Linking microbial community structure to groundwater arsenic concentrations in Pannonian basin wells

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The groundwaters within the Pannonian basin are known to have As concentrations that exceed the 10 ppb WHO provisional guide value. The mechanisms that govern As release, however, are unknown but believed to be microbially mediated. Microorganisms are capable of performing a wide variety of biogeochemical transformations that can influence the levels of As and other geogenic chemicals, such as S, Fe, and Mn. To date, it is not known which groups of microorganisms inhabit aquifer systems within the Pannonian Basin and their role, if any in geogenic chemical release mechanisms. In order to elucidate the role microbes play in groundwater geochemistry in this region, we collected water from artesian, pumped, and open dug groundwater wells in western Romania and eastern Hungary. The collected groundwaters ranged from mildly reducing to strongly reducing, with typical As concentrations between 1 and 200 ppb. We used a combination of 16S rRNA gene sequence analysis and terminal restriction fragment polymorphisms to investigate the communities in these systems. Our results revealed several types of known and unknown bacterial genera, capable of many types of transformations that can affect the cycling of As and other geogenic chemicals. The microbial communities present in groundwater wells in the Pannonian basin and their role in geogenic chemical cycling will be discussed.

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Arsenite sequestration by Fe(II)-containing minerals after microbial dissimilatory reduction of arsenic-sorbed lepidocrocite

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EXAFS and XANES were used in combination with HRTEM, XRD, and Mössbauer spectroscopy to obtain detailed information on arsenic and iron speciation in the products of anaerobic reduction of pure and As(V)- or As(III)-adsorbed lepidocrocite by *S. putrefaciens* ATCC 12099. We found that this strain is capable of using both Fe(III) in lepidocrocite and As(V) in solution or adsorbed on lepidocrocite surfaces as electron acceptors. Bioreduction of pure and As(III)-sorbed lepidocrocite resulted in the formation of hydroxycarbonate green rust 1 [GR1(CO_3)], prior to formation of ferrous-carbonate hydroxide (FCH). However, the presence of As(III) slows down this transformation, leading to the co-occurrence of both phases. As(III) was then found to be adsorbed on the surfaces of GR1(CO_3) and FCH. Bioreduction of As(V)-bearing lepidocrocite led directly to the formation of FCH in association with nanoparticles of a minor As-rich $Fe(OH)_2$ phase, with no evidence for green rust formation. As(V) was fully converted to As(III) and dominantly sorbed at the surface of the $Fe(OH)_2$ nanoparticles as oligomers binding to the edges of $Fe(OH)_6$ octahedra in the octahedral layers of $Fe(OH)_2$. These multinuclear As(III) surface complexes are characterized by As–As pairs at 3.32 ± 0.02 Å and by As–Fe pairs at 3.50 ± 0.02 Å and represent a new form of As(III) surface complexes. Chemical analyses show that the majority of As(III) is associated with iron-bearing hydroxycarbonate or hydroxide solids, reinforcing the idea that, at least under some circumstances, bacterial reduction can promote As(III) sequestration instead of mobilizing it into solution.