European Mineralogical Conference Vol. 1, EMC2012-65, 2012 European Mineralogical Conference 2012 © Author(s) 2012



Mechanisms and Products of the Weathering of Mine Tailings: A Column Leaching Study

K.A. Hudson-Edwards (1), D. Kossoff (2), W.E. Dubbin (3), and M. Alfredsson (4)

(1) Department of Earth and Planetary Sciences, Birkbeck, University of London, London, UK

(k.hudson-edwards@bbk.ac.uk), (2) Department of Earth and Planetary Sciences, Birkbeck, University of London, London,

UK (jkoss02@mail.bbk.ac.uk), (3) Department of Mineralogy, The Natural History Museum, London, UK

(w.dubbin@nhm.ac.uk), (4) School of Physical Sciences, University of Kent, UK (m.l.alfredsson@kent.ac.uk)

The weathering of mine tailings can contaminate river waters and soils with potentially toxic elements. To understand the mechanisms, extent and products of long-term weathering of complex Bolivian tailings, three-year long laboratory column experiments were carried out to model 20 years of dry- and wet-season conditions in the Pilcomavo basin. Two duplicate columns modeled sub-aerial tailings weathering alone, a third modeled the effects of long-term floodplain tailings contamination and a fourth modeled that of a tailings dam spill on a previously contaminated floodplain. Chemical analysis of the leachate and column solids, optical mineralogy, XRD, SEM, EPMA, BCR and water-soluble chemical extractions, and speciation modeling were carried out to determine the processes responsible for, and products of, the leaching of major and trace metals and metalloids (Al, As, Ca, Cd, Cu, K, Na, Mg, Mn, Pb, Sb, Sn, Sr, Ti and Zn). Over the 20 cycles, the pH declined to a floor of ca. 2 in all columns, due to the oxidation of pyrite, ferroan sphalerite and arsenopyrite, and the dissolution of soluble sulfate salts. Arsenic, Ca, Cd, Cu, Fe, Mg, Mn, Na and Zn showed significant cumulative losses of up to 29%, 95%, 100%, 60%, 20%, 30%, 95%, 40% and 60%, respectively, compared to those of Al, K, Pb, Sb, Sr, Sn and Ti, which were up to 3%, 1.5%, 1.1%, 1.9%, 5%, 1% and 0.05%, respectively. The high losses are attributed to the dissolution of relatively soluble minerals such as biotite, and oxidation of pyrite, chalcopyrite and wurtzite, while low losses are attributed to the presence of sparingly soluble minerals such as cassiterite, rutile and svanbertie. A series of secondary minerals, including soluble sulfate salts, Fe oxides and jarosite, formed during the weathering experiments, and were partly responsible for the retention of some of the metals and metalloids (e.g., Pb, Sb). Retention of other metals (e.g., Cu) in the soil-containing columns is postulated to be due to complexation with low molecular weight organic ligands. The results demonstrate the influence of mine tailings on the mobility of potentially toxic metals and metals from tailings and soils, and strongly suggest that these materials should be isolated from fluvial environments.