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Progressive cooling of the subglacial Gjalp hyaloclastite ridge: 1996 - 2005

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The Gjalp eruption in 1996 formed a 6 km long and 500 m high subglacial hyaloclastite ridge. During the eruption a large depression was formed in the surface of the Vatnajökull ice cap as ice was melted and the meltwater drained away from the eruption site.Ice flow measurements and surface depression mapping have been done annually since the eruption, allowing inflow of ice and volume changes of the depression to be monitored. Taking into account the surface mass balance, these data can be used to estimate heat output from the subglacial ridge. In the first year after the eruption a heat flux of several thousand megawatts was estimated. The heat output decreased to 900$\pm$200 MW in 1998 and this value persisted until 2002. However after 2002 the mountain cooled down and from 2002 to 2005 heat output of only a few tens of MW was obtained. These results indicate a 5 - 6 years period with major geothermal activity in the ridge, while in the last 4 years the ridge appears to be much colder. Since the ridge is fully covered by ice, no direct measurements of observations are available to explain this thermal record. Ridges of similar size and shape to that of Gjalp are a prominent feature of the volcanic zones in Iceland. A prominent part of these ridges are consolidated hyaloclastite, formed by alteration of the volcanic glass into palagonite. The rate at which this alteration takes place for ridges formed in short-lived subglacial eruptions is unknown. However, in most cases they have acquired considerable consolidation before glacial erosion could remove the initially unconsolidated hyaloclastite pile. In the oceanic island of Surtsey formed in 1963-1967, the rate of alteration was temperature dependent and took a few years. It is possible that the 5-6 years of geothermal activity at Gjalp was sufficiently long for consolidation but this remains speculative until examined by drilling.