New Methods of Categorization of Coal Seams Prone to Coal and Gas Outbursts

Vlastimil Hudeček and Petr Urban[1]

Abstract

Many regions are historically connected with the mining of hard coal of highest quality. The mining transfers into areas considerably tectonically disturbed and into areas with numerous anomalous manifestations of the rock mass.

As for this wide range of problems, I paid attention to the problems associated with a complicated geomechanical event, i.e. coal and gas outbursts. In the contribution I summarised the existing knowledge of various aspects of forecasting the coal and gas outbursts and indicated possible methods of reclassifying already classified seams into the category with the lower degree of hazard.

***Key words**: Categorization of Coal Seams, Gas Outbursts*

Introduction

It is solid fuels that continue to be the decisive source of our fuel and energy base. The next development of coal reserves in underground mining is connected with the solving of mining and geological conditions, under which these reserves occur. These problems concern great depths, rockbursts and worsened geological conditions. One of the most serious hazards to labour safety in underground mines is represented by coal and gas outbursts. Although by closing uneconomical mines in the Czech Republic the number of localities with a hazard of some anomalous events has been diminished, risks associated with these events still exist.

In my article I summarised the knowledge obtained from driving and mining under conditions with a hazard of coal and gas outbursts in the area of forecasting this event.

Forecasting of Coal and Gas Outbursts in the Czech Republic

Forecasting serves the classifying of seams and workplaces. The classifying of seams is carried out on the following basis:

Forecasting done in the course of development works

Local forecasts (local forecast tests, special long boreholes for forecasting purposes); according to their results the seam (workplace) is placed in an adequate category of hazard:

- without hazard
- with hazard - 1st degree of hazard
- - 2nd degree of hazard.

The result of the local forecast test (LFT) is the determination of indicators of limit values of the 1st and the 2nd order, according to which the classifying is performed:

- indicators of the 1st order
  - o gas pressure
  - o initial desorption velocity
  - o initial gas production.

- indicators of the 2nd order
  - o the coefficient of seam thickness variability
  - o the initial velocity of desorption into the vacuum
  - o the indicator of coal breakability.

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The result of special long forecasting boreholes (SLFBs) is the determination of indicators (limit values), according to which the classifying is performed:

Indicators of: - gas pressure
- initial desorption velocity
- initial gas production
- desorbable gas content.

A workplace is usually assigned to the category with the same hazard degree as the seam. A mine working driven in the seam placed in the category with the 2nd hazard degree may be included into the category with the outburst hazard of the 1st degree merely on the basis of equal results of the evaluation of at least two local forecast tests. Diagrams of conducting the LFTs for the face No. 084 362/2 and the SLFBs for the face No. 059 521/11 are presented in Figs. 1 and 2.

Face Reclassifying

In the following part of forecasting, an example of the procedure for reassigning the face No. 059 521/1 in a part of the seam 059 (16) from the category with the 2nd degree to that with the 1st degree of coal and gas outburst hazard is given.

The face No. 059 521/1 illustrated in Fig. 2 is delimited by the haulage entry No. 059 5131, 0-380 m stationing, the initial connecting entry of the face No. 059 8521/2, 0-175 m stationing, the return airway No. 059412, 0-503 m stationing, and the plane of the crosscut No. 2021.

The reclassifying was conditioned by favourable values of the local and continuous forecasts and gas conditions in the area and was performed on the basis of experience from mining in the adjacent face No. 059 521.

By evaluating the continuous forecast, values of measured indicators given in Table No. 1 were acquired. The average values of the indicator of gas pressure show with all the mentioned mine workings values placing the mine workings in the category with the 1st degree of coal and gas outburst hazard (henceforth referred to as CGO). The maximum values of the indicator of gas pressure and the values of the indicator of initial desorption velocity (average and maximum) correspond to values assigning the mine workings to the category without CGO hazard (WH).

