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PREDICTING ZONES OF INCREASED WATER INFLOWS IN LOCAL FOLDED STRUCTURES

Purpose. To predict zones of increased water inflows based on geological exploration and mining-geological data in the real conditions of an operating coal mine using the method of predictive evaluation of prospects of local structures for the presence of gas accumulations.

Methodology. The research was carried out by constructing a map of local structures using trend analysis. The synclinal fold is allocated in the plan and its main parameters – amplitude and width – are determined. Based on these parameters of the structure, the authors performed calculations of relative linear deformations and relative volume deformation of the studied fold.

Findings. According to the deviation of the hyposometry of layer c_{10}^{v} ("Samarska" mine) from the approximating surface, a local synclinal structure is allocated on the map. Based on calculated data on the volumetric deformation of rocks (siltstones and sandstones) and average values of open porosity, fracture porosity and absolute permeability were calculated. The obtained data indicate the formation of a fractured zone with improved filtration and capacity properties of rocks within the studied area. According to the actual mining and geological data, within the defined area, there are increased water inflows into the mine workings, which further confirms the results of the prediction.

Originality. For the first time, the algorithm of predictive evaluation of the prospects of local anticlinal structures for the presence of gas accumulations was used to predict areas of increased water inflows.

Practical values. In the real conditions of an operating mine, in the area of mining operations, the method for predicting zones of increased water inflows was tested according to a predictive evaluation of the prospects of local folds for the presence of gas accumulations.

Keywords: *local structures, synclinal folds, linear and volumetric deformations, fractured zones, increased water inflows*

Introduction. A large number of geological problems are associated with the forecast of fracturing and the determination of fractured zones in rock massifs. Fractured zones are associated with oil and gas reservoirs with improved reservoir properties, zones of higher water inflows, accumulations of minerals, the formation of which is due to the circulation of fluids along existing cracks. The formation of fracturing is largely caused by tectonic processes when stresses in rock massifs exceed the tensile strength of rocks and cause a violation of their continuity.

The process of cracking should be considered one of the leading natural factors in the formation of reservoirs in low-porous rock strata. Compaction and fracture formation of rocks due to tectonic processes increase the permeability of dense rocks, promote the redistribution of water and gas, increase the mobility of phases in the water-gas system of the rock massif and the concentration of fluids – free methane and (or) water in the form of accumulations. It is proved that the minimum tensile deformations that exceeded the maximum permissible limit for breaking continuity and led to brittle deformations of the gap form filtration properties in low-porous rocks with absolute gas permeability of tens of milidars, which corresponds to industrial reservoirs of class IV [1]. Therefore, devising methods for studying rock fracture formation and predicting fractured zones in rock massifs is a relevant task on the way to solving many geological problems associated with rock fracturing.

Methods for studying fracturing can be field-based – direct and indirect, analytical – by analyzing the available geological and mining-geological data, as well as combined. Direct studies include direct investigations in mine workings, in wells (and/or well core), rock outcrops.

The indirect ones are implemented according to a number of related features, by which the degree of fracturing of the rock massif can be indirectly assessed.

Direct assessment based on core examination is the most reliable method for studying the fracturing of reservoirs. However, during drilling, rocks are deformed and stressed states are relaxed, as a result of which new (man-made) cracks form and the aperture of previously existing cracks changes. In addition, the radius of research in such methods slightly exceeds the radius of the well. Borehole methods include hydrodynamic surveys of wells which make it possible to estimate the distance from wells to zones of increasing fracturing. Hydraulic listening of wells and tracer studies allow one to identify the preferred directions of filtration. One can also study fracturing on outcrops where it is possible to observe the propagation of cracks and their interaction over a large area. It should be noted that the above research methods only are not enough to reliably determine the distribution of a network of cracks in rock reservoirs.

