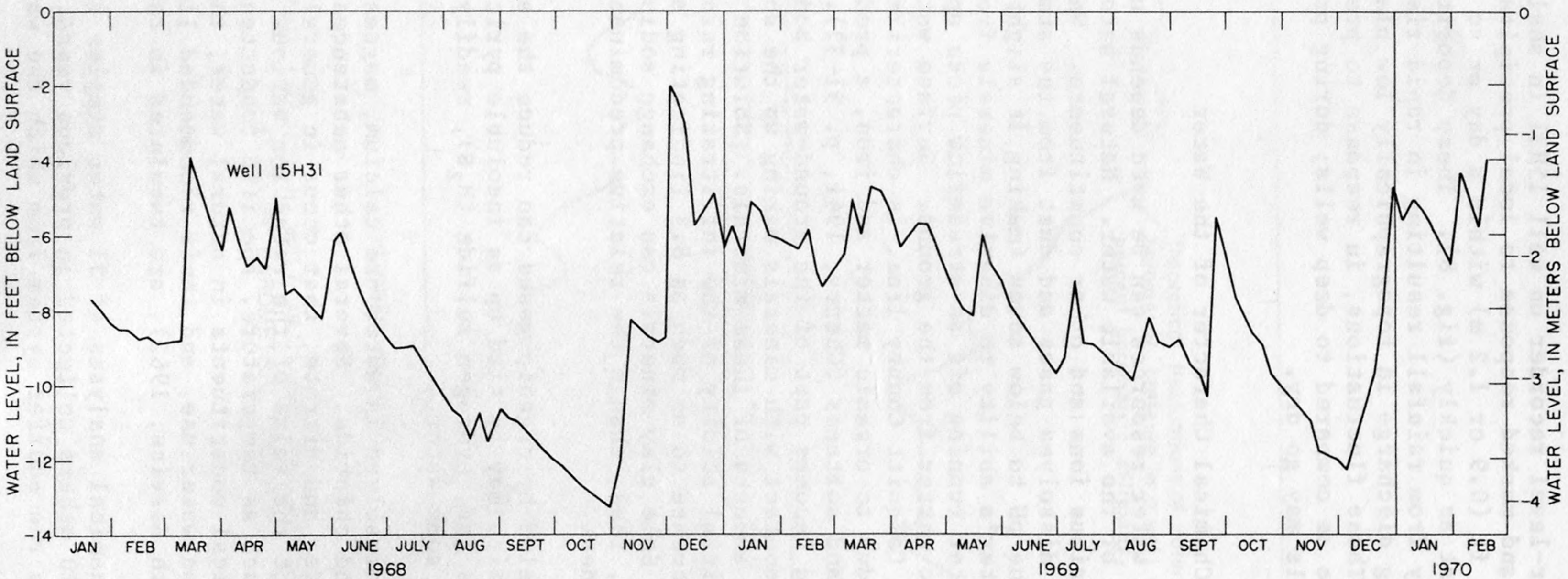

FIGURE 8.—WATER LEVEL CHANGES IN WELL 15H31 TAPPING ALUM BLUFF DEPOSITS.

Table 5. – Major chemical constituents in water – their sources, concentrations and effects upon usability (Concentrations are in milligrams per liter - mg/l).

