Arsenic variability, redox processes, groundwater age, and chemical time series at three water supply wells

JOSEPH P. LEVITT*, JAMES R. DEGNAN

U.S. Geological Survey, New England Water Science Center, 331 Commerce Way, Pembroke, NH 03275
*correspondence:jlevitt@usgs.gov

Over what time periods does groundwater quality change and what controls these changes? Collecting high frequency groundwater chemistry data helps shed light on these questions. Analysis of continuous and discrete time series shows that many factors, including groundwater level, drought conditions, atmospheric precipitation, and pumping volumes can act as controls on the geochemistry of groundwater.

Three wells in southeast New Hampshire, United States, representing the most common aquifer and well designs in the region, were sampled bimonthly over four years to evaluate the temporal variability of arsenic concentrations, redox processes, and groundwater age. In addition, the wells were montiored continuously for parameters such as pH, dissolved oxygen, specific conductance, water temperature, pumping rate, and depth to water.

The bedrock public supply well, producing the oldest water, has elevated arsenic concentrations (median=18.8 µg/L). Decreased pumping volume coincided with increased arsenic, iron, and manganese over time. Arsenite concentrations also increased at this well indicating a more reducing environment with lower pumping volumes.

Arsenic concentrations at the glacial aquifer public supply well were generally low (median=4.1 µg/L) but correlated significantly (ρ=0.81, $p<0.001$) with the bedrock aquifer public supply arsenic concentrations. This suggests that some of the water captured by the glacial aquifer well may originate in the bedrock aquifer, as no other drivers of arsenic variability were observed in the glacial aquifer well. Pumping volume and water table flucuations also corresponded with changes in chemical concentrations and the mean age of groundwater over time.

The bedrock aquifer domestic well had the highest concentrations of arsenic (median=37.2 µg/L), which coincided with both high water table and periods of high precipitation. Of special interest were large spikes in many chemical concentrations following a regional drought in 2016. This may suggest flushing during post-drought recharge when low dissolved oxygen, more reduced water entered the wells causing reductive desorption and dissolution.