

Abstract

PhD dissertation presents the results of a multi-criteria assessment of the occurrence of geogasodynamic phenomena in a coal deposit prone to rock bursts in longwall areas. Geogasodynamic phenomena occur as a result of destruction of the rock mass structure and are caused by stress relief or rock burst, and sometimes by blasting works. Their indispensable effect is the outflow of gases such as methane.

The parameters of co-occurrence of rock burst and methane hazards, which would make it possible to assess the mining area in terms of geogasodynamic hazard, have not been established so far. There are also no criterion values of parameters for assessing the level of potential geogasodynamic phenomenon hazard. No studies have been carried out that would make it possible to determine the parameters enabling the occurrence of such phenomena resulting from the conditions of longwall exploitation. The knowledge of such a hazard would make it possible to develop appropriate and, most importantly, effective prevention of such events.

The dissertation was aimed at broadening knowledge on geological and mining conditions in mining underground areas where geogasodynamic phenomena have occurred and may occur. Also an identification of values of criterion parameters characterizing the underground mining areas in terms of the threat of geogasodynamic phenomena was important during the study. Moreover, the PhD dissertation proposes the use of geogasodynamic hazard assessment criteria for ongoing assessment of the mining areas in terms of this hazard. It was also proposed to use this criteria to assess the potential level of the hazard at the stage of designing the exploitation, which will make it possible to optimise the development of the deposit and adjust the prevention in the exploitation area to the level of this hazard.

The study presents analysis of geological and mining conditions and effects of geogasodynamic phenomena occurring in 1996-2019 in the Polish hard coal mining industry. The studies on conditions occurring at the time of geogasodynamic phenomena were carried out both for longwall areas and for places outside these areas. This concerned 6 selected phenomena occurring in longwall areas and 6 phenomena occurring outside these areas. For each of these phenomena, the following conditions were presented: geological and mining conditions, forecasted rock mass tremor energy, seismic activity, methane content of the seam and adjacent seams, forecasted absolute methane-bearing capacity, actual absolute methane-bearing capacity, location of the tremor focus and its energy, concentration and volume of released gas.

As the negative effects of geogasodynamic phenomena are much greater in the longwall areas than outside of it, the remaining part of this study focuses on the longwall areas. Therefore, 20 factors defining geological and mining conditions as well as geodynamic and gas-dynamic factors were analysed, from which 12 key factors were selected for the purpose of assessing the potential level of the geogasodynamic phenomenon hazard. These factors are related to the geosphere, to the gasiness of the coal bed and to the dynamics of seismic phenomena.

For each of the factors considered as significant - C_{1-12} - a spectrum was determined and boundary parameters were adopted, delimiting three areas of intermediate values, defining the level of potential hazard of geogasodynamic phenomenon in the longwall area, as:

- potentially low level,
- potentially medium level,
- potentially high level.

The classification of a given longwall area as belonging to a specific level of potential geogasodynamic hazard is determined by the number of occurring C_i geogasodynamic factors and the sum of weights w_i attributed to each factor C_{1-12} . At the same time, 10 factors C_{1-10} were taken into account for preliminary assessment of potential hazard level, which is carried out at the stage of designing the method of exploiting the seam, as two factors - actual absolute methane-bearing capacity C_{11} and actual seismicity C_{12} - may be taken into account only for the running assessment of a longwall exploitation. Therefore, criteria were defined for factors related to the geosphere around the coal seam, to the gasiness of the coal seam, to the dynamics of seismic phenomena and to factors occurring during the longwall operation. The assessment of the level of potential hazard of geo-gasodynamic phenomena in the area of an active longwall was based on multi-criteria indicator of potential hazard of geogasodynamic phenomena called WZGGD. Its value is determined by the sum of the values of w_i weights ascribed to each of the three groups for each of the analysed C_i factors:

- in case of the assessment of the operating longwall it is $WZGGD^{12} = \sum wC_{1-12}$,
- in case of the assessment of the area of the planned longwall, it is $WZGGD^{10} = \sum wC_{1-10}$,

and then its level is determined - depending on its value - of potential hazard of geogasodynamic phenomenon.

In the area of the operating longwall there is:

- potentially low level $P1$, if $WZGGD^{12} < 5$,
- potentially medium level $P2$, if $5 \leq WZGGD^{12} < 9$,
- potentially high level $P3$ if $WZGGD^{12} \geq 9$.

In the area of the designed longwall, the level of potential geogasodynamic hazard is assessed taking into account 10 factors ($n = 10$) using the formula:

$$WZGGD^{10} = \frac{(\sum wC_{1-10}) \cdot 12}{n}$$

In order to verify the accuracy of the adopted multi-criteria assessment of the occurrence of geogasodynamic phenomena in coal beds prone to rock bursts in longwall areas, values and parameters for the phenomena described earlier in the dissertation and occurring in each of the analysed six longwall areas were used. The values of index $WZGGD^{12}$ and index $WZGGD^{10}$ determined for each of the examined longwalls confirmed their classification to a potentially high level.