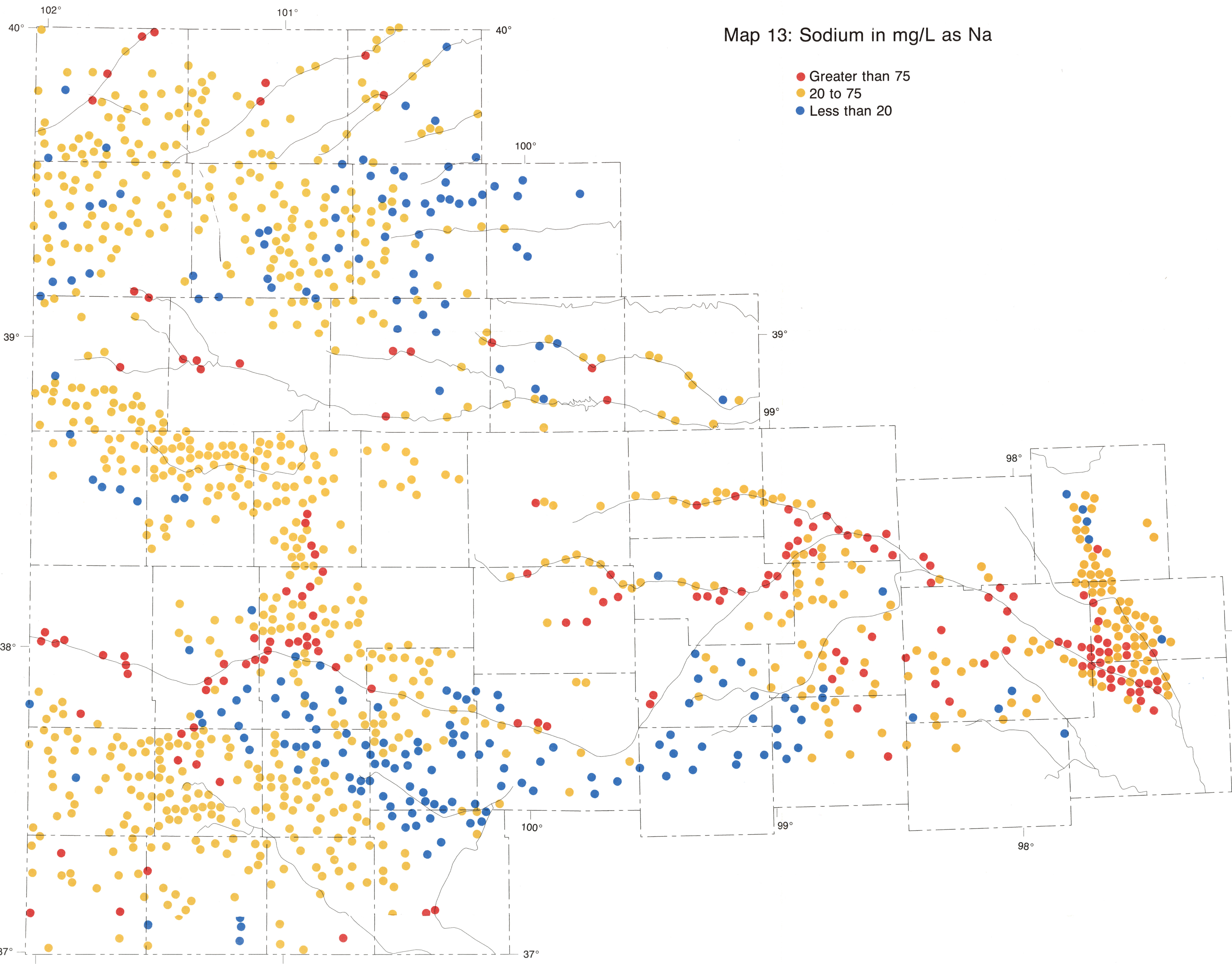


by  
L. R. Hathaway and L. M. Magnuson  
Kansas Geological Survey  
1985

