

Small scale variations in slab-derived fluxes: Insights from melt inclusions from the Valu Fa ridge

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Major, trace and volatile element abundances in melt inclusions from mafic basalts from the Valu Fa ridge, southern Lau Basin, provide insight into volatile cycling within the southern Lau Basin and in particular allow us to gauge variations of slab-derived fluxes within individual back-arc melting systems. It is widely appreciated that fluxes of volatile elements (H, C, S, Cl, F) play key roles in elemental cycling associated with subduction zones, although the specific behaviour and roles of different volatiles during dehydration, fluid-mediated elemental transport and mantle melting are less well understood. Accordingly a major goal of many recent studies of arc and back-arc magmatism has been to combine volatile information with other geochemical parameters to constrain the roles of volatiles in subduction magmatism, although data on the volatile contents of primary arc and back-arc magmas remain scarce.

Olivine- and clinopyroxene-hosted melt inclusions were analyzed by EMPA, SIMS and LA-ICP-MS from three samples from the Valu Fa Ridge. All lava samples have relatively high matrix glass MgO contents (>7 wt.%) and compositions consistent with significant contributions from a slab-derived fluid component (e.g. Ba/Nb 130-355; Cl ~ 700 ppm). Previous work shows that slab-derived fluids contributing to these lavas had a salinity equivalent to ~5-10 wt.% NaCl – sufficient to substantially modify fluid transport properties. Melt inclusions from Valu Fa lavas are more primitive than host lavas, with MgO contents (corrected for host crystallization) of 10-12 wt.%. Inclusions also show considerable variation in volatile element and LILE abundances (e.g. Cl 600-2200 ppm, S 200-1600 ppm, K₂O 0.1-0.4 wt.%). Using a simple flux melting model the calculated Cl/K₂O_{slab} (the Cl/K₂O ratios of the slab-derived material) varies from 0.2-5 for melts trapped in inclusions. Large variations in this ratio are also evident in inclusions from other arc and back-arc suites. The inferred slab-fluid heterogeneity may reflect: (1) changes in the composition of the slab fluid flux over short spatial or temporal scales (heterogeneity must occur on scales smaller than the melting region, but large enough to be manifest in individual melt batches); and/or (2) variations in fluid composition induced during melting or fluid transport within the mantle wedge.

Tholeiitic to alkalic transition in basaltic liquids: Some inferences from high-pressure garnet-pyroxenite melting

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In this study, the role of garnet-pyroxenite melting in the origin of strongly alkalic basaltic liquids and the transition from tholeiitic to alkalic liquids in ocean-island basalts (OIBs) is explored. High-pressure melting experiments, at 2.0-2.5 GPa, on a natural, high-MgO, bi-mineralic garnet-clinopyroxenite from Salt Lake Crater (SLC), Oahu, Hawaii were performed. The starting material used is tholeiitic. At 2 and 2.5 GPa, the solidus is bracketed between 1280-1310°C and 1320-1345°C, respectively; the liquidus is bracketed between 1440-1470°C and 1478-1495°C, respectively. At 2 GPa, the liquidus phase is opx, and multiple saturation with opx, cpx, and spinel (sp) is reached at ~ 40°C below the liquidus. Opx reacts out early on at high temperatures and cpx and spinel (sp) are joined by garnet in the near-solidus melting interval; spinel is minor. At 2.5 GPa, co-saturation with cpx and garnet is reached at ~ 10°C below the liquidus. The subsolidus at 2 and 2.5 GPa is dominantly cpx and garnet. At both pressures, high-*F* melts are *ol-hy* normative, and they give way to strongly *ne*-normative liquids as the solidus is approached. The near-solidus liquids at 2 GPa are intriguing as opx is in reaction with the liquid and spinel is part of the crystalline assemblage, two processes that should have caused residual liquids to become Si-rich. A comparison with phase relations at 2-3 GPa in CMAS indicates that the alkalinity of near-solidus liquids in the experiments can be explained by a large expansion, in natural systems, of the cpx-gt surface, a surface that is limited to the tholeiitic part in CMAS at 2-3 GPa. Thus, even if opx dissolves in the liquid, the nature of the cpx-gt surface in the basaltic tetrahedron prevents such liquids from becoming Si-rich with progressive cooling. By 2.5 GPa, the cpx-gt surface considerably expands into the alkalic volume. While it is possible, that such high-MgO garnet-pyroxenites (along with mantle lherzolite) could be suitable source materials for some OIBs, some major-element systematics cannot yet be explained solely by these exquisite lithologies. One possible "resolution" to this "problem" is partial melting at lower temperature, maybe with some amounts of CO₂±H₂O in the garnet-pyroxenite source.