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Kozynska I.P.
Uman State Pedagogic University named after Pavlo Tychyna

Underground version of industrial landscapes in the region of uranium mining in Ukraine

In this article I examined the main types of underground industrial landscape that were formed in the region of uranium excavation – Mining and Drilling. I characterized the main features of underground mining cavities together with the corresponding to them types of tracts. It is noted that this type of landscape is dominating in all fields of uranium ore, where the excavation is conducted with underground mining method (e.g. Ingylsk mine). Type of the area "underground industrial cavities", depending on the variety of extracted rocks that contains uranium, can be divided into different variants: granite, iron ore, sandstone etc.

It is outlined that in Ukraine the granite variant of terrain type "underground industrial cavities" is dominating. In its structure the dominating types of underground mining tracts are shafts, tunnels, mining chamber blocks, mines, crosscuts, tunnels, and horizons that penetrate and outline the granite rocks. It was also stated that the iron ore variant of terrain type "underground industrial cavities", which, as well as sandstone variant, was developed in the early stages of the formation of industrial landscape in the uranium mining region of Ukraine. It is indicated that underground drilling type of industrial landscapes, is forming only in fields where the mining of uranium is possible using underground leaching method. Using this method two deposits of uranium ore are worked out in Ukraine- Devladivske and Bratsk in Dnipropetrovsk and Mykolaiv regions respectively. It is outlined that the deposits suitable for mining of uranium using underground leaching method, are of the hydrogenous type. They are located in water-permeable crumbly sedimentary deposits of Paleogene. Apart from the exogenous-epigenetic uranium deposits, the deposits of sandstone-type can be also developed using underground leaching method.

Keywords: underground landscape, underground mining cavity, mining type of underground industrial landscapes, non-mining (drilling) type of underground industrial landscapes, underground leaching, field of uranium ore, shafts, tunnel, well, the chamber-block mining, mine-crosscut.

Розглянуто основні типи підземних промислових ландшафтів, що сформувались в регіоні видобутку уранових руд – *шахтний та свердловинний*. У структурі шахтного типу підземних промислових ландшафтів виокремлено один тип місцевості – підземні гірничопромислові порожнини з належними їм типами урочищ. Зазначено, що цей тип *місцевості* домінує на всіх родовищах уранових руд, де розробки ведуть підземним способом (наприклад Інгульська шахта). Тип місцевості «підземні гірничопромислові порожнини», залежно від різновиду видобувної породи, яка містить уран, поділено на варіанти: гранітний, залізорудний, пісковиковий тощо. Окреслено, що в Україні переважає гранітний варіант типу місцевості «підземні гірничопромислові порожнини». В його структурі переважають такі типи підземних гірничопромислових урочищ, як шахтні стволи, тунелі, добувні камери-блоки, шахти-квершлаги, виробки, штольні, гезенки, горизонти, що пронизують і оконтурюють гранітні породи.

Розглянуто з*алізорудний варіант типу місцевості «підземні гірничопромислові порожнини»*, котрий, як і піщаниковий, розвивався на початкових етапах формування промислових ландшафтів урановидобувного регіону України. Зазначено, що с*вердловинний* тип підземних промислових ландшафтів, формується лише на родовищах, де можливий видобуток урану способом підземного вилуговування. Таким способом в Україні відпрацьовано два родовища уранових руд – Девладівське й Братське у Дніпропетровській та Миколаївській областях відповідно. Окреслено, що родовища, які придатні для видобутку урану способом підземного вилуговування, відносяться до типу гідрогенних. Вони локалізовані у водопроникних сипких осадових відкладах палеогену. Крім екзогенно-епігенетичних родовищ урану, підземним способом вилуговування можна розробляти й родовища пісковикового типу.

Ключові слова: підземний ландшафт, підземні гірничопромислові порожнини, шахтний тип підземних промислових ландшафтів, нешахтний (свердловинний) тип підземних промислових ландшафтів, підземне вилуговування, родовище уранових руд, шахтний ствол, тунель, свердловина, добувні камера-блок, шахта-квершлаг.

