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Density analysis of magmatic and phreatomagmatic phases of the 934 AD Eldgjá Eruption, southern Iceland

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Eldgjá is a ∼75 km long volcanic fissure vent system associated with the Katla volcanic system in southern Iceland, formed during an eruption in the mid-tenth century. The fissure is of the mixed-cone row type and produced both large lava fields and a widespread basaltic tephra deposit. Proximal tephra fall deposits are up to 4 m thick and contain numerous fall units of varying thickness which run parallel to the fissure, indicating many sources of eruption. The lower-most fall units thicken towards Mýrdalsjökull, demonstrating that the initial explosive phases took place within the glacier. Later fall units generally thicken towards the northeast with dispersal axes indicating origin at the more easterly segments of the Eldgjá vent system and a stepwise migration in an easterly direction. Both magmatic and phreatomagmatic explosive activity occurred along the vent system, where phreatomagmatic activity is confined to fissure segments within the Mýrdalsjökull glacier.

Two key sections, chosen to represent magmatic and phreatomagmatic deposits, were logged and sampled for density analysis. A section at Skælingar, half a kilometre southeast of Eldgjá Proper was chosen to represent the magmatic products. It is 3.70 m thick and contains 9 fall-units including a distinct bomb-layer. The phreatomagmatic products are represented by a section from Stóragil, 20 km north-northeast of the Katla caldera and the sampled section is 1.12 m thick.

Density analysis involves selecting 100 clasts 8-32 mm in diameter from <5 cm layers within the sub-units of each section. These clasts are then weighed, sealed and then weighed again in water to calculate their volume by Archimedes' principle and therefore their density, from which vesicularity can be calculated. The results were then plotted as histograms and compared with the section logs.

The magmatic samples have unimodal, normal vesicularity distributions with typical modal values of 60-70% and a span of ∼40%. Several of the samples have weakly negatively skewed distributions – the bomb layer has a plateau-like vesicularity distribution and a span of 51% – indicating that outgassed magma was also involved in the explosive activity. This outgassed portion of the tephra deposits is best explained by the pulsating explosions on the same fissure segment.

The section at Stóragil contains both phreatomagmatic and magmatic products. The phreatomagmatic samples exhibit characteristic plateau-like distributions with modal vesicularity between 70-80% and a span of 40-50%. In one of the fall units a gradual change from plateau-like to normal distribution is observed indicating a change from phreatomagmatic to magmatic activity during the course of a single explosive phase. This implies that either gradual change in access of external water to the erupting vents or that the external water source was being exhausted.

Thin-sections will be made of clasts in each sample which show extreme vesicularities. SEM photographs will be taken of these and vesicle-size distributions measured by image analysis. These results will also be presented.