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Magma flow, eruption column and magma pressure change during 2010 Eyjafjallajökull and 2011 Grímsvötn eruptions, Iceland: Constraints from volcano geodesy on physical models of eruptive processes

Freysteinn Sigmundsson[1], Sigrun Hreinsdottir[2], Andrew J Hooper[3], Ronni Grapenthin[4], Elias Rafn Heimisson[5], Benedikt Ofeigsson[6], Erik C Sturkell[7], Matthew J. Roberts[6], Magnus Tumi Gudmundsson[8], Armann Hoskuldsson[5], Halldor Bjornsson[6], Þordur Arason[6], Michelle Parks[1], Stephanie Dumont[1] and Vincent Drouin[1]

(1) University of Iceland, Nordic Volcanological Center, Institute of Earth Sciences, Reykjavik, Iceland,
(2) GNS Science-Institute of Geological and Nuclear Sciences Ltd, Lower Hutt, New Zealand,
(3) University of Leeds, Leeds, United Kingdom,
(4) University of California Berkeley, Berkeley, CA, United States,
(5) University of Iceland, Reykjavik, Iceland,
(6) Icelandic Met Office, Reykjavik, Iceland,
(7) University of Gothenburg, Gothenburg, Sweden,
(8) Univ Iceland, Reykjavik, Iceland

Ground deformation in relation to 2010 Eyjafjallajökull and 1998, 2004 and 2011 Grímsvötn eruptions in Iceland provide constraints on subsurface magma flow and pressure change. When compared with eruptive activity, eruption column and estimates of mass flow rate they can be used to constrain physical models of eruptive processes. The 1998 and 2004 Grímsvötn eruptions were captured by intermittent GPS observations but in 2011 the detailed temporal evolution of co-eruptive deformation was revealed by a kinematic 1 Hz solutions for the position of a single continuous GPS site on the volcano, supplemented with ground tilt observations. The observations can be explained by inflow of magma and pressure buildup between eruptions in a shallow chamber at about 1.7 km depth beneath the center of the Grímsvötn caldera complex, and pressure drop and magma outflow during eruptions. The rate of pressure change in the magma chamber correlates with the height of the volcanic plume over the course of the 2011 eruption. Peaks in activity relate to periods of rapid pressure drop in the chamber. GPS observations and interferometric analysis of satellite radar images from

the TerraSAR-X satellite show that the explosive 2010 eruption at Eyjafjallajökull was on the other hand associated with gradual contraction of a source, distinct from pre-eruptive inflation sources at the volcano. For the initial 10-days of the summit eruption, a deflating sill source under the summit at about 5 km depth can explain the observed deformation, but then the source geometry appears to evolve. The rate of deflation was interrupted by inflow of new magma into the deflating source during the eruption in relation to peaks in explosive activity. The contrasting behavior of the two volcanoes is interpreted in terms of different magma plumbing systems of the volcanoes. In both cases, the erupted volume of magma is much larger than the inferred co-eruptive volume change, attributed to compressibility of magma residing in the sources where the eruptions originated from.