Рассмотрены основные типы подземных промышленных ландшафтов, которые сформировались в регионе добычи урановых руд - шахтный и скважинный. В структуре шахтного типа подземных промышленных ландшафтов выделен один тип местности – подземные горнопромышленные полости с принадлежащими им типами урочищ. Указано, что этот тип местности доминирует на всех месторождениях урановых руд, где разработки ведут подземным способом (например Ингульская шахта). Тип местности «подземные горнопромышленные полости», в зависимости от разновидности породы, которая содержит уран, делится на варианты: гранитный, железорудный, песчаниковый и т.д. Определено, что в Украине преобладает гранитный вариант типа местности «подземные горнопромышленные полости». В его структуре преобладают следующие типы подземных горнопромышленных урочищ: шахтные стволы, тоннели, добывающие камеры-блоки, шахты-квершлаги, выработки, штольни, гезенки, горизонты, которые пронизывают и оконтуривают гранитные породы. Рассмотрены железорудный вариант типа местности «подземные горнопромышленные полости», который, как и песчаниковый, развивался на начальных этапах формирования промышленных ландшафтов уранодобывающего региона Украины. Отмечено, что скважинный тип подземных промышленных ландшафтов, формируется на месторождениях, где возможна добыча урана способом подземного выщелачивания. Таким способом в Украине отработано два месторождения урановых руд - Девладовское и Братское в Днепропетровской и Николаевской областях соответственно. Определено, что месторождения, пригодные для добычи урана способом подземного выщелачивания, относятся к типу гидрогенных. Они локализированы в водопроницаемых сыпучих осадочных отложениях палеогена. Кроме экзогенно-эпигенетических месторождений урана, подземным способом выщелачивания можно разрабатывать и месторождения песчаникового типа.

Ключевые слова: подземный ландшафт, подземные горнопромышленные полости, шахтный тип подземных промышленных ландшафтов, нешахтний (скважинный) тип подземных промышленных ландшафтов, подземное

выщелачивание, месторождение урановых руд, шахтный ствол, тоннель, скважина, добывающая камера-блок, шахта-квершлаг.

Problem presence. During the centuries of active and versatile operation the human being rebuilt not only a significant portion of terrestrial landscapes, but also intervened in the upper part of the lithosphere, which led to the formation of peculiar and still poorly studied underground man-made landscapes, some of which are on the stage of landscape engineering systems. Special attention should be drawn to the underground industrial landscape, in particular those formed in the uranium mining region in Ukraine.

Analysis of former studies. In the twentieth century the rapid development of industry and its significant impact on the environment has led to a fundamental restructuring not only of small plots of land, but also individual regions of the landscape sphere of the Earth. In the mid-twentieth century the role and meaning of industry in restructuring of landscapes caught attention of the scientists in Ukraine, and in particular geomorphologists and geologists. V.G. Bondarchuk, as mentioned above, even suggested and introduced to the literature the term "mining industrial landscape", although still in "landscape" sense [1].

Landscape research on industrial, especially mining industrial, regions and individual exploitation of mineral resources in Ukraine began only in the middle of 70th after the book of F.M. Mil'kov "Man and landscapes" [12] was published. Y.I. Glushchenko was first in Ukraine to get interested in studying anthropogenic and mining industrial landscapes, particularly in the southern Ukraine. He was working on the typology of anthropogenic and natural complexes of Kerch Peninsula, describing mining exploitation.

The question of human integration and differentiation of the Crimean landscapes was considered by G.E. Grishankova [4], but she paid little attention to industrial landscapes. Certainly, the impulse for active research of industrial, especially mining landscapes in Ukraine were theoretical and methodological development of anthropogenic landscape by Voronezh geographers – F.M. Mil'kov, V.I. Fedotov, V.N. Dvurechenski, etc., and scientists landscapers from Moscow landscape school.

