

Ecological Problems of the Ukrainian Carpathians Region development

V.V.Hoblyk, T.D.Shcherban, V.I. Kobal, K.M. Movchan, O. D.Lendiel

Abstract. *The Carpathian region of Ukraine includes the territory of Transcarpathian, Ivano-Frankivsk, Lviv and Chernivtsi oblasts with an area of 5660.7 thousand hectares (9.4% of the state territory) and is a true natural pearl of our country, where 22% of forests, 26% of nature reserve fundland is concentrated, 36% of river water resources are formed, 42% of unique and rare underground mineral water deposits are located. There is an intensification of ecologically unfavorable phenomena in the Carpathian region of Ukraine - threatening and catastrophic floods, soil erosion, pollution of surface and groundwater, windfalls, damage to forests by pests and diseases. The mineral base of the region has 271 deposits of more than 30 mineral resources of Transcarpathia. It is one of the most studied gold-bearing provinces in Ukraine. Almost 55 tonnes of gold have been explored here - the Muzhiivsky deposit and the Sauliak deposit. The Muzhiivsky gold-polymetallic deposit with a gold content of 4.5-15 g/t in ore was put into commercial development in 1999. Since 2006, gold production has been suspended. Ore dumps stockpiled at an industrial site are a source of pollution of surface and underground waters [1]. The purpose of the article is to investigate the current ecological state of surface water within the Muzhiivsky gold-polymetallic deposit. Research methods. Landscape-ecological, hydrochemical method, statistical analysis, literature analysis, and stock materials have been used in the article. Results. Based on the results of geoecological studies of the territory of the gold-polymetallic deposit, the state of surface water has been assessed. According to the processed results of the analysis of water samples, it has been revealed that the main sources of pollution are two dumps of ore and ore-bearing rocks containing sulfides and oxides of heavy metals. Under the influence of atmospheric precipitation, weathering of ore-bearing rocks and oxidation of sulfides FeS, ZnS, PbS, CdS take place. At the bottom of the dumps, waters are formed with increased mineralization, low pH, enriched with sulfides and heavy metals, which flow into drainage channels and subsequently spread in the region's water system. Based on the research data, a scheme of the process of groundwater pollution by dumps has been developed. It has been found that in the ore location zone near the rural settlement the filtrate from the dumps flows into drainage channels containing salts of the main types of heavy metals (cadmium, chromium, lead, zinc, copper) and exceed the maximum permissible norms. Considering that the Muzhiivsky gold-polymetallic deposit is not used due to the shutdown of the gold processing factory, it is necessary to develop a program to neutralize its negative impact on the environment.*

Keywords: *ecological and geochemical research, chemical element, gold polymetallic deposit, environment, ecological problems.*

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I. INTRODUCTION

To establish the development opportunities for individual industries or enterprises in relation to the holistic natural system, which is Transcarpathia, it is necessary to conduct a comprehensive environmental and economic assessment of all possible environmental management options in the Carpathian region, which covers an area of 56,600 square kilometers within four administrative regions: Transcarpathian, Ivano-Frankivsk, Lviv and Chernivtsi [2].

More broadly, the Carpathian macro-region can be classified as a geographical area covering different countries and regions and characterized by common features or problems. The Carpathians is one of the largest mountain ranges in Europe, covering seven European countries: the Czech Republic, Hungary, Poland, Romania, Serbia, the Slovak Republic and Ukraine. The total length of the Carpathians is more than 1500 kilometers and the width of the mountain range is within 12-540 kilometers. The Carpathian Mountains cover an area of 190,000 square kilometers being one of the largest mountain systems in Europe.

