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# Methods for intensification of borehole uranium mining at the fields with low filtration characteristics of ores

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**Abstract**

**Purpose.** Improving the efficiency of borehole uranium mining and the selection of special decolmating solutions to improve the filtration characteristics of the seam due to effective destruction, as well as by preventing the sedimentation in the productive horizon, depending on the mineralogical composition and structure of sediment-forming materials.

**Methods.** The advantages and disadvantages of the main methods used for improving the filtration characteristics of the productive horizon, when mining the uranium deposits by the borehole method, have been studied. Samples of sedimentation from the productive horizon are taken at the uranium deposit of the Shu-Syrasu depression. The quantitative and qualitative parameters, as well as the peculiarities of the mineral compositions have been determined by the X-ray phase method. A methodology has been developed and laboratory experiments have been conducted on the treatment of sedimentation samples by the drop method using various compositions of selected decolmating solutions. The microscopic method is used to determine the structure and peculiarities of sedimentation before and after treatment with various decolmating solutions.

**Findings.** The effectiveness of the main methods used to improve the filtration characteristics of seams in the uranium deposits, mined by the borehole method, has been determined. The structure and composition of sedimentation, which causes a decrease in the filtration characteristics of the productive horizon, have been determined. To destroy and prevent the sedimentation in the productive horizon, an effective composition of a special decolmating solution using ammonium hydrogen fluoride with the addition of sulphuric acid and surfactants has been selected. An effective method for increasing the filtration characteristics of the productive horizon with the use of special decolmating solutions has been developed and scientifically substantiated.

**Originality.** The use of special decolmating solutions based on ammonium hydrogen fluoride with the addition of sulphuric acid and surfactants according to the developed methodology allows to effectively destroy and prevent sedimentation in the productive horizon of borehole uranium ore mining.

**Practical implications.** The use of the developed decolmating solution and a special methodology for the intensification of borehole uranium mining can reduce the operating costs of its production. This increases the ecological and industrial safety of the work to intensify the leaching of uranium ores.

***Keywords:*** *borehole mining, sedimentation, decolmating, intensification, X-ray phase method, microscopic test*

## 1. Introduction

Uranium is the most representative element of the actinide series and is of fundamental importance in the nuclear fuel cycle. It is expected that the nuclear energy market will grow substantially over the next 20 years, for example, in the United States alone, according to forecasts, by 2030 it will grow by 50%, and global electrical energy consumption, according to the Ministry of Energy, will double by 2030 [1]. Intergovernmental Panel on Climate Change (IPCC) stresses the urgent need to use all available low-carbon technologies to prevent climate change. International Energy Agency (IEA) and Nuclear Energy Agency (NEA) predict that nuclear capacity will have to double by 2050 [2], [3]. [3]In combination with the expected growth in nuclear power, uranium demand will also rise sharply in the future [4]. Kazakhstan has 14% of the world's proven uranium reserves, 70% of which are suitable for borehole mining, and ranks second after Australia (Fig. 1). Borehole mining of uranium ores in the Republic of Kazakhstan is conducted at 26 sites united in 13 uranium mining companies. The total volume of natural uranium production is more than 40% of the global volume (Fig. 2).

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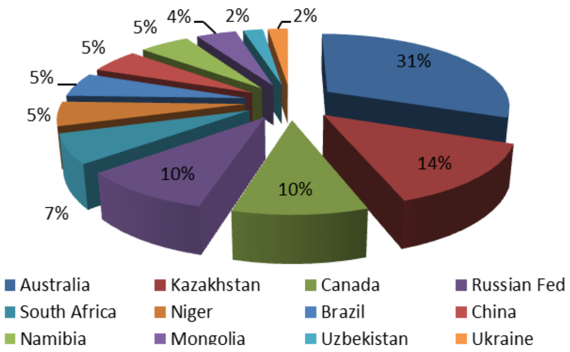


***Figure 1. Uranium reserves explored by countries***

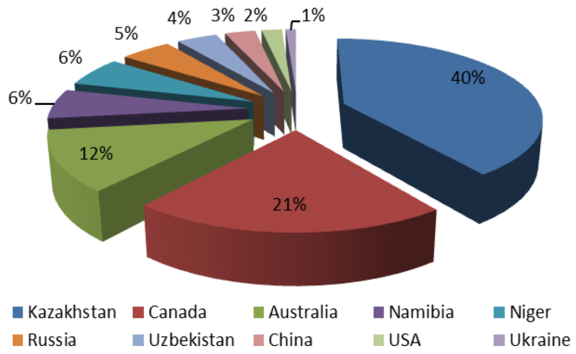


***Figure 2. Share production of uranium by countries of the world***

Uranium deposits in Kazakhstan are localized in six provinces: Shu-Syrasu, Syrdarya, North-Kazakhstan, Pre-Caspian, Pre-Balkhash, and Ile. The main production is carried out in the first two Kyzylorda and Turkistan regions. They are schematically shown in Figure 3.

