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Hypocenter migration of fluid-induced earthquake swarms in the Tjörnes Fracture Zone (North Iceland)

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The Tjörnes-Fracture-Zone separates Iceland's Nordic Volcanic Zone from Kolbeinsey-Ridge (Greenland-Sea). Seismicity mainly occurs in swarms, often 100 and more per day, with similar waveforms and commonly offshore.

Earthquake swarms are often related to volcanic activity, frequently pre-eruptive activity. The migration of hypocenters within these swarms allows conclusions on fluid propagation in the subsurface, e.g. a magma dike. Therefore, the propagation of seismic clusters, as observed at Krafla volcano during the most recent rifting episode in 1978, could indicate magmatic or hydrothermal fluid circulations in the north of Iceland and motivates the present study.

We analysed three earthquake swarms between June and September 2004, recorded by 35 stations, i.e. the permanent Icelandic SIL network and a temporary setup of land and ocean-bottom seismometers, and 5 swarms of the years 1994-1997, only recorded by SIL. Events occurring in the same swarm often show similar waveforms at the same station. We cross-correlated these time series by using a new approach of three component cross-correlation in order to relocate the hypocenters relative within the swarms and to precisely determine the direction and velocity of migration. The newly tested method delivered relocations with acceptable small spatial and temporal errors (< 300 m, < 50 ms). This allows the interpretation and characterisation of the observed earthquake swarms. We try to classify observed migration velocities by comparing them to already known typical fluid- and crack-propagation velocities. Therefor, we make also use of additional findings, such as focal-mechanisms and orientation of the best fitting plane through the hypocenter distribution.

We separate the investigated events into two types of earthquake swarms, supposably dike-induced and hydrothermally- or gas-induced swarms, by pointing out typical

characteristics of both types and by comparing them to similar events of other volcanic regions. Based on different migration velocities, we will discuss possible mechanisms and their triggers of all single clusters within a swarm. Hypothetic models will be established, trying to explain the processes during the swarm episodes.