

UDC: 911.3

DOI: <https://doi.org/10.26565/1992-4224-2022-37-03>

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HISTORY OF THE FORMATION OF KRYVYI RIH LANDSCAPE TECHNICAL SYSTEM

Purpose: to investigate the history of the formation of Kryvyi Rih landscape technical system, to highlight and justify three stages of development that were formed as a result of the mining industry in the territory of Kryvyi Rih landscape technical system.

Methods: historical analysis, cartographic, method of anthropogenic landscape forecast.

Results: During the study of the history of the formation of Kryvyi Rih landscape and technical system, three stages of the development of the system were identified and analyzed: artisanal development and development of natural resources (5th century BC – 17th century), where mostly the descriptions and development of individual geocomponents prevailed, that were of direct importance in people's lives. The first genesis of the formation of Kryvyi Rih landscape technical system began near the riverbeds of the Saksagan and Ingulets rivers, where iron ore deposits extend; research of natural resources for the purposes of their initial industrial development (18th - first half of the 20th century), which made it possible to form an industrial base and start intensive extraction of minerals; (the second half of the 20th century – the beginning of the 21st century) – the development of one of the largest landscape systems not only in Ukraine, but also in the world. In just 150 years, a new, complex and dynamic landscape structure was formed within the borders of Kryvorizhzhia, with a clear advantage of industrial, mostly mining landscapes, which, together with residential landscapes, form the modern landscape background of Kryvorizhzhia. Schemes and maps have been developed that reflect the development of Kryvyi Rih landscape and technical system.

Conclusions: Kryvyi Rih landscape technical system began its formation in the 4th century BC, but the most active and dynamic development of the mining industry took place only 150 years ago. In such a short period of time, a new, complex and dynamic landscape structure was formed on the territory of Kryvorizhzhia, with a clear advantage of industrial, mostly mining landscapes, which together with residential landscapes form the modern landscape background of Kryvyi Rih landscape technical system.

KEY WORDS: iron ore basin, mining industry, development, stages

Як цитувати: Коптієва Т. С. History of the formation of Kryvyi Rih landscape technical system. *Людина та довкілля. Проблеми неоекології*. 2022. Вип. 37. С. 37-46. DOI: <https://doi.org/10.26565/1992-4224-2022-37-03>

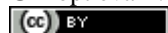
In cites: Коптієва Т. С. (2022). History of the formation of Kryvyi Rih landscape technical system. *Man and Environment. Issues of Neoecology*, (37), 37-46. <https://doi.org/10.26565/1992-4224-2022-37-03>

Introduction

The mining industry has the ability to completely change the landscape structure of any territory, Kryvyi Rih is no exception. For 150 years on the city territory of Kryvyi Rih landscape technical system (KLTS) is being developed [1]. The basis of its development is Kryvyi Rih iron ore basin. Iron ore reserves,

which amount to more than 18 billion tons in the basin, led to the appearance of a powerful mining industry. In such a short period of time, the mining industry has completely transformed natural landscapes into anthropogenic ones. A small number of scientific studies are dedicated to the formation of Kryvyi Rih landscape tech-

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nical system. Among them there are studies of Bulava L.M. [2], Denysyk G.I. [3,4,5], H.M. Zadorozhnia. [3,6], Kazakov V.L. [4,7,8], Koptieva T.S. [9,11,12,13,14,15], Palienko V.P. [16], Paranko I.S. [17], Petrun V.F. [10], Yarkova S.V. [4].

Today, the landscape structure of Kryvyi Rih landscape technical system is represented by various anthropogenic landscapes, among

which the most common are agricultural, residential and industrial. And that is why an urgent question arises in the detailed study of the formation of Kryvyi Rih landscape technical system. What factors contributed to the fact that for such a short period of time, industrial landscapes prevail in the territory of Kryvyi Rih landscape technical system, mainly represented by their mining subclass.

Object and methods of research

The object of research is Kryvyi Rih landscape technical system. The subject of research is the history of formation. In the analysis of the history of the formation of Kryvyi Rih landscape technical system, the historical method was applied, which was used

to characterize the formation and development of this system, the cartographic method, which was used to analyze cartographic materials, the method of anthropogenic landscape forecasting allowed to predict future changes in Kryvyi Rih landscape technical system.

