



Phosphorus as indicator of magmatic olivine residence time, morphology and growth rate

Alexander Sobolev (1,2) and Valentina Batanova (1,2)

(1) ISTerre, University J. Fourier, Grenoble, France (alexander.sobolev@ujf-grenoble.fr), (2) Russian Academy of Sciences, Vernadsky Institute of Geochemistry and Analytical Chemistry, Moscow, Russian Federation (sobolev@geokhi.ru)

Phosphorus is among of slowest elements by diffusion rate in silicate melts and crystals (e.g. Spandler et al, 2007). In the same time it is moderately incompatible to compatible with olivine (Brunet & Chazot, 2001; Grant & Kohn, 2013). This makes phosphorus valuable tracer of olivine crystallization in natural conditions. Indeed, it is shown that natural magmatic olivine crystals commonly possess strong and complicated zoning in phosphorus (Milman-Barris et al, 2008; Welsch et al, 2014).

In this paper we intend to review phosphorus behavior in olivine in published experimental and natural olivine studies and present large set of new EPMA data on phosphorus zoning in olivine phenocrysts from MORBs, OIBs, komatiites and kimberlites. We will show that sharp olivine zones enriched in phosphorus by a factor of 10-20 over prediction by equilibrium partition may be due to formation of P-rich boundary layer on the interface of fast growing olivine. This is proved by finding of small-size (normally 10 μm or less) exceptionally P-rich melt inclusions in olivine, which are otherwise similar in composition to typical melt. These observations could provide potential olivine growth speedometer. We will also demonstrate, that sharp zoning in phosphorus may provide valuable information on the residence time of olivine crystals in different environments: magma chambers and conduits as well as mantle sources.

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References:

Spandler, et al, 2007, *Nature*, v. 447, p. 303–306; Brunet & Chazot, 2001, *Chemical Geology*, v. 176, p. 51-72; Grant & Kohn, 2013, *American Mineralogist*, v. 98, p. 1860–1869; Milman-Barris et al, 2008, *Contr. Min. Petrol.* v. 155, p.739-765; Welsch et al, 2014, *Geology*, v. 42, p.867-870.