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Electrical and radioactive properties of ash samples from Eyafjallajökull and Grimsvötn

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We have investigated the physical properties of ash samples from the recent Icelandic volcanic eruptions, motivated by two sets of unexplained electrical measurements. Firstly, in situ observations of sustained electrical charging of the Eyafjallajökull plume at 1200 km from the volcano (Harrison et al, 2010), and secondly, the rate of volcanic lightning from Grimsvötn was two orders of magnitude greater than at Eyafjallajökull (Bennett et al, 2010). Electrification of volcanic plumes is likely to be generated by multiple mechanisms which may include: triboelectric or fractoemission processes at the vent, the 'dirty thunderstorm' mechanism if ice forms in the plume, and the internal radioactivity of the plume (Mather and Harrison, 2006; James et al., 2008). Here we investigate the charging properties of the ash from the two eruptions, determined by a combination of the material (including natural radioactivity), particle size distribution and shape.

Volcanic ash samples were provided by the Iceland Meteorological Office. Ash from the 2010 Ejyafjallajökull eruption was collected 22 km from the crater, and ash from the 2011 Grimsvötn eruption was collected 70 km from the crater. Approximately 50 g of ash from each volcano was analysed in an Ortec 7229N gamma ray spectrometer, with the energy response calibrated before use. Both samples indicated natural radioactivity above the background level, with the Eyafjallajökull ash showing significantly more gamma activity than Grimsvotn. Gamma ray peaks associated with the decay products of uranium-238 and thorium-232 were consistently about twice as high in the Eyafjallajökull sample relative to Grimsvötn, after correction for the mass of the samples and the test duration. The 1.46 MeV peak from potassium-40 was about 10% higher in the Eyafjallajökull ash. These measurements are qualitatively consistent with what is known about Grimsvötn and Eyafjallajökull ash which are thought to have about 0.5 wt% and 1.8 - 2 wt% K2O respectively. Data on uranium concentrations of the ash are not available, but it is likely to behave as incompatibly as potassium in these rocks, so should be enriched in the Eyafjallajökull ash compared to the Grimsvötn ash. Measurements of the ash size distribution and shape have also been taken using a particle sizer and a scanning electron microscope. We intend to use this information with the radioactivity data, and laboratory measurements of the triboelectric charging properties of the ash, to help understand the observations.

References

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