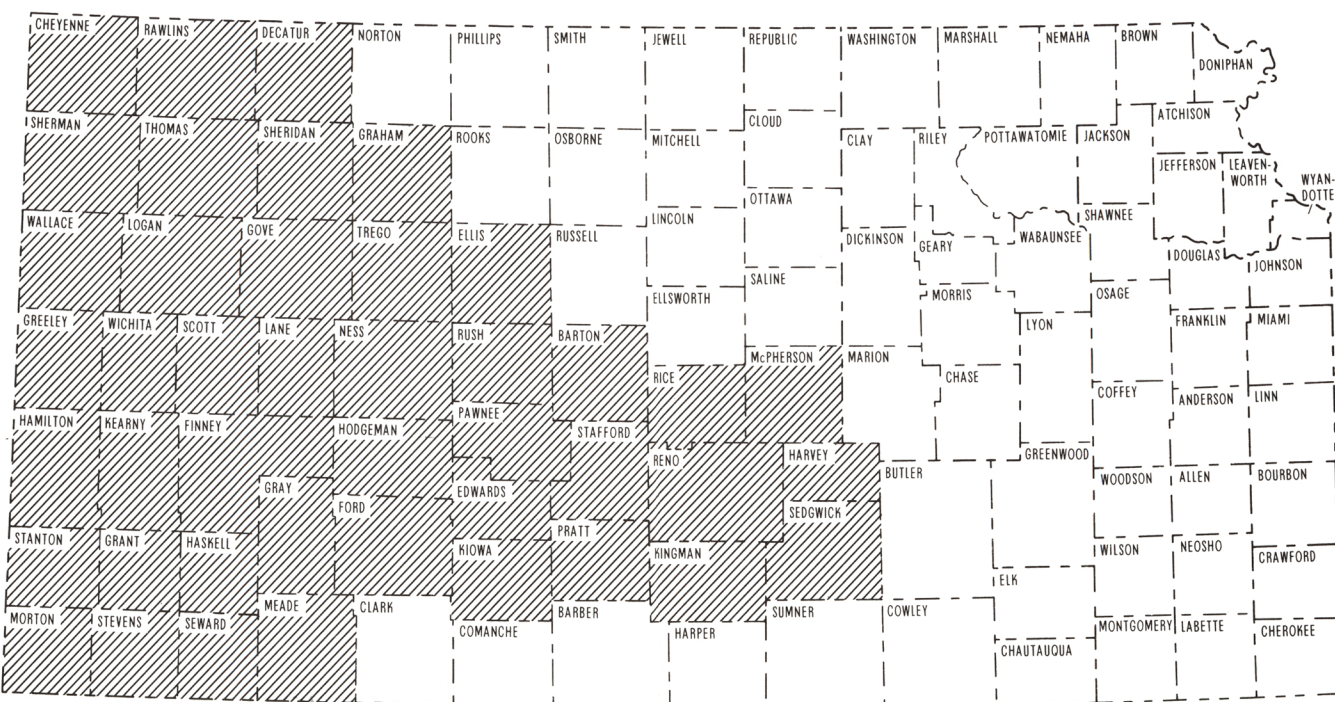
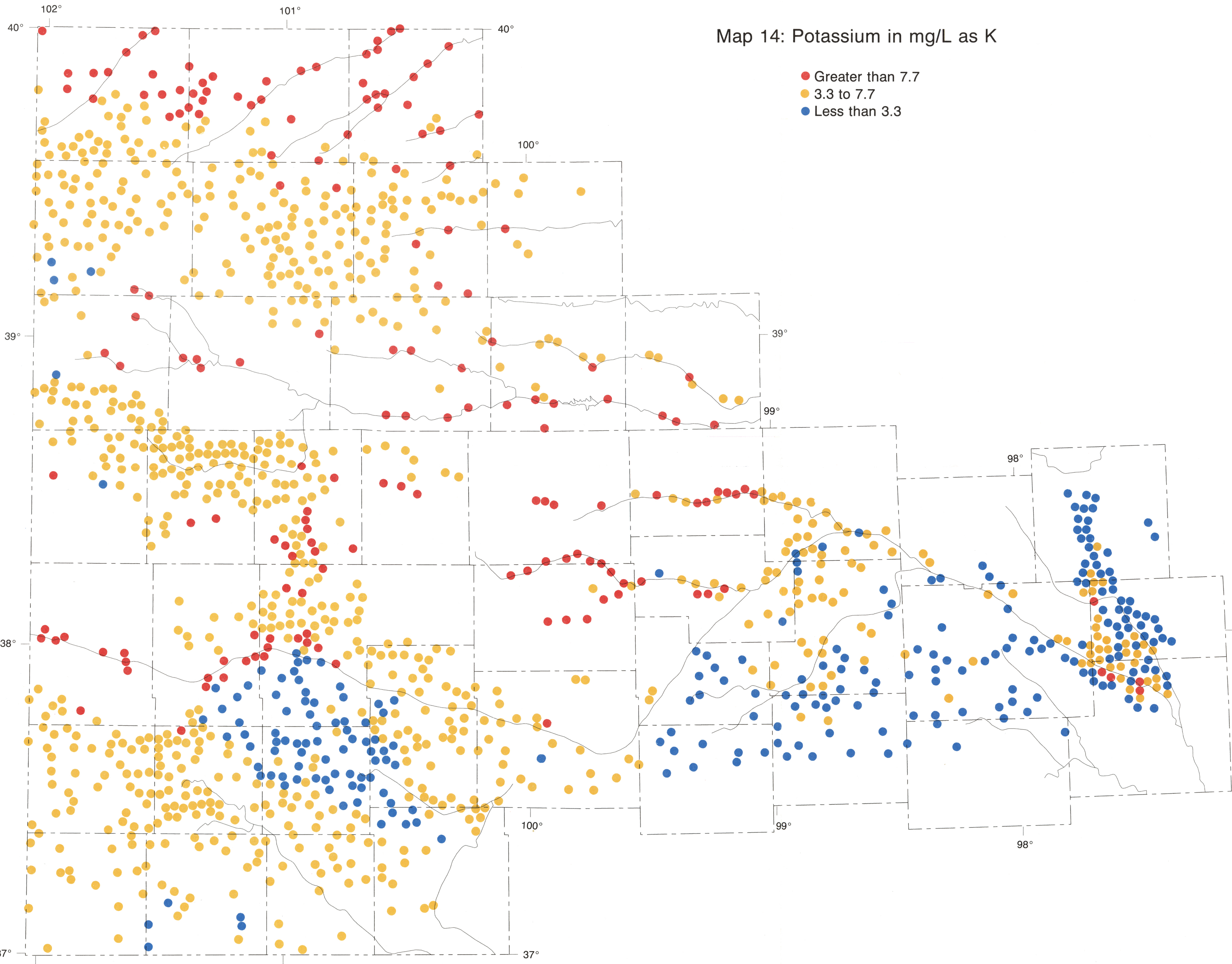
Map 13: Sodium in mg/L as Na

