

# **QUARRY AND DUMP LANDSCAPE SYSTEMS OF KRYVORIZHZHIA**

**Postgraduate student Tetiana Koptieva**

**PhD in Geographical Sciences Bohdan Denysyk**

Vinnitsia State Pedagogical University named after Mikhail Kotsubynsky

Vinnitsia city, **Ukraine**

## **ABSTRACT**

The largest iron ore basin in Europe, located in the city of Kryvyi Rih and in which since 1876 and to this day continues the active development of the mining industry causes the rapid emergence of anthropogenic landscapes. And thus the question arises as to what scale technogenesis has covered, what the largest landscape systems have emerged as a result of the mining industry, and what optimization methods are being carried out to maintain the area to prevent man-made hazards. In our work we have analyzed the quarry - dump landscape systems of Kryvyi Rih. The plateau-like multi-tiered dump type of terrain is described in detail. Emphasis is placed on the Burshchit and Shimakov dumps: conditions of origin and development. Two schemes have been developed that reflect the macro levels of the Burshchit and Shimakov dumps, as well as the scheme of classification of mining landscapes. The map which reproduces territorial arrangement of quarry - dump complexes is designed. The main mine systems of Kryvyi Rih are considered. Measures have been introduced to optimize the disturbed lands of Kryvyi Rih.

**Keywords:** dump, mining landscape, quarry, landscape system, optimization.

## **INTRODUCTION**

The rapid development of the mining industry has led to the formation of a powerful zone of technogenesis on the territory of Kryvyi Rih. Due to the geological structure of the territory, Kryvyi Rih has large deposits of iron ore, which have been extracted since the late 18th century, and in such a short period of time the mining industry has completely transformed natural landscapes into anthropogenic ones. The extraction of iron ore is done both in a closed and open methods and this has led to an

increase of mining landscapes in the area and, especially, an increase of the quarry and dump complexes.

The purpose of the study is to identify quarry - dump landscape complexes on the territory of Kryvyi Rih on the example of Burshchit and Shimakov dumps, analysis of plateau-like multi-tiered dump type of terrain, identification of the main methods of optimization of disturbed lands of Kryvyi Rih.

In the course of our research we used such methods as observation, comparison, measurement, experiment, analysis and synthesis, induction and deduction, historical.

Kryvyi Rih is a metallurgical centre not only in Ukraine, but also in Europe. Mining industry plays a major role in the city industry. Kryvyi Rih is located in the southeast of Central Ukraine, mainly in Dnipropetrovsk region. The territory of Kryvorizhzhia is 4.1 thousand square kilometers, which is 0.67% of the total area of the state. Length from south to north is 96 km and from west to east is 62 km [3].

Kryvyi Rih has large deposits of iron ore, which reach 18 billion tons. Iron ore production was started thanks to the scientific exploration of iron ore by R. Kulshyn, M. Barbot-de-Marne, L. Shtrippelman, S. Hartung, L. Syemyechkin, S. Kontkevich, V. Domger, P. Pyatnytskyi, resulting in emergence of the industrial development of Kryvyi Rih region and, respectively, the active formation of mining landscapes.

Since the overburden power did not exceed 1 – 9 meters from the surface of the ore body, the open method of mining was primarily used. The introduction of the first lifting equipment led to an increase in the depth of the quarries and, consequently, expansion of the dump area [3].

According to H. Zadorozhnia's classification, the mining landscapes are divided into quarry and dump and mine complexes.

Based on the classification of the taxonomic system of mining landscapes of GM Zadorozhnaya, we have graphically selected and singled out the classification of types of mining landscapes of Kryvyi Rih [scheme of classification 1].

