IC 27

GEORGIA

STATE DIVISION OF CONSERVATION

DEPARTMENT OF MINES, MINING AND GEOLOGY
GARLAND PEYTON, Director

THE GEOLOGICAL SURVEY
Information Circular 27

GEOLOGY AND GROUND-WATER RESOURCES OF THE PALEOZOIC ROCK AREA, CHATTOOGA COUNTY, GEORGIA

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U. S. Geological Survey

Prepared in cooperation with the U.S. Geological Survey

ATLANTA
1964

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GEOLOGY AND GROUND-WATER RESOURCES OF THE PALEOZOIC ROCK AREA, CHATTOOGA COUNTY, GEORGIA

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ABSTRACT

Chattooga County, in northwestern Georgia, is underlain by rocks ranging in age from Middle Cambrian to Pennsylvanian. All the geologic formations except the Chattanooga Shale and the Sequatchie Formation yield adequate water to wells for domestic and farm use. Most wells are less than 200 feet deep, though a few are deeper than 300 feet.

Drilled wells yield as much as 435 gpm. The largest yields are from the Conasauga Formation, the Knox Group and limestone of Mississippian age.

Well water sampled in the county ranged in hardness from 6 to 470 ppm (parts per million), and had an iron content ranging from 0.2 to 2.9 ppm.

Springs in the county discharge more than 45 mgd (million gallons per day). The springs range in size from about 0.1 to 13 mgd. The six largest springs, which are in the Knox Group, discharged as much as 35 mgd during 1961. Most of the water is unused and is a good source of industrial supply.

Water sampled from springs in the Knox Group had a hardness ranging from 96 to 107 ppm, and an iron content ranging from 0.03 to 0.11 ppm.

INTRODUCTION

Chattooga County includes an area of 317 square miles in northwestern Georgia (fig. 1). The 1960 census gives the population as 19,954. The county is bounded on the north, east, and south by Walker and Floyd Counties, Ga., and on the west by De-Kalb and Cherokee Counties, Ala. Summerville, the county seat, is on U.S. Highway 27 about 35 miles south of Chattanooga, Tenn.

Chattooga County has a mild climate with an average January temperature of 42°F and an average July temperature of 78°F. The frost-free season is about 192 days. The average annual precipitation is about 55 inches and includes a small amount of snow. Precipitation in the county is heaviest in the winter and midsummer and lightest in autumn.

The county is in the drainage basin of the Coosa River. The western part of the county is drained by the Chattooga River; the eastern part is drained by Armuchee Creek.

The principal industries of Chattooga County are textile manufacturing and lumbering.

Agriculture is mainly part-time and residential farming. A major part of the agricultural income is derived from dairying and milk processing and poultry and poultry products. The soils of the county are derived from sandstone, siltstone, claystone, and limestone. Valley bottoms are used for growing cotton, corn, small grains, and pastures. The lower ridges are used for growing truck, hog, and pasture crops, and the rougher terrane is used for growing timber.

U.S. Highway 27 links Trion and Summerville with Chattanooga, Tenn. and with Rome, Ga. Paved roads connect all towns in the county and give them direct access to U.S. Highway 27. The paved roads are interconnected by a network of all-weather roads. The Central of Georgia Railroad and the Tennessee, Alabama, and Georgia Railroad serve the county.

Physiography

Chattooga County is partly in the Valley and Ridge physiographic province and partly in the Cumberland Plateau section of the Appalachian Plateau province.

The Valley and Ridge province is part of the Appalachian Valley (Butts, 1948, p. 3), which is a comparatively narrow belt of low-lying country extending from Canada to northern Alabama. The terrane consists of parallel valleys, separated by steep or by well-rounded ridges. Lowland areas are about 650 to 800 feet above sea level. The highest ridges reach an altitude of 1,600 feet.

The Cumberland Plateau is a large tableland of relatively flat-lying rocks extending to the eastern edge of Lookout Mountain. Lookout Mountain has a terrane of rolling hills and shallow valleys except where downcutting streams have left canyons. The mountain rises about 1,200 feet above adjacent valleys.

Purpose and Scope

This investigation was made by the U.S. Geological Survey in cooperation with the Georgia Department of Mines, Mining, and Geology to evaluate the ground-water resources of Chattooga County. The investigation is part of a statewide reconnaissance program to appraise Georgia's ground-water resources, the amount of ground water being used, and the quantity, quality, and availability of ground water in each county. This study is of one county of ten in the Paleozoic rock area of Georgia. Field work was done from January to October 1961.

The investigation included an inventory of more than 350 wells to obtain information about the range in depth of wells in the county and to determine the quantity and quality of the ground water. Twenty springs were inventoried to determine their reliability, fluctuation, and water quality. Ten of these springs were measured with a current meter to determine their rate of dis-

