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Features of Development of Superimposed Coal Seams in Zones of Disjunctive Geological Disturbances

Vladimir Pavlovich Zubov and Aleksandr Vladimirovich Nikiforov

Saint Petersburg Mining University, 2, 21 line, Saint-Petersburg 199106, Russia.

Abstract
The article presents the issues related to the justification of rational schemes of the joint development of superimposed seams in the ascending order in the mine field areas, complicated by disjunctive geological disturbances. The numerical simulation of the stress-strain state of undermined seam sections located between the thrusts with the amplitude of more than 5-6 m was performed. The influence of the pillars being left between adjacent sections of the bottom (protective) seam on the parameters of the unloaded zones in the undermined seam was studied. It was found that in the location of excavation pillars in the lower seam parallel to the strike line the protective effect of advanced undermining is significantly reduced compared with the case in which the pillars are located parallel to fault planes of disjunctive geological faults oriented at an acute angle to the seam dip line. Technical and economic performance of the developed option was defined.

Keywords: superimposed seams, laydown areas, disjunctive geological disturbances, thrusts, long pillars

INTRODUCTION

In connection with the intensive priority development of the mine field areas characterized by the most favorable mining and geological conditions, there is a need to expand the raw material base in coal mines with a long service life by engaging in development the deposit areas complicated by disjunctive geological disturbances and the unsafe ones by gas-dynamic manifestations. The creation of the cost-effective development technologies for the sites can not only lead to an increase in reserves and the conservation of retired capacities of mines, and increase their useful life, but also help stabilizing the geomechanical situation within the mine fields both during their development, and in subsequent periods.

The solution of these issues is the most difficult one in the development of multiple superimposed coal seams, which is connected with the mutual influence of mining operations performed in adjacent seams, which can be both positive and negative one [1, 3, 6]. As a rule, the positive effect is due to the formation of areas with reduced stresses and additional fracturing in the seam under development and enclosing rocks, the negative one is due to the formation of areas with increased stress in the mountain range. Errors in determining the location of these areas and planning of mining operations therein can result both in a significant economic damage, and increase the danger of mining.

This article deals with the issues related to the substantiation of rational schedules of development of superimposed seams in the mine field areas in an ascending order, complicated with disjunctive breaking-type geological disturbances.

As an example illustrating the nature of the results obtained, let us consider the data obtained for the Olzherasskaya coalfield developed by the "Raspadskaya-Koksovaya" mine. The thrusts with the angle of fault plane incidence up to 30° (Figure 1) are the predominant type of geological disturbances in the field.

The field of the "Raspadskaya-Koksovaya" mine includes a few large disjunctive geological disturbances with the vertical shift amplitude of 2 to 42 m oriented subparallel to the seam dip line at an angle of 25°. The angle of incidence of fault planes with the bedding surface is 5-15°.

The dimensions of areas of influence of geological faults on the physical and mechanical properties of rocks adjacent to disturbances vary from 2 to 25 meters.

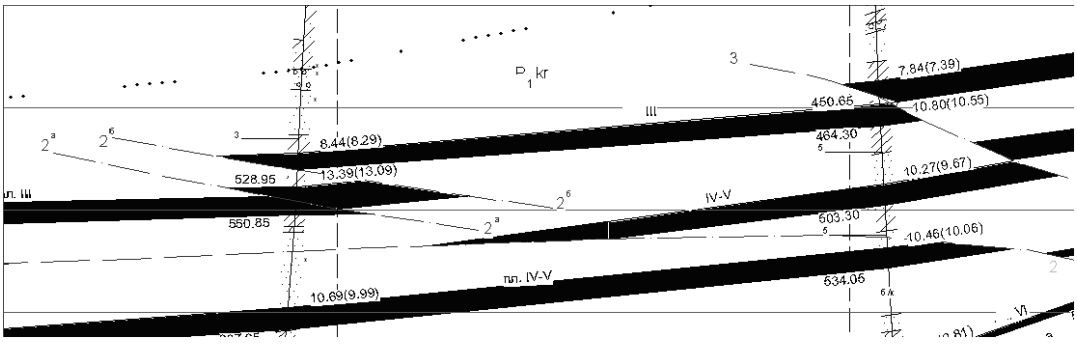

Figure 1. Typical geological disturbances in the "Raspadskaya-Koksovaya" mine

The distance between the disturbances, not passed by clearing mechanized complexes, is 450 to 1,100 m. Taking into account the configuration and dimensions of these disturbances the mine field is divided (Figures 2 and 3) into the excavation units with the location of the long block boundaries parallel to the disturbance fault planes.

