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An easier way to measure volatile contents from melt inclusions using FTIR imaging?

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Melt inclusions enclosed within crystals have provided a wealth of geochemical information to constrain magmatic systems. As melt inclusions are trapped during crystal growth they are isolated from any processes that occur subsequently, such as magma mixing or degassing, so preserve a more primary composition than the bulk glass. The abundance of volatiles, particularly water, in inclusions can provide important constraints on the origin and role of volatiles in mantle sources. Carbon dioxide concentrations can also be used to estimate the pressures at which the melt inclusion was entrapped.

The quantitative measurement of volatiles is now widely performed by Fourier-Transform Infrared Spectroscopy (FTIR). In terms of analysis of melt inclusions it provides numerous advantages over other techniques. It is non-destructive, allows micro-analysis (beam diameters can be as narrow as 10 microns), has low detection limits and can be used to determine the speciation of H- and C-bearing volatile species. However, there are also some drawbacks namely, laborious double polished sample preparation, the difficulty in preparing such samples when the inclusions are typically on the order of only a few 10s of microns thick, and the requirement to determine the thickness of the analysed material. Furthermore, in crystals containing multiple inclusions, the majority will be lost when doubly polishing one inclusion, unless others happen to be at the same level within the host crystal.

We have analysed many inclusions hosted in olivine crystals from basaltic samples by single beam and imaging FTIR techniques. Overtone and combination bands in the FTIR spectra related to the silicate structure of the olivine cause absorbance between 1600 cm-1 and 2100 cm-1. These peaks are dependent on the crystallographic orientation and the thickness of the crystal. If the thickness is constant and the crystal is not rotated they should not change across the crystal. In contrast to inclusions, crystal thickness is easily measured using a micrometer or more precisely using reflection spectra. However, if an inclusion is in the beam path, the crystal comprises less of the beam path and the absorbance of the peaks should decrease in proportion to the thickness of the inclusion. We will examine whether this change can be used to determine inclusion thickness, once the crystal thickness is known. If successful this technique will ease sample preparation, the host olivine crystal does not need to be ground away and can be used to protect the inclusion and allow the prepared sample to be larger and easier to handle. More importantly, if the crystal hosts several inclusions it will allow all of them to have their volatile concentrations measured, particularly by imaging FTIR, greatly increasing the rate of volatile data collection from basaltic melt inclusions within olivine.