GROUP ON EARTH OBSERVATIONS

GSNL GEO Geohazards Supersites and Natural Laboratories

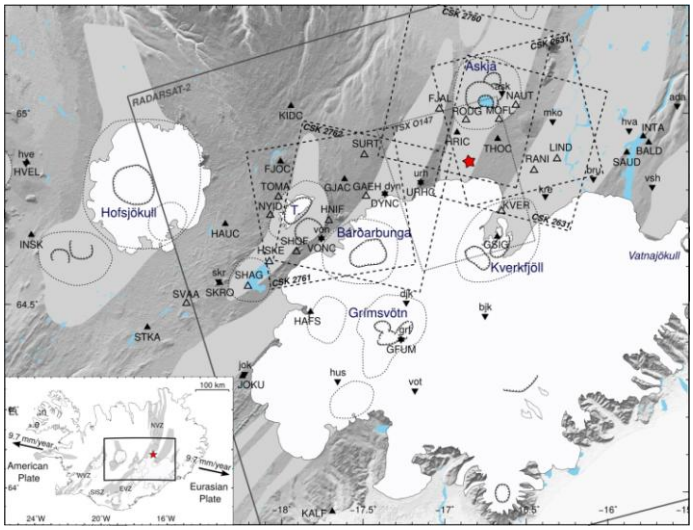
GSNL Success Stories

Support to Emergency Management during the Bardabunga, Iceland, 2014 eruption

The Bardabunga volcano erupted in 2014, in the area covered by the Iceland Supersite. Thanks to the Supersite framework, three radar satellites were constantly monitoring the area: Radasat 2 of the Canadian space agency, CSA; TerraSAR X of the German space agency, DLR; and COSMO-SkyMed of the Italian space agency, ASI.

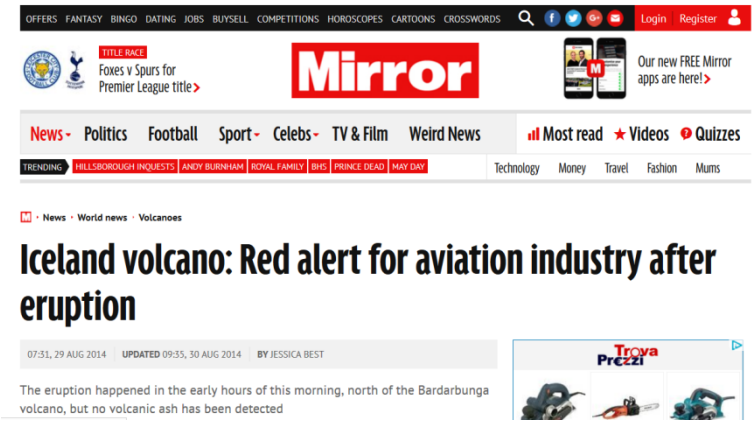
The SAR images provided by these satellites were used to generate constantly updated maps of the ground deformation in the volcanic area. This information was integrated with precise GPS measurements collected on the ground, and with seismological and geological data, to generate models of the volcanic plumbing system which allowed to closely monitor the evolution of the eruption.

This eruption also shows the use of Supersite scientific products in the decision making process of end-users, as explained in the figures below provided by the FUTUREVOLC EC project, supporting the Supersite.

