



The neighbours of the Eyjafjallajökull volcano: Katla, Grímsvötn and Bárðarbunga

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Although tephra from eruptions in Iceland has been transported to Europe on and off through the millennia, a long time has passed without an eruption affecting Europeans as much as the Eyjafjallajökull eruption in spring 2010, making Eyjafjallajökull one of Iceland's best-known volcanoes at present. However, since the Settlement of the Vikings, Eyjafjallajökull has only erupted four times which makes it a rather quiet volcano compared to its neighbours, Katla, Bárðarbunga and Grímsvötn volcanic systems. Katla, partly located below the Mýrdalsjökull ice-cap, lies on the non-rifting part of the Eastern Volcanic Zone (EVZ), as does Eyjafjallajökull, but Grímsvötn and Bárðarbunga are partly located under the Vatnajökull ice-cap, close to the assumed centre of the Iceland mantle plume. Unlike Eyjafjallajökull, which erupts silicic magma, Katla, Grímsvötn and Bárðarbunga characteristically erupt basaltic magma. Eruptions below the ice have produced widespread basaltic tephra layers, some of which have reached the mainland of Europe. Since 870 AD Katla has erupted at least 21 times (~2 eruptions/100 years), Bárðarbunga has erupted no less than 23 times (~2 eruptions/100 years) and 70 eruptions (~6 eruptions/100 years) are known from Grímsvötn, Iceland's most active volcanic system.

Tephra layers have been used to study prehistoric eruption history of the three volcanic systems. In the case of Katla, data goes back ~8400 years but for Grímsvötn and Bárðarbunga data covers the last ~7600 years.

East of Katla 208 tephra layers were found and using field criteria such as colour, grain size and clast morphology, 172 of those layers were assigned to Katla. In total 126 samples were analysed for major elements by electron microprobe confirming Katla origin for 88% of them. Only 50% of known historical tephra layers were found east of the volcano so assuming that tephra preservation was the same in historical and prehistoric time we can estimate the prehistoric eruption frequency of Katla to be as high as 4 eruptions/100 years and that Katla has erupted over 300 times during the last 8400 years. Katla shows a lull in activity from 7-4 ka ago.

Stratigraphic positions and geochemical compositions were used for fine scale correlation of basaltic tephra around Vatnajökull where 345 tephra layers were identified, of which 64% come from Grímsvötn and Bárðarbunga. The eruption frequency of each volcanic system was estimated using the preservation ratio of tephra layers from known eruptions in the last 800 years. Grímsvötn has an average of ~7 eruptions/100 years (range 4-14) during prehistoric time (before ~870 AD) and Bárðarbunga shows ~5 eruptions/100 years (range 1-8). Both volcanic systems showed lulls in activity between 5-2 ka.

In prehistoric time a lag of 1000-3000 years was observed between a peak of activity at the volcanoes directly above the mantle plume and at volcanoes located on the southern, non-rifting part of the EVZ. This time-space relationship suggests a significant increase may be expected in volcanism on the southern part of the EVZ in the future.