Methods for studying fracturing are direct and indirect instrumental, field-based, and, mainly, geophysical ones. Attempts to find a way to directly isolate fracturing, as well as estimate its spatial density, have been made for a long time. Since the second half of the last century, scientists have been actively trying to use data from the geophysical exploration of wells (GEW) to solve these problems. However, no unambiguous solution to this problem has been obtained so far. This is mostly due to the difficulty of selecting cracks. Thus, for example, it turned out that the task of describing the crack system in the wellbore is very difficult and this cannot be done unequivocally correctly. Because of these reasons, the solution to the problem, as is usually customary in geophysics, began to be sought in the integration of well logging methods.

The most popular for the study of fracturing are methods of geophysical exploration of wells (GES) – the method of spontaneous polarization, gamma method, cavernometry, thermometry, and inclinometry. The group of GES methods for determining hollowness usually involves acoustic, neutron, and density logging, which make it possible, on the one hand, to assess fracturing, and on the other hand, under favorable conditions, to register the presence of secondary hollowness (acoustic logging).

Separately, it is necessary to mention the modern methods of crack identification, offered by one of the world's leading companies "*Schlumberger*". These are "Sonic Scanner" – 3D acoustic sensing, FMI (azimuthal electric micro imager), Quanta Geo (azimuthal electromagnetic micro imager), UBI (ultrasonic high-resolution micro imager), OBMI (azimuthal electromagnetic micro imager) [2]. The use of these methods involves the use of expensive equipment, original proprietary procedures, and qualified personnel. Nevertheless, even these procedures, taken separately, do not make it possible to unambiguously identify cracks and assess the fracturing of reservoirs as a whole.

Combined methods imply the integrated application of two or more methods. For example, this is a combination of analysis of field outcrops, core, and logging [3], a combination of instrumental and analytical methods [4, 5].

Analytical methods are implemented by analyzing the available geological and mining-geological data with subsequent calculations [6, 7] or modeling [8, 9].

The IGTM NAS of Ukraine has developed an analytical methodology for predictive assessment of the prospects of local anticlinal structures based on geological exploration data in order to search for areas of accumulation of free methane of coal-bearing sediments [1]. The essence of the forecast assessment is to determine, by calculation, based on the parameters of local structures and the thickness of the bed, quantitative indicators of filtration-capacitive properties, which sandstones acquire in the process of folding, and to compare compliance of the obtained data with the conditions of existence of gas accumulations in coal-bearing sediments.

In the proposed theoretical model, the prerequisite for the formation of the reservoir is cracking in the vaulted part of the anticlinal structure during its formation (during tension and deformation), which exceeds the maximum permissible limit for this rock. As a result of tectonic processes, the bendings of the rock strata are accompanied by interlayer sliding and cracking. During rock bending into an anticlinal fold, rock layers are stretched, increasing from the sole to the roof, which contributes to the increase in cracking in this direction. In the lower part of the sandstone, in which the tensile deformations do not reach the maximum allowable values, cracks do not develop, and in the upper part, they do, which increases permeability. The process of fold formation helps to increase the filtration characteristics of sandstone layers disturbed by cracks. Methane in these layers acquires mobility due to increased fracture permeability and can accumulate in the form of deposits. The screen of the deposit is a layer of this same sandstone, which becomes flatter upwards and is not affected by cracks due to a smaller bending, as a result of which it is gastight, and the methane located in the pores is practically immobile.

This mechanism provides for the possibility of calculating the effective thickness of sandstone in the vaulted parts of local anticlinal folds, depending on the curvature of the fold. The radius of curvature of an anticlinal fold is determined by the values of its width and height.

The effective thickness is understood as the thickness of the sandstone, or the thickness of the layer in the sandstone strata, which is characterized by improved reservoir properties and can potentially be suitable for the accumulation of free methane. The critical thickness is calculated as the difference between the two radii of curvature of the fold, which are used to determine the lengths of arcs that differ from each other by an amount proportional to the maximum allowable tensile deformation for this rock. The effective thickness is calculated as the difference between the thickness of the sandstone seam and its critical thickness.

