Crossref
DOI: 10.31643/2026/6445.01
Earth Sciences

Views on drilling effectiveness and sampling estimation for solid ore minerals

[1] Rabatuly M., [1] Myrzathan S.A., [2] Toshov J.B., [3] Nasimov J., [4] Khamzaev A.

[1]Abylkas Saginov Karaganda Technical University, Karaganda, Kazakhstan
[2] Islam Karim Tashkent State Technical University, Tashkent, Republic of Uzbekistan
[3] Institute of Mineral Resources, University of Geological Sciences Tashkent, Republic of Uzbekistan
[4] Navoi State Mining and Technological University, Republic of Uzbekistan

** Corresponding author email: jnasimov@yandex.ru*

Received: *September 26, 2024*
Peer-reviewed: *October 31, 2024*
Accepted: *November 6, 2024*

ABSTRACT
As a result of well drilling, a geological sample recovery was taken as a cylindrical rock sample. This rock sample core would be used for further study of the conditions of occurrence of ore minerals. The great practical importance of supplying reliability and representativeness of geological surveys is the assessment of drilling quality and effectiveness. We were attempting to study the core recovery measuring ways for efficiency estimating of drilling for solid minerals, which will be submitted in this article. Also analyzed existing methods, their advantages and disadvantages. The RQD (Rock Quality Designation) measuring method we suggest as criteria is the best way of unbiased effectiveness assessment. It is necessary to closely research the lithological section finished by drilling wells, and the geological, technical and hydrogeological conditions of the explored fields to solve economic efficiency at the down-the-hole cleaning method. In-depth study methodology of the main elements of the "diamond bit-rock" pair and the conditions of the normal drilling process can be the basis for successful implementation of geological tasks by drilling personnel. Currently uses three main methods of core recovery measuring (linear, volume, weight). However, they did not consider coefficients of fragmentation, fracturing and loosening and that is why the RQD method has a clear advantage over the traditionally used methods. The RQD method has already been successfully introduced to the geological exploration sites of the Ministry of Mining Industry and Geology of the Republic of Uzbekistan.

Keywords: estimation, efficiency, well drilling, solid ore minerals, criteria, drilling method, core recovery, down-the-hole cleaning, diamond bit.

Information about authors:

Rabatuly Mukhammedrakhym	*Ph.D., Acting Associate Professor of the Department of Development of Mineral Deposits of Abylkas Saginov Karaganda Technical University, 100027, The Republic of Kazakhstan, Karaganda, Ave. Nursultan Nazarbayev, 56. E-mail: mukhammedrakhym@mail.ru; ORCID ID: https://orcid.org/0000-0002-7558-128X*
Myrzathan Sultanbek Amangeldiuly	*Master's student of the Department of Development of Mineral Deposits of Abylkas Saginov Karaganda Technical University, 100027, The Republic of Kazakhstan, Karaganda, Ave. Nursultan Nazarbayev, 56. E-mail: sultanbek.98kz@gmail.com; ORCID ID: https://orcid.org/0009-0008-8248-9087*
Toshov Javokhir Buriewicz	*Doctor of Technical Sciences, Professor of Islam Karim Tashkent State Technical University, 100095, Republic of Uzbekistan, Tashkent, Almazar district, Universitetskaya Street 2. E-mail: j.toshov@tdtu.uz; ORCID ID: https://orcid.org/0000-0003-4278-1557*
Nasimov Jahongir	*Ph.D., Senior researcher of Institute of Mineral Resources, University of Geological Sciences, 100125, Republic of Uzbekistan, Tashkent, A Olimlar str.64A. E-mail: jnasimov1901@gmail.com; ORCID ID: https://orcid.org/0000-0002-4495-2674*
Khamzaev Akbar	*Candidate of Technical Sciences, Associate Professor of the Department of Mining Electromechanics, Navoi State Mining and Technological University, 210100, Republic of Uzbekistan, Navoi, Galaba St 27. E-mail: akbar-86-86@mail.ru; ORCID ID: https://orcid.org/,0009-0005-4362-2488*

Introduction

The current level of scientific and technological progress in drill machine manufacturing and the increasing range of various drilling methods by the appearance of boring systems determines the detailed investigation and application of drilling efficiency assessment methods, in particular, for solid ore minerals.

Along with a large number of manufacturers and modifications of fully hydraulic drill machines for solid ore minerals, their expensiveness, drilling capacity, and high operating costs cause an objective choosing of models and their quality estimating at the designing and operating.

Wherein, has a special relevance and industrial significance in detecting the drilling parameters function by the deepening for one rotating of the bit, energy consumption for rock destroying in the bottom of the hole, the real cross-sectional area of the well and the diamond tool wear from the results of drilling at the form of core and cuttings.

Experimental part

Below are some fundamental concepts about evaluating the effectiveness of drilling operations for solid minerals.

V.G. Kardysh and A.S. Okmyanskiy [[1], [2]] suggested the technical level and quality estimation of the equipment for exploration well drilling by the specific indicator, which will accepted in the power-to-weight ratio and metal consumption.

