AUTOMATED LOCATION OF THE MAY 2008 SOUTH ICELAND AFTERSHOCKS USING COALESCENCE MICROSEISMIC MAPPING

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Abstract

While a dense array of seismic stations encompassing the earthquake source region will improve detection thresholds and minimize velocity model uncertainties and location errors, the accuracy of absolute earthquake locations is still being studied. Slunga *et al.* (1995) first investigated the sensitivity of differential arrival times to absolute earthquake locations within the South Iceland Seismic Zone, (SISZ) Iceland, recognizing relative location of micro-earthquakes to be a viable tool for mapping faults and fractures while retaining the absolute location of the earthquake sources among unknown variables. More recent synthetic tests have shown that the double-difference earthquake location method minimizes errors due to 3D variations in velocity structure and can, in principle, be used to determine the absolute locations of earthquakes (Waldhauser and Ellsworth, 2000; Menke and Schaff, 2004).

We applied a coalescence micro-seismic mapping method (CMM) for detection and localization of the aftershock sequence of the May 29, 2008 M6.1 and M6.0 Ölfus earthquakes (Hreinsdóttir *et al.*, 2009). This technique is both automatic and robust, and has been shown to give accurate absolute earthquake locations in spite of velocity model uncertainties (Drew *et al.*, 2005). Instead of using an interactive generalized inversion of travel time picks to derive a hypocenter and origin time of an event, the CMM method uses a short/long time average and continuous 3D polarization to detect P and S phases from the data stream and time-spatially maps the origin of each event before coalescing data from each sensor into a joint solution. The point of coalescence occurs at the same time and location, as might be predicted by inverting using travel time picks. Whereas the magnitude of each 4D map is a relative measure of the occurrence of a micro-seismic event the shape of the map describes the fit between modelled and measured data, and characterizes the uncertainty in the time and location estimate for the event.

More than 10,000 events, recorded on an 11 station temporal array were located during the period 30 May to 2 July, using the CMM method. Filtering based on signal-to-noise ratios and station numbers resulted in 7,643 usable event locations. The SIL system located more than 5,000 events during this period. In addition to the two main N-S faults, the aftershock distribution reveals several smaller parallel faults as well as conjugate NE-SW and ENE-WSW oriented faults Most hypocenters originate within the uppermost 9 km. Events on the Reykjafjall fault are concentrated at 1-5 km depth whereas aftershocks along the southern extension of this fault, in Flói, lie at 5-9 km depth. A comparison between CMM and SIL locations revealed a systematic westward shift of events by about 600 m, which we attribute to sparse SIL station distribution and marked 3D variations in upper crustal structure between the far-field SIL-stations located within the Western Volcanic Zone and the Tertiary, S-Iceland.

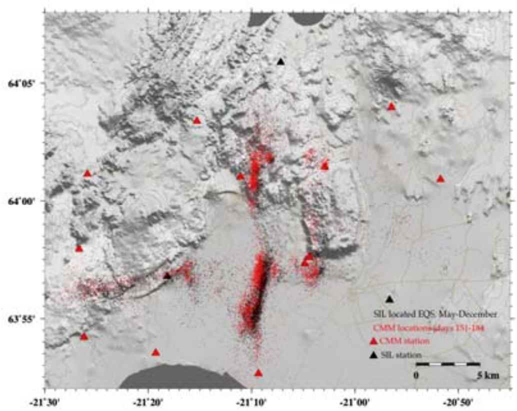

Figure 1: Aftershock distribution from the May 2008 Ölfus earthquakes. CMM located events (red) are shifted westwards compared to SIL locations (black).

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