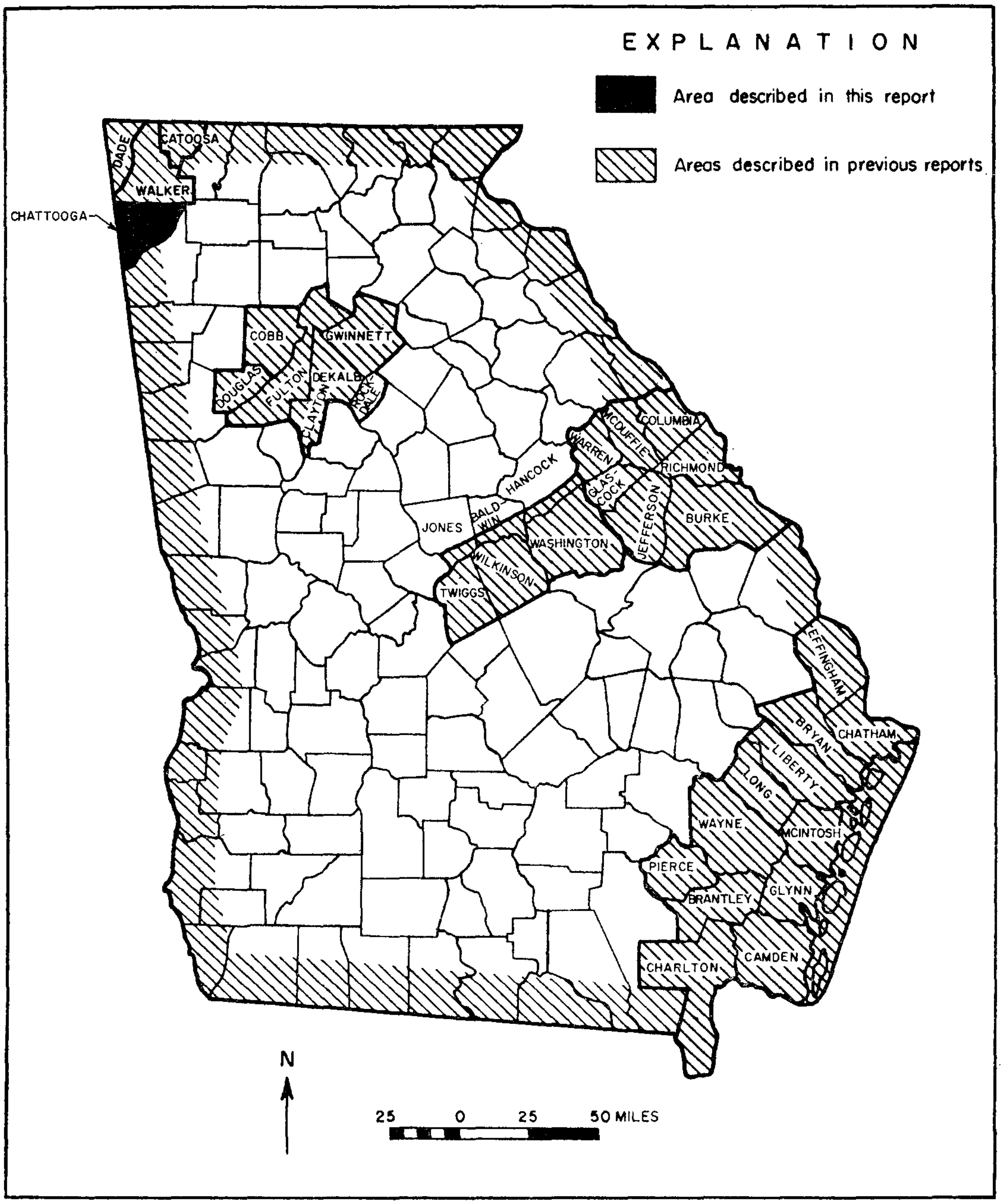

Figure 1.—Map of Georgia showing Chattooga County and areas described in previous reports.

charge and six of the largest were measured in the spring and fall to determine the amount of seasonal variation in discharge.

Water samples from 14 wells and 7 springs were analyzed by the U.S. Geological Survey. Additional analysis data were obtained from the Georgia Department of Mines, Mining, and Geology.

The geology of the county was mapped in sufficient detail to determine the limits of the aquifers.

Acknowledgments

The writer expresses his sincere appreciation to the well and spring owners of Chattooga County for their cooperation in supplying data on their water supplies.

Mr. Harry E. Blanchard, Hydraulic Engineering Technician, did most of the well inventory.

The report was prepared under the supervision of H. B. Counts, district engineer, Ground Water Branch, U.S. Geological Survey; the State Cooperator was Garland Peyton, Director of the Georgia Department of Mines, Mining, and Geology.

Previous Investigations

Among the earliest geologic investigations in the area were those made in 1891 by C. W. Hayes of the U.S. Geological Survey. Hayes (1894) mapped the geology and described the formations in some detail. Butts (1948) made the most comprehensive study of the region. Several other reports dealing with the geology of the county have been published as Georgia Geological Survey Bulletins and are listed in Butts (1948).

GEOLOGY AND GROUND WATER

Geologic History

The rocks exposed in Chattooga County (table 1) originated as sediments on the floor of a shallow inland sea. The oldest sediments were washed from nearby land areas about 450 million years ago and gradually were compacted into rock. Material that formed the youngest rocks in the county was deposited about 225 million years ago, mostly in fresh water or in shallow lagoons. Changing conditions of deposition are indicated by the animal and plant remains preserved in the rocks. Shells of salt-water animals constitute the bulk of fossils in the older rocks, whereas plant remains are abundant in the younger rocks.

After many thousands of feet of rock was deposited on the sea floor, the area was uplifted, and the sea retreated. About the same time, forces from within the earth began to compress the area from the southeast. The pressure was so great that it bent the rocks into folds and broke them in many places.

After being uplifted the rocks were eroded to sea level. Similar cycles of uplift and erosion were repeated several times. The present-day topography of Chattooga County represents an incomplete cycle of erosion following uplift, but much remains to be eroded to reduce the area to sea level. Lookout and Pigeon Mountains remain high in comparison with the surrounding country because they are capped by resistant sandstone. Other rocks in the county are less resistant and have been worn away more readily.

Structural Setting

The geologic formations of Chattooga County have been deformed into a series of anticlines and synclines, some of which are broken by faults (fig. 2).

A large wave-like fold, the top of which has been eroded, brought the rocks on the eastern side of the county up over the valley at Summerville, down beneath the valley at Berryton, up again over the valley east of Menlo, and back down beneath Lookout Mountain. Thrust faults displaced the rocks in the folds at Menlo and west of Summerville and on the eastern side of the county.

Most rocks in the county have shallow dips, 5° to 25°, but some dip more steeply than 40°. Local folding is not great except in the Conasauga Formation and the Chattanooga Shale.

Hydrologic Cycle

The earth's moisture is involved in a continuous circulation from the oceans to the land and back to the oceans. Water from the ocean evaporates into the atmosphere and is carried by trade winds to land areas where it condenses and falls to earth as precipitation.

Precipitation feeds lakes and rivers and fills underground reservoirs. Rivers carry some of the water back to the oceans. Evaporation from the rivers, land, and the oceans puts water back into the atmosphere, where it again falls to earth as precipitation. The exchange goes on continuously; water travels endlessly from earth to atmosphere and back to earth in what is called the hydrologic cycle.

Source and Occurrence of Ground Water

Ground water of Chattooga County is derived from precipitation. Precipitation either runs off the surface to a stream, evaporates back to the atmosphere, or soaks into the ground. Of water that soaks into the ground, some remains near the surface, clinging to soil particles, or is used by plants, and some passes downward into the zone of saturation. The zone of saturation is that part of the earth in which all pore space and other openings are filled with water under pressure equal to or greater than atmospheric; this water is called ground water.

The quantity of ground water stored in the zone of saturation depends on the amount of open space in the rocks. Openings in the rocks of Chattooga County consist mainly of joints and fractures. Joints in shale and sandstone are nearly closed and have small storage capacity. Joints in limestone, on the other hand, commonly are enlarged by solution and have large storage capacity. For

Table 1. Geologic formations and their water-bearing properties, Chattooga County, Ga.

