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Cadmium and Zinc isotopic variations to trace anthropogenic contamination in a metal-impacted watershed

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The potential of Cd and Zn isotopes for tracing the pollution generated by a zinc ore industrial exploitation was studied. The factory is located at Decazeville, in the Lot watershed (Aveyron, France). The contaminated Riou Mort stream contributes to 23% and 47% of the total Zn and Cd fluxes into the Gironde River estuary, whereas its hydrological contribution is only 0.4%. The Zn and Cd isotopic compositions of polluted soils, suspended matter, stream waters, smelting wastes, stream and dam sediments were analyzed with a Thermo-Finnigan Neptune MC-ICP-MS, in order to better constrain the polluted system.

The δ^{66}Zn of Riou Mort sediments downstream the factory, 0.91$\pm$0.03 per mil, is significantly different from the signature of upstream sediments and of the local geochemical background, 0.33$\pm$0.06 per mil and 0.31$\pm$0.03 per mil, respectively. However, it is identical to the signature of Lot riverbank soils, which confirms that the major pollution occurring in the Lot is due to the smelting wastes of the Zinc-ore metallurgy in the Riou Mort watershed.

The δ^{66}Zn of Riou Mort sediments downstream the factory are also similar to the δ^{66}Zn values on the top of a sedimentary core drilled in a Lot dam far downstream (δ^{66}Zn = 0.82 $\pm$0.01‰). In this core, the variations of Zn and Cd isotopic signatures are related to the successive changes in hydrometallurgical processes of the Decazeville factory.

The Zinc and cadmium concentrations in present-day soils near the Zn-ore facility are clearly influenced modified by the industrial activity ([Zn]=2983 mg.kg^{-1}, [Cd]=47.4 mg.kg-^{1}), while the Zn isotopic signatures found in soils upstream and downstream of the Zn-ore facility are similar (δ^{66}Zn = 0.48$\pm$0.05 per mil and 0.42$\pm$0.03 per mil respectively). These latter signatures, different from that of the geochemical background, maybe due to the coal ashes produced by the local thermal power plants.

Finally, this study indicates that the Zn and Cd isotopic signatures can be used as tracer of the origin of pollution sources, and even to the metallurgic processes themselves. From this point of view they complement the information given by the measurement of concentrations only.