2028; 345(2):72-83 ISSN-L 2616-6445, ISSN 2224-5243

Crossref

DOI: 10.31643/2028/6445.17
Earth and Planetary Sciences: Earth-Surface Processes

Identification of Methane-Bearing Coal Seams in Borehole Sections of the Karaganda Basin Using Geophysical Logging Data

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Received: *March 17, 2026*
Peer-reviewed: *March 19, 2026*
Accepted: *June 9, 2026*

ABSTRACT
The Karaganda coal basin is one of the most gas-bearing in the world. Its feature is that there are no large accumulations of free gas in it, while the natural gas content reaches up to 25-30 m³/t; this is confirmed by a large volume of gas sampling, gas logging data, and gas survey data in operating mines. Methane from coal seams enters the atmosphere through natural migration through overlying rocks, as well as at the places where seams outcrop under overburden and through the shafts of closed mines. During degassing of coal seams in the Karaganda basin during the opening of seams by mine workings, including during open-pit mining, seam outcrops to the surface, degassing of the worked-out space of closed mines, part of the extracted methane is used at the mines for obtaining thermal and electrical energy, and the larger part enters the atmosphere during degassing of coal seams. It is known that methane entering the atmosphere retains the Earth's heat significantly higher, by 25-30 times, than carbon dioxide. The extraction of methane from unloaded coal seams for its industrial use in obtaining thermal and electrical energy is an important task in the development of technologies for the integrated development of coal-methane deposits, as well as for reducing the environmental load on the regions where they are located. The purpose of the research is the identification in the section of gas-bearing coal seams for assessing the potential of methane extraction from unloaded seams for its industrial use and reducing emissions into the atmosphere. Methods. A complex of geophysical methods for studying exploration wells to investigate the physico-mechanical and filtration-capacity properties of coal seams and host rocks, sampling and analysis of coal seam samples in mine workings. Results. Patterns of changes in the complex of physical properties of coal seams determining their gas content have been established, geological justification for these changes and changes in the physico-mechanical properties of host rocks has been given. Application. The gas-bearing coal seams identified in the section can be used in planning methane extraction from all gas-bearing seams of the geological section, including coal seams being developed by mines, and the patterns of changes in physico-mechanical and filtration-capacity properties of coal seams prepared for development or being developed can be used in geomechanical calculations. The factual materials for conducting the research were obtained from the results of laboratory and geophysical studies of exploration wells, materials from geological and production reports.

Keywords: coal suites, metamorphism physico-mechanical characteristics of coal and host rocks, gas content, forms of methane occurrence in coals, ecology, geomechanics.

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Indroduction

The gas content of coal seams in the Karaganda Basin is studied to ensure safe working conditions during mining operations in underground mines. As the depth of mining increases, both the gas content and gas pressure in coal seams rise, and their physico-mechanical as well as filtration-capacity characteristics undergo significant changes.

These factors govern the mechanism of coal and gas outbursts, which encompass a complex sequence of physical processes: destruction of the coal mass, gas desorption, diffusion and seepage of gas, and transport of pulverized coal within the gas flow [[1], [2], [3]].

Investigations of gas-dynamic phenomena in the basin's mines indicate the synergistic influence of several key factors, including: in-situ stress and gas pressure within the coal seam, physico-mechanical properties of the coal, its micro- and macrostructure, and the surface energy of coal particles. The latter increases markedly with the degree of tectonic pulverization of coal in zones of tectonic dislocations and abrupt changes in seam hypsometry [[4], [5], [6]].

Analysis of the factors controlling the manifestation of gas-dynamic events — and their implications for safe mining practices — highlights the necessity of comprehensive studies of the physical properties of coal seams and host rocks, not only under natural (undisturbed) conditions but also in areas already prepared for extraction [[7], [8]].

The development of fracture networks during pre-mine degasification, as well as fracturing induced by mining-induced destressing of the coal seam (including that created by boreholes drilled from development workings and in-seam boreholes), substantially enhances the effectiveness of coal seam degasification operations. All these processes lead to alterations in the physico-mechanical characteristics of the coal-rock mass, which must be duly accounted for in geomechanical calculations [[9], [10]].

