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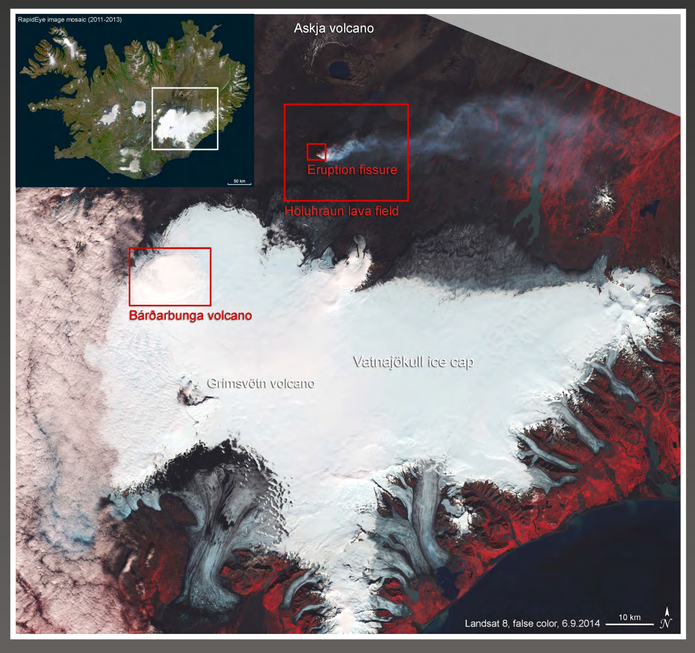
Volcanic activity at Bárðarbunga, Iceland, monitored with TerraSAR-X and TanDEM-X data

Julia Jaenicke[1], Ulrich Münzer[1], Christian Minet[2], Michael Eineder[2], Florian Siegert[3], Ludwig Braun[4], Ágúst Guðmundsson[5]



Volcanic events

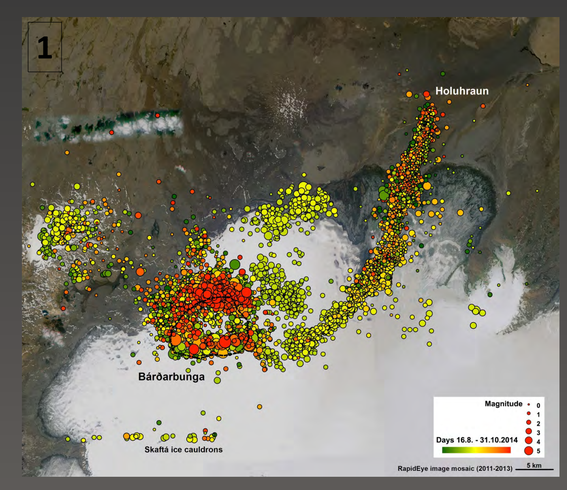
The **subglacial** volcano Bárðarbunga, with a 65 km² large caldera, is located on the northwestern edge of Vatnajökull within the SW-NE running Neovolcanic Zone of Iceland.

1 On 16.8.2014 high **seismic** activity started in the area.

2 A six months lasting **fissure eruption** took place in the glacier forefield, called Holuhraun (29.8.2014 – 27.2.2015).

3 A ca. 800 m wide **graben** formed between Bárðarbunga and the eruption site.

4 **Subsidence** of the ice masses within the Bárðarbunga caldera occurred (up to 64 m).



TerraSAR-X

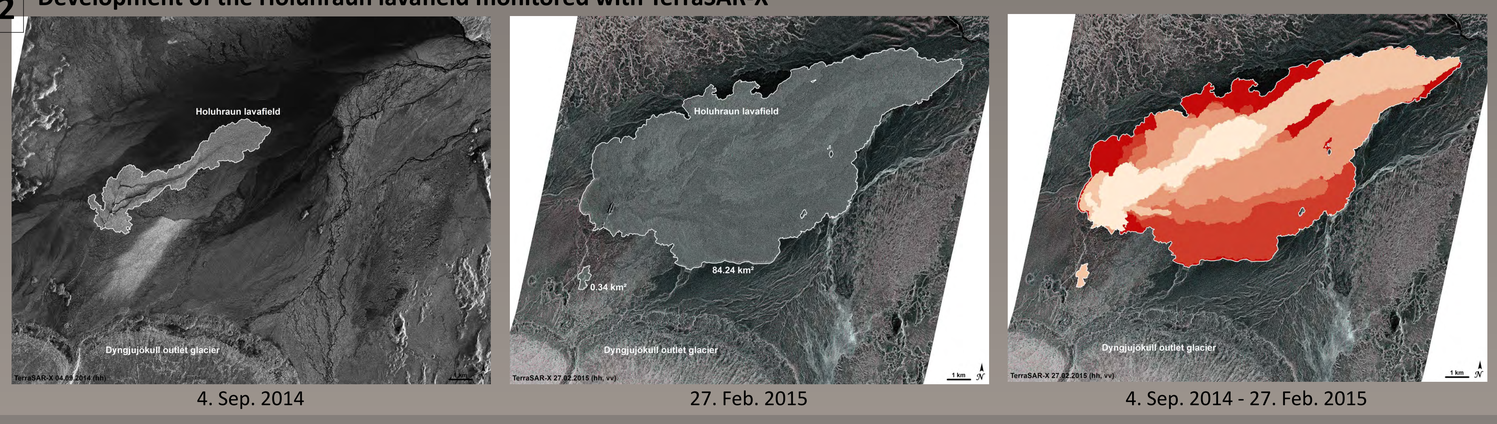
Risk assessment of the fissure eruption was made possible by continuous monitoring with high resolution TerraSAR-X Stripmap data (1.25 m pixel size) and near real-time data delivery.

