EGU2020-18744
https://doi.org/10.5194/egusphere-egu2020-18744
EGU General Assembly 2020

Rapid resurgence of the subglacial Bárdarbunga caldera following collapse in 2014-2015, quantified with repeated Bouguer gravity surveys

Magnús Tumi Gudmundsson, Thórdís Högnadóttir, Freysteinn Sigmundsson, Halldór Geirsson, Siqi Li, Hannah I. Reynolds, Eyjólfur Magnússon, and Finnur Pálsson
University of Iceland, Institute of Earth Sciences, Nordic Volcanological Center, Reykjavik, Iceland (mtg@hi.is)

The 65 km^2 Bárdarbunga caldera is located in the NW part of the Vatnajökull glacier in central Iceland. The caldera floor lies under 500-800 m thick ice and the rims are fully subglacial as well. The caldera subsided by 65 m during the Bárdarbunga-Holuhraun eruption in 2014-2015, when about 2 km^3 of magma drained out from a magma reservoir at ~10 km depth leading to the largest eruption in Iceland since Laki in 1783. Deformation surveys outside the caldera have indicated inflation since soon after the end of the eruption in February 2015 and seismicity has been elevated. The extensive ice cover precludes conventional microgravity surveys or detailed surveys of caldera floor elevation. However, we have studied gravity changes by comparing results of repeated Bouguer anomaly surveys. We perform a full Bouguer correction using detailed DEMs of both the ice surface and the ice-radar-derived bedrock. Ice surface changes are also mapped, allowing the removal of effects on gravity by ice mass changes. Possible sources of significant anomalies are either changes in bedrock elevation between surveys, other more deep-seated mass changes beneath the volcano, or changes in the water table and pore pressure. Surveys were carried out using a Scintrex CG-5 in 2015, 2016, 2018 and 2019, with measurements done at 25-50 locations each time. As no benchmarks exist on the ice the spatial difference in station location of 10-20 m exists between survey years. However, post-processing provides kinematic GPS position and elevation accuracy better than 0.1 m. Analysis of the data and error sources indicate an accuracy in estimates of changes of 50-100 μGal. The results obtained indicate change with an amplitude of a few hundred μGals; over the four years between 2015-2019 a clear Bouguer anomaly increase is recorded over the caldera relative to the surrounding area. Sharp gradients in the gravity difference near the caldera boundary point to a shallow source, consistent with the gravity signal arising from or near the ice-bedrock boundary. This indicates fast resurgence at Bárdarbunga since 2015. The elevation of bed reflections delineated from radio echo sounding profiles (~2 MHz), measured within the caldera in June 2015 and accurately repeated in June 2019, further supports this. The suggested deformation mechanisms can be compared to geodetic observations outside the caldera for further evaluation. If all the signal is interpreted in terms of magma movements, a rise of the caldera floor by several meters and the inflow of 0.2-0.3 km^3 of new magma is inferred.