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ENVIRONMENTAL PROBLEMS CAUSED BY GROUNDWATER CONTAMINATED WITH RADIONUCLIDES AND CHEMICAL TOXIC SUBSTANCES

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Abstract: Groundwater is one of the sources of nutrients for rivers. They are more protected from *contamination* than surface waters, but during infiltration in mining areas, factories, industries, landfills, and megacities, pollutants actively penetrate aquifers. Contamination of groundwater causes deterioration of its composition and properties, which limits or prevents its use (for domestic, drinking, cultural, and other purposes). Contamination of groundwater occurs under the influence of two processes: natural and man-made.

The scientific results presented in the article do not purport to be original but are a summary of the results given in the cited articles.

Keywords: Groundwater, contamination, anthropogenic processes, groundwater *contamination*

The anthropogenic load on the environment increases every year. Anthropogenic processes affect the soil, atmospheric air, the hydrosphere, and humans. The impact of such processes is becoming more and more profound and diverse. The interaction between humans and the underground hydrosphere has various aspects. Among the negative consequences, the most serious is the depletion and contamination of groundwater. This problem is related to the *contamination* of large rivers and lakes in countries with larger populations. Densely populated areas tend to use groundwater than water from surface sources, leading to depletion and *contamination* of this water source. The resources of these waters are evaluated by the criteria - quantity. It can also be regional or local.

Contamination of groundwater: Human economic activity has led to the accumulation of large amounts of waste on the Earth's surface and hence, to environmental pollution. Most wastes are produced in industry, agriculture, transport, energy, mining, and utilities. Pollutants contained in the waste stored on the surface of the Earth are filtered by sewage, atmospheric precipitation, and a part of surface water and enter the groundwater, worsening their quality. Deterioration of groundwater quality leads to its abstraction for water supply and reclamation purposes during the exploitation of mineral deposits. Contamination of groundwater can also be caused by natural factors: the content of high concentrations of naturally stable strontium or iron in water, and natural disasters (earthquakes, volcanic eruptions, etc.) cause the contamination of groundwater [1].

Groundwater contamination can be local and regional. There is a large variety of sources of this type: ponds, earthen tanks (which contain wastewater), sumps, sludge reservoirs, ash dumps, industrial wastewater filtration sites, individual wells in oil and gas fields, radioactive waste storage sites, landfills, oil filling stations, quarries, livestock farms, etc. [9]. Regional contamination of groundwater occurs from regional, diffuse contamination sources, having a wide distribution on the surface of the Earth. Regional sources of contamination include large metropolitan areas; urbanized areas where large cities are concentrated; land reclamation

facilities; areas of intensive agricultural production; oil and gas fields; energy and transport facilities; mining enterprises, etc. Such groundwater contamination sources cover large areas of aquifers. Groundwater contamination occurs as a result of wastewater seepage, gas and smoke emissions, and solid waste solutions. Linear sources of groundwater pollution need to be identified. Such sources include highways, contaminated rivers, municipal and industrial sewers, and oil pipelines. Linear sources, in turn, are divided into local and regional according to their nature, the volume of contamination sources, and the degree of their impact on groundwater. Contaminants can be anthropogenic (man-made) and natural. Natural sources of groundwater contamination include natural low-quality groundwater (seas, oceans, aquifers, rivers, and saline lakes) that contain certain chemicals in quantities that do not meet drinking water quality standards. Anthropogenic contamination sources play a major role in groundwater contamination. Basically, contaminants enter groundwater through other components of the environment, undergo various biological and chemical changes, and through chains of different lengths (from atmosphere to soil, from soil to rocks in the aeration zone, and from aeration zone to groundwater). Of course, contaminants can enter groundwater directly from leaking wells and other structures that open up aquifers [1]. Let us consider groundwater contamination from anthropogenic sources only, regrouping them into several groups.

Industry: Among industrial wastes, industrial waters play a major role in groundwater contamination [9].