In recent years, there has been growing global interest in the exploration and development of unconventional hydrocarbon resources [[11], [12]]. A promising direction for the development of Kazakhstan's fuel and energy sector is the integrated development of coal-methane deposits, among which the Karaganda Basin holds a prominent position. One of the key components of this raw material is coalbed methane — an environmentally friendly and highly efficient energy and chemical feedstock [[13], [14]].

Methane extracted during coal seam degasification is utilized for industrial purposes. This reduces its emissions into the atmosphere, thereby mitigating its contribution to global warming, climate change, and adverse effects on human health [[15], [16]]. It is used for the generation of thermal and electrical energy, and its utilization promotes the intensive socio-economic development of the coal-methane deposit region.

Experimental part

The object of the study is the Karaganda Coal Basin, which includes the following districts: Karaganda, Sherubai-Nurinsky, Tenteksky, and Verkhne-Sokursky. The most productive and workable coal-bearing suites are the Karaganda and Dolinskaya formations.

Coal samples for laboratory investigations were collected in accordance with GOST R ISO 18283-2010 "Hard coal and coke. Manual sampling".

It is well known that the gas content of coals is determined by the degree of metamorphism. In this regard, the studied stages of metamorphism were determined based on vitrinite reflectance (R^o), volatile matter yield (A^{daf}), carbon content in the coals, heat of combustion, and caking properties. These analyses were performed in the specialized laboratory of LLP "Scientific Research Center " Ugol' l" in Karaganda.

It was established that the coals of the basin belong predominantly to the III and IV stages of metamorphism, with vitrinite reflectance (R^o) ranging from 0.52% to 2.8% [17].

Studies on the forms of methane occurrence in coals were carried out using the DMT method (Germany) at the "Spetsmontazhdegazatsiya" department of the Mining Department of JSC "Qarmet". It was found that a dynamic equilibrium exists in the coal matter between adsorbed methane, absorbed methane, and methane in the free phase. The measurements were performed on 250 coal samples taken from boreholes in seam D6 at the "Kazakhstanskaya" and "Lenina" mines in underground workings. During the studies, the ash content, volatile matter yield, and moisture content of the coals were also determined.

Geophysical logging in open exploration boreholes (GLB) was performed by the companies Weatherford and IGeo.

To investigate the density and volumetric clay content of coal seams within the Tentek (T) and Dolinsk (D) formations at the Kazakhstanskaya mine (boreholes Nos. 1/2, 2, and 3) and the Lenin mine (boreholes Nos. 1–4), studies were conducted under conditions of the natural stress–strain state. The research was carried out using an integrated suite of well-logging (geophysical logging) methods, including gamma–gamma density logging (GGDL), gamma-ray logging (GR), and broadband acoustic logging (BAL), employing calibrated borehole instruments.

Coal seams in the borehole sections were identified using gamma–gamma density logging (GGDL), characterized by lower density relative to the surrounding host rocks, as well as by borehole-derived clay content values from gamma-ray logging (GR). Additional criteria included elevated electrical resistivity obtained from the apparent resistivity method (AR). Gas-bearing intervals were delineated using the neutron–neutron logging method based on thermal neutrons.

Drilling regimes for 128 mm diameter boreholes adhered to the recommendations specified for the Karaganda Basin in references [[18], [19]].

Results and Discussion

For the Karaganda coal basin, a general relationship has been established between the gas content of coal seams and the degree of coal metamorphism, as well as changes in their physical properties [[20], [21], [22]], including their association with tectonically weakened coals [[23], [24], [25]]. Table 1 presents the systematic relationship between the thickness of coal-bearing formations in the Karaganda basin and the stages of metamorphism.

Table 2 presents the balance of volatile products generated during metamorphism of organic matter. The intensity of volatile release varies across different stages. Carbon dioxide emissions increase during the transition from peat to lignite, whereas hydrogen sulfide is released in minimal amounts. With increasing degree of metamorphism—particularly during the transition from bituminous coal to anthracite and from anthracite to graphite—the maximum amount of methane is generated [[26], [27], [28]].

The results presented in Tables 1 and 2 confirm that variations in the gas content of coal seams within the basin depend on both burial depth and the degree of metamorphism. The general pattern of metamorphic influence is expressed in the increase in methane content with stratigraphic depth, rising within a formation from the upper seams to the lower ones (Table 3).

