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

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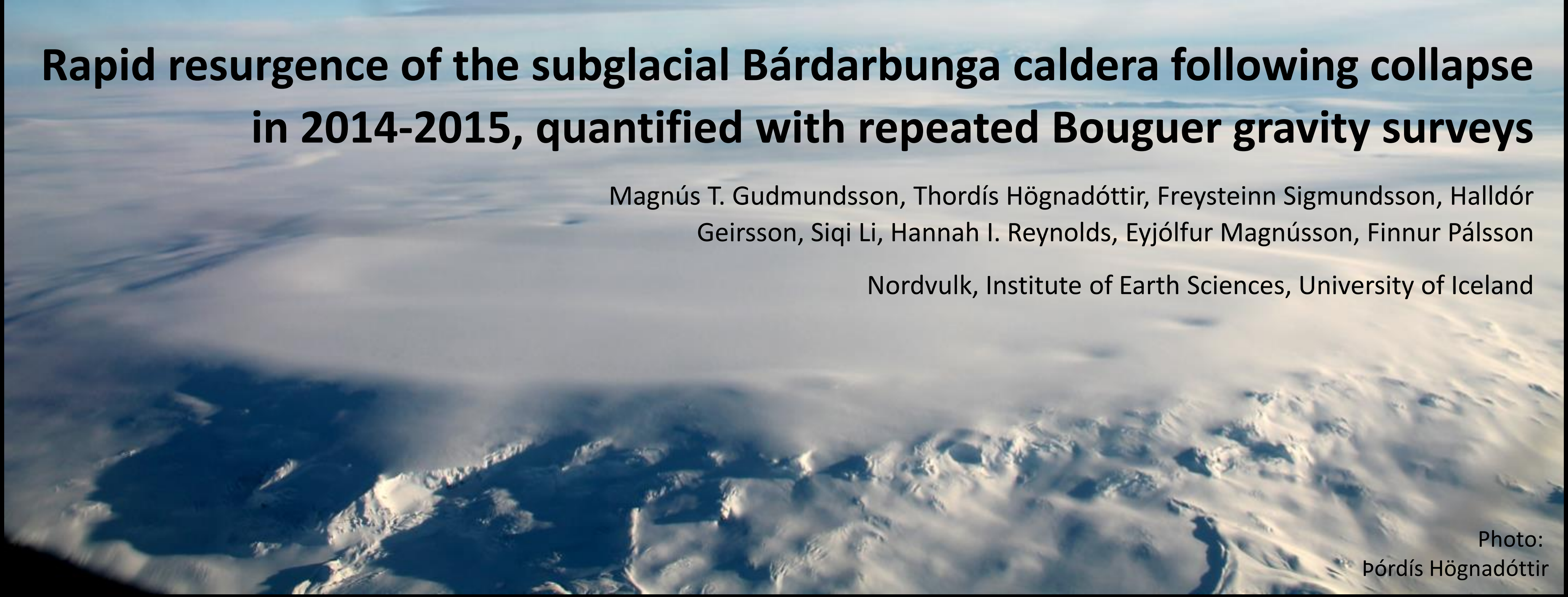

October 2014
Bárðarbunga subsiding

Photo:
Þordís Högnadóttir

January 2015
collapse visible in
eastern part of caldera

D1594 - EGU2020-18744 – Tuesday 5 May 2020
GMPV9.7: Multi-disciplinary volcano monitoring and imaging

