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Amplitude ratios for source mechanism retrieval – the shear-tensile crack vs. moment tensor approach

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Determination of source mechanisms introduces several troubles. In seismic data both the effects of source and the propagation are coupled. To decouple the effect of propagation when parameters of the source are searched, response of the medium between the focal zone and seismic stations should be well known. As simplified structural models only are usually available, all model uncertainties are harmfully reflected in the source mechanism. Contrary to amplitudes of seismic body phases themselves, their ratios are less vulnerable to the mismodeling of the earth structure, as their ray paths are similar. Therefore, amplitude ratios have been advantageously used to determine the earthquake mechanism. Additional benefit of processing of amplitude ratios instead of absolute amplitudes is lifting the demand for a precise calibration of the instrument. The drawback of the approach is a non-linearity of the problem.

We developed a method of inversion of amplitude ratios (SV/P, SH/P) and P-wave polarities to determine source mechanism. To get a better control over the appearance of non-shear components in the mechanism, we search for two kinds of source models capable to describe non-double-couple source components like tensile crack opening. In the first place we applied the unconstrained moment tensor (MT) source model. However, synthetic tests showed that orientation of nodal planes was distorted and spurious non-double-couple components appeared. Therefore, we also invert for an alternative source model - shear-tensile crack (STC), which can simulate the traditional shear slip, optionally combined with an opening or closing the fault. It is represented by a slip along the fault with an off-plane slip component, and can be described by four angles pointing the fault plane normal and non-orthogonal slip vector, and the magnitude. Decreasing the number of model parameter from six to four when working with amplitude ratios implies an enhanced robustness, which is important especially in sparse monitoring configurations. We demonstrated it on a series of synthetic experiments, where the dominance of the STC approach over the traditional MT is manifested.