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Atmospheric sulfur loading by the ongoing Nornahraun eruption, North Iceland

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The ongoing Nornahraun fissure eruption has maintained a 1–4 km-high, gas-charged and sulfur-rich eruption plume since the onset of eruption on 31 August 2014 and had discharged $\sim$1 km^3 of lava at the end of 2014. During this time (i.e. September through December 2014), the SO_2 emissions have produced significant volcanic pollution across Iceland with several short-lived events where the SO_2 concentrations have exceeded toxic levels [1]. Although measurements of SO_2 concentrations and fluxes is relatively straightforward at specific sites or localities within Iceland, it has been challenging to obtain good ground- or satellite-based time series measurements of the SO_2 flux released by the magma upon venting. These difficulties arise because: (i) the eruption site is remote and nested in the centre of the Icelandic highland, thus these measurements are hampered by access and by weather conditions, (ii) the plume is confined to the lower troposphere where the conversion rate of SO_2 to H_2SO_4 aerosols is very rapid, or hours (?) to days [2] and (iii) the plume is commonly obscured by clouds due of its low rise heights.

The empirical sulphur emission method of Thordarson et al (2003) is an alternative way to obtain estimates on the total as well as temporal atmospheric SO_2-loading by the Nornahraun eruption. We use the TiO_2/FeO value of 0.156, obtained via microprobe analyses of groundmass glass in tephra grains, to calculate initial (1420 ppm) and degassed (435 ppm) S values for the Nornahraun magma. These values compare well with measured groundmass values (425 ppm = degassed S content) and melt inclusion values ($\sim$1400 ppm = initial S content of the magma). The difference in the above listed values represents the amount of S released into the atmosphere at the vents and indicates a 5.3 kg SO_2-loading by each cubic meter of erupted magma. This implies a total atmospheric SO_2-mass-loading of 5 million tons (= 5 terragrams) by the Nornahraun event during the first 4 months of activity. Furthermore, using a magma discharge scheme developed from eruption parameter data sets of [3] and [4], we calculate the SO_2 emissions for the first two weeks of the eruption to have been in the range of 80–120 thousand tons/day, then dropping to 45–70 thousand tons/day until end of September. In the first week of October the SO_2 emissions increased to 80–90 thousand tons/day, then dropped abruptly to a flux of 30–60 thousand tons/day that was maintained to end of November. In December the flux is calculated to have been in the range of 25–40 thousand tons/day.

[1] http://www.ust.is/einstaklingar/loftgaedi/maelingar/

[2] Khoder MI, 2002 Chemosphere 49 675–684.

[3] Coppola et al, 2015, this session.

[4] Dürig et al, 2015, this session.