GROUND—WATER QUALITY

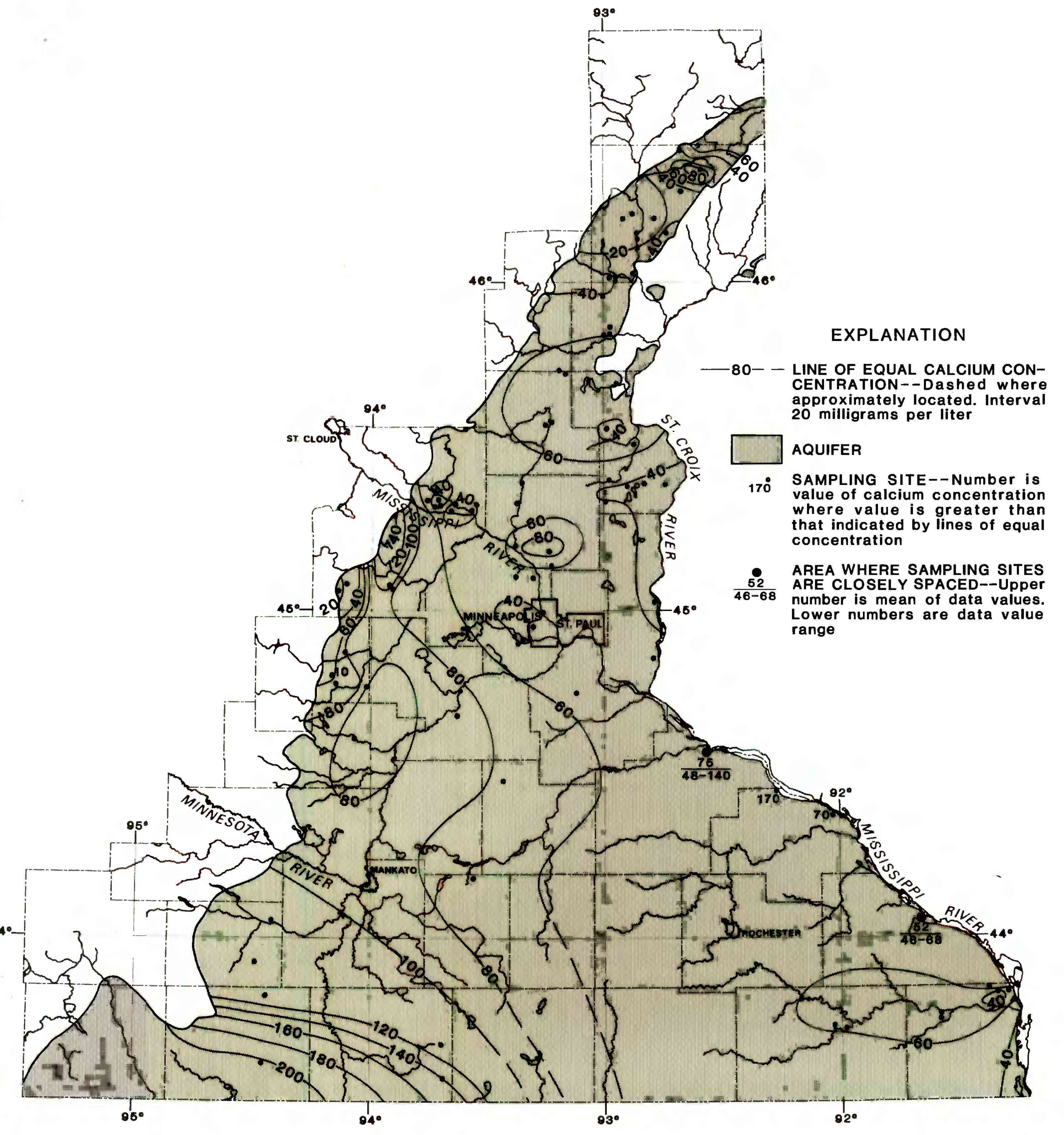

Figure 9.--Calcium concentration

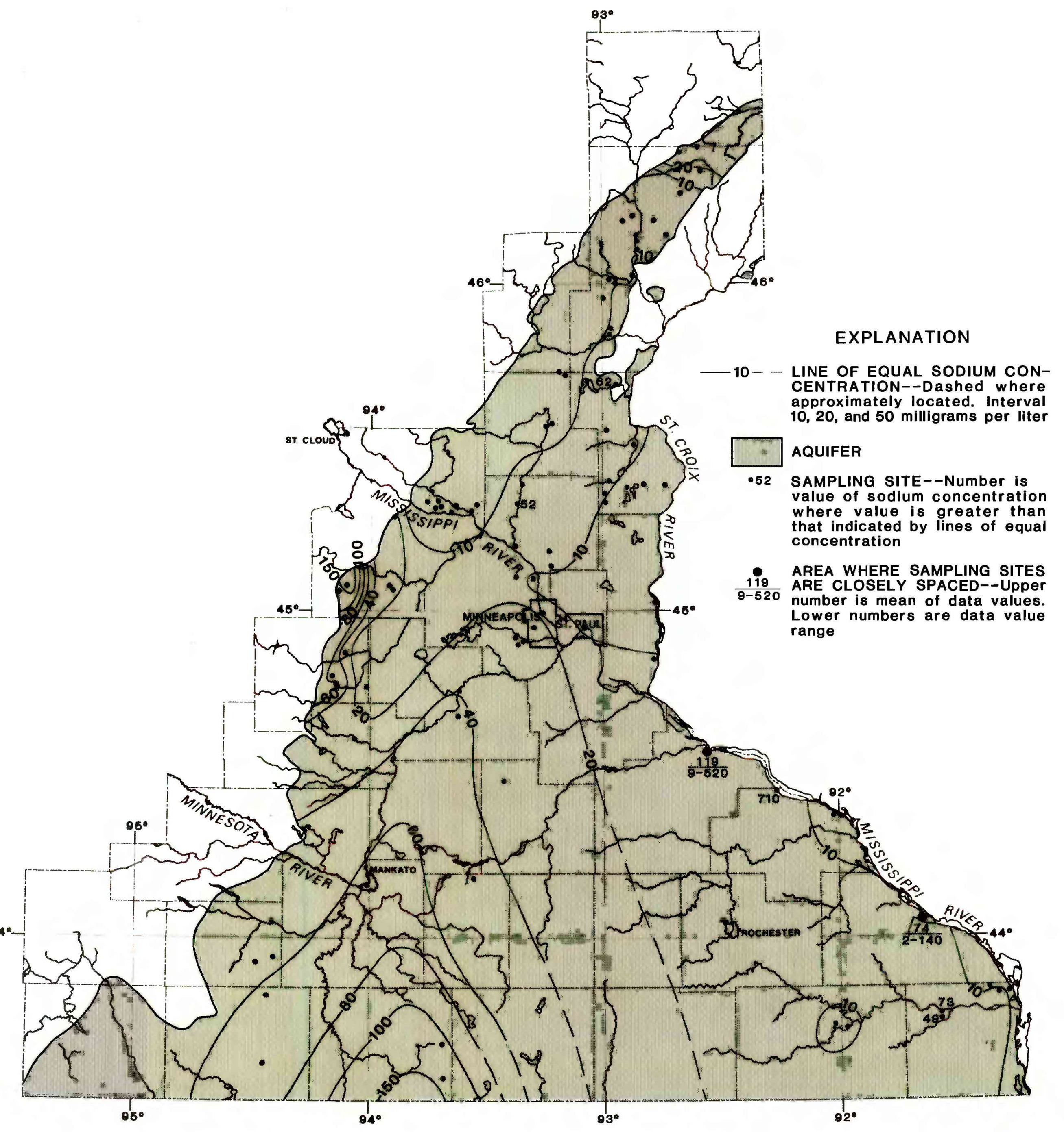

Figure 10.--Sodium concentration

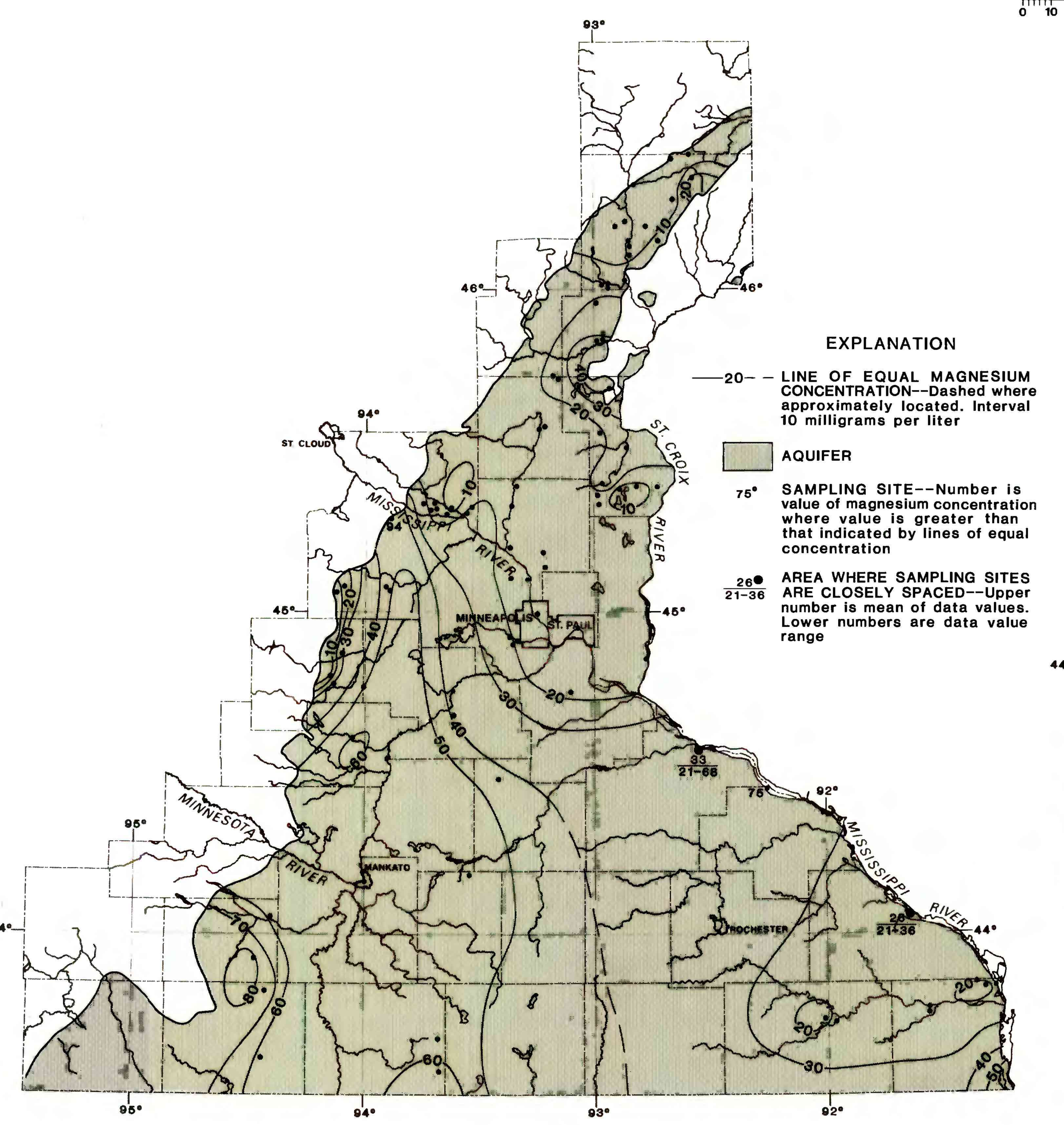

Figure 11.--Magnesium concentration

GROUND-WATER QUALITY

The quality of water in the Mount Simon-Hinckley aquifer is generally acceptable for municipal, industrial, and domestic uses. The mean, median, and range of selected chemical-constituent concentrations and properties of water from the aquifer are shown in table 3. Values used in preparation of table 3 and the dissolved-solids and ion-concentration maps (figs. 8-14) are based on data from the U.S. Geological Survey Water Data Storage and Retrieval System (WATSTORE), from the U.S. Environmental Protection Agency Storage and Retrieval System (STORET), and from the Minnesota Department of Health. The bulk of the chemical analyses were made during 1960-80.

Dissolved Solids

Dissolved-solids concentration, a measure of dissolved substances in water, is a common indicator of suitability for various uses. Water with less than 500 milligrams per liter (mg/L) dissolved solids is generally satisfactory for domestic and industrial uses.

The known dissolved-solids concentration in water from the aquifer ranges from a minimum of 48 mg/L to a maximum of 2,810 mg/L (table 3). The lowest values are in the eastern and northern parts of the aquifer (fig. 8), where bedrock is at or close to the land surface. The highest concentrations are in the southwestern part of the aquifer because of highly mineralized leakage from overlying Cretaceous rocks. Concentrations are also high along the Mississippi River valley, where ground water from deep in the flow system discharges to the River. Generally, the dissolved-solids concentration increases with depth in the aquifer (Anderson and others, 1974).