Table 1 - Thicknesses of coal-bearing sequences and stages of coal metamorphism by districts and coal-bearing suites

Districts and deposits	Formation thickness, m (stage of metamorphism)		
	Karagandinskaya	Dolinskaya	Karagandinskaya, Nadkaragandinskaya, Dolinskaya, Tentekskaya
Tentek District	750 (IV-II)	520 (IV-II)	2400
Samarskoe Deposit	600 (II-III)	390 (II)	1965
Zavyalovskoe Deposit	650 (III)	450 (III)	2100

Table 2 - Balance of metamorphism products in organic matter, % [20]

Volatile component	The metamorphic series of coals			
	Peat brown coal	Brown coal bituminous coal	Bituminous coal anthracite	Anthracite graphite
H_2O	4.7	14.4	15.0	7.6
CO_2	74.8	53.6	18.4	9.3
CH_4	11.6	26.3	57.6	65.1
H_2S	0.2	5.4	2.8	9.0
NH_3	8.7	0.3	6.2	9.0
Total volatiles released at each stage	28.8	29.6	18.7	10.5

Table 3 - Average values of in-seam methane pressure, volatile matter yield, gas content, and permeability in coal seams K10 and K12 of the Karaganda Basin

Coal seam	Depth, m	Volatile matter yield, %	Coal rank	Thickness of surface layer d, nm	Change in in-seam pressure, MPa	Methane content, m³/t	Gas permeability, mD
K12	600	29.5	G	190.0	6.2	19.2	0.35-0.2
K10	370	27.5	G	198.5	3.8	15.0	1-1.4
	510	23.0	GF	180.7	4.0	17.5	0.90-0.55
	610	26.0	CF	158.1	4.2	18.5	0.30-0.20
	680	21.5	C	161.8	4.9	18.2	0.15-0.10

Table 4 - Components of methane occurrence forms in coal seams

Depth, m	Moisture, W, %	Ash Ad, %	Volatile matter r, %	Methane content, m³/t					Desorbable gas D
				Total Q	q_1	q_2	q_3	q_{1bar}	
-30	0.76	21.6	27.80%	15.9	1.1	11.6	3.2	2.3	13.6
-25	0.99	9.9	24.70%	17.2	1.2	13.7	2.3	2.7	14.5
-25	0.84	22.5	25.70%	13.9	0.9	10.7	2.3	2.5	11.4
-25	0.79	24	27.30%	12.7	0.7	6.9	5.1	2.5	10.2
-165	0.58	14.1	28.80%	11.6	0.9	6.2	4.5	2.3	9.3
-170	0.67	17.3	27.10%	15.8	1.4	10.4	4	2.4	13.4
0	0.66	19.6	28.30%	18.6	1.5	15.6	1,5	2.3	16.3
-100	0.9	14.7	28.80%	19.1	1.5	15.6	2	2.4	16.7
-13	0.99	14.7	26.00%	7.6	0.4	3.2	4	2.4	5.2
-80	1.02	26.8	24.50%	13.8	1	8.9	3.9	2.4	11.4
-76	0.98	21.2	27.50%	5.9	0.3	2.6	3	2.4	3.5
-70	0.91	18.4	27.20%	5.9	0.3	2.5	3.1	2.3	3.6
-40	0.9	10	25.80%	6.7	0.3	4.3	2.1	2.5	4.2
Average	0.85	18.06	26.88%	12.67	0.88	8.63	3.15	2.12	10.25

The results presented in Table 3, including the evaluation of volatile yield, thickness of the near-surface coal layer, reservoir pressure, methane content, and gas permeability across coal ranks at different depths, indicate that methane reservoir pressure in coal seams increases with depth. For example, in seam K11 "Felix," methane pressure at a depth of 320 m is 2.80 MPa with a gas content of 15 m³/t, whereas at a depth of 690 m these values increase to 4.90 MPa and 18.2 m³/t, respectively.

Methane in coal seams occurs predominantly in sorbed and free states, accumulated within micro- and macropores. The ratio between these forms varies with depth depending on changes in porosity.

The natural gas pressure within micropores and natural microfractures of the coal matrix determines the volume of methane in the sorbed state, whereas the content of free gas increases slightly with depth and subsequently stabilizes. This behavior is associated with metamorphic processes classified as first-order phase transitions: one part of the coal substance forms an activated complex, another contributes to the growth of the aromatic carbon network, and a third transitions into the gaseous phase, which migrates from the coal seam toward the surface.

