STATE OF ARKANSAS

Geological and Conservation Commission

Norman F. Williams, Geologist-Director

WATER RESOURCES SUMMARY NUMBER 1

RESUME OF THE GROUND-WATER RESOURCES OF BRADLEY, CALHOUN, AND OUACHITA COUNTIES, ARKANSAS

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Availability of ground water

In Bradley, Calhoun, and Ouachita Counties many relatively shallow wells have been dug, driven, and bored in the deposits of Tertiary and Quaternary age. These wells are used extensively for household and small farm supplies and have been developed almost everywhere in the counties at depths less than 50 feet. The wells generally are pumped at rates less than 25 gpm (gallons per minute). Considerably larger quantities of ground water could be obtained from shallow wells, especially if properly developed in the terrace deposits and alluvium of Quaternary age.

Water for household and farm uses also can be obtained from deeper wells drilled into most of the geologic units of Tertiary age. However, the water in the Wilcox Group, the Carrizo Sand, and the Cane River Formation becomes increasingly salty with depth, and, as the formations dip easterly toward the axis of the Mississippi embayment, the Sparta Sand becomes the deepest formation containing fresh water.

The Sparta Sand is by far the most important aquifer in the counties. Each day municipal and industrial users withdraw approximately five million gallons of fresh water from the aquifer. The maximum depth that can be drilled in the Sparta Sand before completely penetrating the formation or reaching salty water ranges from less than 200 feet in central Ouachita County to about 1,100 feet in northeastern Bradley County. Much more water can be obtained from the Sparta Sand than presently is being withdrawn from it. Almost anywhere in the area from central Calhoun County eastward through Bradley County, a system of properly spaced wells could be screened in the Sparta Sand that would have a total yield greater than that of all existing wells in the three counties combined.

From central Calhoun County eastward through Bradley County, as much as 500 gpm of good-quality water can be obtained from the Cockfield Formation. At present this aquifer is utilized for household or farm supplies, although, especially in Bradley County, it is capable of supplying small industries or municipalities.

In extreme northeastern Bradley County, several household-supply wells less than 250 feet deep obtain water from the Jackson Group. Although the supply is less than 25 gpm, it is possible that wells with a somewhat larger capacity could be developed in the Jackson Group in this limited area.

Figure 1 on the reverse side of this sheet shows the areas in which the Carrizo Sand, the Cane River Formation, the Sparta Sand, and the Cockfield Formation contain fresh water, and the maximum depth that could be drilled in each formation without either completely penetrating the formation or reaching salty water.

Quality of ground water

All ground waters contain minerals dissolved from the atmosphere and from the rocks with which the water has been in contact. The concentrations of the common mineral constituents in a water are determined by chemical analyses, which indicate the chemical suitability of the water for various uses without regard to its sanitary or bacteriological condition. Most of the mineral constituents are objectionable in drinking water only when they are in concentrations high enough to become noticeable to the taste. However, a few of the constituents or properties cause undesirable characteristics in waters used for drinking and ordinary household purposes. The Arkansas State Board of Health has adopted the standards of quality specified by the U. S. Public Health Service for drinking water used on interstate carriers, and recommends that the mineral constituents in the following table should not exceed the concentrations as shown.

Table 2 summarizes chemical analyses of water samples from 136 selected wells in Bradley, Calhoun, and Ouachita Counties. Water for household and farm use is obtained from most of the deposits of Tertiary and Quaternary age, although the concentration of one or more mineral constituents may exceed the limits recommended for drinking water. Uncommonly high nitrate concentrations were found in water from 40 of the relatively shallow wells in the counties, and 20 of these contained more than 45 ppm nitrate. These high-nitrate concentrations are particularly significant because methemoglobinemia, or cyanosis, the so-called "blue-baby" disease, apparently is a hazard, sometimes fatal, to infants whose feeding formulas are mixed with high-nitrate waters. Because of the widespread distribution of the nitrate, water from shallow depths in Bradley, Calhoun, and Ouachita Counties should be tested to determine whether a methemoglobinemia hazard is preesnt before the water is fed to infants.

Water for the larger municipal and industrial supplies in the counties is obtained from wells screened in the Sparta Sand which, of all the geologic units, most consistently yields good-quality water to wells.

Constituent or property	Maximum recommended concentration (parts per million)	Significance
Iron (Fe)	0.3	Causes stains on fabrics and plumbing fixtures.
Sulfate (SO_4)	250	May cause laxative effect.
Chloride (Cl)	250	Causes a salty taste.
Nitrate (NO_3)	45	Possible cause of methemoglobinemia, or cyanosis, in infants. Sometimes fatal.
Dissolved solids	500	Affects the chemical and physical properties of water for many uses.

