

## Global Neodymium - Hafnium isotope systematics – Revisited

T. VAN DE FLIERDT<sup>1</sup>, S.L. GOLDSTEIN<sup>1</sup>, S.R. HEMMING<sup>1</sup>,  
M. FRANK<sup>2</sup> AND A.N. HALLIDAY<sup>3</sup>

<sup>1</sup>Lamont-Doherty Earth Observatory, Columbia University,  
Palisades, U.S.A., (tina@ldeo.columbia.edu)

<sup>2</sup>IfM-GEOMAR, Leibniz Institute for Marine Sciences, Kiel,  
Germany, (mfrank@ifm-geomar.de)

<sup>3</sup>University of Oxford, Oxford, U.K., (alexh@earth.ox.ac.uk)

Combined Nd and Hf isotope analyses have become widely used in solid Earth geochemistry studies, but their application for low-temperature processes is still limited. The residence time for both of these elements in the ocean is thought to be similar (500 – 2000 years) and there is a growing number of studies addressing the sources of Nd and Hf as well as internal cycling processes in the ocean. In the case of Nd, these studies have been accompanied by a number of emerging applications of Nd isotopes as a tracer for past water mass mixing and ocean circulation, since the Nd isotopic composition of various archives in the ocean has been shown to record the Nd isotopic composition of ambient seawater reliably. Due to very low concentrations of Hf in seawater and hydrothermal fluids, and associated analytical difficulties of measuring Hf isotope compositions, our overall understanding about fractionation processes and internal cycling of Hf in the ocean is not as well developed as for Nd. However, recent studies have shown that direct measurements of seawater and river waters are feasible.

The global Nd-Hf isotope systematics can be described by two linear arrays in Nd-Hf isotope space, the global silicate Earth array (“the terrestrial array”) and the global ferromanganese crust and nodule array (“the seawater array”). The offset between these two arrays provides evidence for the sources and mechanisms by which these elements are added to seawater. However, the reason for this offset is under debate, with the two preferred hypotheses being (i) incongruent release of Hf during continental weathering and (ii) hydrothermal supply of Hf to seawater.

In this paper we revisit the cause for the offset of the seawater array from the terrestrial array using simple mass balance considerations. We use these calculations for a test to what degree the seawater array can be a product of preferential weathering of “non-zircon minerals” of the upper continental crust, implying retention of zircons in the solid residue of weathering. Lutetium-Hf and Sm-Nd evolution and mixing calculations show that the global seawater array can be generated with continental sources only. On the other hand, a predominantly hydrothermal origin of Hf in the ocean is not possible because the seawater Hf isotopic composition is significantly less radiogenic than hydrothermal sources and requires a minimum contribution of 50% continental Hf. While hydrothermal sources may contribute some Hf to seawater, continental contributions are unambiguously required to balance the budget.

## Reaction between ascending melt and peridotite: An experimental investigation

G. VAN DEN BLEEKEN<sup>1</sup>, O. MÜNTENER<sup>1,2</sup> AND P. ULMER<sup>3</sup>

<sup>1</sup>Institute of Geological Sciences, University of Bern,  
Switzerland (greg.vandenbleeken@geo.unibe.ch)

<sup>2</sup>Institute of Mineralogy and Geochemistry, University of  
Lausanne, Switzerland (othmar.muntener@unil.ch)

<sup>3</sup>Institute for Mineralogy and Petrology, ETH Zürich,  
Switzerland (peter.ulmer@erdw.ethz.ch)

Melt-rock reaction in the upper mantle is known from a variety of ultramafic rocks and is an important process in modifying melt composition on its way from the source to the surface. Evidence for depletion or enrichment by melt percolation is found in ophiolites, mantle xenoliths, and mantle sections exposed along MOR's. It includes disequilibrium textures, changes in major-to-trace element compositions and isotopic ratios.

In this experimental study, we present a consistent set of data to evaluate the compositional and time-dependent evolution of ascending magma over a range of temperatures and pressures as a function of initial melt and peridotite compositions. In order to simulate melt-peridotite reaction processes, we perform nominally dry piston cylinder experiments with a 3-layered setup: a bottom layer composed of vitreous carbon spheres (serving as a melt trap) overlain by a peridotite layer and on top a “melt layer” corresponding to a primitive MORB composition. The peridotite layer is mixed from pure separates of orthopyroxene, clinopyroxene and spinel (Balmuccia peridotite), and San Carlos olivine. Melt from the melt layer is forced to move through the peridotite layer into the melt trap. Therefore this setup allows us to simulate reactive melt flow, as opposed to other experimental studies in which diffusion is the main driving force for reaction between a melt and a mantle rock.

Experiments have been conducted at 0.8 GPa with peridotite of variable grain sizes, in the temperature range 1200 to 1320°C. In this P-T range, representing conditions encountered in the thermal boundary layer beneath MOR's, migrating melt is subjected to fractionation, whereas the peridotite is partially melting (solidus around 1260°C). Results show a strong dependence between phase relations in the melt layer and changes in the modal composition of the peridotite layer. Textural and compositional evidence demonstrate that reaction between percolating melt and peridotite occurs by a combination of dissolution-reprecipitation and, to a lesser degree, by solid-state diffusion. Glass compositions in our melt layers resemble those from crystallization experiments on the pure starting liquid at similar P-T conditions (Villiger *et al.*, J. Petr., 2007), but change progressively in the peridotite layers. Silica and alkali enrichment are the most significant changes.