Constraining SO2 Emissions From Basaltic Eruptions

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Basaltic volcanic eruptions are fairly frequent in the geologic record and while not as spectacular as large explosive eruptions, they may contribute much more sulphur to the atmosphere over certain time periods. This is especially true for very large basaltic fissure eruptions such as Laki, 1783. These volatile emissions can significantly affect atmospheric, environmental and climate conditions on earth. Hence understanding the mechanisms of volcanic sulphur release and its total amount is crucial in predicting its effects on environment and society.

Conventionally the SO2 released by eruptions is estimated by a petrologic method through analysing glass inclusions in crystals (to obtain pre-eruptive volatile content) and matrix glasses (to obtain degassed volatile content), and multiplying the difference by the total mass of magma erupted. However comparison with independent satellite measurements of SO2 (TOMS), shows that for some large silicic eruptions the TOMS value exceeds the petrologic value by more than an order of magnitude. Recent work has implied that a separate vapour phase accumulating in the magma chamber prior to eruption may be responsible for this excess sulphur (e.g. Wallace 2001). Our work addresses the outstanding problem of testing the petrologic method against independent measurements of volatile release (TOMS) for basaltic magmas. In doing this we are also performing a general analysis of the inherent errors associated with the petrologic method; for example estimates of the total erupted mass of magma may contribute an error of ±50% to the result.

A suite of lava and tephra samples from three Icelandic basaltic eruptions, Krafla, 1984, Hekla, 1980 and Hekla, 2000 have been collected and analysed for volatile species (S, Cl, F), using the electron microprobe. For all three eruptions sulphur emissions are independently known from TOMS satellite data. All three studied eruptions have tight constraints on erupted volume, and other petrologic method inputs. Combining these results with the TOMS data, eruption style, eruption volume and magma composition, we can attempt to model the physical and chemical processes involved in volatile segregation prior to eruption, and during dispersal throughout and after eruption.