The option with the development of two superimposed seams was considered: III (upstream) and VI, at a distance of 60-70 m from III. The incident angles of the coal seams are changed from 8 to 12°.

The coal seams III and VI are classified as prone to outbursts and beyond-category ones by gas: The natural gas content of III and VI seams is 11-24 m^3/t and 17.4-24.2 m^3/t, respectively. At depths of 150 m, the seams are the dangerous ones by rock bursts. The depth of location of the seam III from the earth's surface is 250 m.

In order to provide degassing of the upstream seam III and to improve the mining safety for gas-dynamic phenomena, the ascending order of seams mining ahead of clearing works on the seam VI was adopted.

The ultimate goal of the research was to study the rational schedule of the seams mining in the areas of influence of geological disturbances, the implementation of which will allow the maximum use of the positive effect of discharge associated with the development of the seam III in areas complicated with breaking-type geological disturbances.

METHODS

Numerical modeling, based on the application of the boundary element method, which has been successfully applied to solve various problems of mining in the works of many researchers, was adopted as the main method of research of reduced stress areas in the developed seam [2, 7-8]. As the characteristics of the stress state of the mountain mass, the average level of stresses occurring in rocks was used, defined as follows:

$$\sigma_{av} = \frac{(\sigma_x + \sigma_y + \sigma_z)}{3}$$

where σ_x, σ_y, σ_z are the stress components on the respective axes, MPa.

The research of the parameters of unloaded areas in the seam III was conducted using the advanced options of the long-pillar system for the following cases:

- in case of leaving pillars between the extraction pillars;
- in case of non-pillar development of a seam, provided in [4-5];
- in case of different sequence of development of excavation pillars.

RESULTS

In developing the reserves located between the disjunctive geological disturbances, two options were studied, namely: with the location of excavation pillars along the strike of the seam (Figure 2), and with the location of excavation pillars parallel to fault planes of disjunctive geological disturbances (Figure 3).

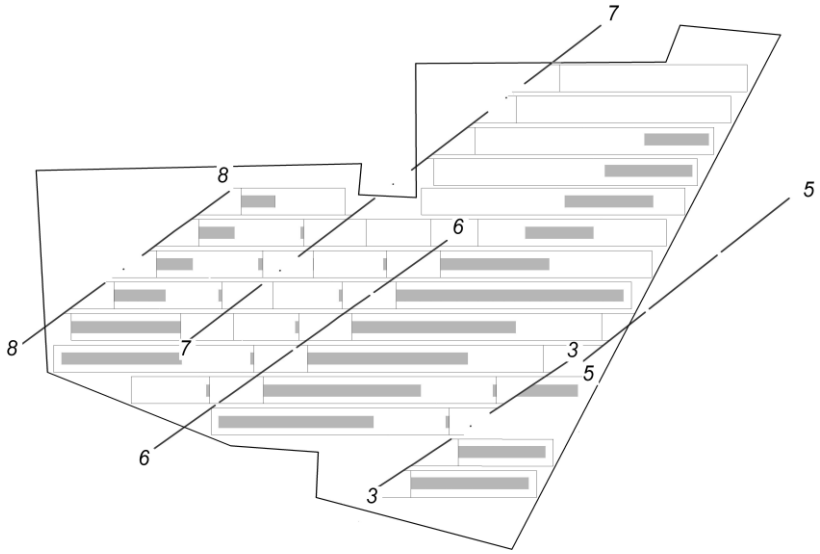

Figure 2. Zones of reduced stress on the seam III in case of the seam IV system of mining by long pillars along strike leaving coal pillars between adjacent areas (field No. 2 of the "Raspadskaya-Koksovaya" mine): 8-8, 7-7, 6-6, 3-3, 5-5 – disjunctive geological disturbances

The research showed that the option with the location of excavation pillars along the strike of the seam (Figure 2) is characterized by a lower efficiency of the protective effect of advanced mining of a downstream seam VI compared to the option in which the pillars are located parallel to fault planes of disjunctive geological disturbances. The total area of the zones on the seam III, unloaded from the high rock pressure, is:

- about 11% of the area of the developed extraction pillars on the seam VI using long-pillar system along strike, by leaving the coal pillars between them;

- below 40% when using long-pillar system along strike without leaving coal pillars in the developed area of lava.