Water Types and Major Ions

Ground water is commonly classified on the basis of relative concentrations of major cations and anions, in milliequivalents. This classification provides the basis for grouping waters of similar types and for evaluating chemical mechanisms that effect changes in water quality. The general chemical types of water from the Mount Simon-Hinckley aquifer are shown by nine patterns of the major cations and anions (fig. 8). Water in the aquifer is predominately of the calcium magnesium bicarbonate type. This water type generally occurs where drift immediately overlies the aquifer and in the upper part of the aquifer. Sodium chloride type water occurs at depth locally in the aquifer and in the discharge area along the Minnesota, St. Croix, and Mississippi Rivers (fig. 8). Magnesium and sulfate concentrations locally increase where the aquifer is overlain by Cretaceous deposits.

The areal distribution of major ion concentrations varies considerably (figs. 8-14). Highly mineralized leakage from overlying Cretaceous deposits and the general pattern of lateral flow away from the southwest corner are influences on the ionic concentration patterns. Gradual dilution of ground water is likely as the water moves from recharge areas in the southwest toward discharge areas along major rivers. The concentrations of calcium, magnesium, and sulfate generally increase toward the southwest. The decrease in bicarbonate concentration in the southwest corner corresponds to the area where sulfate is the dominant anion. The several areas with similarly high concentrations of calcium and bicarbonate ions attest to the predominance of these ions throughout the aquifer. The concentration of chloride ion decreases from the area of high values in the east-central area of the aquifer. Sodium decreases away from the western and southern parts of the aquifer, but bicarbonate decreases away from peak values closer to the center of the Hollandale embayment.

Water-Quality Problems

The concentrations of iron, manganese, sulfate, and dissolved solids in water from the aquifer all locally exceed standards recommended by EPA for public supply (table 3). High concentrations of calcium and magnesium also occur where the water has been in contact with limestone, dolomite, and gypsum.

Contamination from near-surface pollutants is unlikely because the aquifer is deeply buried throughout most of the area. However, faults and buried valleys that intersect the aquifer could provide paths for the entry of contaminants. The aquifer is unconfined in the northern part of the area, where it crops out or lies directly under the drift (Helgesen and others, 1973; Lindholm and others, 1974b). In these areas, the aquifer is highly susceptible to contamination from spills and leaks, agricultural activities, and waste disposal. In the Twin Cities basin, the aquifer is generally protected from contamination by overlying confining beds. However, improperly constructed or multiaquifer wells could provide conduits for the entry of contaminants (Hult and Schoenberg, 1981).

In the southern part of the area, the aquifer is deeply buried and is protected from contamination by overlying confining beds. However, as in the Twin Cities basin, contamination is possible through multiaquifer wells and by leakage through deteriorated or improperly grouted well casings and fractures in the confining layers.

Table 3.—Summary of representative water-quality analyses for selected constituents and properties of water from the aquifer

[Values are given in milligrams per liter, except as indicated. micromhos per centimeter, μmhos/cm; microgram per liter, μg/L]

Constituent or property	Recommended maximum or range for public supply[1]	Number of analyses	Mean	Median	Minimum	Maximum
Specific conductance (μmhos/cm at 25°C)	—	43	767	427	95	5,500
pH (units)	5.0-9.0	58	—	7.7	6.8	8.9
Temperature, water (°C)	—	31	10.8	11.1	7.1	14.4
Hardness as $CaCO_3$ (Mg,Ca)	—	58	230	220	36	740
Noncarbonate hardness	—	53	33	<1	<1	470
Calcium, dissolved (Ca)	—	58	61	56	10	210
Magnesium, dissolved (Mg)	—	55	27	22	<.1	94
Sodium, dissolved (Na)	—	55	44	15	2.0	710
Sodium percentage	—	40	21	14	<1	76
Potassium, dissolved (K)	—	47	7	3	.9	68
Bicarbonate (HCO_3)	—	51	280	280	44	550
Carbonate (CO_3)	—	34	<1	<1	<1	<1
Sulfate, dissolved (SO_4)	250	56	54	17	.5	570
Chloride, dissolved (Cl)	250	58	50	8	<.1	1,300
Fluoride, dissolved (F)	—	57	.3	.2	<.1	3.0
Silica, dissolved (SiO_2)	—	44	13	12	7.1	39
Dissolved solids (residue on evaporation at 180°C)	500	46	432	290	48	2,810
Nitrate, dissolved as N	10	33	.48	.22	<.01	2.5
Boron, dissolved as B, μg/L	—	44	99	—	<10	1,600
Phosphate, dissolved (PO_4)	—	19	.30	.02	<.01	4.8
Phosphorus, dissolved (P)	—	10	.04	.01	<.01	.13
Iron, dissolved as Fe, μg/L	300	46	924	535	10	9,200
Manganese, total as Mn, μg/L	50	45	96	40	<1	960

