ARSENIC IN GROUND-WATER RESOURCES OF THE UNITED STATES: A NEW NATIONAL-SCALE ANALYSIS

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The USGS National Water-Quality Assessment (NAWQA) Program has recently analyzed a database of about 28,000 measurements of arsenic in ground water across the United States. This database comes from the USGS National Water Information System and several comparable state databases, and describes ground-water resources used for several purposes. Approximately one-half of the samples in the database are from wells currently used for drinking water, including predominantly private domestic wells along with large regulated community water supplies; smaller unregulated community supplies; and wells supplying institutions such as schools, office buildings, churches, and hospitals. The database also includes samples from potential drinking-water resources not currently used for drinking-water supply.

This database is part of the NAWQA Program's work to provide a broad-scale, consistent view of arsenic in ground water across the Nation, with the goal of producing national-scale estimates of where ground-water resources are likely to exceed the maximum contaminant level (MCL) for arsenic in drinking water. This database is intended to represent potable ground-water resources, so only "raw" (untreated) water samples are included and samples from saline and geothermal waters have been excluded from the dataset. Domestic wells are the largest group in the database (30%), followed by shallow monitoring wells (20%). Based on the makeup of the database and on comparisons between USGS data and the National Arsenic Occurrence Survey of public supply wells (Focazio et al., 1999), the database is probably generally representative of arsenic concentrations in domestic wells and in institutional supply wells, and in untreated ground water used by public supply systems in many settings.

In the past, only community wells supplying at least 25 households were regulated by the MCL for arsenic in drinking water. Over the next several years, a new MCL of 10 ug/L will be phased in to regulate not only large community water supplies but also water supplies serving smaller populations, including some non-community supplies serving institutions—a new class of regulated water sources (U.S. Environmental Protection Agency, 2001). Like domestic wells, these smaller community and institutional wells typically supply ground water that has not been treated for arsenic. In addition, although arsenic in domestic wells is not regulated, the new MCL indicates a new, lower threshold considered "safe" to consume as a primary drinking-water source. In about one-quarter of U.S. counties with sufficient data, more than 10% of ground-water supplies are likely to contain arsenic concentrations greater than 10 ug/L (Welch et al., 2000). It is therefore likely that the new MCL will lead to increased concern about the health of rural populations drinking ground water from domestic wells.

Figure 1 shows a moving 75th percentile of arsenic concentrations in ground water across the U.S., based on these 28,000 arsenic samples. In dark-grey and black areas of the map, at least 25% of available ground-water samples have arsenic concentrations exceeding 10 ug/L. In general, ground water of the southeastern coastal plain has low arsenic concentrations (rarely exceeding 3 ug/L). However, arsenic concentrations greater than 10 ug/L are relatively common in many parts of the west, particularly the southwest; and also in parts of the upper Midwest and New England. These widespread high concentrations are generally assumed to be from natural sources. For example, in parts of the southern San Joaquin Valley, California, as well as parts of Arizona and the middle Rio Grande Basin, New Mexico, oxic, alkaline ground water contains high arsenic concentrations that may result from desorption from iron oxide. Elsewhere in the southwest, high arsenic concentrations are associated with iron-rich ground water, which is consistent with dissolution of iron oxide as a source of arsenic. In parts of the Willamette Basin, Oregon, and elsewhere in the western U.S., high pH ground water in felsic volcanics contains high concentrations of arsenic. In the upper Midwest, glaciated quaternary sediments appear to be associated with high arsenic concentrations in ground water, whereas in parts of New England, metasedimentary bedrock aquifers supplying primarily domestic wells tend to have high arsenic concentrations (Welch et al., 1999).

