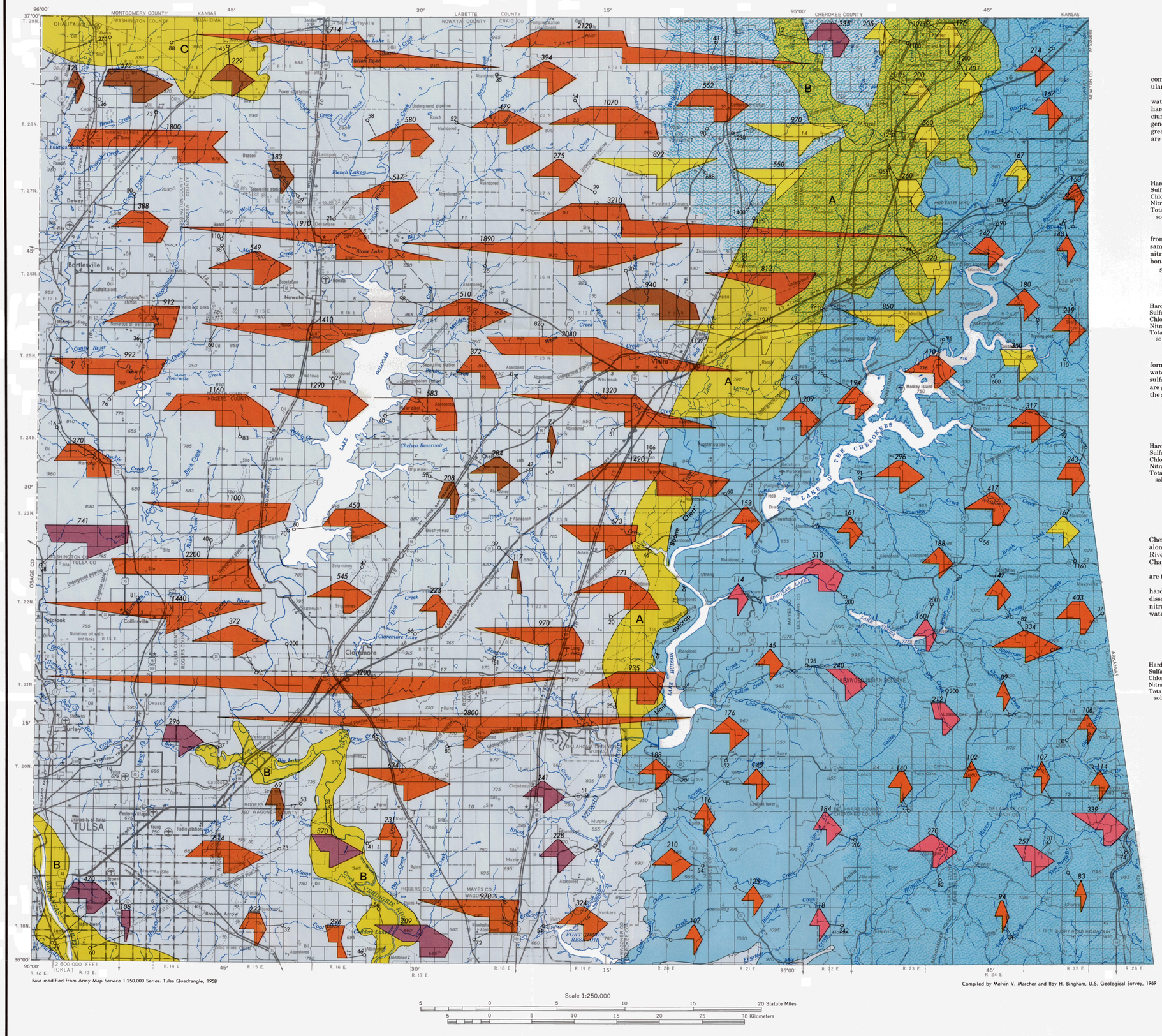

Base modified from Army Map Service 1:250,000 Series: Tulsa Quadrangle, 1958

Compiled by Melvin V. Marcher and Roy H. Bingham, U.S. Geological Survey, 1969

EXPLANATION

Chemical quality of water generally good

This area is underlain by the Keokuk and Reeds Spring Formations, commonly referred to as the "Boone Chert," and older rocks, particularly the Burgen Sandstone.

Hardness is the most troublesome chemical characteristic of the water from the "Boone Chert"; water in 80 percent of the samples was hard or very hard. Water from the "Boone Chert" is usually of the calcium bicarbonate type. The sulfate, chloride, and nitrate contents are generally low, except locally. Three samples had a nitrate content greater than 45 mg/l; two of these were taken from wells that apparently are polluted.

Summary of Chemical Analyses of Water from the "Boone Chert"

	CONCENTRATION (MG/L)					NUMBER OF ANALYSES
	MAXIMUM	UPPER QUARTILE[1]	MEDIAN	LOWER QUARTILE[2]	MINIMUM	
Hardness	328	185	154	126	26	28
Sulfate	79	18	10	4.4	0.2	28
Chloride	103	26	10	3.8	0.2	28
Nitrate	79	38	5.2	0.7	0.1	25
Total dissolved solids	494	332	236	196	106	28

All the springs in this area, except one near Spavinaw, discharge from the lower part of the "Boone Chert." Forty percent of the springs sampled yielded hard or very hard water. The sulfate, chloride, and nitrate contents are low. Spring water is typically of the calcium bicarbonate type.

