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SPECIAL COLLECTION: GLASSES, MELTS, AND FLUIDS, AS TOOLS FOR UNDERSTANDING VOLCANIC PROCESSES AND HAZARDS

Aluminum and iron behavior in glasses from destabilized spinels: A record of fluid/melt-mineral interaction in mantle xenoliths from Massif Central, France†

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Abstract

Infiltrations of melts (and/or fluids) in mantle rocks are witnessed by the presence of glass-bearing pockets in peridotite xenoliths brought to the surface by alkaline volcanism. Several glass-bearing pockets found around spinels corroded at different degrees were investigated for their chemical compositions, including the $Fe^{3+}/\Sigma Fe$ ratios, in two xenolith samples by electron probe microanalysis. The dissolution/recrystallization of spinels enriches the melt in alumina. We show that the spinel-derived Al^{3+} ions could have been accommodated to the melt network first as network-modifiers. Then Al^{3+} ions were network-formers using K^+ ions, extracted from the aqueous fluid upon melt dehydration, as stabilizers within the tetrahedral site. The transfer of K^+ from the aqueous fluid to the melt network is counterbalanced by an inverse transfer of CaO molecules that form crystalline phases exsolved upon eruption. The evolution of the Al content clearly shows that an increasing fraction of the spinel-derived alumina molecules was exsolved as the melt dehydration proceeded. Spinel corrosion could also be at the origin of melt oxidation through dehydrogenation reactions resulting in the formation of Al^{3+} and Fe^{3+} anionic complexes within the melt network. This study shows: (1) how the structure of the percolating melt is modified by the accommodation of chemical elements produced by the dissolution of minerals, and (2) how this process could modify the oxidation state of the melt.

Keywords: Silicate melt, mantle xenoliths, electron microprobe, $Fe^{3+}/\Sigma Fe$ measurements, melt/fluid-spinel interactions