According to V.G. Kardysh seems that the estimation of some drilling methods for non-deep wells must be based on the following criteria:

a) the efficiency drilling possibility for certain deep and diameters in the different lithological rocks;

b) the requested power and transportable equipment designing possibility which suitable for the current conditions;

c) the possibility of achieving the ultimate objective by drilling – quality sampling and stable borehole wall getting.

It is necessary to identify and consider the following terms for objective analysis and comparison of various drilling methods, as well as for the quantitative expression of their most significant positive and negative features: drilling trip speed change, average drilling trip speed, provided drilling trip speed, energy and metal consumption and drilling time.

B.M. Rebrik [[2], [3]] submitted interesting scientific research, which suggests the detecting method of universal indicators of drilling machines' efficiency by conditional accrual of points to each of the operational parameters.

D.N. Bashkatov considers [[4], [5]] that the drilling method of engineering-geological wells and the model of the drill rig should provide the necessary quantity and quality of information about the engineering-geological properties of soils and high technical-economic indicators of well drilling.

By the M.G. Abramson opinion, [[6], [7]] the criteria of exploration well drilling methods and modes estimation may be drilling capacity and the cost of 1 meter well drilling.

M.G. Abramson [[8], [9]] thinks that the property of efficiency of different types of exploration well drilling can be used in the technical parameters: drilling mechanical and trip speed, deepening for one trip, but sinking and drilling capacity for 1 month. However, making a verdict about the one or other drilling method efficiency is not enough just on the one technical parameter, because it doesn't always lead to the correct conclusion about the efficiency and profitability of drilling operations. Therefore, the technical parameters should be added economically: the cost of 1-meter drilling and the economic efficiency of drilling (E_d).

$$\mathrm{E_d} = \frac{\mathrm{C} * R_\mathrm{t}(\mathrm{H,D})}{\mathrm{C_t}} \qquad (1)$$

here C – drilling capacity, meter per month; R_t(H, D) – regulatory time (Time Standards vol.V), suitable for the average rock hardness H and average deep of the holes D; C_t – the cost of 1 shift.

In modern drilling equipment, engine power is the main parameter determining the actual technological capabilities of drilling rigs. In this regard, the correct choice of engine power, which provides the possibility of using forced drilling modes, is one of the urgent tasks that must be solved by conducting experimental work to determine the power costs and a thorough analysis of the energy characteristics of imported equipment [[10], [11]].

The engine power mounted on the advanced drill rigs is the main parameter, which defines the reality technological features of these equipment. Therefore, the correct choice of engine power, which provides the boosted drilling parameters is important. So, we think that the solution to this issue is to test power consumption and energy properties by analyzing imported equipment. We have to be mindful, however, that the energy properties of drill machines are a complex concept, which considers the estimation of the operational features depending on the supplied power – drilling possibility with any rod size with the drilling speed and weight on bit (WOB) combination.

The main task of well drilling is the maximum possible core recovery. Almost all researchers-specialists in the field of exploration well drilling deal with the issue of increasing core recovery. There are frequent cases of rejection and low-quality sampling of individual well intervals. As a result of this, until recently, in many solid mining sites, the obtained drilling data was not used for deposit calculating [[12], [13], [14]].

With the increasing depth of prospecting and exploration of deposits, the high cost of underground works and technological problems of extracting reliable core samples in difficult geological conditions due to selective erosion, as well as violation of the integrity of the core, indicates the need for an in-depth study of the issue of increasing its yield. The issues of objective assessment of the yield of core and cuttings when using new special technical means, technology and drilling methods also arise.

It is known that the following problems can be solved using one intersection or well:

1. Study of the physical and mechanical properties of ores and host rocks;
2. Analysis of the textural and structural features of ores and host rocks;
3. Determining the presence or absence of ore bodies;
4. Studying the material and mineralogical composition of ores;
5. Determination of the content of useful components;
6. The same, associated elements;
7. Harmful impurities;
8. Thickness of ore bodies.

It is known that other tasks related to the study of the variability and distribution of mineralization, processing technology and schemes for extracting useful, associated and harmful components of ores, as well as determining the occurrence elements of ore bodies, their coordinates, etc. are solved using data from several wells.

Analysis of the above tasks shows that for their objective, the completeness, continuity and integrity of the sample are of main importance. Therefore, the main criterion for assessing the quality of drilling technology is the linear core yield, determined by the formula:

$$В_к = \frac{l_k}{h_p} * 100$$

were.l_k - length of the lifted core; h_p - passage per trip.

This approach is valid in cases of drilling through monolithic rocks and obtaining a solid column-core, when estimating the yield of the destroyed core using the given formula, mistakes are made due to the exclusion of the influence of the loosening coefficient.

The objectivity of assessing the reliability of a core sample increases when using the expression:

$$В_к = \frac{l'_k}{h_p * К_{r.}} * 100$$

where l'_k - length of the destroyed core, folded along the diameter of a dense column; h_p - penetration per trip; $К_{r.}$ - core loosening coefficient (with normal drilling diameters of 46-127 mm, it ranges from 1,45-2,07).

