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NEW RECOMMENDATIONS IN THE AREA OF PREDICTION AND PREVENTION OF ROCK AND GAS OUTBURSTS IN THE CZECH REPUBLIC

NOVE PREPORUKE U PODRUČJU PREDVIĐANJA I PREVENCIJE GORSKIH UDARA I IZBOJA PLINA U REPUBLICI ČEŠKOJ

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Abstract

Rock and gas outbursts still represent one of mining risks that has caused considerable loss of life of mine workers and economic losses.

With reference to the fact that outbursts have occurred and will continue to occur, it was necessary to make an analysis (Hudeček, 2008) of previous outbursts and existing and previously acquired parameters of prediction and prevention methods.

In the article, the authors present recommendations and proposals for changes in the area of rock and gas outburst prediction. These proposed changes should be reflected in the increased efficiency of control of this anomalous geomechanical event.

Sažetak

Gorski udari i izboji plina još uvijek predstavljaju jedan od rizika u rudarstvu koji izaziva značajne gubitke života rudara i ekonomske gubitke.

Vežano uz činjenicu da se gorski udari i izboji plina pojavljuju i da će se nastaviti pojavljivati u budućnosti bilo je neophodno napraviti analizu (Hudeček, 2008) prijašnjih akcidenata te postojećih i ranije određenih čimbenika vezanih uz predviđanje i metode prevencije.

U članku, autori predstavljaju preporuke i prijedloge za promjene u području predviđanja gorskih udara i izboja plina. Ove predložene promjene se trebaju reflektirati u povećanoj efikasnosti kontrole ovih geomehaničkih anomalija.

1. Introduction

Rock and gas outbursts belong to complicated anomalous geomechanical events occurring in specific mine-geological conditions. The occurrence of this gas-dynamic event affects negatively above all the safety (Adamus et al, 2011) of mine employees and mining operations; moreover, it affects adversely the selection of technology and the economics of mining. To eliminate maximally the outburst events, quite a number of prediction methods and preventive measures have been developed.

At present, the Ordinance of Ostrava Regional Mining Authority Ref. No. 3895/2002 of June 6, 2002 on ordering necessary measures to ensure occupational safety and health and safety of operations for rock and gas outburst-prone mines (Directive, 3895/2002) is in force.

The aim of the project (Hudeček, et al., 2009) was to acquire new knowledge of the area of rock and gas outbursts and to recommend amendments to regulations in the given area and also to prepare new safety regulations. (Zarębska et al., 2002)

2. Proposal for recommendations in the area of rock and gas outburst prognosis

We recommend that prognoses should be divided legislatively as follows:

- **regional - for outbursts of coal and gases; sandstones, conglomerates and gases**
- **local - for outbursts of coal and gases; sandstones, conglomerates and gases**
- **continuous – for outbursts of coal and gases; sandstones, conglomerates and gases.**

3. Regional prognosis

3.1 Regional Prognosis of Coal and Gas Outbursts

It has not been legislatively specified yet, and for this reason it is not carried out. The introduction of the regional prognosis would make it possible to define more specifically areas of the mine allotment (part of the rock mass) with regard to classification according to the degree of coal and gas outburst hazard.

The regional prognosis of rock and gas outbursts is the basic analytical element of assessment of this risk in every deposit and predetermines the classification of parts of the rock mass and/or of individual coal seams. This sphere of rock mass assessment is based exclusively on the assessment of natural conditions of the given locality and the extent depends on the degree of its exploration.

The basis of the proposed regional prognosis of rock and gas outbursts is comprised of

- the structural-tectonic conditions of the rock mass,
- lithology of the sequence of strata,
- strength properties of rock mass,
- gas properties.

3.2 Regional Prognosis of Outbursts of Sandstones, Conglomerates and Gases

The proposal for the regional prognosis of outbursts of sandstones, conglomerates and gases is based on existing experience in these anomalous gas-dynamic events recorded in the deposit. This experience confirms unambiguously the fact that anomalous gas-dynamic events of this type occur on contact between the Carboniferous rock mass and the overburden. From this experience, the focus of regional prognosis on properties connected exclusively with these parts of the deposit follows. The properties are as given below:

- properties of the Carboniferous relief,
- character of the overburden (above all gas and hydrogeological properties).