Constituents	Major Sources	Effect on usability of water	Drinking water should contain less than concentration shown if more suitable supplies are or can be made available.
Silica	Sand, clay minerals, chert	In presence of calcium and magnesium, silica forms a scale in boilers that retards heat and fluid flow.	
Iron	Iron pyrite, glauconite, well casing, pipes, pump parts.	More than 0.1 mg/l precipitates after exposure to air; causes turbidity, stains plumbing fixtures, laundry and cooking utensils, and imparts objectionable tastes and colors to foods and drinks.	0.3 mg/l
Calcium Ca^{++}	Limestone, gypsum, dolomite, some clay minerals.	Calcium and magnesium combine with bicarbonate, carbonate, sulfate, and silica to form heat retarding, pipe clogging scale in boilers and other heat-exchange equipment. Calcium and magnesium combine with fatty acids in soap to form soap curds; the more calcium and magnesium, the more soap required to form suds. A high concentration of magnesium has a laxative effect.	
Magnesium Mg^{++}	Dolomite, magnesite, sea water.		
Sodium Na^{+}	Evaporites, sea water, some feldspars and clays	More than 50 mg/l sodium and potassium in the presence of suspended matter causes foaming, which aggravates scale formation and corrosion in boilers. Sodium in high concentrations may be harmful to people with cardiovascular ailments.	
Potassium K^{+}			
Bicarbonate HCO_3^-	Limestone, dolomite	When heated, bicarbonate changes to steam, carbon dioxide, and carbonate. The carbonate combines with calcium and magnesium to form a scale that retards heat flow and restricts the flow of fluid through pipes.	
Sulfate SO_4^{--}	Oxidation of sulfides, gypsum, anhydrite, industrial waste	Combines with calcium to form an adherent, heat-retarding scale. Imparts an unpleasant taste to water, and in high concentrations may be cathartic.	250 mg/l
Chloride Cl^-	Connate sea water, evaporites, waste	Imparts a salty taste, enhances corrosiveness.	250 mg/l
Fluoride Fl^-	Apatite, fluorite, mica, hornblende	Concentration between 0.6 and 0.8 (optimum 0.7) in drinking water benefits the structure and decay resistance of children's teeth. Fluoride in excess of 0.8 mg/l (in South Georgia climate) may cause mottled enamel in children's teeth.	0.8 mg/l where annual average of maximum daily air temperature is from 79.3°F. to 90.5°F. (80.1° at Moultrie).
Nitrate NO_3^-	Atmosphere, legumes, plant debris, animal excrement, nitrogenous fertilizer in soil and sewage.	More than 100 mg/l imparts a bitter taste and may cause physiological distress. Water containing more than 45 mg/l can cause cyanosis ("blue baby disease") in infants. Unusually high concentrations suggest pollution with possibly accompanying disease-producing organisms.	45 mg/l
Dissolved solids (abbreviated TDS for total dissolved solids)	The mineral constituents dissolved in water constitute the dissolved solids.	More than 500 mg/l is undesirable for drinking and many industrial uses. High ionic concentrations favor the flow of electric currents promoting galvanic corrosion.	500 mg/l

Properties of Water -- Their Description and Effects Upon Usability of Water

Property and unit of measurement	Description and causes	Effect on usability of water
Hardness (mg/l)	Caused principally by calcium and magnesium ions, but other alkaline earths, free acid, and heavy-metal ions contribute to hardness.	Water low in hardness (soft) may promote corrosion of metal surfaces. Hard water consumes excessive amounts of soap or other detergents when used for washing; it forms insoluble scum and curds in reaction with soaps. Hardness is classified as follows: Hardness range (mg/l) — Description 0-60 — soft 61-120 — moderately hard 121-180 — hard more than 180 — very hard
pH	Negative logarithm of the hydrogen ion concentration -- a measure of acidity. pH values range from 0 to 14. Water with a pH less than 7.0 is acid; that with a pH of more than 7.0 is basic.	Water with a pH of less than 6.0 or over 10 is corrosive. It can damage metal pipes, tanks, and so forth and add dissolved metal ions to the water.
Temperature (degrees Celsius)	Surface water temperature approximates mean monthly air temperatures; shallow ground water temperature approximates mean annual air temperature but increases about 1 degree with each additional 200 feet of depth.	Warm drinking water is objectionable. Cool water is obviously preferable to warm for cooling purposes but warm water is better for some industrial processes.

Table 6. - Chemical analyses of ground water, Colquitt County, Ga. (concentrations are in milligrams per liter)