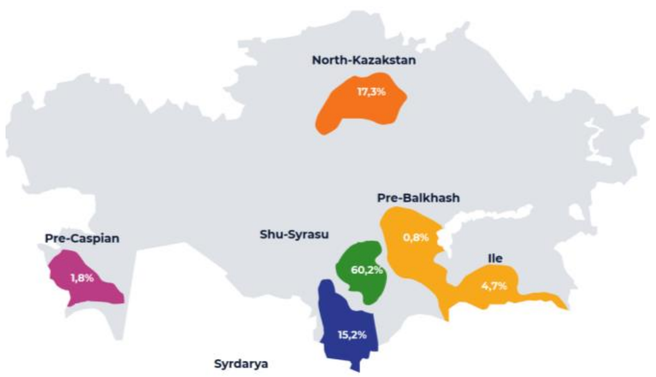


***Figure 3. Location map of regions with explored uranium deposits in Kazakhstan***

The process of mining uranium from ores by the borehole method consists of three conventional stages. The first stage involves the uncovering of the ore interval with a network of geotechnological wells, preparation of the ore mass for mining by supplying to the subsoil of a sulphuric acid solution with an increased acidity of 25-30 g/l. The second stage of mining consists of supplying the leaching solutions (LS) to injection wells with a minimum acidity of 5-7 g/l and pumping out productive solutions (PS) from production wells using submersible pumps. The final third stage consists of additional leaching of uranium from ores with mother solution, washing-out of the ore interval from residual acidity and reclamation of the technological block after mining [5], [6].

A decrease in the rate of mining with the use of sulphuric acid solutions occurs due to a decrease in the productivity of production wells and intake of the injection wells, as well as a decrease in the uranium content in the productive solutions. This is caused by the interaction of sulphuric acid with carbonate and clay minerals, resulting in settling-out of a number of elements, a decrease in the filtration characteristics of the productive horizon and the formation of impermeable areas [7], [8].

Hardly soluble sediments and displaced clay particles in the productive horizon increase the hydraulic resistance and form impermeable areas of geochemical barriers that block the flow lines of solutions. As a rule, a decrease in the filtration characteristics of a productive horizon leads to a decrease in the uranium content in the productive solution, a decrease in the yield and the duration of the uninterrupted operation of wells. This extends the period of mining the technological blocks, thereby increasing the consumption of sulphuric acid, electrical energy and other operating costs [9], [10]. The wells in these blocks are often stopped for repair and restoration work, and also need an additional increase in the permeability of the near-filter zone of the seam. In some cases, cost-intensive, heavy complex treatments with the use of drilling rigs, including flushing, chemical treatment, swabbing and compressor pumping, do not give a positive result [11], [12].

The study of geotechnological parameters and analysis of the main production, technical-and-economic indicators of uranium mining makes it possible to distribute the main costs and estimate the approximate production cost. Analysis of the costs distribution for uranium mining shows that at the deposits of the Syrdarya depression, the average duration of block preparation is 8 months, and mining is 62 months. In this case, the main expenses – 41% of the production cost – relate to general workshop costs, which include costs for the current maintenance of equipment in working order, the salaries for company personnel, tax deductions, and others. General workshop costs start when the block is put into production and cease when production stops, wells are temporary closed or abandoned, and equipment stops operating. Sulphuric acid costs account for 22% of the production cost and continue from the moment the sulphuric acid is fed into the subsoil (acidification) and last on average 24 months, until the acidification of the sorption mother solution is completely stopped. The expenses on mining and preparatory operations amount to 20% of the production cost, provide for the drilling and construction of technological blocks, geophysical surveys of wells, the purchase of equipment and expendable materials necessary for putting a geotechnological field into operation. The expenses on repair and restoration work amount to 12% of the production cost and continue from the beginning of block acidification to complete mining-out of the block and shut-in of wells. Also, the constant expenses include the cost of electrical energy, which is 5% of the total production cost. They begin when submersible electric pumps and technological equipment are put into operation, until the block stops operating and the electric power supply is turned off.