4. Local prognosis

4.1 Local Prognosis of Coal and Gas Outbursts

The proposal for the engineering process of determination of first order indicators has to be modified. A condition is the drilling of such boreholes constructed for prognosis purposes that will enable the measurement of gas parameters in the seam part not influenced by implemented prevention measures yet.

- change in tests of local prognosis (TLP)

To ensure objectivity in the measured gas parameters, the verification of the parameters at a distance of at least 5m (original borehole length was 3 m - measurement was consequently done at the area affected by driving) ahead of the advancing face of the mine working is absolutely necessary. In this case, it means a modification in used equipment for the measurement of the gas pressure parameter, which consists in an extension of the Engler needle so that the prescribed length of the measuring chamber may be kept.

- change in location of special long boreholes drilled for prognosis purposes (SLPB)

Special long operating boreholes have so far been used only for classifying of coal faces to level of danger and were implemented to the side in the direction of the work under consideration faces (perpendicular to the mine working).

We propose to drill special long boreholes carried out for prognosis purposes to verify classifying the seams and mine workings as of relevant degrees of hazard in the framework of local prognosis, in the axis of the mine working. SLPBs are drilled in the course of driving the mine working and the tested part has to be at least 30 m long. This means that the measurements will be done in parts delimited like that always in 6 SLPBs., following one after another. The measurements of the parameters are made in individual SLPBs every 1m from the depth of 5m; the measurement interval of 5 – 6 m being the first one. The total length of SLPB is 10 m. The locations of boreholes for the measurement of gas pressure, initial gas production and long-term desorption in the framework of local prognosis performed by means of SLPBs are given in Figures 1- 3.

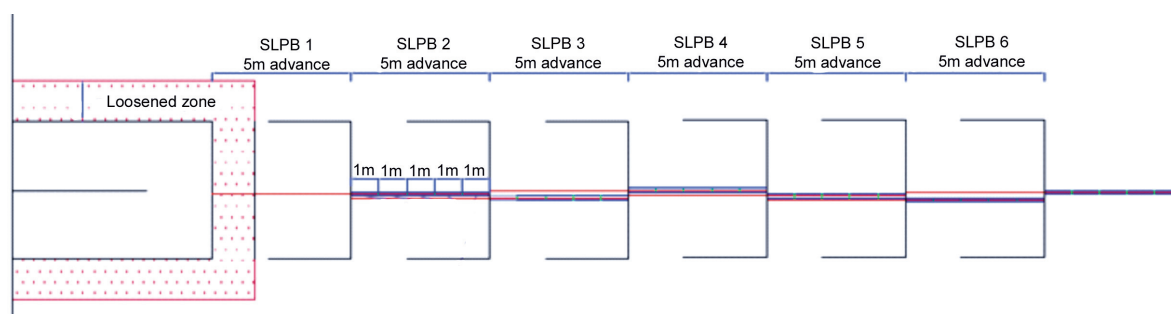


Figure 1. Diagram for the measurement of local prognosis carried out by means of SLPBs

Slika 1. Dijagram za mjerenje lokalne prognoze pomoću SLPB-a

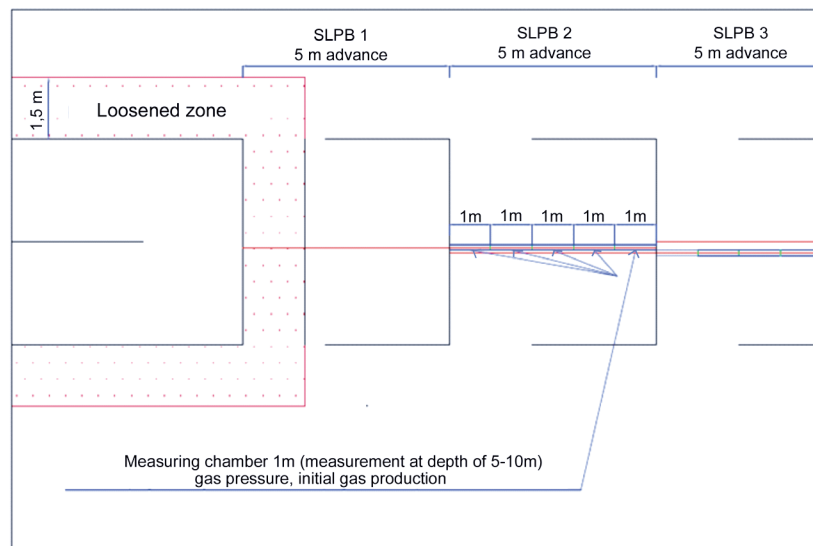


Figure 2. Detail of location of measuring chambers of gas pressure and initial gas production

