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The 20 March – 12 April 2010 Fimmvörðuháls eruption, Eyjafjallajöull volcano, Iceland: Volatile contents and magma degassing.

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The 2010 March to April mildly alkalic basaltic fissure eruption on the east flank (Fimmvörðuháls) of the Eyjafjallajökull volcano, Iceland, was a precursor to the main summit eruption that followed on April 14. The Fimmvörðuháls eruption took place on a 300 m-long radial fissure, featuring up to 150 m-high lava fountains that produced an a'a lava flow field with a mean thickness of 20m, area of 1.3 square km and volume of 0.025 cubic km. The average magma discharge for the eruption is 13 cubic meters per second.
Here we present results on major element composition and initial and residual volatile (sulphur, chlorine, fluorine, water and carbon dioxide) concentrations in the Fimmvörðuháls magma as determined by analysis of 87 melt inclusions (MI) and 177 analyses of glass groundmass obtained from a suite of 9 samples representing the first 14 days of the eruption. The groundmass glass (TiO2 = 4.91±0.2 wt%; FeO = 14.5±0.46 wt%) and the MIs (TiO2 = 4.91±0.2 wt%; FeO =13.1±1.77 wt%) have very similar FeTi basalt composition, although the MIs (MgO = 5.39±0.90 wt%) are slightly less evolved than the groundmass glass (MgO = 4.7±0.20 wt%). The data define distinct trends on bivariate plots consistent with evolution by fractional crystallization. Volatile measurements in the MIs gave the following results: 0.148±0.041 (range 0.016–0.254) wt% S, 0.071±0.031 (range 0.022–0.240) wt% Cl and 0.095±0.042 (range 0.032–0.299) wt% F, 0.54±0.25 (range 0.20–0.88) wt% H2O, 0.19±0.09 (range 0.04–0.32) wt% CO2. The MIs with the highest volatile concentrations are situated in the cores of the phenocrysts; those with lower and more variable volatile contents are typically located near their edges. We interpret this to indicate progressive entrapment of MIs into phenocrysts, first in the magma holding chamber and then during magma ascents, where additional growth is facilitated by the low magma discharge. Thus, only MIs from the cores of phenocrysts contain information on the initial volatile concentration of the magma at depth; the remainder records magma parcels degassed to variably degree during ascent and prior to entrapment. The pre-eruption concentrations of dissolved volatiles in the Fimmvörðuháls magma are therefore represented by the most evolved MIs found in the phenocryst cores, giving the following estimate for the initial volatile values: 0.224±0.016 wt% S, 0.058±0.013 wt% Cl and 0.075±0.017 wt% F, 0.87±0.01 wt% H2O, 0.29±0.02 wt% CO2. This gives a total pre-eruption volatile content of 1.5±0.08 wt% for the Fimmvörðuháls magma. The corresponding groundmass (residual) values are 0.028±0.005 wt% S, 0.045±0.011 wt% Cl and 0.073±0.010 wt% F, 0.07±0.02 wt% H2O, 0.012±0.05 wt% CO2. These data indicate that more than 85% of the water, carbon dioxide and sulphur, but less than 20% of the chlorine and fluorine escaped into the atmosphere upon venting.