In most cases, destroyed core recovery is more accurately determined by the volumetric method:

$$В_к = \frac{v_k}{0{,}785 * d_k^2 * h_p} * 100$$

where $В_к$ - core recovery assessed by an objective method, %; v_k – the volume of actually raised core; d_k - average core diameter in a given trip; h_p - passage per trip.

The volumes of the destroyed core can be determined in special measuring cylinders. A weighting method for estimating core recovery is also used as RQD:

$$В_к = \frac{P_k}{0{,}785 * d_k^2 * l_p * j} * 100$$

where P_k - the weight of the lifted core; d_k - average core diameter; l_p - penetration per trip; j - volumetric weight of the core.

There are other principles for assessing the quality of core samples according to their criteria, which are shown in Table 1.

Table 1 – Main quality criteria for core samples

Criterion	General characteristics of the criterion	Main criterion	Characteristic criterion	Core Evaluation
1	Correspondence of the properties of the core material to the traversed well interval	Amount of core material (core yield)	Linear Weight Volume	Exit, % Same
2	Same	Material composition of core material	The presence of selective erosion of the useful component. Volatile content	Change in content, % Same
3	Same	Structure of core material	Secondary core crushing. Change in physical and mechanical properties, core orientation	Yes, no In units of magnitude, the degree of rotation

Possible combinations of the given characteristics of core samples to preserve the mass and structure of the core, the content of minerals in it under real conditions are given in Table 2.

Assuming a possible loss of 60% of the sample mass and a minimum requirement of 40% of the core mass [15], compiled a classification of core samples according to the degree of reliability of the obtained geological information (Table 3).

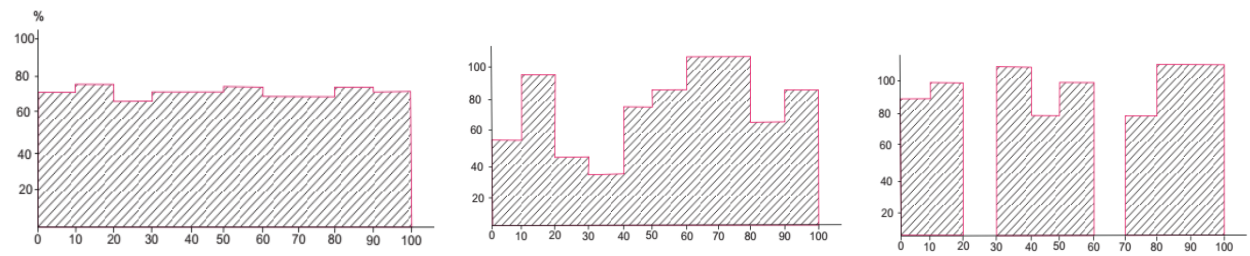
From the point of view of completeness, uniformity and continuity of the material yield in the sample, there can be three cases of core reliability and information content (Figure 1).

Table 2 – Options for correlating the quality characteristics of a core sample

Qualitative characteristics of the core	I	II	III	IV	V	VI	VII	VIII
Core mass conservation	+	-	-	-	-	+	+	+
Preservation of core structure	+	+	-	-	+	-	+	-
Mineral content	+	+	+	-	-	-	-	+

Table 3 – Classification of core samples according to the degree of reliability of the obtained geological information

Sample class	Class characteristics	Degree of reliability of the information received	Solvable geological problems
I	The sample corresponds to the original well interval: by structure; by weight; according to the true content of the mineral component	Maximum	Engineering-geological and hydrogeological surveys in very weak rocks, determination of rock occurrence elements, etc.
II	The sample corresponds to the original well interval: by weight; according to the true content of the resulting component	High	Obtaining complete geological information when exploring for solid minerals of any origin
III	The sample corresponds to the original well interval: according to the true content of the resulting component	Partial	Obtaining sufficient geological information when exploring most metamorphic and sedimentary deposits
IV	The sample does not correspond to the original well interval in all respects	Minimum	Information about the presence of minerals. Information on host rocks



a) Continuous, Uniform b) Continuous, Uneven c) Intermittent, Uneven

Fig.1. - Completeness, uniformity and continuity of sample material output (Drilling feed for 1 trip is 100cm)

Table 4 – Deviation of the material yield of individual samples from the average for the well (Diamond core drilling – NV system)