OWNER	Well Number	Date of Collection	Depth of Well (feet)	Temperature (°C)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved Solids	Hardness: Calcium, Magnesium	Hardness: Non-Carbonate	Specific Conductance (micromhos at 25°C)	Laboratory pH	Strontium (Sr)
										PRINCIPAL ARTESIAN AQUIFER											
W.H. Summerlain	14H7	5/12/65	740	23	39	0.17	22	9.2	10	2.8	136	0.4	5.2	0.3	0.0	156	93	0	222	7.4	0.2
Eugene Gay	14H13	4/19/67	426	22	42	.08	21	13	5.6	2.4	138	.8	3.0	.3	.0	150	106	0	225	8.0	.21
R.L. Millings	14H8	4/30/69	403	22	41	—	24	9.3	8.2	2.0	124	3.6	3.0	.4	.0	159	99	0	200	7.6	.23
J.A. Faison	14H15	4/30/69	810	22	18	—	18	6.5	21	2.2	131	6.4	9.5	.3	.0	150	72	0	205	7.7	.16
D.E. Smith	14J1	4/28/69	350	22	45	—	23	14	5.2	1.9	151	1.6	3.0	.4	.0	171	116	0	230	7.7	.40
Town of Doerun	14J2	5/12/65	555	21	38	.03	30	15	6.0	1.8	172	2.4	4.2	.4	.0	183	138	0	271	7.7	—
Ed Lewis	15G4	5/11/65	494	—	18	.22	66	30	24	3.7	150	194	13	.6	.0	423	288	165	621	7.6	—
Leslie Smith	15G10	4/30/69	431	23	22	—	61	29	25	3.0	154	180	16	.6	.0	441	222	147	610	7.5	1.0
H. Tomlinson	15H2	4/21/64	475	23	23	.02	50	25	23	4.2	140	139	12	.7	.1	369	228	114	525	8.3	—
W.M. Brooks	15H4	5/12/65	930	—	34	.17	20	9.2	13	2.9	134	.4	5.0	.4	.0	151	88	0	221	7.4	—
City of Moultrie	15H12	2/4/38	815	23	23	.00	24	13	25	3.4	135	47	5.9	.5	.0	200	113	—	—	—	—
City of Moultrie	15H12	10/7/69	815	23	26	—	36	20	28	4.5	134	98	16	.4	.0	306	175	65	450	8.0	2.1
City of Moultrie	15H9	12/2/51	825	23	26	.05	24	13	—	—	134	48	6.6	.6	.0	210	113	—	333	7.7	—
City of Moultrie	15H7	12/2/51	752	21	24	.07	86	43	—	—	132	329	8.6	.9	.4	635	391	—	859	7.2	—
City of Moultrie	15H7	4/9/58	752	24	24	.10	102	47	38	5.7	140	405	12	1.2	.0	761	448	334	966	7.8	—
O.C. Causey	15H19	5/12/65	625	—	30	.09	18	6.1	22	4.3	136	1.6	4.5	.5	.0	154	70	0	222	7.4	—
N.D. Gunn	15H22	4/28/69	480	23	24	—	22	6.0	18	2.4	133	.8	9.0	.4	.0	152	80	0	210	7.7	.25
Lawrence Funderburke	15H33	4/30/69	780	23	21	—	13	7.8	26	3.6	140	4.8	6.5	.6	.0	160	66	0	210	7.4	.82
James Kirk II	15H38	4/28/69	840	22	12	—	7.4	3.6	40	2.0	133	1.2	2.5	.5	.0	144	43	0	200	7.5	.12
D.C. Smith	15J3	4/29/69	380	22	37	—	22	13	7.6	2.0	149	3.2	2.5	.4	.0	166	109	0	220	7.6	.36
J.B. Price	15J12	4/28/69	528	22	16	—	17	8.2	19	2.3	140	.0	10	.3	.0	134	77	0	235	7.5	.25
Cecil Lawrence	16G1	4/30/69	307	23	33	—	43	17	4.5	1.0	142	59	4.0	.5	.0	237	178	62	325	7.1	.22
David Bell	16G7	5/11/65	—	22	38	.06	43	13	4.6	1.0	144	46	4.0	.4	.0	221	162	44	322	7.7	—
City of Berlin	16G17	5/11/65	400	22	37	.06	33	8.1	3.5	1.1	133	8.0	2.5	.3	.1	160	116	7	231	7.5	—
Graham Cole	16G22	4/29/69	320	23	40	—	38	15	5.0	1.0	170	34	5.0	.5	.0	223	157	18	290	7.8	.23
