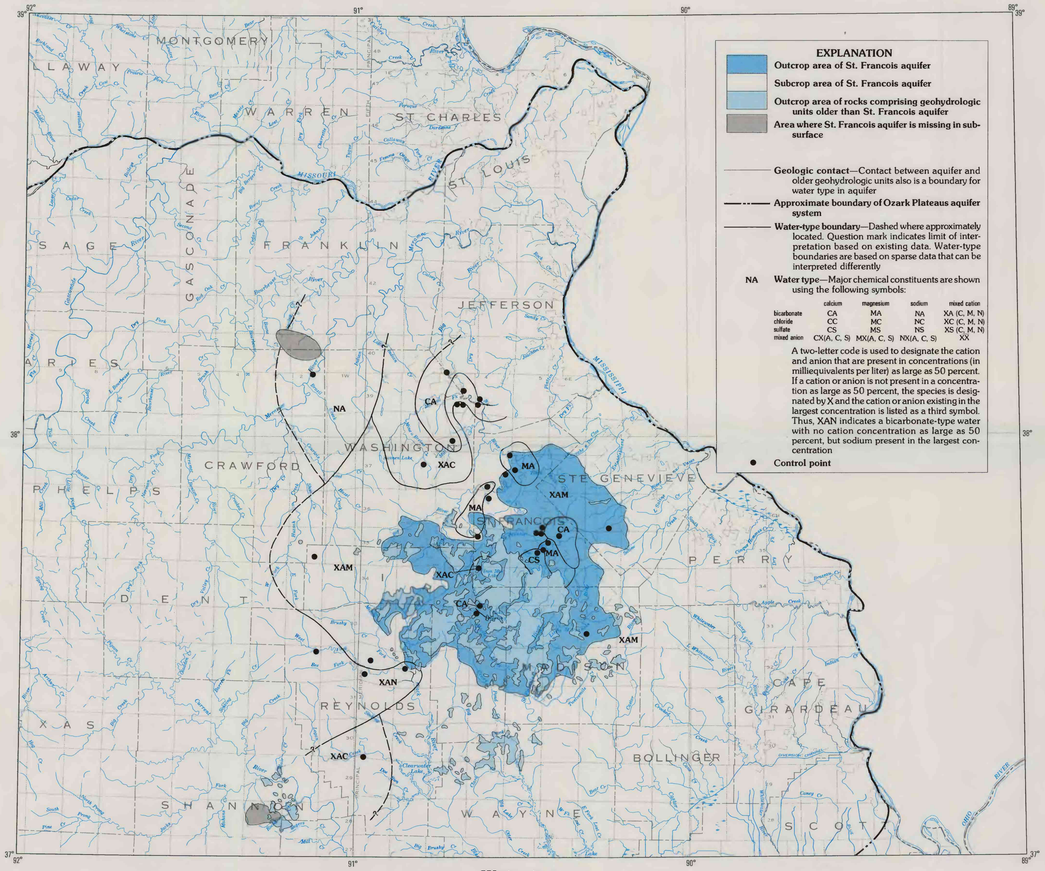
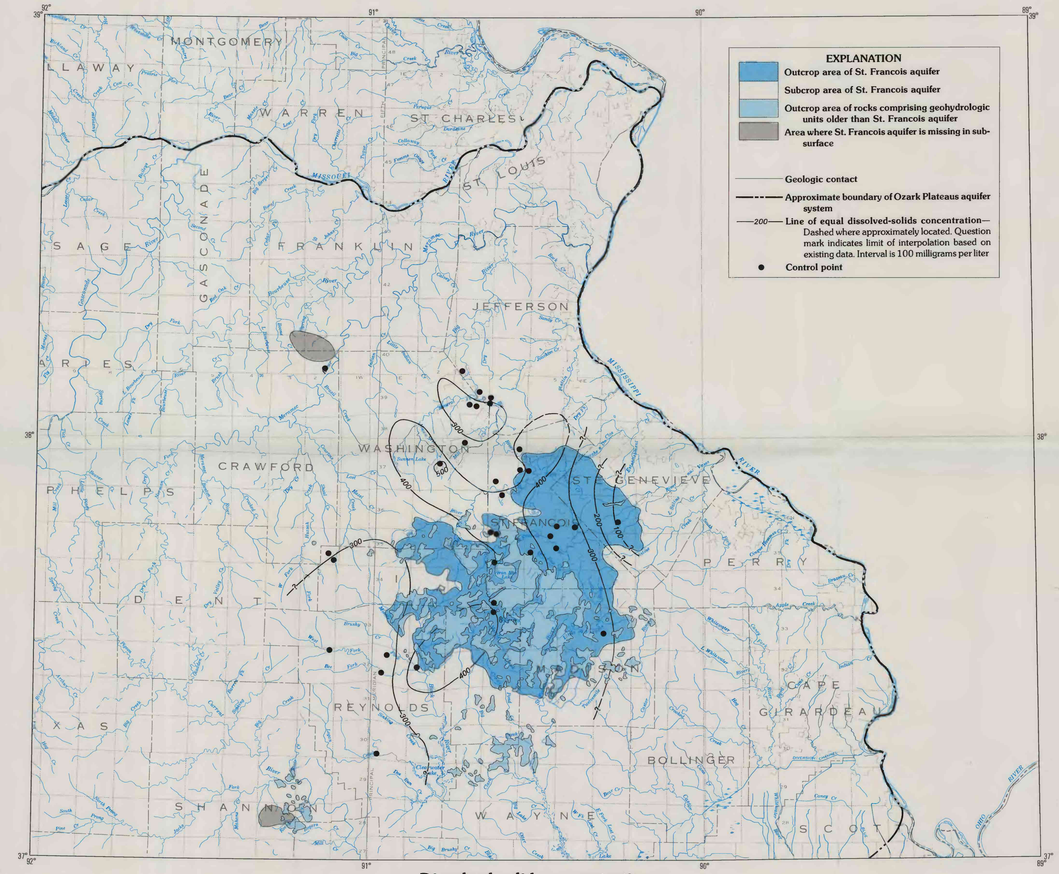