Six images in the same orbit were acquired and show the development of the Holuhraun lavafield:

Date	4.9.2014	15.9.2014	7.10.2014	18.10.2014	1.12.2014	27.2.2015
Area (km²)	10.6	28.4	53.0	59.4	74.6	84.6

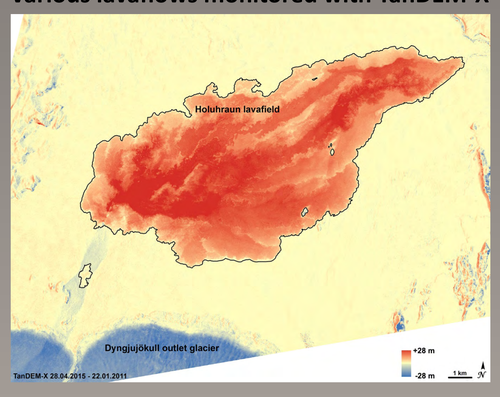
It was an effusive eruption of tholeitic basalt without discharge of volcanic ash, but a total emission of 11±5 Mt **SO_2** [a)]. Anomalously high SO_2 concentrations were even measured in Germany in September.

2 **Development of the Holuhraun lavafield monitored with TerraSAR-X**

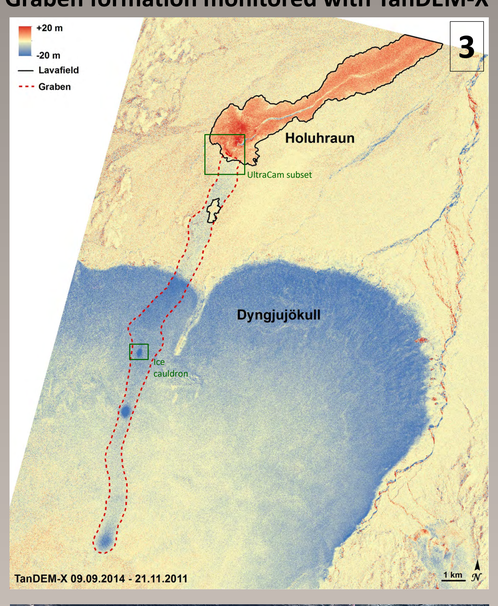


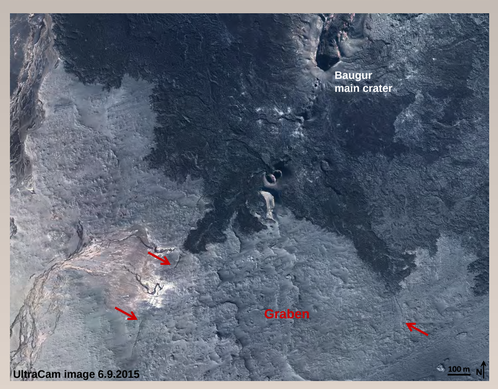
4. Sep. 2014 | 27. Feb. 2015 | 4. Sep. 2014 - 27. Feb. 2015

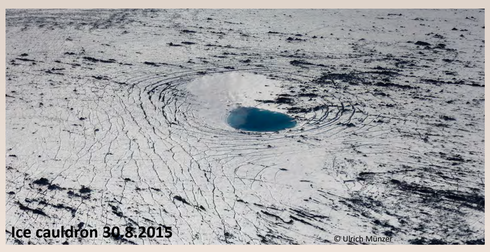
Various lavaflows monitored with TanDEM-X



Graben formation monitored with TanDEM-X







TanDEM-X

The **Holuhraun** lavafield extends on the sandur plain of Dyngjujökull outlet glacier, noth of Vatnajökull.

After vertical adjustment of TanDEM-X RawDEMs, **DEM differencing** was applied and the max. height of the main crater calculated to 48.2 m and the **volume** to 1.48 km³ (verified by UltraCam data).

It was the largest eruption by volume in Iceland since 230 yrs. (Laki).

Over a period of two weeks in August a 45 km long **dyke** propagated laterally from Bárðarbunga northeast to Holuhraun [b)].