Summary of Chemical Analyses of Water from Springs in "Boone Chert"

	CONCENTRATION (MG/L)					NUMBER OF ANALYSES
	MAXIMUM	UPPER QUARTILE[1]	MEDIAN	LOWER QUARTILE[2]	MINIMUM	
Hardness	190	138	110	88	58	22
Sulfate	15	5.2	1.6	1.2	0.5	22
Chloride	49	7.0	5.4	4.0	2.8	22
Nitrate	16	6.7	4.0	2.0	0.1	22
Total dissolved solids	243	164	142	110	83	22

About 40 percent of the wells in the Burgen Sandstone and related formations contained hard or very hard water. Two wells contained water with a total-dissolved-solids content greater than 500 mg/l. The sulfate, chloride, and nitrate contents of water from these formations are generally low except locally. Water from these rocks is typically of the sodium bicarbonate type.

Summary of Chemical Analyses of Water from the Burgen Sandstone and Related Formations

	CONCENTRATION (MG/L)					NUMBER OF ANALYSES
	MAXIMUM	UPPER QUARTILE[1]	MEDIAN	LOWER QUARTILE[2]	MINIMUM	
Hardness	404	164	118	78	9	20
Sulfate	166	26	16	12	0.6	20
Chloride	92	70	12	4.4	2.4	20
Nitrate	26	4.3	1.1	0.2	0.0	20
Total dissolved solids	900	292	221	179	118	20

Chemical quality of water generally fair to good

Areas labeled *A* are underlain at depths of 200 feet or less by "Boone Chert." Areas labeled *B* are underlain by alluvium and terrace deposits along the Arkansas River and alluvium along the Neosho and Verdigris Rivers. Area labeled *C* is underlain by Noxie Sandstone Member of Chanute Formation.

Samples from the Noxie Sandstone and the buried "Boone Chert" are too few to define the characteristics of the water in detail.

About 80 percent of the wells sampled in the alluvium contained hard or very hard water, and nearly 30 percent contained water with a dissolved-solids content greater than 500 mg/l. Sulfate, chloride, and nitrate contents are generally low to moderate, except locally. The water is commonly of the sodium or calcium bicarbonate type.

Summary of Chemical Analyses of Water from Alluvium and Terrace Deposits

	CONCENTRATION (MG/L)					NUMBER OF ANALYSES
	MAXIMUM	UPPER QUARTILE[1]	MEDIAN	LOWER QUARTILE[2]	MINIMUM	
Hardness	540	275	185	156	34	18
Sulfate	519	56	26	5.3	0.0	17
Chloride	265	48	22	11	3.0	18
Nitrate	30	7.6	0.8	0.1	0.0	18
Total dissolved solids	1,140	663	335	240	105	17

Chemical quality of water generally poor to fair

This area is underlain mainly by Pennsylvanian shale, siltstone, and sandstone, and by Mississippian limestone and shale above the "Boone Chert." Of the water samples tested, 27 percent contained more than 250 mg/l sulfate, 20 percent contained more than 250 mg/l chloride, and 62 percent contained more than 500 mg/l total dissolved solids. Seventy-two percent of the wells sampled contained hard or very hard water. Three samples contained more than 45 mg/l nitrate; all three of these are from wells that apparently are polluted. Water from sandstone is least mineralized, whereas, that from shale, particularly shale containing coal beds, is most mineralized.

Summary of Chemical Analyses of Water from Pennsylvanian and Upper Mississippian Rocks

	CONCENTRATION (MG/L)					NUMBER OF ANALYSES
	MAXIMUM	UPPER QUARTILE[1]	MEDIAN	LOWER QUARTILE[2]	MINIMUM	
Hardness	1,300	404	268	116	28	58
Sulfate	2,090	250	75	27	1.8	58
Chloride	1,520	140	37	7.6	1.8	58
Nitrate	228	5	1.4	0.2	0.0	58
Total dissolved solids	3,220	1,100	576	324	117	58

Water from deep aquifers

Water from deep aquifers, notably the Roubidoux Formation, is generally of good quality in Ottawa County, where it is of the calcium bicarbonate type. Farther west, in Craig County, the character of the water changes to the sodium chloride type, and its quality deteriorates. Water from deep wells in this area commonly contains hydrogen sulfide, which gives the water an unpleasant odor. Analyses of water samples collected in the southeastern part of the quadrangle are too few to define the characteristics of the water in detail, but it probably is fair to good. The map pattern shows the estimated approximate limit of at least fair-quality water from the deep aquifers. Farther west, in the vicinity of Pryor, the deep aquifers are known to yield brine.

