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Natural Carbon Sources Drive Arsenic into Groundwater in Shahrasti, Bangladesh

The World Health Organization has described exposure to elevated levels of arsenic in groundwater in Bangladesh as the largest mass poisoning of a population in history. Chronic, low dose exposure to inorganic arsenic in drinking water increases the risk of internal cancers and impairs motor and intellectual function in children. A widely postulated mechanism of arsenic release into groundwater involves heterotrophic bacteria reducing iron oxyhydroxides onto which arsenic is adsorbed in the subsurface. This reduction causes the iron and arsenic to dissociate and allows arsenic to enter the groundwater. Whether the organic carbon fueling these bacteria is obtained from a sedimentary or anthropogenic source is still unclear. This study uses the radiocarbon age of bacterial DNA to determine the source of organic carbon driving microbial respiration in Shahrasti, Bangladesh. This site has a high population density, high levels of dissolved arsenic and high concentrations of phosphate. These characteristics make Shahrasti an end-member site where anthropogenic carbon would be expected to contribute to microbial reduction and subsequent arsenic release.

In April 2011 more than 10,000 liters of groundwater were filtered from three wells at the site. DNA was extracted from collected bacterial cells, purified and sent for radiocarbon dating. DNA ages were approximately 4800, 5700, 8760 years old in the shallow (11 m), middle (43 m) and deep (50 m) wells, respectively. These ages are not modern and indicate that natural carbon from sediment or buried peat could be the primary source of organic carbon driving microbial respiration and subsequent arsenic release in the subsurface. These results demonstrate that at a site with high inputs of anthropogenic carbon and high levels of dissolved arsenic in groundwater, arsenic release is a naturally occurring process.