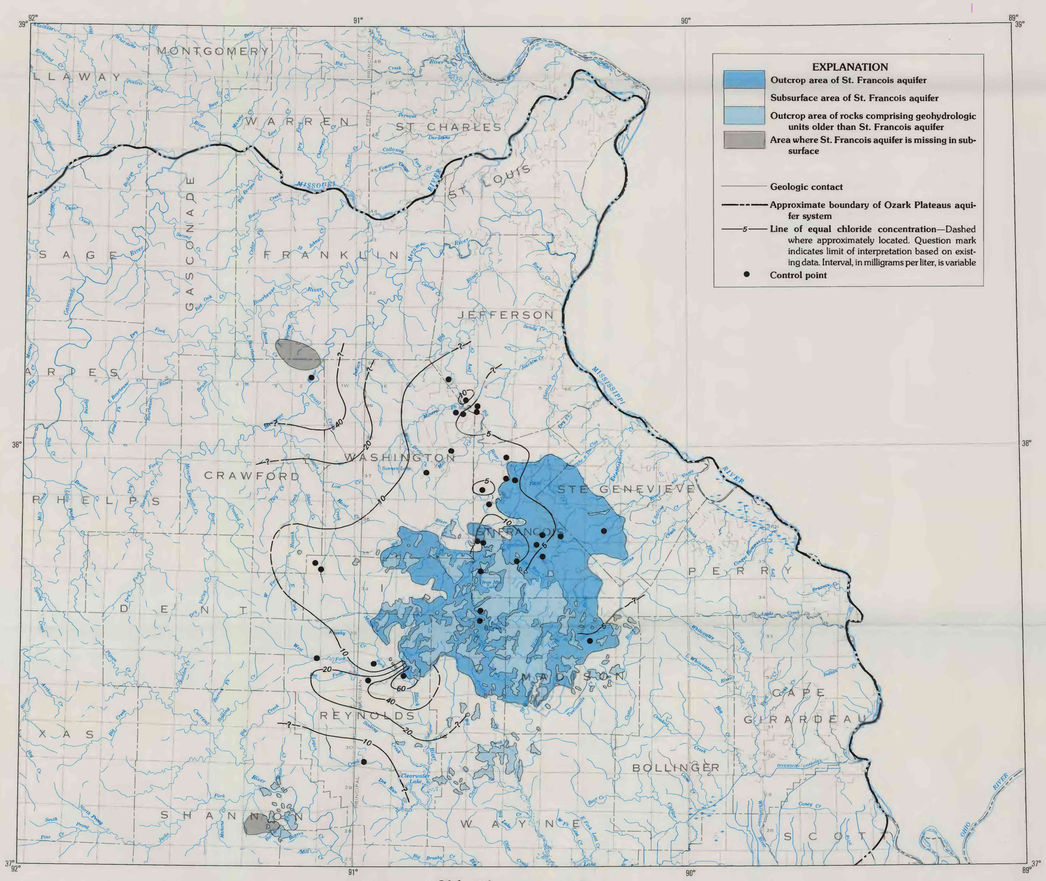
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY



