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Constraints on the Origins of Along-Arc and Cross-Arc Chemical Variations in Arc Volcanic systems Derived from Global Systematics of Fluid-Mobile Elements

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The fluid-mobile element (FME) "clan" (B, Cs, As, Sb; conditionally Pb, Rb, Ba, Li, N, I: Leeman 1996; Noll et al 1996; Bebout et al 1999; Savov et al 2005) comprises a chemically disparate suite of trace elements that have in common evidence for low T°/low P mobility from subducting materials in H_2O-dominated fluid species. The FME are highly variable in volcanic arc lavas, showing marked along-arc and across arc changes in nearly all of the arc volcanic systems that have been examined. Globally, along-arc variability of the FME can be explained as source mixing, with most arcs defining arrays between two predominant sources: the first a strongly FME-enriched endmember, showing enrichment patterns consistent with those observed in subduction-related serpentinites (Savov et al 2005; Hattori and Guillot 2007), and the second an FME-poor source with signatures for other large-ion lithophile elements (LIL) consistent with subducted slab (predominantly subducted sediment) derivation. The mantle is a negligible contributor to FME systematics in those arcs where the inferred thermal structures are cool at relatively shallow (30-40 km) depths (e.g., Syracuse, et al 2011). However, in the relatively few arcs that show hotter thermal structures at shallow depths, the FME-enriched component is absent, and the mixing components are the mantle and the FME-poor, LIL enriched component observed in all arcs.

Regular across-arc declines in enrichments of boron and other FME are a diagnostic feature in volcanic arcs globally. B abundance and isotope systematics for across-arc transects point to a) anomalously high B and B isotope signals near the volcanic front, often some of the highest signatures in the arc, suggesting locally higher inputs of the FME-enriched endmember to mantle sources at that point along the volcanic front. These enrichments, as well as the positioning of the widest volcanic cross-chains, are often linked to physical phenomena (seamount or fracture zone subduction, or faults or grabens perpendicular to the strike of the arc). b) Along cross-arc arrays, there is FME evidence for three-component mixing, involving the two slab-derived FME components and the mantle, in which the FME-depleted slab endmember plays a greater role as subduction depths increase. In general, the overriding arc crust plays a minor role in the FME systematics of arcs, though in those cases where the crustal section is thick and slab-derived signatures are modest, the crustal contribution helps define a baseline level for FME abundance and isotopic signatures throughout the arc.

References: Bebout, et al 1999, EPSL 177, 69; Hattori and Guillot, 2007, GCubed, http://dx.doi.org/10.1029/2007GC001594; Leeman. 1996, AGU Monograph 96, 269; Noll et al, 1996, GCA 60, 587; Savov et al, 2005; GCubed, Q04J15 DOI10.1029/2004GC000777; Syracuse et al. 2011, GCubed, http://dx.doi.org/10.1029/2005GC001045.