The efficiency of borehole uranium mining largely depends on the methods used to restore the initial filtration characteristics of the seam and the ability to increase the yield and the period of uninterrupted operation of wells. The main methods for restoring the permeability of rocks in the near-filter zone during recovery operations are physical, chemical and combined types of recovery operations.

The choice of a method for restoring the productivity of production well or intake of injection well depends on the characteristics of each individual method, budget, design of equipment and wells, hydrogeological and other peculiarities of the field. Table 1 gives a brief description of the main methods for restoring the permeability of the seam and their average production cost.

***Table 1. Methods of repair and restoration work applied at uranium mining enterprises***

| Nature of exposure | Implementation method | Main purpose | Production cost, USD |
|---|---|---|---|
| Hydrodynamic | Compressor pumping | Removal of clay mud, mechanical suspended particles and impurities from the near-filter zone | 142.5 |
| | Flushing with process water | Removal of fine dust particles and clay materials from the near-filter zone | 112.3 |
| Chemical | Sulphuric acid | Dissolution of ferrous and aluminium chemical deposits | 225.0 |
| | Clay-acid | Dissolution of carbonate and silicon chemical and mechanical deposits | 397.5 |
| Combined | Reagent treatments with mechanical action | Removal of sand plugs from the casing and filter zone of the well, dissolution of chemical deposits, intensification by swabbing, clarification of solutions by compressor pumping | 2250.0 |

As can be seen from Table 1, the methods used for repair and restoration are divided by type into hydrodynamic, chemical and combined, aimed at the effective removal of a certain type of sedimentation. Hydrodynamic methods, such as compressor pumping and flushing of wells with process water, are based on the pressure difference effect and are aimed at the destruction and dispersion of mechanical sedimentations [13]. The costs of these methods are comparatively lower due to the use of high-performance technological equipment. Chemical methods of stimulation by dissolution are mainly aimed at the destruction and removal of sediments formed as a result of the interaction of technological solutions with the host rocks of the productive horizon [14]. The expenses on these methods are relatively higher due to the use of technological equipment and the consumption of chemical reagents. Combined methods include performing complex operations using drilling rigs and auxiliary equipment, combining well flushing with subsequent chemical treatment, swabbing and compressor pumping [15], [16]. This method is the most cost-intensive due to the use of a large number of equipment, chemical reagents, maintenance personnel and a long duration of the works. However, these methods are ineffective in difficult mining-and-geological conditions, as multicomponent sedimentations are accumulated in the near-filter zone and form cemented impermeable areas that are not amenable to conventional stimulation methods [17], [18].

The objective of the research is to develop an effective technology for restoring the permeability of the productive horizon, effectively destroying and preventing sedimentations in difficult mining-and-geological conditions of borehole uranium mining. This is achieved by sampling the sedimentations from the uranium deposit of the Shu-Syrasu depression, by the method of X-ray phase analysis of their quantitative and qualitative characteristics and structure. Selection of effective parameters for decolmating solutions of chemical reagents for dissolving and preventing sedimentations. Treatment of sedimentation samples with various decolmating solutions in laboratory conditions and the determination of effective parameters of the decolmating solution using a high-resolution analytical scanning electron microscope. Development of a technology for the preparation and supply of air and decolmating solutions of chemical reagents into the productive horizon for the intensification of borehole uranium mining.

## 2. Research methods

The phase composition of sedimentation is controlled by X-ray phase analysis, which is performed using an X-ray diffractometer X'Pert MPD PRO (PANalytical). Surveying conditions: $CuK_\alpha$ – radiation, Ni – filter, $U = 30$ kV, $I = 10$ mA, rotation velocity 1000 imp/s, time constant $\tau = 5$ s, $2\theta = 10$-90°. The intensities of the diffraction maxima are estimated by a 100-point scale as a percentage relative to the highest line. The experimental database and interplanar distances are processed using the Wulff–Bragg's condition. The phase analysis of the colmatage material chemical composition is performed in accordance with the X-ray data of the International Union of Crystallography. Table 2 shows the results of X-ray phase analysis of sedimentation from the deposit of the Shu-Syrasu depression.

