Fluids in the Earth's interior: from geochemical cycles to super-volcano eruptions

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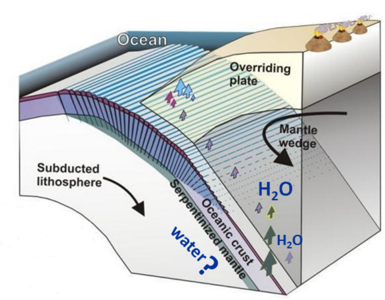
"Fluids" (aqueous fluids, hydrous melts or supercritical liquids) are major vectors of mass and heat transfer in the Earth's interior and play an important role in many geological processes. In subduction zones, fluids released into the mantle wedge during dehydration/devolatilization reactions in down going slabs contribute to element recycling, chemical differentiation and mediate the prolific volcanism observed in arc setting. These processes are strongly influences by the physical and chemical properties of fluids at relevant P-T conditions. Because sampling of natural fluids is restricted to very shallow depths (~20 km depth), experimental studies of fluid's properties are key to model and quantify large scale mass transfer in the Earth's interior.

In this talk I will review recent advancements on *in situ* studies of fluid properties under pressure using synchrotron X-ray radiation engaged with high pressure devices (Sanchez-Valle, 2013) and discuss the implications for magmatic and hydrothermal processes in the Earth's interior. In the first part of the talk, I will present constraints on the chemical composition and molecular-scale structure of subduction zone fluids based on X-ray spectroscopic studies (X-ray Fluorescence SXRF and X-ray Absorption spectroscopy XAS) in the diamond anvil cell and analysis of fluids trapped on synthetic fluid inclusions (SFI). Specifically, I will present data on the solubility, speciation and partitioning of Zr and REE in slab-derived fluids that provide new insights into the mechanism of mobilization of these key geochemical tracers in subduction settings. The implications of these results for the geochemical cycle of HFSE (Louvel et al., 2013; 2014) and REE (Tsay et al., 2014), the nature of slab-derived fluids and the genesis of arc magmas will be discussed. In the second part of the talk, I will discuss the dynamics and triggering mechanisms of supervolcano (e.g., Yellowstone) eruptions based on new data on the density of dry and hydrous granitic liquids (up 4 GPa and 2000K). The experimental studied were conducted in a large volume Paris-Edinburgh press using a synchrotron X-ray absorption technique. I will present density models for large magma chambers and show that magma buoyancy alone creates an overpressure at the roof of the magma chamber that is sufficient to initiate an eruption without additional triggers (Malfait et al., Nat. Geosc. 2014).



References:

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