Geophysical Research Abstracts
Vol. 15, EGU2013-351, 2013
EGU General Assembly 2013

Mining-induced seismicity prediction in the Khibiny mines by complex of precursors

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Problem of mining-induced seismicity is important now for many world regions with an advanced mining industry, including the Khibiny massif region (Kola Peninsula). Studying of seismic activity in rock mass and prediction of rockbursts and mining-induced earthquakes for exploited deposits is carried out using complex assessment method.

The following precursors are considered to be rock seismicity characteristics: decreasing fractal dimension, b-value, concentration, and average length of fractures These precursors are analyzed by complex assessment method developed. Influence of determinative factors is taken into consideration as well: presence of discontinuous disturbances, stope zone limits and edge of falls of the hanging wall rocks.

Changing of the complex assessment is considered in space and time. It has been determined that there are increases of complex assessment values and seismically active zone size before a strong seismic event or events series. Timely detection of the focal source forming is an important stage of the prediction.

The program MIEPS was developed to automate the calculations. By this program we can analyze the seismicity in both real-time and retrospectively.

One of successful prediction by complex assessment is detection of main fault forming and occurrence of roofing failure in the United Kirovsky mine, “Apatit” JSC. A precursor was detected 3 days before seismic events group occurrence (10^5-10^7J). In this time a complex assessment value changed from 0.49 to 0.54 (transfer of stable seismic zone to increasing seismic zone), and a seismic active zone increased in 1.5 times within 24 hours. Factors determining the region’s seismicity are high horizontal stresses in the rock mass, long-term exploited deposits and seasonal rock watering. They result to blocks movements on faults. The blasting of blasthole rings in this part of the rock mass (23.05.2012) triggered growing of the main fault, accompanied by seismic events (energy $< 2 \cdot 10^7$J). This caused rocks self-caving.

Complex assessment method of seismic setting using different precursors allows immediate analysis of the monitored rock mass part. At present the complex assessment method and the software are tested at the mines owned by “Apatit” JSC.