***Table 2. Mineralogical composition of sediments from the deposit of the Shu-Syrasu depression***

| Compound name | Chemical formula | SemiQuant, % |
|---|---|---|
| Quartz, syn | $SiO_2$ | 14 |
| Chalcocite, high, copper (I) sulfide | $Cu_2S$ | 27 |
| Berlinite HP, syn | $AlPO_4$ | 22 |
| Dolomite | $CaMg(CO_3)_2$ | 27 |
| Ankerite | $CaMgFe(CO_3)_2$ | 10 |

It can be seen from data of Table 2, that the basis of the sample 27% and 10% by weight is made up of chemical compounds ($CaMg(CO_3)_2$ and $CaMgFe(CO_3)_2$), minerals – ankerite and dolomite, related to the chemical type of sedimentation. The rest of the sample is quartz 14%, copper sulphate 27%, and berlinite 22%. For effective destruction and prevention of such sedimentations, it is necessary to develop a decolmating solution with the use of hydrofluoric acid and adding a surfactant in the form of a complex former.

Experiments on the treatment of sedimentations are conducted on specimens from one sample with various compositions of chemical reagents of decolmating solutions in order to determine the effective composition of a solution that has the highest dissolving properties. Experiment No. 1 includes treatment with a solution of hydrofluoric acid 10%, sulphuric acid 1.0% by weight, the rest is process water. Experiment No. 2 includes treatment with a solution of ammonium bifluoride 10%, sulphuric acid 10% and with the addition of surfactants 1% by weight, the rest is process water. Experiment No. 3 includes treatment with a solution of sulphuric acid 10% by weight, the rest is process water.

*Experiment No. 1*. The decolmating solution HF – 10%, $H_2SO_4$ – 1.0%, the rest – process water is prepared from a half-finished product of hydrofluoric acid with a concentration of HF – 38.3%, $H_2SO_4$ – 3.3% by weight. The choice of a half-finished product of hydrofluoric acid is conditioned by its high reactivity with aluminosilicate and silicon compounds, which are an integral part of ore-bearing rocks and colmation sediments according to Formulas 1 and 2, availability for sale and low cost.

$$CaAl_2SiO_8 + 16HF = 2AlF_3 + 2SiF_4 + 8H_2O + CaF_2; \quad (1)$$

$$6HF + SiO_2 = SiF_4 + 2\ HF + 2H_2\ O. \quad (2)$$

Experiment No. 2. The decolmating solution is prepared on a basis of ammonium bifluoride, sulphuric acid and with the addition of a surfactant for the experiment at ratios of $NH_4HF_2$ – 10%, $H_2SO_4$ – 10%, surfactant – 1.0%, the rest is process water. The choice of ammonium bifluoride as the main component is conditioned by its ability to exchange reaction with mineral acids (sulphuric, hydrochloric, nitric acids) and to form hydrofluoric acid according to Formula 3. A reagent with complex forming properties is used as a surfactant.

$$NH_4HF_2 + H_2SO_4 = NH_4SO_4 + HF. \quad (3)$$

As a result of the interaction of hydrofluoric acid with sedimentations, both the bridging agent and part of the terrigenous component of the sands dissolve, generally increasing the effective porosity of the ore block mass. The addition of a surfactant provides an increase in the interaction of hydrofluoric acid with sediment-forming minerals. In this case, hydrofluoric acid is completely utilized due to the large amount of quartz contained in the sands.

*Experiment No. 3*. The choice of decolmating solution based on sulphuric acid $H_2SO_4$ – 10% and the rest – process water, is conditioned by its low cost, availability at mining enterprises and reactivity with ferrous oxide according to Formula 4 .

$$FeO + H_2SO_4 = FeSO_4 + H_2O. \quad (4)$$

## 3. Results and discussion

After performing laboratory experiments with samples treated by the drop method with decolmating solutions of various compositions, sedimentations are dried at room temperature to conduct surface studies on a scanning electron microscope. A detailed study of the sample surface and a comparative analysis of the images after treatment with one or another solution, as well as its comparison with the original image, make it possible to visually determine the effectiveness of the composition of the decolmating solution.

