doi:10.1017/S1431927614005479
Microsc. Microanal. 20 (Suppl 3), 2014

Quantitative Mapping of and Secondary Fluorescence Effects in Olivine Hosted Melt Inclusions

Julie Chouinard[1], John Donovan[1], Ellen Aster[2], and Paul Wallace[2]

[1.] University of Oregon, CAMCOR, Eugene, OR, USA
[2.] University of Oregon, Department of Geological Sciences, Eugene, OR, USA

Quantitative x-ray maps were acquired to investigate the homogeneity of melt inclusions and explore possible secondary fluorescence effects from the host material. By using elemental maps, one is more easily able to distinguish large scale patterns from localized features. It can also illustrate instrument effects on measurements, such as detector position (relative to sample orientation) or Bragg defocusing. These attributes are useful when trying to determine authenticity of chemical zonations in samples.

This study was conducted by mapping melt inclusions in grains of olivine from Kilauea on the island of Hawaii. All maps were acquired at 15 keV and 30 nA using Mean Atomic Number (MAN) background intensities; the use of MAN dramatically decreased the overall acquisition time (since high and low off-peak maps do not have to be acquired) without significantly affecting the accuracy [1]. Intensity data was collected for Na, Si, K, Al, Mg, Fe, Ca, Mn, Ti, and F. The melt inclusion that was the focus of this study was mapped over an area that was ~10,000 μm^2, 256 by 256 pixels, with 0.4 μm by 0.4 μm sized pixels. The on-peak elemental maps and MAN calibration curves were then processed with Probe Software's CalcImage to generate quantitative elemental maps.

To examine possible secondary fluorescence effects, the quantitative maps that exhibited changes in composition near the melt inclusion rim were investigated using Golden Software's Surfer® program and the Penepma Secondary Fluorescence Profile Calculations executable in Probe Software's Standard program [2]. Using Surfer® and its Scriptor application, the maps were transected across the melt inclusion to obtain elemental profiles which could be compared with the secondary fluorescence profiles subsequently calculated. Additionally, the composition of the olivine host material and the relatively homogeneous center of the melt inclusion were averaged with Surfer®; these compositions were then used with Penepma to assess the role of secondary fluorescence on the chemistry changes along the inclusion boundary.

The utility of the maps is that small scale features are illuminated in a way that may be overlooked with a line of analysis points across the aspect of interest. For example, the enrichments and depletions seen in this study roughly occurred over only the outermost 5 μm of the melt inclusion. Most notably, the quantitative mapping revealed a decrease in the concentration of Mg (Fig. 1 and 2A) and an increase in Al along the inclusion rim; the cross sections created showed changes of ~1.5-2 wt. % for Mg and Al. Comparatively, the Penepma modeling estimated that secondary fluorescence was only adding up to ~370 ppm for Mg (Fig. 2B), dropping off to less than 10 ppm after 3 μm away from the boundary, and just ~0.33 ppm for Al. Fe had the largest contribution from secondary fluorescence with just ~0.29 wt. % of Fe being added near the edge of the inclusion. This modeling suggests that the concentrational variations seen in this study cannot be explained by secondary fluorescence from the olivine host alone; in some cases, such as Mg, secondary fluorescence actually increased the differences seen [3].

References:

[1] J Donovan and T Tingle, Journal of Microscopy and Microanalysis **2** (1996) p. 1.
[2] J Donovan, X Llovet, and F Salvat, Microscopy and Microanalysis **18** (2012) p. 1742.
[3] The authors would like to acknowledge Robin Tuohy for collecting the samples used in this study.