City of Moultrie (Spence Field)	16H5	9/2/41	748	—	27	.01	65	35	—	—	152	176	14	.2	.2	405	310	185	—	8.0	—
Bridgeport Brass Co.	16H14	5/25/65	579	24	23	.07	32	17	21	3.1	140	62	10	.6	.0	238	148	34	367	8.1	—
Tyson and Dean	16H18	4/29/69	400	23	32	—	30	15	18	2.0	146	38	18	.6	.0	232	138	18	310	7.7	.70
S.Georgia Water Co.	16H22	10/8/69	700	24	24	—	12	6.9	26	3.4	132	.0	6.0	.2	.0	151	59	0	220	7.7	.40
Mt. Olive Church	16H32	4/29/69	500	22	33	—	14	5.2	27	2.2	124	.0	12	.5	1.5	159	57	0	190	7.4	.24
City of Moultrie (Spence Field)	16H40	9/14/51	760	20	32	.37	59	26	—	—	146	134	7.5	.5	.1	358	254	—	522	7.6	—
City of Norman Park	16J2	6/12/65	817	25	32	.08	19	9.8	16	3.0	138	8.8	4.2	.5	.0	—	88	—	233	8.1	—
J.R. Vaughn	16J9	4/28/69	630	22	3.2	—	7.3	3.6	33	1.6	123	.0	3.5	1.1	.4	136	33	0	189	8.1	.21
Thomas Williams	16J19	4/28/69	684	22	9.9	—	7.6	3.9	30	2.0	117	.8	6.0	.5	.0	121	36	0	181	7.6	.26
Edgar Walden	16G1	5/11/65	318	22	32	.07	38	12	3.1	0.4	158	14	2.0	.3	.0	180	144	14	267	8.0	—
K.G. Cardin	17G14	10/7/69	310	21	37	—	30	11	3.1	1.0	136	4.8	4.0	.0	.0	162	120	9	230	8.1	.05
K.G. Cardin	17G15	10/7/69	315	21	34	—	33	10	.3	0.7	136	11	4.0	.0	.1	168	124	12	240	8.1	.10
Mrs. Roy Baker	17H14	5/25/65	298	23	34	.03	53	15	5.4	.8	150	75	6.0	.4	.0	—	192	69	372	8.0	—
N.C. Brannon	17H22	4/29/69	350	23	30	—	30	16	11	1.7	148	34	10	.5	.0	261	142	20	275	7.8	.44
Glen Powell	17J15	4/29/69	1,008	26	17	—	25	12	13	1.7	171	3.2	2.5	.3	.0	165	113	0	240	8.0	.52
Median					27	.07	25	13	16	2.0	140	11	6.0	.5	.0	168	116	0	235	7.7	0.25
										MIOCENE UNDIFFERENTIATED											
M.J. Hart	14G10	5/11/65	400	23	47	0.21	26	16	19	3.4	154	32	10	0.5	0.0	230	132	6	318	7.6	—
Troy Lindley	14G16	4/30/69	385	22	53	—	27	16	5.9	1.8	180	4.8	4.0	.5	.0	208	134	0	250	7.2	.16
Moultrie Mfg. Co.	16H44	10/3/69	37	22	7.3	—	1.6	1.5	4.4	1	0	.0	5.0	.0	17	42	10	10	56	4.7	.03
Carl Hamm	16H45	10/7/69	200	21.5	43	—	6.6	3.4	10	1.8	54	.0	7.0	.0	.1	102	31	0	110	7.4	.09
Southern Turf Farm	16J15	10/3/69	104	20	41	—	18	3.5	11	1.6	88	.0	5.5	.2	.0	151	60	0	156	7.8	.09
Sam Wood	16J23	10/7/69	160	—	44	—	8.7	3.8	12	1.6	70	.0	4.0	.0	.2	118	37	0	125	7.8	.11
Ken Roberts	17H29	10/7/69	150	—	37	—	4.1	2.9	5.1	1.6	34	.0	3.0	.1	.0	71	22	0	72	7.2	.04
Alton Stone	17J9	4/29/69	422	23	9.9	—	6.5	3.4	40	1.7	137	5.6	4.0	.8	.0	142	30	0	210	7.8	.18
J.E. Bush	17J10	10/2/69	170	—	58	—	11	6.0	7.2	1.5	76	.0	3.0	.2	.4	129	52	0	135	8.0	.08
Median					43		8.7	3.5	10	1.6	76	.0	4.0	.2	.0	129	37	0	135	7.6	.09
										FLOOD PLAIN DEPOSITS											
William Paramore	16J22	10/8/69	30	22	12	—	1.1	0.6	2.5	0.6	4	0.0	4.5	0.0	0.0	23	5	2	27	6.5	—
A.D. Conger	17H28	10/7/69	30	19	36	—	5.2	3.1	4.0	.0	32	.0	6.0	.1	.1	72	26	0	73	7.3	—