Photo: MTG

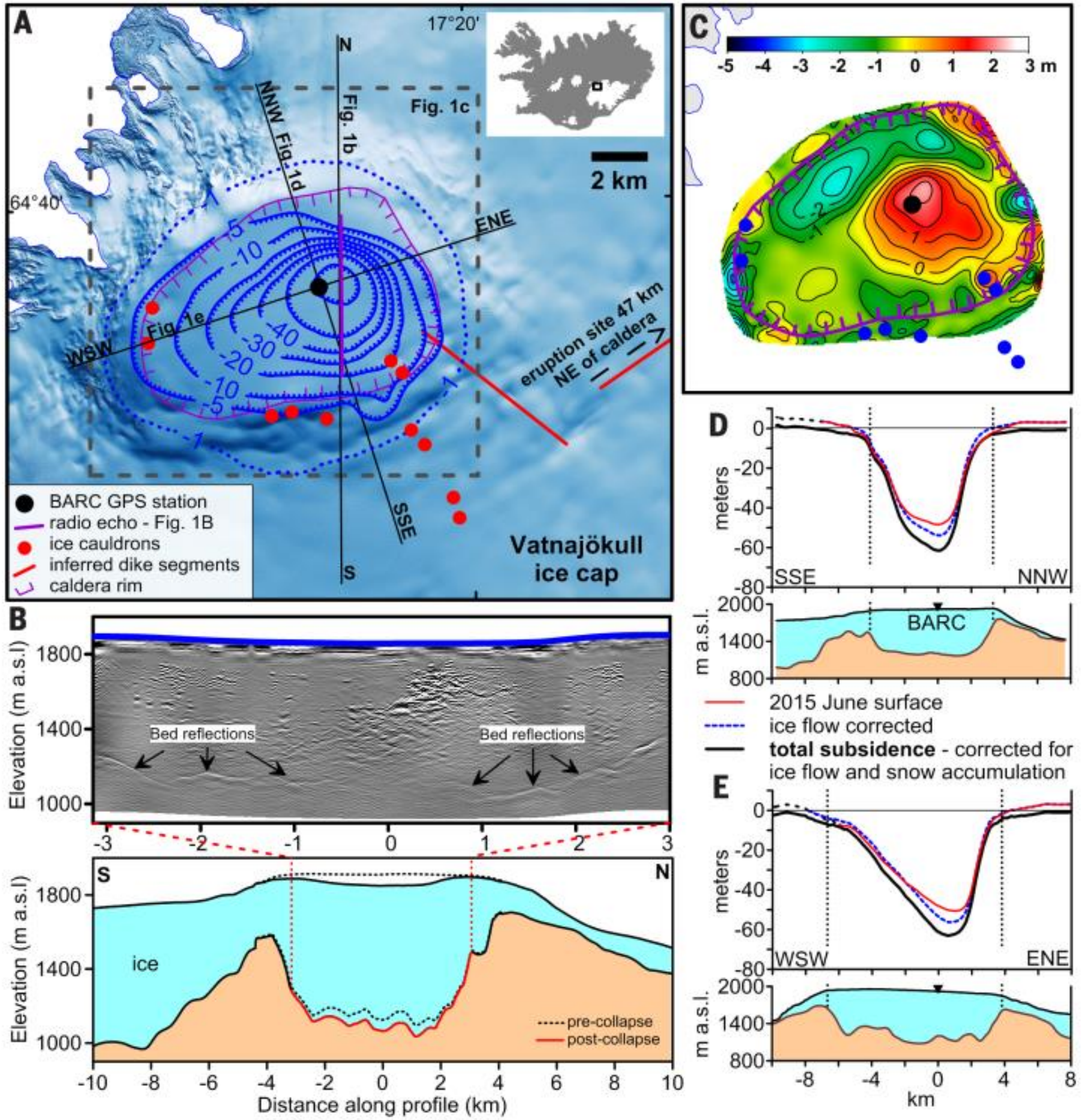

Fig. 1. The collapse of Bárðarbunga over six months in 2014-2015. From Gudmundsson et al. (2016).

The 65 km^2 Bárðarbunga 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.