No.	Well No. 20			Well No. 7			Well No. 17		
	Sample yield, %	Deviation		Sample yield, %	Deviation		Sample yield, %	Deviation	
		±	%		±	%		±	%
1	83	+1	1.2	100	+22		90	+47	
2	84	+2		39	-39		90	+47	
3	71	-11		51	-27		63	+20	
4	89	+7		36	-42	54.9	0	-43	
5	85	+3		65	-13		50	+13	
6	84	+2		66	-12		50	+13	
7	89	+7		100	+22		50	+13	
8	72	-10		88	+10		100	+57	132.5
9	100	+10		100	+22		6	-43	
10	86	+4		100	+22		48	+5	11.6
11	73	-9		68	-10		48	+5	
12	85	+3		100	+22		56	+13	
13	79	-3		83	+5		56	+13	
14	74	-8		70	-8		0	-43	
15	79	-3		100	+22		86	+43	
16	79	-3		100	+22		0	-43	
17	61	-21	25.6	76	-2	2.6	100	+57	
18	62	-20		36	-40		100	+57	
19	78	-4		50	-28		0	-43	
20	75	-7		63	-15		100	+57	
21	100	+18		94	+16		100	+57	
22	75	-7		100	+22		79	+36	
23	100	+18		70	-8		0	-43	
24	100	+18		94	+16		0	-43	
25	90	+8		96	+18		0	-43	
Average	82			78			43		

Table 4 shows the completeness, uniformity and intermittency of the rock material recovery in the form of a sample, according to the trip withdrawals of experimental wells at the Muruntau gold deposit (data of the 2011-2022 year).

From the above, it is clear that with a continuous and uniform (*a*) recovery of rock material - core samples will be the most reliable, since the displacement of rock materials in the sampling interval is unlikely, and there is no selective erosion. This allows us to accurately record the main parameters of the ore: the average content of the useful component, thickness and contacts with the host rocks.

With a continuous and uneven (*b*) rock material recovery, the sample is less reliable and not always representative, since in this option, displacement of materials in the sampling interval is possible and selective erosion occurs, and this will lead to inaccurate determination of contacts and distortion of the true metal content in the ore.

If the material is released intermittently and unevenly (*c*), the sample will be unreliable.

Table 5 shows the parameters of borehole and control furrow samples, showing the relative deviation of the parameters of borehole samples from furrow samples, taken as 100%. Wells No.20 and No.17 were controlled by underground pit No.13, and well No.7 by underground pit No.25.

Table 5 – Influence of material yield on sample reliability

Well number	Sample parameters in arbitrary units						Deviation of parameters of borehole samples from furrow samples, %		
	well			furrow					
	M	C	M%	M	C	M%	M	C	M%
20	25	98	2465	25	89	2198	0	+10	+10
7	25	130	3240	25	107	2680	0	+21	+21
17	12	125	1587	25	88	2198	-48	+44	+68

Table 6 – Dependence of sampling reliability on the completeness of continuity and uniformity of material release into the sample

Wells	Average sample yield, %	Deviation of private samples, %		Average random deviations, %		Metro percent deviation, %	Attitude 7/6
		min	max	absolute	relative		
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
20	82	1.2	25.6	8.2	10.0	+10	1,000
7	78	2.6	54.6	19.4	24.9	+21	0.844
17	43	11.6	132.5	35.9	83.6	-68	0.813

Below, summary Table 6 shows the average material recovery per sample for wells 20, 7 and 17, the limits of deviations of private samples from the average yield of material, the average random deviations of samples for wells and the relative deviation of the metro per cent for well and furrow (gutter) samples.

A.A. Abdumazhitov expressed the opinion [16] that the quality of drilling of prospecting and exploration wells should ensure:

a) geological information fullness (drilling sampling by penetration and by the percentage of its recovery, ore body testing, and geophysical researching);

b) well boring in the given direction (profile) taking into account the permissible deviations for specific geological and technical conditions;

c) the configuration of the borehole within the limits of permissible deviations (cavernous, collapse), which excludes the occurrence of complications during drilling and fastening of wells;

d) borehole sample must be continuously by line and stable by cross-section;

e) The sampling method must be suitable to the geological features of the ore deposits and the mineral resources distribution properties;

f) requirements to the core recovery fullness and bit diameter for randomly oriented vein formations and stockworks sampling must be defined by his liability to the selectively destroy.

He also suggests the consolidation scheme of geological-technical-technological system elements cooperation in just one whole process for drilling results recovery (fig.1), which reflects the equal participation of geological environment, drilling technology and technics features in the drilling process to get an accurate result.

Currently also used the RQD (Rock Quality Designation) - core recovery quality estimation criteria, as an objective evaluation system of drilling effectiveness. This method measures only solid and not destroyed parts of recovered core samples, with lengths of more than 10 cm. The part's length is less than 100 mm don't take to measure. If the length measuring of the core by line gives more than 91% RQD is the best. Besides that, we use the TCR (Total Core Recovery) method and SCR (Solid Core Recovery), but among them, RQD is an objective way of drilling efficiency estimation by each trip [[17], [18], [19], [20]].

Another important way of drilling process efficiency estimation may be deeply researching the main elements of the "diamond bit-rock" pair and the normal drilling process conditions. Here it is appropriate to use a well–known position in tribotechnics – the Kragelsky-Druyanov formula, which determines the condition for the transition from external friction to micro-cutting:

$$\frac{h}{r} + \frac{\tau}{\sigma_s} \geq \frac{1}{2} \tag{2}$$

here h – penetration depth of indenter; r – spherical indenter radius; τ – friction contact strength on moving; σ_s – rock yield strength.

