Kansas Geological Survey
A Division of
The University of Kansas

Chemical Quality Series 11
Plate 1

# Atlas of chemical-quality data for irrigation waters of western Kansas

by
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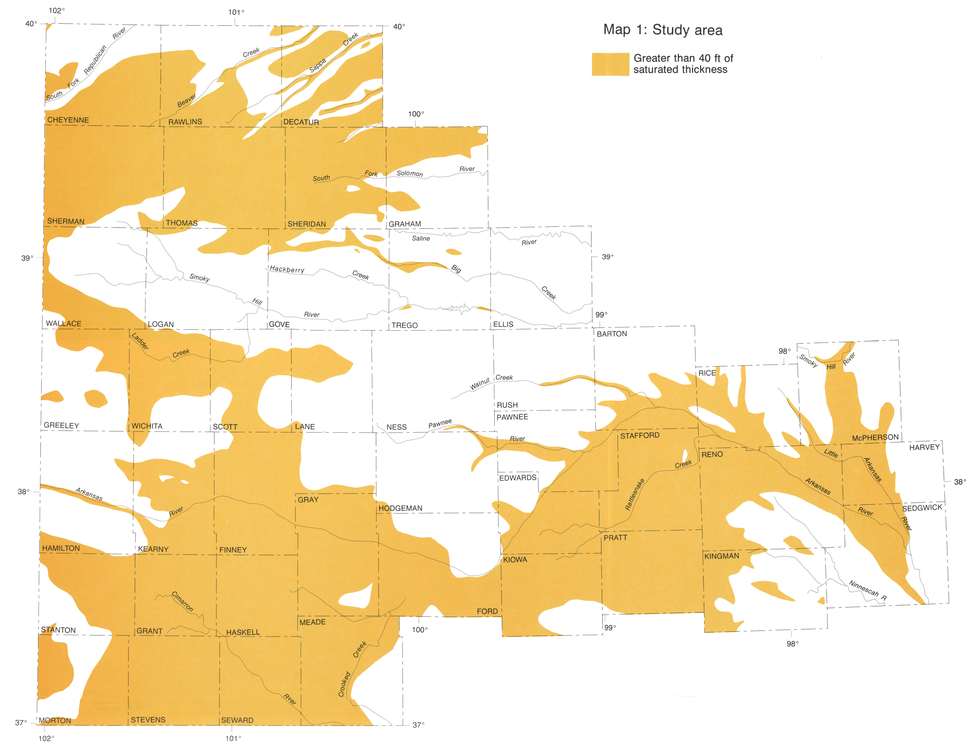
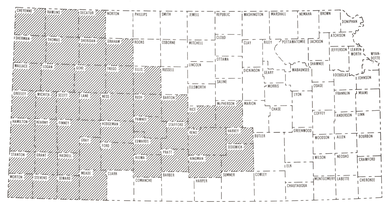



Water-bearing unconsolidated sediments of Quaternary and Tertiary age serve as the major source of freshwater in the irrigated croplands of western and south-central Kansas where annual rainfall averages range from about 16 to 30 inches, respectively. Bedrock underlying these sediments varies from units of Cretaceous age in northwestern Kansas to units of Permian age in southwestern and south-central Kansas. Within the area of study (Map 1), the water table tends to parallel the eastward-sloping land surface. Thus, ground-water movement is in a general easterly direction.

The surficial topography of this part of the state is relatively flat, sloping gently eastward. Three principal drainage systems—the Cimarron River, the Arkansas River, and the Smoky Hill River—make eastward to southeastward trending incisions into the land's surface within the study area. The soil cover throughout much of the region is derived from a loess mantle which covers the unconsolidated aquifer. Dunes and sandy soils cover extensive regions south of both the Arkansas and Cimarron rivers. Patches of saline and/or sodic soils may be found within the alluvium of the drainageways or within areas of restricted surface drainage and shallow water-table conditions.

The information displayed in Map 1 is taken from Kansas Geological Survey Map M–5. The simplified drainage depicted for the study area represents for the most part continuous-flow segments of drainageways shown in M–5. More detailed coverage of the geology and hydrogeology of the study area is contained in the selected readings and the references cited therein.

