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Linking an injection fracture model to seismicity: Application to the Krafla 1975-1984 Caldera unrest episode (Iceland) to estimate overpressure, acting stress gradients and variations of dike opening.

Torsten Dahm (1), Bryndis Brandsdottir (2), and Pall Einarsson (2)
(1) Hamburg University, Institute of Geophysics, Hamburg, Germany (torsten.dahm@zmaw.de), (2) University of Iceland

Recently, a 2D injection model has been developed to explain the asymmetric growth of hydro-fracture induced seismicity in a gas formation (Fischer et al., 2009, GJI, 179, 634-639; Dahm et al., 2010, JGR, in review). The theory explains nonlinear and asymmetric bi- and unilateral growth of the seismicity with respect to the injection center and variations of the event-rate as well as the occurrence of a seismicity backfront.
The Krafla 1975-1984, North Iceland, caldera unrest and rifting episode is an exemplary case of subsequent, alternating, bi- and unilateral dike intrusions over a length of more than 70 km, fed by a central shallow magma chamber beneath the Krafla caldera. Altogether, 16 or more crustal dike events occurred over the period of 9 years. Each dike emplacement was accompanied by rapid caldera deflation, and each dike induced a trace of migrating weak earthquakes which were observed on local seismic stations. The Krafla unrest is one of the best studied rifting events until today. However, dynamic parameters of the intrusions and the controlling pressures and stress distributions are still poorly known.
We apply the new intrusion-seismicity model to the Krafla events in order to estimate pre-intrusion magma pressure, stress gradients and the time-dependent dike opening for the largest of the intrusions. Although the model is 2D only, it gives interesting insights in the mechanics of lateral rifting events and first order estimates of internal pressures and stress gradients.