Method for reconstruction of coal-rock mass stress state: inverse problems solution by seismic tomography data

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Diagnostics and forecast of the state of geotechnical objects of various scale levels, geomechanical justification of mining technologies for mineral deposits, control of the wellbore trajectory during inclined, horizontal and multilateral drilling - the solution of these and many other problems requires an assessment of the stress field in coarse of mining.

Theoretically substantiated and tested on a real object a method that allows using a complex of geotechnical, geomechanical and geophysical information to reconstruct the stress-strain state of a rock mass during the development of solid commercial minerals deposits. The approach includes: lab experiments on biaxial loading of rock samples; passive tomography of the mined section of the deposit using the data of the standard shooting scheme and pulses from dynamic events (with energy exceeding the background level) as probing signals; formulation and solution of the inverse coefficient problem of determining the boundary conditions for the geomechanical model of the object under consideration, the input data for which is the velocity field reconstructed as a result of tomography in the illuminated part of the reservoir.

Coal samples were tested (von Karman scheme), the approximation of the results made it possible to obtain analytical dependences “longitudinal wave velocity - axial stress and confining pressure”.

Numerical experiments performed for a typical configuration of the mined out space during conveyor mining of coal seams in the coal-pits of Vorkutaugol JSC showed that, with the configuration of the standard shooting scheme for the unambiguous solvability of the formulated inverse problem, good illumination of areas of the seam with an increased spatial stress gradient, as well as the presence of a regular component in the frequency range of the order of hundreds of hertz in the probing signal generated by the mining machine and/or equipment for the mechanization of mining operations.

The proposed approach allows, within the framework of the geomechanical model, to monitor the stress-strain state of the rock mass during the development of mining operations.

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