SECOND EUROPEAN CONFERENCE ON EARTHQUAKE ENGINEERING
AND SEISMOLOGY, ISTANBUL AUG. 25-29, 2014

SEISMIC CALM PREDICTORS OF ROCKBURST IN PRODUCING DEPOSITS IN RUSSIA

Tatjana ZMUSHKO[1] and Sergey TURUNTAEV[2]

Seismic events associated with mining operations are observed in more than half of the producing deposits in Russia.

For natural seismicity there is a method for forecasting of strong seismic events, which is known as a "seismic calm" [Sobolev, 2003]. The method is based on observation of significant decrease of the weak seismic event number (with energies of several order smaller than the main shock) during some time period before the main earthquake. Here we will check the applicability of the seismic calm method for forecasting rockbursts on Vorkuta, Tashtagol and Barentsburg mines.

This method is based on the model of unstable cascade fracturing, which describes the phenomena of interaction between stress area of fractures and localization of cracking process at some stage. According to the model, on the first stage the fracturing is statistically homogeneous in space, an increase of stress leads to increase of fracture density. After excess of some critical level the fractures begin to interact with each other, which activate more rapid growth on the second stage of process. This stage is characterized by strain and porosity growth. The third stage is characterized by cracks extension in some local area and corresponding decrease of stress and strain in environment. On the forth stage big cracks consolidate with each other in local area and main fracture forms, which reduce to earthquake.

This method was used on three Russian deposits: Vorcuta coal basin, Tashtagol iron rock deposit and Barentsburg coal basin.

Vorkuta coal deposit is located in the northeastern part of the Vorkuta coal- bearing area, Komi Republic, Russia. Seismic event with M = 2.3 occurred at the North mine in July 16, 2011 at 18 hours 01 min. The events precedent to this rockburst for 6 months were considered. The rate of events with M=1.2 and M=1.5 almost hasn't change, and the number of events with M=0.9 and especially M=0.6 before the rockburst has decreased, which corresponds to the prognostic seismic calm. Isoclines of the number of seismic events occurred during 6 months before the rockburst showed that there is an area where the wall (left pane) was developed during this period, and the area where the airway broke slope (right) was holed (Fig.1). Thus, an area where the production didn't occur, but where seismic events were recorded, could be noticed before the moment of the rockburst.

Barentsburg is the second largest settlement on Svalbard, Spitsbergen, 78°N. The Russian-owned Arktikugol has been mining coal here since 1932. The mine is dangerous of sudden outbursts of coal and rockburst. Two strongest events were chosen from continuous parts of the regional catalog for natural and mine-induced seismicity. The event with K=6,7 (K=lgE), M=1,8, is sufficiently strong for mine-induced seismicity (it can lead to significant damage in the mine), but the event with K=8,5 is really weak for natural seismicity, so the precursors of this event are presumably not so strongly expressed. Some drop of seismic activity was noticed in both cases, but these events are not so strong for good expressed forecast.

[1] PhD, MIPT, IDG RAS, Moscow, tzmushko@gmail.com
[2] Professor, IDG RAS, Moscow, s.turuntaev@gmail.com

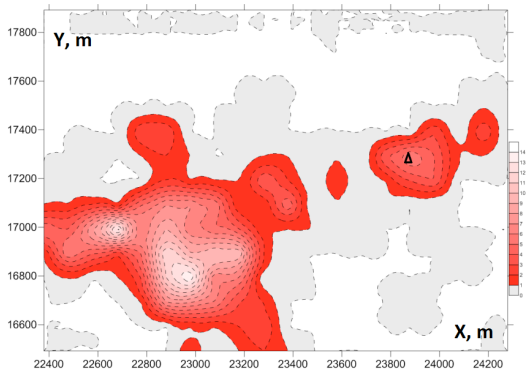

Figure 1. Isoclines of number of events

Tashtagol is an ore deposit, which was discovered in 1911 on Altai. The rockburst hazard in Tashtagol mines is very high. Eight strong events with M>1.5 were considered. Some decrease of number of events and summarized cubic roots of seismic energy was noticed before rockbursts in comparison with the level after it. The decrease wasn't distinctly expressed because in the period when strong events prepared, there were some technological blasts with different energies. These explosions led to changing in the stress-strain state of the rocks. Because this method is based on the theory of natural earthquake prediction, where a strong event is prepared without the influence of induced strong events, a relatively short period and class events, as well as a large number of induced events make forecast to be uncertain.

Our study shows the applicability of the method, based on the idea of seismic calm, for forecasting rockburst at Vorkuta coal mines analyzing the seismic monitoring data. We try the method of seismic calm on seismic data in the region of Barentsburg coal deposit (Spitsbergen) and Tashtagol ore deposit. At the present time due to a small number of observed strong seismic events in Barentsburg it's hard to judge the reliability of the method for forecasting rockburst, but the seismic monitoring should be continued, because the previous data indicated the presence of strong rockbursts at Barentsburg mine in the past. In Tashtagol the forecast is very hard because of technological blasts, which change stress-strain state of rocks.

REFERENCES

Adushkin V, Turuntaev S (2005) Induced processes in the crust (hazard and disaster), INEC, Moscow

Goncharov A, Kulikov V (2010) "Geodynamic events in Vorcuta coal basin", *Trigger effects in the geosystems,* Moscow, 272

Sobolev G, Ponomarev A (2003) Physics of earthquakes and warnings, Moscow, 270

Tomilin N, Damaskinskaya E, Pavlov P (2005) "Statistical kinetics of rock fracture and forecasting of seismic events", *Solid state physics*, 47(5): 955-959

Eremenko A, Eremenko V, Gaidin A (2009) Mining-geological and geomechanical conditions for development of iron-ore deposits in Altai-Sayan folded area, Nauka, Novosibirsk