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Methods of seismic zone localization in the highly stressed geological environment in mining natural-engineering system

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During developing mineral deposits in the geological environment the anomalous energy-saturated zones (parts of highly stressed rocks) are being formed. As a result in the rock mass rockbursts and mining-induced earthquakes occur. The largest mining-induced earthquakes (M 4.0 – 4.2) were registered at the mines of the Khibiny and Lovozersky massifs of the Kola Peninsula. The energy-saturated zones migrate subject to displacement of front of working faces. Location and dimensions of the zones are estimated according to data of analytical investigations and experimental determinations in the rock mass. In some cases (for example, when developing blocks-pillars and transition zones between open and underground mining operations or adjacent mines) all the mining area is a united energy-saturated zone, where the main problems occur concerning mining workings stability management, and under rockbursts hazardous conditions there occur problems concerning mining-induced seismicity manifestations.

Parameters of geological environment seismic emission are objective indicators of geological environment energy-saturation. The assessment of their changing is a basis of methods of seismic zones localization and detection of their migration during mining operations development.

To assess a current state and determine conditions of transition of geological environment parts into the critical state there carried out investigations concerning space-time regularities of rock mass seismicity parameters changing in the mines' geomechanical space.

The following parameters are considered as characteristics of rock mass seismicity: fractal criterion, dip angle criterion for seismic events recurrence graph, concentration criterion, and criterion of fissures' average length. A complex assessment of single parameters range is applied to get the better results. The analysis also takes into account influence of deterministic factors: fracture disturbances and stope face boundaries.

Analysis was carried out of changing parameters of seismicity in the Kukisvumchorrsky and Uksporsky sides of the United Kirovsky mine owned by "Apatit" JSC. As a result there were determined an average value of a complex assessment before large seismic events (10^6-10^8J), as well as minimum and maximum values.

Based on investigations carried out there was made a classification of seismic active zones according to types of their possible development. Four types of seismic active zones were determined: increasing, pulsatory, stable and attenuated ones. The most dangerous rock mass parts are those with increasing and pulsatory seismic active zones revealed. Seismic active zone can transfer from one type to another, i.e., there can be selected stages of preparation of a large seismic event or series of events, what is an important prediction stage.

Thus, based on analysis of dynamics of complex assessment and configuration of seismic active zones there can be determined periods of rock mass parts transition into the hazardous or safe state. Diminution of complex assessment values indicates usually beginning of rock mass parts transition into the safe state. It is a basis for development of preventive measures to prevent manifestations of mining-induced seismicity.