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Volcano-tectonic Interaction in the Hengill Region, Iceland during 1993-1998

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A major tectonic episode was induced in the western part of the South Iceland Seismic Zone (SISZ), at the intersection of the SISZ with the Western Volcanic Zone, over the six-year period between 1993 and 1998. This episode was driven by an intrusion into the Hengill region, just north of the seismic zone. The intrusion was inferred from 2 cm/yr measured uplift during 1993-1997 and was centered in the Hrómundartindur-Grændalur volcanic system. Over 80 thousand earthquakes were recorded on the Icelandic seismic network (SIL) over this period. The activity was episodic and mostly confined to the region north and west of the intrusion, and north of the SISZ. A few swarms also occured south of the SISZ, but the asperities in the SISZ held until June 1998, when during a three-day swarm generating nearly three thousand earthquakes, rupture propagated through the seismic zone, culminating in an M$\sim$5 event and two M$\sim$4 events. Later that same year a second three-day swarm confined south of the seismic zone, ended this volcano-tectonic episode. The swarm counts over four thousand microearthquakes and one M$\sim$5 event. At this time the stress increase generated by the intrusion at the northern margin of the SISZ had propagated through the seismic zone.

Joint interpretation of microearthquake distribution and individual focal mechanisms is used to map the active sub-surface faults and slip directions during this period of stress transfer through the SISZ. Earthquake locations are obtained through cross-correlation of both P and S wave forms and subsequent inversion of relative arrival times; focal mechanisms are obtained by inversion of spectral amplitudes of P and S waves.

The faults revealed in the region north of the SISZ most commonly strike NE and E, but with some N-trending sections. Predominantly faults are near-vertical and a few hundred meters to a kilometer long. Slip directions are generally right lateral on NE striking faults and left lateral on E striking faults. Normal faulting is also observed. In the SISZ, west and south of the center of uplift, the predominant fault direction is N and NNE and fault patches can be as long as 3 km. Slip direction on these is predominantly right-lateral strike-slip, characteristic for faulting in the SISZ. Event distribution around the epicenter of the three main shocks indicate that they occurred on near-vertical N to NNE striking faults in agreement with the focal mechanisms. South of the seismic zone, the fault pattern is very different, it consists of one 9 km long, vertical E- striking fault offset by several short N-striking fault patches. Slip on the E directional fault is left-lateral, weheras on the N directional faults, right-lateral motion prevails.

The time evolution of the stress field through this volcano-tectonic episode is revealed in the slip history on the faults.