Table 1

Dynamics of discharge of contaminated wastewater to surface water bodies in 2022 by industrial sectors [1]

Type of industry	**mln m^3**
non-ferrous industry	421.2
oil industry	4.2
ferrous industry	686.3
coal industry	394.6
oil refining industry	145.1
gas industry	11.6
construction materials industry	125.6
chemical and petrochemical industry	1302.6
machine building and metal processing	473.3
wood processing and pulp and paper industry	1416.6
food industry	89.4
light industry	69.6

Extractive industry: The production activities of the oil industry affect the environment in the following ways: extraction, disturbance, and pollution of soil resources at oil extraction and transportation facilities, the release of pollutants into the atmosphere, wastes into surface and groundwater, and the soil, extraction of oil and highly mineralized regional waters (saline waters), disposal of drilling wastes, accidental oil spills. Additional damage is caused by accidents at drilling rigs and platforms, as well as main gas and oil pipelines. The main causes of emergencies are pipeline breaks due to corrosion. During the production, processing, storage, and transportation of natural gas, the greatest damage to the environment is caused by the release of harmful substances into the atmosphere. During gas production, about 20% of the total volume of waste is neutralized [9]. There are cases of accidents with large gas losses in the existing main gas pipelines. Typical pollutants in the gas industry are carbon monoxide, hydrocarbons, sulfur dioxide, solids, soot, volatile organic compounds, and nitrogen oxides. The coal industry is one of the most complex industries in terms of environmental impact. Mined coal contains many impurities and non-combustible materials. In its natural state, coal contains clay, rock fragments, pyrites, ash, and other classified materials. The process of mining and processing coal deposits adds various types of impurities - ore mass, rock fragments, wood fragments, and sometimes iron impurities. In the process of surface and underground coal mining, transportation, and enrichment of portable coal, air pollution occurs due to drilling and blasting, operation of internal combustion engines and boilers, dusting of coal storages and rock dumps, and other sources. Air emissions from the coal industry include hydrocarbons, methane, soot, volatile organic compounds, sulfur dioxide, and solids.

Energy: Currently, the main share of energy is produced by burning or processing natural organic raw materials - coal, oil, gas, oil shale, peat - as well as using the energy of rivers by building hydroelectric power plants and building reservoirs. Energy plants have different impacts on the environment, depending on the properties of the used initial resources: air pollution by combustion products, thermal pollution of the atmosphere and water bodies, pollution of water bodies by wastewater, etc. [9]. Sulfur dioxide, carbon monoxide, solids, nitrogen oxides, hydrocarbons, volatile organic compounds, formaldehyde, ammonia, soot, benzopyrene, methane, and nitric acid dominate in emissions. The damming of rivers and construction of reservoirs causes changes in the microclimate, affects groundwater levels and the condition of vegetation, and leads to salinization or waterlogging of soils and other consequences. Air consists of solids, sulfur dioxide, nitrogen oxides, carbon monoxide, hydrocarbons, and volatile organic compounds.

Transport: The impact of transport and the infrastructure supporting its operation on the environment is accompanied by significant pollution. The main types of impacts of the transport-road complex are air pollution with toxic components of the exhaust gases of transport engines, pollution of water bodies, generation of industrial waste, and traffic noise. The transport-road complex is connected with gas, liquid, and solid wastes entering the atmosphere, surface and underground waters, soils, and sea waters. The transport complex includes car, river, sea, and air transport. Railway transport and road facilities are among the biggest polluters of the environment. Suspended substances and oil products are predominant in the wastewater of the transport complex [1].

Agriculture: Currently, the negative impact of agriculture on the environment has decreased due to the continued decline in production. This applies to the effect of mineral and organic fertilizers and pesticides. However, the decrease in the volume of use of mineral and organic fertilizers did not lead to a weakening of the corresponding proportions of the impact of criminalization on the natural environment, because the main reasons for their entry into surface and underground waters are - violation of storage, transportation and application rules. About

30% of pesticides and fertilizers applied to crops enter water bodies [9]. Intensive pollution of the environment occurs as a result of the storage of mineral fertilizers and pesticides in the open air or in numerous warehouses that are not properly equipped. Soil erosion causes great damage to soil resources and the environment. Depletion and pollution of water bodies, soil salinization, and the formation of shifting sands and ravines continue. Carbon dioxide, sulfur dioxide, nitrogen oxides, hydrocarbons, volatile organic compounds, etc. are predominant in the waste emitted from agricultural enterprises. The sources of increased risk to the environment are large livestock complexes, especially pig farms where a hydraulic washer is provided for manure disposal, and poultry farms. Due to the accumulation of large amounts of liquid and solid manure near livestock complexes, liquid manure seeps into the soil, creating an unfavorable situation, soil water and agricultural products are polluted.