System	*Formation or Group*	*Thickness (feet)*	*Lithology*	*Water-bearing characteristics*
Pennsylvanian	Pennsylvanian rocks, undifferentiated	500±	Shale and massive-bedded conglomeratic sandstone at base; coarse-grained sandstone and sandstone interbedded with shale; coal beds.	Most wells less than 150 feet deep; yields ample for domestic and farm needs; greatest measured yield 50 gpm; hardness of water from 3 wells ranged from 22 to 114 ppm, iron content ranged from 0.07 to 1.9 ppm; about half of wells have water with iron taste; nearly all well water lathers easily with soap.
Mississippian	Eastern facies Floyd Shale	1,200±	Shale; includes thick units of limestone, sandstone, siltstone; limestone units similar in character to limestone in western facies.	Most wells less than 100 feet deep; yields ample for farms, homes, dairies, and broiler houses; largest yields from wells in limestone; water from 3 wells had hardness ranging from 110 to 266 ppm and iron content from 0.02 to 2.9 ppm; about 10 percent of wells have bothersome quantities of iron in their water; about 3 percent of wells have hydrogen sulfide; small springs used locally.
	Western facies	1,000±	800 feet of limestone overlain by 200 feet of shale; limestone, thick- to massive-bedded, contains numerous solution openings.	Wells about 100 feet deep; yield large volumes of water—more than enough for farm, home, and broiler-raising needs. Water from one well had hardness of 92 ppm and an iron content of 0.08 ppm; iron and hydrogen sulfide no problem in aquifer. A few springs of moderate size discharge up to 2 mgd; water from one spring had a hardness of 46 ppm and an iron content of 0.29 ppm.
	Fort Payne Chert	150	Chert, evenly bedded in layers up to one foot thick; irregularly furrowed along bedding.	Nearly undeveloped as an aquifer; dug wells in residuum yield adequate amount of soft water for home supply; water from one well had a hardness of 6 ppm and an iron content of 0.12 ppm.
Mississippian and Devonian	Chattanooga Shale	10±	Shale, black, highly cleaved.	Not an aquifer; contains hydrogen sulfide, should be cased from wells penetrating it.
Silurian	Red Mountain Formation	1,000±	Sandstone and shale; shale dominant on west side of county; sandstone dominant on east side.	Nearly undeveloped as aquifer; 6 wells penetrate formation on westernmost outcrop; yield ample water for home needs.
Ordovician	Sequatchie Formation	250	Sandstone, calcareous shale.	Not an aquifer; forms steep slopes.
	Chickamauga Limestone	1,500±	Limestone, thin- to thick-bedded, containing beds of calcareous siltstone and claystone; mainly calcareous siltstone in eastern outcrops.	Most wells 100 feet deep; wells are dependable and supply up to 20 gpm or more; wells in all areas of formation yield ample water for domestic and farm needs; water from 2 wells had a hardness of 36 and 226 ppm, and an iron content of 0.05 and 0.16 ppm; springs are rare and unimportant.

Table 1. Geologic formations and their water-bearing properties, Chattooga County, Ga.—(Cont'd)

System	*Formation or Group*	*Thickness (feet)*	*Lithology*	*Water-bearing characteristics*
Ordovician	Knox Group	3,500±	Dolomite and some limestone, thick- to massive-bedded.	Very productive aquifer; wells between 100 and 200 feet deep yield 5 to 10 gpm and more; wells are dependable; water from one well had a hardness of 126 ppm and an iron content of 0.04 ppm. Springs discharge up to 35 mgd; during 1961, water from 5 springs had a hardness ranging from 96 to 107 ppm and an iron content ranging from 0.03 to 0.11 ppm.
Cambrian	Conasauga Formation	1,500-4,000	Siltstone, claystone, some limestone; thin- to massive-bedded.	Wells range in depth from 30 to 325 feet and yield from 5 to 435 gpm; largest yields from wells in limestone; water from two wells had a hardness of 128 and 201 ppm and an iron content of 0.02 ppm; dug wells are common and give large yields. Two springs discharge up to 6 mgd; water from one spring had a hardness of 132 ppm, and an iron content of 0.10 ppm.

this reason, limestone is the most important ground-water reservoir in Chattooga County.

The degree to which rock openings are interconnected affects the general productivity of an aquifer. Joints in limestone and dolomite are largely interconnected. A well in limestone can have a large yield even if it penetrates a joint of small size, because the joint is part of an interconnected system of large capacity from which the well can draw.

Chemical Quality of Ground Water

Ground water dissolves material from the soil and rocks with which it comes in contact. Water from limestone or dolomite may contain more calcium, magnesium, and bicarbonate but less silica than water from sandstone. Shale commonly yields water low in calcium and magnesium, but high in iron and hydrogen sulfide content. The kind and amount of material dissolved in water is important because it largely determines how the water can be used. The U.S. Public Health Service (1961) recommends that water for domestic and municipal supplies contain no more than 250 ppm (parts per million) chloride, 250 ppm sulfate, 0.3 ppm iron, 45 ppm nitrate, and 500 ppm total dissolved solids.

Hardness of water is caused almost entirely by calcium and magnesium, though other constituents, such as iron, aluminum, and free acid also cause hardness. Hard water is objectionable in the home because of its soap-consuming capacity. For satisfactory operation commercial laundries require water that is practically of zero hardness. The processing water for textile mills is required to be very soft. Water with a calcium, magnesium hardness of 0 to 60 ppm is considered soft; 61 to 120 ppm, moderately hard; 121 to 180 ppm, hard; and 181 and above, very hard.

Water for industrial use can have a wide range of chemical quality; almost every industrial application has different standards. Many industries require water with an iron content less than 0.2 ppm. Hardness as calcium, magnesium generally should be less than 100 ppm, though it may be as high as 250 ppm for carbonated beverages. Textiles and general dyeing require a dissolved solids content of 200 ppm or less (Moore, 1940, p. 271).

Utilization of Ground Water

Chattooga County uses an estimated 7.5 million gallons of ground water per day. The largest users are the cities of Trion, Summerville, and Lyerly. Trion pumps a maximum of 5.8 mgd (million gallons per day) from spring S-2, though the amount may be less, depending on the needs of local industry. Summerville uses about 0.5 mgd from spring S-3. Lyerly pumps about 20,000 gpd (gallons per day) from a well in the Conasauga Formation. Ground water is used by Menlo and by the Chattooga County Water District which distributes water locally.

Rural residents of the county use an estimated 1 mgd from wells and springs to supply their farms and homes.

GEOLOGIC FORMATIONS AND THEIR WATER-BEARING CHARACTER

Cambrian System

Conasauga Formation

The Conasauga Formation of Middle and Late Cambrian age underlies valleys southwest and east of Menlo; a narrow strip that passes through Berryton; the valley that includes Trion, Summerville, and Lyerly; and a small arm off that valley that extends through Holland.

The Conasauga consists mainly of calcareous siltstone and claystone that weathers to shale. Some limestone occurs throughout the Conasauga and limestone forms a unit about 300 feet thick near the top of the formation.

The limestone is mostly thick to massive bedded, light to dark gray and contains much silt and clay. Limestone near the top of the formation is distinctive because it contains numerous stylolites. Massive bedded gray limestone containing stylolites is exposed in large areas of the valley east of Menlo, in the valley south of Lyerly, and on U.S. Highway 27 northeast of Trion. Thick-bedded limestone is exposed on both roads between Trion and Harrisburg Church.