During marine regression, the coal-bearing strata are uplifted toward the surface (in this case, the Ashlyarik Formation coals), leading to changes in the thermodynamic parameters of the coal substance. Under these conditions, coal macromolecules become more electrically neutral due to ion diffusion within the coal matrix. The degree of electrical neutrality of coal macromolecules is governed by time, ion concentration, and the structure and size of the coal substance, including its surface layer.

The key factors controlling the preservation and migration of gases through coal seams and surrounding rocks include methane reservoir pressure, coal permeability, sorption properties, and the porosity of both coal seams and host rocks [[29], [30]].

The results of studies on the forms of gas occurrence in coal seam D6, prepared for extraction, are presented in Table 4, where:

q_1 — denotes the amount of gas lost during borehole drilling and prior to placing the sample into a sealed container;

q_2 — gas measured in the container;

q_3 — gas released after sample grinding;

$q_1$bar — gas desorbed after equilibration at laboratory (atmospheric) pressure.

The sum of the first three values (Table 4) corresponds to the total gas content of the sample Q. Subtracting q_{1bar} from this sum yields the amount of desorbed gas in the sample (D). Analysis of Table 4 and Figure 1 shows that the contents of q_1, q_3, and q_{1bar} remain practically unchanged and correspond to the following mean statistical values (m³/t): q_1 = 0.88, q_3 = 3.15, and q_{1bar} = 2.12.

At the same time, the contents of q_2 and D correlate with the total gas content of the sample Q, and the difference between them represents the average content of free gas, which is 2.42 m³/t.

The desorbable gas content, amounting to 10.25 m³/t, is determined by two main factors: the adsorption surface of micropores and microfractures (including the microfracturing of the coal surface layer) and the gases absorbed by the coal matter.

Based on Schlumberger logging results using neutron-neutron logging (NNL) in combination with gamma-gamma density logging (GGL-D), gas-bearing coal seams were identified (see Tables 5 and 6).

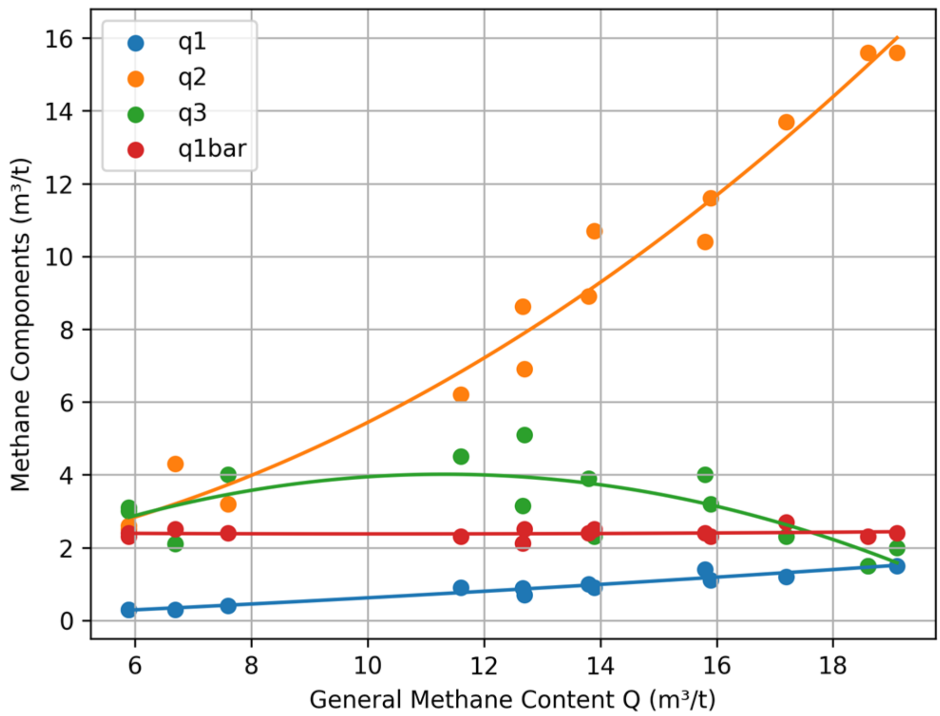

Figure 1 - Methane Components with Average Trend Lines

Table 5 - Average density, volumetric clay content, and lithology of coal seams in the Tentek and Dolinskaya suites

