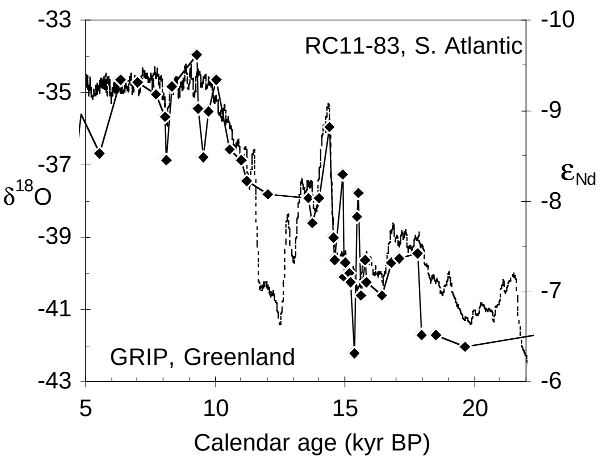
North Atlantic Deep Water strength during the last deglaciation from Nd isotopes

A. M. PIOTROWSKI, S. L. GOLDSTEIN, AND S. R. HEMMING

Lamont-Doherty Earth Observatory of Columbia University, Palisades, New York 10964, USA, (arcturus@ldeo.columbia.edu)

The question of how closely thermohaline circulation (THC) and climate are linked is an important topic of continuing debate. North Atlantic Deep Water (NADW) formation is expected to influence northern hemisphere climate through the return flow of warm surface waters towards the polar regions. Recent empirical evidence, however, indicates that climate changes preceded THC changes. We present a record of the Nd isotope ratios of the Fe-Mn component of core RC11-83, from the Cape Basin, South Atlantic, through the last deglaciation, using an updated chronology extended with new ^{14}C dates, in order to assess the link between NADW strength and climate change.

Our record indicates that NADW began to strengthen at 18 ka, ~3.5 ka prior to the Bølling warming as recorded in Greenland ice, and following the increase of summer insolation at 60°N at the end of the last glacial maximum. It strengthens sharply at the Bølling warming, weakens during the Younger Dryas, and strengthens to an early Holocene maximum at its end. Superimposed on this general increase are millennial-scale “pulses”, which are not seen as warmings in the ice record but are associated with warmer temperatures in northern Europe, as indicated by retreat of alpine and continental glaciers, and meltwater pulses. Since meltwater pulses would be expected to inhibit NADW production, we speculate that the increases are related to changes in sea-ice extent. The record indicates that Nd isotopes are a sensitive monitor of NADW strength, which in turn is sensitively linked to changes in northern hemisphere climate.



Determining the Mechanisms of Lithium Isotope Fractionation During Weathering

JANNA S. PISTINER AND GIDEON M. HENDERSON

Oxford University Earth Science Department, Parks Road, Oxford OX1 3PR, UK (Janna.Pistiner@ox.ac.uk), (Gideon.Henderson@ox.ac.uk)

A comprehensive understanding of how lithium isotopes fractionate as a result of terrestrial weathering is necessary in order to use lithium isotopes as a proxy to trace oceanic cycles, climatic changes and igneous processes. A study of the Orinoco River[1] determined that lithium isotope fractionation is dependent on the intensity of weathering, with greater fractionation during superficial high relief weathering than during the weathering of a stable shield. In order to explain the lithium isotope fractionation observed in the Orinioco, and elsewhere in the natural environment, this study investigates the fractionation generated by primary dissolution, secondary mineral formation and clay-surface exchange processes.

In the first of three experiments pre-washed sample pellets were attacked with weak acid to determine the extent of fractionation by dissolution of primary minerals. The effects of natural weathering processes on lithium fractionation were investigated by analyses of slices from the weathered surface through to the unaltered interior of a homogenous, vesicular Iceland basalt (Laki, 1783) sample. Lithium surface exchange reactions with montmorillonite and ferrihydrite were also conducted.

Samples from these experiments were dissolved in an HF,HNO_3 mixture and loaded onto a 20cm^3 AG50W-X8 200-400 mesh resin column in a mixed HNO_3-methanol media. Lithium was eluted with 1.0M HNO_3-80% methanol, providing a very clean separation from sodium and other cations. Lithium isotope analyses were performed by multiple collector inductively-coupled-plasma mass spectrometry (MC-ICP-MS) by aspirating through a Cetac aridus into a Nu instrument. The reproducibility of an in-house Li standard relative to NIST-LSVEC was 0.4‰ (2σ). External analytical agreement with published lithium isotope values for four international rock standards and with seawater[2,3] confirms successful dissolution, cation separation and instrumental methodologies.

Preliminary findings suggest that the altered surface of the Laki sample is enriched in total lithium concentration with a δ^7Li 2.2‰ lighter than the interior. This suggests preferential incorporation of isotopically light Li into surface clay minerals. Results from clay and oxide exchange experiments will help to provide a greater understanding of the controls on lithium isotope fractionation in environmental weathering. Such knowledge can be applied to the assessment weathering rates and intensities both now and throughout geological time.

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