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Seismic Activity and Magma Movements at Icelandic Volcanoes

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Apart from the quiet nature of Hekla volcano in Iceland, the most commonly observed signs of unrest in Icelandic volcanoes are increased seismicity. This is particularly the case for the Eyjafjallajökull volcano where a dense seismic network coverage enabled high-precision mapping of repeated deep-seated seismic swarms over a period of 18 years, from 1992 until the volcano‘s eruption in 2010. Propagation of the seismicity from the base of the crust into the upper crust enabled tracking repeated magmatic intrusions over time up to the surface. First to an effusive flank eruption, followed 3 weeks later by an explosive summit crater eruption.

To strive for the same resolution of deep seismicity under the caldera of the adjacent Katla volcano, three additional stations were installed in late 2010. The increased sensitivity results in more event detections, but relative earthquake locations show that predominantly the seismicity in the Katla caldera is very shallow and correlates with the locations of geothermal activity. Still a few events have been detected in recent years near the base of the crust under the eastern caldera rim and east of the caldera.

A most profound increase in seismic activity has been occurring at volcanoes in the region underlying the western half of the Vatnajökull Ice cap. The latest eruptions there, were at Gjálp in 1996 and at Grímsvötn in 1998 and 2004. Increased seismic activity preceded these eruptions, but since 2006 the annual activity at Grímsvötn has quadrupled and at Hamarinn, the yearly number of events has increased six fold. The most dramatic increase though is observed at Bárdarbunga where the yearly activity in 2010 rose to about 15 times greater than the average during the preceding decade. High precision locations of earthquakes in these volcanoes show that source depths under the Grímsvötn caldera and under the Skaftárkatlar ice-cauldrons are in general very shallow indicating association with geothermal activity. Seismicity west of the ice-cauldrons however extends down into the middle of the crust and may indicate magma movements. At Bárdarbunga volcano, the seismicity is mainly in the upper 8 km of the crust and strictly confined northeast of the caldera rim, extending NE from the epicentral location of the M5.7 CLVD earthquake at Bárdarbunga in September 1996. This event initiated the sequence leading to the Gjálp eruption a few days later. Relative earthquake locations from the most active volcanoes will be presented and results from seismic recordings at Hekla volcano during 2010.