During the peaks of the irrigation seasons between July 1974 and July 1981, water samples were collected from a cumulative total of 1,232 different pumping irrigation wells in western and south-central Kansas. These samples were analyzed at the Kansas Geological Survey laboratories, and the data from these analyses are the basis for this ground-water-quality atlas. Concentration data for bicarbonate ($HCO_3$) and silica ($SiO_2$) approximate normally distributed sets, whereas data sets for other chemical constituents approach log-normal distributions. Concentration intervals for maps of chemical constituents generally were chosen to set apart the lower 20% and upper 15% fractions of the sample population.

The maps of this atlas present chemical-quality data in a two-dimensional fashion for ground waters as produced and used. Thus, no attempt is made to address variability in water quality that results from different wells sampling unequal portions of the aquifer. Therefore, maps of this atlas merely serve as guides for the general interpretation of chemical quality in the aquifer system as it is being used presently, rather than as definitive or absolute statements of its total status.

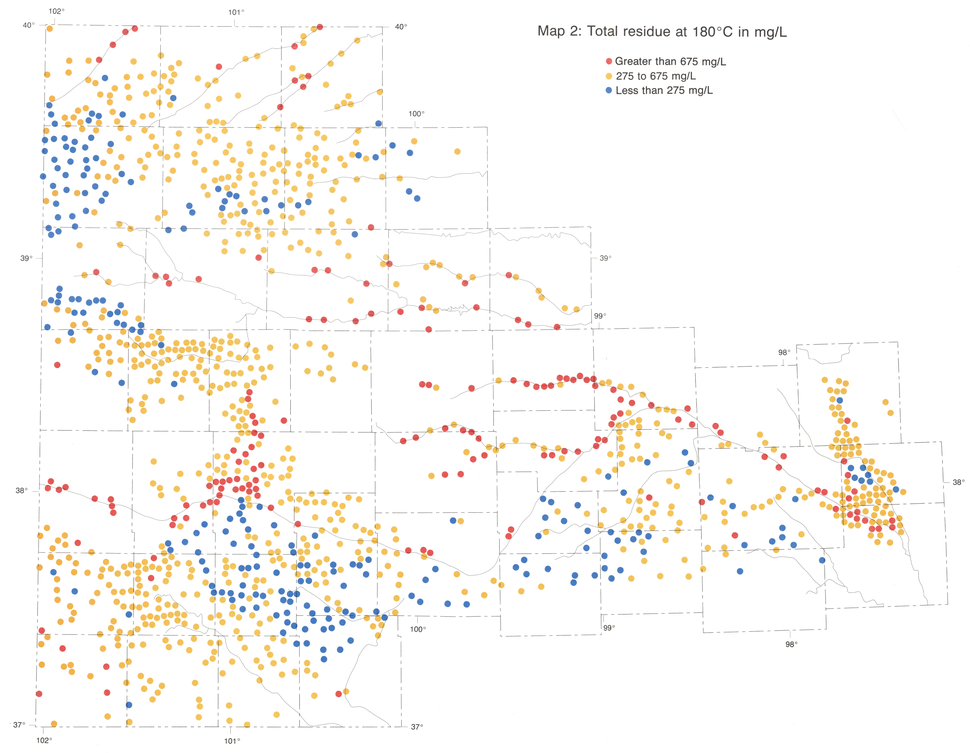
The total residue map (Map 2) makes it possible to visualize those areas in which the dissolved-solids loads of the ground water increase with resultant decrease in general water quality. The low total residue zone south of the Arkansas River and comparable features on other maps which trend in a southeastward direction from eastern Kearny County may be related to Early Pleistocene drainage patterns, reflecting an area where unconsolidated sediments have been reworked. The area south of the Arkansas River in the eastern half of the study area also has received extensive alluviation during Pleistocene times. The low total residue areas of the northwestern portion of the study area are more problematic but may represent regions of local recharge through fracture systems.