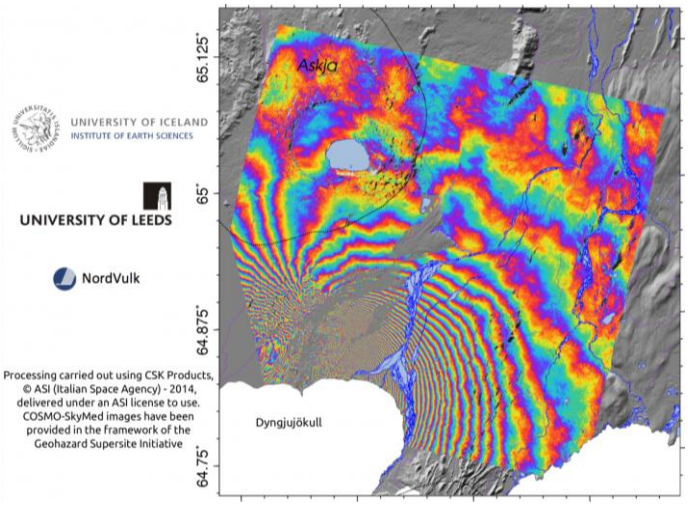


The Bardabunga volcano (caldera) is located underneath the 800-m think Vatnajökull ice cap (white area in the figure).
The rectangles show the extent of the X and C band SAR images used to monitor the area. The Supersite receives over 700 of these images per year.
The eruption started August 16, 2014. The worst scenario prompted for strong magma/water interaction, important explosive activity and emission of >10-km high volcanic ash cloud. Figure from Sigmundsson et al., Nature, 2015.

FUTUREVOLC

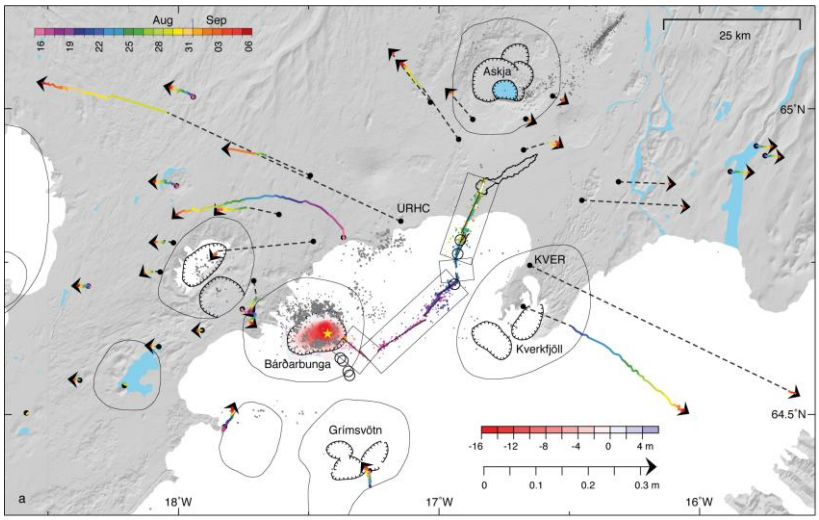


On August 29 a Red alert was issued for commercial air flights. This immediately raised much concern in the international media, for fear of a possible doublet of the 2010 eruption effects of Eyjafjallajökull, which caused global losses of over one billion dollar.

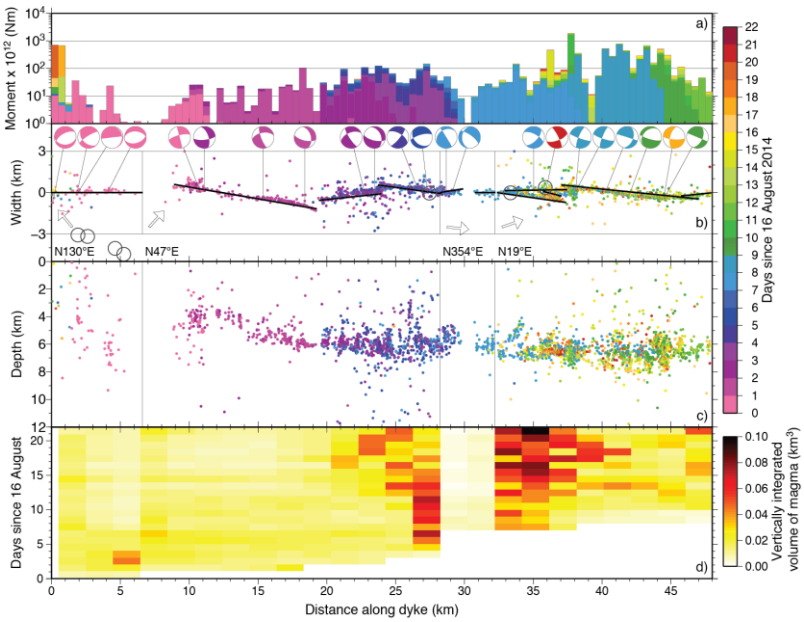


SAR Interferograms generated using the Supersite satellite imagery were used to monitor the ground deformation occurring in the area. These products were generated by a research group including scientists from Iceland, UK, and Norway.
The delivered product consisted of the ground displacement in the considered interval, for each coherent pixel.