The image of the sediment surface before and after treatment with various solutions is obtained using a high-resolution analytical scanning electron microscope for a wide range of research tasks and quality control at the submicron level Tescan MIRA 3 FEG-SEM. SEM TESCAN MIRA electron column, electron source: field emission cathode of the Schottky type. The range of electron-beam energies incident on the sample is from 200 eV to 30 keV (from 50 eV with BDT beam deceleration option). To change the beam current, an electromagnetic lens is used as a device for changing the apertures. Beam current from 2 to 400 pA is continuously adjustable. The maximum field of view is more than 8 mm at WD = 10 mm, more than 50 mm at maximum WD. Electron column resolution, high vacuum mode is 1.2 nm at 30 keV, SE detector 3.5 nm at 1 keV, In-Beam SE detector 1.8 nm at 1 keV, BDT beam deceleration option. Figure 4 shows images of samples with a resolution of 20 μm: (a) – in the initial state; (b) – after treatment with solution 1; (c) – after treatment with solution 2; (d) – after treatment with solution 3.

(a) (b)

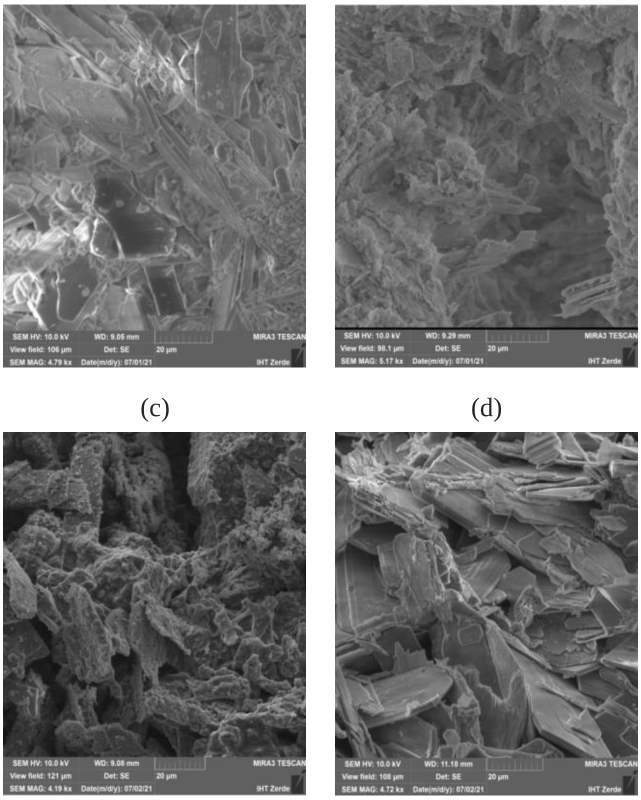


***Figure 4. Surface image: (a) initial sample; (b) experiment 1 samples; (c) experiment 2 samples; (d) experiment 3 samples***

Figure 4a shows that the surface of the initial sample is formed of dense crystals of various sizes from 2 to 30 μm with a characteristic frame structure without breaks and fractures in the body. Crystal shapes are elongated with a chaotic arrangement and uneven surface relief. Figure 4b shows that after treatment with decolmating solution 1, there is a noticeable structure destruction and a change in the crystal shapes, with a decrease in their sizes and with the formation of small loosened flakes. The rounding of the crystal edges and the formation of fractures in the sample body can be seen. Moreover, the arrangement of the crystals has become less dense with the formation of voids and pore space. Partial dissolution of the sample is noticeable; the sizes of the crystals have significantly decreased from 30 to 15 μm. Figure 4c shows that after experiment 2, the sample structure change is more noticeable, there is a dissolution of sedimentation with a decolmating solution and the formation of rills and large fractures along the path of the solution movement. Deformed shapes of crystals are noticeable with a change in shape and structure. Figure 4d shows that after experiment 3, the sample structure after treatment with decolmating solution 3 is practically unchanged. The crystal shapes have retained their structure and shape, without changing their sizes.

The decolmating solution should be applied according to a special method using special technological equipment. The innovative method provides for treatment with a decolmating solution directly in the filter zone of the well to maximize destruction and prevent the sedimentation in the seam. The method provides an increase in the productivity of operating blocks and the completeness of metal extraction from them, helps to reduce and prevents sedimentation in a porous medium. In addition, a reduction is achieved in the specific consumption of sulphuric acid, electrical energy, labour costs and other production costs in the process of borehole uranium mining from various mining and geological blocks. Figure 5 presents the developed scheme of works on the intensification of borehole uranium mining.

