

Chemical Monitoring of Jökulhlaup Water in Skeiðará and the geothermal system in Grímsvötn, Iceland.

SIGURÐUR STEINÞÓRSSON

Science Institute, University of Iceland, Dunhaga 3, 107 Reykjavík.

NÍELS ÓSKARSSON

Nordic Volcanological Institute, University of Iceland, 101 Reykjavík

ABSTRACT

The glacial river Skeiðará was continuously monitored for solute chemistry during the years 1971 and 1972 in which period a jökulhlaup of 3.2 km³ volume took place in the river. In addition, other glacial rivers in Iceland issuing from subglacial volcanic or hydrothermal areas have been monitored from time to time. The article describes the solute chemistry of the rivers Skeiðará and Skaftá, offering an interpretation of the hydrothermal systems beneath Vatnajökull responsible for the jökulhlaups. In conclusion some points are made regarding the prediction of jökulhlaups by the chemical monitoring of glacial rivers.

The dissolved load of the rivers Skeiðará and Skaftá can be traced to three sources, i.e. solutes contained in the precipitation, those derived from the dissolution of the suspended load, and those having a hydrothermal origin. The analyses of the burst water can be corrected for the non-hydrothermal components permitting evaluation of the composition of hydrothermal fluids.

The analyses allow an estimation of (1) the temperature of the Grímsvötn geothermal system in the years prior to the jökulhlaups 1972 and 1982, (2) the dilution of the hydrothermal fluid by melt water and (3) water seeping into the system from other sources, and (4) the power of the system.

The calculated temperature of the geothermal component of the 1972 hlaup was 10°C, that of the 1982 hlaup 19°C. The thermal energy in Grímsvötn was 4160 MW prior to 1972 and 5590 MW prior to 1982; this change could be the result of a minor eruption in Grímsvötn in 1972.

It is shown that the Grímsvötn system is dominated by hydrothermal water whereas that of the Skaftá source is dominated by steam.

INTRODUCTION

Jökulhlaups, or catastrophic bursts of glacial rivers, are fairly common phenomena in Iceland. The mechanism for triggering the hlaups may entail either a purely hydrostatic floating of the ice barrier

of an ice-dammed lake, or a volcanic eruption may be involved. Likewise, the flood water itself may be derived from three sources: precipitation of surface water percolating through the glacier ice, melted ice, and geothermal water from subglacial thermal areas. Instances of all these possibilities are well known in Iceland and have been described by various authors. In particular, Thorarinsson (1974, 1975) has made a comprehensive compilation of the jökulhlaups from Grímsvötn in Vatnajökull and from Katla in Mýrdalsjökull, and Björnsson (1974, 1976, 1977) has elucidated the mechanism of accumulation and flooding.

Three subglacial volcanoes have been active in Iceland in this century: Thórdarhyrna in the SW slope of Vatnajökull erupted in 1903; Katla, beneath Mýrdalsjökull, erupted in 1918 and possibly gave a minor eruption in 1955 (Thorarinsson 1975), and Grímsvötn beneath Vatnajökull erupted in 1922 and 1934 (Thorarinsson 1974). Furthermore, Tómasson et al. (1974) have suggested that the Jökulhlaup in Skeiðará in 1972 may have been associated with a minor eruption in Grímsvötn. Skeiðará, the main river draining Grímsvötn, has flooded on average every 6 1/2 years since 1934 without there being visible evidence of volcanic activity. In the Skeiðará floods water of all three types enumerated above is present: there is a sizeable meteoric component in the flood water, there is almost always a flood associated with an eruption, but the majority of the floods occur without an eruption (e.g. Thorarinsson 1974).

Particularly, the Katla-floods in South Iceland are extremely catastrophic, bursting on suddenly with full force with a minimum of pre-warning. In previous centuries Katla has erupted fairly regularly, twice every century (Thorarinsson 1975). The prediction of an eruption and the associated jökulhlaup is of considerable security moment because of