Borehole №	Depth interval, m	Number of seam intersections	Coal seams	Average thickness, m	Density ρ, g/cm³	Volumetric clay content K_{CC}, %	Lithology
	Lenina Mine						
1	109.1-	12	T_1-$T_{1/2}$	0.79	1.71	9.13	coals
	489.3			0.53	1.74	13.6	coals
	516.6-647.0	2	D_8-D_{11}	0.70	1.35	2.23	gas-bearing
	515.3-702.3	3	D_6-D_{11}				
2	202.7-400.7	18	T_1-T_9	0.87	1.88	21.15	coal
	536.0-68.7	12	D_7-D_{11}	0.81	2.02	23.32	coals
	254.6-391.0	6	T_2-T_8	1	1.64	3.17	gas-bearing
	722.7-727.9	2	6	5.20	1.40	2.40	gas-bearing
3	96.9-445.7	18	T_1-T_{16}	0.80	1.78	14.57	coal
	636.7-727.9	5	D_7-D_9	0.54	1.93	13.36	coal
	186.9-447.3	4	T_1-T_{12}	0.93	1.68	5.40	gas-bearing
	618.9-770.7	3	D_6-D_{11}	1.90	1.55	2.33	gas-bearing
4	94.8-673.6	24	T_1-T_{13}	0.72	1.885	29.30	coal-fired
	676.9-753.7	2	D_8	0.70	1.92	35.30	coal-fired
	552.3-555.7	1	D_{10}-D_{11}	2.57	1.37	3.10	gas-bearing
2	Kazakhstanskaya Mine						
	261.3-321.0	6	T_4-T_6	0.60	1.89	33.85	coals
	505.6-703.2	9	D_6-D_{11}	0.60	1.87	25.48	coals
	347.2-347.9	1	T_3	0.7	1.41	9.70	gas-bearing
	520.4-706.5	7	D_6-D_{10}	1.06	1.55	6.31	gas-bearing

Table 6 - Average characteristics of coal seams by suite

Suite	Density ρ, g/cm³		Volumetric clay content Kcc, %	
	non-gas-bearing	gas-bearing	non-gas-bearing	gas-bearing
	Lenina Mine			
Dolinskaya	1.51 ±0.03	1.41 ± 0,03	17.90 ± 0.21	2.44 ± 0.12
Tentek	1.81±002	1.66 ± 002	21.40 ± 0.22	4.28 ± 0.12
Difference	0.30	0.25	3.50	1.84
Kazakhstanskaya Mine				
Dolinskaya	1.89 ± 0.01	1.55 ±001	26.85 ±0.13	6.30 ±0.14
Tentek	1.81 ± 0.02	1.41 ± 0.02	23.48 ± 0.13	9.70±0.14
Difference	0.08	0.14	3.37	3.40

Table 7 - Average physico-mechanical properties of gas-bearing coal seams in the Tentek and Dolinskaya suites at Kazakhstanskaya and Lenina mines

Seam	Depth interval, m	Density (GGL-D), g/cm³	K_{CC} (GL), %	Poisson's ratio	Modules, GPa			Gas presence
					Young's	Shear	Bulk	
				BAL				
T_3	347.2-347.9	1.91	9.7	0.41	3.88	1.37	7.52	gas
D_8, D_9, D_{10}	520.4-656.9	1.88	10.2	0.37	6.98	2.55	8.78	gas
D_6	701.1-706.5	1.68	4.8	0.41	6.10	2.16	1.38	gas
		1.48	9.9	0.40	4.34	1.55	7.31	gas
		1.41	0.5	0.41	3.92	1.39	7.11	gas
		1.29	3.3	0.35	5.58	2.11	5.92	gas

Analysis of Tables 5 and 6 shows that the non-gas-bearing coal seams of the underlying Dolinskaya Formation at the Lenina mine have an average density 0.30 g/cm³ lower than that of the Tentek seams. The average density of the gas-bearing Dolinskaya coals is 0.25 g/cm³ lower compared to the Tentek coals. This difference is attributed to variations in volumetric clay content. Specifically, for non-gas-bearing coal seams the difference in volumetric clay content is 3.50 %, while for gas-bearing seams it is 1.84 %.