In the late 70's - early 80s the study of anthropogenic landscapes of Bukovina and Podillia was founded by a group of physics − geographers of Chernivtsi University. Their program contained the theory of anthropogenic landscape (L.I. Voropay), the study of man-made (G.I. Denysyk), settler (M.M. Kunytsia) and other landscapes. Furthermore, the studies of anthropogenic, including industrial landscapes of the Right-Bank Ukraine, were continued by G.I. Denysyk [5]. His researches were also based on the area of our study region, but only in the theoretical and methodological aspects.

Landscape complexes of the region of the uranium developments are not mentioned in works of G.I. Denysyk. Overall, the study of industrial landscapes, including mining, in 70s-90s was conducted mainly within the forest and steppe region, and only at the end of the XX − beginning of XXI century similar studies were conducted in Right-Bank Ukraine steppe.

These studies concerned mostly Kryvbas − region of development of iron ore and partially other minerals. Among the works related to the study of industrial landscapes, works of L.M. Bulava [2] and J.G. Tiutiunnyk are worthy of mentioning. We can see that in their works for the first time the industrial landscapes of Kryvbas were described based on the field research, classification schemes were proposed, their geochemical properties were partly explored and the maps were composed. Henceforward their studies carried on by many other scientists, in particular V.L. Kazakov worked on theoretical problems of anthropogenic landscape, put a classification of man-made, especially mining landscapes, into practice, proposed mechanism of its rational use and development through the landscapes of industrial tourism [8]; I.A. Ostapchuk described the ecological risk in the area of Kryvyi Rih natural and economic region. S.V. Yarkov explored syngenesis of the plant communities in landscaped areas of technogenesis taking Kryvbas as an example. G.N Zadorozhna first explored in details the derivative processes and phenomena in the mining landscapes of the same region.

The studies, similar in content to landscape topics, on the level of facies and tracts were also carried out by industry experts, including geologists (I.S. Paranko (1988-2009); I.M. Malakhov (2003-2007.)), biologists and soil scientists (O.M. Smetana and N.M. Smetana (2005-2009) geobotanists (I.A. Dobrovolsky (1979-2000) Y.V. Malenko (1996, 2005)), etc., as well as staff of Botanical Garden of The National Academy of Sciences of Ukraine in Dnepropetrovsk.

Scholars from other scientific and educational institutions partially studied mining industrial landscapes of Industrial Dnipro. One of the first scholars interested in industrial, especially mining, landscapes, was assistant professor (now professor) at the Department of Physical Geography of the University of Voronezh (Russia), representative of Milkov school, V.I. Fedotov. For the purpose of recultivation he studied and mapped tailings ponds in the worked out Oleksandrivka pit of Ordzhonikidze mining and processing plant [15].

There were also other attempts to study strictly industrial and mining landscapes of the region under investigation, but almost all of them were related to industrial landscapes in the formation of which (especially mining landscapes) there were no toxic and radioactive substances.

Mining of uranium ore in Kirovograd region began in the late 40s of XX century. Since then more than two dozen uranium deposits were open, some of which are already exhausted; a series of radioactive tailings ponds were created and they actively interact with the surrounding landscapes, but complex landscape studies of these unique landscapes were not yet conducted.

The aim of investigation - to consider and explore the underground industrial landscape complexes in the region uranium mining.

The results of the investigation. Diverse underground landscape complexes, their size and the number have not yet been counted. Among the underground landscapes clearly distinguishes communication (multiple communication under the cities, industrial facilities, underground sewage channels, etc.); road (tunnels, subways, underground passages etc.); military (storage, missile systems, factories, barracks, command posts) sacral (monasteries, churches, caves); industrial (tunnels, mines, pits, drifts, etc.); water (underground irrigation canals, ponds and reservoirs, wells, etc.). Such diversity allows to reveal the underground version op anthropogenic landscapes.

In Ukraine uranium ore is mined mainly by underground excavation. This leads to the formation of a complex system of underground excavation, all of which results in the formation of a specific, often original, landscape. Certainly, there may be doubts about the rightfulness of the name - underground landscape. However, given the diversity of industrial landscapes, their number and area, as well as their importance in the life of the population, the doubts will disappear. Let's examine this in more details by taking as an example some deposits of uranium ore.

