Petrology and geochemistry of peridotite xenoliths from Vietnam, Indochina block


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Mantle xenoliths entrained in the Neogene basalts at central and southern Vietnam provide important constraints on the nature of the lithospheric mantle beneath the eastern Indochina block. The basalts contain mantle xenoliths (garnet lherzolite, spinel lherzolite, harzburgite, and eclogite), cumulate xenoliths (wehrlite, websterite, and pyroxenite) and megacrysts (olivine, Al-rich clinopyroxene, orthopyroxene, anorthoclase, Ti- amphibole, phlogopite, sapphire, and zircon). The mineral compositions of spinel lherzolite xenoliths studied are typical of mantle phases: Fo-rich olivine, En-rich orthopyroxene, Di-rich clinopyroxene and Cr-rich spinel. Concentrations of trace elements for clinopyroxene were determined in situ by laser ablation ICP-MS. Clinopyroxenes exhibit large compositional variations ranging from LREE-depleted (LaN/YbN = 0.5–0.7) to cryptically metasomatized LREE-enriched (LaN/YbN = 6.7–20.3). Slightly LREE-depleted REE patterns with YbN of 10 indicate these peridotites were originated from very low degree of partial melting. However, most REE patterns present much lower HREE concentrations with YbN of 2–6 suggesting these peridotites were products of either high degree of partial melting or the residual from the removal of garnet. Spidergrams of most clinopyroxenes show Ba, Nb–Ta, Hf–Zr and Ti depletion. Therefore, the hydrous silicate melts/liquids of subduction zone origin are likely candidates for the required metasomatic agent. The subcontinental lithospheric mantle beneath central and southern Vietnam was complicated and heterogeneous.

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Hydrous mantle melting at ridges and back-arc basins

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The net effect of water on mantle melting relates to the pattern of mantle flow and the geometry of the melting regime. At ocean ridges, more water leads to a wider and deeper melting regime. Mixing in of low degree melts (“low F melts”) from depth leads to lower mean extents of melting and greater crustal thickness (Asimow and Langmuir, 2003; Cushman et al., 2004). In contrast, at back-arc basins more water leads to greater extents of melting (Stolper and Newman, 1994). This contrast can be understood as a simple consequence of the arc environment where there is no room for a ridge melting regime with broad and deep low F tails. While back-arc melting has been modeled as an isobaric, isothermal process, (Stolper and Newman, 1994; Kelley et al.) it needs to be considered in the polybaric context of mantle flow and melt segregation. An important constraint is that hydrous back-arc melts show no garnet influence and are exceptionally low in Fe, even when corrected properly for hydrous fractionation. We successfully model these results only by low pressure (<12 kb) equilibrium melting. Back-arc volcanics are then mixtures between low pressure, hydrous melts from the “arc-side” of the melting regime and fractional melts from the “back-side” of the melting regime that are similar to normal MORB. Quantitative modeling shows that the effect of water on melting (dF/dH2O) is largely independent of temperature above the anhydrous solidus, in contrast to results from MELTS modeling (Hirschmann et al., 1999) and from other recent interpretations (Kelley et al.). This result has important implications for sorting out the effects of water and source composition for melts from the entire range of mantle temperatures.

References

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