The normal drilling process, and consequently, the most efficiency rock destroying in the hole bottom might be formulated as below:

$$h_{e.f.t.} \leq h_{n.} \leq h_{b.n.w} \quad (3)$$

here, heft – penetration depth suitable to the (2), which sows micro-cutting mode condition (external friction threshold); hn – penetration for the normal drilling condition; hbnw – penetration for the normal diamond wear.

Research conducted in this direction allows for identifying and characterising the main conditions of "diamond bit-rock" pair collaboration (table 7).

In the work [[8], [9]] submitted that to achieve economic efficiency when choosing a method for down-the-hole cleaning in each case, it is necessary to carefully study the lithological section, geological, technical and hydrogeological conditions of the explored site. This will make it possible to choose the suitable drilling technology in specific conditions and range the required technology in a manner to eliminate possible complications.

Here also presented the results about the advisable and economic justification of the combined drill method: air drilling to the technically possible depth, then drilling with liquid flushing, which is widely used where the upper part of the borehole consists of dry rocks, and the lower part is with water flows [10]. When looking at them from another angle, the upper part of the well with abnormal rocks could be used for liquid flushing, then, after well casing or plugging continue with air drilling. They got good results using the combined drill method at the Samarkand and Almalyk drill sites of the Ministry of Geology of the Republic of Uzbekistan. The cost of a 1-meter combined drill method might allow saving money average of 50-70% in comparison with liquid flushing of the well.

Time-lapse observations were carried out on 78 wells with a total depth of 10,000 meters, of which 8000 meters were drilled with air. To compare the data parameters was taken where used water-clay liquid flushing at 2000 meters of well drilling. In the table 8 shows the balance of drill rig working time with a diameter of 132 and 112 mm in rocks hardness I-VII.

Table 7 – The main conditions of "diamond bit-rock" pair collaboration

The pair collaboration property	The diamond bit wear properties	The rock deformation property	The number of rounds for rock-destroying	The pair collaboration condition during the process
Diamond bit polishing ("bit-rock" pair friction staying)	Fatigues	Elastic displacement (grinding and surface abrasion)	$К \to \infty$	$h/r + \tau/\sigma_s < 1/2$ $(h \to 0)$
		Plastic displacement	$1 < К < \infty$	
The normal drilling process	Fatigues, Abrasive, Erosive	Microcutting	$К < 1$	$h/r + \tau/\sigma_s \geq 1/2$ $(h \to h_{opt})$
High wear of the diamond bit				$h/r + \tau/\sigma_s > 1/2$ $(h \to r/4)$

Table 8 – The drill rig working time balance parameters

Cleaning agent	Drilled, m	Drill time, %	Secondary working time, %	Waiting time, %	Downhole failure, %	Assembly and disassembly, %	Transportation, %
Air	8 000	43.8	28.7	2.3	0.2	9.6	15.4
Water	2 000	34.0	21.8	7.0	5.5	12.8	18.9

Conclusions

Overall, summarizing this article can be noted below:

the issues of evaluating the effectiveness of exploration well drilling for solid minerals is important for research and production units of the geological industry;

the formulation of specific experimental and industrial research in this direction contributes to the improvement of the results of the exploration work carried out;

the introduction of generalized criteria and the results obtained by early research to assess the effectiveness of drilling operations will give a powerful impetus to the sustainable development of the country's mineral resource base;

to assess the effectiveness of drilling operations, it is considered appropriate to use the criterion of the difference between the costs of conducting geological exploration and the value of the results obtained - the amount of forecast resources and mineral reserves;

all other things being equal (especially in terms of information content), drilling methods with greater economic efficiency should be used;

when choosing a combined drilling technology for a specific object, it is advisable to take into account the lithological section of the well, and geological, technical and hydrogeological conditions.

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

CRediT author statement: M. Rabatuly: Conceptualization, Methodology, Software. S.A. Myrzathan: Data curation, Writing- Original draft preparation. J.B. Toshov: Visualization, Investigation, J. Nasimov, A. Khamzaev: Software, Validation.

Cite this article as: Rabatuly M, Myrzathan SA, Toshov JB, Nasimov J, Khamzaev A. Views on drilling effectiveness and sampling estimation for solid ore minerals. Kompleksnoe Ispolzovanie Mineralnogo Syra = Complex Use of Mineral Resources. 2026; 336(1):5-14. https://doi.org/10.31643/2026/6445.01

Бұрғылаудың тиімділігі және қатты кен минералдары үшін сынамаларды алуды бағалау туралы көзқарастар

[1] Рабатұлы М., [1] Мырзатхан С.А., [2] Тошов Ж.Б., [4] Насимов Д., [4] Хамзаев А.