- Greater than 75
- 20 to 75
- Less than 20



Map 14: Potassium in mg/L as K

- Greater than 7.7
- 3.3 to 7.7
- Less than 3.3



Index map of study area.

The two most prominent members of the alkali-metal family of elements are sodium and potassium. Characteristic of these elements is the marked solubility of their common salts. Both sodium and potassium are common constituents of igneous rocks, with sodium being slightly more abundant. Weathering of igneous rocks leads to a fractionation of these two elements. In part this separation is due to the greater resistance of potassium feldspars to chemical attack. Once liberated, potassium tends to recombine with by-products of weathering such as the clay minerals.

Thus, sodium tends to collect in the aqueous phase with the result that natural waters generally contain a greater amount of sodium than potassium. Ion-exchange reactions with clay minerals can serve to alter the sodium concentration of natural waters. Soluble salts of sodium and potassium ultimately are concentrated in nature in the oceans and in evaporite deposits. Some of these deposits serve as important sources of potassium, an essential plant nutrient.

Sodium concentrations for ground water of the study area are displayed in Map 13. As expected, this map shows a great similarity to the distribution of SAR values in Map 6. Low sodium concentrations in ground water in the vicinity of Sheridan County in northwestern Kansas coincide with presence of a carbonate bedrock and an eastward thinning of the unconsolidated aquifer. The low-sodium zone south of the Arkansas River follows a pattern noted for other constituents but gives way to concentrations above 20 ppm in western Pratt and Stafford counties and eastward. This transition in quality reflects a change in nature of the bedrock from Cretaceous- to Permian-age units which contain Na-Cl-type waters. Sodium concentrations may exceed 75 ppm in ground water associated with drainageways, areas contaminated by oil brines, and regions of restricted surface drainage and shallow water-table conditions. Ion-exchange reactions with clay minerals of the soil and aquifer can make high-sodium levels a persistent problem.

Potassium (Map 14), like sodium, shows a build-up in ground water associated with portions of different drainageways. Potassium concentrations of 10-24 ppm are common near drainageways in the western half of the study area, with the 24 ppm levels being found in the northwest area. Map 14 also shows zones of low concentration south of the Arkansas River; unlike the low-sodium zone, the low-potassium zone extends eastward across the region overlying Permian-age bedrock. This divergence in distribution patterns noted between sodium (Map 13) and potassium (Map 14) in areas overlying Permian-age bedrock in the eastern third of the study area may be the result of two different factors. First, the K/Na mass ratio tends to be lower in Na-Cl-type waters derived from the Permian-age bedrock than in the alkaline-earth HCO<sub>3</sub>-type waters from areas overlying younger-age bedrock. Second, an increased amount of clay mineral content seems to be in the aquifer sediments of the eastern half of the study area for the region south of the Arkansas River and the McPherson-Harvey counties area. A low K/Na mass ratio in oil-field brines and reactivity with clay minerals also serve to limit the areal extent of ground water with high potassium concentrations in contaminated regions. Failure of potassium to exhibit low-concentration areas such as sodium does in the northwestern part of the state seems to reflect a source in the sediments of the area.