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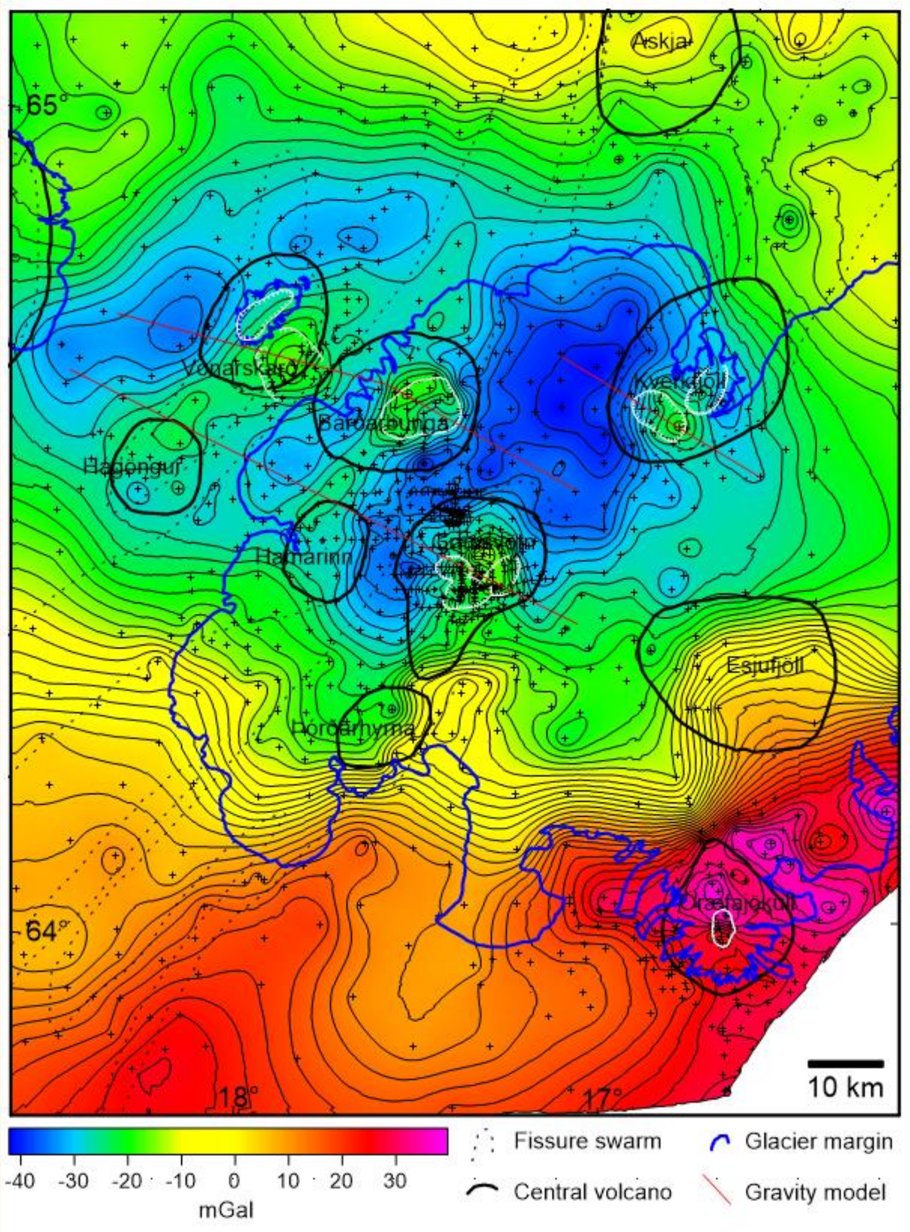

Fig. 2. Bouguer anomaly of Vatnajökull – calderas are associated with 10-20 mGal gravity highs caused by dense intrusions in the upper crust (from Gudmundsson and Högnadóttir, 2007)

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 or other, more deep-seated mass changes beneath the volcano.

Fig. 2. Gravity surveying in June 2015. Scintrex CG5 and Trimble R7 KGPS.

