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Triggered seismicity induced by stresses from the Bárðarbunga 2014 rifting event

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From 16th August 2014 a rifting event at Bárðarbunga volcano in Iceland produced large surface deformation associated with rifting and the propagation of a 45 km long dyke northward away from the central volcano. Continuous GPS data from numerous sites recorded tens of centimetres displacements (Sigmundsson et al., Nature 2014) during the emplacement of this dyke, with a maximum widening between two stations of 1.3m. This continuous GPS data along with campaign GPS, InSAR and seismicity have been used to model the geometry and volume of the intruded dyke (Sigmundsson et al., 2014). The subsequent effect on the stress field caused by this intrusive volume was felt by the many volcanic centres in the surrounding area. Tungafellsjökull, Kistufell, Kverkfjöll and Askja all saw elevated levels of seismic activity during and following the intrusion of the dyke. The rapid final northward advance on 27th August also simultaneously caused a magnitude 4.2 earthquake in the geothermal field on the south-east side of Askja caldera, where recorded earthquakes have never previously exceeded a magnitude of two. Locations of earthquakes focussed at the leading edge of the dyke map out its northward propagation in short rapid bursts, and enable a temporal stressing history to be reconstructed. This can be correlated well with seismicity rates at the nearby Askja, Kistufell and Kverkfjöll volcanoes. We present both detailed seismic analysis and stress modelling which demonstrate triggering of increased seismicity and shut off in stress shadows, allowing us to test quantitative models of stress induced seismicity.

Our local seismic array covers the numerous volcanic systems beneath the Vatnajökull glacier and surrounding areas in the Icelandic interior, and has been operating for many years leading up to this rifting event, providing excellent constraint on relative seismicity rate changes. We use automatic location routines to produce an extensive earthquake catalogue over time. Further results from our manual refinement techniques (probabilistic locations and relative relocations) and fault plane solution inversion reveal the faulting mechanisms of both the background and triggered activity. We use these faults in our stress modelling to place excellent constraints on the stress evolution at these nearby volcanoes.