In addition, most authorities recommend that calcium-magnesium hardness not exceed 100 ppm. Soap does not cleanse or lather in hard waters but forms a curd which is deposited on sinks and bathtubs.

Table 1. Generalized Stratigraphic Sequence of the Rocks in Bradley, Calhoun, and Ouachita Counties, Ark.

System	Series	Geologic Unit	Kind of Material	Water-bearing Characteristics
Quaternary	Recent	Alluvium	Brown, reddish-brown, and orange silty clay, silt, poorly sorted sand, and gravel.	Numerous household and small farm supplies, which generally require less than 25 gpm, are obtained from shallow wells dug, driven, and bored into these deposits.
	Pleistocene	Terrace deposits	Brown, reddish-brown, and orange silt, poorly sorted sand, gravel, and some clay.	
Tertiary	Eocene	Jackson Group	Gray, brown, and green silty clay; contains some sand and lignite.	Yields less than 25 gpm to a few drilled wells in northeastern Bradley County.
		Cockfield Formation	Gray and brown silt and very fine to fine sand; contains dark-gray, dark-brown, and green lignite silty clay.	Yields as much as 500 gpm of good-quality water to wells from central Calhoun County eastward through Bradley County.
		Cook Mountain Formation	Dark-Gray to dark-brown silty clay.	Generally a poor aquifer.
		Sparta Sand	Gray very fine to medium sand, and brown and gray sandy clay.	Best aquifer in area. Yields from 300 gpm in central Ouachita County to as much as 1,000 gpm in Bradley County.
		Cane River Formation	Dark-gray to dark-brown silt and silty clay; contains some lignite and glauconite.	In northwestern Ouachita County these deposits furnish water for household and farm uses, and are capable of yielding as much as 100 gpm. However, the water is salty, especially in sands of the Wilcox Group, at short distances downdip from the outcrop areas. See maps on figure 1 for areas and depths where fresh water can be obtained from the Carrizo Sand and the Cane River Formation.
		Carrizo Sand	Gray and brown very fine to medium sand.	
		Wilcox Group	Interbedded dark-gray to dark-brown lignitic clay, light-gray to gray clay, green glauconitic clay, gray and brown very fine to fine sand, and lignite.	
	Paleocene	Midway Group	Dark-gray to black clay.	Generally a poor aquifer.

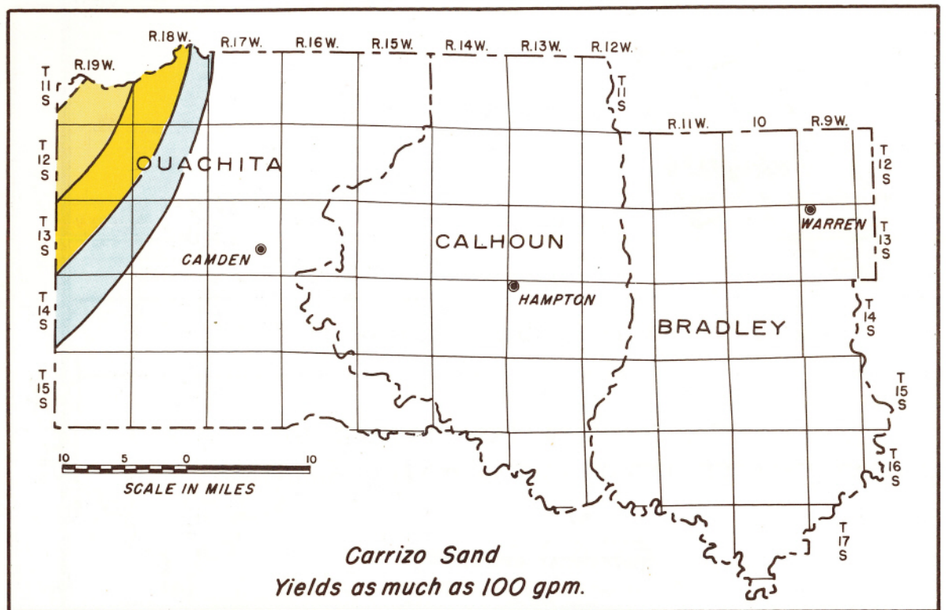
The use of tables 1 and 2 can be illustated by continuing the example given in the discussion of figure 1. A person interested in drilling a water well in the vicinity of Hampton would expect to complete his well at a depth less than 200 feet in the Cockfield Formation or at a depth less than 800 feet in the Sparta Sand. Inspection of table 1 shows that the Cockfield Formation consists of silt and very fine to fine sand, and the deposits yield as much as 500 gpm. Table 1 also shows that the Sparta Sand consists of fine to medium sand, yields as much as 1,000 gpm in Bradley County, and is the best aquifer in the area.