In the worked out face No. 059 521 classified into the category with the 2nd degree of CGO hazard, altogether 2386 measurements of continuous forecast were taken. The maximum gas pressure was 130 kPa, the maximum value of initial desorption velocity was 1.5 cm^3 $(10g \cdot 35s)^{-1}$. The average value of gas pressure was 18.4 kPa and the average value of initial desorption velocity was 0.61 cm^3 $(10g \cdot 35s)^{-1}$. These values also support the reassigning of the face No. 059 521/1 to the category with the 1st CGO hazard degree.

Tab. 1 Continuous forecast values

		Entry No. 059 5131	**Entry No. 059 4121**	**Connecting entry 059 8521/2**
Average value of gas pressure indicator	kPa	86 (1st degree)	86 (1st degree)	77 (1st degree)
Maximum value of gas pressure indicator	kPa	120 (WH)	130 (WH)	120 (WH)
Average value of indicator of initial desorption velocity	$cm^3(10g.35s)^{-1}$	0.74 (WH)	0.68 (WH)	0.63 (WH)
Maximum value of indicator of initial desorption velocity	$cm^3(10g.35s)^{-1}$	1.1 (WH)	1.2 (WH)	1.s1 (WH)

The local forecast was made by measuring in the special long forecasting boreholes. By measurement, maximum values of long-term desorption, initial desorption velocities, gas pressure and initial gas production are determined in each full metre of the special long forecasting borehole. The forecasting boreholes have a diameter of 42 mm and are drilled by a spiral rod in the seam. The measurement is carried out to the depth of 10 m. The measurements were taken from 14 SLFBs drilled from the mine working No. 059 5131 orientated towards the face block No. 059 521/1 (see Fig. 2). Results of the special long forecasting boreholes are given in Table No. 2.

