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Volatile characterisations of Eyjafjallajokull volcano (Iceland): from the magmatic source at depth to the surface

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Studies of volatiles in melt inclusions (MIs) can put constraints on the magma source, transport and storage as well as magma degassing processes. Here, we present new measurements and estimates of pre-eruptive volatile concentrations in magmas of the Eyjafjallajökull volcano in Iceland. The first phase of its 2010 eruption started the 20 March along approximately 500 meters long fissure. It was characterized by 50-100 m-high lava fountains, effusion of fountain-fed lava. This flank eruption of relatively primitive basalt with a slightly alkali character presents a rare opportunity to assess the volatile composition and characteristics of its mantle source as well as estimation of the volatile fluxes during eruption. For this purpose, tephra samples were collected March 25, a few hours after their eruption. Volatile (S, Cl, F), major and trace element concentrations were measured in MIs trapped in olivine (Fo73-87) and plagioclase (An69-70) phenocrysts. Same elements were also measured in the groundmass glass of the tephra. Significant range of composition was observed in the MIs with the most evolved MIs having up to 0.25wt%S, 0.24wt%Cl and 0.3wt%F.

Several MIs are of relatively primitive composition with MgO contents up to 7.4wt% (in olivine Fo87). The measured compositional range of MIs (K2O ranging from 0.35 to 1.18 wt%) cannot be explained easily by a simple fractional crystallisation process. The MIs with more evolved compositions lie upon a differentiation vector that can be extrapolated through the origin, which is a general case. However, the highest values of Cl and F fall above this vector indicating a late volatile input from deeper magma. Hence, the more evolved MIs show a degassing trend during magma ascent througt the crust. The difference between volatile concentrations in MIs and those measured in the groundmass indicates that $\sim$3 Mt of sulphur, $\sim$1.3Mt of chlorine and 1.5Mt of fluorine were released into the atmosphere during the Fimmvörðuháls eruption. These results will be discussed and compared with remote sensing results.

Highly incompatible trace element variation diagrams and primitive mantle-normalised trace-element spectra of MIs in olivine indicate that the magma evolution is consistent with series of magma batches produced by different degrees of partial melting or mixing followed by fractional crystallisation. Finally, trace element behavior imply that Fimmvörðuháls magmas could be linked to the parental magma of Katla and that of Vestmannaeyjar volcanic system.