Fluorine and chlorine are members of the halogen family of chemical elements. In the hydrogeochemical environment they normally exist as halide anions, F<sup>-</sup> and Cl<sup>-</sup>. Fluorine is more abundant than chlorine in igneous rocks and in many sediments. However, in natural waters chloride ions are spread more widely and are of greater importance to the overall water chemistry. This fractionation of the elements probably arises largely from solubility differences.

Chloride is a conservative anion in the aqueous environment. Chloride compounds of the major cations found in natural waters are noted for their solubility. Chloride ions do not exhibit significant tendency to participate in adsorption, complex formation, or oxidation-reduction processes. Hence, chloride, like sodium, tends to become concentrated in the oceans and in some types of evaporite deposits. By contrast, fluoride ions form strong complexes with trivalent aluminum and iron; fluorine-containing common minerals such as fluorite (CaF<sub>2</sub>) and fluorapatite (Ca<sub>5</sub>(PO<sub>4</sub>)<sub>3</sub>F) are fairly insoluble.

Chloride (Map 15), like other major constituents of the dissolved-solids load, exhibits a build-up in concentration in ground water associated with drainageways of the study area and in the area of restricted surface drainage in central Scott and Finney counties. It also displays a low-concentration zone south of the Arkansas River. The low-chloride zone, like the low-sodium zone (Map 13), seems to terminate with the on-set of Permian-age bedrock in the eastern third of the study area. However, chloride concentrations of about 8 ppm in ground water from two flowing artesian wells in eastern Stafford County attest to the complexity of the aquifer in the region south of the Arkansas River. High chloride concentrations also coincide with high sodium levels in areas contaminated by oil-field brines.

Low chloride values occur in greater frequency than low sodium levels throughout the northwestern part of the study area. This observation together with the predominance of Na/Cl mass ratios (Map 8) above 0.75 in the upland areas in the western half of the study area indicates that here sodium and chloride in the ground water probably are not derived from a single, simple source such as halite (NaCl).

Fluoride (Map 16) concentrations above 1.7 ppm are evident in ground water from upland areas of the western half of the study area, and levels below 0.5 ppm are abundant in the eastern half of the study area and in the area south of the Arkansas River where other constituents have shown a low-concentration zone trending southeastward from Kearny County. Unlike other major constituents, fluoride does not accumulate to a great extent in ground water associated with drainageways. The distribution noted for this component of the ground-water-dissolved load probably reflects combined effects of a source such as volcanic ash in the western areas and mineral solubility controls in ground water from the eastern area and regions near drainageways where increased levels of calcium (Map 9) and/or phosphate (Map 19) may occur.

Fluoride concentrations of about 1 ppm are considered to have beneficial effects in reducing dental caries. High levels of fluoride intake can cause mottling of teeth and fluorosis in humans and animals.

#### Selected readings

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3. Hathaway, L. R., Carr, B. L., Galle, O. K., Magnuson, M. L., Waugh, T. C., and Dickey, H. P., 1977, Chemical quality of irrigation waters in Hamilton, Kearny, Finney, and northern Gray counties: Kansas Geological Survey, Chemical Quality Series 4, 33 p.
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8. Hathaway, L. R., Magnuson, L. M., Carr, B. L., Galle, O. K., and Waugh, T. C., 1975, Chemical quality of irrigation waters in west-central Kansas: Kansas Geological Survey, Chemical Quality Series 2, 45 p.
9. Hathaway, L. R., Waugh, T. C., Galle, O. K., and Dickey, H. P., 1979, Chemical quality of irrigation waters in northwestern Kansas: Kansas Geological Survey, Chemical Quality Series 8, 45 p.
10. ———, 1981, Chemical quality of irrigation waters in the Equus Beds area, south-central Kansas: Kansas Geological Survey, Chemical Quality Series 10, 45 p.
11. Chemical-quality data for ground waters from the Smoky Hill River, Pawnee River, and Walnut Creek valleys: Kansas Geological Survey, Open-file Report 80-18 (available from L. R. Hathaway).

