A new technique to analyse unexposed melt inclusions in quartz

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We are trying to develop a new technique to analyse the volatile concentration of quartz-hosted rhyolitic melt inclusions using a micro-FTIR spectrometer without exposing the inclusions to the surface of a doubly-polished thin section. This method is similar to that of Nichols and Wysoczanski (2007) who established a technique to analyse unexposed basaltic melt inclusions in olivine phenocryst. We show the results of the feasibility examination of this technique as summarised below.

When an infrared beam transmits through both the quartz crystal and melt, the resultant spectrum (f) is considered to be the linear combination of the pure spectrum of quartz and melt: f=d(qz)*f(qz)+d(mi)*f(mi). Here, f(qz) and f(mi) represent the pure spectrum of quartz and melt per unit thickness, respectively. d(qz) and d(mi) are the effective thickness. d(qz) is calculated based on the absorbance of a quartz peak in the sample spectrum that is considered to be linearly proportional to the thickness. d(mi) is then obtained by subtracting d(qz) from the total thickness (d). Finally, the volatile concentration is estimated from d(mi) and absorbance of the volatile peaks.

The feasibility of this analytical method was examined as follows. Firstly, we analysed quartz thin sections with a micro-FTIR spectrometer to confirm that absorbance of quartz peaks, which exist in the range of 1500-2200 cm-1, is proportional to quartz thickness. The 1790 cm-1 peak was chosen as an indicator of d(qz), because this peak is free from interference with other peaks.

Secondly, we examined if the mixed spectrum of quartz and melt is the linear combination of pure spectrum of each material, by putting a thin section of obsidian on the section of quartz. We confirmed that the mixed spectrum was the linear combination, and the water content of obsidian was always calculated to a single value irrespective of the quartz/melt ratio.

Thirdly, we applied the method to a quartz-hosted melt inclusion from the Onikobe caldera super eruption. A large inclusion with 150 μm diameter was chosen for this purpose. The water content of this inclusion was determined to be 4.4 wt% by an FTIR analysis with a 10 μm beam. The same inclusion was then analysed with a thick beam with various diameter(<300μm). We observed that the resultant spectrum was not a linear combination: the water content was strongly dependent on the quartz/melt ratio. For example, the water content was calculated to be 2.3 wt% based on 3550 cm^{-1} peak when d(qz)/d =0.23. For the 4500 and 5250 cm^{-1} peaks, the water content was calculated to be 63 and 84 % of the true water content. We are now investigating why such a non-ideal behaviour was observed in melt inclusion analysis, though ideal linearity was confirmed in the quartz+obsidian superimposed sample.

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