Today there is a vicious practice when the development of specific projects and their consideration in expert commissions, even with the involvement of public organizations and international experts, is not considered on a regional scale, and even more so on a macroregional scale. This is all the more important when we talk about the Carpathian mountain range, which covers seven countries and where 7 million people live, and which is distinguished by its unique natural and cultural wealth. Over the years, the region has been facing serious environmental and social and economic problems (depopulation, unemployment, pollution, destructive floods, landslides, etc.). Law of Ukraine No. 1672-4 of 09/07/2004) ratified the Framework Convention for the Protection and Sustainable Development of the Carpathians and the state committed itself to pursuing a policy aimed at the sustainable management of surface and groundwater resources, ensuring an adequate supply of surface and groundwater of good quality, which is necessary for sustainable, balanced and rational water use, as well as proper disinfection and wastewater treatment [3]. Issues related to the study of qualitative composition, pollution of surface waters, migration of pollutants were widely covered in the works of many Ukrainian scientists – O.P. Budza, V.V. Hrebiniya, A.K. Zapolskyi, V.H. Klimenko, O.E. Koshliakov, A. Yu. Lukin, M.S. Ohniansky, V.K. Khilchevskyi, M.A. Khvesyuk, A.V. Yatsyk. Considerable attention was given to this problem in the works of foreign authors – G. Frieda, R. S. Harels, R. Chor, J. Driver. French scientists played an important role in the development of hydrogeology - A. Darcy, J.

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Dupuis, A. Shezi, German - E. Prince, K. Keilhak, H. Hofer, American – A. Hazen, C. Slihter, O. Meinzer. Problems of environmental pollution were investigated in the works of S.Eyrikh, T.Papina, V.Novotny, J.Moore, L.Friberg, G.Nordberg, J.Wood [4] [5] [6] [7] [8]. Despite the wide range of scientific research in this field, these problems require further consideration and improvement in the specific deposit, the enterprise of the region. The purpose of this article is to investigate the current ecological status of surface waters within the Muzhiivsky gold-polymetallic deposit.

II. PROBLEM

Transcarpathian region is most endowed with water resources region of Ukraine. In terms of specific provision with local river flow (6.29 thousand cubic meters per year per person), Transcarpathia exceeds the average figure in Ukraine by almost 6 times. The water resources of the region are formed due to the surface runoff of the rivers of the Tisza basin: local river runoff, which is formed within the region, transit river runoff, as well as operational groundwater reserves. The territory of the region is covered with a dense network of rivers. The average density of the river network is 1.7 km / km². In total, there are 9426 rivers in the region with a total length of 19723 km, belonging to the Tisza river basin (left tributary of the Danube). Tisa, Borzhava, Latoritsa and Uzh have a length of more than 100 km each [1].

The Danube River Basin is the most international river basin in the world. On its way, 2800 km from the Black Forest in Germany to the Black Sea, the river and its tributaries span 18 countries. The largest in Europe Danube floodplains are preserved in the Danube Delta. This is a real find for entomologists, ornithologists and ichthyologists, because 4,500 species of insects, 350 species of birds, 103 species of fish, including 5 species of sturgeons, and more than 950 species of plants live in the Danube floodplains, many of which are listed in the Red Book of Europe and

Ukraine. Migratory birds remain here (one of the most important migration corridors passes through the Danube Delta), you can see white pelicans, a white-tailed eagle and a black stork here [9].

At the same time, the Transcarpathian region, where 284 mineral deposits have been explored, including gold, contains significant fresh groundwater resources with high consumer qualities and favorable conditions for production and sale on the world market. Not to mention the mineral waters. Fresh drinking water is one of the most scarce natural resources in the world. Such a restoration resource of the Carpathians can become an important economic specialization of the region. Therefore, the location of enterprises that use chemical reagents, the disposal of waste from processing in the zone of formation of groundwater flows can lead to environmental disaster.

The scope of activity of the first gold-mining and gold-processing enterprise in Ukraine is geological study, exploration, mining of gold and related components. Despite the fact that study and exploration of the deposit ended with the approval of reserves in the State Reserves Committee, it did not belong to the unique, outstanding or large deposits in the estimates of the mineral resources of the former USSR and therefore was not developed, and was referred to as low-prospective, and only with the proclamation of an independent Ukraine the state showed interest in obtaining the first Ukrainian gold.

Almost all deposits or manifestations of gold in Transcarpathia are not large or medium, and their service life is 7-10 years. The interest of private companies in the development of such deposits leads to a deterioration of the environment, economic and social losses.

As an example, let us dwell on the environmental problems that arose during the development and operation of the Muzhiivsky gold deposit. Geological exploration was conducted for 20-year period and ended in 1990 with the approval of the reserves of gold, silver, lead and zinc in the State Reserves Committee of the USSR.