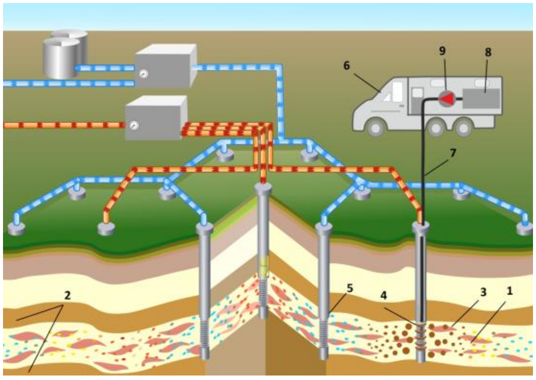


***Figure 5.** Scheme of works on the intensification of borehole uranium mining: 1 – productive horizon; 2 – impermeable rocks; 3 – sedimentation in the near-filter zone; 4 – pumping-out well; 5 – injection well; 6 – equipment for performing chemical treatment; 7 – pressure hose; 8 – container – tank; 9 – transfer pump*

As can be seen from Figure 5, the bulk of sedimentation *3* occurs in the productive horizon *1*, directly in the zone of solution discharge and increasing velocity of solutions movement from injection wells *5* to pumping-out wells *4*. When performing chemical treatment using a complex of chemical reagents, it is possible to provide for the preparation of solutions on special equipment *6*, and supply through the pressure hose *7* to the filter zone of the wells *4*. In this case, the prepared special solution is supplied from the container of a tank *8* by the transfer pump *9*. The supply of decolmating solutions based on ammonium bifluoride 10%, sulphuric acid 10%, and the addition of a surfactant 1.0% directly to the filter zone of technological wells makes possible to reduce the consumption of chemical reagents and increase the penetrating ability for greater destruction and dispersion of sediments.

## 4. Conclusions

The performed quantitative and qualitative research on the sedimentation composition from the deposit of the Shu-Syrasu depression indicates that carbonate minerals 27 and 10% dolomite and ankerite, respectively, constitute the bulk of the sample. The rest of the sample are quartz – 14%, copper sulphate – 27% and berlinite – 22%. The results give evidence of a complex sedimentation structure, the predominance of the chemical type of sediments, as a result of the interaction of sulphuric acid solutions with carbonate minerals and their subsequent settling-out in the discharge zone. The experience of restoring the productive horizon permeability with an obvious chemical type of sedimentation shows the low efficiency of hydrodynamic methods and the complexity of mining out technological blocks. This is conditioned by a decrease in the productivity of production wells and an intake of the injection wells due to the deterioration of the seam filtration characteristics. This leads to additional costs for restoring the productive horizon permeability and an increase in the productivity of production wells and an intake of the injection wells, and also increases the operating costs of mining the blocks.

It has been determined in laboratory conditions, that the preparation of a decolmating solution based on ammonium bifluoride 10%, sulphuric acid 10% and with the addition of surfactants in small amounts increases the dissolving ability and prevents sedimentation in the seam for a longer time.

The developed methodology for restoring the productive horizon filtration characteristics based on the treatment of the filter zone of the wells makes it possible to reduce the specific consumption of chemical reagents and to increase the efficiency of the decolmating solution. The decolmating solution supplied directly to the filter zone of the wells allows to increase the efficiency of production in difficult mining-and-geological conditions. In addition, it effectively restores the productivity of production wells and an intake of the injection wells in ores with increased carbonate content > 2.0% and clay content ≥ 25% of host rocks, and also increases the period of uninterrupted operation of wells by 30%, thereby reducing operating costs of production and ensuring the compliance with ecological and industrial safety requirements.

Further research on the issues of increasing the efficiency of dissolution and prevention of the productive horizon sedimentation in various conditions using physical and chemical methods of stimulation will reduce the cost of finished products and increase labour productivity.

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## Методи інтенсифікації свердловини видобутку урану на родовищах з низькими фільтраційними характеристиками руд

Ж. Кенжетаєв, М. Нурбекова, К. Тогізов, М. Абдраімова, Б. Токтарули


**Мета.** Підвищення ефективності свердловини видобутку урану і підбору спеціальних декольматуючих розчинів для підвищення фільтраційних характеристик пласта за рахунок ефективного руйнування, а також запобігання утворенню відкладень у продуктивному горизонті залежно від мінералогічного складу і структури осадкоутворюючих матеріалів.