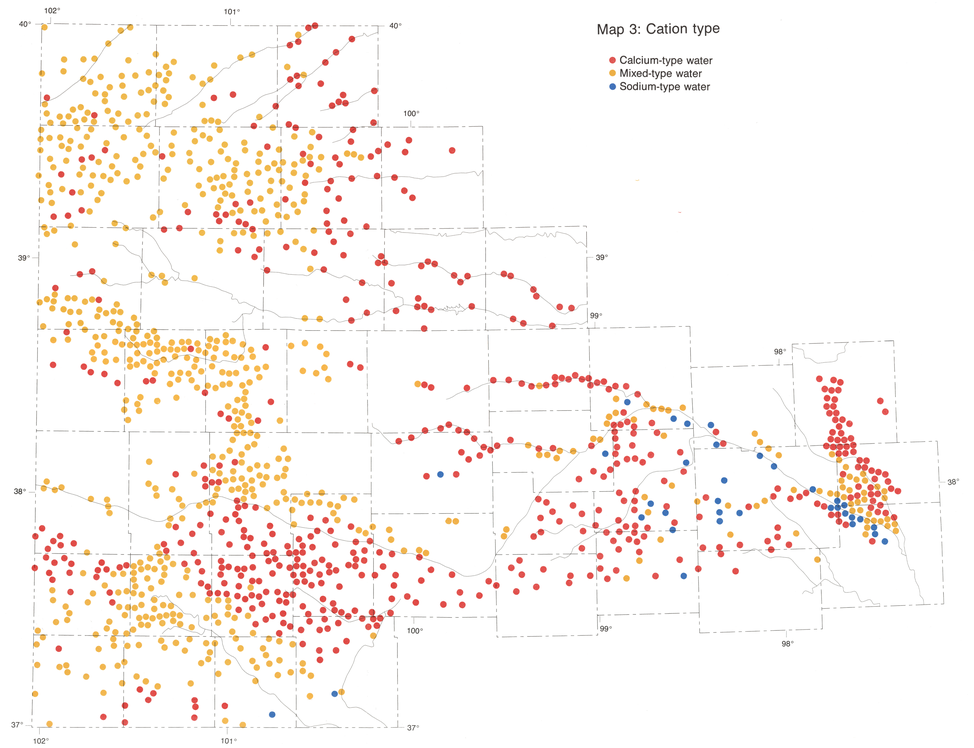
Total residue levels in excess of 500 mg/L typically are associated with alluvial deposits of drainageways. Ground waters in areas of restricted surface drainage and relatively shallow water-table conditions, such as central Scott and Finney counties, may be prone to elevated levels of dissolved salts. In central Finney County this situation has been exacerbated by past use of surface water from the Arkansas River for irrigation. Salt-bearing Permian-age bedrock units can have an adverse effect upon water quality in the overlying unconsolidated aquifer. This is reflected in saltwater seeps into drainageways in Seward and Meade counties and in the practice of water withdrawal only from upper portions of the aquifer in parts of south-central Kansas. Limited well depths and shallower water-table conditions coupled with the extensive oil-gas activity in south-central Kansas have created situations where ground-water contamination is evident locally.

