Geophysical Research Abstracts
Vol. 12, EGU2010-9274, 2010
EGU General Assembly 2010

Advanced characterization of glass/melt inclusions trapped in phenocrysts by combined SEM-EDS, EMP-WDS and FT-IR techniques

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Melt inclusions (MIs) are micrometric-sized and variable-shaped impurity parcels of glass $\pm$ vesicles $\pm$ solids present within cavities or fractures of crystals. Because representing melt droplets that were trapped during crystal growth, they are believed to record the variable physico-chemical conditions of the hosting multi-phase system. Therefore, MIs are unique probe of near-liquidus magmatic conditions, otherwise inaccessible to Earth Scientists, and are widely used to integrate and corroborate conventional petrological and volcanological techniques based on mineral phases and whole rocks.

Electron microprobe (EMP-WDS) and microscopy (SEM-EDS), and Fourier Transform Infra Red (FT-IR) spectroscopy are well-established analytical techniques, commonly used to determine composition of the magma from which MIs formed. Noteworthy, FT-IR is usually adopted to determine the content of dissolved H2O and CO2, providing i) essential information for entrapment pressures, hence depths of crystal growth, and ii) constraints to the volatile budget of magmas. Assessing such volatile contents has significant implications for the understanding of magma evolution and migration, from the depths of parental magma genesis, through the main depths of crustal storage, up to surface. The MI-based quantification of volatile contents and the recognition of degassing patterns are also vital for deciphering magma rheology, which largely affects eruptive dynamics and style.

Limits to melt inclusion studies are i) their typically very small size (< 100 μm), ii) the possible late and secondary crystallization, iii) the diffusivity-driven chemical exchange between melt and host crystal, iv) and the alteration phenomena that mask or even delete the original melt composition.

Here, we present a study of glass/melt inclusions in phenocrysts from Procida Island (Phlegraean Volcanic District, South Italy), analyzed for combined SEM-EDS electron microscopy, EMP-WDS microchemistry and FT-IR spectroscopy. In particular, we have characterized the distribution of volatile H and C species across both the host crystals and the inclusions, by using a focal-plane-array (FPA) of detectors. The FPA technique allows the acquisition of a large number of IR spectra simultaneously and generate mid-IR images with high resolving power of the target molecules in the H-O-C system. The integration of these analytical techniques is a mandatory step in order to provide definite advances in MI characterization and data interpretation.