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Geochemistry of S and Ni in the Subarctic Lake Imandra, Kola Peninsula, Russia

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Lake Imandra is located between 67ºN and 68ºN on the Kola Peninsula, NW Russia. Several heavy, polluting industries, such as an ore processing complex and a Co-Ni smelting complex, operate around the lake. In addition to airborne deposition of sulphate (see de Caritat et al., 1997), Lake Imandra also receives direct discharges of waste water from these industries.

Lake water was sampled in the spring, when the lake still was ice-covered. The water was filtered through 0.45 µm Millipore membrane filters, and the filters with suspended material were totally digested. Solid phase and porewater in the sediment were subsampled from a 20 cm deep sediment core. The analyses were performed mainly by ICP-AES and ICP-QMS.

Particles enriched in Ni, probably mainly Fe and Mn oxyhydroxides, enter the lake and settle. In the anoxic sediment, these particles dissolve, releasing Ni and other associated trace metals. Dissolved Fe, Mn, and Ni (<0.45 µm) diffuse upwards into the water column as well as downwards into the sediment. As the upwards diffusing Mn reprecipitates in the water column, at a depth with a sufficiently high redox potential, Ni ions are sorbed to these Mn oxyhydroxide particles. The Mn particles are the dominating phase in the bottom water suspended material, giving a maximum Mn concentration of 23% (dry weight) approximately 1 m above the bottom (total depth 30 m). The concentration of particulate Ni in the suspended material correlates well with the Mn concentration (R^2=0.78) and reaches a maximum of 0.5% (dry weight). Hence, particulate Ni in the water column is controlled by the redox cycling of Mn.

The downwards diffusing Ni ions are precipitated as sulphides or co-precipitated with/adsorbed to Fe sulphides in the sediment. The concentration of solid phase Ni in the sediment increases upwards from the depth of 10 cm. The concentration of S increases from the same depth, and reaches a maximum 5 cm below the water-sediment interface (300 mmol kg^{-1}). Background concentrations (below 10 cm depth) of S are lower than 100 mmol kg^{-1}. The increasing S concentration probably reflects an enhanced rate of sulphate reduction as a result of the large anthropogenic inputs of sulphate to the lake (cf. Henriksen et al., 1998). The fixation of Ni in the sediment has probably been facilitated by the extended sulphide formation.

Lake Imandra provides a vivid example of how natural processes (redox cycling of Mn in the water column and sulphate reduction in the sediment) can control the distribution of trace metals in polluted waters.

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