At the Kazakhstanskaya mine site, the average density of non-gas-bearing coal seams from both formations differs only slightly (by 0.08 g/cm³), whereas for gas-bearing seams the difference is 0.14 g/cm³. The ratio of volumetric clay content values for gas-bearing and non-gas-bearing seams at the Kazakhstanskaya mine is similar to that observed at the Lenina mine: 3.37 % and 3.40 %, respectively.

A decrease in both density and clay content in gas-bearing coal seams is a characteristic feature. For reliable identification of such seams, the results of neutron-neutron logging based on thermal neutrons were used. The readings of this method are lower in gas-bearing seams compared to non-gas-bearing ones due to their lower hydrogen content.

Based on the integrated interpretation of geophysical well logging data (gamma-gamma density logging (GGL-D) and cross-dipole acoustic imager) in the depth interval of 284–765 m at the Kazakhstanskaya and Lenina mines, the average values of the physico-mechanical properties of gas-bearing coal seams were determined (Table 7).

The results presented in Table 7 confirm the lower density of gas-bearing coal seams compared to non-gas-bearing ones, while following the general trend of density increasing with depth. For non-gas-bearing coal seams of both formations, there is a characteristic increase in physico-mechanical properties (Young's modulus, shear modulus, and bulk modulus) compared to gas-bearing seams.

Overall, the gas content of coal seams in the Karaganda Basin increases with depth of occurrence, starting from the lower boundary of the gas weathering zone. The rate of gas content increase per 100 m of depth decreases with increasing degree of coal metamorphism. Thus, at a depth of 1000 m, the calculated methane content is expected to reach 22–29 m³/t (Ermekov M.A., 1968), and the Langmuir pressure ranges from 1.08 to 1.41 MPa, with an average of 1.27 MPa. This is explained by the fact that the calculated methane quantity according to the Langmuir model is lower than the maximum sorption capacity of the seam, which may be associated with the fracturing of the coal seams and surrounding rocks.

Particular importance is attached to geophysical studies of the physico-mechanical and filtration-capacity properties of coal seams and host rocks in areas prepared for mining, as these parameters change during the implementation of all degasification measures.

As can be seen from Tables 2 and 4, the free gas concentration of 2.42 m³/t is lower than the known values reported in the literature (2–12 m³/t). This is due to the influence of advance degasification of seam D6, during which mainly free gas is extracted from natural macropores and macrofractures, as well as from fractures formed during hydraulic fracturing of the seam. The research results confirmed the elevated methane content in prepared loose coals of seam D6, which is associated with a significant increase in the specific surface area of coal particles and microfractures in the surface nanosized layer of the coal.

From Tables 2 and 4, free gas concentration (2.42 m³/t) is lower than typical literature values (2–12 m³/t), attributable to pre-mine degasification,

Table 8 - Average values of C_u (%), W (%), C_p (J/(kg·K)), and V^{daf} (%) for coals of the Karaganda Basin

Coal rank	d(I), nm	C_u, %	W, %	C_p,	A^{daf}, %
B	214.2	50-77	До 40	1440	42-52
LF	198.7	70-80	17-19	1380	43-46
C	180.8	88-90	2-5	1050	26-29
A	151.5	92-98	1-3	815	<10

which primarily extracts free gas from natural macropores, macrofractures, and hydrofracturing-induced fractures. Gas composition in seam D6 from vertical boreholes (%): H_2 0.01–30, O_2 0.3–6.0, N_2 1.3–42.0, CH_4 25.0–98.0, CO_2 0.12–11.8. These findings confirm elevated methane in loose, tectonically disturbed coals of seam D6, linked to increased specific surface area of microfractures in the surface layer and macrofractures in tectonically pulverized coal.

A critical factor in gas regime formation during coal extraction and storage is spontaneous combustion, governed by specific heat capacity C_p (J/(kg·K)), ash content A (%), carbon content C_u (%), moisture W (%), and volatile matter yield V^{daf} (%) (see Table 8).

The data presented in Table 8 indicate that as the degree of metamorphism increases (coal ranks progressing from B to A), the thickness of the surface coal layer decreases, the carbon content increases, while moisture content, specific heat capacity, and volatile matter yield decrease.

The established regularities can be used in planning operations for the industrial extraction of methane from coal seams identified in the well sections of the basin.

Conclusions

An optimal suite of geophysical logging methods for open-hole wells has been selected to study the physico-mechanical and filtration-capacity properties of coal seams and surrounding rocks.

