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Spatiotemporal patterns of acoustic emission (AE) activity in salt mine

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Assessing the magnitude of completeness (Mc) is essential for the correct interpretation of earthquake catalogs. Knowledge on the spatiotemporal variation of Mc allows the mapping of other seismicity parameters, such as b-values. Spatial and temporal variations of b-values can indicate structural heterogeneities, stress perturbations and time-dependent fracturing processes. In order to precisely estimate Mc in strongly heterogeneous media, we propose a 3D development of the probabilistic magnitude of completeness (PMC) method, which relies on the analysis of network detection capabilities, to study spatial distribution of the Mc and b-value estimations for mining networks. We used a large dataset including more than 1 million acoustic emissions (AE), recorded at the Morsleben salt mine, Germany. Our study shows that the PMC estimations strongly depend on the source-receiver direction, and cannot be correctly accounted using a standard approach. The comparison between Mc using the 3D PMC method and Gutenberg-Richter methods show agreements for two reference depth ranges. Following our approach, we estimate Mc ranging between 1.25 (AE ,relative acoustic magnitude), at the center of the network, and 3.5, at further distances outside the network. Our method provides small-scale details about the capability of sensors to detect an AE event, and spatial distributions of Mc and b-value, which can be linked to the presence of structural heterogeneities or cavities in specific directions. Effects of heterogeneities on detection analysis are confirmed by synthetic tests using waveform modeling in heterogeneous media. This work has been funded by the German BMBF "Geotechnologien" project MINE (BMBF03G0737A).