Results and discussion

Kryvyi Rih landscape technical system was formed quite unstable, and due to this, three stages can be distinguished: artisanal development, initial industrial development, active industrial development (Fig. 1).

The origin and formation of KLTS begins with **artisanal development and development of natural resources** (4th century BC – 17th century). Favorable natural conditions, in particular the climate of the post-glacial period, contributed to the active settlement of the territory of Right Bank Ukraine by primitive people (40-35 thousand years ago – 4th century BC) [2].

In the Neolithic and Eneolithic eras, fine-grained quartzite was mined on the territory of the KLTS, which was used as a substitute for flint. There are also known finds of limestone steles with the remains of ritual drawings, which were applied with ocher and marmot [3].

According to the chronological sequence, the stage of development of handicrafts is highlighted in Fig. 2.

Until the 4th century B.C. on the territory of KLTS, based on the work of V.F. Petrun [10], there was already a mining business, it was the Bronze Age that required people to look for deposits of stone raw materials that will be

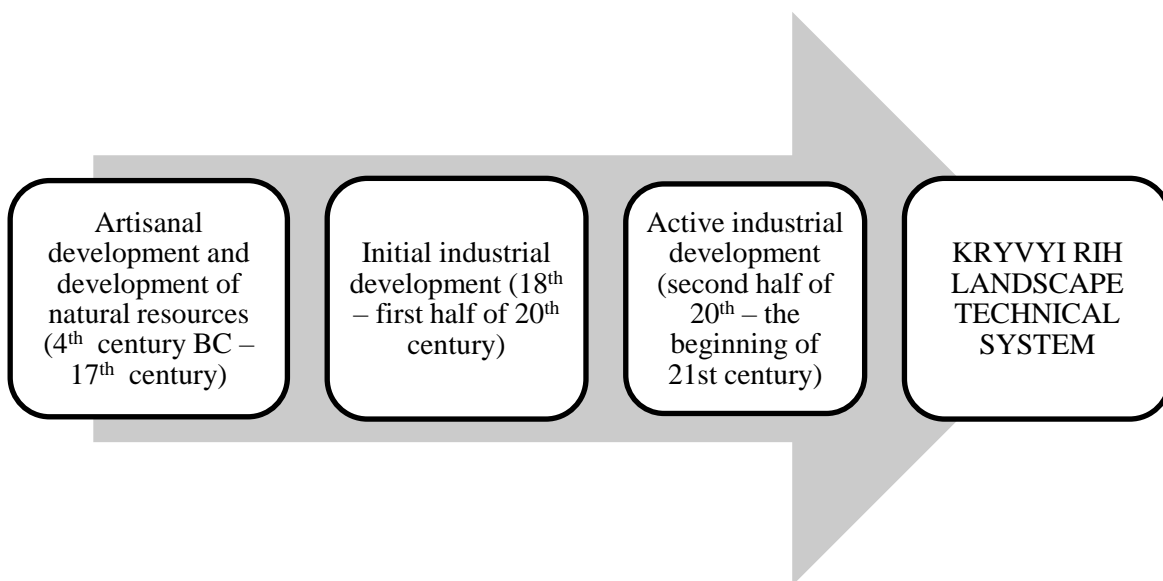


Fig 1 – History of the development of Kryvyi Rih landscape technical system (KLTS)

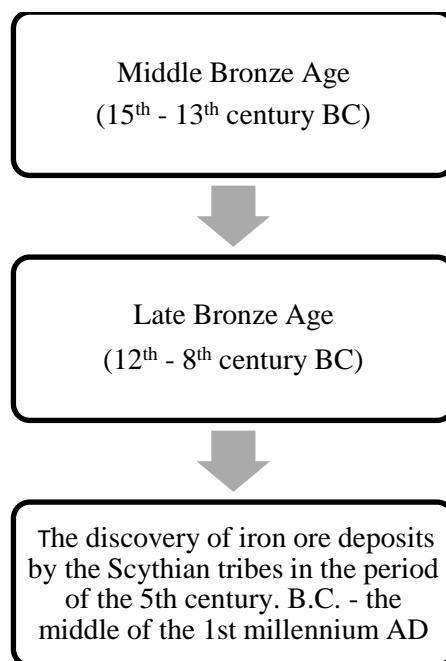


Fig 2 – The first development of deposits of stone raw materials and iron ore on the territory of KLTS

