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SUBSTANTIATION OF INVESTMENT IN STUDY AND INDUSTRIAL DEVELOPMENT OF THE "ZHYRYCHI" COPPER ORE OCCURRENCE IN VOLYN

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Abstract

The stratiform deposits of native copper were found among the trap complexes of the lower Wend In the cover of the Volyno-Podilskiy Plate of the Volyn territory in the southwestern part of the East European Platform. They corresponding to the largest mineralogical provinces of the World by resources.

In the article economical efficiency of the copper deposits geological study and industrial development of the Volynian Vendian traprocks are substantiated by example of the "Zhyrychi" ore occurrence.

The ore occurrence's general characteristics, information about copper-bearing horizons, ores and ore bodies and project data of its prospecting are given. Technical and economical indicators of its industrial development were identified. An approach to the complex processing of copper basalt and basalt tuffs, which involves the extraction from them, in addition to copper, and precious metals, as well as the use of enrichment tails as a peturgical raw material.

The current market value of metallurgical copper averages $ 5,000 per ton.

Considering that, possible income from development of the copper deposits may amount several billion $ from each ones.

The conclusion is that the biggest income will be obtained if 0.2% cut-off grade ores be used, and the highest profitability – at 0.4% cut-off grade.

The obtained results may become a basis for further geological-economical researches of the other numerous ore occurrences in the Volynian traprocks. In total, they delineate a large copper-bearing province of European significance.

Key words: Volyn, traprocks, native copper, ore, prospecting, costs, income, profitability.

Introduction

The scale of modern need for mineral resources, up-to-date technologies of its extraction from ores, demands of expensive infrastructure creation lead to increase of industrial development deposits with significant reserves that belong to the category of large and super large ones.

The greatest prospects of those deposits detection have territories that buried under the platform cover to 1000-1500 meters depth.

The Volyno-Podilska Plate of the Southwestern part Eastern European platform (figure 1) is one of those areas.

Its cover contains large stratiform native copper deposits among Lower-Vend trappean complexes [8,10]. Those deposits belong to the largest mineragenetic provinces of the world. "Zhyrychi" ore occurrence is one of them.

Large native copper deposits are known on the Keweenaw Peninsula since the century before last (Michigan, USA) [3,4].

Those deposits gave over 5 million tons of copper and 500 tons of silver for 120 years of their development.

Discoveries of new large deposits suitable for developing in British Columbia [12] and Yunnan and Guizhou provinces in the Southern China [13] give reason to have a new look at the prospects of native copper mineralization in platform covers, in the Volynian traprocks in particular, where deposits of copper located that discovered by Polish geologists [9] in the last century.

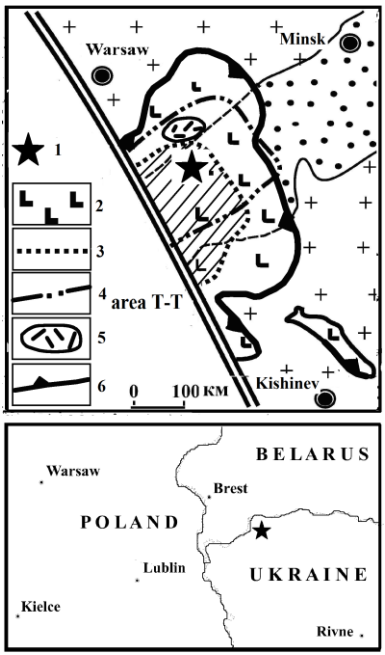

Fig. 1. Position of the "Zhyrychi" copper ore occurrence among the Lower-Vendian trappean complexes of the Southwestern part Eastern European platform:
1 - "Zhyrychi" copper ore occurrence; *2* - Lower Vendian traprocks; *3-6* - dissemination contours of Lower-Vendian trappean complexes: *3* - Zakhidnobuzkiy, *4* - Verkhnopripyatskiy, *5* - Brestskiy, *6* - Bilovezko-Podilskiy

A large volume and lateral spread of ore-containing rocks, a presence of several volcanic stratiform ore levels with an industrial significant copper content, a native character of copper mineralization, an accompanying noble-metal mineralization, an ability of ore-containing rocks complex usage, a satisfactory ecological safety of native copper ore processing evidence of Volyn copper-ore region great prospects [9]. The copper deposits are not inferior to known foreign analogues for those indicators and might surpass all known ones in the Europe.