The general scheme of the method for assessing the prospects of local anticlinal structures contains the construction of maps of local structures, determining their main parameters, and calculating decompression coefficients. After that, calculations of filtration and capacitive characteristics of rocks in the potential zone of accumulation of free methane within the local anticlinal structure are performed. The analysis of the investigated area involves the identification of tectonic structures on structural or hypsometric plans, determination of their parameters (amplitude and size), calculation of the effective thickness of sandstones and identification of the zone of accumulation of free methane (ZAFM).

The application of the procedure makes it possible to predict the prospects of local anticlinal structures of low-porous coal-bearing sediments for the search for accumulations of free methane based on geological and geophysical data. In [10], it is noted that the above procedure can also serve to assess the prospects of local synclinal folds for the presence of accumulations of free methane.

Given the possibility of determining zones of increased fracturing within synclinal folds using this methodology, it can also be used to analyze synclinal structures in order to predict zones of increased water inflows.

The purpose of the work is to predict zones of increased water inflows by geological exploration and mining-geological data under real conditions of an existing coal mine according to the procedure for predictive assessment of the prospects of local structures for the presence of gas accumulations.

The object of the research is a muld-like depression of the coal bed c_{10}^{v} (synclinal structure) within the operational unit No. 2 at "Samarska" mine in the Pavlohrad-Petropavlivsk geological and industrial region.

Methodology. The research was carried out by constructing a map of local structures using trend analysis. According to the hypsometric plan of the coal bed, an approximating surface of the 1st order – a plane – was built. Based on the deviation of the actual hypsometric marks of the coal bed from the corresponding marks of the approximating surface, the interpolation method was used to build a map of local structures. The plan highlights the local synclinal fold and defines its main parameters – amplitude and width. According to these parameters of the structure, calculations of relative linear deformations and relative bulk deformation of the investigated synclinal structure were performed. Subsequently, calculations of fracture porosity and absolute permeability, which rocks had to acquire as a result of cracking, were performed.

Geological structure of the research area. The specified coal industry region is the southeastern part of the Novomoskovsk-Petropavlivska monocline, located on the northeastern slope of the Ukrainian Shield. The monocline in the east merges with the southern wing of the Kalmius-Toretsk basin, in the west – with the platform part of the southwestern side of the Dnieper-Donets depression.

Igneous and metamorphic rocks of the Precambrian of the Ukrainian shield serve as the foundation for the sedimentary strata of the Western Donbas. The crystalline foundation is broken by a large number of tectonic disturbances into blocks. The block structure was inherited by the sedimentary strata.

A powerful complex of Paleozoic, Mesozoic, and Cenozoic sedimentary deposits lying on crystalline rocks of the northeastern slope of the Ukrainian shield takes part in the geological structure of the region. The complex of sedimentary sediments is represented by rocks of the Devonian, Carboniferous, Permian, Triassic, Jurassic, Paleogene, and Neogene systems, covered by a continuous cover of Quaternary sediments.

Sedimentary rocks are characterized by monoclinal occurrence with angles of incidence of 2–5° relative to the axis of the Dnieper-Donets depression. The main type of tectonic disturbances are discharges directed mainly from southeast to northwest. The discharges are steeply falling, with displacement angles of 40–85°, often parallel. The discharges form a whole system of faults with amplitudes from 5 to 350 m.

Plicative forms of dislocations are developed rarely and manifest themselves mainly in the most intensely disturbed areas in the form of wavy occurrence of rocks, sometimes turning into small-flat folding with a fall of wings of 3–5°, occasionally up to 8°.

The sedimentary stratum within the estimated area is represented by rocks of the lower carboniferous, which are overlapped by sediments of the Paleogene, Neogene, and Quaternary ages.

Lithologically, coal deposits are represented by alternating layers of sandstones, siltstones, and argillites, which contain low-power layers of coal and limestone.