used in the manufacture of tools, weapons and household items. V.F. Petrun noted that the tribe of the catacomb culture in the Middle Bronze Age (15th -13th centuries BC) mined porphyry diabase for the manufacture of axes and hammers. Deposits of metabasite deposits, limestones, aplite-like granites, migmatites, and plagiogranites were also developed and used only for local use. And the tribes of the Sabatin and Belozher cultures in the Late Bronze Age (12th – 8th centuries BC) mined talc shale for foundry production.

The researchers came to the conclusion that already during the time of the catacomb culture, mining was operating on the territory of KLTS, this is evidenced by the fact that in the 1960s of the 20th century, on the right bank of the Saksagan River, the remains of a Bronze Age workshop were found, where pestles were made from amphibolite fragments, round stones for work (Fig. 3).

The next stage of development, which in the future will completely change the landscape structure of KLTS territory, is the discovery of iron ore deposits by the Scythian tribes in the period of the 5th century B.C. – the middle of the 1st millennium AD this stage was quite well described by Greek and Roman scientists, as well as by Herodotus [4]. The Scythian tribes

smelted iron and made weapons, as evidenced by the finds found in Dubova Balka and Pivdennaya Chervonaya Balka (Fig. 3). Thus, mining landscapes continue to form on the territory of Kryvorizhzhia [12].

In the 9th century BC the territory of the KLTS was the Wild Steppe, where mainly Turkic nomadic tribes roamed. There are no data on the use of KLTS iron ores. After the Tatar-Mongol invasion, the southern steppe part of Ukraine was occupied by nomads who were mainly engaged in cattle breeding and agriculture [5].

In the 18th century – the first half of the 20th century the stage of **the initial industrial development** of iron ores on the territory of KLTS begins.

Currently, the appearance and development of capitalist relations in Western Europe at the time required new territories for economic development and sales markets. Therefore, the Right Bank Ukraine, rich in natural resources, attracted the interest of Western Europeans, as they began a detailed study of the specified territory.

The first attempts to discover iron ores in Kryvyi Rih iron ore basin took place in the 80s of the 18th century by V.F. Zuiev, but intensive development did not take place [9].

