

Role of Amorphous Ferric Arsenate in the partitioning and mobility of arsenic (As) and lead (Pb) in an ancient Pb–Zn mine in central Mexico.

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High loads of dissolved potentially harmful elements (PHEs) can be naturally attenuated by a series of pH-buffering, (co)precipitation, and sorption reactions when fresh secondary minerals (i.e. ferrihydrite, schwertmannite, jarosite) are formed in acid environments impacted by mining activities [1]. In these scenarios, PHEs may be mobilized and transported to surrounding locations promoting the contamination of soils, sediments, ground and surface waters [2]. Whereas the affinity of PHEs for crystalline secondary minerals in AMD systems have been addressed in many studies [3], relatively few have focused on its sorption on amorphous phases, despite being metastable minerals widely found in these environments. This study delves into the interactions between Pb and As and poorly-crystalline minerals, particularly amorphous ferric arsenate (AFA), in an ancient mine characterized by highly-dispersed pollutants due to strongly acidic conditions originated from AMD [4].

On-site observations at Cerro San Pedro historic mining district (SLP, Mexico) accompanied by laboratory-based mineral formation experiments were undertaken to examine the reactions of mobile Pb and As from abandoned mine residues on the mineralogy of the impacted sediments, as well as to examine associated controls on their mobility. Arsenic and lead partitioning have been determined in natural and synthetic samples by combining different analytical techniques, including XRF, XRD, SEM-EDS, and selective chemical digestion.

Natural attenuation of Pb and As mobility predominantly occurred via formation of $PbHAsO_4$, Pb–As-rich Fe(III)-minerals, and AFA, resulting in solid-phase concentrations spanning ~ 1088 to ~ 1545 and ~ 278 to ~ 734 $mg\ kg^{-1}$ for Pb and As, respectively. Subsequent sorption experiments with synthetic AFA revealed the retention of Pb by the formation of anglesite ($PbSO_4$) due to an appreciable sulfur content (~ 4 wt%) in AFA chemical composition, whereas As was effectively retained by a non-exchangeable surface adsorption mechanism. The results of this study show the occurrence of metastable phases like AFA in AMD environments as well as its role in controlling Pb and As mobility under strongly acidic conditions.

[1] Nordstrom (2011). *Appl. Geochem.* 26, 1777-1791. [2] Hudson-Edwards (2016). *Science* 352, 288-290. [3] Pavoni et al., (2018). *J. Geochem. Explor.* 188, 1-10. [4] Montes-Avila et al. (2019). *Appl. Geochem.* 100, 8-21.