The siltstone and claystone of the formation are light gray to olive gray, weathering to brown. Unweathered siltstone is calcareous and has the appearance of limestone. Layers of siltstone range in thickness from a fraction of an inch where weathered to several inches where unweathered. Weathering leaches calcite from the rock, causing it to separate along minute joints and become fissile and highly cross-jointed.

The Conasauga Formation is a valuable aquifer. Wells in all areas of the formation yield adequate water for farm and home needs. Drilled wells in limestone yield as much as 435 gpm (gallons per minute) and supply the town of Lyerly and an area near Trion. Two springs in the Conasauga discharge as much as 6 mgd.

Drilled wells in the Conasauga range in depth from about 30 to 325 feet and yield from 5 to 435 gpm. Nearly three-quarters of the wells are less than 100 feet deep; about 10 percent are deeper than 200 feet. Most of the wells are equipped with pumps of 5 to 10 gpm capacity and can be pumped for several hours without failing. Deep wells, particularly those in limestone parts of the formation, generally have the largest yields. Well 280, which is 300 feet deep, yielded 225 gpm for 24 hours with a pumping head of 127 feet. Well 267 is 327 feet deep and yielded 435 gpm with a pumping head of 89 feet. Both wells appear to penetrate the limestone unit near the top of the formation.

Analysis data of water from wells 267 and 280, in the Conasauga, showed a hardness of 128 and 201 ppm, and an iron content of 0.02 ppm (table 2). Water containing hydrogen sulfide is rare in the formation.

Dug wells in the formation are common, partly because they are easy to dig and partly because they have large yields of relatively soft water. Most dug wells are between 20 and 40 feet deep and yield enough water for large families.

The water-bearing character of the Conasauga varies considerably because shale and siltstone dominate some areas and limestone dominates others. Generally, the largest yields are obtained from wells in the thick limestone near the top of the formation. Wells in siltstone usually have good yields, but drilling may be difficult if the siltstone layers are steeply dipping. Wells of lowest yield are in clay shale. Dry wells are rare in the Conasauga.

Two springs (S-1 and S-17) discharge about 6 mgd during their maximum flow periods, but decrease to about 2 mgd when precipitation is light (table 3). The springs are along water courses and appear to have resulted from solution channels in limestone being exposed at the surface by erosion.

Water from spring S-1 had a hardness of 132 ppm and an iron content of 0.10 ppm.

Cambrian and Ordovician Systems

Knox Group

In Chattooga County the Knox Group of Late Cambrian and Early Ordovician Age forms several low ridges between Lookout Mountain and Taylor Ridge, and one ridge near the eastern boundary of the county. The Knox underlies about half of the land area west of Taylor Ridge.

The Knox Group in Georgia includes the following formations listed in ascending order: Copper Ridge Dolomite, Chepultepec Dolomite, and Longview Limestone. The Knox Group could not be described in Chattooga County because of limited exposure, so the following description is given, though it may not be applicable to the county. The description is from 30 miles northeast along the strike where the Knox has a thickness of about 3,500 feet. The Copper Ridge Dolomite, which makes up the lower half of the Knox, is dominantly thick- to massive-bedded, brownish-gray to light-gray dolomite. The brownish-gray dolomite has an asphaltic content easily smelled on freshly broken surfaces. The Chepultepec Dolomite is mostly thick-bedded, light-gray to brownish-gray dolomite, though a little limestone is present throughout. The Longview Limestone is made up of thick-bedded, light-gray to light olive-gray dolomite and limestone. The lower part of the Longview is dominantly limestone; the upper and middle parts are limestone and interbedded dolomite.

The dolomite and limestone of the Knox Group are highly siliceous and upon weathering yield large quantities of chert and clay that overlie the formation to depths as great as 200 feet.

The Knox Group is the most important aquifer in Chattooga County. Wells in all areas of the Knox yield more than enough water for domestic and farm needs. Springs in the Knox discharge more than 35 mgd.

Drilled wells range in depth from about 50 to 400 feet. Nearly half of the wells are between 100 and 200 feet deep; about 10 percent are deeper than 200 feet.

Table 2. Chemical analyses of ground water, Chattooga County, Ga.

(Agency making analysis: USGS, U.S. Geological Survey; GDMMG, Georgia Department of Mines, Mining, and Geology)

