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Impact of ground water - surface water interactions on pore-water and solid sediment phase composition of an acidic mining lake

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Biogeochemical processes in lake sediments are influenced by diffusive and advective supply of solutes from lake and ground water. It has been demonstrated that the pore-water pH in lake sediments characterized by low pH and high concentrations of iron and sulfur (e.g. acidic mining lakes) are significantly affected by exchange flows with moderately acidic or near-neutral ground water (Blodau 2004[1]). The resulting pore-water pH is a master variable which controls many biogeochemical processes such as mineral transformations, the reduction of iron and sulfate, etc.

The aim of this study was to investigate whether inflow of ground water into an acidic mining lake leads to a shift from acidic, iron-reducing to near-neutral, sulfate-reducing and pyrite-precipitating conditions within the lake sediment. Therefore, we investigated ground-water advection rates among different sites and related them to concentration-depth profiles of relevant chemical species, and the composition of the solid sediment phase.

We observed a heterogeneous pattern of ground water - surface water exchange within the lake. In shallow areas, ground water inflow occurred in the northern part (up to 7 L m^{-2} d^{-1}) of the lake and outflow (up to 3 L m^{-2} d^{-1}) in the southern part. In deeper areas, ground water generally infiltrated into the lake with rates of up to 6 L m^{-2} d^{-1}except one site ($>$ 200 L m^{-2} d^{-1}). Advective transport affected pore-water concentrations of ferrous iron and sulfate which both ranged from 5 to 30 mmol L^{-1}. Additionally, concentration-depth profiles of these dissolved species were altered by other processes such as schwertmannite transformation, and iron and sulfate reduction. Ground water – surface water exchange flows caused apparent differences in the pore-water pH: under outflow or low inflow conditions the pore water was more acidic (below pH 3.5) compared to the other sites (pH up to 6). Since sulfate reduction is pH-controlled the observed differences in the pore-water pH should have an effect on the sequestration of total reduced inorganic sulfur (TRIS); and this is supported by the preliminary results of the solid sediment phase analysis.

[1] Blodau, C. (2004). "Evidence for a hydrologically controlled iron cycle in acidic and iron rich sediments." Aquatic Sciences 66(1): 47-59.