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Intrusive activity beneath Eyjafjallajökull: Moment- and Stress-Tensor-Inversion of volcanic earthquakes to constrain driving forces of the 2010 eruption

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The Eyjafjallajökull stratovolcano is located at the western border of the Eastern Volcanic Zone (EVZ) in South Iceland, west of Mýrdalsjökull (Katla). The EVZ is propagating southwestwards into older oceanic crust. Since the settlement in 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, seismicity increased again in spring 2009 under the northeastern flank of Eyjafjallajökull. The activity increased throughout the year and culminated in an intense earthquake swarm in February-March 2010. Simultaneous inflation observed by GPS and InSAR data confirmed magmatic accumulation within the volcano which heralded the subsequent eruptions.

In early March, the permanent seismic network around the volcano was augmented by additional stations to enhance hypocentral earthquake locations and to improve the liability of focal solutions. Earthquake locations revealed more than one accumulation zone 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. The April 14th summit eruption was preceded by a seismic cluster beneath the central part 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 the 1994 intrusion event in 1994. 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 reveal valuable information on location, size and driving forces of various earthquake clusters throughout the network of magma intrusion beneath Eyjafjallajökull.