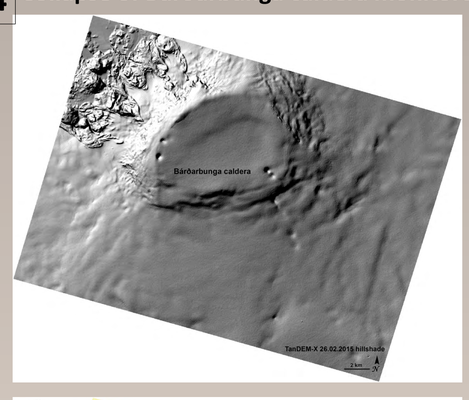
The dyke intrusion was accompanied by an intense seismic swarm, graben formation and caldera subsidence.

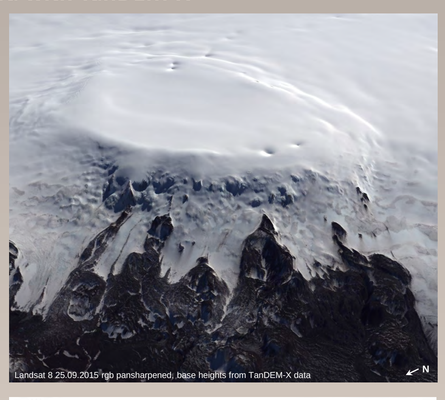
TanDEM-X DEM differencing allowed to detect the 18 km long **graben** even underneath the glacier. Three ice cauldrons, up to 30 m deep, were built. On the sandur the graben is about 5 m deep.

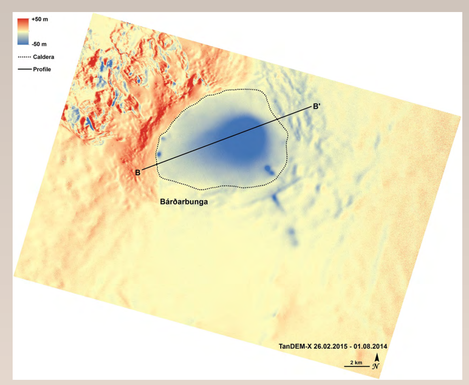
Magma migration out of the **Bárðarbunga** reservoir into the dyke system caused **subsidence** of the caldera [c,d)], which is covered by 850 m thick ice.

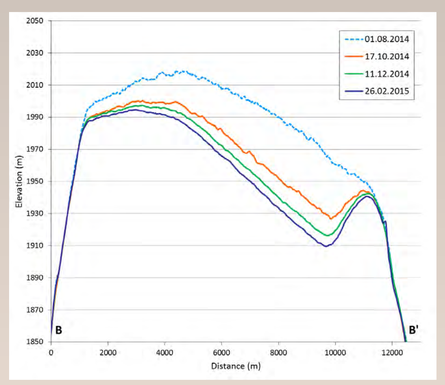
As measured with TanDEM-X data, most of the subsidence took place within the first two months of the event and reached a max. of 64 m depth and 1.64 km³ in volume. DEM differencing shows that ice cauldrons up to 80 m deep formed along the caldera rim.

4 **Collapse of Bárðarbunga caldera monitored with TanDEM-X**









[a)] Gíslason S R, Stefánsdóttir G, Pfeffer M A, Barsotti S et al. (2015) Environmantal pressure from the 2014-15 eruption of Bárðarbunga volcano, Iceland. Geochemical Perspective Letters l:84-93, doi: 10.7185/geochemLet.1509
[b)] Sigmundsson F, Hooper A, Hreinsdóttir S, Vogfjörd K S et al. (2015) Segmented lateral dyke growth in a riftig event at Bárðarbunga volcanic system, Iceland. Nature Letter 517:191-195, doi: 10.1038/nature14111
[c)] Riel B, Milillo P, Simons M, Lundgren P, Kanamori H, Samsonov S (2015) The collapse of Bárðarbunga caldera, Iceland. Geophysical Journal Interantional 202:446-453, doi: 10.1093/gji/ggv157
[d)] Gudmundsson M T, Jónsdóttir K, Hooper A, Holohan E P et al. (2016) Gradual caldera collapse at Bárðarbunga volcano, Iceland, regulated by lateral magma outflow. Science 353(6296), doi: 10.1126/science.aaf8988

[1] Department of Earth and Environmental Sciences, Section Geology, Ludwig-Maximilians-University, Munich, Julia.Jaenicke@lmu.de, ulrich.muenzer@t-online.de
[2] Remote Sensing Technology Institute, German Aerospace Center DLR, Oberpfaffenhofen
[3] Remote Sensing Solutions GmbH, Baierbrunn
[4] Commission for Geodesy and Glaciology, Bavarian Academy of Sciences and Humanities, Munich
[5] Fjarkönnun ehf., Kópavogur, Iceland

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