

TECTONICS AS THE LIMITING FACTOR FOR INTRODUCING THE LONG WALL MINING METHOD IN COAL DEPOSITS

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Abstract: On the basis of theoretical knowledge and theoretical experience this paper presents the principles according to which it is necessary to assess the possibility and technical/economic effects of the long wall mining of coal deposits that have expressed radial tectonics. In addition, we had in mind that tectonics is the basic limiting factor for application of mechanized mining of the coal deposits in Serbia. It is necessary to survey deposits with expressed tectonics in the phase of geological explorations, and especially to study them in the function of optimal projecting of underground mining work and methods of mining. Legal rules in force applying to this field are not an adequate basis for exact conclusions.

Key words: coal, principles of choice of the mining method, tectonics, faults, mining methods

1. INTRODUCTION

Application of the mechanized mining technology and long wall methods in general demands precise definition and numerical determination of all mentioned factors, as well as their spatial and in time joint action with proposed technical-technological solutions in functional and technical-economic sense. Practice has shown that the degree of knowledge of natural characteristics of deposits most often is not adequate to the demands posed by new technology. In scientific and expert circles this issue is not even treated at the adequate level, thus the mutual relationship between the degree of what has been investigated and the effects of application of the certain technology has remained outside the sphere of activity of researchers. Most often, as the cause of this, there has been mentioned that a considerable amount of financial means needed in order to make arrangements for additional investigations. Thus all expert and scientific subjects are to be satisfied with the level of investigation demanded by regulations, when making analyses prior to investments or when working on technical documentation for investing. Even in terms of the given degree of investigation of the deposit consequent methodological analysis and assessment of the mutual action between natural conditions and technical solutions is not carried out. In accordance with the above mentioned we have singled out tectonics as one of the priority factors that need to be studied in detail (Gagić and Gluščević, 2005).

Conditions for categorization and classification of deposits given by regulations are satisfactory only for quantitative defining of the deposit, with acceptable tolerances, but they are not to be applied for the assessment of possible

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application of treated technological solutions. With regard to different characteristics that our coal deposits have, we can almost exclude unification of density of exploration work, therefore each deposit is to be considered individually

2. GENERAL CONSIDERATIONS

All coal deposits in Serbia have relatively complex structural-tectonic form. Namely, in deposits, to a greater or smaller extent there have been found fault zones with different degree and character of disturbance, and this fact frequently causes block structure with blocks of different proportions. Frequently there has been found that the activity of tangential and radial tectonic movements existed (Jakobi, 1981). The influence of tectonic movements before the forming and after the forming of the deposit resulted in changeability of dip angle, coal layer dip direction, strike direction and the thickness of layer. For illustration, Figure 1 shows one characteristic structural geological profile of "Jasenovac" deposit.

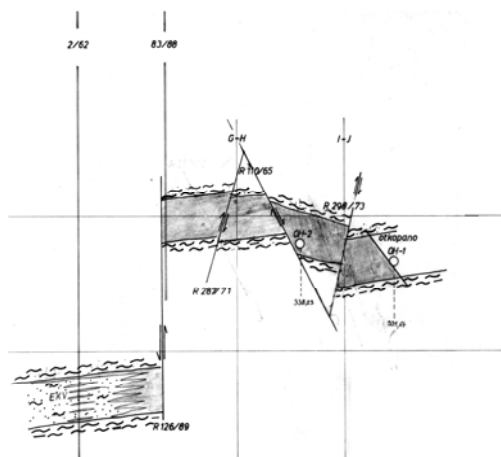


Figure 1 - Characteristic structural geological profile of "Jasenovac" deposit

Expressed tectonic deformations of the deposit may be and most frequently are very unfavorable from the point of view of mine projecting and building, i.e. of designing mining space, mining methods, work safety etc. Very often for rational mining of a small deposit it is necessary to apply two or more mining methods. This means that it is necessary to secure different equipment and different mining technology, and there is also a difference in direct mining costs and technical-economic effects of exploitation.

Special importance in complex mining-geological conditions has mining sequence and time viewed from the technical-economic as well as safety aspect. Thus, each investment move should be preceded by a detailed scientific analysis of exploitation conditions on the basis of which it is possible to select rational technical

solutions of all technical-technological subsystems in the complex underground production system as a whole.

Faults may enable flow of underground and surface waters to the deposit and in that way make more difficult or make production completely impossible. Negative economic and safety consequences of that problem can not be avoided. They (the faults) may also be convenient for accumulation or circulation of harmful gases. Economic and safety risks become greater in case when the site and spatial location of the fault is unknown.