[1] U.S. Environmental Protection Agency, 1975, p. 59566-59587; 1977, p. 17143-17147.

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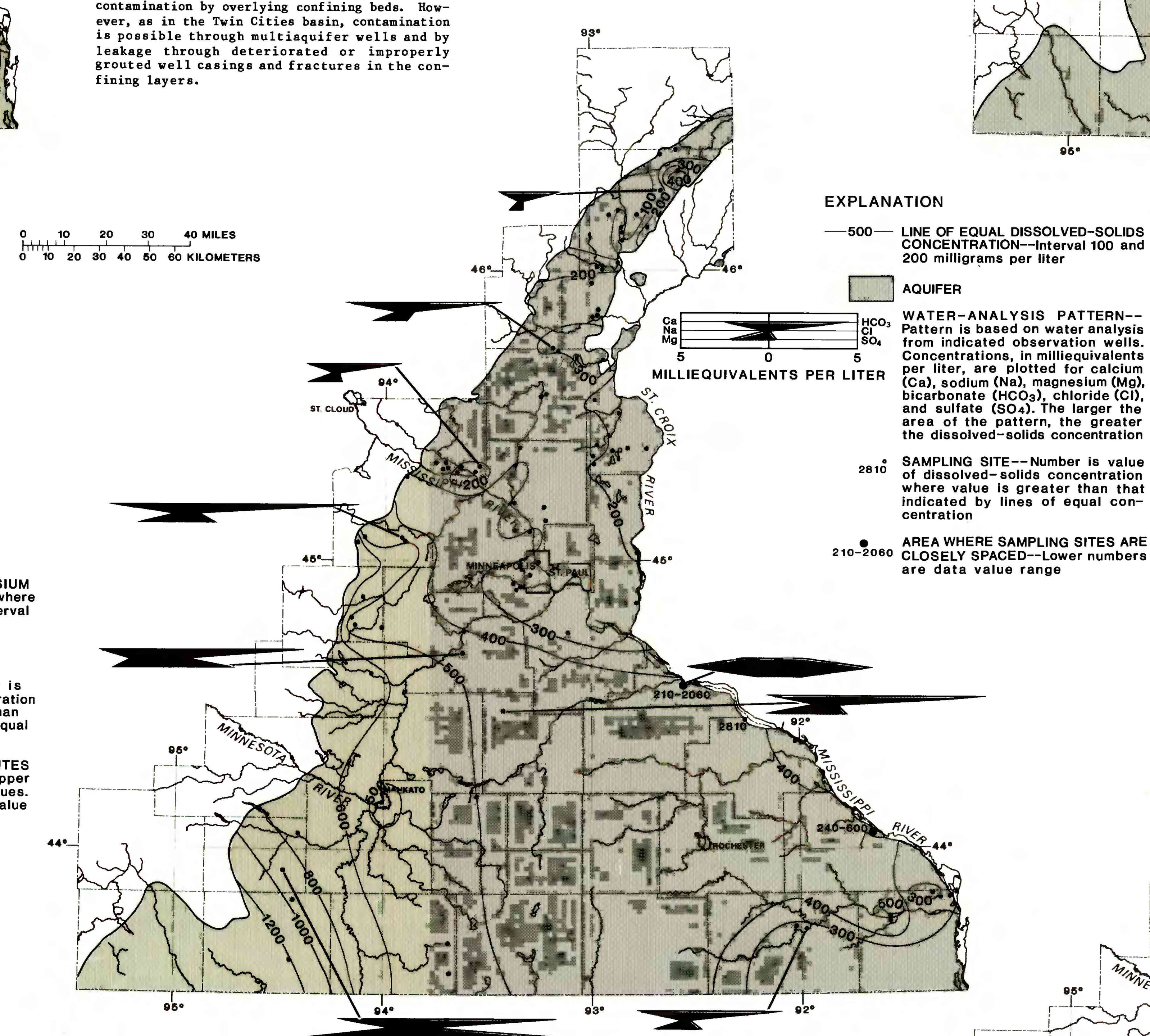

