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Post-eruptive Deformation after the 2014-2015 Bárðarbunga Dike Instrusion and Rifting Event, Iceland

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On August 16, 2014 an intense seismic swarm started below the eastern part of Bárðarbunga caldera at the NW edge of the Vatnajökull ice cap in Iceland. The seismicity migrated in 3 major segments changing direction at least twice until the advance stopped around 10 km south of Askja Volcano, more than 45 km from Bárðarbunga. The dike opening was accompanied by a 65 m collapse of the Bárðarbunga caldera floor and broad deflation due to 2 km^3 magma removal from a 12 km deep reservoir (Gudmundsson et al., 2016). The area of the erupted lava flow is 84 km^2 with a volume of about 1.4 km^3, which makes it the second largest eruption in Iceland since the Laki Fires in 1783 that produced an order of magnitude more lava. The caldera collapse was accompanied by over 40 M5 earthquakes; an immense seismic energy release for a volcano. The majority of seismicity in the dike clustered between 6-8 km depth. Sigmundsson et al. (2015) derive a maximum opening of 5 m shallower than 6 km from GPS and InSAR data.

The co-eruptive deformation is followed by a complex juxtaposition of predominantly viscoelastic post-eruptive processes that include post-rifting relaxation and isostatic adjustment to the new lava flow, which modulate the long-term processes of plate spreading, subsidence at Askja Volcano, reinflation at Bárðarbunga, and glacial isostatic adjustment (GIA) due to the melting of the nearby ice caps. Here, we present results deciphering the deformation field in consistent Earth models using data from the continuous GPS network and InSAR analysis of Sentinel-1 data.

We remove long-term contributions from GIA and plate spreading, as well as seasonal deformation from the data. We furthermore correct for time dependent contributions to the displacement field from the lava flow. Using the software RELAX, we embed a model of the dike that propagated away from Bárðarbunga into a two-layer Earth model composed of an elastic plate over an visco-elastic half space to model the post-eruptive, visco-elastic relaxation. Preliminary models using a viscosity of $4x10^{18}$ Pa s suggest that GIA dominates the vertical deformation field through uplift around Vatnajokull, but post-rifting relaxation induces subsidence that almost eliminates the GIA signal above and near the dike. In the horizontal component, post-rifting relaxation dominates the deformation field with maximum velocities in the GPS data of 1-2 cm/yr after removal of secular processes.