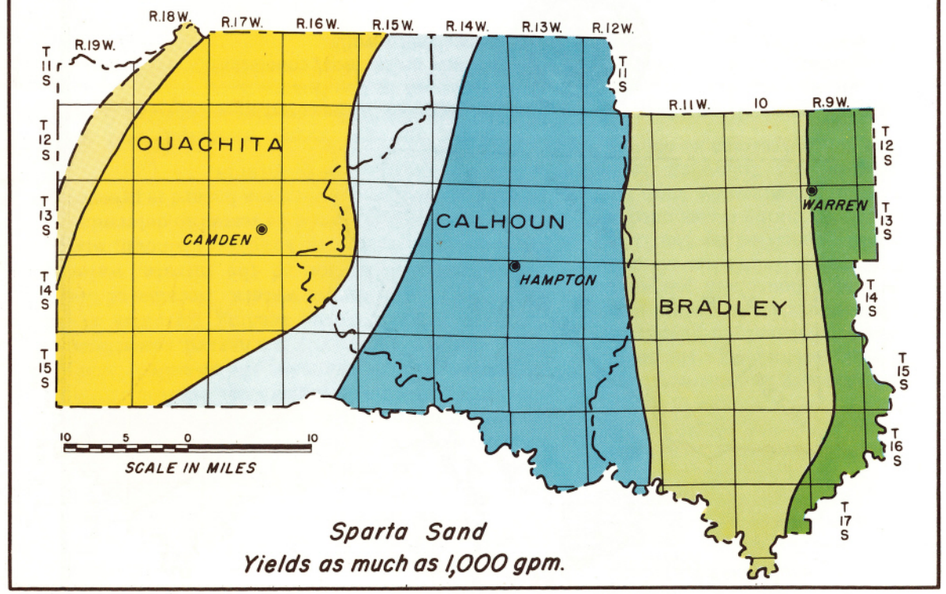
Inspection of table 2 shows that the chemical quality of water from the Cockfield Formation and the Sparta Sand generally is good. (See discussion of quality on the reverse side of this sheet.) However, most of the water samples analyzed from the Cockfield Formation contained slightly more iron than is recommended for drinking water. Table 2 also shows that water from the Cockfield Formation contains higher concentrations of Sulfate and calcium-magnesium hardness in some localities than is recommended, and that some water from the Sparta Sand contained higher concentrations of iron than is recommended.

Table 2. Summary of chemical analyses of water from selected wells in Bradley, Calhoun, and Ouachita Counties, Ark.

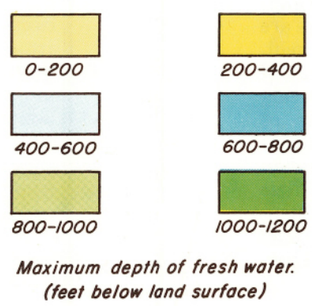
[Results in parts per million except as indicated. Min., minimum concentration; Max., maximum concentration; M.R., most representative concentration (either the mode, or the average of the modal range). Chemical analyses made by the Quality of Water Branch, U. S. Geological Survey. Silica and fluoride concentrations for Sparta Sand based on seven water samples.]