[1] А. Сағынов атындағы Қарағанды техникалық университеті, Қарағанды, Қазақстан
[2] Ислам Кәрім атындағы Ташкент Мемлекеттік Техникалық Университеті, Ташкент, Өзбекстан
[3] Минералды Ресурстар институты, Ташкент Геология Ғылымдары Университеті, Өзбекстан
[4] Навои Мемлекеттік Тау-Кен Технологиялық Университеті, Өзбекстан

Мақала келді: *26 қыркүйек 2024*
Сараптамадан өтті: *31 қазан 2024*
Қабылданды: *6 қараша 2024*

ТҮЙІНДЕМЕ
Ұңғыманы бұрғылау нәтижесінде цилиндрлік тау жыныстарының үлгісі түрінде геологиялық сынама алынды. Бұл тау жыныстарының жынысөзегі (керн) кен минералдарының пайда болу жағдайларын одан әрі зерттеу үшін пайдаланылады. Бұрғылау сапасын және оның тиімділігін бағалау геологиялық зерттеулердің сенімділігі мен репрезентативтілігін қамтамасыз ету тұрғысынан үлкен практикалық маңызы бар. Біз осы мақалада ұсынылатын қатты пайдалы қазбаларды бұрғылаудың тиімділігін бағалау үшін жынысөзек (керн) өндіруді өлшеу әдістерін зерттеуге тырыстық. Сондай-ақ, қолданыстағы әдістер, олардың артықшылықтары мен кемшіліктері талданды. Критерий ретінде біз өнімділікті объективті бағалаудың ең жақсы тәсілі болып табылатын тау жыныстарының сапасын (RQD) (Тау Жыныстарының Сапасын Белгілеу) өлшеу әдісін ұсынамыз. Ұңғымаларды тазалау әдісінің экономикалық тиімділігі туралы мәселені шешу үшін ұңғымаларды бұрғылау нәтижесінде алынған литологиялық қиманы, барланған кен орындарының геологиялық, техникалық және гидрогеологиялық жағдайларын мұқият зерделеу қажет. «Алмас қашау – тау жынысы» жұбының негізгі элементтерінің әдістемесін және қалыпты бұрғылау процесінің шарттарын терең зерттеу бұрғылау персоналының геологиялық тапсырмаларды сәтті орындауына негіз бола алады. Қазіргі уақытта жынысөзек (керн) өндіруді өлшеудің үш негізгі әдісі қолданылады (сызықтық, көлемдік, салмақтық). Бірақ оларда фрагментация, сыну және қопсыту коэффициенттері ескерілмейді, сондықтан RQD әдісі дәстүрлі қолданылатын әдістерден айқын артықшылыққа ие. RQD әдісі Өзбекстан Республикасы Тау-кен және геология министрлігінің геологиялық барлау учаскелерінде сәтті енгізілді.

Түйін сөздер: бағалау, тиімділік, ұңғымаларды бұрғылау, қатты кен минералдары, критерийлер, бұрғылау әдісі, жынысөзектерді алу, ұңғымаларды тазарту, алмас қашау.

	Авторлар туралы ақпарат:
Рабатұлы Мұхаммедрахым	*PhD докторы, Әбілқас Сағынов атындағы Қарағанды техникалық университетінің пайдалы қазбалар кенорындарын өндіру кафедрасының доцентінің м.а., 100027, Нұрсұлтан Назарбаев даңғ. 56, Қарағанды, Қазақстан. E-mail: mukhammedrakhym@mail.ru; ORCID ID: https://orcid.org/0000-0002-7558-128X*
Мырзатхан Сұлтанбек Амангелдіұлы	*Әбілқас Сағынов атындағы Қарағанды техникалық университетінің пайдалы қазбалар кенорындарын өндіру кафедрасының магистранты, 100027, Нұрсұлтан Назарбаев даңғ. 56, Қарағанды, Қазақстан. E-mail: sultanbek.98kz@gmail.com; ORCID ID: https://orcid.org/0009-0008-8248-9087*
Тошов Жавохир Буриевич	*Техника ғылымдарының докторы, Ислам Карим атындағы Ташкент мемлекеттік техникалық университетінің профессоры, 100095, Алмазар ауданы Университет көшесі 2, Ташкент Өзбекстан. E-mail: j.toshov@tdtu.uz; ORCID ID: https://orcid.org/0000-0003-4278-1557*
Насимов Джахонгир	*PhD докторы, Геология ғылымдары университетінің минералды ресурстар институтының аға ғылыми қызметкері, 100125, А. Олимлар көшесі.64А, Ташкент Өзбекстан. E-mail: jnasimov1901@gmail.com; ORCID ID: https://orcid.org/0000-0002-4495-2674*
Хамзаев Акбар	*Техника ғылымдарының кандидаты, Тау-Кен электромеханикасы кафедрасының доценті, Навои Мемлекеттік Тау-кен технологиялық университеті, 210100, Галаба Көшесі, 27., Навои, Өзбекстан. E-mail: akbar-86-86@mail.ru; ORCID ID: https://orcid.org/0009-0008-8248-9087*

Взгляды на эффективность бурения и оценку отбора проб твердых рудных полезных ископаемых

[1] Рабатұлы М., [1] Мырзатхан С.А., [2] Тошов Ж.Б., [4] Насимов Д., [4] Хамзаев А.