Well or spring number	Name or owner	Date of collection	Water-bearing formation	Agency making analysis	Temperature (°F)	Parts per million															Specific conductance (micromhos at 25°C)	pH
																	Solids		Hardness as $CaCO_3$			
						Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Silica (SiO_2)	Dissolved (residue on evaporation at 180°C)	Total	Calcium, magnesium	Non-carbonate		
U.S. Public Health Service drinking-water standards						0.3		125				250	250		45			500				
267	Chattooga County	2-28-61	Conasauga Formation	USGS	—	.02	47	1.6	2.6	0.6	146	0.8	3.5	0.0	9.1	13	154	150	124	4	241	7.7
280	City of Lyerly	9-22-52	do	GDMMG	—	0	73	0	0	0	184	0	7.0	0	3	13	—	225	170	—	—	7.3
280	Do	9-28-61	do	USGS	—	.02	69	1.9	5.3	.5	194	13	8.0	.1	12	14	220	220	180	21	369	7.5
86	Ollie McGraw	2-28-61	Knox Group	do	—	.04	50	.2	3.6	.1	141	5.2	6.0	.1	6.3	8.2	158	168	126	0	257	7.6
265	John Owens	2-28-61	Chickamauga Limestone	do	—	.16	75	2.7	6.4	.5	208	18	11	.1	11	6.2	250	233	198	28	410	7.3
81	John H. Wooten	2-28-61	do	do	—	.05	9.6	2.9	216	4.1	446	16	36	1.6	1.7	11	551	551	36	0	899	8.9
269	Georgia Highway Department	2-27-61	Sequatchie and Red Mountain Formations	do	—	.09	56	38	3.6	2.4	148	174	2.0	.5	.4	11	379	361	296	174	559	7.3
266	D. P. Brown	2-28-61	Fort Payne Chert	do	—	.12	2.4	0	1.8	.1	16	.4	3.2	0	.8	5.9	30	22	6	0	42	6.2
61	Earl Copeland	2-28-61	Mississippian rocks, undifferentiated	do	—	.08	31	1.6	1.6	.2	92	1.2	3.0	0	9.0	6.7	106	99	84	8	173	7.4
111	Chattooga County	2-27-61	Floyd Shale	do	—	.02	44	1.5	2.5	.1	129	13	1.0	.1	1.3	16	143	144	116	10	232	7.2
112	William Hughes	2-28-61	do	do	—	1.2	92	8.9	9.7	.3	332	22	2.0	.1	.6	19	326	319	266	0	546	8.2
113	O. B. Millican	2-27-61	do	do	—	2.9	38	3.6	26	9.3	144	29	11	.1	20	4.1	213	212	110	0	365	6.8
24	Juliette Lowe Girl Scout Camp	2-28-61	Pennsylvanian rocks, undifferentiated	do	—	.07	6.8	1.1	1.1	.3	26	3.6	.8	0	.9	5.4	39	33	22	0	56	6.8
33	E. C. Galloway	2-28-61	do	do	—	1.9	23	3.8	5.1	.7	72	22	0	.1	.6	24	118	114	73	14	167	6.9
324	Furman M. Owens	2-27-61	do	do	—	.64	39	4.0	7.9	.2	154	1.6	1.0	.1	.7	28	159	158	114	0	245	7.3
S-1	J. S. Knox	2-13-61	Conasauga Formation	do	59	.10	44	4.1	1.1	.4	149	2.0	2.0	.1	5.1	7.2	142	139	127	5	249	7.5
S-2	Trion Spring	4-20-38	Knox Group	GDMMG	—	.01	23	11	1.1	.6	118	1.4	1.5	0	2.4	7.0	—	103	103	—	—	—
S-2	Do	2-28-61	do	USGS	57	.04	23	8.9	.7	.1	112	0	1.0	0	2.2	6.7	97	98	94	2	180	7.6
S-3	City of Summerville	2-10-47	do	GDMMG	—	.15	32	4.0	0	0	144	10	3.7	0	0	12	—	125	86	—	—	7.9
S-3	Do	3-23-61	do	USGS	60	.11	26	6.8	15	.3	110	.8	2.0	0	2.0	8.1	108	102	93	3	183	7.6
S-4	Summerville Fish Hatchery	5-20-53	do	GDMMG	—	0	35	1.0	0	0	117	0	2.5	0	0	6.0	—	134	86	—	—	8.5
S-4	Do	2-15-61	do	USGS	60	.03	29	7.9	.4	.2	126	.8	.5	0	1.1	8.2	106	110	105	2	204	7.6
S-5	Perennial Spring	2-15-61	do	do	59	.10	26	9.0	.6	.1	120	.8	1.0	0	1.2	10	107	108	102	4	193	7.6
S-6	Moses Spring	2-13-61	do	do	60	.05	24	10	.8	.2	117	.8	1.0	0	2.6	8.9	105	106	101	5	189	7.5
S-7	Blowing Spring	2-28-61	Mississippian rocks, undifferentiated	do	57	.29	18	.2	1.0	.4	57	.8	.8	0	0	7.3	61	56	46	0	96	7.3

Table 3. Spring flows in Chattooga County, Ga.

(Measurements: 1950 by S. M. Herrick, U.S. Geological Survey; 1954 by Surface Water Branch, U.S. Geological Survey; 1961 by author)

Name and/ or number of spring	Geologic source	Temperature °F	Date of measurement	Discharge (gallons per day)
Knox, S-1	Conasauga Formation	60	11- 2-50	870,000
		59	2-13-61	2,100,000
		59	4-28-61	3,400,000
		59	10-25-61	1,700,000
Trion, S-2	Knox Group	—	10-19-54	7,700,000
		58	3- 3-61	10,500,000
		58	6- 5-61	8,300,000
		59	10-25-61	7,700,000
City of Summerville, S-3	do	60	3- 3-61	1,500,000
		—	6-12-61	700,000
		—	10-25-61	400,000
Summerville Fish Hatchery, S-4	do	—	10-19-54	1,000,000
		60	2-15-61	800,000
Perennial, S-5	do	60	11- 8-50	4,200,000
		—	10-20-54	2,200,000
		59	2-15-61	4,100,000
		60	4-25-61	4,200,000
		60	10-25-61	2,900,000
Moses, S-6	do	60	11- 8-50	3,300,000
		60	10-20-54	1,900,000
		60	2-13-61	2,800,000
		60	4-25-61	4,100,000
		60	10-25-61	2,500,000
Blowing, S-7	Mississippian rocks, undifferentiated	58	10-31-50	61,000
		58	3- 3-61	1,400,000
		58	4-28-61	440,000
Montgomery, S-8	Knox Group	59	11- 2-50	2,800,000
		—	2-15-61	1,300,000
Taliaferro, S-9	do	60	11- 8-50	850,000
		59	10-20-54	580,000
Vernon, S-10	do	61	11- 8-50	420,000
Marble, S-11	do	60	11- 7-50	270,000
Gamble, S-12	do	60	11- 2-50	680,000
Rider, S-13	do	60	11- 1-50	290,000
Water's, S-14	do	—	11- 9-50	11,000,000
		59	10-25-61	13,900,000
Berryton Mills, S-15	do	60	11- 8-50	14,000
Phillip's, S-16	Conasauga Formation	—	11- 1-50	190,000
Cleghorn, S-17	do	61	8-22-50	2,600,000
		60	11- 2-50	1,600,000
		—	10-19-54	460,000
S-18	Floyd Shale	59	6-12-61	700,000
Hick's, S-19	do	59	11- 9-50	290,000

The maximum yield of most wells is unknown, but several have been pumped at rates from 5 to 10 gpm for 24 to 48 hours without failing. Well 185 was tested at 165 gpm for 3 minutes and had a drawdown of 3 inches. Well 249 was bailed at 17 gpm and had a drawdown of 1 foot. Several other wells yielded 18 to 33 gpm for short periods. Very few wells in the Knox go dry from heavy use.

Analysis data of water from well 86 in the Knox showed a hardness of 126 ppm and an iron content of 0.04 ppm. Well water is reported to be free of hydrogen sulfide.

Dug wells in the Knox are relatively uncommon compared to drilled wells, but are used satisfactorily by some people. Well 65 is 98 feet deep and furnishes water for two homes with baths, plus an additional house in summer. The yield of this well probably is better than average, though most dug wells do supply enough water for domestic and farm needs.

Springs in the Knox Group are the largest and most important in the county. Measurements indicate that the six largest springs discharge more than 35 mgd during their period of maximum flow, and about 25 mgd during their period of lowest flow. The maximum flow period is in the winter when precipitation is greatest. The low-flow period is in autumn when rainfall is light.

The principal springs discharge at the base of ridges formed by the Knox Group and along stream courses in the Knox. Topography seems to have been a major factor in the location of the springs, as they all are level with a valley floor or stream bed. The largest springs discharge from solution channels in limestone or dolomite; the smallest seep through gravel. The springs are not associated with faults or formation contacts, but occur where dipping strata intersect a valley floor or stream course.

Water sampled during 1961 from five springs in the Knox Group had a hardness ranging from 96 to 107 ppm, and an iron content ranging from 0.03 to 0.11 ppm. The spring water is clear except during times of heaviest discharge when it is turbid.