Types of Groundwater Contamination: Contaminants in man-made waste can penetrate groundwater and cause chemical, bacterial, radioactive, and thermal pollution.

Chemical Contamination of Groundwater: Chemical contamination of groundwater is most common because it is caused by most pollutants. This type of pollution is very persistent and therefore can last for a long time, causing it to spread over long distances in aquifers.

Contamination of groundwater with macrocomponents. After entering the aquifers, the pollutants settle at the bottom of the layers due to their high density, thereby changing the natural geochemical zoning of the aquifers [8].

Contamination of groundwater water with oil and oil products. Pollution with such substances occurs as a result of all human production activities. Oil differs from water in its properties. Most petroleum hydrocarbons are less dense than water. What are oil and oil products? It is a mixture of mostly weak hydrocarbons with different solubility in water. Due to their density differences, oil and its products are usually located in the upper part of aquifers [1]. In the case of contamination of groundwater with oil products, lenses consisting of single-phase liquid - hydrocarbons are formed on their surface, the strength depends on the number of oil products penetrating the aquifer and can be different (from centimeters to several meters). Below the single-phase layer is a layer containing a two-phase mixture in the form of an emulsion, and the most soluble hydrocarbons (mainly aromatic) form a solution with water. As a result of the pollution of groundwater with oil, a stratified part of the aquifer is formed, the upper layers of which contain oil itself, the middle layers contain a two-phase mixture, and the lower layers contain a solution of oil products [8]. The areas occupied by emulsified and water-soluble hydrocarbons are several times larger than the area occupied by the oil lens. A characteristic feature of groundwater pollution with oil is the presence of a specific smell of oil and oil products, and the presence of an oil film on the surface of the water.

Contamination of groundwater with heavy metals. Various industrial wastes, vehicle wastes, agricultural pesticides, and other products contain various metals: lead, copper, zinc, nickel, cadmium, cobalt, antimony, tin, bismuth, and mercury [9]. The wastes of non-ferrous metallurgical enterprises contain especially many heavy metals; where their content can exceed background concentrations by hundreds and thousands of times.

Contamination of groundwater with nitrates. Contamination of groundwater with nitrate mainly occurs in three forms - ammonium, nitrite, and nitrate. Nitrate is the final product in the nitrogen conversion chain during nitrogen oxidation.

Contamination of groundwater with pesticides. All chemical plant protection means are called pesticides. Depending on the purpose, there are herbicides (against weeds), insecticides (against insects), and fungicides (against fungi). According to their chemical composition, pesticides are divided into organochlorine compounds (DDT, HCCH, lindane, heptachlor, dichloroethane, chloropicrin, etc.), organophosphorus (dichlorvos, metaphos,

karbophos, phosphamide, chlorophos, organochlorine) [1]. Pesticides undergo decomposition processes over time. This phenomenon reflects the persistence of pesticides. Pesticides are biologically active toxic substances, many of which are transformed into intermediate compounds (metabolites), which in some cases are more toxic than the initial substances. Pesticides are poorly soluble in water. For practical purposes, pesticides are used in the form of solutions and emulsions, powders, and aerosols. They are applied to the soil, sprayed from airplanes, and sprayed on plants.

Bacterial contamination of groundwater. Domestic and agricultural wastes contain various micro-organisms, and when they are discharged into aquifers, they change their biological properties and degrade the sanitary conditions of the waters. An indicator of bacterial or microbial contamination of groundwater is the increase of pathogenic and sanitary-indicative microorganisms compared to the natural background concentration. Sanitary-indicative microorganisms include bacteria of the Escherichia coli group, enterococci. Pathogenic microorganisms are bacteria that cause infectious diseases. Pathogenic microorganisms include enterobacteria (shigella and Salmonella), bacteriophage E, and eteroviruses (poliomyelitis virus). Bacteria of the Escherichia coli group are of particular importance for characterizing the microbiological state of water [8]. The epidemiological safety of drinking water is determined by its compliance with standards for microbiological and parasitological indicators. Bacterial contamination is only a part of the total biological pollution, which can be caused by algae, viruses, and other representatives of microflora and microfauna in addition to bacteria. A characteristic of bacterial contamination is its limited distribution in the water layer. This is due to the relatively short life of bacteria in groundwater. According to national and foreign publications, this time is 30-400 days, which determines the temporality and location of bacterial contamination of groundwater.