Table I: Base reserves and prospective resources of Muzhiivsky deposit [10]

Name of deposit	Indicators	Unit of measure	Explored reserves			Perspective reserves			Total C1+C2+P1
			C1	C2	C1+C2	P1	P2	P1+P2	
<i>Muzhiivsky deposit</i>	Ore	million tons	4,44	12,31	16,75	2,35		2,35	19,1
	Gold	tons	15,4	19,8	35,2	18,8		18,8	54
	Silver	tons	162,4	452,5	614,9	35,2		35,2	650,1
	Lead	thousand tons	84,4	245,1	329,5				329,5
	Zinc	thousand tons	112,3	620,6	732,9				732,9

In all, 49590 meters of underground mine workings of various sections, from 11m² to 2.7m², have been traversed during the whole study of the Muzhiivsky deposit. The mined mass was stored on the surface in ore and non-ore dumps. Ores were stored in the ore dumps during the mining of ore bodies; empty rocks, obtained during the passage of underground workings, were stored in the non-ore dumps. The total volume of ore and nonmetallic dumps on the surface of the deposit amounted to about 250,000 m³ or 425,000 tons.

Dumps of sulphide, gold polymetallic ores, which are the main pollutants of the territory, are on the surface of the deposit in the open state and are subject to constant oxidation. The dumps located on the mountain slopes are constantly eroded, and the mineralized acidic waters are saturated with metals PbS, ZnS, FeS, CuS, CdS, drain and fall into surface and underground waters.

III. RESULTS AND DISCUSSION

On the slopes of VelykaBerehivskamountain, there is a significant amount of rock dumps that can affect the environment. However, neither during the operation of the enterprise Zakarpatpolymetaly LLC nor after its complete stoppage the problem of dumping was resolved. In the ore dump, the rocks of which contain sulfide minerals and

harmful elements are particularly dangerous. Considering the long term of their accumulation due to precipitation and the increase of temperature in the summer, the process of oxidation of sulfides and their migration to surface waters takes place in the dumps. These waters drain into the valley part of the area where they penetrate the groundwater. (Fig. 1).