**Методика.** Вивчено переваги та недоліки основних застосовуваних методів підвищення фільтраційних характеристик продуктивного горизонту при розробці уранових родовищ свердловинним способом. Відібрано проби осадкоутворення з продуктивного горизонту на урановому родовищі Чу-Сарисуйської депресії. Рентгенофазовим методом встановлено кількісно-якісні характеристики та особливості складів мінералів. Розроблено методику та проведені лабораторні досліди з обробки проб осадкоутворення крапельним методом із застосуванням різних складів підібраних декольматуючих розчинів. Мікроскопічним методом визначена структура та особливості осадкоутворення до і після обробки різними декольматуючими розчинами.

**Результати.** Встановлено ефективність основних застосовуваних методів підвищення фільтраційних характеристик пластів на уранових родовищах, які відпрацьовуються свердловинним способом. Визначено структуру та склад осадкоутворення, що викликає зниження фільтраційних характеристик продуктивного горизонту. Обрано ефективний склад спеціального декольматуючого розчину для руйнування та запобігання осадкоутворенню у продуктивному горизонті із застосуванням біфторида амонію з додаванням сірчаної кислоти і поверхнево-активних речовин. Вироблений і науково обґрунтований ефективний метод підвищення фільтраційних характеристик продуктивного горизонту із застосуванням спеціальних декольматуючих розчинів.

**Наукова новизна.** Застосування спеціальних декольматуючих розчинів на основі біфторида амонію із додаванням сірчаної кислоти та ПАР за розробленою методикою дозволяє ефективно руйнувати і запобігати осадкоутворенню у продуктивному горизонті при свердловинному видобутку уранових руд.

**Практична значимість.** Застосування розробленого декольматуючого розчину і спеціальної методики при інтенсифікації свердловинного видобутку урану дозволяє скоротити експлуатаційні витрати на його видобуток. При цьому підвищується екологічна та виробнича безпека робіт з інтенсифікації вилуговування уранових руд.


***Ключові слова:*** *свердловинний видобуток, осадкоутворення, декольматація, інтенсифікація, рентгенофазовий аналіз, мікроскопічні дослідження*

## Методы интенсификации скважинной добычи урана на месторождениях с низкими фильтрационными характеристиками руд

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**Цель.** Повышение эффективности скважинной добычи урана и подбора специальных декольматирующих растворов для повышения фильтрационных характеристик пласта за счет эффективного разрушения, а также предотвращения осадкообразования в продуктивном горизонте в зависимости от минералогического состава и структуры осадкообразующих материалов.

**Методика.** Изучены преимущества и недостатки основных применяемых методов повышения фильтрационных характеристик продуктивного горизонта при разработке урановых месторождений скважинным способом. Отобраны пробы осадкообразования из продуктивного горизонта на урановом месторождении Чу-Сарысуйской депрессии. Рентгенофазовым методом установлены количественно-качественные характеристики и особенности составов минералов. Разработана методика и произведены лабораторные опыты по обработке проб осадкообразования капельным методом с применением различных составов подобранных декольматирующих растворов. Микроскопическим методом определена структура и особенности осадкообразования до и после обработки различными декольматирующими растворами.

**Результаты.** Установлена эффективность основных применяемых методов повышения фильтрационных характеристик пластов на урановых месторождениях, отрабатываемых скважинным способом. Определена структура и состав осадкообразования, вызывающий снижение фильтрационных характеристик продуктивного горизонта. Выбран эффективный состав специального декольматирующего раствора для разрушения и предотвращения осадкообразования в продуктивном горизонте с применением бифторида аммония с добавлением серной кислоты и поверхностно-активных веществ. Выработан и научно обоснован эффективный метод повышения фильтрационных характеристик продуктивного горизонта с применением специальных декольматирующих растворов.

**Научная новизна.** Применение специальных декольматирующих растворов на основе бифторида аммония с добавлением серной кислоты и ПАВ по разработанной методике позволяет эффективно разрушать и предотвращать осадкообразование в продуктивном горизонте при скважинной добыче урановых руд.

**Практическая значимость.** Применение разработанного декольматирующего раствора и специальной методики при интенсификации скважинной добычи урана позволяет сократить эксплуатационные расходы на его добычу. При этом повышается экологическая и производственная безопасность работ по интенсификации выщелачивания урановых руд.

***Ключевые слова:*** *скважинная добыча, осадкообразование, декольматация, интенсификация, рентгенофазовый анализ, микроскопические исследования*