Temperatures reported for samples taken directly from well. Values underlined exceed U.S. Public Health Service Standards. Analyses by U.S. Geological Survey.

The water from the principal artesian aquifer is of three chemical types: (1) most of the wells sampled yield moderately hard to hard water containing chiefly calcium bicarbonate; (2) wells along the trend of the Ochlockonee fault as far north as Moultrie yield very hard water containing chiefly calcium sulfate; and (3) wells in a band along the deeper parts of the Suwannee strait yield soft water in which sodium and bicarbonate ions predominate. The distribution of the wells sampled in the principal artesian aquifer, the chemical type of water, the hardness, and the dissolved-solids content, are shown in figure 9.

The type of water shown in figure 9 is illustrated by means of Stiff diagrams (Stiff, 1951, p. 15-17). These diagrams are based on the percentage of the reacting values (equivalents) of the various ions.

Concentrations of sulfate differ within the widest range of any of the individual constituents in water from the principal artesian aquifer. Water having a high sulfate content and consequently, high dissolved-solids content, occurs in a localized northeastward band along the trend of the hypothetical Ochlockonee fault. Three hypotheses may explain this anomaly:

1. The fault may exist and act as a conduit for inferior water to rise from below in response to pumping.

2. A rock facies incorporating sulfate minerals may underlie the trend.

3. The depth of the wells within the trend may happen to coincide with a zone of relatively high-sulfate water.

The hardness of the water from the principal artesian aquifer also differs greatly. The hardest water is found in wells along the hypothetical Ochlockonee fault where the sulfate and total dissolved-solids concentrations are also high. Anomalously soft water occurs along the trend of the Suwannee strait. The trend of soft or moderately hard water along the strait continues to the southwest; the city of Meigs, in Thomas County, has a well that produces water with a hardness of 68 mg/l (Sever, 1966a, p. 11). If softness characterizes water from the principal artesian aquifer northeastward along the projected course of the Suwannee strait, this may provide a means of tracing the strait.

Natural softening by ionic exchange of sodium for calcium may explain the hardness anomalies. Certain minerals, including several clays and zeolites, have the ability to adsorb sodium or calcium ions on their crystal structure and to exchange the adsorbed ions for other ions in ground water. If adsorbed sodium ions are exchanged for calcium ions in the water, the water is softened. As may be noted on the Stiff diagrams in figure 9, the soft water occurs where sodium ions predominate over calcium and magnesium. This phenomena is discussed more fully in Hem (1970, p. 137). Clays associated with the marl deposits noted in the principal artesian aquifer (especially in the Marianna Limestone equivalent) probably account for softening observed in Colquitt County.