Ordovician System

Chickamauga Limestone

The Chickamauga Limestone of Ordovician age crops out in three belts that cross the county diagonally to the northeast. The western belt is between Menlo and Summerville, the central belt passes along Taylor Ridge and Simms Mountain, and the eastern belt is at the base of Johns Mountain.

The Chickamauga in the western belt consists of evenly bedded, blue to gray limestone that is flaggy to thick bedded and contains beds of calcareous siltstone and claystone and locally includes dolomite at the base. The formation in the central belt is similar to that in the western belt except that it contains a larger amount of silt and clay and is more flaggy. The eastern belt is mainly maroon calcareous siltstone and claystone except for some dolomite in the lower part.

Thickness of the Chickamauga in Chattooga County was not determined because exposures are limited and the entire formation is not present. Outside the county to the north the Chickamauga is 1,500 to 2,000 feet thick.

The Chickamauga Limestone is extensively developed by hundreds of wells yielding adequate amounts of water for farm and home needs. Drilled wells in the formation range in depth from about 30 to 400 feet, though most are less than 100 feet deep. The wells are dependable and many supply enough water to permit lawn watering and car washing during dry fall months. Yields of 10 gpm are common. The greatest measured yield was 20 gpm from well 48 which is 86 feet deep.

Wells in all areas of the formation are productive. Only one well (317) was a dry hole.

Analysis data from wells 81 and 265 showed a hardness of 36 and 226 ppm respectively. Water from well 81 had a sodium content of 216 ppm which is higher than other water sampled in the county. Several wells in the Chickamauga Limestone north of Chattooga County yield water high in sodium content. Only two wells (82 and 83) were reported to yield water containing objectionable amounts of hydrogen sulfide.

Springs in the Chickamauga are rare and unimportant.

Sequatchie Formation

The Sequatchie Formation of Late Ordovician age is exposed in the cut of U.S. Highway 27 on Taylor Ridge and on Taylor Ridge east of Trion.

The Sequatchie Formation is composed of about 250 feet of calcareous shale and sandstone, some of which contains quartz conglomerate. Very fine grained brownish sandstone in thick to massive layers also occurs. The formation becomes distinctively reddish upon weathering.

The Sequatchie is not used as an aquifer in Chattooga County because its outcrop areas are limited to uninhabited ridge slopes. Lateral drainage wells in the Sequatchie are discussed in the following section on the Red Mountain Formation.

Silurian System

Red Mountain Formation

The Red Mountain Formation of Silurian age makes up several prominent ridges in Chattooga County, including Dirtseller Mountain, Gaylor Ridge, Taylor Ridge, Simms Mountain, and Johns Mountain.

The Red Mountain is composed of sandstone, siltstone, shale, and a few beds of fossil iron ore. In its westernmost outcrop, the formation is dominantly shale and contains relatively little sandstone. Going east, the proportion of sandstone to shale increases, and the formation is progressively thicker at each outcrop. On Taylor Ridge it has a thickness of about 1,000 feet.

Sandstone of the Red Mountain is gray to tan where freshly exposed, but is ferruginous and weathers to brown or maroon. Sandstone beds range in thickness from less than 1 inch to several feet. Many beds are interfingered with shale and some grade into shale along the strike. Grain size of the sandstone is very fine in western outcrops and coarse in eastern exposures. Quartz pebbles occur in the sandstone on Taylor Ridge.

Shale of the formation is gray to light brown and weathers to brown. The shale is interbedded with sandstone in the lower and upper parts of the formation but is nearly free of sandstone in the middle part.

The Red Mountain Formation in Chattooga County is practically undeveloped as an aquifer. The only inhabited area of the Red Mountain is the small ridge west of Menlo where six wells derive water from the formation. The wells are between 50 and 100 feet deep and supply more than enough water for household needs.

The Red Mountain Formation and the underlying Sequatchie Formation yield a small amount of water to lateral drainage wells in the cut of U.S. Highway 27 on Taylor Ridge. Eighty-three wells were drilled horizontally into rock above the highway to divert water from the road fill. The wells range in depth from 39 to 147 feet and penetrate shale, siltstone and some sandstone. Drilling was nearly parallel to the strike of the bedding, so each well penetrates only a few beds. The wells appear to be in the Sequatchie Formation, but derive at least part of their water from the Red Mountain Formation which overlies the wells and forms the upper part of the road cut.

Discharge from the drainage wells varies from a few thousand gallons per day during wet periods to practically none during dry periods. After a period of heavy rainfall in February 1961, 20 wells discharged water, most of them at a slow drip, but one at the rate of 2 gpm. During the following June, when rainfall was less, only 4 wells were wet with seepage and dripped slowly.

Dewatering of the rocks following rainfall is fairly rapid. During the period February 23 to March 2, 1961, which was preceded by heavy rainfall, the number of wells discharging water decreased from 20 to 13, and the greatest rate of discharge decreased from 2 to 0.5 gpm.

Wells having the greatest discharge appear to penetrate sandstone, whereas less productive wells are in shale and claystone. The sandstone layers are highly fractured and ground water can readily pass through them.

Water from well 269 had a hardness of 470 ppm, an iron content of 0.09 ppm, and a sulfate content of 174 ppm. The high sulfate content may have resulted from oxidation of pyrite which is present in the formation.

Devonian and Mississippian Systems

Chattanooga Shale

The Chattanooga Shale of Devonian and Mississippian age is a black fissile shale generally about 10 to 15 feet thick though west of Menlo it is more than 50 feet thick. Exposures of the Chattanooga are limited to road cuts and gaps through ridges because the formation is nearly everywhere covered by residuum from the overlying Fort Payne Chert. The best exposures in the county are in a cut of U.S. Highway 27 west of Gore and in a cut of Georgia Highway 48 west of Menlo.

The Chattanooga Shale is not an aquifer in Chattooga County, as it is thin and generally impervious. The little water coming from the shale has a high iron and hydrogen sulfide content. For this reason, the Chattanooga should be cased from wells that penetrate it.

Mississippian System

Fort Payne Chert

The Fort Payne Chert of Early Mississippian age crops out on the ridge west of Menlo, the east side of Taylor Ridge, the ridge at Silver Hill, and on Dick Ridge.

The Fort Payne, as exposed in a cut of U.S. Highway 27 on Taylor Ridge, consists of about 150 feet of bedded chert that is dense, brittle, gray to black, and evenly bedded. The beds generally range in thickness from 2 inches to 1 foot, and are irregularly furrowed along the bedding surface. The furrowing appears to have resulted from solution by ground water. Abundant fossils in the Fort Payne make its chert easily distinguishable from chert of other formations. Locally the chert is replaced by dark calcareous shale named the Lavender Shale Member.

The Fort Payne Chert has wide distribution in the county, and everywhere underlies younger Mississippian rocks.

