Geophysical Research Abstracts, Vol. 8, 04215, 2006
SRef-ID: 1607-7962/gra/EGU06-A-04215

The abyssal Mantle Lithosphere as indicated by Xenoliths from Ocean Islands

E.-R. Neumann , N.S.C. Simon
Physics of Geological Processes, University of Oslo, Norway (e.r.neumann@geo.uio.no)

When studying metasomatism and other processes in the abyssal mantle, it is essential to know the composition of the unmodified lithospheric mantle. Most information available on the abyssal lithospheric mantle has been obtained on the basis of peridotites sampled through dredging and drilling along mid ocean ridges and fracture zones. However, the compositions of such samples have been modified through serpentinization, marine weathering, metamorphism, melt infiltration and deformation. Furthermore, such samples represent only the uppermost part of the abyssal mantle, and thus cannot give information about potential vertical zoning. An alternative approach is through peridotite massifs and ophiolites, but also these rocks have experienced a complex set of processes after initial formation, and the origin of a given unit (oceanic or continental) is not always easy to determine. As a matter of fact, it is doubtful if any of the units for which data are available represent abyssal mantle. A third setting where information about the abyssal mantle lithosphere may be obtained is ocean islands where mantle xenoliths are commonly brought to the surface during volcanic eruptions. Although the intraplate magmatism forming ocean islands leads to metasomatism of the underlying abyssal lithosphere, and there is evidence that there may be fragments of continental lithosphere beneath some ocean islands (e.g. Cape Verde), mantle xenoliths from ocean islands are proving to be a fruitful source of information about the abyssal mantle lithosphere. The mantle xenolith series from many ocean islands include samples that have mainly suffered cryptic metasomatism so that their pre-metasomatism chemistry is preserved in the most abundant major elements (SiO_2, MgO, FeO and CaO) and in their modal phase proportions. These parameters are most robust against metasomatism. We use major element and modal data on spinel harzburgite and lherzolite xenoliths from different oceanic islands (Canary Islands, Cape Verde, Azores, Kerguelen, Hawaii, Tahiti, Samoa) in order to throw light

on the compositional character of the abyssal mantle lithosphere.

The least metasomatized xenoliths from different ocean islands are, on average, significantly more refractory (most of these samples fall in the range 44-49 wt% MgO, 0.4-1.1 wt% CaO, $\leq$1.5 wt% Al_2O_3) than peridotites sampled along mid-ocean ridges and fracture zones (40-48 wt% MgO, 0.3-2.5 wt% CaO, 0.3-4.0 wt% Al_2O_3; with the least refractory suites along slow-spreading ridges). The major element and modal compositions of the mantle xenoliths from ocean islands indicate that they represent residues after partial melting into the olivine+orthopyroxene$\pm$spinel stability field. Small amounts of clinopyroxene ($<$2 volume %) found in these samples appear to have formed as the results of exsolution from orthopyroxene. Comparison with experimental data suggests partial melting at $\geq$1 GPa. Samples with $>>$65 % olivine and significant amounts of clinopyroxene generally show abundant evidence of metasomatism, including clinopyroxene-producing reactions. The peridotite series xenoliths from Hawaii and Tahiti are anomalous as they are less refractory (on the average, lower MgO and modal olivine, higher FeO_{total}, CaO, TiO_2, Al_2O_3 and modal clinopyroxene). The observed major element and modal differences between spinel harzburgite/lherzolite series collected in ocean islands and along mid-ocean ridges and fracture zones are interpreted as (1) the result of partial melting at higher pressures of the former (leading to exhaustion of clinopyroxene at a lower olivine-content), and (2) melt infiltration and refertilization which has affected the shallow mantle close to the mid-ocean ridges, but not the deeper parts of the upwelling mantle that has moved away from the mid-ocean ridge zone without being subjected to the refertilization processes in the main ridge zone.