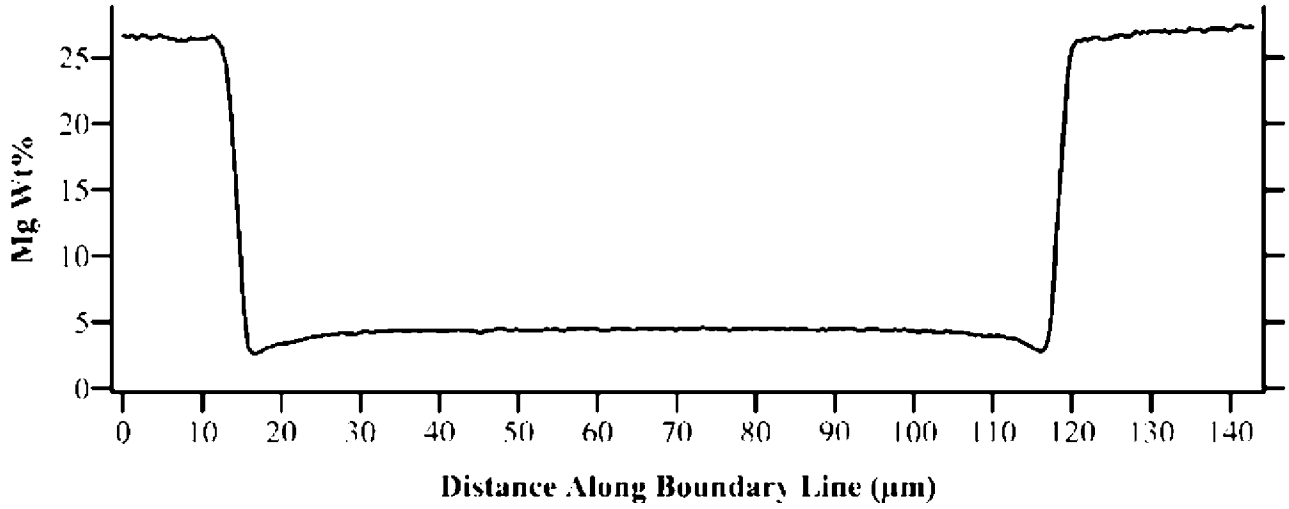

Figure 1. Concentration of Mg along a cross section (see Fig. 2A for exact location) through an olivine hosted melt inclusion.

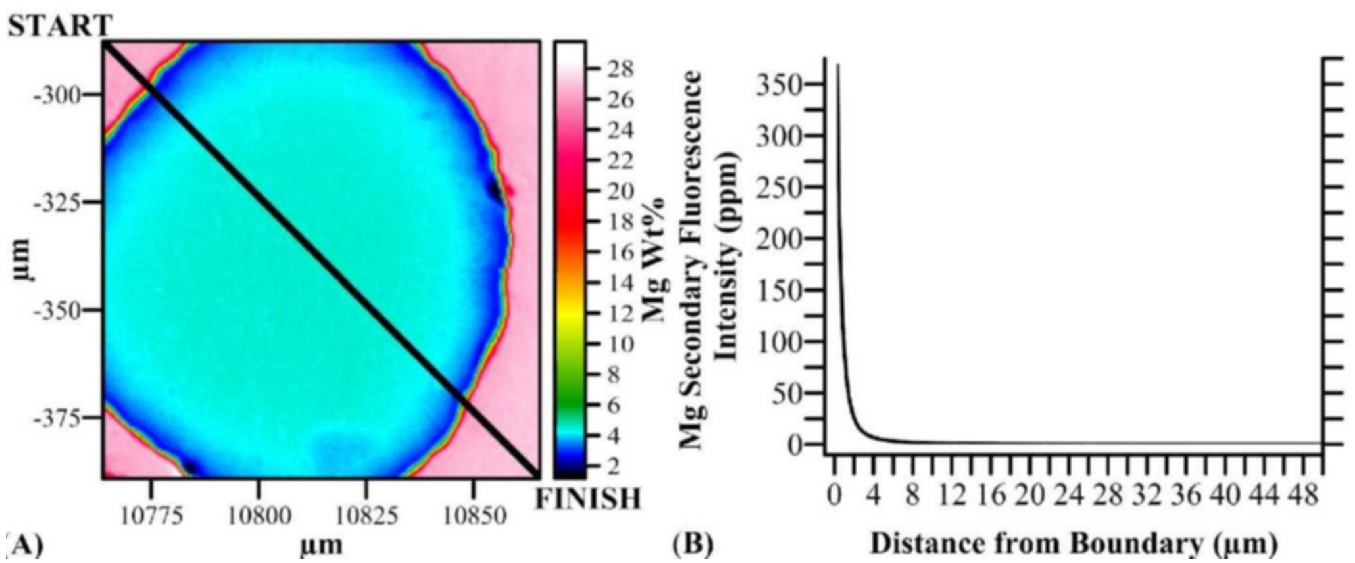

Figure 2. (A) Quantitative map of Mg concentration in the melt inclusion and surrounding olivine; (B) secondary fluorescence intensity of Mg in melt inclusion due to the host olivine.

https://doi.org/10.1017/S1431927614005479 Published online by Cambridge University Press