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Whole deposit grain size for the tephra of the 2004 Grímsvötn eruption, Iceland.

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The most recent explosive eruption of Grímsvötn volcano, Iceland (Nov 1st-6th 2004) commenced as a subglacial event within the Grímsvötn caldera before breaking through the ice cover to produce a 6-10 km high eruption column. Basaltic tephra was dispersed via concurrent plume fallout and pyroclastic density currents to produce an apron extending >50 km across the ice surface northwards from the eruption site. Although on a much smaller scale to that of the 2010 eruption of Eyjafjallajökull, this event also caused disruption to air travel over Iceland and the North Atlantic. The basaltic explosive eruption record in Iceland is dominated by events on the Grímsvötn volcanic system and in the past 100 years there have been 25 confirmed eruptions from ice-capped volcanoes in Iceland, of which 11 were from Grímsvötn. Characterisation of the grain size distribution and dispersal characteristics of small-volume basaltic englacial volcanic events is therefore of particular relevance to the multinational hazard mitigation community because of (i) their frequent occurrence and (ii) Iceland's strategic location within the North Atlantic – a region of heavy air traffic between Europe and North America.
Grain size distribution has been determined for more than 100 samples collected over the 3 years following the G2004 eruption and covering all stratigraphic units within the tephra dispersal area. We have reconstructed the whole-deposit grain size distribution for the 2004 Grímsvötn eruption as well as for the tephra units produced by the seven eruption phases. In the proximal and medial sectors (<5 km from source) the tephra is, as whole and on basis of individual units, very poorly sorted fine to medium ash, with a typical median diameter of 1 – 1.5 Φ (500 – 375 micrometers), size bin range of -5 to 10 Φ (32000 to 1 micrometers) and sorting values of 2.38 – 2.75. The distribution is slightly positively skewed and polymodal with a principal mode at ∼1 Φ and secondary modes at 3 Φ, and 4 Φ. The ash-grade domination in the proximal tephra is attributed to enhanced fragmentation by phreatomagmatic eruption processes as well as aggregation-induced deposition of fine ash in the near-vent region. In the distal sector (i.e. >5 km from source) the median diameter of the tephra is 2.5 Φ (175 micrometres). The information provided by this study on the whole deposit grain size and ash aggregation in the G2004 eruption will help to better define source parameters for englacial basaltic explosive eruptions in Iceland and thus aid the application of numerical models aimed at predicting and forecasting tephra dispersal and atmospheric removal from such events.