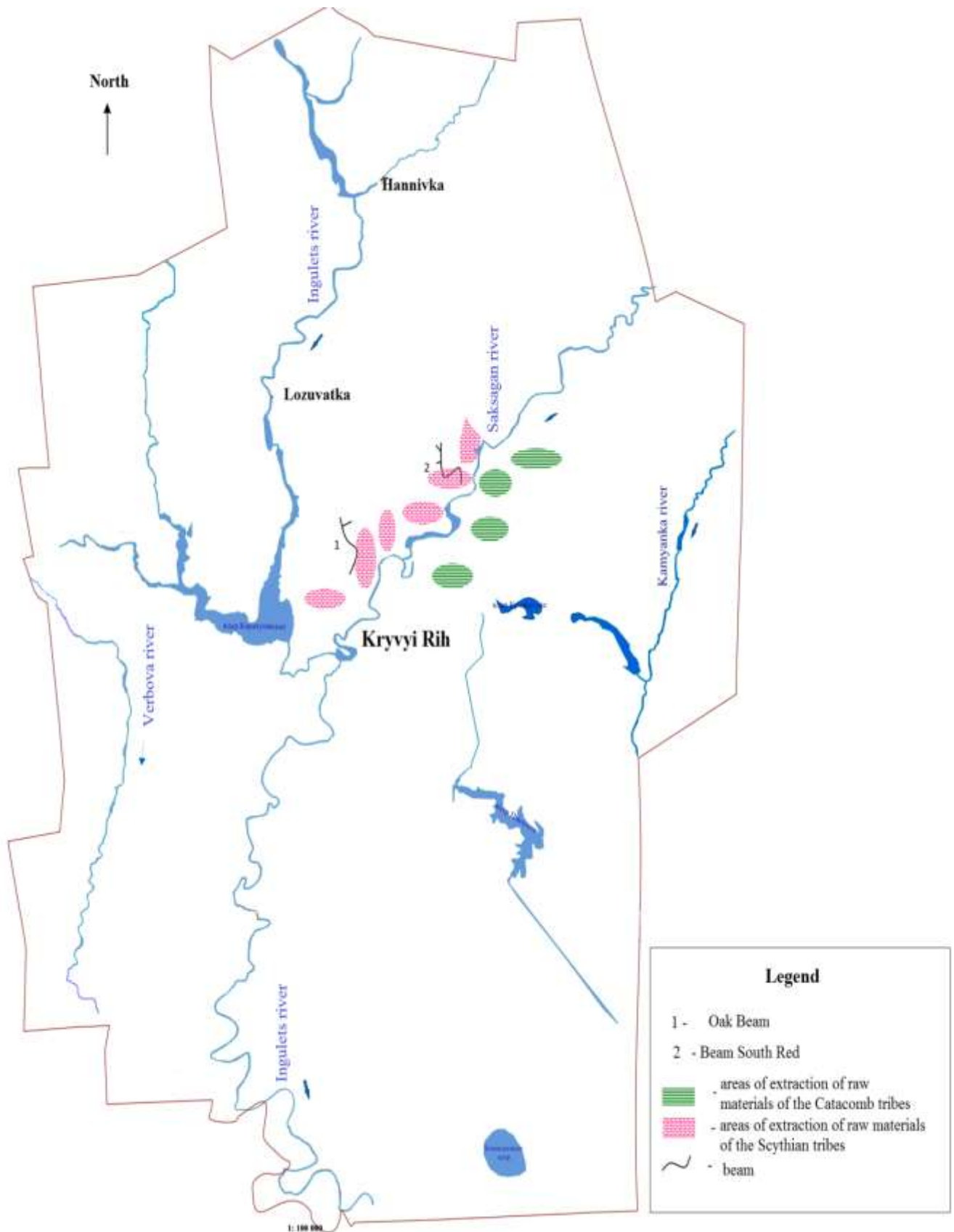


Fig. 3 – Areas of the first extraction of raw material deposits of catacomb and Scythian tribes

The active stage of iron ore development on the territory of the Kryvyi Rih landscape technical system began in 1881. O.M. Paul started the industrial development of iron ore deposits in the Saksagan ore field [14].

Since the end of the 18th century, scientific research aimed at the exploration of iron ores has been conducted in the region. According to the results of research by P.I. Kulshyn (1825-1839), M.P. Barbot-de-Marny (1866-1867), Strieppelman (1872), S. Hartung (1872-1873), G.D. Fedoseev (1874), L. Semyechkina (1874), S.O. Kontkevich (1878 – 1887), V.A. Domger (1875), P.P. Pyatnytskyi (1881), the powerful industrial development of the KLTS begins. The first areas of mineral development were confined to the iron ore

layers of the Saksagan ore field, mainly to the slopes of the streams and in the river valley [6].

The open method of developing useful raw materials with a slight thickness of overburden rocks – up to 9 m – prevailed. The dumps were low, but wide, with a slope angle of 6 - 8°. The depth of the quarries did not exceed 40 m. However, after the purchase of 21 thousand hectares of land for mines in 1895-1897, their number increased significantly [11].

During the late 19th – early 20th century at the first mines of KLTS, open mining of the upper horizons of rich ore – 55% and more iron content was carried out. The manual labor of workers with typical tools was used: picks, sledgehammers, picking shovels, handcarts (Fig. 4).



Fig. 4 - Kryvyi Rih miners at the beginning of the 20th century and mining tools [1].

Horsepower was often used to lift and transport ore from the mines, in particular, horse-drawn drum lifts were very common. The ore was shipped to wagons, which went to the stations of the Yekaterynynska main railway on rolling railways (Fig. 5).

The development of iron ore deposits led to the emergence of working villages consisting of barracks for workers and primitive infrastructure, later settlements expanded. The increase of such settlements, their convergence and mutual integration led to their unification

into one system, which led to the formation of Kryvyi Rih landscape technical system.

