American Mineralogist, Volume 92, pages 1966–1977, 2007

Mineralogy of the hardpan formation processes in the interface between sulfide-rich sludge and fly ash: Applications for acid mine drainage mitigation

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Abstract

In the present study, experiments in non-saturated leaching columns were conducted to characterize the neoformed phases that precipitate at the interface between two waste residues having different chemical characteristics: an acid mine drainage producer residue (i.e., pyritic sludge) and an acidity neutralizer residue (i.e., coal combustion fly ash). A heating source was placed on top of one of the columns to accelerate oxidation and precipitation of newly formed phases, and thus, to observe longer-scale processes. When both residues are deposited together, the resulting leachates are characterized by alkaline pH, and low sulfate and metal concentrations. Two mechanisms help to improve the quality of the leachates. Over short-time scales, the leaching of pyrite at high pH (as a consequence of fly ash addition) favors the precipitation of ferrihydrite, encapsulating the pyrite grains and attenuating the oxidation process. Over longer time scales, a hardpan is promoted at the interface between both residues due to the precipitation of ferrihydrite, jarosite, and a Ca phase—gypsum or aragonite, depending on carbonate ion activity. Geochemical modeling of leachates using PHREEQC software predicted supersaturation in the observed minerals. The development of a relatively rigid crust at the interface favors the isolation of the mining waste from weathering processes, helped by the cementation of fly ash owing to aragonite precipitation, which ensures total isolation and neutralization of the mine residues.

Keywords: Acid mine drainage, fly ash, mine residue, microencapsulation, hardpan formation