Determination of seismic moment tensor of acoustic emission events at three-point bending of marble

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This paper is devoted to the development and hardware/software implementation of a set of algorithms aimed at determining the seismic moment tensor of acoustic emission events recorded in laboratory experiments. Full information on the seismic moment tensor for a specific event allows determining both its mechanism and the orientation of the rupture plane together with the direction of displacement. The decomposition of the acoustic emission source mechanism into a spherical component and two deviators provides additional information about the dominant contribution of a particular deformation mode.

Algorithms for the seismic moment tensor components existing in seismology require significant modernization and adaptation to apply acoustic emission data. The set of algorithms developed by the authors includes: an algorithm for determining the P-wave arrival time, a two-step method for specifying the solution of a spatial location problem based on the USBM method, a procedure for absolute calibration of acoustic emission sensors and subsequent deconvolution of wave forms to determine the absolute magnitude of the P-waves, as well as three-step algorithm for determining the seismic moment tensor and its refinement. At the first stage, the solution found for the components of the seismic moment tensor is refined using the hybrid algorithm for inversion of the seismic moment tensor [1]. At the second stage, all solutions found are checked for resistance to variations in the amplitudes of the waves registered by the antenna (according to the method proposed in [2]). At the third stage, for the remaining solutions, the rms discrepancy between the registered amplitudes of displacements and theoretically predicted is calculated, and those solutions are rejected, the discrepancy for which also exceeds 50%.

Testing of the developed set of algorithms was carried out on acoustic emission data obtained at three-point bending of Koelga marble samples. The tasks of determining and clarifying the mechanisms of acoustic emission events are consistently solved. After the third stage of refinement from the original 1669 decisions of the mechanisms of the sources of acoustic emission, 557 remain. It is established that the overwhelming majority of the mechanisms relate to cracks of normal separation (collapsing and opening) with different magnitudes of the additional shear component. In the direction of movement, the found mechanisms of acoustic emission sources are faults and thrusts. It is also shown that in the first half of the experiment on bending marble samples, the number of acoustic emission sources with positive (opening) and negative (closing) ball parts grows consistent and proportionally, whereas closer to the moment of appearance of a macroscopic crack, the number of opening cracks begins to predominate.

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