On the basis of Vatutinsky deposit of uranium, in 1972 "Smolinska" mine was established. Uranium mining was started there in 1976. The projected capacity is 800 thousand tons of ore per year. Industrial site of Smolinska mining complex is located 4 km away from the village Smoline of Malovyskivskyi district in Kirovograd region.

Vatutinsky deposit is represented by lenticular deposits of highly complex contours. In the field 17 large ore deposits are explored in detail. Dimensions of individual deposit vary widely: the strike - 50-690 m, the fall - 35-180 m. The total length of the mineralization is 950 m of strike, and up to 850 m of fall. The main rock-forming mineral of all kinds of albitites is albite, which in average contains 60-80% of host rocks. Uranium ore deposits of Vatutine are characterized by poor and ordinary CaO content, that is only 1-3% [14]. The structure of the deposit consists of three zones - Eastern, Central and North-West, each of which represents a series of ore bodies.

The deposit is open by three vertical round shafts: paired "main" and "Subsidiary" till the horizon of 460 m in the southern, and "ventilating" till the horizon of 280 m on the northern flank. The lower part of deposit (between horizons of 460 m and 640 m) is open by two blind shafts "blind-1", which stretches from horizon 280 m to horizon 640 m, and "Blind 2" - from horizon 460 m to horizon 640 m. Stocks below the horizon 640 m are not disclosed.

Delivery of the rock mass on the surface is conducted by two shafts "Main" and "Subsidiary". Lifting capacity of these shafts is 800 thousand tons of rock mass per year. The main excavation of ore is conducted in the level 550-460 and 100-70 meters.

Production of ore reserves occurs by using surface-chamber system of development, followed by filling the excavated space with hardening mixture. As a result a complex system of partially filled cavities is formed. This system is constantly improved and modernized [14].

The volume of accumulated solid waste from mining amounted to 330 thousand tons at the end of 2012.

Novokostiantynivka deposit of uranium is the biggest, giant (the area of deposit is approximately 1,5x1,5 km), it was open in 1975, and in 1984 the construction of the mine complex started. "Novokonstantinovska" mine is located in the village Oleksiivka in Malovyskivskyi district of Kirovograd region. In 2011, for the first time since the opening of the regular deposits continuous excavation of uranium ore began. The design capacity of the mine complex is 250 thousand tons per year. Uranium ore reserves at the mine ensure mining project for more than 40 years.

We can differentiate three ore zones that are similar in its reserves on the field. Ore zones contain 178 ore bodies consisting of spatially separated ore deposits and differ in size, morphology, quality of ores and other parameters [14].

The field is opened by three shafts: "main" that traverses the horizon at 680 m, "the intelligence and operational" (RE-6) - up to horizon at 1086 m and "ventilation" − up to the horizon at 680 m. Mineralization can be traced to the depth of about 1200 m. The total length of mineralization along the strike is 1.5 kilometers, and the fall is 1.2 km. In ores they found 9 uranium and 5 uranium-containing minerals, the most important of which are: oxides - uraninite, pitchblende, uranium hydroxide constituting in total 74% of metal mineralization, silicates of uranium - coffinite, uranophan, boltwoodite, betauranotil 21% and titanates - 5% of brannerite .

Development takes place in the form of surface-chamber system. Height of the floors planned for working is 90 m, height semi-floors - 30-40 m. Sewage treatment works are on the horizon of 240-300 m, mountain - on the horizon 300 m.

Ore albitites and granites that contain them are solid, so the excavation is held without roofing. Their strength is 160-180 MPa. Ore-containing zones 1, 2 and 3 are located in the north-western part, near the intersection of the fracture and in the eastern part of the deposit, stocks of which are 38, 25.6 and 36.4% of balanced reserves, respectively.

