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Katla volcano, Iceland: magma composition, dynamics and eruption frequency from the Holocene tephra layer record

B. A. Oladottir (1), O. Sigmarsson (1, 2), G. Larsen (2), T. Thordarson (3)

(1) Laboratoire Magmas et Volcans, Université Blaise Pascal-CNRS, Clemont-Ferrand, France, (2) Institute of Earth Sciences, University of Iceland, Reykjavík, Iceland, (3) University of Edinburgh, School of Geoscience, Edinburgh, UK

(b.oladottir@opgc.univ-bpclermont.fr)

The Katla volcano in Iceland is characterized by subglacial explosive eruptions of Fe-Ti basalt composition. It last erupted in 1918 and its historical activity has been thoroughly studied as well as the major element composition of the erupted products. The long term evolution of Katla's volcanic activity and magma production is less well known. A study of the tephra stratigraphy east of the volcano has been undertaken in a composite soil section with main focus on the prehistoric part. The section records ∼8400 years of explosive activity from Katla volcano and includes 208 tephra layers of which 126 samples were analysed for major-element composition. The age of individual Katla layers was calculated using soil accumulation rates (SAR) derived from soil thicknesses between 14C-dated marker tephra layers. Temporal variations in major-element compositions of the basaltic tephra divide the ∼8400 year record into eight intervals of 510-1750 year durations. The change in concentration of incompatible elements (i.e., K2O) in individual intervals is characterized as steady, irregular and steadily increasing. These variations in incompatible elements correlate with changes in other major-element concentrations and suggest that the magmatic evolution beneath Katla is primarily controlled by fractional crystallisation. In addition, binary mixing between basaltic component and a silici melt is inferred for several tephra layers. Small eruptions of silicic (SILK) tephra occur throughout the Holocene, but these events do not appear to exhibit strong influence on the magmatic evolution of the basalts. It is worth noting, however, that the peaks in the frequency of basaltic and

silicic eruptions are contemporaneous. The observed pattern of change in tephra composition within individual time intervals suggests different conditions in the plumbing system beneath Katla volcano. Two cycles are observed throughout the Holocene, each involving three stages of plumbing system evolution. A cycle begins with a simple plumbing system, as indicated by a steady state in major element compositions. This is followed by a sill and dyke system, a period that is characterized by irregular variations in major element composition with time, and eventually leads to the formation of a magma chamber, represented by a uniform increasing in incompatible elements. The eruption frequency within each cycle increases from the stage of a simple plumbing system to the sill and dyke complex stage and then drops again during magma chamber stage. In accordance with this model, the Katla volcano is at present in a stage of a simple plumbing system characterized by steady state magma composition and relatively low eruption frequency.