A somewhat biased overview of evidence for and against lithologically-heterogeneous sources of oceanic basalts

MARC M. HIRSCHMANN[1,2] AND FRED A. DAVIS[1]

[1]Dept Geology and Geophysics, U. Minnesota, Minneapolis, MN 55455 USA

[2](Marc.M.Hirschmann-1@umn.edu)

In the past two decades, the notion that basalt source regions may be lithologically diverse has become increasingly mainstream, but different probes of mantle source characteristics yield very different constraints on the apparent proportion of unconventional (non-peridotitic) lithologies in the sources of ocean island (OIB) and mid-ocean ridge basalts (MORB). A key generalization, which is not without exception, is that investigations emphasizing compatible or mildly incompatible elements or their isotopes (Os, transition elements, major elements) tend to suggest greater evidence for non-peridotitic lithologies, whereas those emphasizing incompatible elements or their isotopes (trace elements, U-series isotopes) generally are more consistent with peridotitic soucres and, in particular, with small-degree partial melting of peridotitic sources. Together, this suggests that OIB source regions typically consist of multiple lithologies that interact by autometasomatism. But what are the lithologies?

Experimental determinations reveal that incipient partial melts of fertile garnet lherzolite at 3 GPa have compositions similar to alkalic OIB, but with important distinctions. Most importantly, such partial melts cannot account for OIB enrichment in FeO* or depletion in Al_2O_3. The enrichments in FeO* are unlikely owing solely to high temperatures and pressures, as these may be inconsistent with evidence for small-degree melting, and this may confound application of FeO-MgO thermometry to alkalic OIB. Further, the lower SiO_2 and higher CaO of HIMU basalts compared to partial melts of fertile peridotite strongly suggest CO_2-enrichment in HIMU sources. On the other hand, enrichments in K_2O and SiO_2 in EM basalts are consistent with metasomatic enrichments from either small-degree partial melts or sedimentary components. Thus, although alkalic OIB cannot be derived from 'normal' fertile garnet lherzolite, it remains possible that the principal major element features of alkalic OIB can be explained by peridotites that have been modified by metasomatic additions, provided that the sources of metasomatic melt have distinct and appropriate compositional features. Further experimental work is required to test this scenario and to determine the plausible sources of these metasomatic components.

Library of Experimental Phase Relations (LEPR): Status, prospects, challenges

MARC M. HIRSCHMANN[1], MARK S. GHIORSO[2] AND ROGER L. NIELSEN[3]

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

[2]OFM Research – West Seattle, WA 98115 (ghiorso@ofm-research.org)

[3]Dept. of Geosciences, Oregon State U. (nielsonr@geo.oregonstate.edu)

The Library of Experimental Phase Relations (LEPR) is an online database that seeks to compile published data on experimental igneous phase equilibria, including the compositions of coexisting phases as well as the metadata that allows evaluation of the experimental procedures and quality. Originally, LEPR was developed as an adjunct to the ongoing development and calibration of xMELTS, but in 2008 it was made available to the earth sciences community through an online portal. At present, LEPR incorporates data from 219 published studies, includes major element data on 11,317 mineral compositions and 5,646 melt compositions spanning room pressure up to 27.5 GPa and 500-2,350°C. Current web traffic on the LEPR site is approximately 100 users/month.

New features of the LEPR web portal include an interface with the EarthChem database, which allows searches for experimental liquids similar to natural rock compositions (or vice versa), and enhanced tools to allow uploads of new experimental data. A database for mineral/melt partition coefficients, TraceD, which is modelled after LEPR and will be interoperable with it, is in development.

An important challenge to LEPR is how it will be updated. Without renewed efforts to incorporate new experimental data, the utility of the database will decay. However, data entry is labor intensive. Further, owing to the idiosyncrasies of how experimental data are reported in the published literature, data entry requires individuals with significant familiarity with the methods and practices of the experimental community. Ideally data would be uploaded by the authors of published experiments and the LEPR interface provides a number of methods for uploading new experimental data directly to LEPR. However, thus far the interface has received little use.