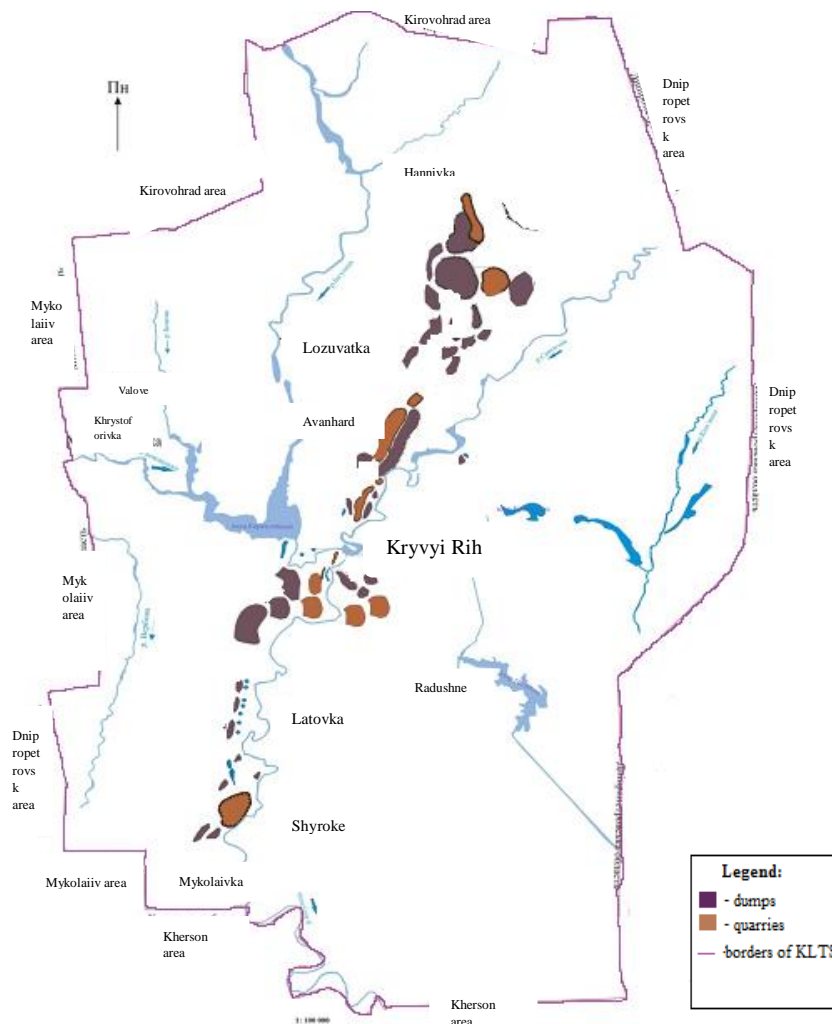
| Structure of types of mining landscapes of<br>Kryvyi Rih landscape-technogenic system  |
|--|
| <i>1. Quarry and dump landscape complexes</i>  |
| <ul style="list-style-type: none"> <li>➤ •Dump and monoexcavation type <ul style="list-style-type: none"> <li>*shallow excavations</li> </ul> </li> <li>➤ •Plateau-like multi-layered dumping type. <ul style="list-style-type: none"> <li>*multi-tiered dumps</li> </ul> </li> <li>➤ •Comb-like multilayered dumping type <ul style="list-style-type: none"> <li>*dumping of heaps "technogenic valleys"</li> </ul> </li> <li>➤ • Quarry and dumping and lake type <ul style="list-style-type: none"> <li>*karst funnels "blue lakes"</li> </ul> </li> <li>➤ • Quarry-dumping-terraced type.</li> <li>➤ •Quarry- lake-terraced type <ul style="list-style-type: none"> <li>*deep reservoirs, deep terraced excavations</li> </ul> </li> <li>➤ •Quarry-terraced type. <ul style="list-style-type: none"> <li>*landslides, sapping</li> </ul> </li> </ul> |
| <i>2. Mine Complexes</i>   |
| <ul style="list-style-type: none"> <li>➤ •Mine falling type <ul style="list-style-type: none"> <li>*fallen watering cans</li> </ul> </li> <li>➤ •Mine falling drawdown type <ul style="list-style-type: none"> <li>*galleries, shafts of mines, crossbars, drifts, winzes with sites, winzes with horizons, transitional wells, extraction chambers</li> </ul> </li> <li>➤ •Lake-wasteland (extractive) type <ul style="list-style-type: none"> <li>*sludge storage</li> </ul> </li> </ul>   |

Scheme 1 Classification of types of mining landscapes Of Kryvyi Rih

We will focus on the career-dumping complex in more detail, namely Plateau-like multilayered dumping type. An appropriate type of terrain is characteristic of the whole territory of Kryvyi Rih. The characteristic features are the railway or road dump

because of which multilayered dumps have been formed. Their surface is lined and plateau-like. Rock, loose and mixed dumps are represented on the territory of Kryvorizhzhia. Solid loose rubble rocks, quartzites, shales, brown iron boulders, granites are characterized for composition of rock dumps. Loose dumps have more loose types of rocks, namely, limestones, marls, clays, loam and sand. The mixed type of dumps, respectively, include the mixing of all the above mentioned rocks.

