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Microtextural analysis of the 934 A.D. Eldgja and 1783-84 Laki tephra: patterns of vesiculation and fragmentation for explosive basaltic eruptions

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The neovolcanic zones of Iceland sustain unique environmental and tectonic conditions for volcanic eruptions. The largest eruptions of basaltic magma in historic times are the prolonged fissure-fed eruptions of Laki (15.1 km^3) in 1783-84 AD and Eldgja (19.6 km^3) in 934-40 AD, where >93% of the erupted magma was emplaced as lava (Laki, 14.7 km^3 and Eldgja, 18.6 km^3) and the remainder was erupted as tephra (Laki, 0.4 km^3 DRE and Eldgja, 1.3 km^3 DRE). The histories of these classical flood lava eruptions Laki possess a dynamic nature, featuring explosive activity ranging from Hawaiian to subplinian intensities as well as shifts from purely magmatic to phreatomagmatic fragmentation.

The Laki eruption took place on the Grímsvötn volcanic system within the Eastern Volcanic Zone (EVZ) in south Iceland. The surficial expressions of Laki vent system are along 10 NE-trending en echelon fissures which stretch 27 km. The fissure were formed in successive eruptive episodes where each episode began with a 0.5-1 day-long subplinian phase followed by longer-lasting Hawaiian activity and lava effusion. In total Laki featured eight magmatic and two phreatomagmatic explosive phases over the time span of 5 months.

The Eldgja eruption took place, south of Laki, at the Katla volcanic system within the EVZ. The vent system is 75 km long and featured distinctive episodes of similar nature to those at Laki, producing 24 phreatomagmatic and 10 subplinian tephra fall units.

We have investigated the patterns of vesiculation in magmatic explosive phases of

both eruptions by studying the microtextures of the ejecta. The tephra samples from Laki are more diverse. Samples from the explosive phases at the beginning of each eruption episode exhibit the highest vesicularity (mean values of 83-86%) and few relatively dense clasts. Samples from weak late-stage explosive activity are markedly less vesicular (means 71-76%) and possess tails of relatively dense clasts ($\sim$40-50% vesicular). The Eldgja samples are more homogeneous, all are dominated by vesicular scoria with vesicularity means ranging from 61-71% but with time we see development of a distinctive tail of dense, partially outgassed clasts which range from 36-40% vesicular.

Preliminary interpretations of the density/vesicularity data suggest that high vesicularities correspond to high intensity (subplinian) phases while the samples with low vesicularity relate to following periods of weak eruption intensity where open system degassing played a more significant role during ascent.