The field of "Samarska" mine is located on the southern slope of the Dnieper-Donets depression, in the zone of articulation with the Ukrainian crystalline massif. In structural-tectonic terms, the area of "Samarska" mine is confined to the southern part of the Central Graben of Western Donbas.

In general, the mining field is characterized by the calm monoclinal occurrence of the sedimentary strata of carbon with rock falling to the north and northeast at an angle of 2–4°. Gentle occurrence is complicated by a number of large and small disjunctive disorders such as discharges.

Among them, it is necessary to note the largest tectonic disturbances Bohdanivskyi, Bohuslavskyi, and Pivdenno-Ternivskyi discharges. The amplitude of rock displacement along these discharges varies: along the Bohdanivskyi fault, from 35 to 305 m; along Bohuslavskyi, 70–150 m; along Pivdenno-Ternivskyi, 3–105 m.

In addition, the mine workings recorded a number of low-amplitude disturbances with an amplitude of 0.2 to 2.0 m. These disturbances do not have a large length, are common without a visible pattern, and have different elements of occurrence. The angles of incidence are mainly 60–85°. Despite the small amplitudes, these disturbances are often accompanied by significant areas of weakened rocks, which reach 10 m.

The tectonic structure of the subsoil area, the disturbance of coal beds, and their morphology are quite complex; in this regard, the field of "Samarska" mine is assigned to group 2 according to the complexity of the geological structure based on the Classification of Mineral Reserves and Resources of the State Subsoil Fund.

The industrial coal content of the mining field is confined to the lower carboniferous sediments of suite c_1^3 "Samarska". The coal-bearing strata of rocks are enclosed between the limestone c_1 and the layer c_8^v. The section of the suite contains 25 coal beds and layers. The coefficient of industrial coal content is 3.59.

Within the field of "Samarska" mine, of industrial importance are coal beds c_6, c_5, c_4^2, c_4^1, c_4, c_1, beds that are being developed are c_4^2, c_{10}^v.

According to the approved conditions, reserves of all coal beds are attributed to balance ones. By the nature of industrial coal content, the mining field belongs to a multilayer with a significant advantage in terms of relatively mature and non-mature beds.

In terms of maturity, coal beds include:

- relatively mature – beds c_6, c_5, c_4^2, c_4, c_1;
- non-mature – bed c_4^1.

By capacity, all coal beds belong to the group of thin and very thin ones (thickness does not exceed 1.35 m). Beds c_6, c_5, and c_4^1 are characterized mainly by a simple structure, and beds c_4^2, c_4, c_1 have both simple and complex structures. Within the mining field, zones of erosion of coal beds and their replacement with sandstone can be traced.

The hydrogeological conditions of the mining field are complex due to the presence of hydraulically interconnected aquifers and complexes of the Mesocene and high-pressure aquifers of the coal system. Sandstone seams and lower carbon coals go directly under the sands of the aquifer of the Buchach sediments (P_2bc), as a result of which the carbon aquifers are directly fed at the expense of groundwater reserves of cover sediments. The average annual general mine water inflow for 2021 across the field of "Samarska" mine amounted to 721.0 m^3/hour. According to technical indications, the water is unsuitable for reclamation and irrigation. Drainage water reserves in the mine were not calculated.

The coal-bearing strata of the lower carboniferous suite c_1^3 are degassed to a depth of 150–200 m. The natural methane content of coal beds c_6 and c_5 is 4.5–4.8 m^3 in terms of 1 ton of dry ashless coal mass; beds c_4^2, c_4^1, c_4, c_1 – 7.8–8.4 m^3 in terms of 1 ton of dry ashless coal mass. The methane content of the mine treatment workings does not exceed 10 m^3 in terms of 1 ton of dry ashless coal mass.

