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Microseismic sources of rotational type

Elena Pasternak (1), Arcady Dyskin (2), and Junxian He (3)

(1) University of Western Australia, School of Civil, Environment and Mining Engineering, Crawley, Australia (arcady_m@me.com), (2) University of Western Australia, School of Mechanical and Chemical Engineering, Crawley, Australia (elena.pasternak@uwa.edu.au), (3) University of Western Australia, School of Civil, Environment and Mining Engineering, Crawley, Australia (20657168@student.uwa.edu.au)

Traditionally the sources of seismic and microseismic events are related to shear fractures. The analysis of the seismic moment tensors of the sources associated with rock fracturing and hydraulic fracturing in the laboratory experiments and in-situ reveals that while there exist tensile and compressive sources, the shear sources prevail. The appearance of multiple shear sources, accompanied rock fracturing contradicts the results of the direct experiments suggesting that the rock as well as other materials not exhibiting clear plastic flow fail in tension. This contradiction is conventionally resolved by assuming the presence of multiple pre-existing shear fractures (faults or microfaults) whose sudden sliding provides microseismic events of shear type. We consider alternative mechanisms associated with bending of links between rotating particles and fragments of geomaterial and bending of bridges connecting opposite sides of hydraulic fractures. In both cases the fracturing is caused by the action of moments (or moment stresses) leading to bending, while at microscale the failure is associated with tensile microstresses leading to formation of tensile microcracks. In other words, at microscale the moment-related failure is failure in tension, as routinely observed in materials even in compression. It is easy to demonstrate that from a distance the sources of rotational type are equivalent to a standard double couple, similar to the one associated with shear fracturing. In other words what is currently interpreted as shear microseismic sources can in fact be rotational sources. This calls for new methods of detecting and interpreting microseismic sources; some possible methods are discussed.