The Fort Payne is only slightly developed as an aquifer in Chattooga County, mainly because it underlies steep slopes. A few dug wells in the residuum of the formation yield water in adequate amounts for home supply.

Water from one dug well had a hardness of 6 ppm and an iron content of 0.12 ppm.

The furrowed bedding planes and the high degree of jointing in the Fort Payne indicate a potentially productive aquifer. Large outcrop areas on the east slope of Taylor Ridge may be a valuable source of ground water in the future.

Other Mississippian Rocks

Rocks of the Mississippian System that overlie the Fort Payne Chert include an eastern and western facies of the same age. Outcrops of the two facies are separated by a distance of 10 miles.

Eastern Facies — Floyd Shale. — Rocks of the eastern facies of the Mississippian System crop out in a broad belt between Taylor Ridge and Little Sand Mountain. The eastern facies is called the Floyd Shale.

The Floyd Shale consists of shale and thick units of interbedded limestone, sandstone, and siltstone. The shale is gray to black, calcareous, and in places fossiliferous. Where black and lacking in fossils, the shale is difficult to distinguish from the Chattanooga Shale. Limestone in the Floyd is thick bedded, bluish gray to dark gray, and fine to coarse crystalline. The sandstone is thin to thick bedded and fine to medium grained. The siltstone is largely thin bedded and fractures to small pieces.

The thickness of the Floyd Shale was not determined because much of the formation is poorly exposed and the dip of the strata is uncertain. Hayes (1902) estimated the thickness to be 1,200 feet. The units of limestone, sandstone, and siltstone in the Floyd pinch and swell and seem to be discontinuous. Limestone units reach a thickness of several hundred feet.

The Floyd Shale is one of the best aquifers in Chattooga County. All but two wells inventoried in the Floyd supplied enough or more than enough water for farms, homes, dairies, and chicken houses. Several wells were reportedly bailed or pumped for 6 to 12 hours without the water level lowering.

Wells in the formation range in depth from about 30 to 600 feet; nearly half are less than 100 feet deep and all but a few are less than 200 feet deep.

The water-bearing character of the Floyd Shale varies considerably because of the diversity of rock types in the formation. The yield of wells and particularly the quality of well water varies. Largest yields are obtained from wells penetrating solution openings in limestone. Water from limestone generally is harder than water from shale or sandstone, but is less likely to contain objectionable amounts of iron or hydrogen sulfide.

Analysis data of water from 3 wells in the Floyd showed a hardness ranging from 110 to 266 ppm and an iron content of 0.02 to 2.9 ppm. Seven out of 80 wells inventoried in the formation were reported to contain iron in objectionable quantities. Only three wells contained hydrogen sulfide. Well 113, when drilled to a depth of 596 feet, penetrated black rock. Water from this rock was clouded by coal-like particles and had a high iron and hydrogen sulfide content.

Western Facies. — The western facies of the Mississippian System forms the slopes of Lookout Mountain below the rimrocks and underlies the adjacent valley.

The western facies consists of about 800 feet of limestone overlain by 200 feet or more of shale. These thicknesses are taken from exposures to the north outside the county because the formation is practically unexposed in the county.

The limestone in the lower 300 feet of the western facies is thick bedded, dark gray, and fine grained. The upper 500 feet of limestone are thick bedded, coarsely crystalline, and bluish gray. The shale overlying the limestone is light to dark gray and weathers to shades of brown, red, and yellow. Marine fossils are abundant in the limestone and shale.

The western facies is a highly productive aquifer, yielding large volumes of water from solution openings in limestone. Wells in limestone average about 100 feet deep and supply plenty of water for farm, home, and poultry-raising needs. The wells, equipped with pumps of 5 to 10 gpm capacity, can be pumped several hours, or overnight, without failing.

Water from well 61 in limestone had a hardness of 92 ppm and an iron content of 0.08 ppm. No water was reported to have objectionable quantities of iron or hydrogen sulfide.

Dug wells, which are the most common type in the western facies, are reported to yield soft water in amounts sufficient for farm and home needs. The wells generally are about 60 feet deep, and all are in residuum overlying limestone.

Springs discharging from limestone of the western facies are important sources of water for domestic supply and maintaining cattle watering ponds. The springs discharge from the base of Lookout Mountain or from stream banks on the adjacent valley floor.

Blowing Spring (S-7), at the base of Lookout Mountain, discharges about 1.4 mgd during its period of maximum flow, but decreases to less than 75,000 gpd during dry periods. Water from this spring had a hardness of 46 ppm and an iron content of 0.29 ppm during February 1961 when its discharge was high. The hardness and iron content may be greater during times of reduced flow.

Pennsylvanian System

Rocks of the Pennsylvanian System make up the tops of Lookout Mountain and Little Sand Mountain. Thick sandstone units of the Pennsylvanian form the rimrocks on both mountains.

The Pennsylvanian rocks of Georgia include several formations; those in Chattooga County are described below, using nomenclature and descriptive material from Johnson (1946).

Lookout Sandstone

The oldest formation of the Pennsylvanian System is the Lookout Sandstone, which includes the Gizzard Member below and the Sewanee Member above. The Gizzard Member is about 150 feet thick and consists of fine-grained sandstone and gray shale. Four coal beds occur in the Gizzard. The Sewanee Member consists of about 175 feet of coarse grained, generally massive bedded, white to buff, conglomeratic sandstone.

Whitwell Shale

The Whitwell Shale is a thin-bedded, light- to dark-gray shale about 50 feet thick at a maximum. The shale thins to the south, where it is only from 5 to 10 feet thick.

Bonair Sandstone

The Bonair Sandstone is a crossbedded fine- to coarse-grained, light-colored sandstone about 200 feet thick that weathers to reddish brown. In many exposures the Bonair contains pebbles much like the Sewanee Member of the Lookout Sandstone. In Chattooga County the Bonair forms a line of cliffs above those of the Lookout Sandstone.

Wells in Pennsylvanian rocks on Little Sand Mountain yield ample water for domestic and farm needs. Drilled wells range in depth from 34 to 88 feet and will not pump dry under normal use. Many wells can be pumped at 5 to 10 gpm for more than 12 hours without failing. Water level in the wells is about 30 to 40 feet below land surface.

Water from well 324 had a hardness of 114 ppm and an iron content of 0.64 ppm. Several wells were reported to yield water high in iron content. No relation was found between iron content and the depth of wells or their location.

Dug wells in sandstone yield enough water for household needs.

Most wells in the Pennsylvanian rocks on Lookout Mountain are between 50 and 150 feet deep, though some are deeper than 275 feet. The wells generally are dependable and give ample yields. The largest sustained yield is 50 gpm from well 33 which is 215 feet deep. Well 33 supplies 60 to 70 homes in summer and 20 homes in winter. The well is good for one year, then has to be deepened about 3 feet in order to maintain the required yield.

