**Atlantic Conference on Eyjafjallajökull and Aviation**

**September 15-16, Keflavik Airport, Iceland**

# What happened in Eyjafjallajökull 2010: Role of crustal deformation studies to infer magma movements

Freysteinn Sigmundsson[1], Sigrún Hreinsdóttir[1], Andy Hooper[2], Thóra Árnadóttir[1], Rikke Pedersen[1], Matthew J. Roberts[3], Níels Óskarsson[1], Amandine Auriac[1], Judicael Decriem[1], Páll Einarsson[1], Halldór Geirsson[3], Martin Hensch[1], Benedikt G. Ófeigsson[1], Erik Sturkell[4], Hjörleifur Sveinbjörnsson[3], Kurt L. Feigl[5].

(1) Nordic Volcanological Center, Institute of Earth Sciences, University of Iceland.
(2) Delft University of Technology, The Netherlands.
(3) Icelandic Meteorological Office, Reykjavik, Iceland.
(4) University of Gothenburg, Sweden.
(5) University of Wisconsin-Madison, USA.

Monitoring of eruption precursors, such as increased seismic activity, enhanced rates of crustal deformation and emission of heat and gas, is important for understanding volcanoes and for improved air safety. Seismic observations provide primary information, but observations of how volcanoes deform can provide invaluable additional information. When magma intrudes volcano roots it induces displacements at the surface of the Earth, typically on the scale of centimetres. Such movements can be precisely measured by two complementary space geodetic techniques: Global Position System (GPS) geodesy, and satellite radar interferometry (InSAR) by combining synthetic aperture radar images acquired by satellites. With these techniques we have mapped deformation at Eyjafjallajökull in details during 18 years of intermittent unrest prior to the 2010 eruptions. From these observations the shape and volume of extensive repeated magmatic intrusions occurring in 1994, 1999 and 2010 can be inferred. More than two months prior the 2010 eruptions of Eyjafjallajökull seismicity and deformation began at enhanced rates. Continuous GPS measurements reveal how daily rate of deformation exceeded 5 mm/day. The spatial extent of deformation was well mapped by images from the TerraSAR-X satellite of the German Space Agency. These measurements allow mapping of the intrusion that grew in the roots of the volcano prior to the flank eruption of basalt March 20 – April 12. The subsequent explosive eruption of trachyandesite beginning on April 14 was then associated with pressure decrease in another source under the summit of the volcano. Our observations provide a good case for improving monitoring of volcano deformation worldwide, as a wealth of information was provided by these observations on subsurface activity taking place at Eyjafjallajökull.

The present techniques for automated geophysical monitoring of subsurface magmatic activity may provide insights for improvements in eruptive monitoring. Geophysical sensors such as seismometers and GPS-receivers are used to continuously map the consequences of earthquakes and intrusions. These data can be modelled in near real time to provide information on origin of recorded signals. In an analogues manner, development of automated instruments to map fallout from eruption plumes and its characteristics could, together with near-real time advanced modelling, help provide timely information on mass of tephra/ash ejected into eruption plumes.