So, taking into account the above-mentioned characteristics of the quarry-dump landscape complex, we have developed a map that reflects the territorial organization of quarries and dumps in the territory of Kryvyi Rih.



Map 1. Territorial organization of quarry - dump landscape complexes in the territory of Kryvyi Rih

In order to get acquainted with the dump complexes in more detail, a study was conducted at the Burschit dump.

In general, the term "dump" is used in the scientific literature, as embankment on the earthen surface of empty rocks, obtained during mining of mineral deposits, tails of processing plants [1].

The Burschit dump was formed by loose overburden, characterized to Cenozoic. The dump is located in Kryvyi Rih, in the Ingulets district, near Gdantsevka, Shevchenko village, towering over the Ingulets River. It has the following coordinates: 47°52'23 "N, 33°20'0" E. It was compiled by Novokryvorizsky mining and processing plant. The height of the Burschit dump is 80 m, the steepness of the slopes is 35 - 45°. The climate of the dump location is moderately continental. The average January temperature is 5 °C, the average July temperature is + 22 °C, and the average annual temperature is + 9 °C. The highest rainfall in June and July is up to 65 mm, the lowest number is in February and March with 28 mm, annual rainfall is up to 483 mm. In the geological structure of the dump there are the following bulk layers - stripes:

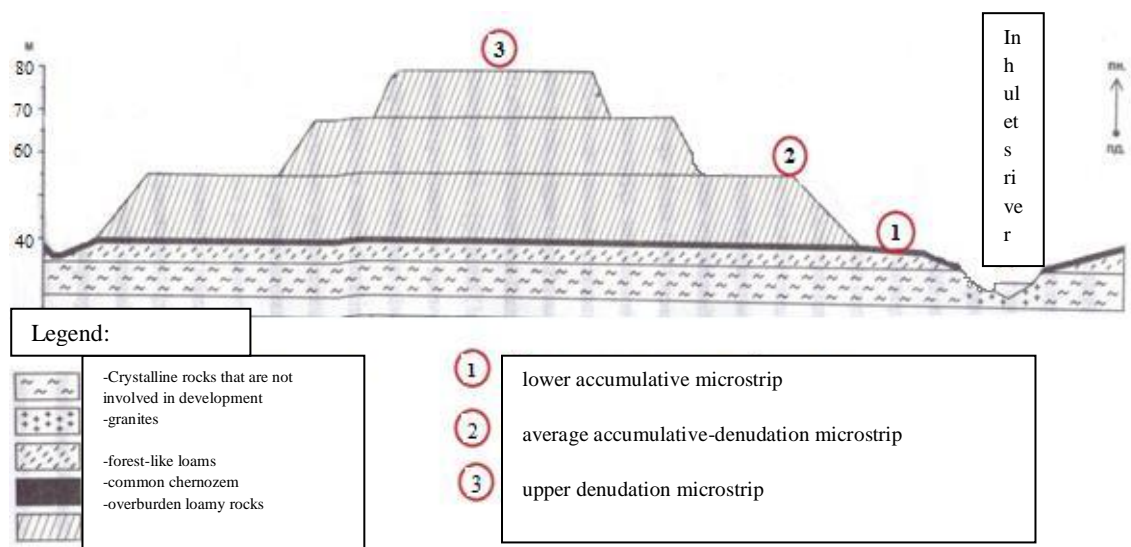


Fig.1. Bulk layers - microstrips of the Burschit dump

1) Lower - accumulative microstrip, is characterized by crystalline rocks that are not involved in development. The average accumulator-denudation microstrip is represented by forest loams, and granites are presented near the terrace of the Ingulets

River. The upper denudation microstrip corresponding to the upper aboveground part of the dump is composed of overlying loamy rocks. Burschit dump was backfilled in the late 1950s and early 1960s. The dump was completely reclaimed during this period. There are such plants as white poplar, elm hornbeam, maple ash, white clover, mouse peas, wormwood, wheatgrass, roofing scads, fescue grooved, bluegrass, white clover, celery, granary. It is completely adapted to the natural landscape and it is used for tourist purposes for residents of Kryvyi Rih now.

