Melt inclusions constrain S behaviour and redox conditions in Etnean magmas

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Mount Etna is a complex magmatic system characterized by a continuous variability both in terms of eruptive style and composition of erupted products. Currently, its volcanic activity is marked by high gas fluxes (of above all SO2), both during eruptive and non-eruptive periods.

In this study, we have studied the volatile contents and Fe speciation of olivine-hosted melt inclusions from 6 eruptions of the last 15 ky, mainly to investigate the behavior of S during ascent and differentiation of Etnean magmas. Samples selected come from the FS eruption which is the most primitive (picritic composition, Fo91), Mt Spagnolo (the oldest) and from more recent eruptions: 2002/3, 2006, 2008, and 2013.

S concentrations in glass inclusions are extremely variable, from a few hundred ppm in recent lavas up to 4000 ppm in the older Mt Spagnolo products (Fo88). This variation broadly correlates with the degree of differentiation of the melt, as expressed by the major element (SiO2, K2O) chemistry. However, both degassing and variations in redox conditions influence the S behavior, as revealed by variations in volatile concentrations, sulfide saturation and Fe speciation in melt inclusions.

Fe3+/ΣFe spectra in some glass inclusions were collected by XANES synchrotron radiation. Results span a large range of Fe3+/ΣFe ratios, generally decreasing from the most primitive (FS) to the most recent (2013) melts. Fe3+/ΣFe ratios were used for estimating the redox conditions of Etnean magma, yielding quite oxidizing and fairly variable fO2.

Interpretation of the glass inclusion data (notably S content and Fe speciation) uses hydrous and S-bearing basaltic experimental glasses synthesized in the range of conditions (P, T, fO2) relevant to the Etnean system. Results corroborate an important control of fO2 and of the melt Fe concentration on the S concentration of Etnean glasses.