Characteristic features for identifying gas-bearing coal seams have been established based on a comprehensive set of physico-mechanical and filtration-capacity measurements obtained through well logging methods.

Using the example of the Kazakhstanskaya and Lenina mine sites, gas-bearing coal seams were identified throughout the entire well sections for potential methane extraction, with subsequent aggregation of gas volumes obtained during coal seam degasification.

Regularities in the variation of physico-mechanical and filtration-capacity properties of coal seams in the overlying Tentek Formation and the underlying Dolinskaya Formation have been established, as well as for coal seam sections prepared for mining. These findings are an important factor used in geomechanical calculations to ensure efficient coal extraction while maintaining safe working conditions.

It is recommended to conduct a comprehensive suite of geophysical logging in the open hole of all vertical exploration and drainage wells to monitor the variability of physical properties along the dip and strike of coal seams when planning hydraulic fracturing operations. The results should be used for geomechanical calculations during coal mining. This approach will enable monitoring of changes in the strength and filtration properties of the coal massif, as well as the intensity of gas emission, thereby contributing to the assessment of risks associated with gas-dynamic phenomena.

To standardize and improve the accuracy of studies on the physico-mechanical and filtration-capacity properties of rocks and coal seams, it is necessary to establish a specialized laboratory in the Karaganda Basin. This laboratory should include a well logging crew (party) dedicated to geophysical investigations.

Conflict of interest. On behalf of all the authors, the correspondent author declares that there is no conflict of interest.

***CRediT author statement*: V. Portnov, M. Rabatuly:** Conceptualization, Methodology, Software; **N. Khuangan, A. Kenetayeva:** Data curation, Writing-Original draft preparation; **G. Duganova, A. Golik:** Visualization, Investigation; **Peng Hou:** Software, Validation.

Cite this article as: Portnov VS, Golik A V, Duganova G K, Khuangan N, Kenetayeva A A, Rabatuly M, Peng Hou. Identification of Methane-Bearing Coal Seams in Borehole Sections of the Karaganda Basin Using Geophysical Logging Data. Kompleksnoe Ispolzovanie Mineralnogo Syra = Complex Use of Mineral Resources. 2028; 345(2):72-83. https://doi.org/10.31643/2028/6445.17

Қарағанды бассейні ұңғымалары кесіндісінде метаны мол көмір қабаттарын геофизикалық каротаж деректері бойынша бөліп шығару

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Мақала келді: *17 наурыз 2026*
Сараптамадан өтті: *19 наурыз 2026*
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ТҮЙІНДЕМЕ
Қарағанды көмір бассейні әлемдегі ең газға бай бассейндердің бірі болып табылады. Оның ерекшелігі – оның құрамында бос газдың көп мөлшерде жиналмауы, ал табиғи газдылық 25-30 м³/т-қа жетеді; бұл газдық сынамалаудың үлкен көлемімен, газдық каротаж деректерімен және жұмыс істеп тұрған шахталардағы газдық түсірілім деректерімен расталады. Көмір қабаттарының метаны атмосфераға жоғарыдағы жыныстар арқылы табиғи миграция жолымен, сондай-ақ қабаттардың қабыршақ астында шығу орындарында және жабық шахталардың оқпандары арқылы түседі. Қарағанды бассейнінің көмір қабаттарын газсыздандыру кезінде, тау-кен жұмыстарымен қабаттарды ашуда, соның ішінде ашық карьерлік өндіру кезінде, қабаттар жер бетіне шыққан кезде және жабық шахталардан шығатын газды газсыздандырылған кезде, өндірілген метанның бір бөлігі шахталарда жылу мен электр энергиясын алу үшін пайдаланылады, ал көп бөлігі көмір қабаттарын газсыздандыру кезінде атмосфераға шығарылады. Атмосфераға шығарылатын метан Жердің жылуын көмірқышқыл газына қарағанда 25-30 есе тиімдірек - сақтайтыны белгілі. Өңделмеген көмір қабаттарынан метанды өнеркәсіптік пайдалану мақсатында жылу және электр энергиясын алу үшін, көмір-метан кен орындарын кешенді игеру, технологияларын дамытудың маңызды міндеті болып табылады, сондай-ақ олар орналасқан өңірлердегі экологиялық жүктемені төмендету болып табылады. Зерттеулердің мақсаты – қабат кесіндісінде газға бай көмір қабаттарын бөліп шығару, оны өнеркәсіптік мақсатта пайдалану үшін өңделмеген қабаттардан метанды алу және атмосфераға шығарындыларды азайту мүмкіндігін бағалау. Әдістер. Барлау ұңғымаларын зерттеудің геофизикалық әдістерінің кешені көмір қабаттары мен қоршаған жыныстардың физика-механикалық және сүзгі-қуыстық қасиеттерін зерттеу үшін, тау-кен жұмыстарындағы көмір қабаттарының сынамаларын алу және талдау. Нәтижелер. Көмір қабаттарының газ құрамын анықтайтын физикалық қасиеттер кешенінің өзгеру заңдылықтары анықталды және осы өзгерістер мен негізгі қоршаған жыныстардың физика-механикалық қасиеттерінің өзгеруіне геологиялық негіздеме берілді. Қолдану. Кесіндіде бөлінген газға бай көмір қабаттары геологиялық кесіндінің барлық газға бай қабаттарынан, соның ішінде көмір қабаты шахталары игеріп жатқан қабаттардан метанды алуды жоспарлау кезінде пайдалануға болады, ал игеруге дайындалған немесе игеріліп жатқан көмір қабаттарының физикалық-механикалық, сүзу-сыйымдылық қасиеттерінің өзгеру заңдылықтарын геомеханикалық есептеулерде пайдалануға болады.

