



## Seismic calm predictors of rockburst

Tatjana Zmushko (1,2), Sergey Turuntaev (1), and Vladimir Kulikov (1)

(1) IDG RAS, Moscow, Russian Federation, (2) MIPT, Moscow, Russian Federation

The method of “seismic calm” is widely used for forecasting of strong natural earthquakes (Sobolev G.A., Ponomarev A.V., 2003). The “seismic calm” means that during some time period before the main earthquake, the smaller events (with energies of several order smaller than that of the main earthquake) don’t occur. In the presented paper the applicability of the method based on the idea of seismic calm for forecasting rockburst is considered. Three deposits (with seismicity induced by mining) are analyzed: Tashtagol iron deposit (Altai, Russia), Vorkuta (North Ural, Russia) and Barentsburg (Spitsbergen, Norway) coalmines. Local seismic monitoring networks are installed on each of them. The catalogues of seismic events were processed and strong events (rockbursts) were studied (Vorkuta  $M=2,3$ ; Barentsburg  $M=1,8$ ; Tashtagol  $M=1,9 \div 2,2$ ). All catalogues cover at least two years (Vorkuta – 2008-2011, Barentsburg – 2011-2012, Tashtagol – 2002-2012). It was found that the number of seismic events with magnitudes  $M=0,5 \div 1$  decreased in a month before the main strong event at Vorkuta coalmines. This event was not directly related with coal mining, its epicenter was located aside of the area of coal mining. In Barentsburg mine the rockburst wasn’t so strong as in Vorkuta. The number of events with energies  $M=0,5$  decreased slightly before the rockburst, but not so obviously as in Vorkuta case. The seismic events with high energies occur often at Tashtagol iron deposit. Mining methods used there differ from the coal deposit mining. At coalmines the mining combine runs from edge to edge of the wall, cutting off the coal. The considered iron deposit is developed by a method of block blasting. Not all rockbursts occur immediately after the blasting, so, the problem of the rockburst prediction is important for mining safety. To find rockburst precursors it is necessary to separate the events occurred due to the block blasting from the seismic events due to relocation of stresses in the rocks. Only the events of the second type should be used if one is looking for the rockburst precursors. As the result of the analysis, the decrease of number of events with energies  $M=0,5$  was noticed only in 65% of considered cases. Meanwhile, some diminishing of the seismic activity was detected in all mines, so the “seismic calm” precursor of the strong rockbursts (which are not immediately follow the blasting) should be considered more thoroughly in application to mine seismicity.