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Seismicity caused by dyke propagation in the Bárðarbunga volcanic system, NE Iceland

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The Bárðarbunga volcanic system lies in the Eastern Volcanic Zone in central Iceland close to the centre of the Iceland mantle plume. Iceland is situated astride the Mid-Atlantic Ridge with the geology characterized by the interaction of the ridge and the underlying hotspot. The Bárðarbunga volcanic system consists of a central volcano and a fissure swarm extending 115 km to the SW and 55 km to the NNE. The volcanic system is known to have experienced eruptions both in the SW and NNE part of its fissure swarm (e.g. Veiðivötn 1477, Holuhraun c. 1797 and Tröllahraun 1862-1864). The Gjálp 1996 subglacial eruption between the central volcanoes Grimsvötn and Bárðarbunga was likely triggered by the Bárðarbunga volcanic system. The most recent eruption within the Bárðarbunga central volcano is believed to be in 1910.

Seismic activity in Bárðarbunga has increased steadily since 2005. On 16th August 2014 an intense seismic swarm started at the Bárðarbunga central volcano with an emplacement of a radial dyke, which propagated to the SE. After the dyke left the caldera it turned to the NE and propagated 45 km in 14 days to the NNE to where it erupted in Holuhraun, reoccupying the old craters from the eighteenth century. The dyke propagated at depth in sequences of rapid advance with intervening periods of little or no movement.

A dense seismic network surrounding Askja and Vatnajökull and operated by the University of Cambridge has recorded the propagation of the dyke in great detail. The network consists of over 75 broadband seismometers providing good coverage of the volcanic and seismically active area.

We use an automated detection and location algorithm to calculate the locations of over 30,000 seismic events recorded during the period of the dyke propagation, including the onset of both eruptions at Holuhraun. During the propagation of the dyke only the tip was active and once a pathway had been made there was very little activity, indicating that the flow of magma was not hindered. Precise relocations of a smaller subset of manually refined events spanning the entire dyke in length and time show that the seismicity was focused at c. 7 km bsl, most likely at the brittle-ductile boundary, which is mapped at a similar depth underneath Askja.