THE BEHAVIOR OF AS IN DRINKING-WATER AQUIFERS CONTAINING MISSISSIPPI VALLEY-TYPE MINERALIZATION: A CHARACTERIZATION OF THE OZARK PLATEAUS REGION OF THE U.S.

Lopaka Lee and Martin Goldhaber
USGS, Crustal Imaging and Characterization Team.
MS 973 Denver Federal Center Denver, CO

Mississippi Valley-Type (MVT) sulfide mineralization is widespread in the drinking-water aquifers of the Ozark region. Throughout most of the Ozark region, aquifer rocks contain MVT mineralization that consists of trace amounts of pyrite (FeS_2). This epigenetic pyrite contains anomalous concentrations of MVT-related metals, including As, within it's structure. In localized areas, aquifer rocks can contain high concentrations of other MVT sulfides such as sphalerite, galena, and mixed-metal sulfides. These sulfides can also host anomalous concentrations of As. Our study characterizes the behavior of dissolved As in Ozark region groundwater by examining the relationships between rock-geochemical and water-quality data and characterizing the geochemical controls on groundwater chemistry. The larger goal of this study is to develop a working model of the processes and controls of MVT-water interactions by first characterizing a classic MVT terrain that contains a wealth of information on rock and water chemistry.

Chemical analyses on over 17,500 rock samples from 300 core-holes in Ozark-region aquifer rocks show that elevated arsenic concentrations in rocks form trends that coincide with major structural zones of the Ozark region (Figure 1). Whole rock arsenic concentrations range up to 1500 ppm**,** and the insoluble residues of rocks (that contain the arsenic-bearing sulfides) can contain up to 10,000 ppm As. Throughout the Ozarks, arsenic is most enriched within the lower Ozark and St. Francois aquifer units.

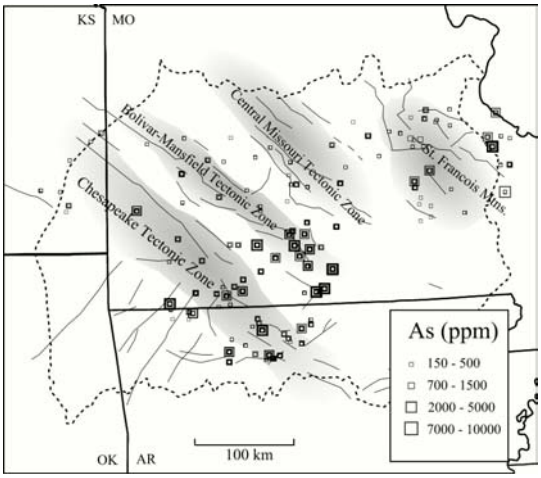

Figure 1. As concentrations in insoluble residues of borehole rocks from the Ozarks

Despite this widespread occurrence of As in aquifer rocks, 400 analyses of groundwater from throughout the Ozark region show that dissolved As in groundwater is typically less than 1 ug/L (Figure 2). Sporadic occurrences of slightly higher As concentrations (from 2-10 ug/L) are associated with elevated dissolved concentrations of other MVT-related metals, and sulfate, along the faults and fractures of the Chesapeake Tectonic Zone in northern Arkansas and southwestern Missouri.

Mass-balance and reaction-path modeling of groundwater, which incorporates the well-characterized geology and mineralogy of the Ozark region, shows that dissolved As concentrations are usually low because MVT-sulfide oxidation typically occurs as the oxidation of trace pyrite in a system closed to influxes of atmospheric oxygen. The modeling also indicates that the elevated dissolved As along the Chesapeake Tectonic Zone, is related to the oxidation of an increased proportion of sphalerite, relative to pyrite, in a system open to influxes of atmospheric oxygen. Thus, As concentrations in MVT-water interactions of the Ozark region are ultimately controlled by structural features, such as faults, fractures, which favor both the occurrence and abundance of As-bearing MVT sulfides, while simultaneously promoting the influx of dissolved oxygen to mineralized zones.

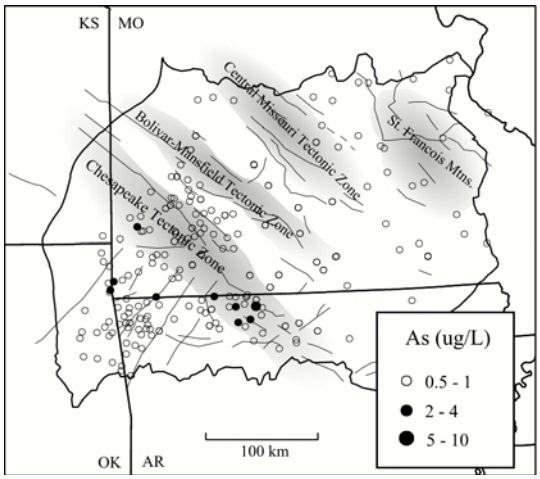

Figure 2. Dissolved As concentrations in groundwater of the Ozark Region