Thallium(I) sequestration by Fe- and Mn-bearing secondary minerals: Structural incorporation vs surface sorption

J. AGUILAR-CARRILLO[1] AND L. HERRERA-GARCÍA[2]

[1] Instituto de Metalurgia - CONACyT, UASLP, 78210, S.L.P., Mexico, javier.aguilar@uaslp.mx
[2] Instituto de Metalurgia, UASLP, 78210, S.L.P., Mexico. liahgarcia@gmail.com

Dissolved potentially toxic elements (PTEs) in acid environments, such as those produced in mining-metallurgical activities, may be mobilized and transported to surrounding locations promoting the contamination of soils, sediments, ground and surface waters [1]. Thallium (Tl) is identified by the USEPA as a priority pollutant since is more acutely toxic than As, Hg, Cd, and Pb in mammals [2] However, Tl is not efficiently removed by conventional techniques, easily reaching groundwater and fluvial systems once released [3]. High concentrations of PTEs can be naturally attenuated by a series of pH-buffering, precipitation and sorption reactions when fresh secondary Fe and Mn (oxyhydr)oxides, along with other poorly-crystalline phases, are formed in these scenarios [4]. The purpose of this work is to delve into the geochemical understanding of Tl behavior when Fe- and Mn-bearing secondary minerals are present either during or after its formation.

Natural samples were collected from acid waste-weathering process at Cerro San Pedro historic mining district (SLP, Mexico). Also, series of pure and Tl(I)-dopped jarosite and birnessite minerals were synthesized to determine the sorption mechanism involved and retention capacity. Thallium partitioning has been determined in natural and synthetic samples by combining different analytical techniques: XRD, SEM, FTIR, chemical digestion. Thallium has been found both adsorbed (25 and 46 mmol kg^{-1}) and incorporated (1.43 and 2.69 mmol kg^{-1}) into the structure of jarosite and birnessite, respectively, indicating that Tl(I) can be efficiently removed while these phases are forming.

The results of this work have important environmental implications: Fe- and Mn-bearing secondary minerals play a key role in controlling the water chemistry of many acidified streams and can be used as a sustainable mitigation strategy for long-term storage of Tl.

[1] Sparks (2003) Environmental Soil Chemistry. Academic Press, San Diego. [2] Peter and Viraraghavan (2005) Environ. Int. 31: 493-501. [3] Casiot et al. (2011) ES&T 45: 2056-2064. [4] Carbone et al. (2013) J. Geochem. Explor. 132: 188-200.