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Basaltic Tephra Layers reveal the Eruption History of the Icelandic subglacial Volcanoes, Grimvötn, Bardarbunga and Kverkfjöll during the last 7000 Years

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

(1) Institute of Earth Sciences, Iceland, (2) Laboratoire Magmas et Volcans, CNRS - Université Blaise Pascal, France (bergrun@hi.is / Phone: +354 525 5863)

The Vatnajökull ice-cap covers Grimsvötn and Bardarbunga, both of which are amongst the most active Icelandic central volcanoes. The eruption history of these volcanoes during the last 1100 years is well established but the prehistoric eruption history is mostly unknown. A third central volcano covered by Vatnajökull, Kverkfjöll has not erupted during historical time and little is known about its past behaviour. The location of these subglacial volcanoes, above the presumed centre of the Iceland mantle plume, allows assessment of its activity as recorded by eruption frequency. The eruption frequency can be estimated using basaltic tephra layers preserved in soils around Vatnajökull.

Tephra has been collected from nine outcrops around the ice-cap. All outcrops can be correlated using previously mapped and dated regional marker tephra from volcanoes outside Vatnajökull. First results from three outcrops; north, west and south of the Vatnajökull ice cap, are presented here. Each of these outcrops contain from 71 to 169 tephra layers, covering 6000 to 10000 years. By assuming constant soil accumulation rate (SAR) between key tephra layers of known age it is possible to calculate an approximate age for each tephra layer. Most of the tephra layers in the outcrops were sampled and analysed for major elements by EMP, which allows identification of their origin. From each outcrop a tephra layer frequency (TLF) is calculated and by correlating outcrops all around the volcanic edifices the minimum eruption frequency of each volcano is obtained.

The preliminary results show that the overall TLF in outcrop north of Vatnajökull generates two distinctive activity peaks, aged 7-5 ka and 3-1 ka. The other two outcrops show only one specific peak, aged 2-1 ka, although some increase in activity is observed, from 7-6 and 4-3 ka in the western outcrop and from 4-3 ka in the southern. Looking at eruption frequency of each volcano rather than each location it is remarkable that all volcanoes have clear activity peaks from 2-1 ka. Moreover, Bardarbunga and Kverkfjöll also show simultaneous increase in activity at 7-5 ka. It is worth noting that Grimsvötn seems to be slowly increasing its activity through the last 7000 years, with a slight drop in eruption frequency between 3-2 ka, until a maximum is reached at 2-1 ka, possibly with over 100 eruptions in 1000 years. Kverkfjöll, however, have the lowest eruption frequency of the three volcanoes throughout the 7000 years. Several questions arise from these results. For example, is the activity peak in all volcanoes from 2-1 ka related to a pulse in the Iceland mantle plume? How direct is the link between melt production at depth and eruption frequency?