

Seismic monitoring system of the industrial site of the Vostochny mine of the KB JSC "Apatit"

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In 2020, employees of the Kola branch of the FRC EGS RAS, within the framework of an agreement with the Kirovsk branch (KB) of Apatit JSC, began work on the creation of an automated system for seismic monitoring of the industrial site of the Vostochny mine of the KB JSC Apatit (ASSM VM).

In seismic monitoring of open pit and underground mining sites, it is important to ensure the maximum accuracy in determining the hypocenters of seismic events and the minimum energy threshold for registration. These two parameters are extremely important in terms of identifying possible activated structures for further taking measures to reduce the risks of mining operations.

The accuracy of determining the coordinates of seismic events is largely controlled by the geometry of the location of the elements of the network of seismic stations. At the design stage of ASSM VM at the KB FRC EGS RAS, work was carried out to determine the maximum possible location errors using mathematical modeling methods. The initial positions of the seismic stations were chosen to ensure uniform azimuthal coverage of the controlled area, the availability of conditions for providing power, and also taking into account the production plans for the development of the mine for the life of the system.

An equally important factor in improving the accuracy of determining the hypocenters of seismic events is the use of the most realistic models of the natural environment in which seismic waves propagate. In local seismic monitoring of small objects - when the expected epicentral distances (distance from the seismic station to the source) are commensurate with the linear dimensions of natural or man-made relief elements (as in the case of quarries or mines) it is important to take these factors into account when building velocity models and tables of travel times of body seismic waves. To this end, a three-dimensional model of the environment was developed for the controlled area, taking into account both the natural terrain and the excavation volumes. To locate seismic events in such a model of the environment, special algorithms were developed that use not tables of wave travel times, but tables of so-called "pseudo-velocities" for each station depending on the wave approach azimuth, distance, and depth.

As a result, a network of 12 seismic stations was created. Registration of ground vibrations is carried out by velocimeters HS-1 coupled with digitizers "Ermak-5". Data is transferred to the storage and processing server in real time via Internet. Autonomous systems based on wind turbines are used to power part of the seismic stations.

The results of ASSM VM operation for 2020-2021 revealed zones of manifestation of natural seismicity in the controlled area. The accumulation of seismic monitoring data makes it possible to observe seasonal variations in seismic activity. The first results of the system operation will form the basis of decisions to reduce the risks of mining operations in the open pits of the Vostochny mine of the KB JSC "Apatit".