Figure 8.--Dissolved—solids concentration

CONVERSION FACTORS

For use by readers who prefer to use metric units, conversion factors for terms used in this report are listed below:

Multiply	By	To obtain
foot (ft)	0.3048	meter (m)
square mile (mi^2)	2.590	square kilometer (km^2)
gallon (gal)	3.785	liter (L)
gallon per minute (gal/min)	0.06309	liter per second (L/s)
foot per day (ft/d)	0.305	meter per day (m/d)

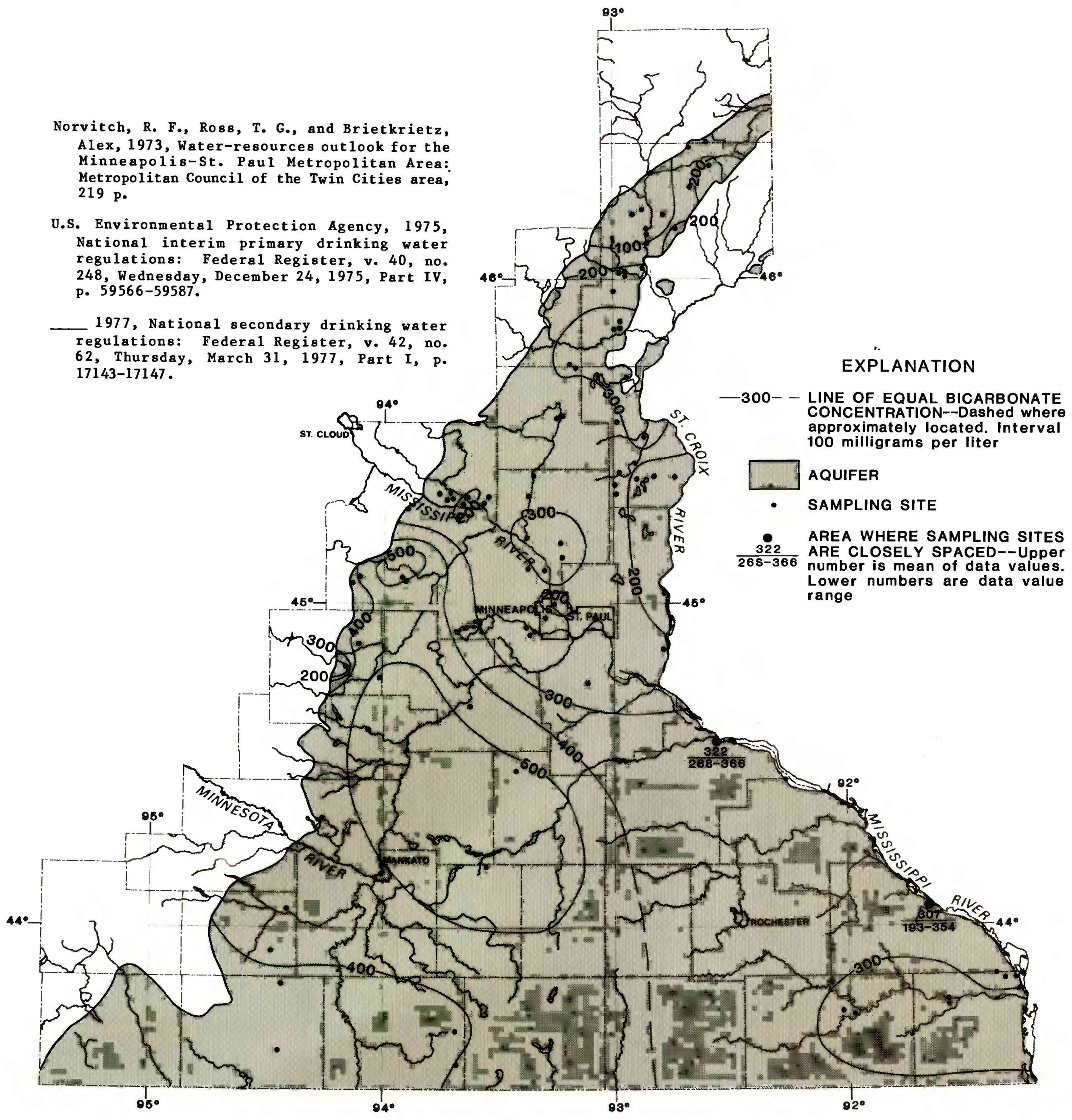

Figure 12.--Bicarbonate concentration

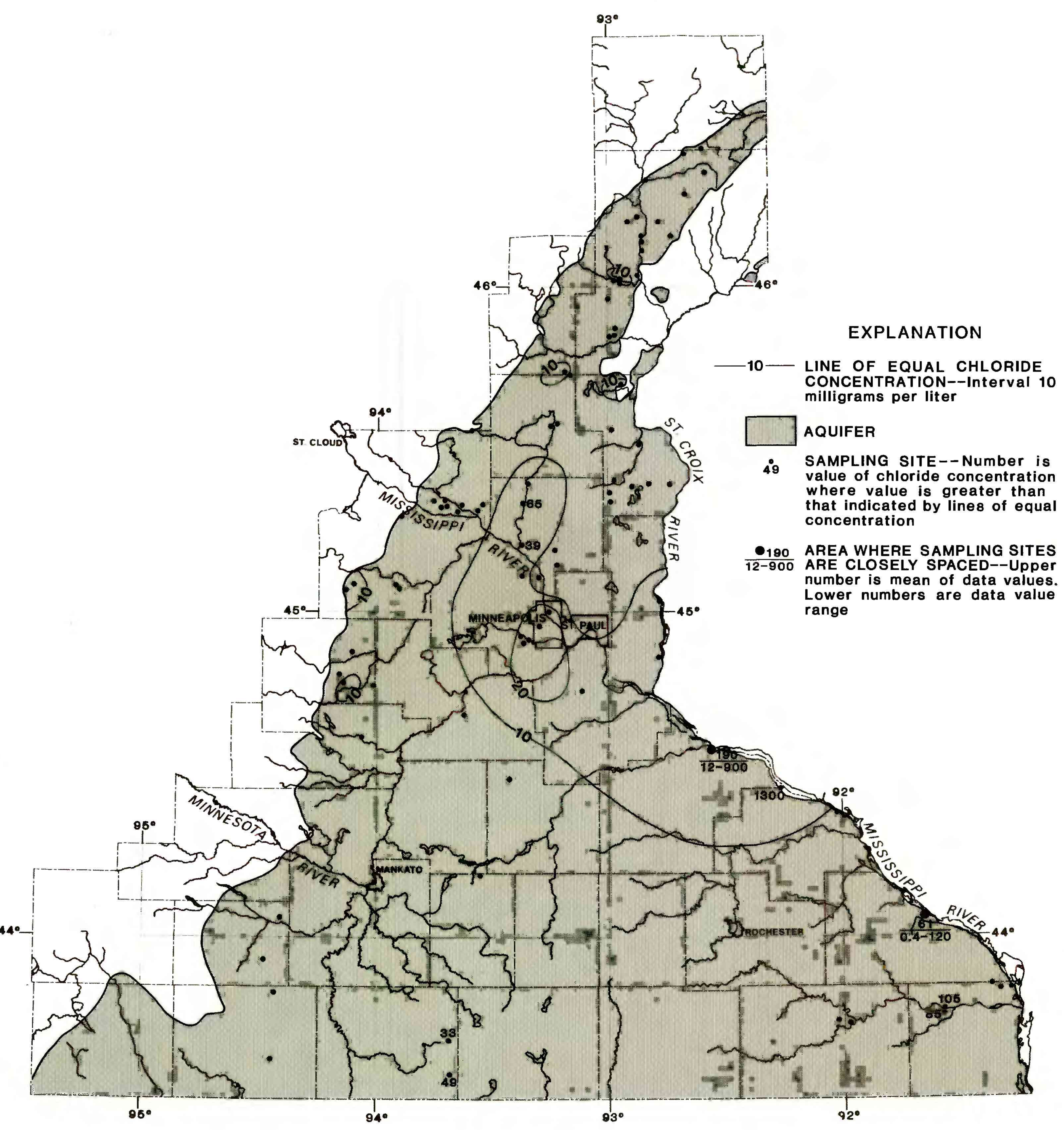

Figure 13.--Chloride concentration

