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Seismic moment tensor: a review

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A seismic moment tensor (SMT) is the most complete characteristic of an earthquake source in an instant point source approximation, i.e., when analyzed wavelengths significantly exceed source dimensions. In general, the SMT has six independent components and can be decomposed into isotropic and deviatoric parts. The isotropic part describes a volume change in an earthquake source. Usually, its estimates are characterized by significant errors. Therefore, in routine procedures used, for example, in the Global Centroid Moment Tensor Project, only the deviatoric SMT is determined. In turn, the deviatoric SMT can be represented as a sum of compensated linear vector dipole (CLVD) and double-couple components. The CLVD-component describes a complex geometry of a fault plane and, as a rule, is observed in sources of large tectonic earthquakes or volcanic seismic events. The double-couple component relates to a shear planar dislocation. The double-couple model well satisfies sources of a major part of small to even large earthquakes. In this approximation, the SMT can be constrained by a scalar seismic moment and earthquake focal mechanism. An earthquake focal mechanism can be determined by parameters of nodal planes (strike, dip, and slip angles) or by orientation of principal stress axes. One of the nodal planes is a fault plane and the second nodal plane is auxiliary.

In this review, some methods of SMT calculations, mainly used in international seismological agencies, are briefly discussed. Special attention is paid to determination of an earthquake focal mechanism from P-wave first-arrival polarities, as it is still the most common approach to constrain parameters of a seismic source in a double-couple approximation. The requirements to initial data and their quality are formulated. Finally, some applications of data on earthquake focal mechanisms for various geological and geophysical tasks (calculations of the crustal stress-strain field and a seismotectonic analysis) are illustrated.