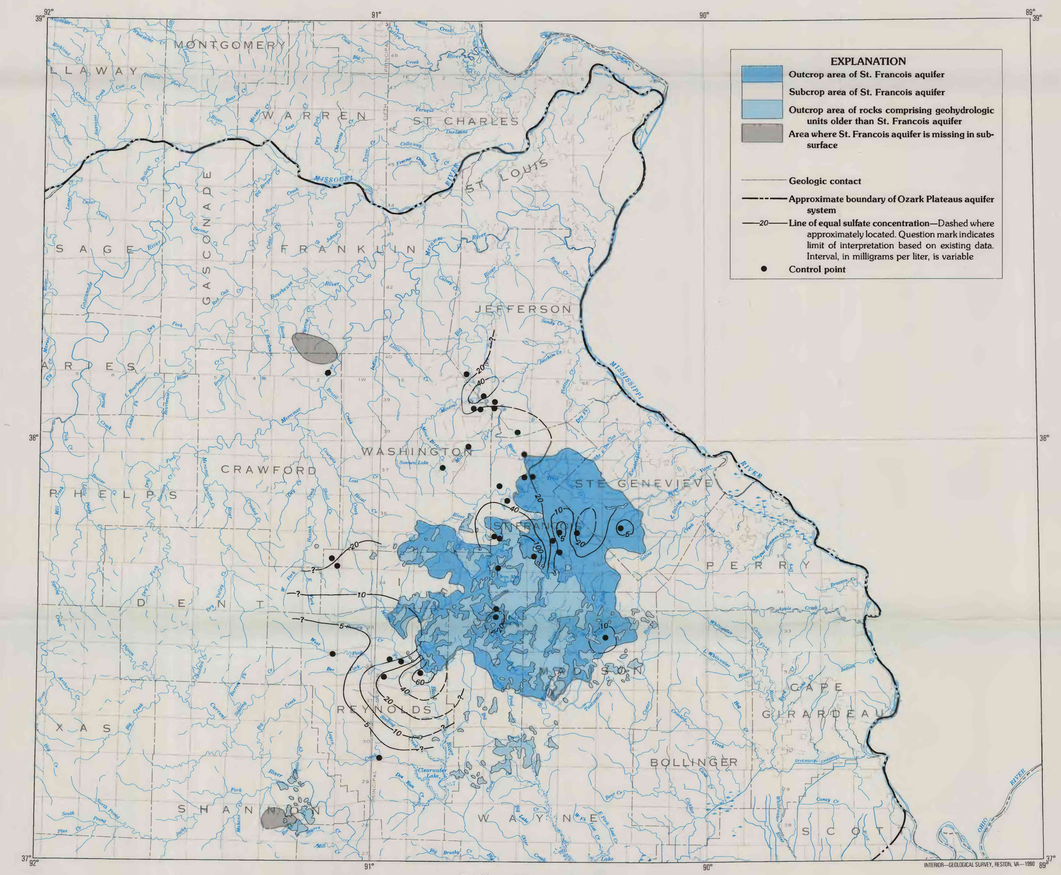
Water type



Dissolved-solids concentration



Chloride concentration



Sulfate concentration

Base from U.S. Geological Survey
Missouri State base maps, 1:500,000; 1973

SCALE 1:750 000

25 0 25 50 75 100 MILES
25 0 25 50 75 100 KILOMETERS

WATER TYPE AND CONCENTRATION OF DISSOLVED SOLIDS, CHLORIDE, AND SULFATE IN WATER FROM THE ST. FRANCOIS AQUIFER IN MISSOURI, ARKANSAS, KANSAS, AND OKLAHOMA

By
J.L. Imes and J.V. Davis
1990

HYDROLOGIC INVESTIGATIONS
ATLAS HA–711–J

INTRODUCTION

The St. Francois aquifer, the lowermost of three regional aquifers that form part of the Ozark Plateaus aquifer system, is composed of water-bearing sandstone and dolostone of Late Cambrian age. The aquifer was studied as part of the Central Midwest Regional Aquifer-System Analysis (CMRASA; Jorgensen and Signor, 1981), a study of regional aquifer systems in the midcontinent United States that includes parts of 10 States. Because of its significance as a source of freshwater in and adjacent to the Ozark Plateaus province (index map) of Missouri, Arkansas, Kansas, and Oklahoma, a subregional project was established to investigate the Ozark Plateaus aquifer system in more detail than the regional study could provide.

The geologic and hydrologic relation between the Ozark Plateaus aquifer system and other regional aquifer systems of the Midwest is presented in Jorgensen an others (in press). The relation of the St. Francois aquifer to the Ozark Plateaus aquifer system is explained in Imes [in press (a)]. A companion publication, Imes [in press (b)], contains contour maps of the altitude of the top, thickness, and potentiometric surface of the St. Francois aquifer. This report contains maps that show water type and concentration of dissolved solids, chloride, and sulfate in water from the St. Francois aquifer. Most of the data from which these maps are compiled is stored in the CMRASA hydrochemical data base (R.B. Leonard, U.S. Geological Survey, written commun., 1986). Only water quality analyses that ionically balanced to within 10 percent are included in this report. Because few water wells are completed in the St. Francois aquifer beyond the vicinity of the St. Francois Mountains in southeastern Missouri (index map), water-quality data, with few exceptions, are limited to a relatively small area near the outcrop of the aquifer.