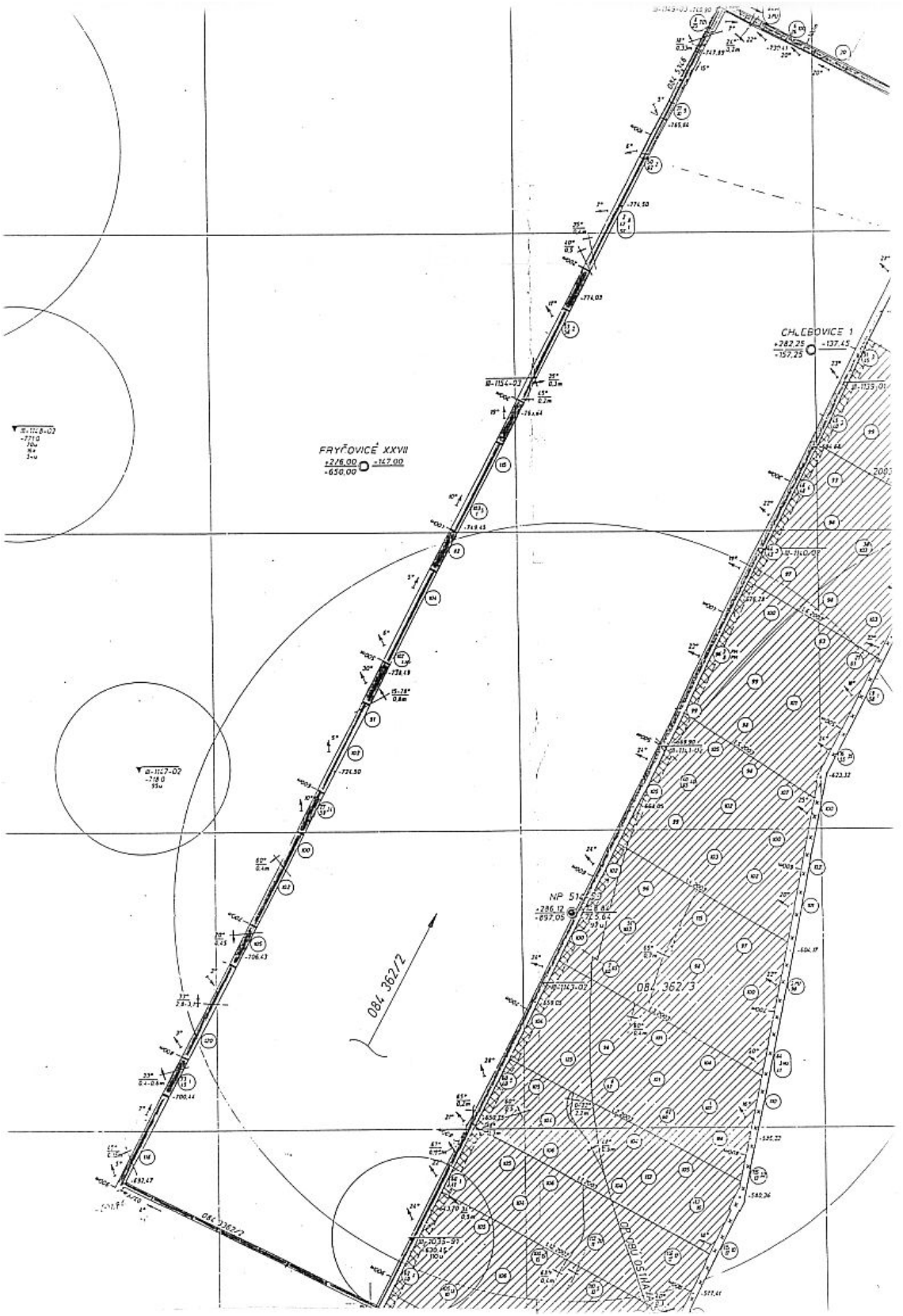

Fig. 1. Diagram of conducting the local forecast tests (LFTs) in the face No. 084 362/2

