

Quantification and description of As species in aquifer solids with μ XAS

S. L. NICHOLAS*¹, A. S. GOWAN², A. R. KNAEBLE²,
M. A. MARCUS³, L. G. WOODRUFF⁴, M. L. ERICKSON⁴,
J. K. LYNCH⁵ AND B. M. TONER¹

¹Department of Soil, Water, and Climate, University of Minnesota, St. Paul, MN 55108 (*correspondence nich0160@umn.edu, toner@umn.edu)

²Minnesota Geological Survey, St. Paul, MN 55114

³Advanced Light Source, Lawrence Berkeley National Laboratory, Berkeley, CA 94720

⁴U.S. Geological Survey, Mounds View, MN 55112

⁵Department of Genetics, Cell Biology, and Development, University of Minnesota, Minneapolis, MN 55455

Western Minnesota, USA, is a regional locus of drinking-water wells with high arsenic concentrations ($As > 10 \mu\text{gL}^{-1}$). Arsenic (As) concentrations vary widely among neighboring wells with otherwise similar water chemistry [1] [2]. The As is sourced from glacial deposits partially derived from Cretaceous sedimentary bedrock (shale). Our hypothesis is that As speciation in the solid phase controls As liberation to groundwater.

Sediment samples for analysis were frozen under argon at the time of collection to preserve their redox state. XAS work on the samples followed a *quantitative track* of speciation mapping [3] to measure the relative abundance of different As species, and a *descriptive track*, in which point XANES were collected on co-located As and Fe particles within the maps. Open-air aliquots of the same samples were analyzed to identify preservation effects. Bootstrap resampling was used to calculate confidence intervals for the speciation maps.

The speciation maps show a greater relative abundance of oxidized As near the aquifer-till contact than in the bulk till, indicating oxidation of the aquifer sediments. This arsenic is vulnerable to mobilization by even small redox changes in groundwater from oxic or suboxic to anoxic (Fe-reducing).

Point XANES data show three main As populations: AsV, As sulfide, and mixed valence As. The Fe population was more diverse than As, but can be broadly grouped as Fe sulfides and Fe oxyhydroxides. In both As and Fe populations, sampled points resemble each other more closely than they do our reference materials.

Work was supported by LBNL-ALS, ANL-APS, USGS-MNWSC, MGS, and CURA.

[1] Berndt & Soule (1999) [2] Erickson & Barnes (2005) [3] Toner et al. (2014).