Tracing anthropogenic aerosol trace metal sources in the North Atlantic ocean using Pb, Ni and Zn isotopes

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Aerosols are an important source of trace elements (TEs) to the surface ocean. However, their character is poorly constrained, due to diverse origins and variable solubilisation of TEs. Interestingly, metal-enriched anthropogenic aerosols are highly soluble and thus potentially influence the TE biogeochemical cycles in the ocean.

Here we use Pb, Ni and Zn isotopes to trace the impacts of aerosols on the surface ocean. Aerosols were collected in the North Atlantic ocean, off the Moroccan and Senegalese coasts (AWA and EPURE projects). Both the Sahara desert/Sahel (mineral dust) and anthropogenic sources (e.g., fossil fuel burning, mining) contribute to the bulk aerosol in these areas. Generally, aerosol δ^{60}Ni correlates positively with Ni contents, with the δ^{60}Ni of highly enriched samples being as heavy as +0.50‰. This feature, as well as good correlations between Ni and V, suggests that Ni is supplied by oil combustion from ship traffic or power production. Aerosol δ^{66}Zn is lower than North African mineral dust (~ +0.30‰), indicating imprints of combustion processes. Comparisons between aerosol ^{206}Pb/^{207}Pb, δ^{66}Zn and Zn/Pb elemental ratios imply contributions from multiple anthropogenic sources, such as local mining and industrial activities.

Our multi-isotope study highlights that anthropogenic emissions can perturb the natural cycle of trace metals in the surface ocean, potentially explaining low δ^{66}Zn in the global surface ocean.