In conditions of insufficiently completed or neotectonic movements there primarily occur additional stresses in lower zones. Additional stress in layers is not felt near faults of larger proportions. On the contrary, wide fault zone filled with large pieces of rock acts as relaxation to the layer. This fact emphasizes possible occurrence of caving of hanging wall rocks when making underground rooms and in mining, also uncontrolled circulation of air through the system of cracks may cause auto-oxidation processes and may cause occurrence of fires in mines. Statistics shows undisputable connection between tectonic disturbances and frequent rock bursts. Especially dangerous are the zones directly beside the fault, as well as the zones with great curvature in synclines. Namely, on one side of the fault plane there occur great stresses that may participate in causing rock bursts. On the other hand, as has been previously pointed out, there are no additional stresses and the conditions for exploitation from the standpoint of bursts are favorable. The cause of the noticed asymmetry is in the fact that only one wing of the fault moves along the fault plane towards another one (Nikolić, 1984).

Typical conclusion is that in the phase of geological and mining investigations it is indispensable to study in detail tectonic relationships in the deposit in order to project rational technical exploitation solutions from the point of technical-economic effects and work safety. On the basis of direct insight and analysis of individual unwanted events, the impression imposes itself that tectonics does not get sufficient attention. The causes may be associated with the fact that it is exceptionally complex scientific and expert set of problems, and that for such detailed investigations very often lack adequate technical and financial means.

3. TECTONIC CHARACTERISTICS OF THE DEPOSIT AND THEIR INFLUENCE ON THE CHOICE OF THE MINING METHOD

The basic limiting factor for the application of long wall mining method, especially for the application of mechanized mining technology is complex tectonic structure and relationships within the deposit. Incomplete or superficial investigation of the tectonics, as a rule, gives wrong conceptual and project solutions as a result, extends the building time, it does not achieve projected production capacity, decreases coefficient of deposit recovery, shortens the exploitation time, etc. Final consequence is considerably more unfavorable economic production effects, and a complete failure in replacement of technologies is not excluded, when small deposits with limited reserves are in question (Gagić, 1986).

The most significant indexes of the continuity of the deposit are frequency and intensity of faulting. Extensive delevelling of the layer demand special technological treatment of the blocks that originated in that manner, together with all technical-economic consequences that originate from that. This means that when investigating possibilities to change technologies we must first eliminate all dilemmas connected with continuity of the deposit which demands mechanized mining technology on the long wall. In other words, the degree of investigation must be such as to exclude the possibility of the occurrence of the previously non defined delevelling which would completely refute the projected PPS construction and technological solutions. Besides this, of vital importance is technical criterion used to define the scope of additional prospecting work and economic criteria formed by comparing means necessary for the realization of prospecting program and expected effects. The fact is that universal rules can not be laid as well as the rules on defining the necessary scope of prospecting works, but they have to be determined for each deposit at the beginning of the period before the investment analysis is done.

It is clear that crossing through fault zones may be designed in sites where the difference between the thickness of the layer and the throw of the fault is less than the permitted minimal layer thickness for the certain type of support. It is important to point out here that within the interval $d_s - h_r > 0$ it is difficult to place some limitations for the crossing through fault zone, since during the crossing itself a series of other natural and technical-technological factors (width of the disturbed zone, degree of disturbance, mechanical characteristics of the layer and surrounding rocks, technical and functional characteristics of mining machines and MHP etc.) are manifested. Principle model for preparation of the mining field with crossing through fault zone is shown in Figure 2 and it will serve for further analysis of the problem.

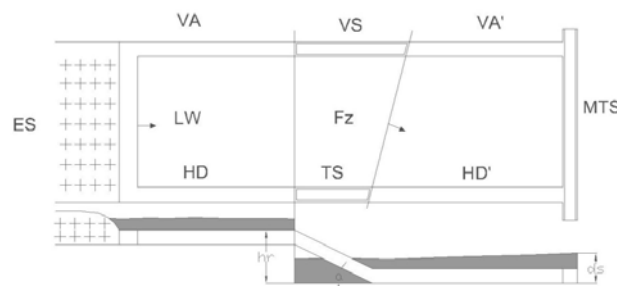


Figure 2 - Principle model for preparation of the mining field with crossing through fault zone (TS-transport slope, HD-haulage drift, VA-ventilation airway, MTS main transport slope, VS-ventilation slope, LW-long wall, d_s -layer thickness, h_r -throw of the fault, F_z -fault zone, ES-excavated space, a -connecting slope inclination)

Constant improvement of mining machines that have great installed force makes possible, in most cases, mining hanging wall and footwall rocks without to many difficulties and in that way secure gradual lowering (lifting) of the stope. Thus crossing through each fault zone from the fixed interval $d_s - h_r > 0$ is technically easy to

perform. Crossing through the fault zone is possible in case when we have $d_s - h_r > 0$, under condition that economic justification may be proved.