Location of reduced stress zones (Figure 2) in the middle of the pillars does not create conditions for cost-effective and safe mining operations on the seam III.

In the implementation of an option with the location of excavation pillars parallel to fault planes of disjunctive geological disturbances (Figure 3).

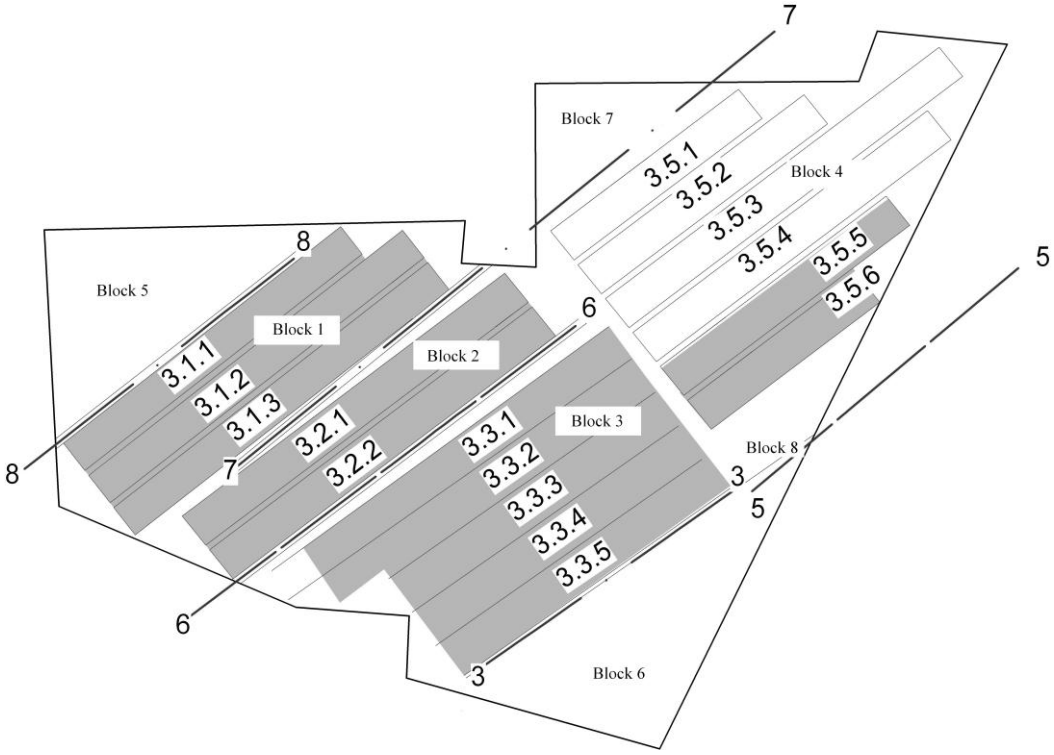

Figure 3. Reduced stress zones on the seam III when developing the seam VI using long-pillar system, with the pillars arranged parallel to geological disturbances

The total area of the zones on the seam III, unloaded from the high rock pressure, is 15 and 45%, respectively, while leaving pillars between adjacent sections and non-pillar development of the seam VI.

DISCUSSION OF RESULTS

The comparison of technical and economic indicators in the considered options of the pillars location with respect to geological disturbances for the conditions of the field No. 2 of the "Raspadskaya-Koksovaya" mine is shown in the table. The data in the table show that a number of significant advantages of the option with the location of excavation pillars parallel to fault planes of disjunctive geological disturbances include the reduction of operational losses of coal by 27%; reduction of the length of lava downtime associated with the assembling and dismantling operations in lavas by 30%; reduction of the amount of lava transfer up to 40%. Reduction of operational losses of coal in case of location of excavation parallel to geological disturbances is due to a more rational geometric shape of pillars leaving at the geological disturbances. The results obtained are summarized in Table 1. The values of parameters in case of location of pillars parallel to geological disturbances are given in fractions of the relevant indicators obtained in case of location of pillars parallel to the strike of the seam.