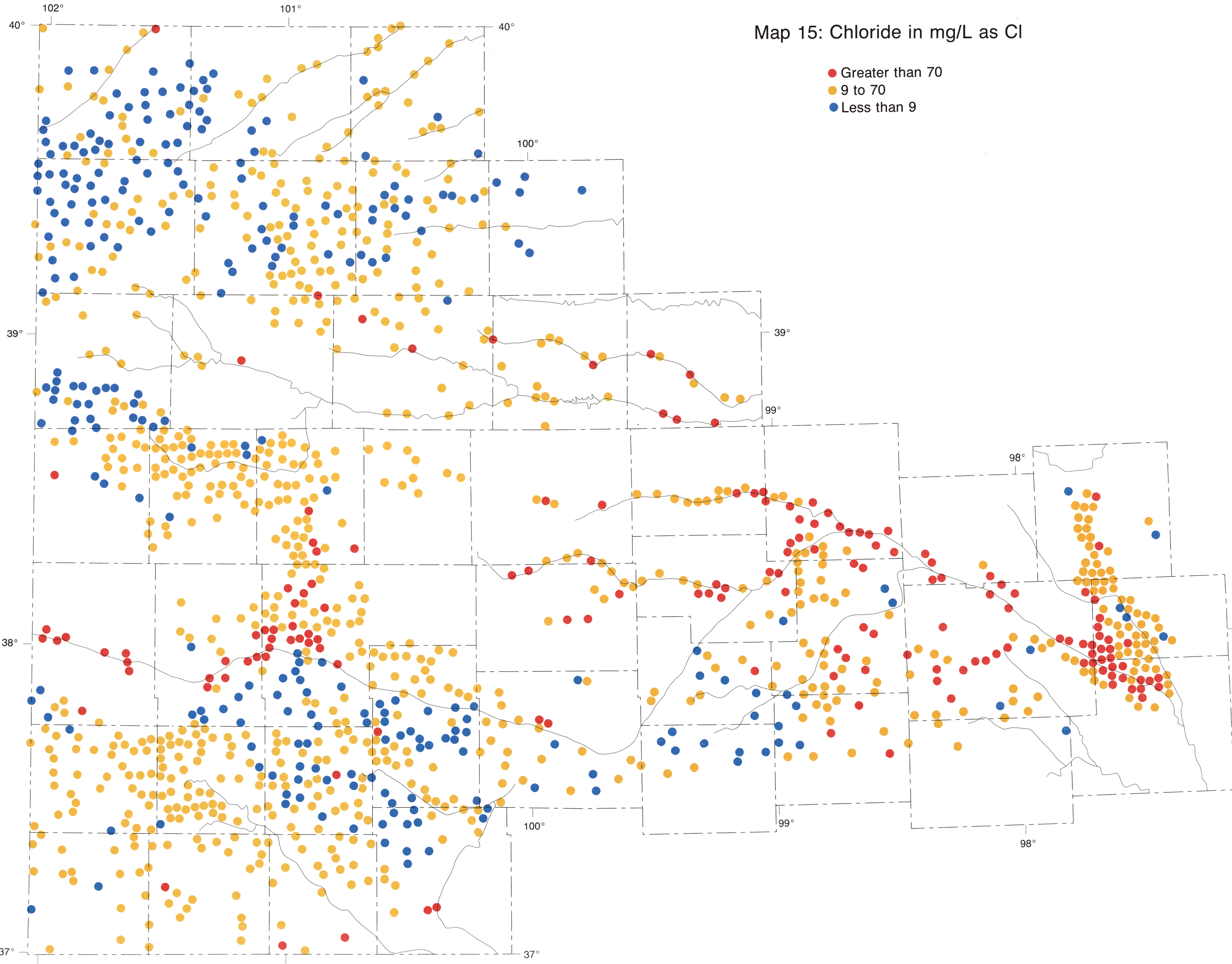


Scale 1:1,000,000  
0 10 20 30 40 mi  
0 10 20 30 40 km

The county boundaries, streams, contours of saturated thickness shown on Plate 1, and color-separated dot symbols on all five plates were produced by computer in the Automated Cartography Laboratory of the Kansas Geological Survey. Dot symbols were generated from supplied locations. Software used to perform these tasks is a part of GIMAP (Geospatial Interactive Management Map Analysis and Production), a computer-assisted cartography system developed at the Kansas Geological Survey. All other preparation and layout by Renate Henselek.

Map 15: Chloride in mg/L as Cl

- Greater than 70
- 9 to 70
- Less than 9



Map 16: Fluoride in mg/L as F

- Greater than 1.7
- 0.5 to 1.7
- Less than 0.5

