

Carbonatite-mantle interaction in the formation of highly alkalic oceanic island basalts

MARC M. HIRSCHMANN¹ AND RAJ DASGUPTA²

¹Dept. of Geology and Geophysics, University of Minnesota, Minneapolis, MN 55455 USA
(Marc.M.Hirschmann-1@umn.edu)

²Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY 10964, USA (rajdeep@ldeo.columbia.edu)

In heterogeneous basalt source regions, variations in mantle composition correspond to variations in melt production, leading more enriched compositions to produce partial melts at depths where more refractory lithologies do not. Migrating melts from easily melted heterogeneities can enrich refractory surroundings, which may subsequently partially melt. Thus, there is a direct link between heterogeneity and metasomatism in basalt source regions. In the source regions of oceanic islands, carbonated lithologies partially melt to form small amounts of carbonatite at >300 km. These highly mobile melts react with mantle rocks at shallower depths to form carbonated silicate liquids. Experiments show that these silicate partial melts are stabilized in peridotite and eclogite ~130 °C and ~250 °C cooler, respectively, than the volatile-absent peridotite solidus (Dasgupta *et al.*, 2006; 2007). Thus, migrating carbonatite produces carbonated silicate liquids when it encounters eclogite bodies at depths of >150 km. Such melts may metasomatize surrounding peridotite, which can produce highly alkalic carbonated magmas at depths of 90-150 km that are compositionally similar to basanites, nephelinites, and melilitites common in many OIB localities. Such magmas are expected where potential temperatures are not much greater than those in the MORB-source mantle (weak plumes, the margins of hotter plumes, or petit spots). Implantation of small-degree partial melts produces peridotite that is enriched in highly incompatible elements and that has isotopic signatures of crustal recycling, characteristics typical of sources of highly alkalic OIB.

References

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How nanoscience has changed our understanding of environmental geochemistry

M.F. HOHELLA, JR.

NanoBioEarth, Department of Geosciences, Virginia Tech, Blacksburg, Virginia, USA (hochella@vt.edu)

Naturally occurring nanoscale materials, many containing trace elements, appear to be ubiquitous in the environment, and it can be hypothesized that due to their behaviour which is unlike both molecules and bulk materials, they play roles that have not yet been appreciated, or even realized. More specifically, nanoscale particles, films, and/or confined fluids are present throughout the Critical Zone, and in the atmosphere and oceans. And it has been well established that the structural and electronic properties of these materials change, often dramatically, as a function of their size in the nanorange. As a result, chemical and physical properties of nanomaterials change as a function of size (in the case of particles) or thickness (in the case of films). Yet we do not understand these nanomaterials very well, even from a fundamental physical chemistry point-of-view. Nevertheless, it is straight forward to hypothesize about their importance because it is becoming more common to observe their deviant behavior (relative to the same material at a larger scale) in laboratory and field studies in both biologically and abiotically dominated systems. In addition, because of the minute sizes involved, the interface to bulk ratios are extremely large in these nanoscale components of bulk systems, and therefore interfaces become even more important than usual. Critical insights into local, regional, and even global phenomena await our understanding of processes that are relevant at the smallest scales of Earth science studies. More and more investigators are beginning to uncover a fascinating story of how the immense surface area, unusual properties, and widespread distribution of natural nanomaterials affect Earth phenomena in ways that are surprising.