Geochemical analyses and isotopes as a fingerprinting method to distinguish geogenic and anthropogenic emissions at mine environments – a case study at Finnish gold mine

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Areas with bedrock abundant in ore and metallic minerals have naturally high amount of harmful elements in soil as well as in ground and in surface waters. After the beginning of the mining also the anthropogenic contamination specially related to mine waters tends to increase. Thus, it is important to estimate both geogenic background and anthropogenic emissions when assessing the long term environmental consequences of mining activities. In addition to geochemical analyses, an isotopic fingerprinting method can be used to identify the anthropogenic contamination from the geogenic background and to assess the migration from mining areas to the surrounding environment.

Isotopic methods are rather new approach to estimate mining related emissions in Finland and thus, a new approach of isotopic methods for investigation and monitoring of migration of harmful substances from mine sites will be tested in a Finnish gold mine. At the mine, mine dewatering waters and process effluent waters are directed to treatment peatlands which are used to delay the flow of as well as to improve the water quality before the waters are discharged to recipient water system. In addition to mine water discharges, the anthropogenic emissions can migrate to ground and surface waters through dust emission and seepage from mine tailings and waste rock areas. The aim of this study was to use the geochemical analysis and stable and radiogenic isotope composition of waters as a natural tracer for assessing the emission sources, flow paths and interaction between mine waters, soil and bedrock groundwater and surface waters.

A set of data, including S, Li, Mg, U, Sr, Pb, oxygen, and hydrogen isotopic ratios, combined with major solutes concentrations, will be acquired. Different types of waters are being investigated, including mine waters, springs, pit lakes, streams, reservoirs, and precipitations. Water samples are analyzed for total and soluble metal and metalloid concentrations, anions, ferrous iron, nitrogen compounds, suspended solids and total and dissolved organic carbon. This complex approach will allow a detailed insight in migration of potentially harmful substances, their reactions, mixing and dilution in ground and surface waters. The data will be used also when comparing geogenic and anthropogenic emissions. The results obtained from water analyses and field measurements will be used in hydrogeochemical modelling for the prediction of chemical transformation and long-term impacts of mining at study site and its surroundings.