[1] Карагандинский технический университет имени А. Сагинова, Караганда, Казахстан
[2] Ташкентский государственный технический университет имени Ислама Карима, Ташкент, Узбекистан
[3] Институт минеральных ресурсов, Ташкентский университет геологических наук, Узбекистан
[4] Навойский Государственный Горно-Технологический Университет, Узбекистан

Поступила: *26 сентября 2024*
Рецензирование: *31 октября 2024*
Принята в печать: *6 ноября 2024*

АННОТАЦИЯ

В результате бурения скважины был получен геологический образец, взятый в виде цилиндрического образца горной породы. Этот образец породы – керн будет использован для дальнейшего изучения условий залегания рудных минералов. Большое практическое значение с точки зрения обеспечения достоверности и репрезентативности геологических исследований имеет оценка качества бурения и его эффективности. Мы предприняли попытку изучить способы измерения извлечения керна для оценки эффективности бурения на твердые полезные ископаемые, которые будут представлены в этой статье. Также были проанализированы существующие методы, их преимущества и недостатки. В качестве критерия мы предлагаем метод измерения качества горных пород (RQD), который является наилучшим способом объективной оценки эффективности. Для решения вопроса об экономической эффективности скважинного метода очистки необходимо тщательное изучение литологического разреза, полученного при бурении скважин, геологических, технических и гидрогеологических условий разведанных месторождений. Углубленное изучение методологии основных элементов пары “алмазное долото - порода” и условий нормального процесса бурения может стать основой для успешного выполнения геологических задач буровым персоналом. В настоящее время используются три основных метода измерения извлечения керна (линейный, объемный, массовый). Однако они не учитывают коэффициенты фрагментации, трещиноватости и разрыхления, и именно поэтому RQD-метод имеет явное преимущество перед традиционно используемыми методами. Метод RQD уже успешно внедрен на геолого-разведочных объектах Министерства горной промышленности и геологии Республики Узбекистан.

Ключевые слова: оценка, эффективность, бурение скважин, твердые рудные минералы, критерии, метод бурения, извлечение керна, очистка скважины, алмазное долото.

	Информация об авторах:
Рабатулы Мухаммедрахым	*Доктор PhD, и.о. доцента кафедры «Разработки месторождений полезных ископаемых» Карагандинского технического университета имени Абылкаса Сагинова, 100027, Республика Казахстан, г.Караганда, пр. Нурсултана Назарбаева, 56. E-mail: mukhammedrakhym@mail.ru; ORCID ID: https://orcid.org/0000-0002-7558-128X*
Мырзатхан Султанбек Амангелдіулы	*Магистрант Карагандинского технического университета имени Абилкаса Сагинова, кафедра «Добыча месторождений полезных ископаемых», 100027, Республика Казахстан, г. Караганда. Нурсултана Назарбаева пр. 56., E-mail: sultanbek.98kz@gmail.com; ORCID ID: https://orcid.org/0009-0008-8248-9087*
Тошов Жавохир Буриевич	*Доктор технических наук, профессор Ташкентского государственного технического университета имени Ислама Карима,100095 Республика Узбекистан, г. Ташкент, Алмазарский район улица Университетская 2. E-mail: j.toshov@tdtu.uz; ORCID ID: https://orcid.org/0000-0003-4278-1557*

Насимов Джахонгир	*Доктор PhD, старший научный сотрудник Института минеральных ресурсов университета геологических наук, Республика Узбекистан, 100125, г. Ташкент, ул. А. Олимпара.64А. E-mail: jnasimov1901@gmail.com; ORCID ID: https://orcid.org/0000-0002-4495-2674*
Хамзаев Акбар	*Кандидат технических наук, доцент кафедры горной электромеханики, Навойский государственный горно-технологический университет 210100 Республика Узбекистан, Навои, улица Галаба, 27. E-mail: akbar-86-86@mail.ru; ORCID ID: https://orcid.org/,0009-0005-4362-2488*

References

[1] Fan L, Gao J, Du X, Wu Z. Spatial gradient distributions of thermal shock-induced damage to granite Journal of Rock Mechanics and Geotechnical Engineering. 2020; 12(5):917-926. https://doi.org/10.1016/j.jrmge.2020.05.004

[2] Ghasemi S, Khamehchiyan M, Taheri A, Nikudel MR, Zalooli A. Crack Evolution in Damage Stress Thresholds in Different Minerals of Granite Rock Rock Mechanics and Rock Engineering. 2020; 53(3):1163-1178. https://doi.org/10.1007/s00603-019-01964-9

[3] Spirtovich PA, Villeneuve MC, Cole JW, Kennedy BM, Bégué F. Saturated heating and quenching of three crystal rocks and implications for thermal stimulation of permeability in geothermal reservoirs. International Journal of Rock Mechanics and Mining Sciences. 2015; 80:265-280. https://doi.org/10.1016/j.ijrmms.2015.09.023

