Geophysical Research Abstracts
Vol. 18, EGU2016-16383-1, 2016
EGU General Assembly 2016

Seismic tremor signals from Bárðarbunga, Grímsvötn and other glacier covered volcanoes in Iceland's Vatnajökull ice cap

Kristin S. Vogfjörd (1), Eva Eibl (2,3), Chris Bean (2), Matthew Roberts (1), Benedikt Ófeigsson (1), and Tómas Jóhannesson (1)

(1) Icelandic Meteorological Office, Reykjavik, Iceland (vogfjord@vedur.is), (2) Dublin Institute of Advanced Studies, Dublin, Ireland, (3) University College Dublin, Dublin Ireland

Many of Iceland's most active volcanoes, like Grímsvötn and Bárðarbunga are located under glaciers giving rise to a range of volcanic hazards having both local and cross-border effects on humans, infrastructures and aviation. Volcanic eruptions under ice can lead to explosive hydromagmatic volcanism and generate small to catastrophic subglacial floods that may take hours to days to emerge from the glacier edge. Unrest in subglacial hydrothermal systems and the draining of subglacial meltwater can also lead to flood hazards. These processes and magma-ice interactions in general, generate seismic tremor signals that are commonly observed on seismic systems during volcanic unrest and/or eruptions. The tremor signals exhibit certain characteristics in frequency content, amplitude and behavior with time, but their characteristics overlap. Ability to discriminate between the different processes in real-time or near-real time can support early eruption and flood warnings and help mitigate their detrimental effects.

One of the goals set forth in the FUTUREVOLC volcano supersite project was in fact to understand and discriminate between the different types of seismic tremor recorded at subglacial volcanoes. In that pursuit, the seismic network was expanded into the Vatnajökull glacier with four permanent stations on rock and in the ice, in addition to three seismic arrays installed at the ice margin, to enable location and possible tracking of the tremor sources. To track subglacial floods with better resolution three GPS receivers were also installed on the ice, one in an ice cauldron above the Skaftárkatlar geothermal melting area and two down glacier, above the track of the expected subglacial flood. During FUTUREVOLC this infrastructure has recorded all the types of process expected: Magmatic dyke intrusion and propagation from Bárðarbunga, subaerial fissure eruption of that magma at Holuhraun, two subglacial floods, one small and one large, draining from the Skaftárkatlar area, a small flood from Grímsvötn and a small hydrothermal explosion at Kverkfjöll volcano.

During the Bárðarbunga dyke propagation under the ice several sequences of tremor were observed, some particularly energetic. Examination of these signals in relation to the advancing dyke intrusion shows that they occurred when the migrating seismicity moved through the areas that later developed cauldrons on the ice surface, indicating increased melting at the bedrock-ice interface and possible magma-ice interaction. The subglacial flood from the Eastern Skaftár cauldron geothermal area, generated a strong tremor signal as well as small ice quakes recorded on near-by stations. Continuous real-time transmission of the GPS signal from inside the cauldron enabled near-real time processing and webcasting of the subsiding cauldron and thus early warning of the oncoming flood and its expected size. The signals recorded above the subglacial track also showed the glacier uplifting and advancing as the flood peak passed underneath. These observations allowed joint interpretation of the seismic single stations and array signals with the GPS signals. Results from the different processes will be presented and explained.