Radioactive contamination of groundwater. It occurs as a result of the release of radionuclides into the atmosphere and onto the Earth's surface as a result of nuclear explosions and the abnormal operation of wastewater from nuclear power plants or enterprises that extract or use radioactive substances for scientific, medical, and industrial purposes, as well as the accidents at nuclear industry facilities. The most harmful elements are durable radioactive elements (strontium-90, uranium-235, radium-226, cesium-137, etc.) [1] that increase their mobility in water. Groundwater is considered contaminated when the concentrations of radionuclides exceed their background values (formed after the first nuclear weapons tests) and the contamination degree is determined by the ratio of background and observed concentrations. For example, the accident at the Chornobyl Nuclear Power Plant showed that groundwater is sensitive to radioactive contamination.

Determination of radionuclides in groundwater. "Determination and sorption of radionuclides in groundwater released with oil" [2] was studied at ANAS IRP. The presence of radioactive elements in groundwater released with oil was known at the beginning of the 20th century and it was determined that some groundwater has a certain amount of radioactivity. Radioactive elements with the highest concentration in groundwater that comes out with oil are potassium and uranium. The most common isotope of uranium is U^{238}. The amount of uranium in groundwater is 10^{-7}-10^{-6} %, thorium - 10^{-8}-10^{-7} %, and radium - 10^{-12}-10^{-11} %. Radioactive elements are found in oil as well as groundwater. V. I. Vernadsky determined that uranium is mainly collected in the asphaltene and tar parts of oil, and the largest amount of uranium is collected in the asphaltene part separated from the oil. Many authors suggest the existence of uranyl naphthenates. It has been determined that there is a correlation between the amount of thorium and the amount of sulfur compounds in most oils. Thorium is almost never found in asphaltenes. Thorium was found to be combined with condensed bicyclo aromatic compounds

and oxyquinioline. It is these compounds that are spread in resins. And radium enters the composition of oil as a result of the decomposition of uranium. Since radium is an alkaline-earth metal, it is dissolved in water-in-oil emulsions and enters acidic organic compounds as a cation. Since the chemical property of K^{40}, a natural radioactive isotope of potassium, does not differ from the chemical property of the K^{39} isotope, its distribution in oil fractions is similar to the distribution of potassium elements in oil fractions. As in all natural materials, the K^{40} isotope in crude oil and all oil fractions is 0.0127% of potassium. Rb^{87} isotope is also 100% beta active and makes up 27.83% of rubidium in nature. It is known that rubidium is an alkali metal and occurs in most oils. This radioactive isotope (Rb^{87}) also accumulates in the heavy fractions of the oil, as does the stable isotope (Rb^{85}). Mineral salts enter the groundwater that comes out together with oil during the contact of groundwater with various rocks. These waters contain a large amount of dissolved mineral salts. According to their chemical composition, these waters are divided into chlorcalcium and alkaline waters. The degree of mineralization in these waters is measured by the mass of dissolved salts in a unit volume. Groundwaters also contain colloidal SiO_2, Fe_2O_3, Al_2O_3, and water-insoluble (suspenders) inorganic substances. An extensive analysis of the mineral content of groundwaters has shown that its main component is sodium chloride. Besides, chlorine, iodine and bromine compounds of magnesium and calcium have also been found. Sodium, magnesium, iron, and vanadium sulfides were also found in groundwaters that came out together with oil. However, their amount is very small compared to sodium chloride.

Thermal contamination of groundwater. Thermal contamination of groundwater manifests itself in the form of an increase in its temperature compared to background values. Thermal contamination usually occurs in areas where large industrial enterprises are located, mainly in energy complex enterprises (heat, nuclear power plants), as well as in urban areas as a result of the discharge of heated industrial and domestic wastewater to the surface [8]. As water temperature increases, its solvent power also increases. which leads to the intensification of karst-suffuses processes. Temperature changes affect the increased toxicity of contaminants in groundwater. Thermal contamination, together with chemical contamination, causes the most negative changes in the composition of groundwater [9].