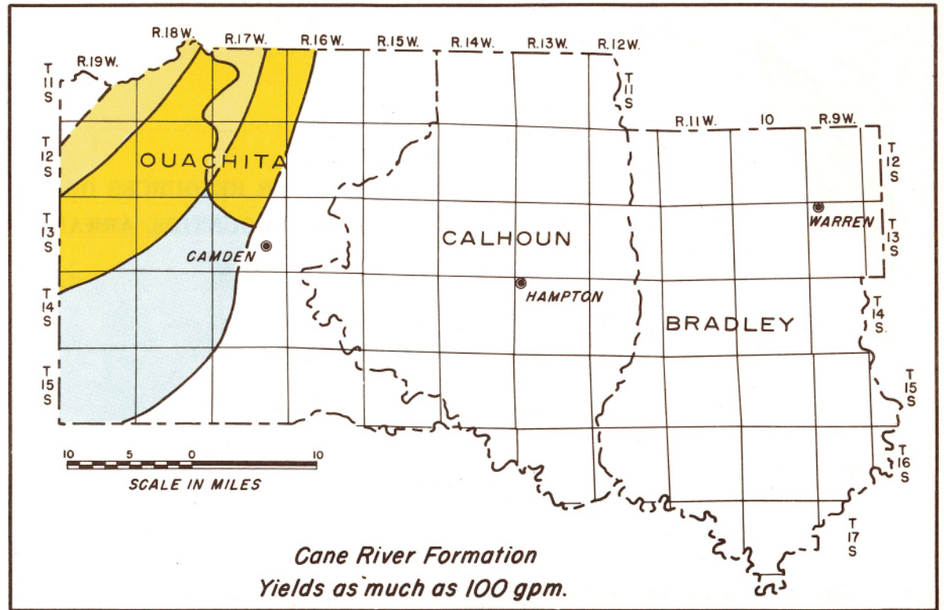
Mineral Constituent or Property	Geologic Units																			
	Alluvium and Terrace deposits			Jackson Group			Cockfield Formation			Sparta Sand			Cane River Formation			Carrizo Sand			Wilcox Group	Midway Group
	Number of Water Samples Analyzed																			
	57			4			27			34			9			3			1	1
	Min.	Max.	M. R.	Min.	Max.	M. R.	Min.	Max.	M. R.	Min.	Max.	M. R.	Min.	Max.	M. R.	Min.	Max.	M. R.	M. R.	M. R.
Temperature (°F)	63	74	67	68	73	71	65	74	70	65	83	66	66	71	69	65	65	65	----	64
Silica (S_1O_2)	----	----	----	----	----	----	----	----	----	3.9	53	20	----	----	----	----	----	----	6.6	----
Iron (Fe)	0.00	7.5	0.90	0.06	0.62	0.09	0.04	62	0.35	0.00	23	0.30	0.04	3.6	0.40	0.04	0.77	0.30	0.00	00.7
Calcium (Ca)	----	----	----	14	45	26	1.9	117	7.5	1.0	24	5.2	4.9	65	12	4.0	20	5.6	17	13
Magnesium (Mg)	----	----	----	3.6	13	5.0	0.0	38	1.9	0.0	6.3	2.3	1.7	18	3.7	1.2	7.0	1.5	2.6	3.1
Sodium (Na)	----	----	----	29	153	75	1.2	182	54	2.3	132	18	3.4	964	490	18	1050	35	427	842
Potassium (K)	----	----	----	4.1	8.2	6.0	0.7	11	3.2	0.7	5.6	3.5	0.6	16	9.3	0.6	11	2.0	13	8.4
Bicarbonate (HCO_3)	0	341	15	204	272	237	8	428	181	0	334	110	44	400	268	58	518	100	254	320
Carbonate (CO_3)	0	0	0	0	0	0	0	0	0	0	2	0	0	4	0	0	10	0	10	0
Sulfate (SO_4)	1.0	68	2.0	4.8	152	100	0.0	470	3.9	0.2	25	4.1	0.2	31	1.6	0.4	6.0	4.9	8.8	6.2
Chloride (Cl)	3.0	1190	10	7.0	15	11	2.2	58	8.2	3.5	84	5.8	4.0	1410	870	5.8	1350	7.3	540	1120
Fluoride (F)	----	----	----	----	----	----	----	----	----	0.1	1.2	0.1	----	----	----	----	----	----	0.9	----
Nitrate (NO_3)	0.5	198	8.8	0.8	3.8	2.2	0.0	9.5	0.6	0.0	2.1	0.4	0.2	1.9	1.2	0.8	4.7	0.9	0.1	1.5
Dissolved Solids	----	----	----	196	482	400	27	958	197	42	362	147	55	2720	1450	90	2820	134	1170	2260
Hardness as $CaCO_3$ Calcium, Magnesium	6	399	30	51	153	100	5	448	22	4	84	30	22	236	44	15	79	20	53	45
Noncarbonate	0	399	5	0	0	0	0	300	0	0	20	0	0	26	0	0	0	0	0	0
Percent sodium	----	----	----	28	85	69	23	97	75	15	97	34	69	94	90	60	96	78	----	97
Sodium Adsorption Ratio	----	----	----	1.0	9.3	3.0	0.2	29	3.2	0.2	24	1.2	2.8	34	24	1.6	51	25	----	55
Specific Conductance (Micromhos at 25°c)	46	4130	141	336	734	535	25	1180	310	43	584	210	83	4610	2400	127	4680	194	1820	3970
pH	4.5	7.9	6.5	7.3	8.0	7.9	5.8	8.2	7.6	4.30	8.4	7.6	7.4	8.3	8.2	7.2	8.4	7.7	8.6	8.0





