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Chemistry and modeling of the response of a small stream to a short-term in-stream acidification

T. NAVRATIL[1], M. VACH[1], S.A. NORTON[2] AND P. SKRIVAN[1]

[1] Inst. of Geology, Czech Academy of Science, Rozvojova 135, Prague 6 (navratilt@gli.cas.cz)
[2] Dept. of Geological Sci., University of Maine, Orono.

Several in-stream acidification experiments have clarified some of the important chemical processes, including adsorption, desorption, and dissolution occurring within the stream itself. Three general processes have been documented for interaction between the acidifying stream water and sediment. First and most important, H^+ exchanges with other cations adsorbed on the stream substrate, releasing them into solution. Second, adsorption of SO_4^{2-} by stream substrate may occur. Third, dissolution of an Al-rich solid phase occurs, along with trace elements associated with that phase. These reactions are generally reversible during recovery.

Lesni potok stream drains a forested headwater catchment in central Czech Republic. It was artificially acidified with HCl for 4 hours to assess the role of stream substrate in acid-neutralization and recovery. The pH was lowered from 4.7 to 3.2. Desorption of Ca and Mg, and desorption or solution of Al dominated acid-neutralization; Al mobilization dominated later. The stream substrate released 4,542 meq Ca, 1,184 meq Mg, and 2,329 meq Al over a 45 m long and 1 m wide stream segment. Smaller amounts of Be, Cd, Fe, and Mn were released. Adsorption of SO_4^{2-} and desorption of F^- occurred during the acidification phase of the experiment. The exchange reactions were rapidly reversible for Ca, Mg, and SO_4^{2-} but not symmetric as the substrate resorbed 1,083, 790 and 0 meq Ca, Mg, and Al, respectively, in a 4-hour recovery period. Desorption of SO_4^{2-} occurred during the resorption of Ca and Mg. These exchange and dissolution reactions delay acidification, diminish the pH depression, and retard recovery from episodic acidification. The behavior of stream substrate-water interaction may be a good analog for soil – soil water interactions. A mathematical model, MASS (Modeling Acidification of Stream Sediments), was developed to simulate the adsorption and desorption of base cations during the experiment and was successfully calibrated to the experimental data [1]. The dynamic MASS model is based on mass balance.

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References

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Iron oxidizing bacteria, *Gallionella* and *Leptothrix,* from seven locations in Denmark

S.T.S. SOMMER, S.L.S. STIPP AND T.B. ZUNIC

Geological Institute, University of Copenhagen, Øster Voldgade 10, DK-1350 Copenhagen K
(delm@stud.ku.dk; stipp@geol.ku.dk; tonci@geol.ku.dk)

Seven natural ochre samples have been examined to determine their mineralogical and chemical composition and to check for the presence of the iron oxidizing bacteria, *Gallionella ferruginea* and *Leptothrix ochracea*. All samples were collected from groundwater effluent points in Denmark. Aquifers included chalk and sandy or clayey glacial till. One of the samples came from a spring, two from drainage ditches under agricultural land, two from springs at the base of hills, one from an artesian well near a beach and one from an old limestone quarry. The presence of bacteria was verified by the morphology of the solid material, seen using a petrographic microscope. *Gallionella* is very small but the twisted stalks it produces are characteristic. *Leptothrix* is revealed by sheaths and rods (figure). The relative distribution of bacteria species varied. Three samples contained *Gallionella* almost exclusively, with very few of the other species, whereas the other four mostly contained *Leptothrix.* X-ray diffraction showed the iron precipitate to be 2-line ferrihydrite in all cases. No other Fe-oxide minerals could be found. Synthetic ferrihydrite recrystallises in weeks to months in the laboratory in the absence of bacteria or other organic compounds, so the pervasiveness of ferrihydrite in these natural samples rich in biological material is interesting.

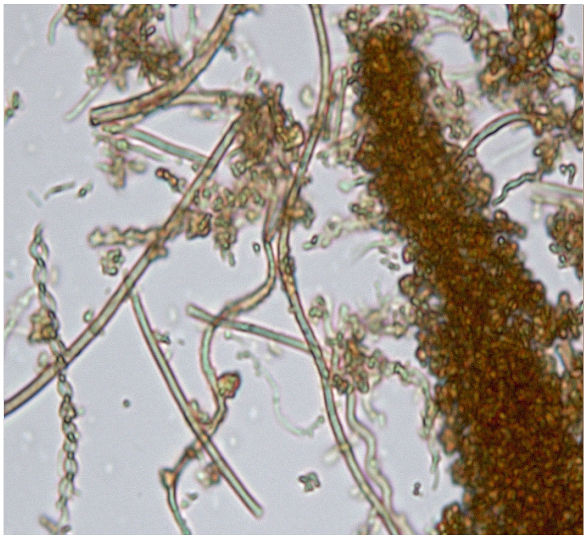

Figure 1. *Gallionella* and *Leptothrix* from Hindsgavl on Fyn, Denmark (magnification is 630 times).