Slika 2. Detalj lokacije komora za mjerenje tlaka plina i inicijalne proizvodnje plina

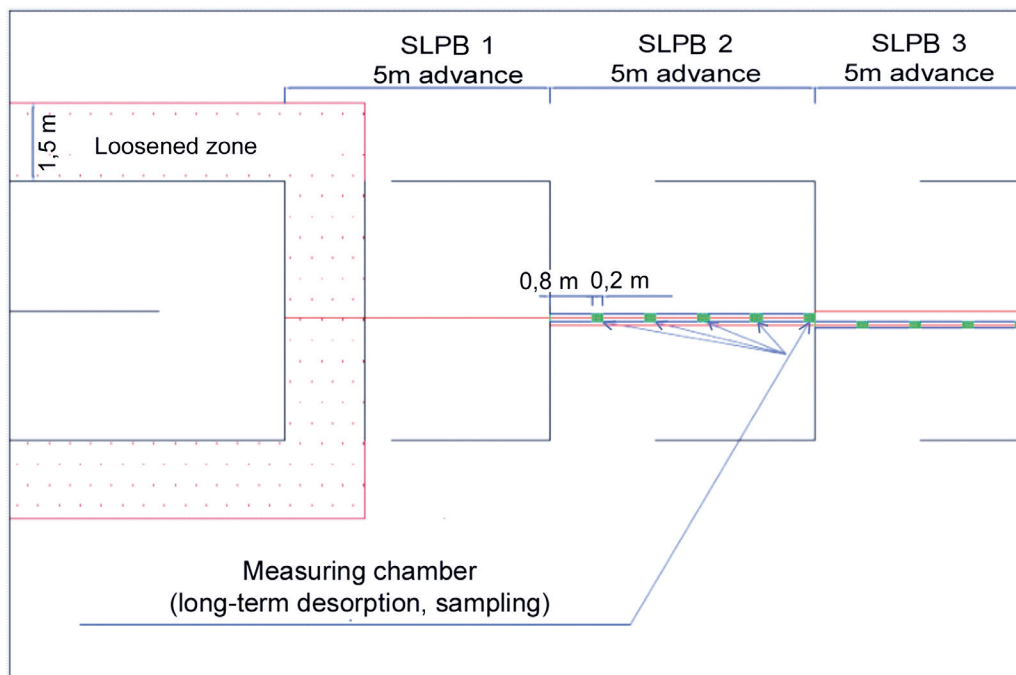


Figure 3. Sampling points of long term desorption

Slika 3. Točke uzorkovanja za dugotrajnu desorpciju

4.2 Local Prognosis of Outbursts of Sandstones, Conglomerates and Gases

The proposal for the local prognosis of outbursts of sandstones, conglomerates and gases is based on the construction of cored exploratory and verification boreholes.

For the local prognosis, three exploratory boreholes are proposed. One is located in the axis of the mine working and drilled at an angle of 70° towards the overbur-

den (additional hydrogeological borehole) and other two boreholes exceeding the circumference of the mine working are deflected from the axis of the mine working by an angle of 25° to either side and are drilled at an angle of 20° towards the overburden. A diagram of location of the exploratory boreholes is provided in Figure 4.

In the course of driving, two verification cored boreholes are drilled; the core diameter being 40 mm as a minimum. They are driven sub-horizontally at the corners of

the mine working and their deflection from the axis of the mine working to either side is 20° . A diagram of location of the verification boreholes is given in Figure 5.

Criteria for the evaluation of verification and exploratory boreholes are recommended.

