INTERPRETATION OF NON-DC COMPONENTS OF MOMENT TENSORS: A REVIEW

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The moment tensors describe equivalent body forces acting at a seismic point source and are the basic quantity evaluated for earthquakes on all scales. The most common type of the moment tensor is the double-couple (DC) source, which represents the force equivalent of shear faulting on a planar fault. However, accurately determined moment tensors of earthquakes reveal that they frequently deviate from shear faulting and contain significant non-double-couple (non-DC) components. The non-DC components are reported, for cavity collapses in mines, in hydraulic fracturing, in geothermal fields and volcanic areas. The DC as well as non-DC components of the moment tensors provide essential information about details of source processes and tectonic stress conditions of the rock mass.

I review the recent methods for interpreting the DC and non-DC components of the moment tensors and discuss their applications to various types of seismicity. I show that the DC components of moment tensors can be inverted for tectonic stress, fracture orientations and fracture instability. Analysing the DC components of earthquakes, it is possible to monitor spatial and temporal changes of stress and pore pressure, and to map systems of cracks or fractures. The non-DC components can be exploited for characterizing the mode of fracturing and for determining rock properties in the focal zone. Using the model of shear-tensile earthquakes, the non-DC components can be used for distinguishing whether the crack systems are opening or closing and the opening/closing angle between the slip and the fracture plane can be evaluated. Furthermore, the vP/vS ratio of rocks in an isotropic focal zone or the tensor of elastic parameters in an anisotropic focal zone can be determined.