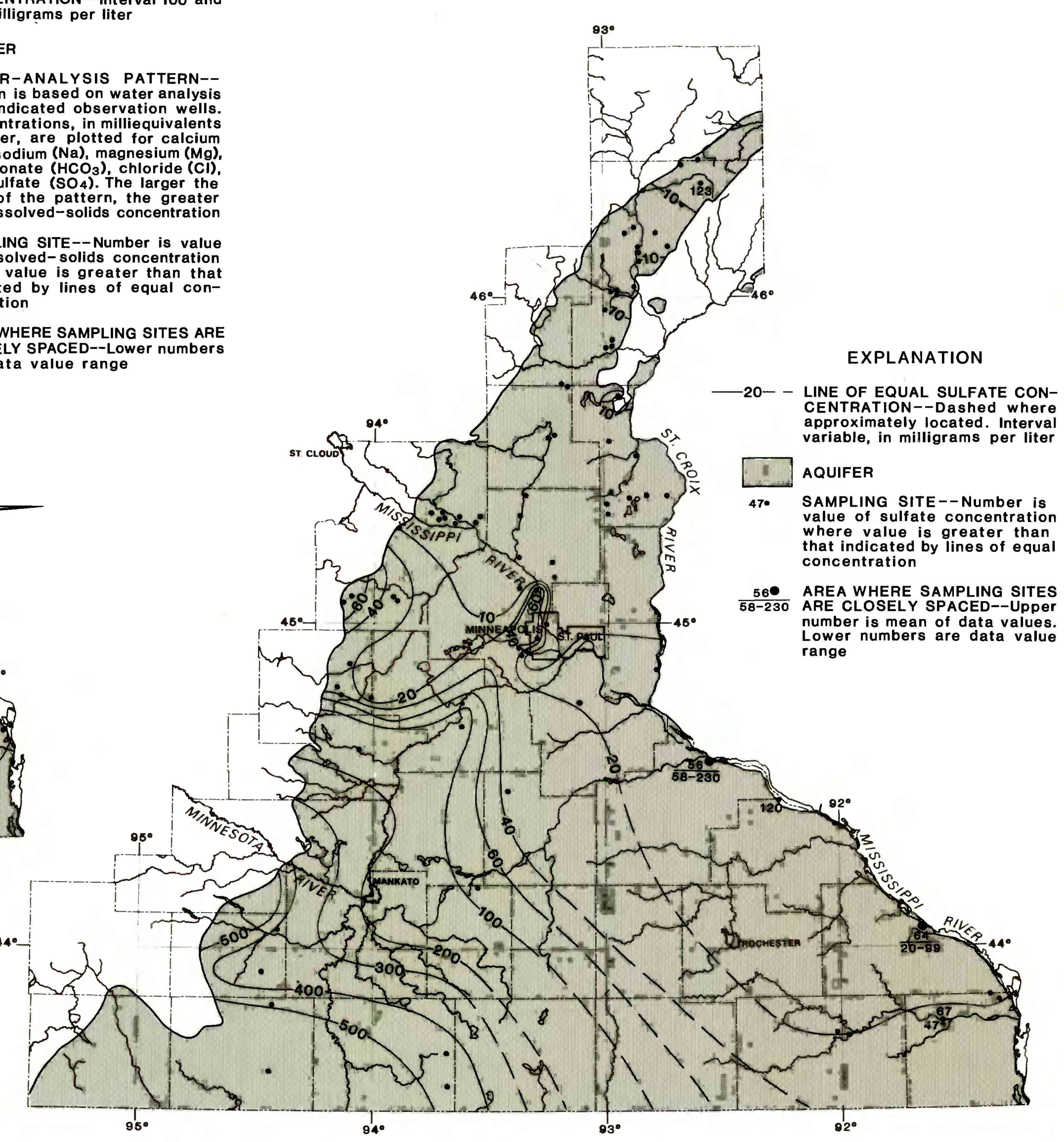

Figure 14.--Sulfate concentration

HYDROGEOLOGIC AND WATER—QUALITY CHARACTERISTICS OF THE MOUNT SIMON—HINCKLEY AQUIFER, SOUTHEAST MINNESOTA

BY
R. J. WOLF, J. F. RUHL, AND D. G. ADOLPHSON, 1983

Base from U. S. Geological Survey
State base map, 1:1,000,000, 1965