

## **Properties of Subglacial Heat Sources estimated by Numerical Studies of Ice Flow**

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Subglacial geothermal areas of various magnitudes occur in glaciated volcanic regions. Such spots of elevated heat flow are common in Iceland, especially under Vatnajökull and Mýrdalsjökull but they are also found elsewhere, including the West Antarctic Ice Sheet and several ice-filled calderas around the world. A heat source at the base of an ice stream may influence the basal sliding properties by providing water to lubricate the basal layer and in that way enhance ice flow. The heat sources underneath the Icelandic glaciers produce meltwater at the base, which drains along the bedrock towards the glacier margin. When the meltwater accumulates near the thermally active site, the collected meltwater will drain in a jökulhlaup after overcoming the hydrostatic boundary (ice dam). Such jökulhlaups can pose a threat to man made infrastructure. Since subglacial geothermal areas cannot be observed directly, their properties have to be inferred from the effect that they have on the overlying glacier. Properties such as heat output and areal extent of the geothermal area can be inferred by studying the depressions formed at the ice surface. A simple calorimetric estimate of heat output can be carried out from ice volume changes but ice flow is then ignored. This, however, is unsatisfactory in areas where significant ice flow occurs. We have addressed this by applying Full-Stokes flow models that allow the simulation of ice flow above basal heat sources in such detail that differences between the modeled and the measured surface evolution can be used to infer the heat source properties. Through forward modeling it is possible to estimate the strength of the heat source and identify lateral variations in the heat flux. This method of estimating basal heat source properties underneath glaciers is evaluated through synthetic models. The heat fluxes used in the forward models are of order  $10^2 \text{ W m}^{-2}$ , a magnitude considered applicable to hydrothermal activity. It is found that for this magnitude of heat sources, ice flow becomes increasingly important in compensating for the basal melting as the heat flux increases. The method is applied to an elongated subglacial geothermal area in the eastern part of Grimsvötn in Vatnajökull. It is found that the model can reproduce the characteristics and magnitude of the observed depression.