

100 days of continuous eruptive activity in Holuhraun

Earthquakes

The earthquake sequence associated with the magma movements and volcanic activity at Bárðarbunga differs greatly from all volcanic earthquake swarms that have been observed in Iceland since the beginning of seismic measurements. Summing up the energy release of all earthquakes detected so far reveals a corresponding magnitude of 6.6 if the same energy was released in one big earthquake.

This number might sound small, however it has to be kept in mind that the magnitude scale of earthquakes is logarithmic. An increase of one magnitude corresponds to an energy increase by a factor of around 30, i.e. a magnitude 5 earthquake releases around 30 times more energy than a magnitude 4. It is however worth to notice that a tectonic earthquake like the 1912 earthquake in the eastern South Icelandic Seismic Zone or 1963 in Skagafjörður (both were around magnitude 7) can easily outnumber the recent activity around Bárðarbunga in just one event, by means of moment release.

The cumulative moment release during the migration of the dyke intrusion between 16 August and 1 September corresponds to a single earthquake of about magnitude 6.0. In contrast, the whole moment released in the earthquake swarm prior to the Eyjafjallajökull eruptions in 2010 hardly reached magnitude 5. However, a direct comparison of both swarms is impossible as the length of the present dyke is also significantly larger than in 2010. The activity on the Bárðarbunga caldera rim remains unprecedented as it is the first opportunity ever to follow a caldera subsidence in Iceland with modern scientific measurements and methods.

Number of earthquakes between 16 August 2014 00:00 and 09 December 2014 at 08:30

	all	intrusion	caldera	Kistufell	Askja	HB / HBT	TFJ	Kverkfj.
automatic	~ 34.000	-	-	-	-	-	-	-
checked	~ 17.500	~ 7.500	~ 7.000	~ 120	~ 340	~ 1500	~ 470	~20
M3.0-3.9	836	99	721	6	2	3	4	1
M4.0-4.9	462	7	453	1	1	0	0	0
M>5.0	74	0	74	0	0	0	0	0

HB / HBT Herðubreið and Herðubreiðartögl

TFJ Tungnafellsjökull

Kverkfj. Kverkfjöll

Kistufell cluster north of Bárðarbunga that was active during the first days

GPS measurements

Great crustal movement was detected while the intrusive dike was being formed. The GPS measurements showed the advance of the intrusion and, simultaneously, subsidence towards the center of Bárðarbunga. Models based on GPS and on InSAR images from satellites indicate that the volume of the magma in the intrusion is about 0.5 cubic kilometers and that it was fully formed, already in the beginning stages of

the eruption. Horizontal spreading across the dike on a 25 km stretch between Urðarháls and Kverkfjöll measured 1.3 m maximum. But InSAR measurements indicate that the spreading next to the dike is considerably larger. Since the onset of the eruption the subsidence has been continuous, however slightly diminishing, towards Bárðarbunga. Tectonic movement during the seismic events in Bárðarbunga which began in the middle of August 2014, are the greatest which have been detected in Iceland since the Krafla volcanic events in the seventies and eighties.

Gas measurements

The ongoing eruption at Holuhraun is very rich in gas. We should go 150 years back to find an event (Trolladyngja) that had a comparable impact on Iceland and its inhabitants, in terms of environmental and health issues.

IMO is monitoring gas releases from Holuhraun using DOAS and FTIR instruments for the estimation of SO₂ flux and amount of other components in the volcanic cloud. The more abundant gases present are SO₂, CO₂, HCl, HF, H₂O.

In the first month and half we had an averaged flux equals to 400 kg/s (~35 kT/d) with peaks up to 1300 kg/s (~112 kT/d). Assuming a constant release of gas until today, the eruption has injected into the atmosphere an amount of SO₂ in the range 3.5 Mt (considering the average flux) – 11.2 Mt (considering the peak).

These numbers could be compared with the largest gas-rich eruption occurred in Iceland in 1783-1784 (Laki eruption) and lasted 8 months. It has been estimated that during that eruption up to 122 Mt of SO₂ were released into the atmosphere. Assuming a constant gas flux during the 8 months, the Laki eruption injected ~51 Mt in 100 days (5 - 15 times the Holuhraun's amount).