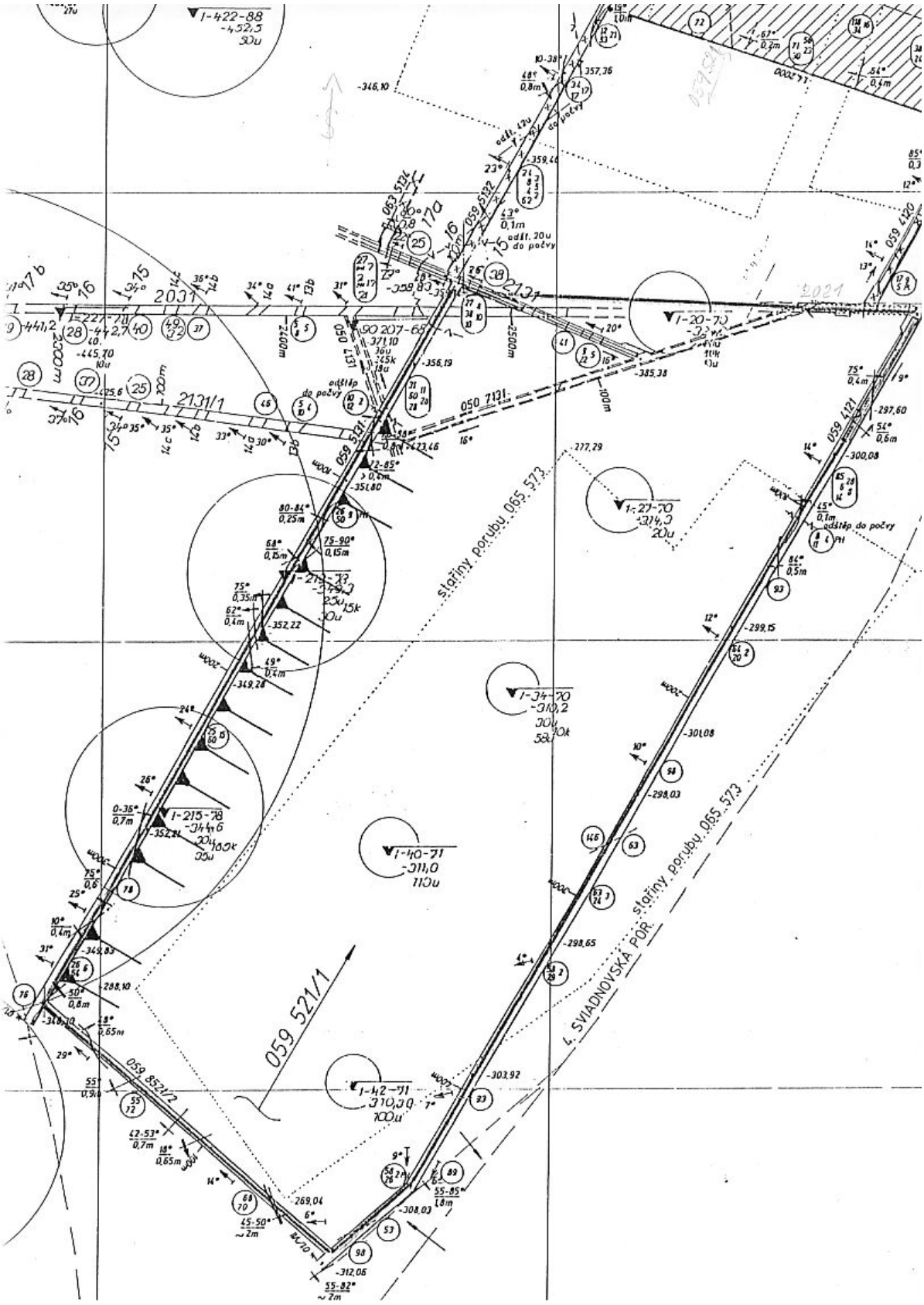

Fig. 2. Diagram of drilling special long forecasting boreholes (SLFBs) in the face No. 059 521/1

Table No. 2 Results of SLFBs in the mine working No. 0595131

SLFB station-ing	Pressure	Classification category	Initial desorption velocity	Class. category	Gas production	Class. category	Q_{RH}	Class. category
M	kPa		$cm^3(10g.35s)^{-1}$		$l.min^{-1}$		$m^3.t^{-1}$	
67	10	WH	0.1	WH	0.1	WH	0.01	WH
87	0	WH	0.01	WH	0	WH	0	WH
106	0	WH	0.01	WH	0	WH	0	WH
143	10	WH	0.01	WH	0.1	WH	0.01	WH
161	40	WH	0.14	WH	0.9	WH	0.05	WH
179	0	WH	0.03	WH	0	WH	0	WH
194	80	WH	0.06	WH	0.4	WH	0.01	WH
215	0	WH	0.05	WH	0	WH	5.3	WH
223	70	WH	1.6	WH	0.7	WH	1.69	WH
248	30	WH	0.06	WH	0.5	WH	0.04	WH
268	40	WH	0.06	WH	0.5	WH	0.02	WH
284	50	WH	0.1	WH	0.7	WH	0.05	WH
334	120	WH	0.36	WH	0.9	WH	0.35	WH
350	50	WH	0.18	WH	0.4	WH	0.05	WH

The evaluation of particular SLFB parameters was carried out by using the highest found values of particular measured and calculated parameters. In all the SLFBs the values of gas pressure (p) are less than 130 kPa, the initial desorption velocity (V_1) ranges from 0 to 1.6 cm^3 $(10g.\ 35s)^{-1}$, the initial gas production (q) moves in the range from 0 to 0.9 $l.min^{-1}$ and the desorbable gas content (Q_{RH}) does not exceed 5.3 $m^3.t^{-1}$.

The found results of all the indicators in the special long forecasting boreholes drilled in the framework of local forecast makes it possible to place a part of the seam in the category with the lower degree of CGO hazard.

Continuous Forecast

Continuous forecasting is made in the course of driving and mining in the workplaces belonging to the category with the 1st and the 2nd degree of hazard. It consists in the measurement of the following:

- gas pressure (p)
- initial desorption velocity (V_1)
- relative changes in the seam thickness (z).

The gas pressure is measured in the three-metre forecasting boreholes (in long mine workings they are drilled from the face with the deflection of 30° from the axis of the mine working, in the longwalls then perpendicularly to the pillar). Measurements are made by the Engler probe (packer) in the space of the borehole before the packer 1.8 m long. The probe has a length of 1.2 m. The indicator of gas pressure expresses the pressure of free gas in the zone in front of the mine working in kPa.

