

OCCURRENCE AND RELEASE OF GROUND WATER ARSENIC IN PUBLIC WATER SUPPLY WELLS IN OHIO

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Ground water arsenic is receiving increased attention as a result of U.S.EPA's proposed reduction in the primary drinking water standard (MCL) from 50 µg/L to 10 µg/L. A review is made here of the distribution and geochemical settings of waters with elevated total arsenic concentrations in selected Ohio public water system (PWS) wells. PWS data from ~1970 through the 1980's often had high detection levels (5, 10 and 20 µg/L), limiting the usefulness of these data. More recent data, having better detection limits (3-5 µg/L), reflect a general increase in analytical precision for PWS data. Elevated ground-water arsenic is found in all three major aquifer types across Ohio, in both raw ground water (Ambient Monitoring Network wells (AMN)) and treated ground water (PWS wells), suggesting that redox controls are more important than lithologic or stratigraphic controls. Regional patterns of arsenic occurrence do not support an anthropogenic source for the arsenic.

Among the major aquifer types, elevated total arsenic concentrations are most common in the buried valley (unconsolidated sand and gravel) aquifers (Ambient Monitoring Network median = 2.95 ug/L). For the Ambient Monitoring Network wells, a good correlation between total arsenic and depth in the sand and gravel aquifers is found. The Silurian/Devonian carbonate system wells (median = 2.16 ug/L) and Mississippian/Pennsylvanian sandstone system wells (median = 2.00 ug/L) both record lower total arsenic concentrations. Lack of arsenic in shallow, oxic wells, and an increase in alkalinity with arsenic under reducing conditions suggests that the bulk of Ohio's ground water arsenic results from reductive dissolution of Fe and Mg oxyhydroxides, rather than through the oxidation of arsenopyrite. Arsenic is strongly adsorbed onto these oxides, presumably deposited as secondary cements or dispersed coatings on the aquifer matrix. Microbially mediated redox processes first consume dissolved O₂ and then NO₃; arsenic may then be mobilized through the reduction of the As-bearing iron oxides.

A long sampling history of AMN sites permits numerous ground water time series to be constructed from all three aquifer types; many series have 30 or more data points. These data are particularly useful in studying the locally transient nature of ground water chemistry, and its relationship to aqueous arsenic concentrations. The presence or absence of total arsenic in ground water is observed through two apparently well-behaved end members, particularly in the sand and gravel and carbonate aquifer systems. The first end member is illustrated by significant positive co-variation of total arsenic with total iron, accompanied by complete exclusion of any detectable nitrogen species. The lack of nitrogen (as NO_x or NH⁺) along with increasing alkalinity appears to most strongly suggest an arsenic release mechanism related to the mobilization of iron oxides in a reducing ground water environment. The second end member is characterized by a lack of both total arsenic and iron (both below the detection limit), and some level of N activity. This particular mode may simply be the result of mildly oxidizing conditions in which the iron oxides remain out of solution. These correlations suggest that ground water chemistry may be useful for identifying areas where As is mobilized through this process.