Fate of volatiles and fluid-mobile elements in forearcs: Some metamorphic avenues for subduction-zone chemical flux

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Studies of forearc HP and UHP metamorphic suites have demonstrated that, in relatively 'cool' subduction zones, volatiles and 'fluid-mobile elements' (FME such as B, Cs, As, Sb, and N) can largely be retained in sediments to depths approaching those beneath arcs [1, 2]. In warmer margins, enhanced devolatilization in forearcs is thought to prevent delivery of sedimentary volatiles and FME to such depths [1]. Oher avenues can be envisioned for the deep subduction and differential release of key subduction-zone chemical tracers.

Study of sedimentary devolatilization and related element mobility in subduction zones has thus far been restricted to work on circum-Pacific suites and W. Alps suites exhumed during collision but thought to have experienced low-temperature exhumation-related history [1, 2]. Studies of metabasaltic and metagabbroic suites are complicated by the known great heterogeneity in their protoliths (variably altered oceanic crust) and difficulties in ascertaining these protoliths. In many cases, such rocks show metasomatic enrichments in sediment-sourced trace elements (B, N, LILE), particularly along veins representing fluid avenues [3, 4] and at rims of blocks in melange zones. Redistribution of these elements into disparate lithologies (mafic and ultramafic rocks and melange) could affect their release profiles across arcs.

Fluid-rock interactions in the 'subduction channel, ' involving large amounts of hydrous fluid released from sub-crustal slab ultramafic rocks, could serve to mobilize (leach, resdistribute) FME within this zone. Recent work investigates the trace element and isotopic signatures of devolatilization of these deeply subducted ultramafic rocks. Mechanical and metasomatic mixing of disparate rocks along the slab-mantle interface could result in release or deep retention of volatiles and FME [5, 6]. Further work on UHP rocks representing depths greater than those beyond arcs must evaluate the properties of subarc slab 'fluids' and the effects of their release on compositions of residues entering the deep mantle.

[1] Bebout *et al.* (1999) *EPSL* **171**, 63–81. [2] Busigny *et al.* (2003) EPSL **215**, 27–42. [3] Gussone *et al.* (2010) GCA, this volume. [4] Halama *et al.* (2010) *GCA* **74**, 1636–1652. [5] Bebout & Barton (2002) *Chem. Geol.* **187**, 79–106. [6] Spandler *et al.* (2008) *Contrib. Mineral. Petrol.* **155**, 181–198.

Divisions among ultramafic cumulates from a differentiated asteroid

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Traditional view

Diogenite meteorites are ultramafic cumulates from one of the largest differentiated asteroids, 4Vesta. They are thought to have formed through fractional crystalizaion in crustal plutons. Traditionally, these plutons are believed to be orthopyroxenitic with small ammounts of primary olivine [1]. Due to the brecciation in most samples, the assumption that all phases come from a single lithology may be invalied. Furthermore, only a fraction of the brecciated diogenites contain olivine, suggesting there may be separate olivine-bearing and non-olivine bearing litholigies. Here we investigate 13 diogenites with a range in olivine abundance to constrain petrologic divisions in the group.

Division among the diogenites

We propose that the diogenites consist of multiple lithologies that have been mixed, producing polymict breccias (Fig. 1). This is supported by harzburgite (Mg-opx + olivine) and orthopyroxenite (Fe-opx) fragments found in these samples. Harzburgite is represented by a few olivine-rich samples, and orthopyroxenite is akin to traditional diogenites. A wide range in pyroxene major element compositions suggests that these lithologies fractionated in multiple plutons. Variation in pyroxene minor elemts, specifically aluminium, may indicate that these plutons had varied starting compositions. The discovery of multiple diogenite lithologies alleviates problems with spectral observations and geologic models for Vesta, which invoke an olivine-rich mantle composition [2,3].

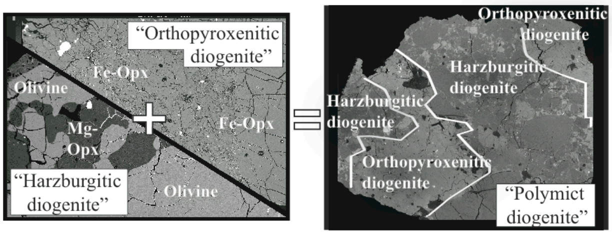

Figure 1: Proposed for different diogenite lithologies.

[1] Mittlefehldt D. W. *et al.* (1998) *Rev. Min.* ch. 4. [2] Binzel R. P. *et al.* (1997) *Icarus* **128**. [3] Righter K. *et al.* (1997) *Meteor. Planet. Sci.* **32**.