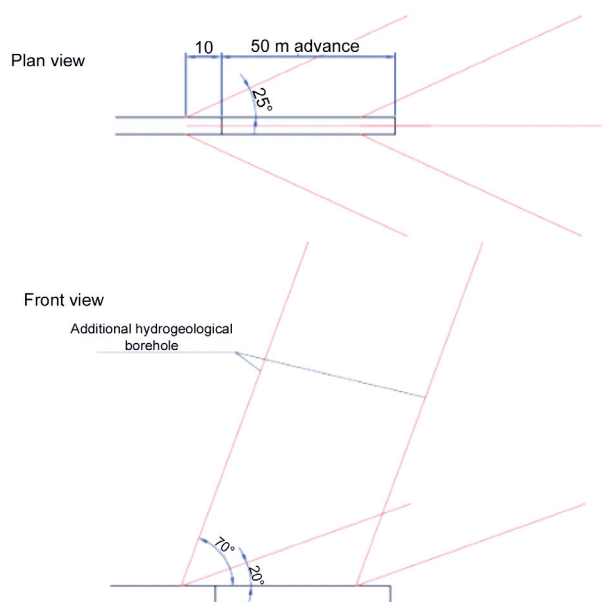


Figure 4. Diagram of location of exploratory boreholes

Slika 4. Prikaz lokacije istraživačkih bušotina

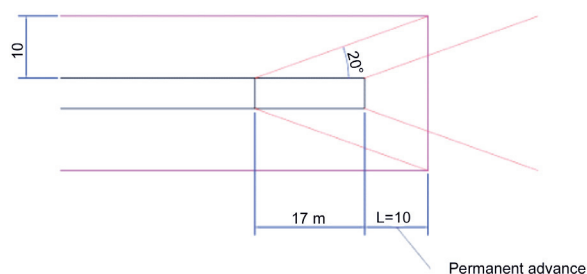


Figure 5. Diagram of location of verification boreholes

Slika 5. Prikaz lokacije verifikacijskih bušotina

L - Distance between the boreholes and the end of the coal face, where
L = 10 (permanent advance) - we have to drill a new boreholes

4.3 Proposal for the Local Prognosis When Extracting Coal through Large Diameter Boreholes

Before the commencement of mining operations, the location of special long boreholes for prognosis purposes (SLPB) in the seam was proposed. A diagram of location of the boreholes can be seen in (Hudeček, 2008) (Hudeček et al., 2010, 2011).

5. Continuous prognosis

5.1 Continuous Prognosis of Coal and Gas Outbursts

The aim of modifications of the existing continuous prognosis of coal and gas outbursts when driving long mine workings is to select such a technique that will ensure unambiguously that the prognosis parameters will not be affected negatively by mining operations. This means that the gas properties of seams will be measured and evaluated in a way eliminating the effects of driving technology and rock mass local destruction caused by it.

When applying the existing system of prevention utilizing stress-relief blasting (SRB – blasting without the breakup, aimed at reduce hazardous stress in front of the mine work) and stress-relief boreholes (SRBo – boreholes with a diameter of 80-200 mm, drilling is to ensure adequate and continuous zone of reduced stress in front of the mine work) to driven long mine workings, this means a change in location of the boreholes for prognosis purposes so that the parameters of continuous prognosis could be measured in that part of the seam which is there outside the zone already influenced by prevention measures (Directive, 3895/2002). In the case of application of preventive SRB, it means both a change in orientation of prognosis boreholes at the corners of the face drilled parallel with the axis of the mine working and an extension of the length of them to 5m at the conservation of the length of the measuring chamber (1.2 m) in compliance with valid legislation. Diagrams of a continuous prognosis modified according to the proposal are there in Figs. 6 and 7.

-If a system of legislative changes in the extent defined in the final report on Project No. 57-07 (Protection of Employees against Consequences of Rock and Gas Outbursts - The author analyses coal and gas outbursts and generalizes the available data on the approaches to solving the problematic of these gas-dynamic events in the framework of Czech Republic Grant “Estimate of the Safety Precautions for Coal and Gas Outburst Hazardous Strata”) will be applied to the areas of regional and local prognosis, the continuous prognosis carried out at faces as implemented so far can be in the majority of cases reasonably regarded as irrelevant, and we propose to change it from the point of view of method of execution. In this case, the continuous prognosis carried out at faces should be implemented merely in the expected most hazardous parts (close to the tectonic disturbances), it means in the nearest surroundings of structural-tectonic elements of the rock mass affected by the face. The frequency of measurement will comply with current legislation.

