The fate of arsenic adsorbed by schwertmannite in natural attenuation process

Kenichi Ito[1]; Ayumi Katagiri[2]; Keisuke Fukushi[3]; Hodaka Ikeda[4]; Koichi Hashimoto[5]; Tsutomu Sato[6]

[1] Kanazawa Univ. Natural Sci. & Tech.; [2] Earth sci.,Kanazawa Univ.; [3] JHU; [4] SOPHIA CO.,LTD.; [5] JOGMEC; [6] Inst. Nature, Environ. Technol., Kanazawa Univ.

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Abandoned mine tailings dominantly comprising sulphide ores from former mines generate acidic wastewaters (usually referred to as AMD) when they interact with groundwater and rainwater. The waste water usually contains large amounts of dissolved metals such as As, Fe(II) and Cu. There are over 100 abandoned mines in Japan that are currently experiencing suffering AMD conditions and are typically treated by neutralization of the acidic wastewater. However, this remediation method has two main problems: (1) an enormous expenditure, and (2) a massive amount of neutralized sludge. Furthermore, the hazardous trace metals are not stabilized on a long-term basis. Furthermore, it is unclear whether the hazardous trace metals are stabilized on a long-term or not.

An alternative and novel remediation method can be implemented using schwertmannite, which has been found to naturally attenuate trace metals in AMD waters (Fukushi, et al., 2003). It has been applied in the Horobetsu mine in Hokkaido, Japan where dissolved arsenic concentrations are very high. The high dissolved arsenic concentration is removed by in situ formation of schwertmannite resulting to less sludge than the contemporary neutralization procedure. Furthermore, As stabilizes the schwertmannite (Fukushi, et al., 2003) consequently preventing the release of the sorbed As.

The long-term stability of schwertmannite and its susceptibility to transformation to goethite is investigated in this study. Alteration experiments were conducted on 5 types of samples: (1) Syn-Sch - synthesized schwertmannite based on the methods of Bigham et al. (1996); (2) Sch-As - Syn-Sch with sorbed arsenic; (3) Sch-Sludge - sludge from the Horobetsu mine which contains about 60% schwertmannite (i.e. from an in situ pilot study); (4) N-sludge - sludge from contemporary neutralization procedures; and (5) N-Sch - a natural schwertmannite from Nishinomaki mine.

Suspensions from 30mg of each sample in 40 ml deionized water (0.01 M $NaNO_3$ support electrolyte) were stored in 50 ml polycarbonate centrifuge tubes. These were aged at a constant temperature (e.g. 50, 70, 100 deg C) for several weeks (e.g. 1 to 8 weeks). The pH and ORP of the suspensions was measured and the solid are separated by 0.2 micro m filters. Dissolved Fe, As and SO_4 concentration in suspensions were measured with ICP-MS and ion chromatography. Mineralogical changes in the solids were determined by XRD.

Sch-As, Sch-Sludge, and N-Sch did not release any significant amount of As indicating it has been stabilized in the schwertmannite. The N-sludge released As into the solution. Characterization by means of XRD showed that iron oxides present in the Syn-Sch and N-sludge transformed to goethite and to some extent scorodite. Scorodite is stable under most natural surface conditions. These results verify the safe and efficient use of schwertmannite as a remediation tool in areas affected by AMD.