

Weathering of Pb-Zn-bearing minerals in a neutral mine drainage setting, Gunnerside Gill, Yorkshire, UK

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Numerous areas throughout the world are affected by circum-neutral pH, low Fe drainage with high concentrations of Zn, Pb and Cd arising from discharges from, and weathering of, mine wastes. Gunnerside Gill, a small upland tributary in the headwaters of the River Swale in Yorkshire, is such a site affected by historic lead and zinc mining in the Northern Pennines, UK. Concentrations of Pb, Zn and Cd exceed background levels in waters of both Gunnerside Gill and the River Swale. The aim of the study is to determine the controls on Pb and Zn mobility from the mine tailings and river bank sediments using column leaching experiments and aqueous field data. Ten tailings and sediment samples were recovered from the length of Gunnerside Gill starting from near its headwaters down to the convergence with the River Swale. The samples were characterised using XRD, EMPA, BCR sequential extractions and total metal extractions. Four of these samples were then used to model 10 years of weathering by undertaking a column leaching experiment.

The original tailings and river bank sediment minerals are mixtures of Pb- and Zn-bearing sulphides, carbonates and Fe-Mn oxyhydroxides. Weathering of these minerals in the column experiments results in an early 'wash out' of Pb, Zn, Cd, Mn and S, which generally decline over time. The Zn and Cd show similar trends, but after the initial washout and decline the concentrations of Pb and Mn in one column gradually increase, suggesting that Pb cycling is related to the redox cycling of Mn oxyhydroxides. The results of the study will be used to determine the influence of climate change and potential changes in the surrounding geochemical environment on Pb and Zn mobility.