Longevity of acid rock drainage (ARD): Mineralogical and chemical comparison of mine-waste piles and post-glacial talus rock producing acidic solutions

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Abstract. Natural processes and mining activity expose sulfide-rich material, such as pyrite, to atmospheric conditions and water, thus accelerating the oxidation of the sulfides and increasing the acidity and metal concentrations in the environment, including surface waters. This project documents the mineralogy and chemical characteristics of originally pyritic material exposed to oxidizing environments for different time periods, in order to determine natural and anthropogenic acid production rates, and quantify these rates over orders of magnitude longer time frames than have been previously investigated.

Two acid producing sites with similar alteration mineralogy and climate, but orders of magnitude different exposure time (100 vs. 10,000y), are located in major mineralized districts of the Colorado Rocky Mountains. The Chattanooga acid iron fen, located in the Silverton caldera of southwestern Colorado, is fed by natural acid generating, post-glacial (~10,000y) talus slope, while a series of abandoned 100 year-old mines and sulfide-rich waste piles in the Sugar Loaf mining district, on the western edge of Leadville, CO mining district, generate acidic solutions.

Field mineral distributions, petrographic observations, scanning electron microscope (SEM) work, sequential leachate analyses, and whole rock chemistry were conducted on samples from different depths in the waste piles from Sugar Loaf, while weathered clasts from talus slopes, outcrops, and secondary mineral precipitates from fossil and active seeps were investigated at Chattanooga. Sequential leaching of the samples with deionized water, ammonium acetate, and hydrochloric acid, identified secondary minerals which are in part readily soluble in the environment and hosts of Al, Ag, As, S, Fe, Pb, and Zn. Distribution patterns of the elements of environmental interest are evident in surface and subsurface material, and provide estimation of the rate of release and remobilization of these elements in natural systems. Using the compiled mineralogical and chemical data of material, both naturally and anthropogenically exposed to atmospheric conditions for 100-10,000 years, we will estimate the long term acid production and metal loading, which is critical for feasible restoration of mined sites.