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 SO_2), 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, Fo_{91}), 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 (Fo_{88}). This variation broadly correlates with the degree of differentiation of the melt, as expressed by the major element (SiO_2, K_2O) 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.

$Fe^{3+}/\Sigma Fe$ spectra in some glass inclusions were collected by XANES synchrotron radiation. Results span a large range of $Fe^{3+}/\Sigma Fe$ ratios, generally decreasing from the most primitive (FS) to the most recent (2013) melts. $Fe^{3+}/\Sigma Fe$ ratios were used for estimating the redox conditions of Etnean magma, yielding quite oxidizing and fairly variable fO_2.

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, fO_2) relevant to the Etnean system. Results corroborate an important control of fO_2 and of the melt Fe concentration on the S concentration of Etnean glasses.