[4] Mannanov U, Toshov J, Toshniyozov L. Perspective Solutions for the Design of Drilling Tools. E3S Web of Conferences, IVth International Innovative Mining Symposium. 2019; 105:03027. https://doi.org/10.1051/e3sconf/201910503027

[5] Griffiths L, Heap MJ, Baud P, Schmittbuhl J. Quantification of microcrack characteristics and implications for stiffness and strength of granite. International Journal of Rock Mechanics and Mining Sciences. 2017; 100:138-150. https://doi.org/10.1016/j.ijrmms.2017.10.013

[6] Toshov JB, Rakhutin MG, Toshov BR, Baratov BN. The method of constructing the scans of the toroidal belts of the faces during drilling wells. Eurasian Mining. 2024; 1:62-66. https://doi.org/10.17580/em.2024.01.15

[7] Demin V, Mussin R, Iconopisceva E, Khalikova E, & Burak Y. Organization of stage-by-stage anchoring of mine workings. Complex Use of Mineral Resources. 2019; 308(1):20-29. https://doi.org/10.31643/2019/6445.03

[8] Simon S, Hylke J. Integrating the Theory of Sampling into Underground Mine Grade Control Strategies. Minerals. 2018; 8(6):232). https://doi.org/10.3390/min8060232

[9] Clifford Stanley, Barry Smee. Strategies for reducing sampling errors in exploration and resource definition drilling programmes for gold deposits. Geochemistry Exploration Environment Analysis. 2007; 7(4):329-340. https://doi.org10.1144/1467-7873/07-128

[10] Lotter NO, Kowal DL. Sampling and flotation testing of Sudbury Basin drill core for process mineralogy modelling. Minerals Engineering. 2003; 16(9):857-864. https://doi.org/10.1016/S0892-6875(03)00207-3

[11] Rupert Bodden W, Robert Ehrlichb. Permeability of coals and characteristics of desorption tests: Implications for coalbed methane production. International Journal of Coal Geology. 1998; 35(1-4):333-347.https://doi.org/10.1016/S0166-5162(97)00039-6

[12] Zhang S, Tang S, Zhang D, Fan G, & Wang Z. Determination of the Height of the Water-Conducting Fractured Zone in Difficult Geological Structures: A Case Study in Zhao Gu No. 1 Coal Seam. Sustainability. 2017; 9(7):1077. https://doi.org/10.3390/su9071077

[13] Tutak M, & Brodny J. Predicting Methane Concentration in Longwall Regions Using Artificial Neural Networks. International Journal of Environmental Research and Public Health. 2019; 16(8):1406. https://doi.org/10.3390/ijerph16081406

[14] Demin V, Khalikova E, Rabatuly M, Amanzholov Zh, Zhumabekova A. Research into mine working fastening technology in the zones of increased rock pressure behind the longwall face to ensure safe mining operations. Mining of Mineral Deposits. 2024; 18(1):27-36. https://doi.org/10.33271/mining18.01.027

[15] Wei Huang, Fengnian Shi. A method to determine the minimum quantity of ore sample required for laboratory scale study of ore pre-concentration by high voltage pulses. Minerals Engineering. 2018; 127:247-255. https://doi.org/10.1016/j.mineng.2018.08.003

[16] Cun Zhang, Shihao Tu, Min Chen, Lei Zhang. Pressure-relief and methane production performance of pressure relief gas extraction technology in the longwall mining. Journal of Geophysics and Engineering. 2019; 14(1):77-89. https://doi.org/10.1088/1742-2140/14/1/77

[17] Zeitinova S, Imashev A, Suimbayaeva A, Alzhanov R, & Makhmudov D. Assessment of the stability of the underworked sides and ledges of the quarry to determine the area of possible location of the shaft. Kompleksnoe Ispolzovanie Mineralnogo Syra = Complex Use of Mineral Resources. 2023; 325(2):72-79. https://doi.org/10.31643/2023/6445.20

[18] Kontny A, Friedrich G, Behr H, De Wall H, Horn E, Moeller P, Zulauf G. Formation of ore minerals in metamorphic rocks of the German continental deep drilling site (KTB). J. Geophys. Res. Solid Earth. 1997; 102:18323-18336. https://doi.org/10.1029/96JB03395

[19] Khursanov A, Hasanov A, Tolibov B. Physical Properties of Liquid Slag, their Influence on the Basic Parameters of Technological Processes. Challenges of Science. 2023; VI:225-232. https://doi.org/10.31643/2023.27

[20] Rabatuly M, Musin RA, Demin VF, Usupaev ShE, Kenetaeva AA. Improving the efficiency of methane extraction from coal seams. Kompleksnoe Ispolzovanie Mineralnogo Syra = Complex Use of Mineral Resources. 2023; 324(1):5-11. https://doi.org/10.31643/2023/6445.01