

ARSENIC IN GEOTHERMAL SYSTEMS

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Abstract

The geothermal environment is a geochemically dynamic environment where the variations in pH, redox and temperature greatly affect the stability of aqueous ligands present. Arsenic complexes dominance and stabilities are greatly influenced by these physicochemical variations, and thus their affinity with mineralogical hosts.

In the study areas in Japan and the Philippines, amorphous silica and a smectite were found to uptake arsenic stably. Their resistance to rigorous leaching in either highly alkaline or highly acidic solution suggests that they must be structurally incorporated, especially in the smectite found in Japan. X-ray spectroscopy has further shown that the arsenic is dominantly in the form of $\text{As}^{\text{III}}\text{-O}$ species and only minor contributions from both $\text{As}^{\text{V}}\text{-O}$ and $\text{As}^{\text{III}}\text{-S}$ forms. The potential of the clay to uptake arsenic was further investigated in synthesis experiments designed to determine the mechanism involved. Both co-precipitation with smectites through initial $\text{As}^{\text{III}}\text{-Si}$ complexation, and sorption to precursory poorly crystalline phyllosilicates was able to uptake arsenic in large amounts and offers significant stability.

Despite difficulties in characterizing the poorly crystalline synthesized phyllosilicates, the timing of arsenic uptake based on co-precipitation and sorption experiments provide insights on the possible crystallographic location of arsenic in the phyllosilicate structure. Arsenic uptake through initial complexation with dissolved silica would suggest incorporation into the tetrahedral structure, and would also support its affinity with amorphous silica in the natural environment. Initial adsorption with a poorly crystalline phyllosilicate and later incorporation would more favorably enable it to substitute into octahedral sites (i.e. Mg^{2+}) rather than the tetrahedral sites. In both cases of uptake, it is implied that arsenic can go into the phyllosilicate structure with the *in situ* formed mineralogical hosts similar to the documented arsenic-bearing smectite.

Keywords: arsenic, geothermal environment