The volatile content of Mount Etna magma: An FTIR and Raman study of glassy melt inclusions

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The 1983 eruption of Mount Etna

Mount Etna volcano, Sicily, is amongst the highest emitters of volcanic carbon dioxide worldwide, however the origin of this prolific output is still debated. As such, characterising the occurrence of CO_2 in Mount Etna magmas has important implications for our understanding of deep Earth degassing.

Lavas from the 1983 eruption of Mount Etna have been found to contain native carbon, in the form of graphite and diamond [Adrian Jones, pers. comm.]. This unprecedented observation suggests that this, so far little-studied eruption, may have sampled an unusually deep source of carbon beneath Etna. These lavas therefore represent an ideal target for the further characterisation of the carbon output of this volcano.

By the time they are erupted, lavas are heavily depleted in CO_2, as it begins to degas at large depths within the volcanic system. Melt inclusions are small pockets of magma which become trapped within crystals growing within a magma body, and – as they are isoltated from the effects of degassing – can preserve the early volatile composition of magmas. Importantly, the analysis of H_2O together with CO_2 allows the trapping depth of these inclusions to be estimated.

Work plan

Glassy melt inclusions, hosted within olivine phenocrysts from lavas of the 1983 Etna eruption, will be analysed using FTIR (Fourier Transform Infra Red) Spectroscopy, and Raman microscopy, in order to determine the concentrations of dissolved CO_2 and H_2O, respectively, in the glasses. Using the Raman method, the presence of H_2O has already been verified in the inclusions (fig. 1), and FTIR analysis will be performed on the same samples, starting in April 2013.

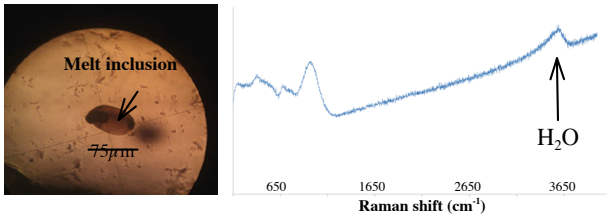

Fig. 1. Left: Sample prepared melt inclusion within its olvine host crystal; Right: Raman microprobe spectrum of the same inclusion, which shows a prominent OH peak indicating the presence of dissolved H_2O.

Seasonal distinction of hydrological variability in speleothem calcite

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Speleothem chemical records have been employed in the reconstruction of environmental change on a broad range of timescales. Whilst sub-annual records are scarce, it is here that one of the research frontiers resides, providing a modern calibration between speleothem proxy and meteorological conditions. Here, we use Synchrotron μXRF spectrometry at ID21, ESRF, to reveal trace element patterns of Zn, Pb and S within speleothem calcite over three annual cycles. In this way, archived signals are calibrated to modes of trace element incorporation and meteorological conditions. Concentrations of Zn and Pb in speleothem Obi84 show in-phase cyclicity and are attributed to transport in complexes with natural organic matter (NOM) originating from the soil/epikarst above the cave. Peak fluorescent laminae occur on an annual basis, although banding of lower fluorescence intensity reveals multiple events at the sub-annual scale. Meteorological data reveals the delivery of NOM-metal complexes to the speleothem is dependent upon water excess, snowpack condition, and soil microbiological activity. Sulphur demonstrated annual cyclicity, with minimum and maximum concentrations coinciding with winter and summer respectively, dependent upon internal cave atmospheric conditions and the pH value to which cave drip waters degas. At the current resolution of analysis, this represents some of the first evidence linking event-based meteorological records to the trace element content of speleothem calcite and is the initial phase of work which aims at developing records of seasonal infiltration patterns and cave ventilation dynamics, building towards proxy records of winter duration and seasonal infiltration patterns as indices of climatic change.

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