Carbon-containing rocks are represented by alternation of argillites, siltstones, rarely sandstones. The main complications during the operation of the mine are observed in the form of dumps from the roof, soaking, and heaving of rocks of the sole of mine workings. The rocks of the roof of the formation are unstable and very unstable, easily collapsing, the sole rocks are both unstable and medium resistant. Mining-geological and mining-technical conditions are difficult due to the complexity of the structure of coal beds, the presence of fragile rocks of the roof and sole and watered tectonically disturbed zones.

Results and discussion. Bed c_{10}^v is mined by "Samarska" mine within block No. 2, cut from "Zakhidno-Donbaska" mine. Bed c_{10}^v is one of the main beds of industrial importance, it lies 112 m stratigraphically below limestone c_5 and is the upper layer of industrial importance. The depth of the bed ranges from 224.6 to 501.0 m. Within the mining field, it is characterized by widespread distribution with a stable operating capacity of 0.60 to 1.35 m. In the eastern part of the field, it is dominated by a capacity of 1.10 m; in the central part, behind the splitting line, it decreases to substandard – 0.25–0.50 m and loses its industrial value. In the central part of block No. 1, the bed is eroded and replaced with sandstone. The erosion is in the meridional direction, its contours have a complex configuration. The width of the erosion in the north of the mining field reaches 3.5 km, in the south – up to 2.0 km. In the eastern part of block No. 1, the bed is mature, with high values of working capacity (0.90–1.20 m), which extends further east.

Within operational unit No. 2, the bed is mature and retains operating capacity (0.95–1.20 m) practically over the entire area of the block, except for its southern part, where post-formation erosion of the bed over a large area is observed. The erosion width is 600–800 at complex contour configuration.

The coal bed c_{10}^{v} in the study area lies at depths of 270–300 m, it has a simple structure. The capacity of coal bed c_{10}^{v} is non-mature, which complicates the prediction of capacity within the excavation columns. The capacity ranges from 0.86 to 1.28 m. The coal bed is black, strong, viscous, semi-matte, hatched-striped, wet, fractured, contacts with lateral rocks are sharp, weak.

On the main roof, there are sandstone, argillites, siltstones, and coal beds. In the immediate roof, there are mainly siltstone, argillite, and sandstone. In the immediate sole – argillite, sandstone, and silt.

Argillite lying in the immediate sole is dark gray, with horizontal, mild lamination; at the beginning of the layer, of lumpy texture, "curly", with the inclusion of siderite buds, of medium strength (f = 1–3), very unstable. Aleurolite lying in the immediate sole is grey, massive, fine-grained; its texture is layered, thin, gently wavy, unstable, moist, and of medium strength (f = 1–3).

According to data from the geological exploration of wells, a hypsometric plan of the bed section c_{10}^{v} within the field of "Samarska" mine was built (Fig. 1).

According to the results of tectonic analysis within the investigated area, the coal bed has a monoclinal structure, complicated by local bends and sinks in the northeast direction. The marks of the sole of the coal bed vary from –107.7 m in the area of well NZ-4165 to –180.45 m in the area of well No. 6124.

Using the data on the obtained hypsometric plan of the coal bed c_{10}^{v}, a map of the approximating surface (trend) of the *1st* order was constructed (Fig. 2), which allows us to assess the regional features of the occurrence of rocks in the research area. As can be seen from the resulting map, the coal bed sinks in a northeasterly direction with an azimuth of incidence of about 20°.

Based on the deviation of the bed hypsometry from the approximating surface, a map of local structures of the *1st* order of the coal bed c_{10} was constructed (Fig. 3). The maximum values of deviation from the approximating surface are about +30 m in the area of well NZ-2928 and northwest of it, but no anticlinal local structures were detected. On the resulting map, the synclinal local structure in the central part of the study area is clearly distinguished, in the area of wells Nos. NZ-4166, 6124, 6122.

The greatest deviation from the approximating surface within the structure is –21.1 m (east of well No. 6122 in the direction of well No. 3257). The width of the structure (line A–B) within the isoline 0 m is 1055.8 m, the length (line C–D) is 1161.2 m. If we limit the selected structure to the isoline –10 m, then the dimensions of the structure are 925.2 by 786.5 m, respectively, the length and width of the fold.

