Arsenic in Shallow and Deep Glacial Drift Aquifers --Illinois

Kelly L.Warner
U.S. Geological Survey
Urbana, IL

The lower Illinois River Basin (LIRB) and the upper Illinois River Basin (UIRB) were studied as part of the U.S. Geological Survey National Water-Quality Assessment program in 1994-98 and 1997-01, respectively. Nearly 90% of the ground-water supplies are from the deep and shallow glacial drift aquifers. Glacial deposits infilling buried bedrock valleys and overlying Paleozoic bedrock are common hydrogeologic settings in the Midwest.

The highest concentration of arsenic (83 μg/L) in ground water in the LIRB and UIRB is in the deep glacial drift aquifer. Arsenic concentrations in the shallow glacial drift aquifer, in the LIRB and UIRB, range from 1 to 28 μg/L. Arsenic is not detected as frequently (10 to 15 percent of samples) in the shallow glacial drift aquifer. In the LIRB, 63 percent of the wells in the deep glacial drift aquifers used for public and domestic drinking-water supply have arsenic concentrations above 5 μg/L (a proposed new U.S. Environmental Protection Agency drinking water standard). Public and domestic drinking water from the deep glacial drift aquifer have a similar frequency of detecting measurable arsenic. Arsenic concentrations greater than 25 μg/L in ground water are mostly in the form of arsenite (AsIII). The proportion of arsenate (AsV) to arsenite does not change along the flowpath of the deep glacial drift aquifer. Because of the limited number of arsenic species analyses, no clear relations between species and other trace elements, major ions, or physical parameters could be established. Arsenic and barium concentrations increase from east to west in the deep glacial drift aquifer and are positively correlated. Chloride and arsenic are positively correlated and provide evidence that arsenic may be derived locally from underlying bedrock.

Solid-phase geochemical analysis of the till, sand and gravel, and bedrock show the highest presence of arsenic in the underlying organic-rich carbonate bedrock. The black shale or coal within the organic-rich carbonate bedrock is a potential source of arsenic. Most high arsenic concentrations found in the deep glacial drift aquifer are west and down-gradient of the bedrock structural features. Geologic structures in the bedrock are potential pathways for recharge to the deep glacial drift aquifer from surrounding bedrock.

Differences are present in arsenic concentration by aquifer material in discrete samples, but the relation between arsenic in the aquifer material and arsenic in ground water is more complex than just presence in the solid phase.