Geophysical Research Abstracts, Vol. 7, 08755, 2005
SRef-ID: 1607-7962/gra/EGU05-A-08755

Tracing Subduction Serpentinization Through the Geochemistry of the Izu Bonin Volcanic Arc

S. M. Straub (1,2) and G. D. Layne (3)

(1) Lamont Doherty Earth Observatory of Columbia University, Palisades NY, U.S.A

(2) Department of Earth and Planetary Sciences, Harvard University, Cambridge MA, U.S.A.

(3) Woods Hole Oceanographic Institution, Woods Hole MA, U.S.A.

(smstraub@fas.harvard.edu, glayne@whoi.edu)

Among the volatile elements recycled at convergent plate margins, water has the most profound impact on the physics and chemistry of subduction. However, the sources, pathways and distribution of water in subduction zones remain poorly understood. In recent years, compelling evidence has accumulated that the upper mantle in subduction zones is extensively hydrated (or 'serpentinized'). Serpentinization occurs either in the mantle wedge above the slab by slab dewatering ('wedge serpentinite'), or at the trench prior to subduction through deep-cutting faults that penetrate several tens of kilometers into the upper mantle ('lithospheric serpentinite'). Water contained in serpentinites may considerably exceed the amount of water stored in the sediments and basaltic crust (metacrust), and hence serpentinite formation and destruction likely controls the fluxes of water through subduction zones.

Experimental and seismic evidence predicts the existence of serpentinite well beyond arc front depth. In active arcs, however, geological observation of subduction serpentinites is confined to the outer edge of forearc ($\sim$25 kilometer above slab). Information beyond this depth must be gained through the chemistry of arc volcanism. An obvious problem is that hydrous fluids from the metacrust rich in fluid-mobile elements may easily mask the signals of fluids that originate from serpentinized upper mantle. However, serpentinites are commonly selectively enriched in Cl, B and Li, and display high δ^{11}B and δ^{7}Li. Consequently, these elements and isotope ratios may serve to trace the presence of hydrous fluids from serpentinites in the arc magma sources.

We conducted a systematic study of Cl, B, Li and F (and δ^{11}B), using glasses and melt inclusions in fallout tephra from the Izu Bonin arc volcanic front (Izu VF). A thin crust (20 km), a highly depleted mantle wedge, and absence of slab melt components favour the detection of slab fluids here. The Izu VF melts clearly contain a fluid component derived from the metacrust. However, an additional fluid component is indicated by (1) inverse correlation of B isotopes with ratios of fluidmobile elements to fluid immobile elements, and (2) selective enrichment of Cl, Li and F in melt inclusions. This fluid component is consistent with an origin from the wedge serpentinite; no indications for fluid contributions from the lithospheric serpentinite are apparent. Significant fluid contributions from the lithospheric serpentinite, however, are suggested by mass balance calculations that indicate the Cl output at the Izu VF equals or exceeds the trench input of Cl by the metacrust alone. This strongly indicates another major source of Cl, which can only be the lithospheric serpentinite.

Including the lithospheric serpentinite as a source, the percentage of the subducted water recycled at the Izu VF ($\sim$13-18% if metacrust is considered as the only source) is even smaller. Assuming that $>$92% of the subducted water is extracted at convergent margins (Dixon et al. 2003, Nature), these results imply that most of the subducted water must be either released at the trench, or trenchward to the volcanic arc. Alternatively, the subducted water may become deposited in the progressively hydrated mantle wedge, implying that water recycling may influence the growth and maturation of arcs.