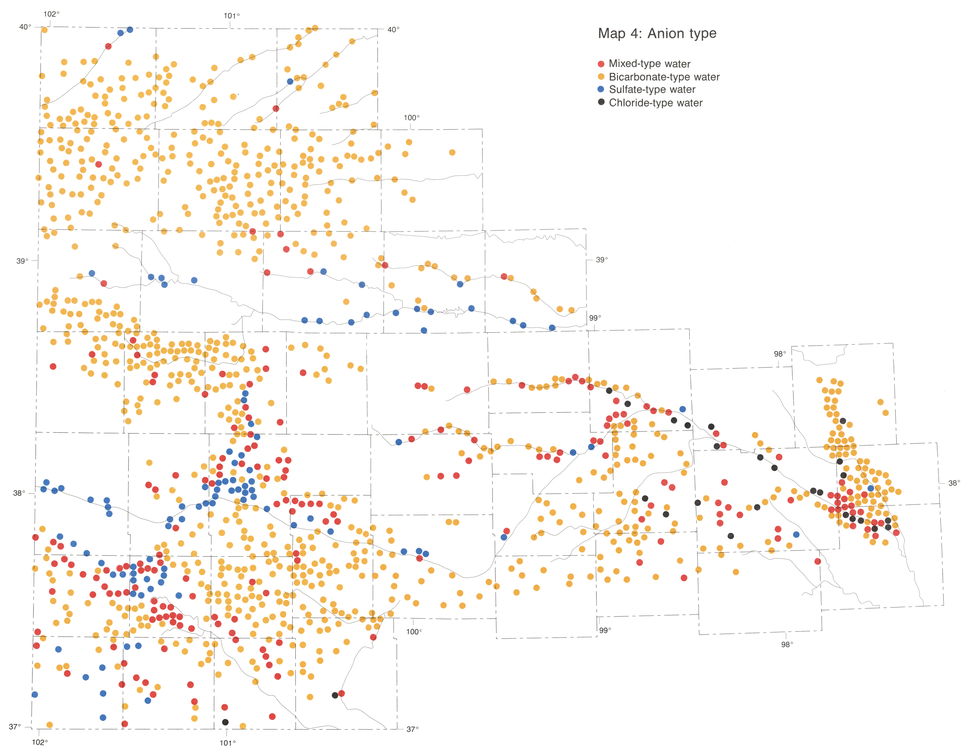
The cation (Map 3) and anion (Map 4) water-type classification maps convey general information concerning chemical compositions of the solids dissolved in the ground water. These classifications are based upon percent milliequivalent contributions of the various chemical species to the total number of milliequivalents per liter of cations or anions. Ca–$HCO_3$ and mixed(Ca–Mg)–$HCO_3$-type waters provide the underlying fabric for water classification in the unconsolidated aquifer system. Ca–$HCO_3$-type waters prevail in sandy soil regions south of the Arkansas River and in the eastern half of the study area where shallower water-table conditions generally are encountered. Superimposed more broadly upon this basic ground-water chemistry are the Ca–$SO_4$ and Ca-mixed($HCO_3$–$SO_4$)-type waters of the alluvial deposits of drainageways and of areas with restricted external surface drainage such as central Scott and Finney counties. The major influence of Na–Cl-type waters in the unconsolidated aquifer is noted in areas overlying Permian age bedrock containing halite (NaCl) or Na–Cl-type waters, or in areas in which oil-gas brines have escaped and sandy soil and/or shallow water-table conditions exist.

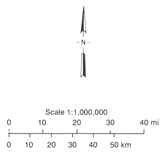
## Selected readings

1. Berendsen, P., and Hathaway, L. R., 1981, Uranium in unconsolidated aquifers of western Kansas: Kansas Geological Survey, Mineral Resources Series 9, 43 p.
2. Hathaway, L. R., Carr, B. L., Flanagan, M. A., Galle, O. K., Waugh, T. C., and Dickey, H. P., 1978, Chemical quality of irrigation waters in southwestern Kansas: Kansas Geological Survey, Chemical Quality Series 6, 33 p.
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.
4. Hathaway, L. R., and Dickey, H. P., 1978, Soil associations of southwestern Kansas: Kansas Geological Survey, Map M–8A.
5. ———, 1980, Soil associations of northwestern Kansas: Kansas Geological Survey, Map M–8B.
6. ———, 1982, Soil associations of south-central Kansas: Kansas Geological Survey, Map M–8C.
7. Hathaway, L. R., Galle, O. K., Waugh, T. C., and Dickey, H. P., 1978, Chemical quality of irrigation waters in Ford County and the Great Bend Prairie of Kansas: Kansas Geological Survey, Chemical Quality Series 7, 41 p.
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).




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 GIMMAP (Geodata Interactive Management Map Analysis and Production), a computer-assisted cartography system developed at the Kansas Geological Survey. All other preparation and layout by Renate Hensiek.