The extraction of iron ore caused great damage to the landscape structure of the system, and oak forests were destroyed. The total area

of mining developments was 320 hectares. In the south of Kryvyi Rih Basin, limestone (opencast) and brown iron ore were mined (underground) [3].



Fig. 5 – A horse-drawn drum that was used to lift iron ore [1].

The commissioning of the first lifting equipment led to an increase in the depth of the quarries and, accordingly, an expansion of the dump area [11].

The use of the underground method of iron ore extraction began in 1898. At the same time, the area of mining developments grew - from 800 hectares in 1934 to 2,700 hectares in the middle of the 20th century. The depth of the quarries reached 90 m, the height of the dumps was from 12 to 25 m [3,8,17]. In 1935, the first culverts were formed above the underground workings.

The third stage of the development of Kryvyi Rih landscape technical system begins **in the second half of the 20th century – the beginning of the 21st century**. This stage is the most influential on the landscape structure of KLTS, in the 50s and 60s of the 20th century, mining and beneficiation plants appear, which will later turn into powerful mining complexes [11]. Together with the technical development of means of mining operations, the morphometric characteristics of quarries and dumps are increasing accordingly.

At the beginning of the 21st century, within KLTS, the average depth of quarries is more than 400 m (quarry of the Southern Mining and Processing Plant), the height of dumps and dam-slurry storages is up to 100 m

(dumps of the Hannivskiy quarry, Voikivske, Mykolaivske tailings), the depth of the mines is up to 1,400 m (Rodina, Yuvileyna mine) [7, 13]. According to V. P. Palienko's calculations, the total area occupied by quarries in Kryvbas is 33.34 km², dumps - 60.0 km², tailings storage - 52.74 km², and the surface subsidence zones above mine fields make up 34.71 km² [16]. The formation of mining landscapes continues to this day.

But with the development of mining landscapes, the active development of residential landscapes of KLTS took place. The expansion of production, expressed in the emergence of the plant with a complete metallurgical cycle Kryvorizhstal, a number of mining enterprises and auxiliary industries, led to the development of the population. Due to this, KLTS has a clearly expressed submeridional altitudinal zonation, the so-called "double tier" not only with quarries, dumps and mines, but also with a residential landscape. The largest older lane is the western one, which corresponds to 1-2 storey buildings of the end of the 19th century. - 30 - those of the 20th century, where there were existing and abandoned mining enterprises. The middle strip of 2-5 storey buildings from the 1950s-1960s, where in the the temporary structure of KLTS concentrates a number of enterprises of the

residential landscape: various spheres of the economy and socio-cultural, educational, business institutions. The eastern strip is a 9-16-story building with a minimal number of businesses.

Therefore, industrial and residential landscapes are very closely connected with the formation of KLTS, with the emergence of the mining industry, settlements appeared, and later in the elongated KLTS. The borders of KLTS are changing very dynamically, this is primarily influenced by the continuous intensive development of industry. In the mid-70s of the 20th century, the boundaries coincided with the boundaries of the Ingulets and Saksagan valley-balk physiographic region of the steppe spurs of the Dnieper highlands of the Dniester-Dnieper north-steppe province [8]. At the end of the 80s of the 20th century mining industry construction was carried out in the eastern part of the Middle-Inguletsky sloping physical-geographical district. As indicated by G. I. Denysyk and H. M. Zadorozhnia [8], in the period from the 90s of the 20th century to 2010, the boundaries of the

quarries of Kryvorizhzhia were changed and new territories were set aside for waste disposal. Based on these data, the boundaries of the KLTS were determined, taking into account all the listed changes.

As a result of such rapid changes in the landscape structure of KLTS with the active appearance of mining and residential landscapes, there is a need to develop measures that will help to organize the structure of mining landscapes in such a way that they not only do not harm the environment, but also bring benefits. [15,18].

And therefore, at the third stage of the development of KLTS in 1963 of the 20th century for the first time, the reclamation of the landscape complexes of I. A. Dobrovolskyi and V. M. Danko, which is aimed at optimizing the disturbed lands, in order to prevent man-made disasters in the future, is being started. In the KLTS, the third stage of formation is not the last, until then the mining industry will function on the territory of Kryvorizhe and until then KLTS will develop and its borders will grow.

