Thallium (Tl) Mobility in Sulfidic Mining Catchments under Carbonate Environment: A Speciation and Isotopic Approach

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The exploitation of metallic sulfide deposits generates significant quantities of mining waste. These residues release toxic metals, leading to long-term contamination of surface and groundwater. In the Cévennes region, former lead-zinc mines—some active until the 1990s—contaminate downstream watercourses, particularly with thallium (Tl), whose biogeochemical behaviors remain poorly understood.

The proposed internship aims to elucidate the sources and processes controlling the fate of Tl in a mining watershed. The research questions addressed are: 1) Which mineral phases host Tl in mining waste, and what processes control their mobilization into water? 2) What processes affect Tl during downstream transport in watercourses? 3) Can the isotopic ratios of Tl help identify the sources and biogeochemical processes at play?

These questions will be explored through the study of a model site in the Cévennes, where lead-zinc mineralization was exploited in a carbonate-rich environment. The mine left behind 9 million tons of mining waste, contaminating downstream watercourses with Tl concentrations up to 6,552 times higher than global river average. The approach will involve field observations (mineralogical and geochemical characterization of mining waste and rocks, sampling of water and sediments during high and low flow periods to analyze concentrations, speciation (Tl(I), Tl(III)), and isotope ratios (ICP-MS, HPLC-ICP-MS, MC-ICP-MS)). The internship will involve optimizing the separation of thallium from complex matrices (water, sediments, mining waste) and analyzing its isotopes using MC-ICP-MS.

The expected outcomes include improved understanding of the following : 1) Identification of the processes controlling Tl mobility in a carbonate rich, sulfide-mining environment. 2) Assessment of water resource vulnerability to this contaminant in the model watershed. 3) Enhanced isotopic data to use Tl isotopes as tracers of sources and biogeochemical processes. 4) Improved knowledge for postmining management and the evaluation of future environmental impacts.