

Can We Distinguish Regional From Local Variations in Trace Element Concentration in the Glacial Aquifer System?

George E. Groschen¹, Terri L. Arnold¹, and Kelly L. Warner¹

¹U.S. Geological Survey, 1201 W. University Ave, Suite 100, Urbana, Illinois 61801-2347

Biographical Sketches of Authors

George E. Groschen attended the University of Minnesota, and received a MSc. in 1981. He has worked for the U. S. Geological Survey for 26 years. Research interests in water resources are aqueous geochemistry and contamination. Since 1994 he has been in Urbana, Illinois as the chief of the Lower Illinois River Basin NAWQA study. In 2001 he also became chief of the Upper Illinois River Basin study.

Terri L. Arnold is the GIS Specialist for the U.S. Geological Survey, National Water-Quality Assessment (NAWQA) Program's Upper Illinois River Basin Study Unit. She received her BS in Geography from the University of Illinois. Her responsibilities include spatial and geostatistical analysis and mapping of water samples and environmental data.

Kelly L. Warner is a hydrologist with the U.S. Geological Survey, NAWQA Program. She received a BA from Knox College and an MS from Northern Illinois University, both in Geology. She currently leads an effort to synthesize data to assess the regional ground-water quality for the glacial, Cambrian-Ordovician, and New England crystalline aquifer systems.

Abstract

Variability is large in ground water trace element concentrations in the glacial aquifer system of the northern United States, in both local and regional scales. Ground-water sampling, from 1992 through 2003, of the National Water-Quality Assessment (NAWQA) Program of the U.S. Geological Survey, determined trace element concentrations in 847 wells in the glacial aquifer system. Concentrations of antimony, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, strontium, thallium, uranium, and zinc vary as much within NAWQA study units (local scale; ranging in size from few thousand to tens of thousands of square miles) as over the entire glacial aquifer system. The glacial aquifer system includes areas from most of New England, through the Midwest, and portions of the Pacific Northwest and Alaska. The sampled wells are from both land-use surveys and water-supply well networks.

Relations between trace elements in ground water and glacial or bedrock geology, are difficult to determine, in part, because of the large variability in mineral content and bulk trace element chemistry of the geologic units. Patterns of trace element detections in glacial aquifer ground water were examined using techniques suitable for dataset with zero to 80 percent non-detections. During the time period of sampling, the analytical techniques changed and, in general, improved sensitivity. Multiple reporting limits complicate comparing detections and concentrations. Regression on Order Statistics was used to characterize the medians and other quantiles of the trace element concentrations. Quantiles of dissolved iron concentrations are similar for selected study units and the entire data set. Other trace elements that show similar variability between study-unit scale and the extent of the glacial aquifer are: barium, lead, cadmium, copper, and zinc. Characterization of this variability is a step in determining the regional probability of these trace elements exceeding drinking-water or other human health standards.