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Exploring new frontiers in fluids processes in subduction zones

Recycling Bromine in subduction zones: New insights from X-ray absorption measurements on fluids, melts and glasses.

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Volatiles fluxes in subduction zones play a critical role in the Earth's chemical evolution, contributing not only to the hydrous melting of the mantle wedge and development of arc volcanism, but also to the composition of our atmosphere. While halogens are minor volatiles compare to H_2O and CO_2, their ability to complex with other elements makes them key agents of the chemical transfer in subduction zones. Furthermore, they are important tracers of magmatic and degassing processes and provide insights about subsurface magma movement and eruption likelihood in volcanic arcs [1]. Amongst all halogens, bromine is of further interest as its volcanic degassing has been found, through the formation of BrO in volcanic plumes, to be significantly more effective in ozone destruction than more abundant Cl [2].
A better understanding (and consequent modelling) of Br and other halogens fluxes from the subducting slab to the mantle wedge, volcanic arc and ultimately the atmosphere requires an improved understanding of the mechanisms behind their incorporation in fluids and melts. Here, we combined in situ X-ray absorption (XAS) measurements on high P-T fluids and melts in diamond anvil cells to high-energy resolution fluorescence detected (HERFD) XAS on silicate glasses to constrain Br speciation over a wide range of P-T conditions and compositions. Especially, investigated melt and glass compositions include natural basalt, andesite, rhyodacite [3] and haplogranite so as to provide an improved view of structural controls on Br incorporation in silicate melts. The structural information derived from XANES and EXAFS analysis, compared to existing constraints on Br fluid-melt partitioning [4,5,6], is used to explain Br transfer from the subducting slab to volcanic arc.

References: [1]Aiuppa et al., 2008. Chemical Geology 263, 1-18. [2]Bobrovski et al., 2003. Nature 423, 273. [3] Cadoux et al., 2017. Chemical Geology 452, 60-70. [4] Bureau et al., 2000. EPSL 183, 51-60 [5] Louvel, 2011. PhD thesis, ETH Zurich. [6] Cadoux et al., in press at EPSL.