

Reactions of mine-tailings pore water with carbonate mineral surfaces

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Aqueous geochemistry and analysis of coatings on carbonate-mineral surfaces have been used to study mineral-water reactions in tailings. The coatings were studied with Time-of-Flight Laser-Ionization Mass Spectrometry (TOF-LIMS) and Transmission Electron Microscopy (TEM). Water and mineral grain samples were collected from the oxidized tailings, and the unoxidized tailings at depth. The pore-water pH at the sample locations varies between 3.85 and 6.98. Near the tailings surface, sulphide oxidation decreases the pH, and releases metals such as Cu, Pb, Zn, Cd and As to the pore water. Other dissolution reactions release Na, K and Al to the pore water. TOF-LIMS analyses of mineral grains along profiles from the surface coating to the ankerite [Ca(Fe, Mg)(CO₃)₂] substrate indicate decreasing abundances of Fe with depth at all of the sample locations. In contrast, the abundances of Ca and Mg increase with depth below the surface coating. A linear relationship is observed between the abundances of Fe and Ca along the depth profiles, suggesting that Fe replaces Ca during weathering. This is consistent with

TEM observations of siderite [FeCO₃] coatings on the ankerite. A variety of secondary minerals have been identified in the coatings using energy dispersive X-ray spectroscopy and electron diffraction. These include siderite, goethite [α FeO(OH)], lepidocrocite [γ FeO(OH)] and akaganeite [β FeO(OH,Cl)]. Abundances of the metals Cu, Pb, Zn and Cd on the mineral surfaces are lowest, and pore-water concentrations are highest, in the low-pH oxidized tailings. Abundances of As on the mineral surfaces are greatest, and pore-water concentrations are lowest, in the low-pH sulphide-oxidation zone. These trends vs pH are consistent with an adsorption mechanism for attenuation of these elements from the pore water. Abundances of Na, K and Al are greatest at the surfaces of the mineral grains in the low-pH zone which is inconsistent with an adsorption mechanism for attenuation from the pore water. The pore-water concentrations of Na, K and Al in the low-pH zone may be controlled by precipitation or co-precipitation reactions at the carbonate surface.