

Impact of mining operations on the seismic activity in the rock mass of the Khibiny underground mines

Kagan M.M. (1), Kozyrev A.A. (1), Motorin A.Y. (2), Streshnev A.A. (2)

(1) Mining Institute KSC RAS, Apatity, Murmansk region, Russia

(2) Kirovsk Branch of JSC Apatit, Kirovsk, Murmansk region, Russia

e-mail: ayumotorin@phosagro.ru

The paper presents the results of the spatial - temporal analysis of seismic activity in the rock mass of the Khibiny underground mines, produced with the sublevel caving with the end ore drawing. The analysis was based on the results of the seismic monitoring data gathered from 2019 to 2020 at two mines of the KB Apatit JSC. The total volume of the data array amounted to more than 60,000 events registered during this period by the seismic station of the KB Apatit JSC. The analysis was based on the empirical function of the blast impact assessment.

It has been established that in the vast majority of cases (about 80%), the seismic activity in the mine fields occurs in the places of driving and stoping operations with the use of blasting.

The analysis has revealed two types of seismicity occurrence: seismicity in the working zones related to technological blasting, and natural seismicity determined by structural-geological factors.

In general, the difference in the characteristics of seismicity occurrence is as follows:

1. Seismic activity after blasting fades in time, similar to aftershocks after large earthquakes. At that, seismic events that occurred with a short delay time from the moment of blast, i.e. such, which may be the result of the direct impact of shock waves from blasts, are practically absent in the analyzed data.

2. As the stoping front approaches, the blasts activate areas in the mine field that are close to the ultimate state in the form of spatially compact clusters of seismic events.

3. Seismic activity in the zone of technological blast impact is represented by less energetic seismic events in comparison with seismic activity outside of it (the b-value for seismic events inside the zone is twice as large as outside of it).

Significant differences in the characteristics of seismic activity in the identified zones can be interpreted as follows: seismic activity in the technological blast impact zone is associated with the cracking processes during redistribution of stresses during mining operations, while outside the blast impact zone the seismic activity is determined by tectonic processes and processes associated with global reorganization of the stress-strain state of the rock mass as the deposit is mined.