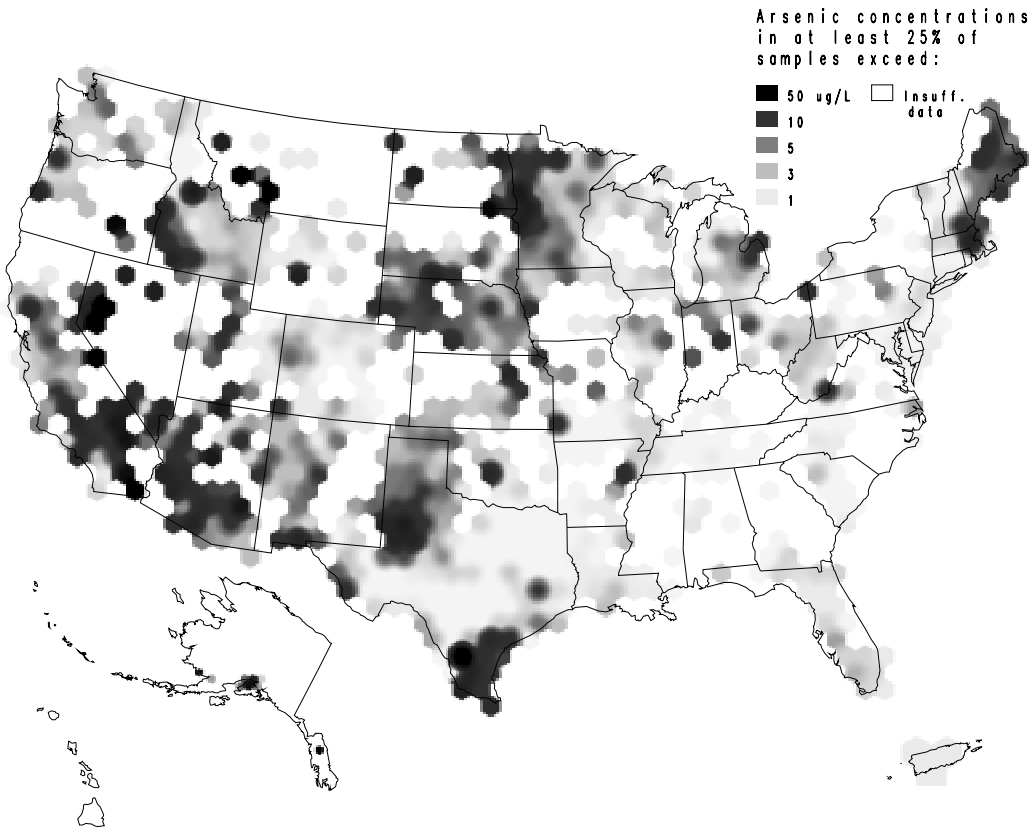

Figure 1. Moving 75th percentile of arsenic concentration in ground water, based on data from 28,000 wells and springs.

The NAWQA Program is currently working with a broad group of USGS researchers as well as other federal and state agencies to collect additional data and apply geologic, hydrologic, and agrochemical knowledge to explanatory models for arsenic in ground water. This work is taking place at several scales. National efforts are underway to describe general arsenic controls across the U.S. by constructing regional maps of pH by aquifer type, and geochemical characterizations of the principal aquifers of the U.S. (U.S. Geological Survey, 1998). In addition, during 2001-2005, several studies will be conducted in current NAWQA study units (figure 2) to identify both arsenic-rich source materials and processes by which arsenic is mobilized into drinking-water aquifers.

