Geophysical Research Abstracts
Vol. 19, EGU2017-1082, 2017
EGU General Assembly 2017

Water content estimation of natural glasses and melt inclusions: a Raman spectroscopy study

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Water is the most abundant volatile dissolved in silicate melts and strongly affects melt structure, magma transport and eruptive style.
Raman spectroscopy can give insight into the silicate structure and water content of silicate melts. This technique presents several advantages such as: 1) high-spatial resolution; 2) non-destructive character; 3) minor sample preparation 4) crystals detection; and 5) the possibility to perform in-situ investigations at high temperature and pressure.
Several approaches to estimate the water content of silicate glasses (mostly iron-free) and melt inclusions have been presented based on internal and/or external calibration. Here, we discuss these different approaches using a wide range of chemical composition of glasses, which has never been investigated so far. We used 25 natural samples from basaltic to rhyolitic composition and water content up to 7wt% (independently measured). By using two different Raman spectrometers we also explore potential causes for variations in the estimation of water content due to instrumental effects. Based on the results of this study, we show that the difference in instrumental response is the main factor against a unique calibration for the estimation of water content. On the other hand, the choice of the analytical procedure depends significantly on the iron content and its oxidation state. We applied the proposed model to a set of melt inclusions trapped in crystals belonging to the Green Tuff eruption (Pantelleria Island, Italy) in order to provide insights on magma pre-eruptive storage conditions (i.e. dissolved water content and iron oxidation state).
Finally, we show a simple correlation between the glass structure as inferred by Raman spectroscopy and the glass transition temperature.