Contamination of groundwater from hydrocarbon production. Hydrocarbons are organic compounds that contain only two elements: carbon (C) and hydrogen (H). Sources of hydrocarbons vary not only by location (on land or sea shelf), but also by their state: liquid (oil), gas (methane), and solid (coal). Groundwater contamination from hydrocarbon extraction is a major problem in hydrogeology and ecology because groundwater is a strategic water resource intended for drinking purposes.

Contamination of groundwater as a result of oil and gas production. The development of promising oil and gas fields, the construction of pipelines, the development of related infrastructure, and other large related engineering structures create large anthropogenic effects on the natural environment, threatening it with contamination and degradation [3]. The extent of the man-made influence of exploration and development of hydrocarbon deposits on groundwater depends on the geological structure, hydrodynamic and thermobaric conditions, and the operating technology of oil-gas water-bearing complexes. The negative impact of oil and gas deposits on natural waters is possible at all stages of production: well drilling, production, preparation for transportation, and transportation of extracted raw materials. Emergencies are particularly important in terms of the extent of contamination[4]. The main contaminants are: in the areas of oil fields - oil and oil products, highly mineralized reservoir waters, drilling fluids, chemical reagents used in them, synthetic surfactants, and suspended solids. The high mobility of oil and its processing products creates conditions for extensive contamination of the soil, aeration zone, and groundwater. For oil and most oil products, the MPC for domestic and

drinking water ranges from 0.01 to 0.3 mg/l. They migrate in the oil phase state as well as in dissolved, adsorbed, and dispersed forms. Their solubility is very high, which causes a large amount of groundwater contamination, and contamination is provided not only by the organic component of oil but also by its inorganic parts (sulfur, nitrogen, metals, acids). The conversion of petroleum products in groundwater causes the formation of large amounts of carcinogenic substances. Petroleum products are removed from groundwater as a result of sorption by aluminum material, as well as oxidation and biochemical decomposition. The annual loss of oil is 1.25% of its production; about 20% of the total oil losses end up in water bodies (an average of 700-800 thousand tons per year) [12]. Oil spilled on the surface enters the nearest water bodies as a result of washing from the water basin by surface slope and underground flow. Therefore, their most intensive contamination is observed during spring floods, melting of contaminated snow cover, as well as rain floods. The amount and composition of oil and oil products entering unorganized water bodies from the territory of the oil and gas field is mainly determined by the chemical composition of the oil, as well as its physical and chemical properties. Water produced with oil and groundwater from oil refining facilities can enter water bodies. These waters are characterized by high mineralization (from 1 to 50 g/l and more), contain oil (15-1000 mg/l, sometimes up to 3 g/l), various organic substances (naphthene, acids, phenols, ethers, etc.) associated with oil deposits. The groundwater of some deposits contains iron, H_2S, carbon oxides, fluorine, iodine, boron, bromine, lithium, strontium, etc. [5]. Contamination with oil is one of the most dangerous and widespread types of pollution. A specific feature of the annual distribution of the composition of oil products in the waters of most rivers of this region is, as expected, the limitation of the annual maximum concentration to the period of spring floods. Contamination with acid is a less dangerous type of environmental contamination in oil and gas production areas [4]. The effect of acid compounds on the chemical composition of surface water can occur in two main ways: directly - during dry and wet deposition of acid-forming substances on the water surface, indirectly - during their percolation from the soil, they are later collected in water bodies by underground flow. Indicators of direct contamination of natural water with acid emissions are as follows: decrease in pH values of water and increase in the amplitude of their fluctuations, increase in the content of sulfates, and change in the natural hydrocarbonate content of water. Contamination of the natural environment with acid is a long, complex, and difficult-to-predict process. The consequences of long-term geochemical changes in water bodies due to the deposition of acid emissions are particularly difficult to predict. Salt pollution of water bodies is primarily due to the effect of highly mineralized groundwater and is accompanied by a sharp increase in water salinity and the amount of salt-forming components (Cl^-, SO_4^{2-}, Na^+). Water bodies with low dilution capacity react most sensitively to this type of contamination. During the release of highly mineralized groundwaters, initial salinization of the soil occurs on the surface of the water basin, the effect of this on the chemical composition of the surface slope and underground flow and then on the chemical composition of the water of water bodies depends on the following: conditions of geochemical transformation of groundwater in the soil, drainage in the catchment area and other factors [7]. In addition to high salinity, these waters contain toxic elements (boron, lithium, bromine, strontium, etc.) and organic substances (naphthenic acids, phenols, ethers, benzene, etc.). Related water contains mechanical impurities, petroleum products, as well as chemicals used in the process of drilling wells. The impact of the polluting components of oil and gas on the biological resources of water bodies is also significant. Current levels of oil pollution in freshwater ecosystems are toxic to the entire biological society, including fish, and are particularly harmful to eggs and larvae. It was determined that all group components of oil - hydrocarbons, resins, and asphaltenes have a mutagenic effect. Polyaromatic hydrocarbons

