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

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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. It was an effusive eruption of tholeitic basalt without discharge of volcanic ash, but a total emission of 11±5 Mt. Anomalously high SO₂ concentrations were even measured in data (1.25 m pixel size) and near real-time data delivery.

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:

<table>
<thead>
<tr>
<th>Date</th>
<th>Area (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.9.2014</td>
<td>10.6</td>
</tr>
<tr>
<td>5.9.2014</td>
<td>28.4</td>
</tr>
<tr>
<td>7.10.2014</td>
<td>53.0</td>
</tr>
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<td>8.10.2014</td>
<td>59.4</td>
</tr>
<tr>
<td>11.12.2014</td>
<td>74.6</td>
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<tr>
<td>27.2.2015</td>
<td>84.6</td>
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</tbody>
</table>

It was an effusive eruption of tholeitic basalt without discharge of volcanic ash, but a total emission of 11±5 Mt SO₂. Anomalously high SO₂ concentrations were even measured in data (1.25 m pixel size) and near real-time data delivery.

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).

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 dyke even underneath the glacier. Three ice cauldrons, up to 30 m deep, were built. On the sandur the graben is about 5 m deep.

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.

References:

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8. Remote Sensing Solutions GmbH, Baierbrunn
9. Department of Earth and Environmental Sciences, Section Geology, Ludwig-Maximilians-University, Munich, Julia.Jaenicke@lmu.de, ulrich.muenzer@t-online.de
10. RapidEye image tiles: BlackBridge, Landsat 8: USGS
12. UltraCam data: project IsViews
13. Background photo: Max Schmid, Winterthur
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