

Tephra reveals Holocene magmatic evolution and eruption frequency of the subglacial Katla volcano, south Iceland

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Recent unrest at the subglacial Katla volcano, Iceland, has spurred a new interest in its prior behaviour. Its historical activity has been thoroughly studied as well as the chemical composition of the erupted products, which are of homogeneous FeTi basalt composition. However, it is not certain that the last 1000 years are representative for the entire Holocene concerning both eruption frequency of Katla and its magma composition. Therefore we have undertaken a study of the prehistoric tephra stratigraphy in a composite soil section east of the volcano. The section records ~8400 years of explosive activity from Katla volcano in 175 tephra layers of which in total 112 samples were analysed for major-elements. An age was calculated for the Katla layers using soil accumulation rate (SAR) estimated from previously ¹⁴C-dated marker tephra layers. Given the assumption that wind directions were similar through the ~8400 years, the eruption frequency was twice as high as known for the last 1000 years or 4 eruptions per century. Temporal variations of major-element compositions of the basaltic tephra divide the ~8400 year record into eight intervals of 630-1750 year duration. These compositional variations are characterized by steady, irregular and increasing value of the incompatible element K₂O correlated with changes in other major-element concentrations. The magmatic evolution is mainly controlled by fractional crystallisation although binary mixing between a basaltic component and a silicic one occurs in few cases. Silicic (SILK) eruptions do not affect the magmatic evolution of the basalts but high basaltic eruption frequency seems to trigger the SILK eruptions. The compositional variability of the tephra suggests different behaviour of the plumbing system beneath Katla volcano. Two cycles are observed each one beginning with a simple plumbing system, displayed by a steady composition of the major elements, followed by a sill and dike system, which is characterized by irregular major element composition vs. time leading to the formation of a magma chamber, represented by a regularly increasing K₂O value. The eruption frequency of each period shows increasing value from a simple plumbing system to a sill and dike system, which drops again when a magma chamber has evolved. According to this model the Katla volcano is actually in a period of a simple plumbing system with a relatively low eruption frequency.