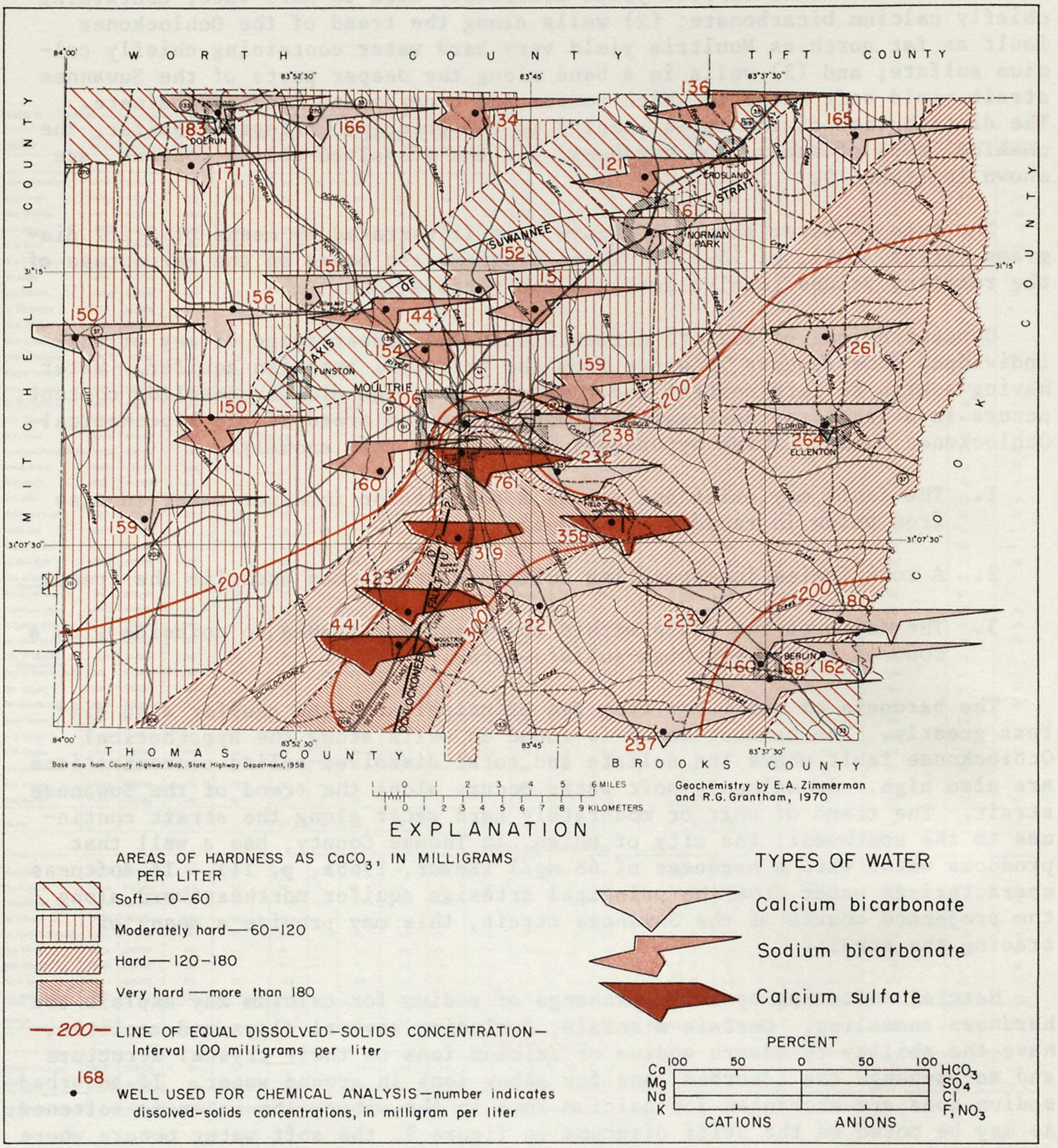

FIGURE 9.—QUALITY OF WATER FROM THE PRINCIPAL ARTESIAN AQUIFER.

Miocene and Holocene aquifers yield water that differs widely in character, as shown in table 6. Figure 10 shows the distribution of samples and Stiff diagrams illustrating the character of the water from these aquifers. Five different types of water are shown. The deeper wells (more than 100 ft, or 30 m) generally yield water containing chiefly calcium or sodium bicarbonate, though well 17H29 (150 ft, or 45 m) deep produces water in which magnesium bicarbonate predominates. Samples taken from two bored wells less than 40 ft (12 m) deep showed that one produces water containing very dilute sodium nitrate. The presence of nitrate in this water may indicate contamination from the surface or from septic-tank effluent.

With respect to major inorganic constituents, the water analyzed is suitable for most purposes. Few samples contain any constituents in excess of U.S. Public Health Service recommendations for drinking water (table 5); those that do are underlined in table 6. Three water samples from the wells at Spence Field contained excessive iron (by Public Health Standards) and water from Moultrie city well 15H7, used as a standby emergency supply, contained excessive sulfate, fluoride, and dissolved solids. When sampled in 1948, water from the Moultrie well also contained excessive iron.

Several wells were sampled more than once and the analyses differ. Some of these differences may be the result of the analyses having been done by different laboratories, but they also may reflect actual changes in quality with time. Such changes can result from varied stress on the aquifer that causes varying amounts of leakage of inferior water from underlying beds or a greater proportionate production from beds yielding poor water. Such leakage would be likely near a vertical conduit, such as the hypothesized Ochlockonee fault.

The suitability of water for irrigation is determined by a complex set of factors including type of crop, nature of the soil, proportion of water applied to that used by the crop, and mineral content of the water. The fact that Colquitt County has a humid climate means that irrigation water applied would ordinarily be only a fraction of the total soil moisture and that these factors are of lesser importance here than in an arid climate. Nevertheless, even by standards for an arid climate, ground water in Colquitt County is fair to excellent for use in irrigation. Water from only one well (15H7) has a great enough specific conductance to present a high salinity hazard and even this water can probably be used for supplementary irrigation in this humid climate where leaching by rainfall protects against the accumulation of salt.

CONCLUSIONS

Colquitt County is predominantly agriculatural, but has some light industry. Anticipated growth in industrial activity and an increase in irrigation will impose some additional strains on the water supply. Streams in the county generally are small and undependable as sources of water, so wells are the principal source of water for domestic, municipal, and industrial uses in the county. They are increasingly being used to supplement impounded runoff for irrigation.