Түйін сөздер: көмір свиталары, метаморфизм көмір мен қоршаған жыныстардың физика-механикалық сипаттамалары, газдылық, көмірлердегі метанның болу пішіндері, экология, геомеханика.

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Выделение метаноносных угольных пластов в разрезе скважин Карагандинского бассейна по данным геофизического каротажа

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Поступила: *17 марта 2026*
Рецензирование: *19 марта 2026*
Принята в печать: *9 июня 2026*

АННОТАЦИЯ
Карагандинский угольный бассейн является одним из наиболее газоносных в мире. Его особенностью является то, что в нем нет крупных скоплений свободного газа, а природная газоносность достигает до 25-30 м3/т, это подтверждается большим объемом газового опробирования, по газовому каротажу и данными газовой съемки в действующих шахтах. Метан угольных пластов попадает в атмосферу путем естественной миграции через вышележащие породы, а также в местах выхода пластов под наносы и через стволы закрытых шахт. При дегазации угольных пластов Карагандинского бассейна при вскрытии пластов горными выработками в том числе при открытой разработке, выхода пластов к поверхности, дегазации отработанного пространстве закрытых шахт часть извлеченного метана используется на шахтах, для получения тепловой и электрической энергии, а большая часть попадает в атмосферу при дегазации угольных пластов. Известно, то, что метан, попавший в атмосферу, удерживает тепло Земли значительно выше, в 25-30, раз, чем диоксид углерода. Извлечение метана из неразгруженных угольных пластов для его использовния в промышленности при получении тепловой и электрической энергии, является важной задачей развития технологий комплексной разработки углеметановых месторождений, но и снижением экологической нагрузки на регионы, где они располагаются. Целью исследований является выделение в разрезе газоносных угольных пластов для оценки потенциала извлечения метана из неразгруженных пластов для его промышленного использования и снижения выброса в атмосферу. Методы. Комплекс геофизических методов исследований разведочных скважин для изучения физико-механических и фильтрационно емкостных свойств угольных пластов и вмещающих пород, отбори анализ проб угольных пластов в горных выработках. Результаты. Установлены закономерности изменения комплекс физических свойств угольных пластов, определяющих их газоностность, дано геологическое обоснование этих изменений и изменений физико-механических свойств вмещающих пород. Применение. Выделенные в разрезе газоносные угольные пласты могут быть использованы при планировании добычи метана из всех газоносных пластов геологического разреза, включая разрабатываемые шахтами угольного пласта, а закономерности изменения физико-механических, фильтрационно-емкостных свойств, подготовленных к разработке или разрабатываемых угольных пластов, могут быть использованы при геомеханических расчетах. Фактические материалы, для проведения исследований получены по результатам лабораторных, геофизических исследований разведочных скважин, материалов геологических и производственных отчетов.

Ключевые слова: угольные свиты, метаморфизм физико - механические характеристики угля и вмещающих пород, газоносность, формы нахождения метана в углях, экология, геомеханика.

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