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The feeder system for the 2014 fissure eruption at Holuhraun, Bárðarbunga volcanic system, Iceland: Geodetic and seismic constraints on subsurface activity in the area north of the Vatnajökull ice cap

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An intense earthquake swarm began on 16 August 2014 at Bárðarbunga volcano under the Vatnajökull ice cap in Central Iceland. It marked the beginning of an intrusive activity, with a dyke propagating over 45 km northward. Such major magmatic activity has not been observed for the last three decades in Iceland, since the Krafla rifting episode 1975-1984. The dyke propagation stopped 15 days after the onset of the seismic activity, with the dyke distal end in the Holuhraun plain north of the Vatnajökull ice cap. A small 4 hour eruption marked the beginning of extrusive activity. A new fissure eruption opened up on 31 August at the northern dyke tip, with lava fountaining and feeding extensive lava flows. In January 2014 the surface covered by the lava had exceeded 80 km2, and the eruption activity does not show significant decline.

We have carried out interferometric analysis of SAR data (InSAR) since the onset of the unrest. X-band satellite images from COSMO-SkyMed and TerraSAR-X satellites were acquired and analyzed to map ground surface deformation associated with the dyke emplacement. Despite most of the dyke propagation occurring under several hundreds meters of ice, the last 10 km were outside the ice cap, allowing better characterisation of the dyke-induced deformation. Here we focus on the deformation in the Holuhraun plain, in order to better understand the link between the surface deformation detected in the vicinity of the dyke by InSAR as well as GPS measurements, and the eruptive activity.

The regular SAR acquisitions made over the Holuhraun area since the beginning of the unrest offer a unique opportunity to better understand the evolution of the intrusion feeding the fissure eruption. For that purpose, we focus on the faults and fissures forming the graben borders on the glacier as well as in the Holuhraun plain, initially mapped using high-resolution radar images, acquired by airborne radar. We extract movement along and perpendicular to these structures from the interferograms. During the first weeks of the volcanic unrest, the surface deformation near the top of the dyke exceeded one meter in the line of sight, resulting in a systematic decorrelation in the phase signal observed above the dyke. However the amount of subsidence may be evaluated using the estimate of offsets in range and azimuth.

We compare the distribution of slip along these fissures/faults and its space-time evolution to the amount of dyke opening at depth obtained from modeling of geodetic data for different time spans defined by the interferograms. By comparing geodetic and seismic data, we investigate the development of the dyke and its influence on the surface deformation. This allows us to analyse the plumbing system feeding the eruptive fissure as a clue to better understand the ongoing volcanic eruption.

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