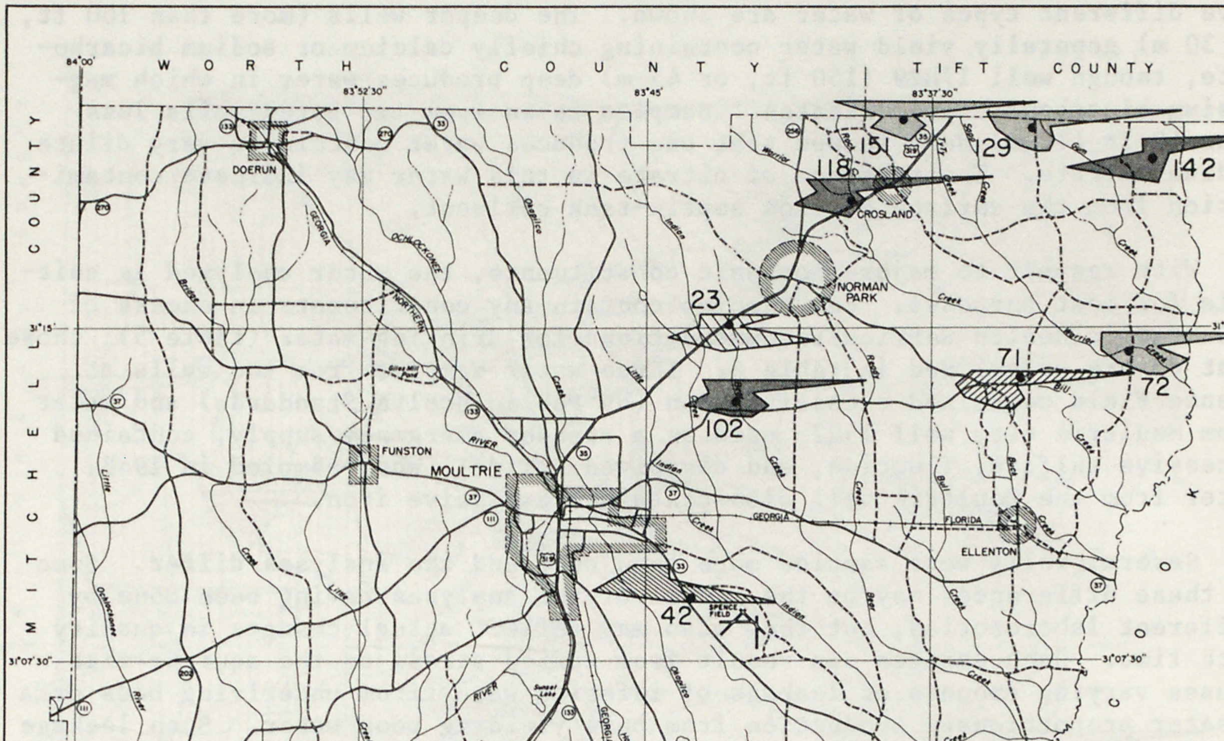

FIGURE 10.—QUALITY OF WATER FROM MIOCENE AND HOLOCENE AQUIFER.

Fortunately, Colquitt County is supplied with abundant ground water of generally good quality. The most productive sources are limestone beds of Eocene, Oligocene, and Miocene age that make up what is called the principal artesian aquifer. These beds can yield in excess of 1,000 gal/min (5,450 m^3/d) of water to wells. The ability to transmit water to wells is modified by a structural, or a paleogeographic feature called the Suwannee strait, which extends from near the southwest corner through the northeast part of Colquitt County. In this strait limestone beds seem to be partly replaced by marl, which greatly impairs their transmissivity. Aquifer tests suggest that the transmissivity of the principal artesian aquifer is as much as 10 times as great southeast of the strait as it is to the northwest. A shallow depression in the potentiometric surface of the principal artesian aquifer near the center of heaviest pumping at Moultrie seems to parallel the hypothesized northeast-trending Ochlockonee fault, and may reflect enhanced anisotropic transmissivity.

Beds of sand, clay, and sandy limestone of Miocene age, overlying the principal artesian aquifer, yield water to many so-called "shallow" or "semi-deep" wells. These wells, which usually produce less than 20 gal/min (109 m^3/d), are used for domestic and stock supplies. The Miocene age beds are less transmissive and, thus, yield less water than the underlying principal artesian aquifer. As they contain unconsolidated sand, they tend to cave. Thus, wells in these beds are more troublesome to construct, and consequently are less popular with drillers than are wells in the principal artesian aquifer.

