Zinc isotopic variation of water and surface sediments from the German Elbe River

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Highlights

• Zn isotope-amount ratios as a potential tracer for anthropogenic Zn emissions.
• Analysis of water and sediment samples from the Elbe River and its tributaries.
• MC ICP-MS analysis with low blank levels and double spike calibration.
• Enrichment of heavier isotopes in selected anthropogenically impacted tributaries.
• Influence of natural fractionation processes on Zn isotopic composition in water.

Graphical abstract

Abstract

Recent studies suggested the use of the isotopic composition of Zn as a possible tracer for anthropogenic Zn emissions. Nevertheless, studies mainly focused on sampling areas of a few km² with well-characterized anthropogenic Zn emissions. In contrast, this study focused on analyzing a large sample set of water and sediment samples taken throughout the course of the Elbe River, a large, anthropogenically impacted river system located in Central Europe. The primary objective was to evaluate the use of the isotopic composition of Zn to trace anthropogenic Zn emission on a large regional scale. In total 18 water and 26 surface sediment samples were investigated, covering the complete course of over 700 km of the German Elbe between the German/Czech border and the German North Sea, including six tributaries. Stable isotope abundance ratios of Zn were assessed by multi-collector inductively coupled plasma mass spectrometry (MC ICP-MS) in water filtrates (<0.45 μm) and total digests of the sieved surface sediment fraction (<63 μm) after analyte/matrix separation using Bio-Rad AG MP-1 resin via a micro-column approach and application of a 64Zn/67Zn double spike. Measured isotopic compositions of δ66Zn/δ64Zn IRMM-3702 ranged from −0.10 ‰ to 0.22 ‰ for sediment samples, and from −0.51 ‰ to 0.45 ‰ for water samples. In comparison to historical data some tributaries still feature high mass fractions of anthropogenic Zn (e.g. Mulde, Triebisch) combined with δ66Zn/δ64Zn IRMM-3702 values higher than the lithogenic background. The dissolved δ66Zn/δ64Zn IRMM-3702 values showed a potential correlation with pH. Our results indicate that biogeochemical processes like absorption may play a key role in natural Zn isotopic fractionation making it difficult to distinguish between natural and anthropogenic processes.

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