



Adsorption and oxidation of arsenite by iron minerals in the presence of microorganisms

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It is known the two most commonly occurring forms of As in the environment are anionic arsenate [AsO_4^{3-} , As(V)] and arsenite [AsO_3^{3-} , As(III)]. Arsenite has been found to be the more mobile and toxic species in soil environments (Tamaki and Frankenberger, 1992). Arsenic speciation and toxicity are functions of pH, redox potential, the presence and type of adsorbing surfaces, and microbial populations. Biotransformation of arsenic species (reduction or oxidation) is mainly enzymatic process, while biosorption is metabolism independent process that governed by physico-chemical interactions on the cell surface.

Special ternary bio-mineral systems, consisting of iron minerals (synthetic goethite, and magnetite, which was prepared by oxidation from special commercial product – nano-iron), special strains of arsenite-oxidizing microorganisms (*Ancylobacter dichlorometanicus*) and arsenite solution, were constructed and processes of arsenic compounds adsorption and oxidation were studied. As control experiments without microorganisms or without minerals were carried out. For determination of arsenic species, adsorbed on the surface of the minerals, desorption experiments were carried out also. Desorption ability of several chemicals, used for arsenic extraction from soils, was tested.

Magnetite and goethite, with very small size of particles, have high chemical affinity to arsenite at wide range of pH values, but at pH above 9 adsorption of arsenite decreased in comparison with pH below of the isoelectric points of the minerals. We carried out experiments at initial pH 7,2. Experiments on kinetics of adsorption showed that equilibrium time for adsorption is 2 hours.

In the ternary bio-mineral systems consisting of fresh-prepared magnetite, the effect of arsenite-oxidizing microorganisms on the oxidation process was negligible in all cases, because magnetite demonstrated very high oxidation ability in comparison with bacteria. During 4 hours all arsenite, adsorbed on the magnetite surface, was chemically oxidized to arsenate (initial concentration in the solution – 0,6 mmol), while for *Ancylobacter dichlorometanicus* for oxidation was necessary more long time (about 24 h). However, during time the iron oxide changed the surface properties, which resulted in reduction of adsorption capacity and oxidation ability.

In the ternary bio-mineral systems, consisting of goethite, the mineral showed very low oxidation ability. In the presence of microorganisms ($0,5 \times 10^9 \text{ cell ml}^{-1}$), added to the mineral 17 h before arsenite solution, adsorption of arsenite by goethite decreased sufficiently, but about 15% of arsenic species in the equilibrium solution was as arsenate. Desorption of arsenic species from the bio-mineral surface was low and all recovered arsenic was oxidized.

So, interactions in the system “mineral-microorganism-solution of pollutant” are very complex and depend on such factors as concentration of arsenic species and microorganisms in the solution, presence, oxidation ability and sorption capacity of minerals. Understanding of these interactions is very important for cleaning of polluted sites and waters from toxic arsenic species.

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