Elemental and isotopic study of lake sediments: evidence for long-term anthropogenic perturbations

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During mining activities, the surface cycle of metals is disturbed by land use changes and associated erosion providing new metal sources. Typically, metal flux in lake systems increases during mining to reach significant enrichment factors (10 to >100 times) as compared with the geochemical background. After exploitation, return to the initial steady state may vary with dynamic and kinetic conditions that depend on several environmental and catchment factors (i.e., site restoration, climate, geomorphology and vegetation).

A preliminary study of demographic and mining impacts on a lake in the mining region of Schefferville, subarctic Quebec, revealed a significant increase in metal fluxes (including Zn, Pb, Fe) in sediments associated with advanced euthrophisation indices during the mining era. During the post-mining period, metal concentrations in lake sediments decreased but without ever reaching the geogenic background concentrations, even more than 30 years after the end of exploitation! Here we investigated metal sources using elemental and isotopic (Pb, Zn, Fe) analyses of sediment cores from two lakes, with one lake located close to the city of Schefferville and expected to yield a stronger "urban" impact, while the second lake was expected to show a stronger "mining" signal due to atmospheric deposition. We also analysed ore and residues from the nmining activities and epiphytic lichens from the area.

In both lakes, enrichment factors of up to 6 were observed for Pb, Zn and Fe as compared to Al. These increaseswere also accompanied by variations of Pb isotopes in both cores. Iron and Zn isotopic composition were different in both cores but remained almost constant. Only Zn isotopes in one lake seemed to be affected during the mining period. Three to four end-members were identified for Fe, Pb and Zn, including local geogenic, urban influence, mining influence and long-distance transport. The mining impact on the lakes in the Schefferville area is local and restricted and the perturbation occurs rapidly. However, the return to the initial, pre-mining state is longer than expected and long-range contamination dominates the post-mining sources.