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Fractional magma degassing at Holuhraun, Bárdarbunga volcanic system, Iceland?

Pierre-Jean Gauthier (1), Séverine Moune (1), Olgeir Sigmarsson (1,2)

(1) Université Clermont Auvergne, CNRS, IRD, OPGC, Laboratoire Magmas et Volcans, F-63000 Clermont-Ferrand, France, (2) NordVulk, Institute of Earth Sciences, University of Iceland, Reykjavik, Iceland (olgeir@hi.is)

How the solubility of volatile elements varies with magma composition, pressure and temperature controls their outgassing at active volcanoes. In general, the relative solubility of major volatile species in basalt increases from CO_2, H_2O, S, Cl to F. The first three species are known to form a gas phase both before and during volcanic eruptions, whereas the last two principally outgas during and after an eruption. Filter-pack gas samples collected from the main crater of the Holuhraun eruption (29 August 2014 to 27 February 2015) a few days after the eruption ended have been compared with those of the main eruptive plume, confirming the degassing order of the major gaseous elements. The eruption was characterized by high lava discharge rate and significant gas emission with approximately 10 Tg, SO_2. Primary magmatic degassing had elevated S/Cl, infinitive S/F due to almost negligible F degassing and high trace metal fluxes to the atmosphere (Gauthier et al., 2016; Gislason et al., 2015) causing a significant environmental impact (Ilyinskaya et al., 2017; Stefansson et al., 2017). Nevertheless, snow precipitated around the lava field and collected during the eruption had significant F concentrations despite its very low abundance in the main gas plume.
The post-eruptive diluted gas emissions of Holuhraun is characterized by concentrations of major gases with SO_2, HCl and HF ranging from 98-327, 55-107, 28-49, respectively (mg/m3), with much lower S/Cl (1.4 $\pm$ 0.4), Cl/F (2.0 $\pm$ 0.2) and hence elevated F/S (0.4 $\pm$ 0.1) compared to the syn-eruptive gas (46 $\pm$ 8, 11 $\pm$ 5, $\sim$0, respectively). Low S/Cl mass ratios (0.9-1.6) correspond to a factor of four decrease in S degassing and a factor of seven increase in Cl degassing compared to the primary magmatic degassing. High F/Cl suggests that 50 times more F is released during the secondary degassing event. Outgassing of the lave field thus explains the elevated F in the environmental samples such as the snow and rivers flowing to the lowland. The lava composition remained uniform during the entire eruption but the late stage degassing is possibly related to internal differentiation forming segregations in the lava field and thus the changing solubility could reflect outgassing from a more evolved basalt composition. An alternative explanation is a Rayleigh distillation process with the most soluble volatiles degassed at the end of the eruption.