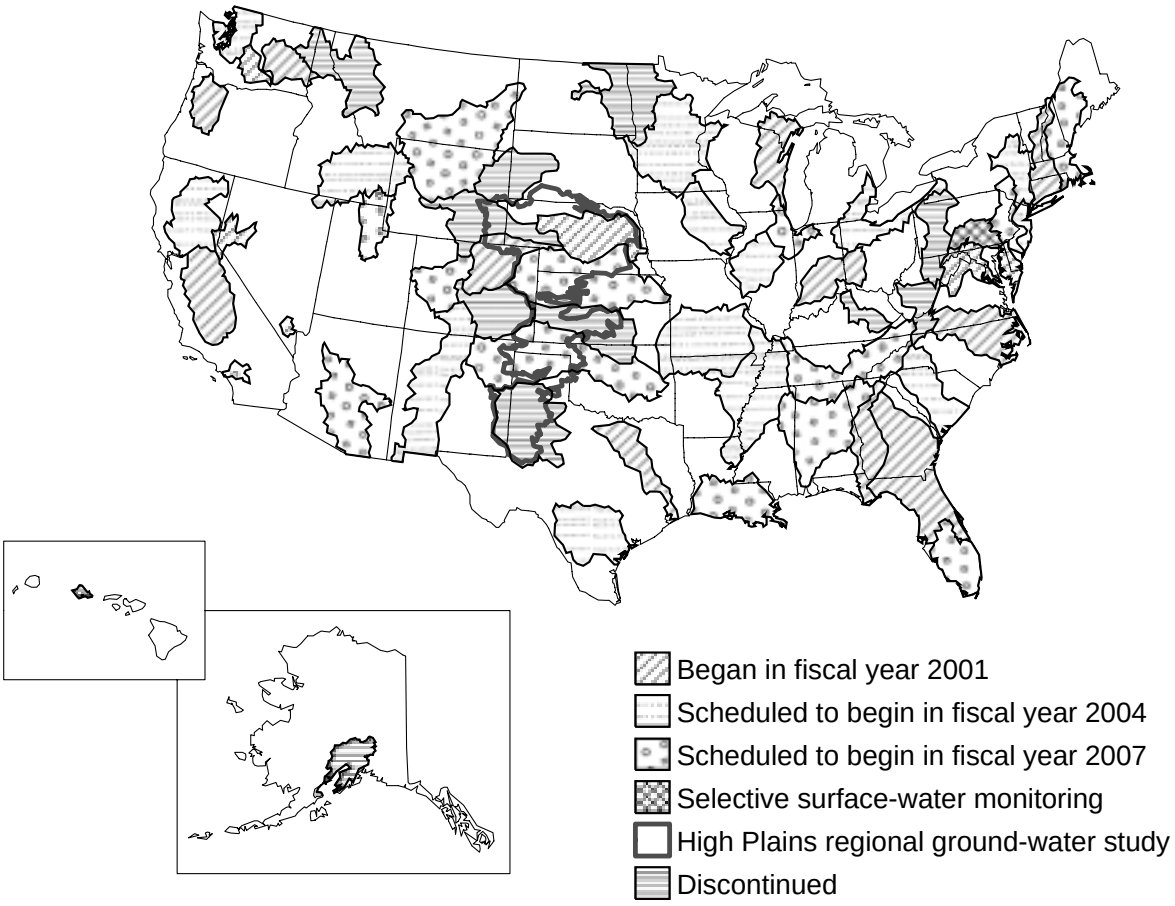

Figure 2. Locations of National Water-Quality Assessment (NAWQA) study units.

References

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U.S. Environmental Protection Agency, January 2001, "Drinking Water Standard for Arsenic" fact sheet on the arsenic rulemaking process: EPA 815-F-00-015. On line at: http://www.epa.gov/safewater/ars/ars_rule_factsheet.html

U.S. Geological Survey, 1998, Ground Water Atlas of the United States-- Principal Aquifers of the 48 Contiguous United States: U.S. Geological Survey, Madison, Wisconsin. On line at: http://capp.water.usgs.gov/gwa/

Welch, A.H., Helsel, D.R., Focazio, M.J., and Watkins, S.A., 1999, Arsenic in ground water supplies of the United States, in: Arsenic exposure and health effects, W.R. Chappell, C.O. Abernathy and R.L. Calderon, Eds., Elsevier Science, New York, pp. 9-17. Abstract on line at: http://co.water.usgs.gov/trace/pubs/segh1998/

Welch, A.H., Watkins, S.A., Helsel, D.R., and Focazio, M.F., 2000, Arsenic in ground-water resources of the United States: U.S. Geological Survey Fact Sheet 063-00, 4p. On line at: http://co.water.usgs.gov/trace/pubs/fs-063-00/

Data sources

Maine Department of Health
Massachusetts Department of Environmental Protection
Minnesota Pollution Control Agency, on line at:
http://www.pca.state.mn.us/water/groundwater/gwmap/gwbaseline.html
New Hampshire Department of Environmental Services
Rhode Island Department of Health
Texas Water Development Board, on line at:
http://www.twdb.state.tx.us/data/waterwells/well_info.html
USGS National Water Information System, on line at:
http://water.usgs.gov/nwis/