Sources, sinks, and fluxes of acidity in a coastal acid sulfate soils site

S BEAVIS[1], P. SOMERVILLE[1], L. ISAACSON[2], M KEHOE[2], FR BEAVIS[2], D KIRSTE[2], SA WELCH[2]

[1] Centre for Resource and Environmental Studies, sarab@cres.anu.edu.au, psomerv@cres.anu.edu.au
[2] Department of Earth and Marine Sciences, dirk@ems.anu.edu.au, swelch@ems.anu.edu.au
Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC LEME), The Australian National University, Canberra, ACT Australia 0200

Acid sulfate soils (ASS) are a major environmental problem in coastal regions of Australia. This study investigates physical, chemical and biological controls on acidity. The study site is an ASS hot spot in the Clybucca catchment NSW, Australia. It is a former backswamp that has been cleared and drained to optimise pastural productivity. These landuse practices have imposed oxidising conditions resulting in surface scalding and leaching of acid and heavy metals into surface and groundwaters which have a deleterious impact on ecosystem health.

The site is characterized by extreme variability in acidity, over both spatial and temporal scales, in surface and pore water as well as shallow groundwater. The pH of pore water ranges from ~ 2.5 to 3 in the upper 50 cm of the sediment profile. However, pore water pH is near neutral below this due to the buffering capacity of a shell layer. The pH of the standing surface water ranges from < 3 to > 7, and can vary by up to 3 pH units over ~ 1 m horizontal distances, coincident with the boundary between scalded and vegetated areas. This pH gradient indicates that acid consumption by iron and sulfate reduction is greater than mixing-diffusion with surrounding waters.

Experiments were conducted to determine the kinetics of acid release from the sediments. Sediment water (1:5) leaches show that acidification is rapid, solution pH decreased to ~ 3 to 4.5 within an hour and then decreased ~ 0.1 to 0.3 pH unit over several days. Subsequent water leaches were ~ 0.1 to 0.5 pH units higher than the first, indicating a large store of acid in the sediments, and that the kinetics of acid release will be rapid compared to flushing of the sediments by rainfall events. Jarosite dissolution experiments were conducted under a range of conditions. All show a rapid release of acid and ions to solution (hours), followed by a slower release (weeks). Steady state jarosite dissolution rates range from ~ 0.5 to 2 µmole jarosite/g-day. Batch experiments were conducted to determine the role of bacteria on acid generation. Although enrichment cultures show growth for both Fe(II) and sulfide oxidizing microbes, slurry experiments show little evidence of increased acidification, which suggest either microbes were not active, pyrite oxidation was limited by acid neutralization, or pyrite was depleted.