



Surface fracturing and graben subsidence during the 2014 Bárðarbunga dike intrusion in Iceland

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A dike propagated laterally away from the Bárðarbunga central volcano in August 2014. The dike propagated about 48 km towards the northeast and north-northeast, mostly beneath the Vatnajökull glacier. However, the farthest 8 km of the dike were located north of the glacier, where the ice-free area allowed surface fractures and graben subsidence to be observed. This dike intrusion was accompanied by eruptions, the most prominent ones occurring within the graben at the distal end of the dike.

In this study, photographs taken from airplanes were rectified by using the ArcGIS software. This was done in order to map the fractures and eruptive fissures which were formed or reactivated during this dike intrusion, and to show the temporal evolution of the fracture pattern. Ground deformation across the graben was measured from an airplane with a radar altimeter and kinematic GPS.

The propagation of the dike was shown by laterally propagating earthquakes and by ground deformation recorded by GPS geodetic network. Three days after the dike had propagated north of the Vatnajökull glacier, new and reactivated fractures were detected in this area, above the dike. The fractures delineated two grabens in direct continuation of each other. The southern graben extended 5 km northwards from the glacier boundary, and was 700-1000 m wide. Before the eruptions, the northern graben was seen ~6.6-7.5 km north of the glacier, and was only 250-450 m wide. Two days later, on the 29th of August, a four-hour long eruption took place on a 600 m long eruptive fissure 6 km north of the glacier. Then, the narrow northern graben was seen extending about 1-1.6 km farther to the south than before the eruption, with the new eruptive fissure in the middle of it. The eruption resumed again two days later, extending the same eruptive fissure towards the south and north, to a total of ~1900 m length. This eruption is still ongoing (in January 2014). On the 5th of September, three short (~100 to 250 m) eruptive fissures also opened up ~3 km north of the glacier, although these eruptions only lasted two days. Notably, the eruptive fissures activated on 29th and 31st August were located within the eruptive fissures of the older Holuhraun lava, which erupted in the 17th and/or 18th century. A profile taken on the 30th December 2014 by radar measurements across the southern graben, 4 km north of the glacier, showed that the graben had then subsided ~4-5 m, compared with a TanDEM-X Digital Elevation Model acquired before the dike intrusion.

The width of a graben implies the depth to the top of the dike. The narrow grabens observed before the eruptions thus indicated that the dike was shallow, and that an eruption was likely to occur. The width of active grabens therefore is an important observable in hazard assessment during dike intrusions.