WATER QUALITY

Water type is determined by the relative concentration of major cations (calcium, magnesium, and sodium) and anions (bicarbonate, chloride, and sulfate) in the water. Water-type maps can contain general information of the chemical evolution of ground water as it moves through the rock matrix. Several factors collectively determine the distribution and concentration of chemical constituents in ground water. The more significant factors include the concentration of carbon dioxide in the water as it percolates to the water table and enters the ground-water flow system, the minerals present in each of the various lithologic units encountered by the water as it moves through the rock matrix, the order in which ground water encounters the lithologic units, and the residence time of the water in each rock unit. The water-type map shows the distribution of cations and anions that are most prevalent in water from the St. Francois aquifer.

The dissolved-solids concentration in fresh ground water is a general measure of the quantity of minerals that may have been dissolved from the surrounding rocks. The dissolved-solids concentration of a water sample can be directly measured as the residue obtained after evaporation of the fluid or calculated as the sum of the concentrations of the individual chemical components in the water sample. Both methods are represented in the data used in this report.

The U.S. Environmental Protection Agency (1968) recommends an upper limit of 500 mg/L (milligrams per liter) dissolved-solids concentration for potable drinking water. Larger dissolved-solids concentrations can cause an unpleasant taste and cause corrosion and encrustation of metal water pipes, depending on the composition of the dissolved solids. However, no obvious detrimental effect has been noted on the health of populations that must, through lack of alternative supplies, drink water containing more than 500 mg/L (exclusive of toxic materials) dissolved-solids concentration (Hem, 1985, p. 212). Sodium commonly is a primary constituent in water containing a large concentration of dissolved solids. Drinking water that contains a large sodium concentration may be detrimental to the health of persons who require a low-sodium diet.

The U.S. Environmental Protection Agency (1986) recommends 250 mg/L as the maximum concentrations of chloride and sulfate in domestic water supplies. Chloride ions impart an unpleasant taste to water in lower concentrations than some other constituents. Hem (1985, p. 212) reported that chloride concentrations of 400 mg/L cause a noticeable salty taste for most people. Excessive sulfate concentrations in drinking water have a laxative effect.

WATER TYPE

Water type near the outcrop area primarily is a product of dissolution of the dolostone and limestone that dominate the upper part of the St. Francois aquifer. Bicarbonate is the dominate anion in most samples of water from wells near the outcrop area of the aquifer. In much of this area, the concentration of none of the three major cations (in milliequivalents per liter) exceeds 50 percent of the total ions, but calcium and magnesium generally are present in the largest concentrations. Locally, the water type can be calcium bicarbonate or magnesium bicarbonate. The water type in four wells located a few miles northwest and southwest of the outcrop area are sodium bicarbonate, or mixed-cation bicarbonate with sodium as the dominant cation.

DISSOLVED SOLIDS

Near the St. Francois Mountains the dissolved-solids concentration of water in the aquifer generally ranges from about 100 to about 500 mg/L. The smallest concentration of dissolved solids was measured in a water sample from a well located east of the mountains in the largest uninterrupted part of the outcrop area. Most of the available data show dissolved-solids concentrations greater than 300 mg/L. Dissolved-solids concentration of the water in one well northwest of the St. Francois Mountains exceeded 500 mg/L. The dissolved-solids concentration of water in the St. Francois aquifer, near the outcrop area, generally is within the recommended 500 mg/L limit for potable water (U.S. Environmental Protection Agency 1986).

CHLORIDE

The chloride concentration in water from the St. Francois aquifer near the St. Francois Mountains generally range from 5 mg/L to 60 mg/L. Water from only three wells, located northwest and southwest of the St. Francois Mountains, contained chloride concentrations that exceeds 20 mg/L. Elsewhere chloride concentrations were less than 20 mg/L and generally were less that 10 mg/L. Wells east of the St. Francois Mountains, in the largest unbroken outcrop area, generally contained less than 5 mg/L chloride.

SULFATE

Sulfate concentrations in water from the St. Francois aquifer generally range from 2 to 100 mg/L. The areas of larger and smaller sulfate concentrations have a somewhat similar distribution pattern to that shown by chloride concentrations. The wells that contained large concentrations of sulfate are located at the northern edge of the St. Francois Mountains in southwest St. Francois County. Water in one well contained 150 mg/L sulfate. The principal source of sulfate in the predominately dolostone and sandstone aquifer probably is oxidation of the sulfide-rich mineral deposits that surround the core of the St. Francois Mountains. Lead and zinc ores have been, and are being, extensively mined along the western and northeastern flanks of the mountains.

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INDEX MAP

For sale by U.S. Geological Survey Map Distribution, Box 25286, Federal Center, Denver, CO 80225