

Preferential mobilisation of oxidised iron by slab-derived hydrous silicate melts

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Arc magmas are characterised by a higher oxidation degree than magmas from other tectonic settings, including mid-oceanic ridge and ocean arc basalts [1]. The oxidised signature is thought to arise from the influx of oxidising slab-derived fluids or melts into the mantle wedge [2,3] although the actual oxidising agent and the transport mechanism remain a topic of discussion. Iron, as the most abundant redox-sensitive element in the upper mantle, may play a pivotal role in this process, and constraints on its mobility and speciation in slab-derived phases are thus critical to elucidating the range of redox state conditions of subduction zones.

We have investigated the mobility and redox state of iron in hydrous silicate melts by carrying out solubility measurements of hematite–magnetite assemblages in a piston-cylinder apparatus combined with electron microprobe and Mössbauer analysis of the recovered glasses. The experiments were performed at subcritical conditions, i.e. two-fluid phases coexisting with the solid assemblage. We observe concentrations of total FeO as high as 1.85 ± 0.18 wt. % (2.07 ± 0.41 wt. % in saline systems) at 2 GPa and 900 °C, with $\text{Fe}^{3+}/\text{Fe}_{\text{tot}}$ ratios of 0.79 ± 0.04 (0.45 ± 0.07) that indicate the dominance of oxidised iron in the melt phase. Combined with thermodynamic modelling [4] to reconstruct the composition and speciation of the coexisting fluid phase, we demonstrate that hydrous silicate melts can transport 20 times more dissolved iron, preferentially as oxidised iron, than aqueous fluids at sub-arc conditions. Our results support the efficient dissolution of ‘fluid-insoluble’ iron oxides in slab-derived hydrous melts, which are thus efficient agents for the transfer of oxidised iron to the mantle wedge, ultimately contributing to the oxidation of the arc magma source.

[1] Kelley & Cottrell (2009), *Science* 325, 605–607. [2] Burgisser & Scaillet (2007), *Nature* 445, 194–197. [3] Evans & Frost (2021), *Journal of Petrology* 62, 1–32. [4] Sverjensky, Harrison & Azzolini (2014), *Geochimica et Cosmochimica Acta* 129, 125–145.