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# Manual MT inversions in microseismic areas: good practices and building a reference database for the Hengill region, Iceland

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The determination of seismic moment tensors (MTs) for microseismicity poses challenges because of both the large number of events that are typically recorded, and their low signal to noise ratio. In recent years, automated moment tensor inversion methods have become more and more accurate, but an objective evaluation of their performance is often problematic due to the absence of site-specific, reference databases for comparison. In this study, we build a database of manually inverted MTs for the recent COSEIMIQ project, using the well-tested FociMT/HybridMT inversion method. COSEISMIQ focussed on microseismic monitoring in the Hellisheiði geothermal field, in the Hengill region, southern Iceland, where a dense network of 33 temporary seismic stations was deployed during 2018-2021, offering an ideal case study for microseismic MT inversion.

As a first step, we test the efficacy and possible pitfalls of the manual MT inversion on both a realistic and a simplified synthetic events waveform database. After careful, repeated manual tests, we observe that the inversion is robust across widely different choices of frequency band, but can be triggered to fail by not including key stations in some rare source-station geometries.

We then analyse the real data from the COSEISMIQ experiment, using previously located events from a large, recently developed microseismic catalog of the area. By running preliminary inversions of a subset of events in the centre of the deployment, we are able to pinpoint pre-processing steps that have a key effect on the MT inversion. We find that in strong noise conditions such as in the Hengill region, the order and phase of the used frequency filter are fundamental parameters in correctly processing the P-wave onset used later for inversion.

After fine-tuning the event preprocessing, we select a larger subset of 197 events with magnitude > 0.8 from the catalog across the whole COSEISMIQ area, including several seismicity clusters at the edge of the deployment. We then pick all 197 events and invert them first with FociMT, then cluster the events based on their location using K-means clustering, and finally re-invert each cluster using HybridMT. The clustered inversion using HybridMT changes some MT solutions significantly, reducing the intra-cluster MT variance for most clusters. Interestingly, some event clusters show increased variance after the HybridMT inversion, suggesting that these include substantially different source mechanisms within a small area.

This new database of carefully inverted MT solutions can now be used as a test dataset to evaluate the performance of automated inversion tools.