The next dump, which has the characteristic features of the Burschit dump is the Shimakov dump, which belongs to the rock type of dump. It is composed of alternation of metamorphic rocks: various ferruginous quartzites, varieties of shales and carbonate rocks, as well as granites, migmatites, gneisses and amphibolites. Shimakov dump was formed due to the design surface, which has relative aligned parts of the dumps and small depressions between the heaps that were formed in coming out by automobile transport. The dump is located in the city of Kryvyi Rih, in Ingulets district and, near the quarry of the Southern mining and processing plant. It has the following geographical coordinates: 47 ° 50'36 "N 33 ° 15'54" E. The dump is made by the Southern mining and processing plant in 1960-1967. The height of the Shimanov dump is approximately 80 m, the steepness of slopes is 45-50°, and the dump area is 2.5 ha. The climate of the dump location is moderate - continental; all climatic indicators are identical to the Burschitsky dump. In the geological structure in fig.2 of the dump there are the following bulk layers - stripes:

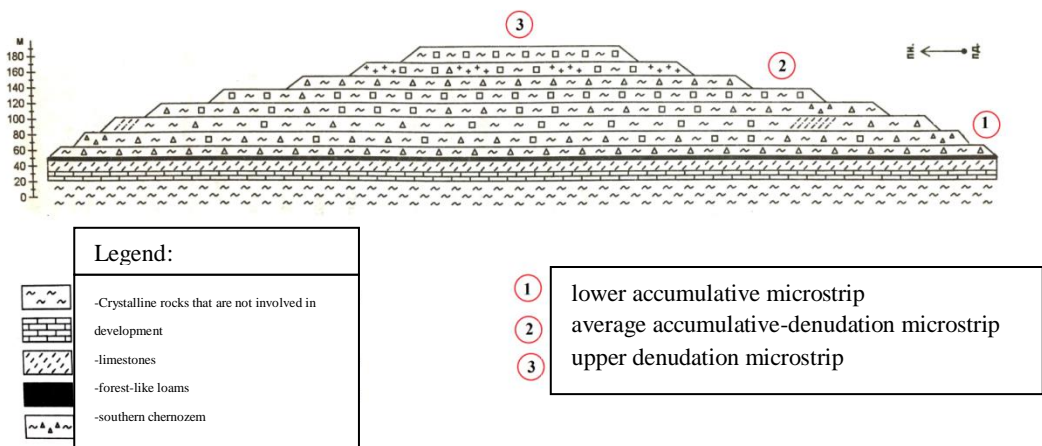


Fig.2. Bulk layers - microstrips of Shimanov dump

1. The lower accumulative microstrip consists of crystalline rocks, which are not involved in development, limestone, loess loams.

2. The average accumulative - denudation microstrip, which is characterized by crushed stone, loam and stone blocks.

3. The upper denudation microstrip is represented by boulders and granites. The Shimanovsky dump is completely reclaimed and has a permanent vegetation that develops rather intensively on the dump.

Such vegetation is typical at these microlevels: narrow-leaved sucker, white and pyramidal poplar, elm hornbeam, common robinia, tatar maple, synanthropic flora (ragweed, zlynka, grindelia, chornoshchir);

Comparing the Burschit and Shimanov dumps, a significant difference is not seen, but due to the rocks which the dumps are composed, it is determined by the intensity of vegetation development, namely: empty rocks easily pass water and roots of trees. The steepness of the slopes and the prevailing winds also play an important role. In general, dumps are completely reclaimed and have tourist and scientific value.

In turn, as indicated above, the dumps are formed by the mining of iron ore by open way in quarries.

**Quarry** is a set of open mines intended for the development of minerals deposits [4]. More than 30 quarries have been operating in the Kryvyi Rih basin during the entire period of extraction of minerals deposits, 23 quarries are out of operation and most of them are flooded. At present, 8 quarries are increasing their area and extraction horizon. The longest and deepest quarry in Europe and Ukraine is the Ingulets mining and processing plant with its depth of 426 m. Every year, in average, 34 million tons of rock weight are extracted where the iron ore concentrate reaches 18 million tons.