According to the values of the amplitude and width of the synclinal fold, the main parameters of the structure were calculated – the coefficient of curvature (bending) of the fold, the coefficients of linear deformation along the length and width of the fold, the coefficient of volumetric deformation, and the critical thickness of the sandy-aleurolite strata, which is located above the coal bed c_{10}^{v} (Table 1).

According to the geological section of well No. 6124, which is drilled in the bottom part of the investigated structure, the sole of the coal bed c_{10}^{v} lies at a depth of 299.8 m, the mark of the sole of the Buchach horizon is 107.8 m. That is, the thickness of Carboniferous rocks within the selected structure is about 192 m. Considering the critical thickness of rocks (26.4–32.0 m), the effective thickness of the sand-siltstone strata over the coal bed c_{10}^{v} is 160–165 m. With such effective capacity, the calculated values of relative linear deformations are up to 1.030 by the width of the structure, by length – up to 1.025. Accordingly, the coefficient of volumetric deformation reaches 1.050–1.056 (Table 2).

The calculation of deformations based on these parameters showed exceeding the critical values for the continuity violation. It is known that the critical values of linear deformations for sandstone are 0.003–0.004; for siltstones, 0.004–0.006 [1]. According to the values of linear deformations that are greater than the critical values, deformations of rock layers are considered to cause a violation of the continuity of the rock massif and form a fractured zone.

Based on the calculated data on the volumetric deformation of rocks (siltstones and sandstones) and the average values of open porosity, the fracture porosity and absolute permeability of rocks in the roof of the bed c_{10}^{v} were calculated (Table 2).

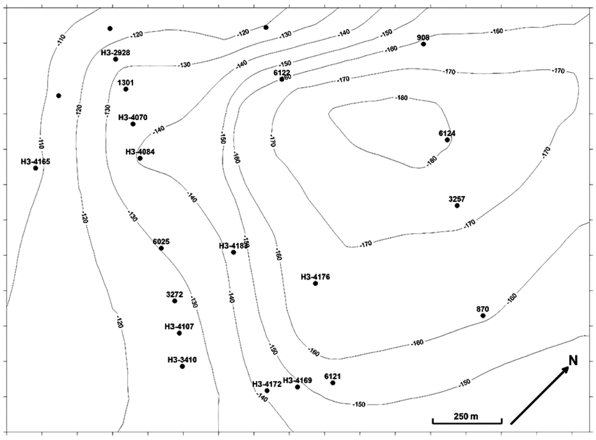

Fig. 1. Hypsometric plan of the bed c_{10}^{v} section of "Samarska" mining field

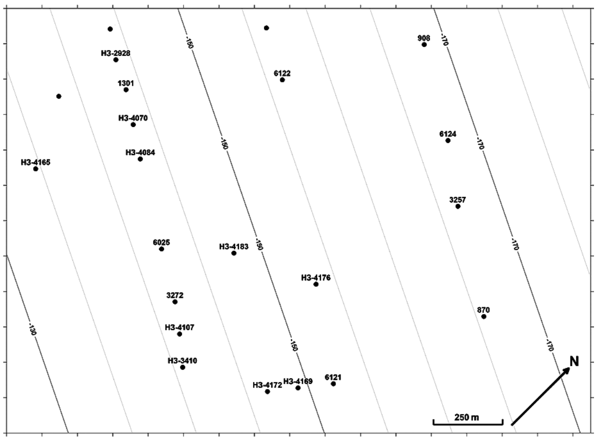

Fig. 2. Approximating surface of the 1st order of the bed c_{10}^{v} section of "Samarska" mining field

