# Hafnium and neodymium isotopes in Atlantic ocean waters

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Numerous studies have documented the sources and behaviour of Nd in the present day ocean providing a background for paleoceanographic interpretations. In contrast, much less information is available on Hf isotopes. As a consequence, there is still an ongoing debate on the sources of Hf in seawater.

We present isotopic compositions for the dissolved Hf and Nd in seawater samples taken on a transect from the Bay of Biscay to Cape Town (RV Polarstern cruise ANXXIII/1 in 2005). Hafnium and Nd were pre-concentrated by iron co-precipitation from 70 to 140 liters of filtered (0.45 µm) seawater. Separation of Hf and Nd followed previously established ion chromatographic procedures. Hafnium and Nd isotopic compositions were measured by MC-ICPMS (Nu Plasma) with a 2σ external reproducibility of 0.65 and 0.3 ε -units, respectively. Sample sizes varied but were typically in the range of 5 to 7 nanograms of Hf.

Surface seawater as well as deep water samples extending to ~5,000 m, plot on the "seawater array" defined previously from measurements of ferromanganese crusts and nodules. Surface seawater isotopic compositions are rather uniform for Hf and Nd at most sampling locations ranging from +0.1 to +1.7 in $\varepsilon_{Hf}$ and from -12.1 to -11.5 in $\varepsilon_{Nd}$. Two locations at 22.5°N and 10.5°N show less radiogenic compositions in the subsurface ($\varepsilon_{Nd}$ down to -12.9 and $\varepsilon_{Hf}$ down to -0.8).

Deep water compositions range from +0.8 to +4.2 $\varepsilon_{Hf}$. The $\varepsilon_{Hf}$ variations with depth in the different profiles generally follow the patterns observed for $\varepsilon_{Nd}$. The overall variations in deep water Nd isotopes in our data set is twice as large as that of Hf isotopes ($\varepsilon_{Nd}$ between -13.9 and -7.9) but the spread in Hf isotopes of some depth profiles is significantly larger than for Nd.

Particularly unradiogenic Nd signatures are found in the Angola Basin, where $\varepsilon_{Nd}$ is as low as -15.4. This may reflect inputs from the Congo River or sediment seawater exchange within the basin. Hafnium isotopes, however, do not show such a shift.

Neodymium isotopes are in general agreement with the results of earlier studies. Antarctic Intermediate Water, however, has been sampled at three locations where it is clearly less radiogenic ($\varepsilon_{Nd}$ = -11.1, -13.9 and -11.4) than reported before ($\varepsilon_{Nd}$ = -8.9 to -6.2).

# Ice migration in the early solar system: From Jupiter to the Earth

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We will report on a project carried out at Uppsala, where we attempt to simulate the dynamical evolution of planetesimals remaining in the region of giant planet accretion after the formation of planetary embryos of substantial masses. The simulation includes the gas drag and gravitational perturbations of the solar nebula. For each orbital period these effects are found by interpolation on a precomputed grid in orbital element space, and close encounters with the embryos are modelled by the Öpik method, thus yielding gravitational kicks that transfer the planetesimals along the routes of the circular restricted three-body problem. We aim to investigate the transfer of icy planetesimals inward across the snow line into the region which is now occupied by the outer parts of the asteroid Main Belt, from where they may have been incorporated into the growing Earth during the late phases of accretion.