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Breaking free – basaltic fragmentation from morphology populations

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Using state-of-the-art grain imaging technology we have generated a unique shape parameter dataset on basaltic tephra morphology from different eruptive settings.
Statistical investigations of the shape parameter dataset clearly show that different eruptive settings have different morphology populations. The populations can in turn be related to a spectrum of fragmentation mechanisms from dry magmatic to phreatomagmatic. This allows for a flexible fragmentation classification in terms of a continuous scale. Such a classification also accommodates an estimate of the influence of magmatic volatiles in the otherwise phreatomagmatically dominated fragmentation regime. This can be very valuable information in relation to hazard evaluation of both past and ongoing eruptions.

Samples have been obtained from deposits of a pristine fire fountain, an older fire fountain, small tuff cones, large tuff cones and from different central volcanoes in Iceland. The pristine fire fountain sample defines a dry magmatic fragmentation extreme of the fragmentation spectrum. The small tuff cones define an extreme phreatomagmatic fragmentation with hardly any magmatic volatile drivers. If both magmatic and phreatomagmatic fragmentation processes are active simultaneously the samples fall within the fragmentation spectrum. This is the case for samples from larger tuff cones and the Icelandic central volcanoes Katla and Grimsvötn.

The study is based on the imaging technology of the Particle Insight Shape Analyzer. Grain projections are imaged, while the tephra is suspended in water flowing in front of the lens. This technique ensures a great variety of grain projection angles and avoids operator induced grain selection bias.
The 2D projection morphology of 20,000 grains has been analyzed in each sample. The morphology is automatically defined by 26 shape parameters including – but not limited to: Circularity, rectangularity, feret width and –length, equivalent area circle diameter (EACD), and equivalent perimeter circle diameter (EPCD). The shape parameters are calculated on the basis of direct pixel-based measurements of grain perimeter, grain area and the longest distance between grain pixels in different directions.