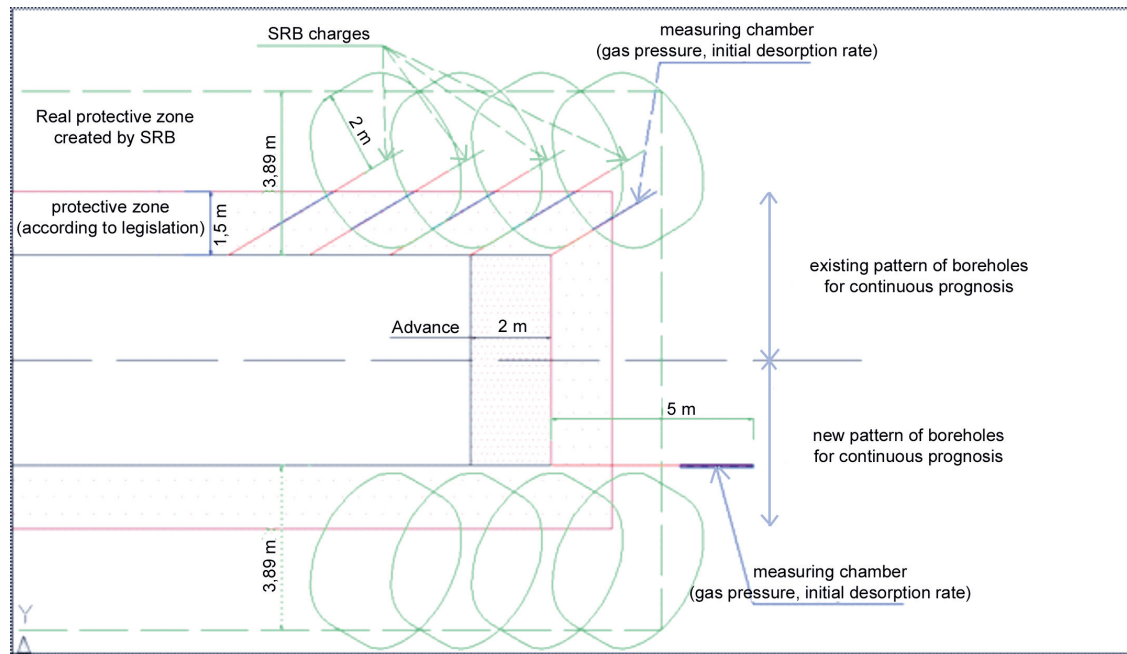


Figure 6. Existing pattern of boreholes for the measurement of gas pressure and of initial desorption rate parameter and newly proposed pattern involving preventive SRB and 2m advance

Slika 6. Postojeći raspored bušotina za mjerenje tlaka plina i čimbenik početnog iznosa desorpcije i novo predloženi raspored koji uključuje preventivni SRB i napredak od 2m

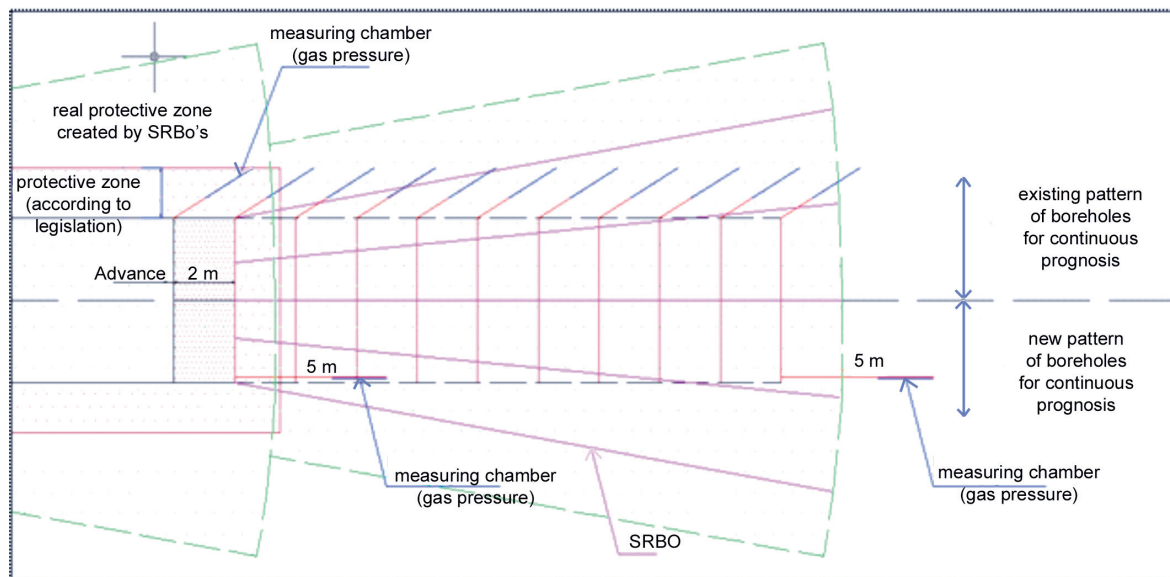


Figure 7. Existing pattern of boreholes for the measurement of gas pressure parameter and newly proposed pattern involving preventive SRBO's and 2m advance