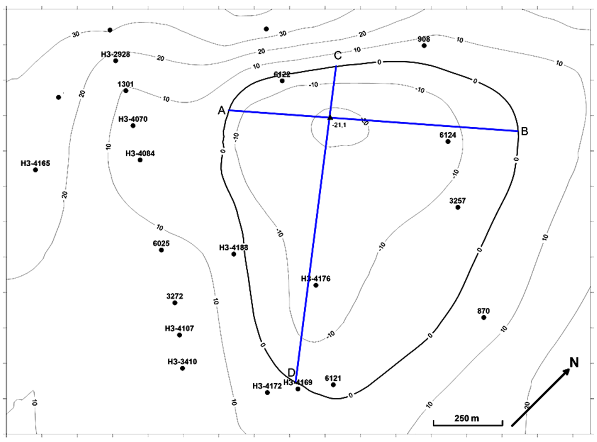

Fig. 3. Map of local structures of the 1st order of the bed c_{10}^{v} section of "Samarska" mining field

Table 1

Parameters of the local synclinal structure of the bed c_{10}^{v} section of "Samarska" mine (longwalls 1002–1004)

Contour-isoline, m	Fold amplitude, m	Fold width, m	Fold length, m	Structure bending coefficient, nd/q		Critical thickness, m	
				by width	by length	by width	by length
0	21.1	1055.8	1161.2	0.020	0.018	26.3	32.0
–10	11.1	786.5	925.2	0.014	0.012	27.9	38.6

Table 2

Data on the assessment of reservoir properties of roof rocks within the local synclinal structure of the bed c_{10}^{v} section of "Samarska" mine (longwalls 1002–1004)

Contour-isoline, m	Coefficient of linear deformation of rock strata		Coefficient of volumetric deformation of sandstone (contour of the vault)	The coefficient of open porosity, average (actual), siltstone-sandstone, %	Coefficient of fractured porosity (calculated), %	Permeability (calculation based on fractured porosity), 10–15 m^2
	by fold width	by fold length				
"0"	1.030	1.025	1.056	9.1–13.6	4.6–4.8	391–408
"-10"	1.029	1.020	1.050	9.1–13.6	4.1–4.3	349–366

The calculated coefficient of fracture porosity is 4.1–4.8 %, and absolute permeability, only due to the acquired cracked porosity, as a result of folding, should be in the range of 350–400 · 10^{-15} m^2 (mD). Consequently, the formation of a fractured zone, with improved filtration-capacitive properties of rocks, should contribute to an increased inflow of mine water into mine workings, within a certain area.

The obtained results on mining and geological conditions within the local synclinal structure are fully confirmed by the results of mining operations. According to the program of mining development at "Samarska" mine, the excavation column of longwall 1003 of bed c_{10}^{v} was worked out. The length of the longwall 1003 is 300 m. The length of the excavation column is 2302 m, the longwall is contoured by the prefabricated drift 1003, side drift 1003, and holing chute 1003.

Based on the mining development program, the place of laying of drainage drift 1003 in accordance with the developed mining and geological forecast was assumed at the lower point (with a minimum altitude elevation) of coal bed c_{10}^{v} on PC-220 along prefabricated drift 1003. The place of laying of the holing chute 1003 was supposed to be on PC-212+8m along prefabricated drift 1003 (above drainage drift 1003). This technical solution was due to the fact that the water formed during the mining of longwall 1003, at the first stage, would accumulate by gravity at the lower point, and, at drainage drift 1003, it was planned to equip a district water reservoir. However, according to the results of the operational exploration of prefabricated drift 1003, the actual position of bed c_{10}^{v} differed significantly from the forecast, namely, the actual lower point of occurrence of the bed along prefabricated drift 1003 of bed c_{10}^{v} was located on PC-250.

In order to ensure the completeness of the extraction of reserves, pumping water from the excavation section of longwall 1003, the place of laying drainage drift 1003 was proposed on PC-250, and holing chute 1003 was planned to begin on PC-244 along prefabricated drift 1003. At the same time, the length of the excavation field of longwall 1003 was increased by 312 m compared to the planned mining development program.

