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Monitoring Hekla Volcano with Shallow Background Microseismicity, Iceland

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Hekla is one of Iceland's most active volcanoes located at the connection between the South Iceland Seismic Zone striking east-west and the Eastern Volcanic Zone striking north-south. It erupted four times in the past 45 years with a repose time of about ten years and a period of quiescence of 14 years since the last eruption. The permanent monitoring network includes satellites, seismometers and strainmeters most of which are in at least 15 km distance of the volcano. Eruptions in 1970, 1980/81, 1991 and 2000 were detected by the network 25, 23, 28 and 80 minutes, respectively, before the visual onset.

Based on measurements from this network, Hekla is thought to be in an inflated but seismically inactive state at the moment. We installed five seismometers temporarily within 4 km of the summit and detected high levels of background microseismicity in autumn 2012.

Amplitude and travel-time based location methods were applied and located two populations of events at shallow depths on the northern flank, close to the summit. The recorded events were either short, high-frequency events with distinct arrivals located beneath the summit on the northern flank of Hekla or longer, emergent, low-frequency events about 4 km northeast of the summit in 200 - 400 m depth below the surface. Estimated moment magnitudes were MW=-1.1 to -0.1 and MW=-0.9 to -0.0 and local magnitudes ML=-0.5 to +0.3 and ML=-0.3 to+0.3, respectively.

This seismicity does not show any correlation with gas output or deformation measurements but is located at the steepest slopes of the edifice. Hence we suggest that current shallow microseismicity at Hekla is structurally controlled. This offers a possible opportunity of using near summit microseismicity monitoring as a tool for monitoring emerging unrest at Hekla. The current detection threshold only allowed increased seismicity to be detected 23 to 80 minutes prior to full scale eruptions. Microseismicity monitoring can increase this time span as observed earthquakes are smaller.