Slika 7. Postojeći raspored bušotina za mjerenje čimbenika tlaka plina i novo predloženi raspored koji uključuje preventivni SRBO-e i napredak od 2m

5.2 Proposal for Carrying out the Continuous Prognosis When Extracting Coal through Large Diameter Boreholes

The proposal for the procedure of carrying out the continuous prognosis was worked out for this new mining method. A diagram of the continuous prognosis is there in (Hudeček et al., 2010, 2011), (Stoniš et al., 2009).

Boreholes for prognosis purposes will be always drilled in the centre of safety pillars at a diameter ranging from 42 to 80 mm. The length of them will exceed the expected length of chambers being exploited (drill holes) by 3 m. The mouth will be equipped with a casing packer to a depth of 8m as a minimum. This depth is verified, with regard to the risk of coal and gas outbursts, in the framework of the stage of local prognosis. Through this

casing packer, a steel pipe ended with stop valves will pass. It will be used for the measurement of prognosis indicators. The measurement will be performed at intervals, always after mining out 3m in each specific chamber.

5.3 Continuous Prognosis of Outbursts of Sandstones, Conglomerates and Gases

The proposed method of continuous prognosis will utilize boreholes situated ahead of the face of the mine working so that the measurement of the gas pressure parameter could be carried out outside the zone influenced by preventive measures and, on the basis of measurement results, the risk of hazard of outburst of sandstone, conglomerate and gases could be assessed according to valid criteria. The proposed solution shown in Figure 8 respects the location of boreholes for prognosis purposes in the zone in front of the mine working. Other safety measures and evaluation criteria can be applied fully in accordance with current legislation.

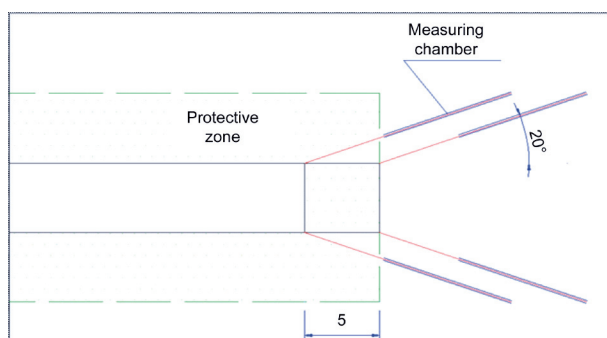


Figure 8. Diagram of location of measuring chamber for gas pressure measurement

Slika 8. Prikaz lokacije komore za mjerenje tlaka plina

6. Conclusion

The proposed changes in the area of prognosis carried out in mines prone to coal and gas outbursts are based on a set of conclusions defined and drawn in the course of dealing with the project Projekt VaV 57-07 "Ochrana zaměstnanců před důsledky průtrži hornin a plynů" (Protection of Employees against Consequences of Rock and Gas Outbursts), in the framework of which all information available from both the area of theoretical works and the area of practical experience obtained in the course of solving these problems in the Czech Republic and abroad in (Hudeček 2008) was evaluated. After evaluating all sub-stages of the project it can be stated that existing **Czech** legislation does not correspond wholly to the current state of knowledge of these problems any more. In the final report on the project, the proposal of areas to which new approaches should be applied is presented (HUDECEK et al., 2009).

A completely new approach is proposed for the area of rock and gas outburst prognosis. What should be applied is a logical principle of advance from fundamental knowledge of the deposit and its division into structural-tectonic blocks in a form of **regional prognosis** that will enable, on the basis of assessment of parts of the rock mass and seams contained in the rock mass, classifying the seams as of relevant degrees of hazard. The function of **local prognosis** should then be to verify this classification and simultaneously to make it possible to classify mine workings driven in the seams as of relevant degrees of hazard. **Continuous prognosis** will enable, in a case of realization of the proposed changes and technical modifications in carrying out the prognosis, the assessment of outburst risk during the operation of mine workings.

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