(PAHs), which have mutagenic and ballastogenic properties, are particularly dangerous. Light hydrocarbons, which are part of gases and gas condensate, pose a significant threat to fish (about 50% of fish die at a concentration of 1-3 mg/l in household gas water) [13]. There have been numerous cases of a relationship between the massive loss of fish and the release of large amounts of natural gas into the water after accidents at drilling rigs. Benthic organisms are significantly affected by oil pollution, their functional and organic changes are already noticeable when oil concentration in bottom sediments is 0.1-1 mg/l, and lethal effects are possible at higher concentrations [11]. A high level of pollution of natural waters in areas where oil and gas production is developed requires highly effective measures to prevent water quality deterioration. In addition to engineering, technological, and organizational-technical planning measures, scientific and methodical works should also be included in the complex of measures to prevent (or minimize) pollution of natural waters in oil and gas production areas. Accidental releases and spills of oil on the surface create huge contamination areas that include soils, aeration zones, groundwater, and sometimes even deeper paleo-bearing systems. In these cases, the oil can be in the following states: a free liquid phase immiscible with suspended water; a gas phase; sorption phase; dissolved in water [6]. Especially during breaks in underground oil pipelines, a lot of oil (hundred thousand tons) can leak around, which is very difficult to detect in time. Contamination of groundwater with oil in the area of oil refineries is mosaic in nature. The contamination of groundwater with oil is one of the most dangerous cases. It can spread rapidly over large areas, reaching the ground surface and entering surface watercourses and reservoirs. In this case, the following characteristics of such contamination should be taken into account:

1) mobility and fluidity of liquid phases of hydrocarbons; their liquid forms (gasoline) have the greatest mobility, and their most solid forms (fuel oil, lubricants) have the least mobility; the movement of oil products poses a great environmental threat: one liter of gasoline can make 2 million liters of drinking water of poor quality [14-15].
2) easily moving forms of oil products are lighter than water and therefore move above the level of groundwater, the other part of oil products moves with water - these are water-soluble and water-emulsified forms. Gaseous forms can move both freely and dissolve.
3) the main pollutants of groundwater are hydrocarbons, heavy metals, and mercaptans. Special attention should be paid to the presence of benzopyrene ($C_{20}H_{12}$) in these waters, with an MPC of only 0.005 μg/l.

In addition, contamination of the upper aquifer is due to the introduction of industrial and domestic wastewater and emulsifiers for dewatering oil, hydrogen sulfide, alkalis, and ammonia used to neutralize sulfuric acid. All these pollutants enter aquifer systems to some extent, despite great efforts to treat industrial wastewater. Their scale is significant, as 2 tons of water are required to process 1 ton of oil [16-17]. A number should be given to estimate the extent of pollution occurring in the refinery area: up to 200 thousand tons of oil are located on its territory at the same time for processing. Under these conditions, pollution manifests itself in three environments: air, lithosphere (soil, ground), and hydrospheric (soil, underground, and surface water). The interaction of hydrocarbons with groundwater leads to the formation of new compounds of oil. Many of them have more dangerous properties than the original main compounds. Therefore, hundreds of new names of organic compounds appeared in the latest SanPiN. Their number may increase significantly in the future, but this is still hindered by the low sensitivity of chemical analysis and the undeveloped analytical base for the study of hydrocarbons in groundwater.

Contamination from coal mines: There are many negative environmental impacts associated with coal mining. In coal mines, mines leave areas that can no longer be used.

