Methods for determining focal mechanisms in laboratory experiments

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In laboratory experiments, acoustic emission (AE) caused by the deformation of geomaterial reflects changes in the strength and stress state of the sample. By analogy with the solution of focal mechanisms of earthquake sources, there are several methods for determining the mechanisms and types of AE sources using the amplitudes and signs of the first arrival of an elastic wave on sensors that register acoustic signals. With 16 receiving acoustic sensors, the number of polarity determinations of the incoming wave usually does not exceed 5-10, while the sign determination on some sensors is often incorrect due to the omission of the first half-period of the weak signal by the automatic registration algorithm. This reduces the reliability of determining the mechanism of the focus in laboratory tests of rocks by well-known methods based on the distribution of signs of the first arrival of the AE wave. We propose a method for determining the directions of the axes and the values of compression and tension in the AE source. The algorithm uses information about the coordinates of events and receivers, values of amplitudes and signs of the first half-period of P-waves coming to the receivers. In this case, the model of the AE source is assumed as a quadrupole with compression and tension axes. The source-receiver distance, the directional diagram of the receiver, and the emission diagram of the source are taken into account for each of the receivers to calculate the value of displacements in the source. To test the proposed algorithm and compare it with the known methods, there was developed a program for generating an acoustic signal source of a given type with random coordinates and directions of the compression and tension axes. An array of signs and amplitudes of the first arrivals coming to the receivers was calculated from simulated data. The high efficiency of the proposed algorithm was shown. The usage of this method together with the determination of AE event types [Zang et al., 1998] in real laboratory experiments allows us to characterize the prevailing processes of destruction during separate phases of the experiment on triaxial loading of rocks in more detail. The developed algorithm makes it possible to determine the directions of the axes and the values of compression-tension with a minimum number of signs of the arrivals of P-waves, to estimate the components of the seismic moment tensor and obtain more complete information about the mechanism of the AE source.

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