The volatile degassing of subglacial volcanoes is a useful indicator of palaeo-ice thicknesses. This is because the solubility of water is pressure dependent, therefore (1) the amount of water which can be retained within the magma can be used to estimate the pressure at which it quenched (Fig. 1). If one assumes that this pressure is caused by overlying ice of a uniform density, then one can estimate the thickness of ice that was covering the volcano at the time of the eruption.

The degassing technique has been applied to three subglacial rhyolitic volcanoes within the Torfajökull complex in southern Iceland (Fig. 2). The results show that the methods also produces useful insights into the eruptive mechanisms of these volcanoes.

Data from top ridge, the feeder dyke, the northern slope and Graenagil suggest that the surface was at 1000 m a.s.l. when Bláhnúkur erupted (Fig. 4) i.e. the ice was 400 m thick. However, samples from the lobe slope and Brændagil under-ripened that this was not the case. This suggests that these locations formed intrinsically where they experienced loading from both volcanic material and ice and hence formed under higher pressure. In contrast, the samples from A rich are water-poor. This data suggests either low pressure conditions (e.g. if there was a hydrological connection to the glacier moulin) or a low initial water content.

Case Study 2: Dalakvísl

The eruption of Dalakvísl, like Bláhnúkur, was also entirely under ice, meaning that field observations provide just a minimum estimate of ice thickness (Fig. 5). However, the eruption was slightly more explosive than Bláhnúkur.

Water contents from Dalakvísl are on average marginally higher than Bláhnúkur and suggest a slightly greater ice thickness. However, the agreement of the curves is too great to provide a good fit to the data, unless hyaloclastite is also considered (compare solubility pressure curves A & B in Fig. 6). This suggests that there has been considerable erosion from all over Dalakvísl to expose samples that originally formed under volcanic material.

Case Study 3: SE Rauðfossafjöll

The eruption of SE Rauðfossafjöll was even more explosive, allowing the volcano to erupt through the ice sheet and produce a tuya. The change observed in the field, from subglacially formed to subaerially formed rocks, allows one to constrain the ice surface to ≈1150 m, but will the degassing method agree?...

Conclusions

- It is important to collect a large data set as the story seems seldom simple.
- Only eruptions that were entirely subglacial, can be used with the degassing technique.
- Uncertainties in some parameter conditions e.g. eruptive temperature, CO2 content or overriding medium (just ice or volcanic debris too), can make a quantitative estimation difficult.
- Relative pressure conditions offer a useful insight into eruptive mechanisms e.g. the occurrence of a jökulhuaf mid-eruption.

References

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