Reviewed research article

Grain characteristics of silicic Katla tephra layers indicate a fairly stable eruption environment between 2800 and 8100 years ago

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Abstract — *Grain size and shape analyses were performed on silicic to intermediate Katla tephra (SILK) formed 2800–8100 years ago to examine whether the grain characteristics had changed with time, and in such a case, could they reflect changes in the eruption environment and/or changes in chemical composition. No systematic changes with time were observed in the grain shape parameters (elongation, ruggedness and circularity), however, the second oldest tephra layer SILK-A11 does not have the typical elongated grain shape that characterizes the other SILK tephra layers. Chemical analyses indicate that the SILK layers can be divided into three subgroups but no correlation between chemical composition and the grain parameters is observed. Changes in grain size of the SILK tephra layers with time indicate an apparent increase in grain size occurring about 6000 years ago, where largest grains are of category -3 Φ compared to 0 Φ in the older layers, all sampled at similar distance from source. This change in grain size could result from variation in ice thickness in the Katla caldera, with finer grain size between 6000–8200 years ago being due to thicker ice cover and greater availability of meltwater for magma fragmentation. Conversely, the younger coarser grained SILK layers may have formed under a thinner ice cover. A shift of the eruption sites to an area with thinner ice is also a possibility. However, no radical changes in the eruption environment 2800–8100 years ago are demonstrated by variations in grain characteristics, a conclusion further supported by large jökulhlaups from Mýrdalsjökull ice cap during this period.*

INTRODUCTION

It has been postulated that ice caps and glaciers in Iceland receded dramatically or even disappeared during the Holocene climate optimum (e.g. Björnsson, 2008; Flowers *et al.*, 2008). Óladóttir *et al.* (2007) argued that the Mýrdalsjökull ice cap (Figure 1) has been present for at least 8400 years, based on sulphur content of basaltic Katla tephra that indicates arrested degassing of the erupting magma by quenching in meltwater. Dugmore (1989) dated the outermost moraines of Sólheimajökull outlet glacier to be over 3300 years old (3100 ^{14}C years BP), indicating a large ice cap at that time. According to model calculations presented by Björnsson (2008), the Mýrdalsjökull ice cap did not exist 4000 years ago, but Björnsson assumes that a caldera lake was present during the ice-free period. However, 11 volcanogenic jökulhlaups from the Mýrdalsjökull massif carrying volcanic ash and pumice westwards into Markarfljót are known throughout the 8400 year period (Larsen *et al.*, 2005; Gröndal *et al.*, 2005; Smith and Dugmore, 2006; Eggertsson, 2013). At least eight of the west-going jökulhlaups, dated between 7500 and 1200 years ago, emanated from the caldera via Entujökull, and the two largest ones, ∼4400 and ∼3500 years ago, had peak discharge of about 200,000 m^3 s^{-1} (Gröndal *et al.*, 2005). This high peak discharge is better explained by a sudden meltwater input than by rapid volume in-