The peritectic reaction of olivine to orthopyroxene in natural silicates

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Using a high resolution ion microprobe with SCAPS imaging, the peritectic reaction of forsterite + silica to enstatite was studied down to submicron level in natural andesitic tephras from the Central Plateau of North Island, New Zealand. The fayalitic component of natural olivines is stable in high-silica melts, and therefore this reaction is in fact a two-step progress (cf. Figure 1): 1. Dissolution of Mg-rich olivine, likely rate-limited by Fe-Mg interdiffusion at the crystal rim, results in enrichment of Fe in the crystal rim and of Mg in the melt boundary layer around the crystal, which is a few microns wide. 2. Orthopyroxenes nucleate and grow in this melt boundary layer; as soon as these microlites touch the rim of the dissolving olivine, they shield the crystals from the silica-rich melt, thereby preventing further olivine dissolution. At this point, Fe-Mg interdiffusion (mostly within olivine, but in part between olivine and orthopyroxene) begins to destroy the Fe-enrichment of the olivine rim. The reaction is completed when the dissolving olivine crystal is completely mantled by orthopyroxene microlites. Thick orthopyroxene mantles likely indicate further orthopyroxene overgrowth that is not associated with the actual peritectic reaction. The textures observed in the olivine core preserve information about the reaction history of the grain. Modelling of Fe-Mg interdiffusion in the olivine rim following its shielding from the melt by orthopyroxene overgrowth may yield the rates of olivine dissolution and the rates of pyroxene growth, and may provide some information about the time between olivine crystal uptake into the SiO_2-rich melt and explosive eruption at the surface.

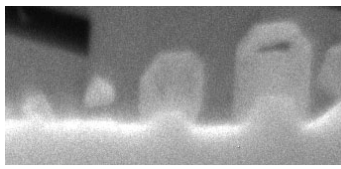

Figure 1: Fe-image of dissolving ol (bottom) and overgrowing opx microlites. Image c. 25 microns wide.