Operational exploration during preparatory mine workings (prefabricated drift 1003, side drift 1003, prefabricated drift 1002, drainage drift 1003, as well as holing chutes 1002 and 1003) determined difficult mining and geological conditions. In local areas, muld-like occurrence of coal bed c_{10}^{v}, the extremely unsustained thickness of coal bed c_{10}^{v} were registered; lithology change zone, within which watered sandstone lies at a height of up to 2.5 m from the roof of the coal bed. With sandstone, the lower layers have weakened contact and are characterized by an increased tendency to detachment and collapse. In all mine workings, there is an inflow of water from the rocks of the roof in the form of downpour, in the sole – mirrors of water. The technical meeting decided to move the laying site of a number of planned mine workings. In particular, to eliminate the risk of flooding of longwall 1003, drainage drift 1003 was made, in which the district drainage system was located. Subsequently, because of unfavorable mining and geological conditions, coal reserves in this area were scheduled for write-off.

Conclusions. In the sandy-aleurite strata above coal bed c_{10}^{v} in "Samarska" mine (longwalls 1002–1004), a local synclinal structure with the presence of rocks with improved filtration-capacitive properties (crack-pore type reservoir) was registered. The improved reservoir properties of rocks in this area are due to the formation of a fractured zone, which formed as a result of folding when the deformations of the rock strata exceeded the limit critical for violation of continuity. The formation of a fractured zone predetermines increased water inflows into the mine workings. Working out the rock massif caused additional volumes of water. This is confirmed by the results of mining, namely difficult mining and geological conditions – in the roof of coal bed c_{10}^{v}, there is watered sandstone, and in all mine workings, there is an inflow of water from the roof rocks in the form of downpour, in the sole – water mirrors.

To analyze the mining and geological conditions within the revealed synclinal structure, a methodology for predictive assessment of the prospects of local structures for the presence of gas accumulations was applied. The obtained results confirmed the possibility of using this procedure to predict zones of increased water inflows.

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Прогнозування зон підвищених водоприпливів у локальних складчастих структурах

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Мета. Прогнозування зон підвищених водоприпливів за геолого-розвідувальними й гірничо-геологічними даними в реальних умовах діючої вугільної шахти за методикою прогнозної оцінки перспективності локальних структур на наявність газових скупчень.

Методика. Дослідження здійснювалися шляхом побудови карти локальних структур із застосуванням тренд аналізу. У плані виділена синклінальна складка й визначені її головні параметри – амплітуда та ширина. За цими параметрами виконані розрахунки відносних лінійних деформацій і відносної об'ємної деформації досліджуваної складки.

Результати. За відхиленням гіпсометрії пласта c_{10}^{v} (шахти «Самарська») від апроксимуючої поверхні на карті виділена локальна синклінальна структура. На підставі розрахункових даних про об'ємну деформацію порід (алевролітів і пісковиків) і за середніми значеннями відкритої пористості розрахована тріщинна пористість і абсолютна проникність. Отримані дані свідчать про утворення, у межах досліджуваної ділянки, тріщинуватої зони з покращеними фільтраційно-ємнісними властивостями гірських порід. За фактичними гірничо-геологічними даними, у межах визначеної площі, спостерігаються підвищені водоприпливи у гірничі виробки, що підтверджує результати виконаного прогнозу.

Наукова новизна. Уперше застосовано алгоритм прогнозної оцінки перспективності локальних антиклінальних структур на наявність газових скупчень для прогнозування зон підвищених водоприпливів.

Практична значимість. У реальних умовах діючої шахти, у процесі ведення гірничих робіт, апробована методика прогнозування зон підвищених водоприпливів відповідно до прогнозної оцінки перспективності локальних складок на наявність газових скупчень.

Ключові слова: *локальні структури, синклінальні складки, лінійні та об'ємні деформації, тріщинуваті зони, підвищені водоприпливи*

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