

Seismicity of the east-bay section (Khakassia): discrimination of weak earthquakes and explosions

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The report focuses on the problem of the discrimination of industrial explosions and earthquakes based on spectral analysis of seismograms of events located in the area of the East Beysky coal mine (Khakassia).

In the study of regional seismicity one of the important tasks is to divide the earthquakes and industrial explosions. This problem is especially important for the surroundings fields, where the development of mineral resources is carried out using explosions.

At the present time it published numerous works devoted to the discrimination of explosions and earthquakes. The criteria for separation are the ratio of the amplitudes of seismic waves (P/S, Pg/Lg), the form of seismic trace, the polarity of P-waves, the existence of a surface waves, the spectral characteristics of seismograms, and others. In areas of high seismicity and lots of explosions also used "random" approach: all weak events that took place in the daytime in an area where blasting operations carried out automatically ranked as explosions. Obviously, that all noted criteria can change depending on geological patterns, depth of explosion and etc. In this paper, we attempt to distinguish the useful criteria for discrimination of earthquakes and industrial explosions for the local area around the East Beysky coal mine (Khakassia).

For analysis we selected 22 industrial explosions (with magnitudes $M=1.2-2.3$) and 6 earthquakes (moderate Abakan earthquake 12 December, 2013, $M=4.9$ and five its aftershocks with $M=0.8-2.2$). We tested different approaches: simple visual analysis of seismograms (the form of seismic trace, the polarity of P-waves, the presence of a surface waves, P/S and Pg/Lg ratios), filtering records by narrowband filter system, calculation of the Fourier spectra and analysis of spectrograms. Analysis of the industrial explosion seismograms showed that the P/S and Pg/Lg ratios can vary greatly; for some events on the record clearly visible S-wave is. The duration and amplitude of the surface wave also varies greatly for different explosions. According spectra comparison, the explosions are characterized by a low-frequency radiation relatively to earthquakes. In general, the explosions are characterized more complex spectra with peaks in the low frequencies. Spectrograms, showing the radiation intensity and the frequency content with time, are significantly more informative. For earthquakes, maximum radiation is observed for the shear waves (4 to 25 Hz range), and its low-frequency component of the radiation decays rapidly. The second maximum of radiation (weaker, higher frequency) corresponds to P-waves. For explosions, maximum radiation locates at P-waves (4 to 25 Hz), the intensity of the radiation of S-waves is much lower) and the surface waves are very well defined. Explosions are characterized by more rapid attenuation of high-frequency component of radiation compared with earthquakes. During the work, it was found two weak earthquakes, previously defined as explosions.

The use of a variety of criteria of discrimination earthquakes and industrial explosions to the area of the East Beysky coal mine showed that the most informative is the use of spectrograms.

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