Science of the Total Environment 707 (2020) 135219

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

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

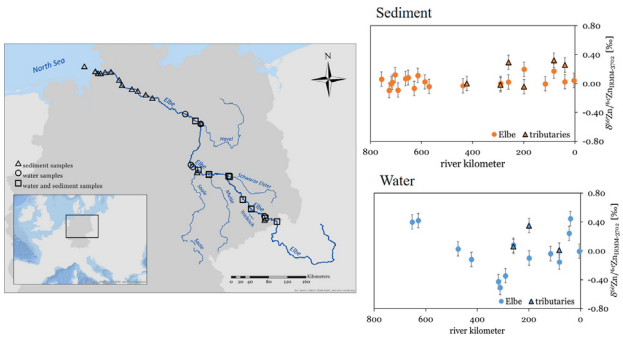
T. Zimmermann [a,b], A.F. Mohamed [c], A. Reese [a,b], M.E. Wieser [c], U. Kleeberg [a], D. Pröfrock [a,*], J. Irrgeher [a,c,1]

[a] Helmholtz-Zentrum Geesthacht, Institute of Coastal Research, Marine Bioanalytical Chemistry, Max-Planck Str. 1, 21502 Geesthacht, Germany
[b] Universität Hamburg, Department of Chemistry, Inorganic and Applied Chemistry, Martin-Luther-King-Platz 6, 20146 Hamburg, Germany
[c] University of Calgary, Department of Physics and Astronomy, 2500 University Drive NW, Calgary, Alberta T2N 1N4, Canada

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



ARTICLE INFO

Article history:
Received 9 August 2019
Received in revised form 24 October 2019
Accepted 24 October 2019
Available online 22 November 2019

Editor: Mae Sexauer Gustin

Keywords:
MC ICP-MS
Zn double spike
Isotope tracer
Environment
Isotopic fractionation
Metal pollution

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 km^2 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 $^{64}Zn/^{67}Zn$ double spike. Measured isotopic compositions of $\delta^{66}Zn/^{64}Zn_{IRMM\text{-}3702}$ ranged from −0.10 ‰ to 0.32 ‰ 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 $\delta^{66}Zn/^{64}Zn_{IRMM\text{-}3702}$ values higher than the lithogenic background. The dissolved $\delta^{66}Zn/^{64}Zn_{IRMM\text{-}3702}$ 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.

* Corresponding author.
E-mail address: daniel.proefrock@hzg.de (D. Pröfrock).
[1] Present address: Montanuniversität Leoben, Department of General, Analytical and Physical Chemistry, Chair of General and Analytical Chemistry, Franz Josef-Straße 18, 8700 Leoben, Austria.

https://doi.org/10.1016/j.scitotenv.2019.135219
0048-9697/