Phosphorus-in-olivine as a tracer of magma chamber processes

ÖZLEM ERSOY[1]*, IGOR K. NIKOGOSIAN[1], PAUL R.D. MASON[1], MANFRED VAN BERGEN[1]

[1]Department of Earth Sciences, Utrecht University, Budapestlaan 4, 3584 CD Utrecht, The Netherlands (*correspondence: S.R.Chaneva@uu.nl)

Fast diffusion and homogenization of divalent cations frequently modify the original composition and zoning patterns of olivine phenocrysts. In contrast, igneous olivines often preserve complex zoning patterns in phosphorous, due to its sluggish diffusion, which makes it the element of choice for reconstructing cooling histories and evolution of the host magma. Phosphorus zoning in olivine has been linked either to crystallization rate variations and diffusion controlled growth [1,2] or to strong compositional controls on melt-mineral partitioning [3]. We illuminate the versatility of P-in-olivine with a comprehensive EPMA and LA-ICPMS dataset on olivines from Italian potassium rich mafic lavas and the primitive melt inclusions (MI) that they host. The olivines are characterized by P concentrations from limit of quantification (22 ppm) to 435 ppm P with MIs containing up to 2.2 wt.% P_2O_5. High resolution (1-2 μm per pixel) element maps show both fine oscillatory and large scale sector zoning in P, which is uncorrelated with zoning in any other element. The MIs are virtually always surrounded by P-depleted zones that are also depleted in Cr and enriched in Al and Ti, which we attribute to a combination of supply-limited slow growth and melt compositional controls on partitioning behavior imposed by the boundary layer. Derivation of quantitative data on solid-liquid equilibrium partitioning from natural samples is therefore often challenging. On the other hand, P zoning in olivine provides valuable information on the nature and timing of mingling/mixing, wall-rock assimilation, subsequent re-equilibration and other magmatic processes operating in plumbing systems.

[1] Milman-Barris *et al.* (2008) *Contrib Mineral Petrol* **155**, 739-765. [2] Welsch et al. (2014) *Geology* **42**, 867-870. [3] Grant and Kohn (2013) *Am Mineral* **98**, 1860-1869.