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Intrusive activity beneath Eyjafjallajökull heralding the 2010 flank and summit eruptions: An analysis of earthquake and geodetic data

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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. Situated near the tip of the propagating zone, Eyjafjallajökull and Katla are interconnected by east-west-striking faults and eruptive fissures. Katla is one of the most active volcanoes of the EVZ, whereas only three eruptions have been documented in Eyjafjallajökull before 2010, in 920, 1612 and 1821-1823.

Following three major episodes of persistent microearthquake activity in the 1990s, seismicity picked up 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 and heralded the subsequent eruptions.

In early March, permanent seismic and continuous GPS networks around the volcano were augmented by aditional stations. Data from these networks greatly enhanced the spatial coverage of the inflation signal and improved the hypocentral earthquake locations. Earthquake locations have revealed more than one accumulation zone at shallow (3-5 km) depth beneath the northeastern flank of the volcano, eventually feeding the March 20th Fimmvörduháls eruption at the eastern margin of Eyjafjallajökull. Another seismic cluster beneath the central part of the volcano was recorded prior to the April 14th summit eruption. Focal mechanisms derived from P-wave polarity analysis and moment tensor inversion indicate E-W striking reverse faulting for the February-March earthquake swarm, same as for a recent intrusion event in 1994, and normal faulting events beneath the summit crater prior to the second eruption.

The GPS data analysis reveals a temporally and spatially complex intrusion rather than pressure changes in a single magma chamber. First modelling on the geodetic data suggests two preeruptive sill intrusions between December 2009 and March 2010 beneath the main earthquake clusters at 4-6 km depth and eastward ascent of a dike prior to the first eruption onset on 20th of March. The analysis of seismic and geodetic data will enable us to further constrain accumulation zones and ascent velocity of the intruding magma prior to the Fimmvörduháls and Eyjafjallajökull eruptions. Focus of this presentation is predominantly seismicity: We relocate earthquake clusters by means of multiple event methods and invert for moment tensors of stronger events to study the stress field and its possible changes. Further, we will analyse migration paths of earthquake clusters closely together with the continuous GPS data.