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Deformation monitoring of the 2014 dyke intrusion and eruption within the Bárðarbunga volcanic system, and associated stress triggering at neighbouring volcanoes

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The recent unrest and activity within the Bárðarbunga volcanic system, Iceland was initially identified by the onset of an intense earthquake swarm on the 16th August 2014 and concurrent movement registered at several nearby continuous GPS (cGPS) sites. Over the following weeks additional cGPS stations were installed, campaign sites were reoccupied and interferograms formed using X-band satellite images. Data were analysed in near real-time and used to map ground displacements associated with the initial dyke emplacement and propagation (NE of Bárðarbunga), responsible for the sudden unrest. On the 29th August 2014, a small fissure opened up just a few kilometers to the north of the Vatnajökull ice cap, at Holuhraun. The eruption lasted only a few hours, but was followed on 31st August by the onset of a fissure eruption, characterised by lava fountaining and the extrusion of extensive lava flows. The eruption continues at the time of writing (January 2015).

We demonstrate how Interferometric Synthetic Aperture Radar (InSAR) analysis, in conjunction with GPS measurements and earthquake seismicity, has been instrumental in the continued monitoring of Bárðarbunga volcanic system since the onset of unrest. We also investigate how changes in the local stress field induced by the dyke intrusion and concurrent magma withdrawal may trigger seismicity and potentially renewed activity at neighbouring volcanoes.

InSAR analysis has systematically been used throughout the eruption to monitor co-eruptive displacement in the vicinity of both the dyke and the eruption site, along with major co-eruptive subsidence occurring beneath the Bárðarbunga caldera – the latter is believed to have commenced shortly after the onset of the unrest and is associated with magma withdrawal beneath the central volcano, feeding the dyke and the ongoing eruption. We use Persistent Scatterer Interferometric Synthetic Aperture Radar (PS-InSAR) techniques to generate a time series of deformation measurements, in the vicinity of both the Bárðarbunga central volcano and the Holuhraun eruption site. These measurements are used in conjunction with GPS observations to estimate the best-fit source geometries responsible for both the inflation of the dyke and simultaneous deflation of the Bárðarbunga central volcano. We calculate the Coulomb stress changes associated with the deformation episode and compare our results to the location of earthquakes in the vicinity of Askja and Tungnafellsjökull.

The vast amount of new SAR data (provided through the Icelandic SUPERSITE) combined with a dense network of GPS observations, has enabled an improved understanding of the sub-surface plumbing in the vicinity of Bárðarbunga volcano and added insight into how the 2014-2015 unrest and eruption has affected neighbouring volcanic systems.