EGU22-12337
https://doi.org/10.5194/egusphere-egu22-12337
EGU General Assembly 2022

Experimental and numerical investigation of acoustic emission and its moment tensors in sandstones during failure based on the elastoplastic approach

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Microseismicity and acoustic emission (AE) studies are a part of earthquake science. Compared to ordinary earthquakes, microseismic events are characterized by higher frequencies, lower magnitudes, shorter duration, and more complex source mechanisms. The researchers associate the induced seismicity with different processes: borehole breakouts, tunnel excavations, hydraulic fracturing, wastewater injection, and stimulation of geothermal reservoirs.

Acoustic emission represents elastic waves generated spontaneously due to the formation of microfractures when the rock is undergoing a sufficiently high load. AE can be used to obtain continuous data at various stages of the deformation process: from distributed plastic failure to localized macroscopic failure. The spatial distribution of AE events indicates the location of fractures, and the source mechanism provides information about the failure mode: a tensile fracture, a shear fracture, or a combination of both.

This work shows the results of an experimental study of borehole breakouts in sandstones. We measured AE during the deformation experiments and applied the moment tensor analysis to microseismic waveforms. We used a continuum mechanics model of Minakov and Yarushina [2021] to relate the laboratory AE data to the deformation processes. The comparison of the failure patterns and corresponding seismic responses obtained in laboratory and simulations, allows to classify the deformation regimes in real rocks based on seismic observables.

EG, MB, SS, and VS gratefully acknowledge support from the Ministry of Science and Higher Education of the Russian Federation under agreement No. 075-15-2020-119 within the framework of the development program for a world-class Research Center.

References:

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