Mine landscaping complex is an integral part of the mining industry. The term "mine" is interpreted in the scientific literature as a mine, a mining enterprise for the extraction of minerals (coal, salts, etc.) by underground way and shipment to consumers, or to a mining and processing plant [2].

Due to the closed method of extraction of iron ore, the mining falling drawdown type is the most common, which is typical for the southern part of Kryvyi Rih. Due to iron ore production tunnels, shafts of mines, shrubs, drifts, winzes with sections, winzes with horizons, transitional wells and mining chambers were formed. But the void that

remains after working out can cause a dangerous situation, namely: the occurrence of underground weathering, which leads to the formation of fractures, peeling, shattering and displacement of rocks.

The deepest mine in Kryvyi Rih is Hwardiiska mine with its depth reaches 1620 m. The mine is located in the Dnipropetrovsk region in Kryvyi Rih city, Ternovsky district. It has the following geographical coordinates: 48 ° 3'38 "N 33 ° 29'7" E. The mine was developed by PJSC "Kryvyi Rih Iron Ore Plant.

The project capacity of the mine is 2000 thousand tons of rich ore. The iron content of the mine array on the working horizons is 59,6%. The mine is still functioning; the content of the iron ore extraction horizon is increasing at a rather rapid rate.

Today, an urgent question raises regarding the introduction of optimization measures of the quarrying and dumping systems of Kryvyi Rih region. Namely, prevention of occurrence of dangerous situations in the landscape complexes such as scree, landslides, breakages, landslide terrace, failure funnels, etc.

The main activities include: reclamation, geological and ecological monitoring and conservation of mining landscapes.

A more progressive method of restoration of disturbed lands is reclamation, divided into biological and technical reclamation, phytomericotic and agrotechnical measures, namely, tree planting and keeping biological state of vegetation. Technical reclamation is aimed at laying and leveling of relief, formation of a certain form of dumps and dumping of soil cover on the dumps to maintain plant balance in the technogenic territory.

Geological and environmental monitoring is an activity aimed at control and environmental observation of the Kryvyi Rih landscape-technogenic system. The mining landscape commandment serves as the maintenance and suspension of hazardous situations on landscape systems.

Therefore, the most widespread landscape systems are quarries and dumps in the territory of Kryvyi Rih landscape-technogenic system. This was caused primarily by the continuous development of the mining industry since the late of the 18th century. Every year, more and more of the territory becomes technogenic and, development of quarry and dump complexes, undoubtedly, leads to this.



Revitalization is a new optimization event that is popular and successfully used in the EU countries, but unfortunately in Ukraine it is not used. As E. Ivanov notes, revitalization is a return to life and is primarily characterized by the restoration (optimization) of anthropogenically transformed geosystems [5, p.184]. The main tasks of revitalization are: 1. socialization of space; 2. development of elements of social infrastructure that regulate recreation and tourism; 3. ensures the development of production; 4.improves the environmental status of mining landscapes.

So, in the territory of Kryvyi Rih, the most widespread landscape systems are the quarries and dumps. This is due, first of all, to the continuous development of the mining industry since the late 18th century. Increasingly, the territory is becoming man-made every year, and the development of quarry and dump complexes is undoubtedly a leader.

## **CONCLUSION**

So, based on the results of the study, we can say that Kryvyi Rih is a unique area, which today is completely modified by anthropogenic landscapes. Quarry and dump complexes, which according to the classification occupy a dense place in mining landscapes, have a large area of Kryvyi Rih and are the main type of landscape system in this area. The most common in the territory of Kryvyi Rih is a plateau-like multi-tiered dump type of area, which includes Burshchit and Szymaniv dumps, which are different in their technical composition, but reclaimed vegetation quite successfully.

Kryvyi Rih is also known for having mine complexes. Mining of iron ore is a very important component of mining industry. This very method makes it possible to extract rich iron ore and the content of iron concentrate is much higher than in the quarrying method. In the study we have also found out that the deepest point of iron ore mining is carried out behind the horizon of 1605 m in the mine "Ternivska".

Unfortunately, Kryvyi Rih has a large number of unrehabilitated dumps and flooded mines, which need optimization measures in order to avoid a man-made catastrophe in the near future. Therefore, according to the results of the study, we propose to focus on revitalization, a new direction of optimization of mining landscapes and implement it not only in Kryvyi Rih, but throughout Ukraine.

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