4.65.14

Arsenic reduction by bacteria in shallow aquifers from Ambikanagar in West Bengal (India)

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Biological processes contributing towards the transformation and mobilization of arsenic (As) in shallow aquifers was investigated in a small town called Ambikanagar situated in the North 24 Parganas in West Bengal. The area has reported several As related deaths in recent years from people consuming As-rich groundwater. The shallow aquifers usually consist of fine-to-medium grained sands, and As concentration is often above the permissible drinking water limit (50 µg/L).

We isolated several pure strains of bacteria from these As-rich aquifer sediments, and evaluated their growth, As(V) reduction rates, and performance. Enrichment cultures indicated several As tolerant species, which actively reduced As(V). However, high As concentration in the cultures increased toxicity, and hence, bacterial types and the heterotrophic plate counts declined. Bacteria isolated from the enrichment cultures were identified as *Acinetobacter johnsonii, Citrobacter freundii, Comamonas testosteroni, Enterobacter cloacae,* and *Sphingobium yanoikuyae*. We noted different growth and As(V) reduction rates under microaerophilic conditions on inoculating the medium with these bacteria. Compared to other As(V) reducing microbes, bacteria isolated in this study indicate lower reduction rates (0.11-0.25 mM/day). A zero-order model best fits the As(V) reduction data. Initial As concentration seems to affect growth and As(V) reduction rates, and they were highest in the bacteria *A. johnsonii*. In contrast, *C. testosteroni* and *S. yanoikuyae* are less affected by initial As(V) concentrations. Arsenic reduction is probably related to detoxification in these two bacteria. We believe that microbial mobilization of As in these aquifers may have an impact, and should be taken into account when designing groundwater treatment facilities for safe drinking water.

4.65.15

A sedimentary framework for arsenic-contaminated groundwater in West Bengal

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Holocene alluvial aquifers of the Bengal Delta Plain provide the public water supply for some 110 million people, and are severely polluted with naturally-occurring arsenic. In Barasat, near Kolkata (Calcutta), ground water wells have high concentrations of arsenic, ranging from <1 to 1180 µg l^{-1}. The ground water is drawn from sedimentary aquifers with variable stratigraphy. In two cores, the sequence comprises an upper confining 9-12 m thick layer of silt, a 30-40 m thick shallow aquifer of unconsolidated sands (the arsenic-polluted aquifer), a lower confining, 35 m thick layer of silt and clay, and a deep aquifer. In another core, the upper confining layer is 24 m thick, with the lower half comprising effectively impermeable clay. Radiocarbon and OSL dating suggests that the arsenic-polluted aquifer is less than 18 000 years old, and fission track analysis indicates that rates of erosion, transport and deposition since 8 000 years BP were extremely high. Organic-rich sediment (peat) formation occurred at three times: (i) brackish swamps in front of a prograding delta, 9Ka – 7 Ka BP, (ii) freshwater – brackish swamps, overlying or interbedded with c. 7 Ka BP sands and (iii) about 2 Ka BP. Dominant age modes (1.5±0.2–3.6±0.6 Ma), recorded by fission track analysis on detrital apatite grains, are consistent with sources across the Main Central Thrust and High Himalayas, in particular, from the syntaxial zone. Mineralogical analysis suggests that the arsenic is associated with iron oxides that might occur within, or as coatings on, biotite and chlorite grains. We propose that the widespread extent, and the severity, of arsenic pollution in the Bengal Basin arises because Himalayan erosion supplies immature sediments to a depositional environment that is rich in organic matter (peat), so that complete reduction of arsenic-bearing FeOOH is common.