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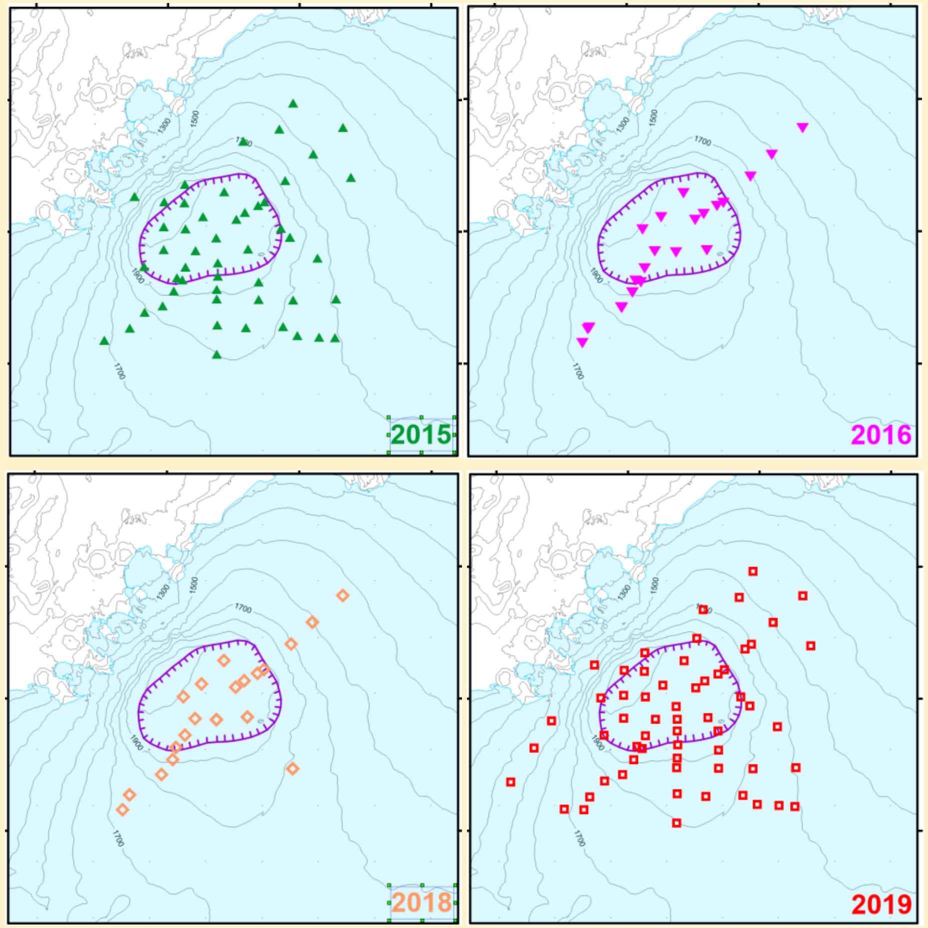

Fig. 2: Surveys were carried out using a Scintrex CG-5 in 2015, 2016, 2018 and 2019, with measurements done at 25-50 locations each time. As no benchmarks exist on the ice the spatial difference in station location of 10-20 m exists between survey years. However, post-processing provides kinematic GPS 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.

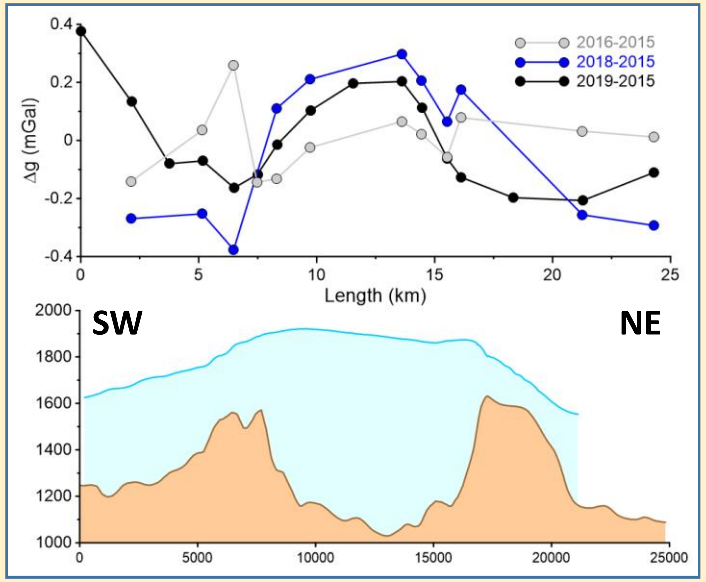

Fig. 3: Gravity changes 2015-2019

The results obtained indicate substantial changes. Over the four years between 2015-2019 a clear Bouguer anomaly increase is recorded over the caldera relative to the surrounding area.

The source is apparently very shallow, consistent with the gravity signal arising from the ice-bedrock boundary.

The results indicate fast resurgence at Bárðarbunga since 2015, a rise of the caldera floor by several meters and the inflow of 0.2-0.3 km^3 of new magma.

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