The geomicrobiology of arsenic release in the Bengal delta

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Arsenic is a metalloid that in its soluble oxidised forms, arsenite (As^{III}) and arsenate (As^{V}), is extremely toxic. Arsenic contamination can be a result of both anthropogenic and natural sources. Natural pollution of groundwater by arsenic adversely affects the health of tens of millions of people worldwide, with the aquifers of South Asia particularly polluted. The pollution is caused primarily by, or as a side reaction of, the microbial reduction of sedimentary Fe^{III}-oxyhydroxides, but the organism(s) responsible for As release have not been isolated. Although As^{V} respirers have been implicated in the reduction of As^{V} to As^{III} no As^{V} respirer has been isolated from the Bengal delta. Evidence will be presented of the first isolation of an arsenate-respiring bacterium, designated WB3, from sediments of the Bengal Basin in West Bengal. WB3 was isolated from brown sands collected at a depth of 35.2 metres below ground level (mbgl). This level was about 3 cm below the boundary between the brown sands and overlying reduced, grey, aquifer sands. This colour boundary is interpreted to be a reduction front that releases As for re-sorption downflow, yielding a high load of labile As sorbed to the sediment at a depth of 35.8 mbgl and concentrations of As in groundwater that reach >1000 μg/L. The bacterium WB3 is a new member of the genus *Desulfuromona*s and respires with soluble arsenate as the electron acceptor, coupling its reduction to the oxidation of acetate. With acetate as the electron donor it can also use dissolved Fe^{III} citrate, solid Fe^{III}-oxyhydroxide and elemental sulphur as electron acceptors. Newly designed degenerate oligonucleotides for the catalytic subunit of the respiratory arsenate reductase were used to detect a homologue of this gene in WB3. The role of organisms like WB3 in As release in the Bengal delta will be discussed.