Ground water in Colquitt County is generally of good quality. Few of the samples analyzed contain any constituent in excess of the limits recommended by the U.S. Public Health Service for drinking water. Much of the water is hard to very hard, but that along the trend of the Suwannee strait is soft to moderately hard--probably softened by ion exchange with clay and marl beds. The water is of several chemical types, and water that contains a greater than usual concentration of dissolved solids generally is enriched in sulfate. Only one well yielded water having a dissolved-solids concentration in excess of limits recommended by the U.S. Public Health Service.

SELECTED REFERENCES

Applin, P. L., and Applin, E. R., 1944, Regional subsurface stratigraphy and structure of Florida and southern Georgia: Am. Assoc. Petroleum Geologists, Bull., v. 28, p. 1673-1753.

Applin, E. R., and Applin, P. L., 1964, Logs of selected wells in the Coastal Plain of Georgia: Georgia Geol. Survey Bull. 74, 229 p.

Chen, C. S., 1965, The regional lithostratigraphic analysis of Paleocene and Eocene rocks of Florida: Florida Geol. Survey Bull. 45, 105 p.

Cherry, R. N., 1961, Chemical quality of water of Georgia streams, 1957-58: Georgia Geol. Survey Bull. 69, 100 p.

Dall, W. H., and Harris, G. D., 1892, Correlation papers - Neocene: U.S. Geol. Survey Bull. 84, 349 p.

Hem, J. D., 1970, Study and interpretation of the chemical characteristics of natural water: U.S. Geol. Survey Water-Supply Paper 1473 (2nd Edition), 363 p.

Herrick, S. M., 1961, Well logs of the Coastal Plain of Georgia: Georgia Geol. Survey Bull. 70, 462 p.

Herrick, S. M., and Vorhis, R. C., 1963, Subsurface geology of the Georgia Coastal Plain: Georgia Geol. Survey Inf. Circ. 25, 67 p., 28 fig.

Jordan, Louise, 1954, Oil possibilities in Florida: Oil and Gas Jour., v. 53, no. 28, p. 370-375.

Owen, Vaux, Jr., 1963, Geology and ground-water resources of Mitchell County, southwest Georgia: Georgia Geol. Survey Inf. Circ. 24, 40 p.

Patterson, S. H., and Herrick, S. M., 1971, Chattahoochee anticline, Appalachicola embayment, Gulf trough, and related structural features, southwestern Georgia-- fact or fiction: Georgia Geol. Survey Inf. Circ. 41, 16 p.

Puri, H. S., and Vernon, R. O., 1959, Summary of the geology of Florida and a guidebook to the classic exposures: Florida Geol. Survey Spec. Pub. 5, 255 p.

Sever, C. W., 1964, Relation of economic deposits of attapulgite and fuller's earth to geologic structue in southwestern Georgia: U.S. Geol. Survey Prof. Paper 501-B, p. B116-B118.

______1966a, Reconnaissance of the ground water and geology of Thomas County, Georgia: Georgia Geol. Survey Inf. Circ. 34, 14 p.

______1966b, Miocene structural movement in Thomas County, Georgia: U.S. Geol. Survey Prof. Paper 550-C, p. C12-C16.

Sever, C. W., 1969, Hydraulics of aquifers at Alapaha, Coolidge, Fitzgerald, Montezuma, and Thomasville, Georgia: Georgia Geol. Survey Inf. Circ. 36, 16 p.

_____1972, Ground-water resources and geology of Cook County, Georgia: U.S. Geol. Survey open-file report.

Sever, C. W., and Herrick, S. M., 1967, Tertiary stratigraphy and geohydrology in southwestern Georgia: U.S. Geol. Survey Prof. Paper 575-B, p. B50-B53.

Stiff, H. A., Jr., 1951, The interpretation of chemical water analyses by means of patterns: Jour. Petroleum Technology, v. 3, no. 10, p. 15-17.

Stringfield, V. T., 1966, Artesian water in Tertiary limestone in the southeastern States: U.S. Geol. Survey Prof. Paper 517, 226 p.

U.S. Public Health Service, 1962, Drinking water standards: Public Health Service Pub. No. 956.

Wait, R. L., 1960, Source and quality of ground water in southwestern Georgia: Georgia Geol. Survey Inf. Circ. 18, 74 p.

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