Now ores are excavated in horizontal layers, which allows extracting small isolated layers on the horizons above to reduce payback periods of construction, mining and capital works.

By the plan of the mine construction a gradual increase of volumes of ore mining from 30 thousand tons in 2009 to 75 thousand tons in 2011 was foreseen, and from 2012 it would make 250, 500, ..., 2457 thousand tons per year. As a result, the length of underground cavities would increase by 12-20 km each year.

Today the main production direction of Novokostyantynivska pit is building an underground and ground production facilities. Rock mass formed during the construction of the underground complex, is taken to the surface and sorted. Extracted along with construction of the mine uranium ore is transported by auto transport to the ore storehouse of Ingulsk pit for loading into the freight railcars for further processing at the hydrometallurgical plant in the town of Zhovti Vody [14].

The structure of mining type of underground industrial landscapes singles out one type of terrain − underground mining cavity with appropriate types of tracts [6, 7].

The type of terrain of underground mining cavity is dominating in all the fields of uranium ore, where the excavation is done with underground mining method. Ingulsk mine could serve as an example. Underground industrial mining cavities are represented by the variety of tunnels, shafts, drifts, excavation, blocks tunnels, crosscut, mining chambers, horizons, that are penetrating and outlining the granite rocks, which contain uranium.

Overall Ingulsk mine at a depth from 160 to 650 meters - is an underground city that is developing two uranium deposits - Michurinske and Central. In 2011 and 2012 they extracted such an amount of ore, from which they could obtain 370 tons of uranium concentrate. The total length of underground cavities of Ingulsk mine exceeds 120 km. The cavities extend not only within the mine location, but also penetrate under the city of Kirovograd and river Ingul. Industrial mining cavities are multi-storied, their height sometimes reaches 20 meters or more (generally 5-15 m), diameter is from 5-8 to 20 - 32m, a form is different - round, square, sometimes cavities of arbitrary shape [10].

After finishing the extraction of the uranium ore, in the abandoned cavities we can observe the processes of self-development, in particular they are filled with fissure waters, radioactive gases, we can also notice that some sinter forms appear, active processes of crumbling are activating, etc.

F.V. Kotlov notes that in the field of underground mining the underground weathering is actively developing, the speed of which is slower than on the surface, but leads to the formation of fractures, delamination, crumbling, shifting of the rock [9].

Experimental and scientific exploration of the cavities uranium developments are extremely dangerous not only because of the unfavorable factors mentioned above, but also because of high rates of radioactivity.

Depending on the kind of mining rocks, that contains uranium, the type of terrain "underground industrial mining cavity" should be divided into variants: granite, iron ore, sandstone, etc. In Ukraine, the granite variant of "underground industrial mining cavity" is dominating. Its structure is dominated by such types of underground mining tracts as shafts, tunnels, mining chamber blocks, mines-crosscuts:

- Shaft is the integral part of any mine. This vertically arranged cavities in rocks, that represent the geological section in the area of uranium ore mining. Mostly its diameter is from 2-3 to 5-6 meters, the depth of the mines of uranium production reaches 1000-1200 m, but the depths of 300-650 m is more common. The walls of the shafts are reinforced with metal and concrete, a special equipment that serves the workers of the mine is concentrated here. Some mines have from 2-3 to 8 shafts. Its peculiar type is a well that is formed in the process of exploration of uranium ore. Their diameter is not significant - 10-30 cm, sometimes more, but depth may reach 2-3 and more kilometers. Only at Novokostiantynivka deposit we can count around 1500 wells drilled on the area 1,5x1,5 km. Another type of shafts are also transitional wells - vertical stepped passages for transporting the ore;

- Tunnels. Tunnels are built to service the mine. They are at the necessary distance from the adits. Mostly the tunnels are laid at the angle to the surface of the ground so that they could carry uranium ore out from the mine. For the service of a remote from the main deposits of uranium Michurinsky deposit - the underground tunnel of nearly 6 km was laid, and it runs under the river Ingul and concentrates there a portion of its water. Every hour up to 500 m3 of water gets into the tunnel. This water is pumped out to the surface, purified from the uranium and other elements and then released into the river system. The tunnels are damp, this the reason why radon more actively influences the population [10];

