

High-pressure fluids geochemistry and controls on element recycling in subduction zones

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High pressure slab-derived fluids (aqueous fluid, hydrous melt or supercritical fluid?) are major vectors for mass transfer and element recycling in subduction zones. However, the poor understanding of the atomic-scale mechanisms that controls the mobilization and transport of elements limits quantitative models of fluid-rock interactions at depths and the estimates of mass recycling.

In the last decade, new experimental designs combining laser or synchrotron-based spectroscopic techniques with high-temperature diamond anvil cells have opened the possibility for determining *in situ* the chemical composition, the molecular structure and thermodynamic quantities for high-pressure fluids [1]. Here, emerging views on the mobility and transport of elements by subduction zone fluids will be discussed in the light of spectroscopic studies that constrain 1) the properties of the solvent (H₂O and NaCl-H₂O) in response to increasing P and T, and 2) the controls of fluid chemistry on the speciation, solubility and partitioning of trace elements. Thermodynamic data on H₂O and NaCl-H₂O fluids [2] [3] show changes in essential properties (e.g. dielectric constant and activity) of the solvent, that affect its ability to hydrate species in solution and hence, its solvent capacity under pressure. Further, speciation studies of HFSE (i.e. Zr) in subduction zone fluids will illustrate the role of coordination chemistry involving halogen ligands (e.g., Cl and F) and polymerized silicate species (Si-Al-Na) in the mobility and transport of trace elements [4]. Importantly, the studies provide spectroscopic evidence for the formation of Zr-O-Si/Na clusters that explain the enhanced solubility and partitioning of HFSE-bearing minerals in alkali-silicate fluids in magmatic-hydrothermal processes [5]. The implications of these results for nature of the slab flux, the HFSE depletion in arc lavas and the formation of (Zr, Nb, REE) ore deposits in crustal granitic complexes will be discussed.

[1]Sanchez-Valle (2013) *Rev. Min. Geochim.* **76**, 265-309.

[2]Sanchez-Valle et al. (2013) *J. Chem. Phys.* **138**, 054505.

[3]Mantegazzi et al. (2013) *Geochim. Cosmochim. Acta* **121**,

263-290.[4]Louvel et al. (2013) *Geochim. Cosmochim. Acta*

104, 281-299.[5]Louvel et al. (2014) *Am. Miner.* **99**, 1616-

1625.