FUTUREVOLC



In situ measurements of ground deformation were collected using GPS by Iceland scientists and integrated with InSAR results to provide very precise information on the movements of magmatic masses in the system.
The delivered products consisted of the station positions in the three cartesian components for the different measurement epochs. Figure from Sigmundsson et al., Nature, 2015.



The international research group analysed satellite and in situ data to monitor the evolution of the eruption and observed the migration of magma from the Bardabunga caldera to a location outside of the ice cap, 40 km to the north.
The delivered products consisted of the model parameters and of the inferred information. Figure from Sigmundsson et al., Nature, 2015.

NATIONAL COMMISSIONER OF THE ICELANDIC POLICE
DEPARTMENT OF CIVIL PROTECTION AND EMERGENCY MANAGEMENT

THE SCIENTIFIC ADVISORY BOARD OF THE ICELANDIC CIVIL PROTECTION		
Date: 03.12.2014	Time: 09:30	Location: Crisis Coordination Centre, Skogarhlid.
Regarding: Volcanic activity in the Bardarbunga system.		
Attending: Scientists from Icelandic Met Office and the Institute of Earth Sciences University of Iceland along with representatives from the Icelandic Civil Protection, the Environmental Agency of Iceland, Vatnajokull National Park and the Directorate of Health.		

Main points
• An overview of the activity in Bardarbunga and the volcanic eruption in Holuhraun
• Air quality
• Scenarios

Notes

- Today the Scientific Advisory Board of the Icelandic Civil Protection reviewed data about the development of events in Bardarbunga and the volcanic eruption in Holuhraun, from the beginning of the unrest until the present day. Most of the data show a decline in the subsidence of the Bardarbunga caldera and the volcanic eruption on Holuhraun. Earthquake activity is though still strong and the flow of lave great in comparison to volcanic eruptions in Iceland for over the last 100 years. The findings of the meetings are as follows:
  - **Earthquakes in Bardarbunga:** Seismic activity has been very strong since mid-august. The activity peaked in first half of September, it has slowly decreased since then, but activity remains intense. The period of seismic unrest is one of the largest ever recorded in a volcano globally.
  - **Earthquakes in the dyke from Bardarbunga to Holuhraun:** Strong seismic activity coincided with the progression of the dyke in the second half of August, but it decreased after the volcanic eruption began on Holuhraun. Earthquakes are still detected in the dyke but they are small and relatively few.
  - **Subsidence of the Bardarbunga caldera:** In the days following the onset of the seismic unrest, the ice-covered base of the caldera began to subsidence up-to 80 cm a day, but the subsidence has since slowed and it is now around 25 cm per day. The subsidence is in the shape of a bowl and it is greatest in the centre of the caldera, about 50 m, but smaller to the edges.
  - **Crustal deformation:** Extensive ground deformation Major was recorded while the dyke was forming, signalling the progression of the dyke and subsidence towards Bardarbunga. Interpretation of GPS data and analysis of satellite interferograms indicates that the volume of the magma in the dyke is about 0.5 cubic kilometres, and that it was fully formed by the beginning of the volcanic eruption. After the eruption started the subsidence has been steady, but slowly decreasing, towards Bardarbunga.
  - **The volcanic eruption in Holuhraun:** The volcanic eruption that began on Holuhraun on 31 of August is characterised by a large and unusually steady flow of lava. The magma that comes up is a rather primitive basalt, with a chemical composition typical of the Bardarbunga volcanic system. The petrology analysis of the magma suggests that it stabilised at 9-20 km depth, meaning that it could not have resided at a shallower depth in the crust. The lava field is now 76 square kilometres in area.

The scientific products generated by the different research groups **were periodically delivered to the Civil Protection authority,** under the responsibility of the Supersite coordinator institutions.

The scientific products **helped take many decisions during the emergency,** eventually lowering the red alert to orange when the data showed that the eruption was not going to happen under the ice cap but well outside of it, in Holuhraun.

Source: Iceland Supersite, supported by FP7 Project FutureVolc, futurevolc.hi.is

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