- Mining chamber blocks. Underground tracts - are "blocks" that are formed as a result of the fact that the uranium ore in the soil is often concentrated in the so-called lens. The size of lens can vary and can reach a diameter of 160 meters or more and length of several hundred meters. Michurinske and Central deposits of Ingulsk mine differ by the complex conditions of occurrence - ore lies by the great size lenses. In the process of ore extraction it is necessary to cut so-called blocks in an average of 50-70 thousand tons. The blocks are gradually blasted and taken for processing, and voids that remain after them, are often filled with waste rock. [11]

In Novokonstantinovska mine two blocks are under exploitation. Introduced in 2011, the block 321-4, with ore reserves of about 70 thousand tons, is located at 240-300 m depth. For its development about 600 meters of mine workings had to be surmounted and 16 thousand meters of exploitation wells to be drilled. The next step is to create two other blocks [6]. Together with wells, tunnels and mines the blocks shape the complex underground systems;

--Mine crosscut. These underground tracts are represented by horizontal excavations, sometimes with a small (3-5°) slope. They form an underground labyrinth of uranium ore deposits that are developed using mining method. The working conditions of workers depend on its conditions and technical equipment. In the mines of uranium ore deposits the background radiation of voids is of particular importance. For workers and professionals who deal directly with ore a permissible exposure dose reaches 1,200 mR / hr. [13]. Specific types of tracts of the crosscut-mines, that the miners mostly lay from the trunk to a layer, are the *drifts* - horizontal passages along the ore deposit. They are laid mainly for exploration of ore bodies, in order to better study them for the future sustainable development.

Iron ore variant of the locality type "underground industrial mining cavity" as well as sandstone one, rapidly developed in the early stages of the formation of industrial landscapes in the uranium mining region of Ukraine. Its remains are now preserved in the fields of Kryvyi Rih and Zhovti Vody. Mostly cavities are covered with waste rock or sand, and those that remained - are blocked or bricked. Sometimes on the walls of the abandoned iron ore pit mines in the town Zhovti Vody we can trace cavities of the underground mining landscapes.

Non-mining (downhole) type of underground industrial landscapes is formed only in the fields where the uranium ore mining is possible only in the most progressive way - method of underground leaching. Due to the fact that this way is new, non-mining type of underground industrial landscape has not received more recognition. At the time being underground leaching method worked only in two deposits of uranium ore - Devladivske and Bratske in Dnipropetrovsk and Mykolaiv regions respectively. But the prospects are considerable. Within the right bank of the Dnieper brown coal basin there are open explored and preliminary estimated over ten deposits and individual deposits of uranium, suitable for underground leaching. Among them, five - Sadove, Safonivske, Novohurivske, Surske and Chervonoyarske are already prepared for development.

All deposits suitable for uranium mining using underground leaching method, are of the hydrogenous type. They are located in water-permeable crumbly sedimentary deposits of Paleogene, that are filling the erosion-tectonic depression in the Precambrian crystalline basement (Fig. 1).

Fig. 1. Location of hydrogenous uranium deposits in the western part of the Dnipro basin, the middle Eocene [3]

1 - marine sediments; 2 - watershed eluvial and deluvial deposits; 3 - watershed lake-marsh deposits; 4 - river sediments of palaeovalleys; 5 - coastal river sediments of the lower tyde of palaeovalleys with significant coal concentration; 6 - streams; 7 - deposits of uranium; 8 - ore occurrences; 9 - points of mineralization. Deposits and ore occurrences: 1 - Sadove 2 - Bratske, 3 - Safonivske 4 - Khrystoforivske, 5 - Devladivske 6 - Novohurivske 7 - Khutirske, 8. Syrske.

