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Moment tensor clustering: a tool to monitor mining induced seismicity

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Automated moment tensor inversion routines have been setup in the last decades for the analysis of global and regional seismicity. Recent developments could be used to analyse smaller events and larger datasets. In particular, applications to microseismicity, e.g. in mining environments, have then led to the generation of large moment tensor catalogues. Moment tensor catalogues provide a valuable information about the earthquake source and details of rupturing processes taking place in the seismogenic region. Earthquake focal mechanisms can be used to discuss the local stress field, possible orientations of the fault system or to evaluate the presence of shear and/or tensile cracks. Focal mechanism and moment tensor solutions are typically analysed for selected events, and quick and robust tools for the automated analysis of larger catalogues are needed. We propose here a method to perform cluster analysis for large moment tensor catalogues and identify families of events which characterize the studied microseismicity. Clusters include events with similar focal mechanisms, first requiring the definition of distance between focal mechanisms. Different metrics are here proposed, both for the case of pure double couple, constrained moment tensor and full moment tensor catalogues. Different clustering approaches are implemented and discussed. The method is here applied to synthetic and real datasets from mining environments to demonstrate its potential: the proposed cluserting techniques prove to be able to automatically recognise major clusters. An important application for mining monitoring concerns the early identification of anomalous rupture processes, which is relevant for the hazard assessment. This study is funded by the project MINE, which is part of the R&D-Programme GEOTECHNOLOGIEN. The project MINE is funded by the German Ministry of Education and Research (BMBF), Grant of project BMBF03G0737.