The maps and tables on this sheet can be used to determine: the aquifer or aquifers that can be utilized at a particular location in Bradley, Calhoun, and Ouachita Counties; the maximum depth that can be drilled before completely penetrating the geologic unit or reaching salty water; the kind of material and the water-bearing characteristics of each geologic unit in the counties; and the general chemical quality of the ground water in each geologic unit. As an example of the use of this sheet, assume that a person living in the vicinity of Hampton desires to obtain a ground water supply. Inspection of the maps of figure 1 shows that Hampton is outside the areas in which fresh water may be obtained from the Carrizo Sand and Cane River Formation, but is within the areas where fresh water is available from the Sparta Sand and Cockfield Formation. Inspection of the maps also shows that wells drilled to produce water from the Cockfield Formation in the Hampton vicinity should not exceed 200 feet in depth, and that wells drilled to produce water from the Sparta Sand should not exceed 800 feet in depth. By shifting the inspection to tables 1 and 2 below, an estimation can be made of the kind of material and the water-bearing characteristics of the formation to be utilized, and the quality of the ground water in that formation.





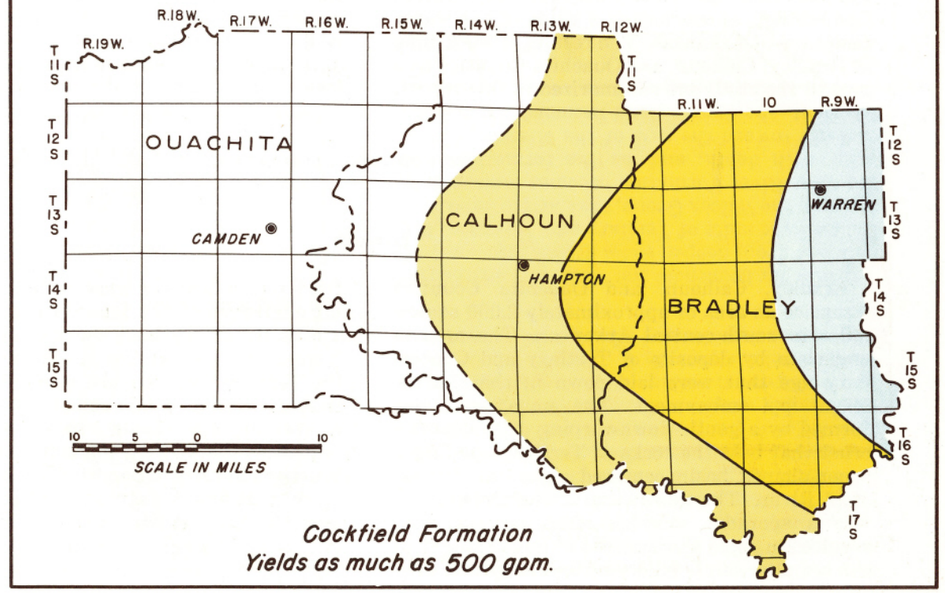


Figure 1. Occurrence of fresh water in the Carrizo Sand, Cane River Formation, Sparta Sand, and Cockfield Formation in Bradley, Calhoun, and Ouachita Counties, Ark.

RESUME OF THE GROUND-WATER RESOURCES OF BRADLEY, CALHOUN, AND OUACHITA COUNTIES, ARKANSAS

By Donald R. Albin

Introduction

The U. S. Geological Survey, in cooperation with the Arkansas Geological and Conservation Commission, is conducting a study of the water resources of Arkansas. The results of work done in Bradley, Calhoun, and Ouachita Counties as a part of the study are summarized in this report. More comprehensive reports are in preparation that (1) describe the geology and ground-water resources of the three-county area, and (2) list well data, water-level records, chemical quality data, and representative lithologic and driller's logs of test holes and wells in the area.

Geology

Bradley, Calhoun, and Ouachita Counties comprise an area of approximately 2,000 square miles in south-central Arkansas. The area is underlain by deposits of Tertiary and Quaternary age that were laid down in the shallow Mississippi embayment. The embayment was formed by a gentle downwarping of the earth's crust that bent the rocks of Tertiary age into a spoon-shaped basin centered along the Mississippi River. The downwarp of the embayment was a sporadic, stop-and-start process, that resulted in rapid fluctuations of environment as the sea alternately advanced and retreated over the land surface. Because of the rapidly changing environment, the deposits of Tertiary age are a mixture of dry land, swamp, and ocean sediments. In much of the Mississippi embayment the Tertiary deposits are covered by relatively thin river-laid sand and gravel deposits of Quaternary age. Table 1 lists the stratigraphic sequence, the kind of material, and the water-bearing characteristics of the various geologic units in Bradley, Calhoun, and Ouachita Counties. Sand of Tertiary age and sand and gravel of Quaternary age are the principal water-bearing formations (aquifers) in the area.