These wells cover the field in rows. In one series of wells a weak solution of sulfuric acid is pumped, which reaches uranium in crumbly rocks, and from the other wells, after a certain period of time - miners pump uranium-saturated solution on the surface and collect it in the closed basins through the pipes. After the "wet" mine working of deposits, there remains an underground system of radioactive bores and cavities formed by subsidence and compaction of loose rocks during the leaching of uranium. On the surface there is a network of radioactive belts (up to 20-50 mR / h), with width of 0.5-1.0 m, that formed from the pipes that transported sulfuric solution of uranium, and industrial facilities where it was collected for further processing, as well as access to the roads.

The presence of uranium in the water-permeable crumbly sedimentary deposits allowed to use the original method of underground mining, the essence of which is that the bored are drilled every 20-25 m , depth of which depends on the depth occurrence of uranium.

The underground leaching method can be used to develop not only exogenous-epigenetic uranium deposits, but also sandstone-type deposits, although they are small and medium-sized with reserves of uranium 1-3 thousand tons.

At the moment in the Central and Eastern parts of the Dnipro brown coal basin 12 areas with the perspective deposits and occurrences of uranium are defined. In each of these areas 1-3 uranium deposits can be open. Furthermore, in the northwest part of the Dnipro brown coal basin there is also a possibility of the opening of 5 to 7 new uranium deposits.

Conclusion. Extraction of uranium ore using mainly underground mining led to the formation of a complex system of underground workings, causing the creation of a peculiar underground industrial landscape.

REFERENCES

1. Bondarchuk V.G. Osnovy geomorfology / V.G. Bondarchuk. – M.: Uchpedgiz, 1949. – S.292-294.

2. Bulava L.N. Landchaftnyj analiz narychenux zemel v cheljax ix rekyltivachyy (na primere Krivorigskogo gornopromychlenogo rayona) avtoref. dis.na zdobyttja nayk.stypenja kand.geogr.nayk speech.11.00.01 Fizicheskaja geografija, geofizika i geoximija landchaftov / L.N. Bylava. – K., 1989/ – 16 s.

3. Gyrskij D. Pro ekonomichny dochilnist zalychennja investichij v rozvidky ta osvoennja yranovux rodovisch Ykrajnu [Elektronnuj resyrs] / Gyrskij D., Metalidi B., Chornokyr I. – Regim dostypy : http://www.-geoproject.com.ua/ en/publ010.html

4. Grishankov G.E Anthropogennaja integrachija i differentchiatchja landchaftiv v yslovijax Kruma / G.E Grishankov // Voprosu geografii. – M., 1977. – № 106. - S. 138 – 145.

5. Denisik G.I. Antropogenni landchaftu Pravoberezhnoï Ukrainu: monografiya / G. I. Denisik. – Vinnitsa: Arbat, 1998. – 292 s.

6. Dergavne pidpriemstvo "Shidny girnicho-zbagachuvalny kombinat" [Eelectronnyj resource]. – Regim dostypy: rudana.in.ua/wostgok_ua.htm

7. Dopovid pro stan, yadernoï radiatsiynoï bezpeki v Ukraïni y 2010 rochi [Electronnyj resyrs]. – K., 2011. – 104 s. – Regim dostypy : http: //www.-/snrc.gov.ua/nuclear/doccatalog/document? id = 174133

8. Kazakov V.L. Antropogenni landchaftu Krivbasy / V.L. Kazakov // Problemu landchaftnogo riznomanittya Ukrainu: zb. nayk. prac’. – K., Karbon Ltd, 2000. – S. 108 – 112.