The water from about half of the wells inventoried on Lookout Mountain has an iron taste; the water from several wells has a strong iron taste and stains clothes. Most wells are reported to yield soft water. Analysis data of water from wells 24 and 33 showed an iron content of 0.07 and 1.9 ppm. Hardness of the water was 22 and 87 ppm.

SUMMARY

During 1961 springs in Chattooga County discharged at a maximum rate of more than 45 mgd and at a minimum rate of 30 mgd. More than 80 percent of this water was unused except to maintain streamflow. The spring flows ranged from about 0.1 to 13 mgd. Six of the largest springs, which flow from the Knox Group, discharged at least 35 mgd during their high flow period. The maximum discharge is unknown because the two largest springs (S-2 and S-14) are covered by surface water during most of the winter.

Chemical quality of the spring water is suitable for domestic and many industrial needs. Water sampled from 6 large springs during 1961 had a total hardness of less than 135 ppm, an iron content of less than 0.12 ppm, and a total dissolved solids content of less than 140 ppm.

Drilled and dug wells in nearly all Chattooga County supply adequate water for farm and home needs. Dug wells generally are less than 50 feet deep and yield 1 to 5 gpm. Drilled wells range in depth from about 30 to 600 feet, though most are less than 300 feet deep. Wells less than 300 feet deep yield 1 to 20 gpm, whereas wells deeper than 300 feet yield as much as 435 gpm. The highest yields are obtained from wells in the Conasauga Formation, the Knox Group, and limestone of Mississippian age.

Chemical quality of well water varies widely from one formation to another and within each formation. Most water sampled from 9 formations had a total hardness of less than 200 ppm, an iron content less than 0.13 ppm, and a total dissolved solids content less than 250 ppm.

References

Butts, Charles, 1948, Geology and mineral resources of the Paleozoic area in northwest Georgia: Georgia Geol. Survey Bull. 66, 104 p.

Hayes, C. W., 1891, The overthrust faults of the southern Appalachians: Geol. Soc. America Bull., v. 2, p. 141-154.

———1894, Description of the Ringgold quadrangle (Georgia-Tennessee): U.S. Geol. Survey Geol. Atlas, Folio 2.

———1902, Description of the Rome quadrangle (Georgia-Alabama): U.S. Geol. Survey Geol. Atlas, Folio 78.

Johnson, J. H., 1946, Coal deposits on Sand and Lookout Mountains, Dade and Walker Counties, Georgia: U.S. Geol. Survey (Prelim.) Map.

Moore, E. W., 1940, Progress report of the committee on quality tolerances of water for industrial uses: New England Water Works Assoc. Jour., v. 54, p. 271.

U.S. Public Health Service, 1961, Drinking water standards, 1961: Am. Water Works Assoc. Jour., v. 53, no. 8, p. 935-945.

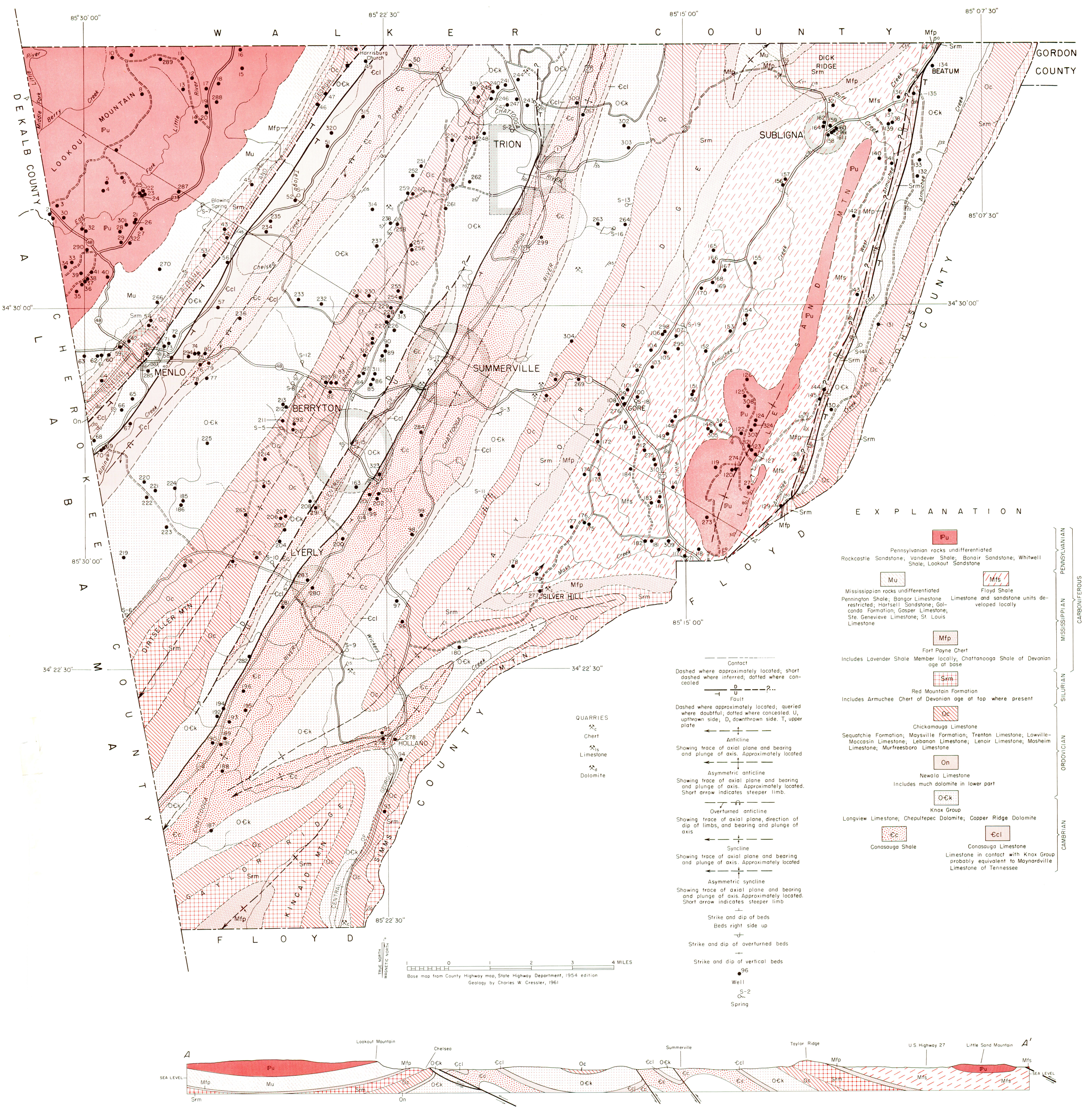

Figure 2.—Geology, geologic section, and well and spring locations, Chattooga County, Georgia.