Moment- and Stress-Tensor-Inversion of volcanic earthquakes to constrain driving forces of the 2010 eruptions at Eyjafjallajökull (Iceland)

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The Eyjafjallajökull stratovolcano is located at the western border of the Eastern Volcanic Zone (EVZ) in South Iceland. Three eruptions have been documented in Eyjafjallajökull before 2010: In 920, 1612 and 1821-1823.

Following three episodes of persistent microearthquake activity in the 1990s, seismic activity resumed in spring 2009. The seismicity escalated throughout the year and culminated in an intense earthquake swarm in February-March 2010, beneath the northeastern flank of Eyjafjallajökull. Simultaneous inflation observed by GPS and InSAR data confirmed magmatic accumulation at shallow depth beneath the volcano which heralded the subsequent eruptions.

In early March 2010, the permanent seismic network around the volcano was augmented by additional stations to improve the reliability of hypocentral earthquake locations and focal solutions. Earthquake locations revealed several seismic clusters, interpreted as magma accumulation zones, at shallow (3-5 km) depth beneath the northeastern flank of the volcano throughout March 2010. The seismic clusters migrated eastwards during the week prior to the Fimmvörðuháls flank eruption on March 21st. The April 14th summit eruption was preceded by a seismic cluster beneath the summit crater of the volcano. Focal mechanisms derived from P-wave polarity analysis indicate E-W striking reverse faulting for the February-March earthquake swarm, same as for an intrusion event in 1994. Contrary, normal faulting events were observed beneath the summit crater prior to the second eruption.

The scope of this study is to constrain driving forces of the intrusive activity beneath Eyjafjallajökull in detail by inverting focal mechanism data towards the stress tensor. By applying a moment tensor inversion to stronger events, one may obtain more details about potential volumetric components due to gas or magma migration, as unstable T-axes of events below the summit crater suggest either a ring-fault structure or positive isotropic moment tensor components. Both analyses provide valuable information regarding location, size and driving forces of the repeated magmatic intrusion events represented by the separate earthquake clusters beneath Eyjafjallajökull.