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Reconstructing past surface and deep water neodymium isotope compositions in the North Atlantic

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Reconstructing the Atlantic meridional overturning circulation is critical to our understanding of past changes in the Earth's climate system. Deep water masses formed in the sub-polar North Atlantic ventilate much of the deep ocean; this is the largest reservoir of CO_2, and therefore controls atmospheric CO_2 concentrations. Surface currents such as the Gulf Stream also play an important role in regulating climate by transporting heat and salt towards the subpolar North Atlantic, affecting regional temperatures and modulating deep water formation rates. Measuring radiogenic isotope ratios on deep and surface ocean substrates, for example neodymium (Nd) isotopes on authigenic sedimentary Fe-Mn oxides and sedimentary planktonic foraminifera, offers the potential for direct comparison of deep and surface water mass mixing and circulation changes on fractions from the same sample (e.g. Piotrowski et al., 2004; Scrivner et al., 2004). Nd isotope depth profiles measured on seawater from throughout the global oceans clearly show that surface waters often have different compositions and are more variable (Goldstein and Hemming, 2003) than deep waters, which integrate Nd from many different sources (Frank, 2002). This is especially true in the North Atlantic, where surface waters range from ε_{Nd} = -9 to -18 while deep waters have a more uniform ε_{Nd} of -12.5 to -14.

The main hurdle for such an approach is to cleanly separate extracted Nd from both phases without admixture, which is made difficult by the large Nd concentration differences between Fe-Mn oxides and calcite. A further issue when dealing with North Atlantic sediments is the prevalence of Iceland-derived volcanogenic material; ini-

tial attempts to extract a pure surface seawater Nd isotope signal from planktonic foraminifera deposited in volcanic-rich sediments (Vance et al., 2004) met with mixed success. Difficulties resulted both from the fact that it proved almost impossible to separate all of the volcanogenic material from the samples, and also because the reagents employed to dissolve the biogenic calcite and thus extract a surface seawater Nd signal were sufficiently strong to attack the fine volcanogenic particulate material that was present. As noted by Vance et al. (2004), it was observed that the contaminating material is either a) visibly adhered to the uncleaned calcite when viewed under a binocular microscope, or b) present within the sample even after all of the clays, organics and Fe-Mn oxides have been removed. Through a series of novel sequential cleaning and dissolution experiments, we were able to remove Iceland-derived volcanogenic components and isolate isotopically-distinct surface and deep water Nd compositions.

Novel approaches have been taken in an effort to both remove the contaminating phase prior to the chemical cleaning procedure and also to selectively dissolve the biogenic foraminiferal calcite without attacking any residual contaminating volcanogenic material. Preliminary experiments using North Atlantic sediment samples suggest that planktonic foraminifera and authigenic Fe-Mn oxides preserve distinct Nd isotope compositions. For example, data indicate that a site from the Eirik Drift (S. of Greenland) has a surface ocean Nd isotopic composition (from sedimentary planktonic foraminifera) which is 2.5±0.4 ε_{Nd} units more positive than that of bottom waters (from authigenic Fe-Mn oxides), while data from another site on the Gardar Drift (S. of Iceland) have a surface ocean Nd isotopic composition which is 1.5±0.3 ε_{Nd} units more negative than bottom waters (from sedimentary planktonic foraminifera and authigenic Fe-Mn oxides, respectively). This may be consistent with the observed greater Nd isotopic variability in surface seawater compared to deep seawater in the North Atlantic. These results demonstrate the feasibility of this approach, and also suggest that methods which cannot fully separate Nd from Fe-Mn oxides and surface ocean carbonate likely combine signals from the surface and deep water.

Frank, M., 2002. Radiogenic isotopes: Tracers of past ocean circulation and erosional input, Rev. Geophys., 40(1), 1001, doi:10.1029/2000RG000094.

Goldstein, S.L. and Hemming, S.R., 2003. Long-lived Isotopic Tracers in Oceanography, Paleoceanography and Ice Sheet Dynamics. In: H. Elderfield (Editor), Treatise on Geochemistry. Elsevier, Oxford, pp. 453-489.

Piotrowski, A.M., Goldstein, S.L., Hemming, S.R., and Fairbanks, R.G., 2004. Intensification and variability of ocean thermohaline circulation through the last deglaciation, Earth Planet. Sci. Lett. 225, 205-220, doi:10.1016/j.epsl.2004.06.002.

Scrivner, A.E., Vance, D., and Rohling, E.J., 2004. New neodymium isotope data quantify Nile involvement in Mediterranean anoxic episodes, Geology 32, 565-568, doi:10.1130/G20419.1.

Vance, D., Scrivner, A.E., Beney, P., Staubwasser, M., Henderson, G., and Slowey, N., 2004. The use of foraminifera as a record of the past neodymium isotope composition of seawater, Paleoceanography 19, PA2009, doi:10.1029/2003PA000957.