EGU21-12116
https://doi.org/10.5194/egusphere-egu21-12116
EGU General Assembly 2021

Improvement of high resolution measurements of neodymium isotope compositions to reconstruct past ocean circulation

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Palaeoceanographic studies of ocean circulations are crucial for understanding the ocean´s impact on the Earth´s climate system. Circulation patterns and the provenance of water masses can be detected from temporal variations of the neodymium isotopic composition (εNd) of authigenic neodymium, preserved in deep sea sediment.

Inductively coupled plasma source mass spectrometry allows for the precise and accurate determination of εNd-values of samples and reference material.

Here, we reevaluate the mass spectrometric measurement protocol and instrument setting with respect to precision and accuracy defined by neodymium standards.

The shape of the ion beam plays a crucial role, which is manifested in the result that an optimal adjustment of the beam shaping quadrupoles can increase precision by a factor of 4.

In addition, the optimal standard neodymium concentration level is roughly 50 ppb yielding uncertainties of the mean of repeated measurements as low as 0.07 ε units whereas 5 times lower concentrations yield 10 times higher uncertainties.

The statistical nature of precision is further demonstrated through an uncertainty inversely proportional to the square root of N measurements. As a consequence, with an increase from 30 to 80 consecutive measurements precision was improved by a factor of 1.22.

Taking all evaluated aspects into account, precision and accuracy of standards and thus sediment samples can be strongly improved, hence contributing to a better comprehension of past ocean circulation, where neodymium isotope gradients are small.