Conclusions

Thus, based on the results of the research, it can be stated that KLTS is a unique territory, which today has been completely changed by anthropogenic landscapes. Kryvyi Rih landscape technical system was formed for almost 150 years, but its origin was formed in more than three different periods: artisanal development (4th century BC – 17th century); initial industrial development (17th, first half of the 20th century) and active industrial development (second half of the 20th – beginning of the 21st century). They are different in terms of time, but they really reflect the peculiarities of the formation of the most powerful landscape and technical system in Ukraine and Europe. Along the extension of the iron ore deposits of Kryvyi Rih structure, iron ore was mined and production waste was stored, which led to the complete destruction of the background northern steppe landscapes here in

the past, the Saksagan and Ingulets riverbeds. The history of the formation of Kryvyi Rih landscape technical system began with catacomb tribes and continues at the expense of large mining plants that form and develop mining landscapes. When studying the history of the formation of KLTS, it was determined that the boundaries of this system are not stable, but rather conditional, because due to the active impact of the mining industry on the landscape structure, they are constantly changing. With the development of industrial landscapes, residential ones were also formed, which form a two-tiered landscape structure of KLTS. Today, in the landscape structure of Kryvyi Rih landscape technical system, residential and industrial landscapes are the background and will dominate in the future and their boundaries will grow.

Conflict of interest

The author declares that there is no conflict of interest regarding the publication of this manuscript. In addition, the author fully complied with ethical standards, including plagiarism, falsification of data, and double publication.

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The article was received by the editors 08.04.2022

The article is recommended for printing 27.05.2022

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ІСТОРІЯ ФОРМУВАННЯ КРИВОРІЗЬКОЇ ЛАНДШАФТНО-ТЕХНІЧНОЇ СИСТЕМИ

Мета. Дослідити історію формування Криворізької ландшафтно-технічної системи, виділити і обґрунтувати три етапи розвитку, які утворились внаслідок дії гірничодобувної промисловості на території Криворізької ландшафтно-технічної системи.

Методи. Історичний аналіз, картографічний, метод антропогенно-ландшафтознавчого прогнозу.

Результати. Виділено та проаналізовано три етапи розвитку системи: кустарних розробок та освоєння природних ресурсів (IV ст. до н.е. – XVII ст.), де здебільшого переважали описи та освоєння окремих геокомпонентів, що мали безпосереднє значення у житті людей. Перше зародження формування Криворізької ландшафтно-технічної системи розпочалося біля русел р. Саксагань та р. Інгулець, де простягаються поклади залізних руд; дослідження природних ресурсів для цілей їх початкового промислового освоєння (XVIII – перш половина XX ст.), що дали можливість сформувати промислову базу і розпочати інтенсивний видобуток корисних копалин; (друга половина XX – початок XXI ст.) – розвиток однієї з найбільших не лише в Україні, але й у світі ландшафтно-технічної системи. Упродовж лише 150 років у межах Криворіжжя сформувалась нова, складна й динамічна ландшафтна структура, з явною перевагою промислових, здебільшого гірничопромислових ландшафтів, які разом із селітебними ландшафтами формують сучасний ландшафтний фон Криворіжжя. Розроблені схеми та карти, які відображають розвиток Криворізької ландшафтно-технічної системи.

Висновки. Криворізька ландшафтно-технічна система почала своє формування IV ст. до н.е., але найактивнішого і найдинамічнішого розвитку гірничодобувної промисловості набула лише 150 років тому назад за такий невеликий проміжок часу на території Криворіжжя сформувалась нова, складна й динамічна ландшафтна структура, з явною перевагою промислових, здебільшого гірничопромислових ландшафтів, які разом із селітебними ландшафтами формують сучасний ландшафтний фон Криворізької ландшафтно-технічної системи.

КЛЮЧОВІ СЛОВА: Криворізький залізорудний басейн, гірничодобувна промисловість, розвиток, етапи

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Стаття надійшла до редакції 08.04.2022

Стаття рекомендована до друку 27.05.2022