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Pseudo-shear seismic sources

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Sources of seismic and microseismic events are distinguished into tensile, compressive and shear. These are usually related to tensile fractures, compaction bands and shear fractures respectively. The shear events are routinely detected across the scales in experiments and observations of rock failure in compression and hydraulic fracturing despite the fact that the rock not exhibiting plastic flow fails in tension as the tensile strength can be an order of magnitude smaller than the compressive one.

Recently a new failure mechanism was considered. It is based on moment stresses generated due to internal rotations of rock constituents or clusters thereof. The failure is then related to bond failure produced by bind bending. Furthermore a new type of (hydraulic) fractures has recently been identifies – the fractures with constricted opening. The constriction is maintained by bridges – parts of intact rock left in the process of fracture propagation. The bridges are normally inclined to the fracture surface and are subjected to bending in the process of fracture opening. Both constituent rotations and bridges produce moment (bending) failure. The signal emitted by this source can be represented by a sudden application of a pair of forces, however due to moment equilibrium the equilibrating pair is generated as well. As a result, the traditional methods of seismic source identification, i.e. the one based on the seismic moment tensor will interpret the moment source as an ordinary shear source. This resolves the apparent contradiction between the abundance of shear sources especially in the situation when shear failure is not supposed to be present.

Resolution of moment sources would require more sophisticated measurement techniques, for instance the one that can distinguish between the pair of forces representing bending (small base) and the equilibrating pair of forces (larger base). This would allow more adequate interpretation of seismic, microseismic and acoustic emission and provide a better insight into the fracture mechanisms.