Rehabilitation can alleviate some of these problems. Waste contains large amounts of acid that can enter rivers and aquifers, affecting the environment and human health. Ground subsidence can also occur due to subsidence in underground tunnels. Methane can release many greenhouse gases, which burn even when wet. Typically, under these conditions, soil disturbance and mine-related impacts lead to erosion. Removal of topsoil from such an area alters or destroys many of the soil's natural properties and can also reduce its agricultural productivity. Also, the soil structure can be disturbed by various kinds of explosions. Coal mining can also have a negative impact on the hydrology in any region. Deterioration of water quality is caused by the penetration of toxic trace elements, the increase in the amount of dissolved solids in groundwater, as well as the increase in the amount of sediments thrown into water streams. Coal dumps can lead to the deposition of harmful components and large amounts of toxic trace elements in watercourses. Surface water may become unsuitable for agriculture, bathing, domestic or other purposes. Controlling these impacts requires careful management and analysis of surface water quality. Rivers, lakes, and ponds are deteriorating, wetlands are drying up and fish, aquatic invertebrates, and amphibians are dying. Contamination of surface waters is directly linked to surface mining. Coal mining and transportation have to be based on rational environmental impact.

Conclusion

Human activity is increasing every year, and the pressure on the environment is starting to become global. Despite the regulations and restrictive indicators, it is necessary to support the economy of the state. Extraction of useful minerals, that is, oil, coal, and gas, is exposed to great risks of contamination of the entire environment of the world around us. The most dangerous contamination is associated with groundwater for several reasons: the self-cleaning process of groundwater takes a long time. When oil and gas wells are drilled, it is practically impossible to clean groundwater. Groundwater is a strategic source of drinking water, and bacteriological development in groundwater causes the risk of serious diseases, and mutations. To minimize the negative impact, it is necessary to follow the rules, and carefully check the operation of the equipment and mining areas.

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ЭКОЛОГИЧЕСКИЕ ПРОБЛЕМЫ, ВЫЗВАННЫЕ ЗАГРЯЗНЕНИЕМ ПОДЗЕМНЫХ ВОД РАДИОНУКЛИДАМИ И ХИМИЧЕСКИМИ ОТРАВЛЯЮЩИМИ ВЕЩЕСТВАМИ

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Резюме: Подземные воды являются одним из источников биогенных веществ для рек. Они более защищены от загрязнения, чем поверхностные воды, но при инфильтрации в районы добычи полезных ископаемых, заводы, производства, свалки и мегаполисы загрязняющие вещества активно проникают в водоносные горизонты. Загрязнение подземных вод обусловливает их состав и свойства портиться, что ограничивает или препятствует их использованию (в бытовых, питьевых, культурных и других целях). Загрязнение подземных вод происходит под влиянием двух процессов: природного и техногенного.

Научные результаты, представленные в статье, не претендуют на оригинальность, а представляют собой краткое изложение результатов, приведенных в цитируемых статьях.

Ключевые слова: Подземные воды, загрязнение, антропогенные процессы, загрязнение подземных вод

RADİONUKLİDLƏR VƏ KİMYƏVİ TOKSİK MADDƏLƏRLƏ ÇİRKLƏNMİŞ LAY SULARININ YARATDIĞI EKOLOJİ PROBLEMLƏR

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Xülasə: Qrunt suları çayların qidalanma mənbələrindən biridir. Onlar səth sularından daha çox çirklənmədən qorunur, lakin mədən ərazilərində, fabriklərdə, sənayedə, poliqonlarda, meqapolislərdə infiltrasiya zamanı çirkləndiricilər sulu təbəqələrə aktiv şəkildə nüfuz edir. Qrunt sularının çirklənməsi onların tərkibinin və xassələrinin pisləşməsinə səbəb olur ki, bu da onlardan istifadəni məhdudlaşdırır və ya qarşısını alır (məişət, içməli, mədəni və digər məqsədlər üçün). Qrunt sularının çirklənməsi iki prosesin təsiri altında baş verir: təbii və texnogen.

Məqalədə verilən elmi nəticələr orijinallığa iddialı deyildir, istinadda göstərilən məqalələrdə verilən nəticələrin xülasəsidir.

Açar sözlər: Qrunt suları, çirklənmə, antropogen proseslər, yeraltı suların çirklənməsi