EFFECT OF CHLORINATION ON ARSENIC RELEASE FROM SULFIDE MINERALS IN THE ST. PETER SANDSTONE AQUIFER, EASTERN WISCONSIN

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High arsenic concentrations (>100 µg/L) have been measured in wells completed in the Ordovician St. Peter sandstone aquifer of eastern Wisconsin. The primary source of arsenic is As-bearing sulfide minerals within the aquifer. There is a concern that periodic disinfection of wells by chlorination may facilitate As release to groundwater by increasing the rate of sulfide mineral oxidation. During typical well disinfection procedures, aquifer solids exposed along the uncased portions of wells remain in direct contact with chlorine disinfection solutions for up to twenty-four hours. This study focuses on abiotic processes that mobilize As from the aquifer during controlled exposure to chlorination solutions, using spectroscopic techniques to characterize St. Peter sulfide minerals and alteration products that form on them. An initial set of experiments have been conducted using cleaned fine grained pyrite (as an analog to the St. Peter sulfide) and chlorine solutions similar to those used in well disinfection (1200 mg/L free chlorine, pH 8.5). The reacted pyrite showed considerable oxidation compared to those exposed to pure water. Surface characterization of the reacted pyrite using scanning electron microscopy (SEM) revealed thorough armoring of the pyrite grains with iron-oxides.

The next set of experiments will be conducted with slices of sulfide bearing core samples of St. Peter. Initial characterization of the St Peter core material using SEM and electron dispersive spectra (EDS) shows that the As-bearing sulfide minerals occur as nodules and as bands within the cement. The sulfides consist of pyritic cores and oxidized edges comprised of iron oxides, indicating that some oxidation of the sulfide materials has already occurred. The nodules and cements are comprised of clusters of small (2µm-10µm in diameter) pyrite grains. The fine grain size of the pyrite could prove to be a very important factor in controlling As release from these sulfides due to their large reactive surface area. After exposure to different chlorine solutions, the core slices will be characterized using electron microprobe methods to provide quantitative geochemical data about the sulfide minerals in the St. Peter and their alteration products that occur both before and after chlorine exposure. Changes in sulfide surface features will be imaged using SEM. The chlorine solutions will be collected after contact with the sulfide minerals and analyzed to quantify amounts of As, Fe, and S released to solution. Experimental results will help identify and evaluate potential short- and long-term impacts of chlorine-induced chemical oxidation of As-bearing sulfides on well water quality.

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