In further elaboration of this issue it is necessary to assess economic justification of the crossing through fault zone. International scientific and expert circles have different opinions and methodological approach for solving this problem. That is surely the consequence of a great number of influential factors and various intensity of their appearance in each deposit. Thus, the most correct procedure is based on the comparison of expenses of the crossing through fault zone with expenses of moving the mining field to another location, i.e.:

$$C \cdot V \cdot l + C_p \cdot l + C_u \cdot t_{pr} < C_p' \cdot l + C_u \cdot T_m \quad (1)$$

where we have:

C - unit expenses of excavated material,

V - volume of waste that has to be excavated in order to cross per meter of stope,

C_p - expenses of lifting, lowering or turning the complex given for meter of stope,

l - stope length,

C_u - conditional losses in unit of time originated from interruption of the production during crossing of the fault, or due to moving of the stope to another location,

t_{pr} - time needed for crossing through fault],

C_p' - expenses originating from stope moving, shown at meter of stope,

T_m - time needed to move the stope.

Incoming parameters for technical-economic analysis are relatively easy to determine. Parameters of the fault zone are determined during the phase of geological prospecting, and unit expenses according to the realization in the mine which is regularly followed up. We point out that the dip angle of the linking inclined drift is limited by possible maximal angle for the selected MHP type.

Previously noticed relatively simple mathematical relation makes possible further analysis to perform optimization of parameters of the stope of each actual deposit, i.e. it would give optimal length of the stope, stope height, production capacity etc. Besides, it is possible to vary stope height drift, basic stope equipment, etc. Here we have in mind that the daily capacity of the stope is:

$$Q_d = f(l, v_d, d_s) \quad (2)$$

where is:

v_d - face advance of the stope.

The task is to be solved by using the adequate algorithm and computer program with function of aim from the domain of economic criteria.

This procedure is to be carried out for each mining field where delevelling exists, as it has to be verified especially when we deal with coal layers of small and medium thickness.

Coal layers of great thickness offer more possibilities when outlining the PPS constructions and when solving the problems of crossing through the fault zones, especially if the variant with coal roof caving. Starting from the basic criterion that rational crossing through fault zone is when the throw of the fault is equal to or smaller than the thickness of the roof slab, the conclusion imposes itself that before or after the crossing through the fault zone the mining is done directly under the hanging wall, while for the mining of the lowest level special technical solutions must be found.

However, in this case also the production effects are smaller, but in a more slight form considering the fact that bridging the deformed zones is mostly done in coal. In spite of that the costs of crossing and of stope dislocation have to be analyzed and compared.

Thus, the presence of tectonic deformations of greater intensity in the deposit frequently demands special technological treatment of the blocks formed in that manner. In order to assess the possibility to continue exploitation, the starting point is rational technical solutions. As for the final assessment it is most justifiable to use economic criteria, i.e. comparison of expenses that are connected with crossing through the fault zone and the expenses connected with the dislocation of the stope.

Under the conditions of the complex tectonic structure of our deposits it is possible to form relatively short mining fields. If we have in mind the fact that in most of underground production sections it is not rational to form more mechanized mining units, then it is clear that short mining fields demand very often interruption of the production for a longer time interval defined by the time needed to move the stope and to start again normal technological cycle. These statements confirm justification of the statement that in the phase of analysis done before the investment it is necessary to define all technical-economic parameters for the whole exploitation period of the deposit, or the period when complex equipment in the stope has been used. Thus the need to determine the "economic threshold" is given as the foremost goal, as regards the length of the mining field.

In known coal basins regular coal layers have mostly been developed, thus the attention of researchers has been directed towards the optimization of the length of mining fields. Optimal lengths of the mining fields, depending on the complexity of the mining-geological conditions and production-technical characteristics of the deposit and the mine, are in a very wide scope from even 1,000 m to 3,000 m, while the proved economic justification for the application of mechanized mining technology for mining fields is the length of 250 m to 300 m.

Possible lengths of mining fields in our deposits are limited by their nature, and the lower economically justifiable length of the mining field must be determined for each deposit separately.

4. CONCLUSION

Most of our deposits are characterized by very distinct tectonic deformations of different intensity which most often are not precisely defined in space, neither in qualitative nor in quantitative sense. All this emphasizes technical-economic risk if technology is replaced. The favorable moment is that coal layers are mostly of great thickness and in most cases there have been noticed greater dislocations.

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