The initial desorption velocity is measured from the drill cuttings taken from the last 20 cm section of the forecasting borehole. The cuttings are treated on the double sieve to the prescribed fraction of 0.5-0.8 mm within 35 seconds from the beginning of taking the cuttings. Measurements are made by desorbometers (isochoric and isobaric types) and take other 35 seconds. The indicator of initial desorption velocity expresses a value of desorbed amount of gas from the 10 g sample in the duration of 35 seconds. The measurement result is expressed by a value in cm^3 $(10\ g.\ 35\ s)^{-1}$.

The relative change in thickness is a difference between the maximum and the minimum thickness related to the product of thickness *x* and the shortest ground distance between the maximum and the minimum thickness *l*:

$$Z = \frac{m_{\max} - m_{\min}}{m_{\max} \cdot l} \quad [\mathrm{m}] \qquad (1)$$

where m_{max} - maximum seam thickness [m]
m_{min} - minimum seam thickness [m]
l -the shortest distance between the maximum and the minimum [m].

An example of graphical processing the results of parameters of continuous forecast in the face No. 065 567 from the Paskov Mine is illustrated in Fig. 3.

Conclusion

It follows from the presented data that a risk of outburst origin when driving mine workings and mining faces is determined on the basis of forecasting that consists in the measurement of chosen gaseous properties of the seam. The susceptibility of the seam to outbursts in the given point is verified by measuring the forecast parameters and by comparing the measured values with the set "critical" values.

However, the critical parameters do not take into account many other factors that affect them directly. It is a case of influencing the forecast parameters by an increase in the geostatic stress associated with mining at greater depths and by influences of additional stresses of various origin. The validity of these "critical" values must be verified on the basis of analysis of available parameters, which is the present task of research on this area.

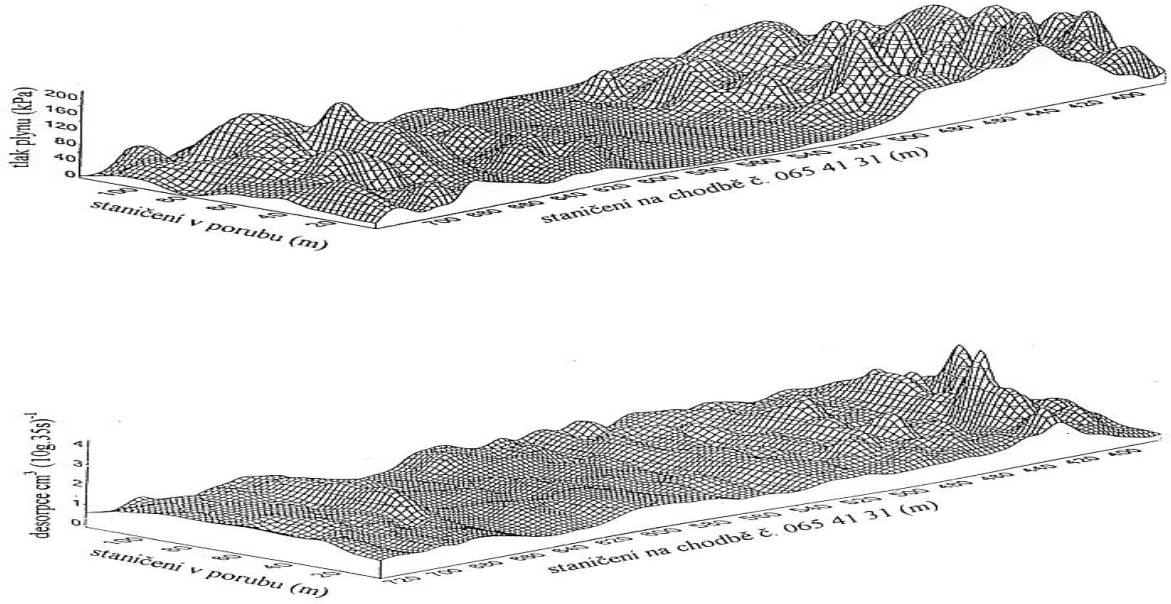

Fig. 3 Graphical processing the results of parameters of continuous forecast in the face No. 065 567

Fig. 4 Outburst at Staříč Mine - Coal Seam No. 21a

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