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Tracing short-term changes in ocean circulation and continental weathering using seawater-derived Nd, Hf and Pb isotopes in marine sediments

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Radiogenic isotopes of elements with oceanic residence times on the order of or below the global ocean mixing time are sensitive tracers for changes in ocean circulation and continental weathering regimes because there are systematic isotopic differences between water masses of different origin.

Variations in the Nd, Hf and Pb isotopic composition of ferromanganese crusts were shown to reflect the changing isotopic composition of ambient deep water on time scales of millions of years. It is not possible, however, to reliably resolve glacial-interglacial isotopic variations in these crusts due to very slow growth rates (1-10 mm/Myr). The authigenic (seawater-derived) fraction of marine sediments represents an alternative archive which allows a better age control and time-resolution of the reconstructions. So far this approach has only been applied for Nd isotopes.

We refined an existing chemical method to extract seawater-derived Nd, Hf and Pb from early diagenetic Fe-Mn oxyhydoxide coatings of pelagic marine sediments. In a sequential leaching procedure the carbonate-, Fe-Mn oxyhydroxide-, organic-, and detrital fractions are separated from each other. The oxyhydroxide fraction was extracted using a reducing cocktail. A complexing agent was admixed in order to prevent re-adsorption of leached authigenic Hf onto particles. The oxyhydroxide fraction and, for a representative number of samples also the detrital fraction were then purified for MC-ICP-MS measurements on a Nu Plasma instrument.

The seawater origin of the Nd, Hf and Pb signature of each sample is monitored using $^{87}Sr/^{86}Sr$, which for the oxyhydroxide fraction must reproduce the present-day seawater ratio of 0.70918 within a narrow range (± 5), otherwise data are discarded. We will present Nd, Hf and Pb isotopic results obtained from a first application on sediments from the North Atlantic. The presented paleo-seawater Hf and Pb isotope time-series from marine sediments are the first of their kind and will be discussed together with the Nd isotope results in relation to short-term changes of ocean circulation and continental weathering inputs.

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Nd and Pb isotopes of Mn/Fe precipitates of the Baltic Sea: Climate change versus pollution

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Ferromanganese (Mn/Fe) precipitates of the Baltic Sea exhibit growth patterns that are predominantly caused by seasonal and decadal variations of the redox conditions within the water column and the sediments. $^{226}Ra_{excess}$/Ba-dated Mn/Fe-precipitates of the Mecklenburg Bay (SW-Baltic, 20 m water depth) indicate growth rates of up to 0.021 mm/year and that their growth started as early as 4300 years BP. Thus we are able to use them as recorders of isotope changes of the last hundreds to thousands of years.

In the $^{207}Pb/^{206}Pb$-ratios we observe pronounced changes, which reflect historically known changes of anthropogenic activities during the industrial revolution and early European Ag and Pb mining. The overall trend suggests an increased input of heavy metals from southern European sources.

In contrast to the Pb record two Nd isotope profiles indicate decreasing ε_{Nd} (-14 to -17) from about 1300 to 1850 AD which points towards an increase in material derived from northern Archean-Proterozoic Scandinavian sources. By about 1850 AD, ε_{Nd} returns to –14, the composition of recent Baltic Sea water. The low ε_{Nd} values coincide with the Little Ice Age during which atmospheric temperatures decreased by about 1.5°C in Scandinavia. In addition, agricultural land use was less intense compared to earlier times known as the medieval warm period. We therefore speculate that decreasing agricultural land use due to the late medieval demographic crisis possibly decreased the input from southerly sources while at the same time climate changes led to an increased input from north-eastern Archean-Proterozoic Scandinavian sources into the Baltic (ε_{Nd} = -22).