Table 1. Comparison of technical and economic parameters upon location of excavation pillars parallel to the strike of the seam and parallel to geological disturbances

Technical and economic indicators	Location of extraction pillars	
	Parallel to the strike of the seam	Parallel to geological disturbances
The total area of the zones unloaded from the high rock pressure %	1	5.5- 6
Operating losses of coal in the pillars, %	1	0.73
Number of lava transfer	1	0.6
Duration of lava downtime associated with the dismantling of the cleaning unit, days	1	0.7

The total area of the zones unloaded from high rock pressure on the seam III, reaching 55-60% of the total of the developed section, creates objective prerequisites for improving security in developing the seam III in the areas located between thrusts.

CONCLUSION

1. The location of the excavation pillars of the lower (protective) seam significantly affects the geomechanical conditions of the developed seam in the areas between thrusts: the most favorable geomechanical conditions are created in case of location of the lower seam excavation pillars parallel to geological disturbances.
2. In the non-pillar development of the lower seam, the total area of the protected zones at the developed seam sections located between the thrusts can reach 55-60% of the total area of the section.
3. Decreasing the distance between impassable disjunctive geological disturbances increases the effectiveness of schemes with the location of excavation pillars parallel to geological disturbances compared with schemes which provide the location of pillars parallel to the strike line of the seam.

REFERENCES

[1] O. Yakobi, “Praktika upravleniya gornym davleniem” [Rock Pressure Control Practice] (Trans. from German). Moscow: Nedra, 1987.

[2] I.M. Petukhov, A. M. Lin'kov and V. S. Sidorov, et al. “Raschetnye metody v mekhanike gornykh udarov i vybrosov”. Spravochnoe posobie [Calculation methods in Mechanics of Rock Bursts and Releases. Handbook]. Moscow: Nedra, 1992.

[3] “Ukazaniya po upravleniyu gornym davleniem v ochistnykh zaboyakh pod (nad) tselikami i kraevymi chastyami pri razrabotke svity ugol'nykh plastov moshchnost'yu do 3,5 m s uglom padeniya do 350 [Notes on Rock Pressure Control in Breakage Faces Below (Above) Pillars and Edge Portions in the Development of Multiple Coal Seams with Capacity up to 3.5 m with an Angle of Incidence up to 350]. Leningrad, 1984.

[4] V. P. Zubov and V. S. Elkin, “Patent RF No. 2441160. Sposob podzemnoi razrabotki ugol'nykh plastov” [Patent RF No. 2441160. Method of Underground Mining of Coal Seams], 2012.

[5] V. P. Zubov and V. S. Elkin, “Otsenka maksimal'no dopustimykh nagruzok na lavu pri bestselikovykh tekhnologiyakh otrabotki plastov na shakhtakh s povyshennym vydeleniem metana” [Assessment of the Maximum Allowable Load on the Lava in Case of Use of Non-Pillar Technologies of Seams Mining in Mines with an Increased Release of Methane]. Gas industry, vol. 672, pp. 29-33, 2012.

[6] C. Mark, F. E. Chase and D.M. Pappas, “Multiple-Seam Mining in the United States: Design Based on Case Histories”. In Proceedings on the New Technology for Ground Control in Multiple Seam Mining, pp. 15-27, 2007.

[7] P. Benergi and R. Butterfield, “Metody granichnykh elementov v prikladnykh naukakh” [Boundary Element Methods in Applied Sciences]. Moscow: Mir, 1984.

[8] V. V. Zubkov, “Raschet zon effektivnoi degazatsii pri otrabotke svit ugol'nykh plastov” [Calculation of the Effective Degassing Zones upon Developing of Multiple Coal Layers]. Marksheideriya i nedropol'zovanie, vol. 3 no. 65, pp. 54-57, 2013.