9. Kotlov F.V. Izmenenija geologicheskoj sredu gorodov pod vlijaniem

dejatelnosti cheloveka / F.V. Kotlov. – M., 1978. – 273 s.
10. Koshchenko O. Na uranovomy gorizonti / Olena Koshchenko / Silski visti. – № 138 (18728)/ – 2 gryd. 2011 r.
11. Maskalevich I. Uran po-ukraïnski [Electronnyj resyrs] / Igor Maskalevich // Dzerkalo tyznja. – 2010. - № 29. – 14 serpnya. – Regim dostypy do gazetu : http://dt.ua/economics/uran_po-ukrayinski-60830.html
Milkov F.N. Chelovek I landchaftu. Ocherki antropogennogo landchaftovedenia / F.N. Milkov. – M., Musl', 1973. – 224 s.
Урановые предприятия Украины [Електронний ресурс]. – Режим доступу : http://rudana.in.ua/uran_predpr.htm
Normu radiachijnoi bezpeku Ukrainu (NRDU-97) [Electronnyj resyrs]. – K., 1997. – 121 s. – Regim dostypy : http://document.ua/normiradiaci-inoyi-bezpeki-ukrayini-nrbu-97-nor5265.html
Uranovue predprijatija Ukrainu [Electronnyj resyrs]. – Regim dostypy : http://rudana.in.ua/uran_predpr.htm

Література

1. Бондарчук В. Г. Основы геоморфологии / В. Г. Бондарчук. – М. : Учпедгиз, 1949. – С. 292–294.
2. Булава Л. Н. Ландшафтный анализ нарушенных земель в целях их рекультивации (на примере Криворожского горнопромышленного района) : автореф. дис. на здобуття наук. ступеня канд. геогр. наук : спец. 11.00.01 «Физическая география, геофизика и геохимия ландшафтов» / Л. Н. Булава. – К., 1989. – 16 с.
3. Гурський Д. Про економічну доцільність залучення інвестицій в розвідку та освоєння уранових родовищ України [Електронний ресурс] / Гурський Д., Металіді В., Чорнокур І. – Режим доступу : http://www.-geo project.com.ua/en/publ010.html
4. Гришанков Г. Е. Антропогенная интеграция и дифференциация ландшафтов в условиях Крыма / Г. Е. Гришанков // Вопросы географии. – М., 1977. – № 106. – С. 138 – 145.
5. Денисик Г. І. Антропогенні ландшафти Правобережної України : монографія / Г. І. Денисик. – Вінниця : Арбат, 1998. – 292 с.
6. Державне підприємство «Східний гірничо-збагачувальний ком-бінат» [Електронний ресурс]. – Режим доступу : rudana.in.ua/wostgok_ua.htm
7. Доповідь про стан ядерної та радіаційної безпеки в Україні у 2010 році [Електронний ресурс]. – К., 2011. – 104 с. – Режим доступу : http://www.-/snrc.gov.ua/nuclear/doccatalog/document?id=174133
8. Казаков В. Л. Антропогенні ландшафти Кривбасу / В. Л. Казаков // Проблеми ландшафтного різноманіття України : зб. наук. праць. – К. : Карбон Лтд, 2000. – С. 108–112.
9. Котлов Ф. В. Изменения геологической среды городов под влиянием деятельности человека / Ф. В. Котлов – М. : Недра, 1978. – 263 с.
10. Кощенко О. На урановому горизонті / Олена Кощенко // Сільські вісті. – № 138 (18728). – 2 груд. 2011 р.
11. Маскалевич І. Уран по-українськи [Електронний ресурс] / Ігор Маскалевич // Дзеркало тижня. – 2010. – № 29. – 14 серпня. – Режим доступу до газети : http://dt.ua/economics/uran_po-ukrayinski-60830.html
12. Мильков Ф. Н. Человек и ландшафты. Очерки антропогенного ландшафтоведения / Ф. Н. Мильков. – М.: Мысль, 1973. – 224 с.
13. Норми радіаційної безпеки України (НРБУ–97) [Електронний ресурс]. – К., 1997. – 121с. – Режим доступу : http://document.ua/normiradiaci-inoyi-bezpeki-ukrayini-nrbu-97-nor5265.html
14. Урановые предприятия Украины [Електронний ресурс]. – Режим доступу : http://rudana.in.ua/uran_predpr.htm
15. Федотов В. И. Техногенные ландшафты: теория, региональные структуры, практика / В. И. Федотов. – Воронеж : Изд-во ВГУ, 1985. – 192 с.