Summary of Chemical Analyses of Water from Deep Aquifers

	CONCENTRATION (MG/L)					NUMBER OF ANALYSES
	MAXIMUM	UPPER QUARTILE[1]	MEDIAN	LOWER QUARTILE[2]	MINIMUM	
Hardness	420	174	146	133	118	32
Sulfate	124	21	16	12	0.3	32
Chloride	780	232	79	14	1.6	32
Nitrate	8.0	2.1	0.8	0.2	0.0	32
Total dissolved solids	1,570	580	276	166	140	32

[1]Upper quartile—25 percent of the samples had a content greater than the value shown and 75 percent had less.

[2]Lower quartile—25 percent of the samples had a content less than the value shown and 75 percent had more.

Area boundary; dashed where approximately located

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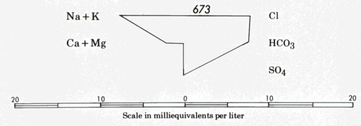
Well from which water sample was taken
Number beside well symbol is well depth in feet

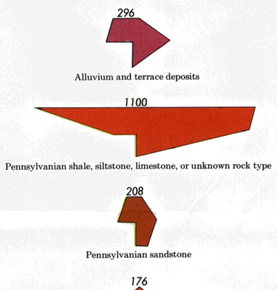
Spring from which water sample was taken

WATER-QUALITY DIAGRAMS

Diagrams show the general chemical character of ground water and are based on analyses of water from wells or springs at the indicated points. Ionic concentrations are plotted for sodium plus potassium (Na + K), calcium plus magnesium (Ca + Mg), chloride (Cl), bicarbonate (HCO_3), and sulfate (SO_4). Anions are plotted to the right of the center line and cations to the left. The area of the diagram is an indication of the dissolved-solids content—larger areas reflect greater dissolved-solids content. Variations in shape of the diagrams reflect variations in chemical character. Numbers above diagrams are total dissolved solids in milligrams per liter.



SOURCES OF WATER



CHEMICAL QUALITY OF GROUND WATER

To provide data on the chemical quality of ground water in the Tulsa quadrangle, water samples from 87 wells and 25 springs were collected and analyzed by the U.S. Geological Survey. Laboratory determinations were made for hardness and sodium and potassium, calcium and magnesium, chloride, bicarbonate, sulfate, nitrate, and total-dissolved-solids concentrations. Other analyses used in the preparation of this report were taken from various published reports and from the files of the U.S. Geological Survey. Several analyses of water in Delaware County were provided by the U.S. Public Health Service.

All ground water contains minerals dissolved mainly from soil and rocks. High concentration of dissolved minerals may restrict use of water for many purposes. The U.S. Public Health Service Drinking Water Standards state that the following chemical substances should not be present in a water supply in excess of listed concentrations if, in the judgment of the reporting agency and certifying authority, other suitable supplies are or can be made available.

CONSTITUENT	MAXIMUM CONCENTRATION RECOMMENDED (MILLIGRAMS PER LITER)
Sulfate	250
Chloride	250
Nitrate	45
Total dissolved solids	500

Various types of minerals in rock are the major source of sulfate in ground water. When in combination with calcium, sulfate may cause hard scale in boilers, water heaters, and pipes. A laxative effect may result when sulfate is in combination with magnesium. Sulfate in excessive amounts gives water an unpleasant taste.

Chloride is derived from some minerals, from ancient sea brines trapped in the rocks, and from human, animal, and industrial wastes. Chloride in small amounts has little effect on the usability of water for most purposes, but in concentrations of several hundred milligrams per liter it gives water a salty taste. Small to moderate amounts of chloride have been reported to increase the corrosive characteristics of water.

Nitrate is derived from human and animal wastes and nitrates in the soil; fertilizer is a source of nitrate. Concentrations greater than 45 mg/l (milligrams per liter) may cause methemoglobinemia ("blue baby") in infants, and, therefore, waters with high nitrate content should not be used for infant feeding or by expectant mothers.

Total dissolved solids consist principally of dissolved-mineral constituents but include organic material that may be present after a measured quantity of water has been evaporated. Large amounts of dissolved solids limit the use of water for many purposes.

Hard water is objectionable because of its scale-forming properties and because it makes large amounts of soap necessary. The U.S. Geological Survey classifies water having a hardness less than 60 mg/l as soft; 60 to 120 mg/l, moderately hard; 121 to 180 mg/l, hard; and more than 180 mg/l, very hard.

Some mineralization may be due to contamination by oil-well brines, particularly in Washington, Tulsa, Nowata, and parts of Rogers Counties, which include many oil fields. Such contamination is caused by seepage from waste pits, defective well casing, defective well plugging, water-flooding operations, and improper brine disposal.

In coal-field areas in Rogers, Craig, and Nowata Counties, much mineralization of ground water is due to its having been in contact with buried coal beds. Water from abandoned coal pits also may be a source of local ground-water contamination. However, the effect of mineralized water from coal pits on ground water probably is small because rocks adjacent to coal pits generally have a very low permeability.

RECONNAISSANCE OF THE WATER RESOURCES OF THE TULSA QUADRANGLE, NORTHEASTERN OKLAHOMA

MELVIN V. MARCHER AND ROY H. BINGHAM

1971

Cartographer: Marion E. Clark, Oklahoma Geological Survey