Influence of precursory phases on arsenic mobility in the geothermal environment

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Since As contamination of groundwater, surface water and soils has been the worst disaster that has affected humans this century (i.e. Bangladesh and China), insights into how As becomes mobile in the surface environment can be derived from its main source in the geothermal environment. The mobility of trace metals such as arsenic in the geothermal environment has been widely associated with the precipitation of discrete As-S mineral phases (e.g. orpiment and realgar), and sorption to Fe-oxyhydroxides. In the absence of these solid phases (e.g. As minerals and Fe-oxyhydroxides), other factors can exert influence on toxic trace metal mobility in the geothermal environment.

In the geothermal fields (Akita Prefecture, Japan), the large fraction of the total As is stably incorporated into the Mg-rich trioctahedral smectite that comprise the bulk of geothermal scales. Selective extractions indicate that sorbed phases only account for the minor fraction of the total As content of geothermal scales. Geochemical modeling of the geothermal fluid (average 14 ppm As) does not predict precipitation of discrete As-S mineral phases or formation of Fe-oxyhydroxides.

In situ and laboratory sorption studies were performed using the geothermal fluid composition and involving mineral phases similar to the bulk composition of the geothermal scales, and possibly precursory solids to the stable mineral phases comprising the geothermal scales. Results show that the relatively stable mineral phases did not uptake significant dissolved As. The possible precursory phases almost completely remove dissolved As to minimum levels (less than 2 ppm As). Observations by XRD, SEM-EDS and IR spectroscopy coupled with geochemical reaction modeling suggest that the uptake mechanism involved initial partial dissolution of the precursory phases and later coprecipitation. Incorporation of As stably into the Mg-rich trioctahedral smectite occurs through subsequent aging of the precursory phase and eventually formation of the stable mineral phase (e.g. trioctahedral smectite).

In the absence of phases usually associated with As uptake in the geothermal environment, precursory phases control the mobility of As in the geothermal environment prior to the formation of stable mineral phases.