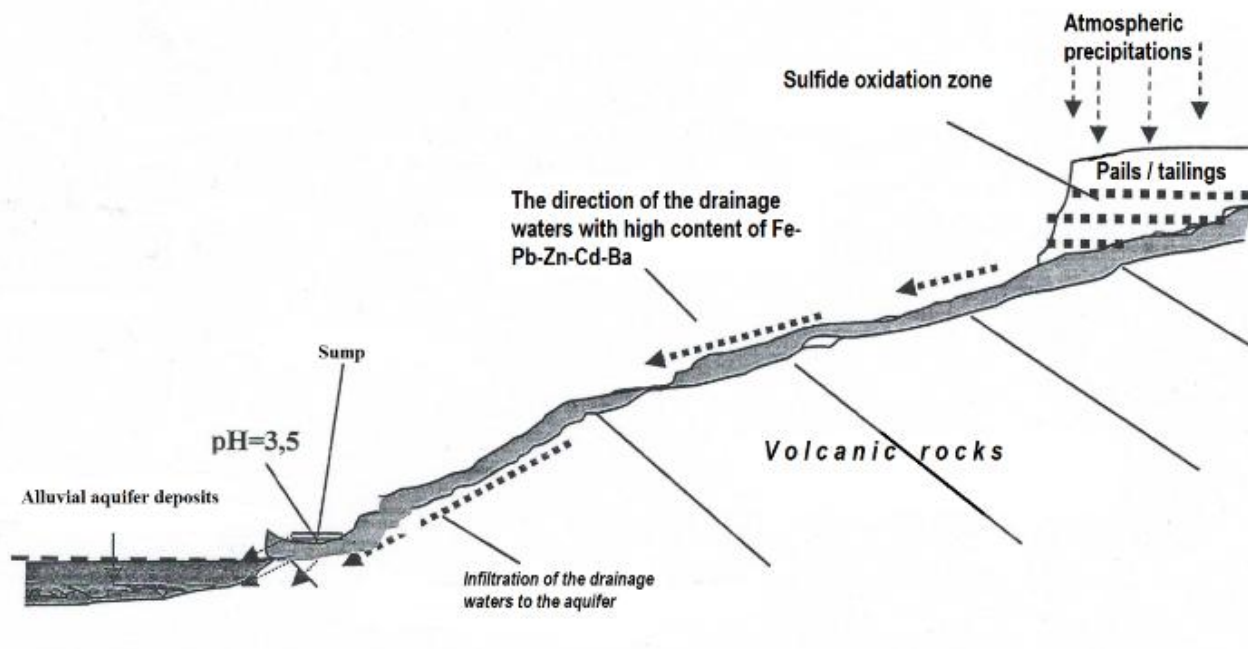


Fig. 1. The scheme of the process of groundwater contamination by dumps

In the 80s, during the exploration, in the lowland part of the Muzhiivsky deposit a special treatment tank and gutter system was built for intercepting drainage water and preventing the oxidation of groundwater with its subsequent neutralization to normal. After the shutdown of the enterprise this system ceased to operate. Further increase in acidity of the already acidic soils can lead to their complete withdrawal from agricultural use. With regard to groundwater, a significant part of the private residential sector uses surface water through wells and an increase in mineralization and acidity can lead to their complete unsuitability for consumption by the population.

After the shutdown of the enterprise for the extraction and processing of gold-polymetallic ores the State Environmental Protection Agency and the state environmental inspection carried out a study of surface water resources in the area of the ore dump near the village of Muzhievo. The study showed that the filtrate from the dumps, which flows into the drainage channels, contains salts of the main types of heavy metals:

- cadmium—up to 9.7 mg/l (exceeding the maximum permissible concentration for reservoirs by 9700 times);
- chromium— up to 1.3 mg/l (exceeding 26 times);
- lead —up to 5.6 mg/l (excess of 187 times);
- zinc— up to 50.0mg/l (exceeding 50 times);
- copper— up to 35,2 mg/l (exceeding 350 times).

The content of cadmium in groundwater (the presence of which in drinking water is not allowed) at the study of wells of residential buildings was as follows:

- well No. 1 - cadmium content - up to 0.002 mg/l;
- well No. 2 - cadmium content - up to 0.006 mg/l;
- well No. 3 - cadmium content - up to 0.002 mg/l;
- well No. 4 - cadmium content - up to 0.01 mg/l;
- well No. 5 - cadmium content - up to 0.0013 mg/l.

The presence of a significant excess of cadmium in wells with drinking water in a housing stock located in the immediate vicinity of the settling pond indicates the infiltration of rain acid effluents into underground horizons. In the territories adjacent to the mine, excess levels of lead, zinc and copper in soil samples have been recorded.

IV. PRACTICAL TASKS

The method of work on the disposal of dumps should be determined based on the mining conditions of their occurrence, physical properties, quantitative and qualitative characteristics. To restore ecological balance in the area of Muzhiivsky Mine, it is necessary to completely isolate groundwater from the negative impact of dumps. For this:

1. To restore the drainage system of the southern slope of the deposit surface, which was created to intercept precipitation.

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2. To establish a temporary modular processing plant for the processing of ore dumps.

3. Waste tailings dumps and non-metallic dumps should be used for land reclamation.

V. CONCLUSIONS

The ore dumps of gold-polymetallic ores, which arose during the exploration at the deposit, are a source of environmental pollution. Precipitation causes oxidation of lead, zinc, and sulfides, cadmium and other heavy metals.

To avoid this contamination, it is necessary to remove lead and zinc sulfides by applying the developed technology for the enrichment of gold-polymetallic ore. Relocation of this ore in an isolated place will lead to significant construction losses and its further storage will not solve this problem. To process these dumps, it is necessary to build and commission a modular factory, which can later be used to enrich the gold-polymetallic ores of the Muzhiivsky deposit.

Earlier, when assessing the industrial value of the deposit, the amount of ore, its quality, the content of gold and silver were taken into account, but today, first of all, it is necessary to anticipate the environmental consequences of the development of the deposit, the planned costs for environmental protection. These costs can be so large that the exploitation of the deposits, even large and medium-sized ones, can be unprofitable. The feasibility of this solution to environmental problems requires further research.

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