Recent times 12 prospective ore fields were defined by prospecting and evaluation works [10]. Their resources (mostly Inferred Resources) estimated in 16 billion tons of copper. The copper reserve of Pivdennorafalivskiy ore occurrence was estimated by the category C_2 (Probable Reserves) and resources of the Zhyrytskiy ore occurrence – by the category P_1 and P_2 (Inferred Resources).The scientific ground of technology of the complex processing of raw material that contains metals at development of basaltic deposits is executed [6].

Significant capital costs in geological study and industrial development of the Volyn copper deposits foresaw by preliminary technical and economical considerations (M.I. Zhykov and others, 2008). At current market price of metallurgical copper approximately 5,000 USD per ton, the possible income form potential deposits exploitation might consist of several billion USD in each of them.

The problem is the efficiency of multi-million investments in further geological study and industrial development of the copper deposits in the Volyn at the current market conditions. The advisability of such investments needs economical substantiation that made in this work by the example of the "Zhyrychi" ore occurrence considering current approaches [5].

General Characteristics of the ore occurrence

The "Zhyrychi" ore occurrence is located in the Ratne Region of the Volynska Oblast between Zhyrychi and Tur villages. It has 40 square kilometers area. Its surface has a plain relief with 155-162 meters altitude. Near 55% of the area belongs to the drained agricultural land and settlements infrastructure. The rest is forestry. There are a drainage canal and a gravel road, which passes through the area. There are gas pipelines of large (800 and 1200 millimeters) diameter along the road. As power-lines are LEP-10kW and LEP-35kW. The fresh water supply is provided by wells and artesian down holes. Sand and wood use as local building materials.

The "Zhyrychi" ore occurrence was studied by prospecting works (M. I. Zhuykov and others, 2008). In the geological structure of the region (figure 2) takes part eroded to various degree Lower-Vendian volcanogenic formation of the Volynska Series: Zabolotivska, Babynska, Ratnivska Suites and their subdivisions, that nave been studying by Polish [1,2] and Ukrainian [8,10] geologists. They are covered Upper-Vendian terrigenous sediments of the Mogyliv-Podilska and Kanylivska Series in the western part ore and the marl-chalky stratums of the Upper Cretaceous (to 40 meters) in the places of their erosion. There are quaternary sediments above them.

The Lagozhanskiy sublatitudinal fault is a limit of the ore occurrence in the North and Northwest. The possible feather-out line of the middle and lower Babynska Series rock complex is in the West. The Pivdennoratnivskiy fault is in the South.

At the limit of the ore occurrence the volcanic rocks strata has mainly a gently dipping seam (to 3^{o}) to the West-Southwest and the presence of a multidirectional mainly steeply dipping to vertical disjunctive dislocations with the displacement amplitude to 20-30 meters, to 80-100 meters rarely. Basalts and tuffs represent the Volynska

Series of volcanogenic rocks, which have mineralized copper intervals.

Different structures of Volynska Series were mapped by their age and facial affiliation due to block structure, conditioned mainly by Hercynian tectogenesis and Pre-Mesozoic denudation on the same surface.

Counted by actual basis geological maps of the area appropriate units of the Volynska Series (Ratnivska, Babynska and Zabolotivska Suites) amount 29.8, 35.2; i 36.4 square km accordingly.

Ratnivska Suite is represented in its ore-bearing part by basalts and lava breccias. The lasts are separated by individual flows. This separation is due to the low thickness tuff layers, within tuff conglomerates, tuff gravestones with exotic petrochemical and petrogparhical rocks variations among ones with the largest thickness. It causes possibility of identification the three different parts by age of the Suite. That is (from bottom to up by cross-section): Luchichivski, Zoryanski (transitive) and Yakushivski Layers. Their thickness stay more or less constant within the area.

Basalt pyroclastic rocks with basalts subordinate role present the Babynska Suite. The total thickness is up to 180 m. 40% of it is effusive basalt surface. These basalts lay approximately in the middle of the tuffaceous rock mass. However, in the overwhelming majority of cases the “under basalt tuffs” thickness slightly exceed (10-15%) the “on basalt tuffs” one.

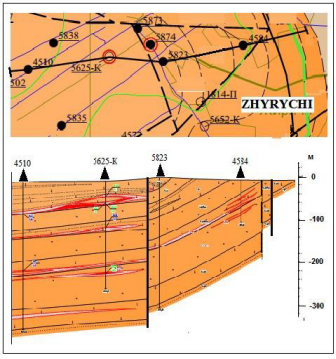

Fig. 2. Geological structure the of "Zhyrychi" copper ore occurrence (ore bodies in the section are shown in red)

Zabolotivska Suite in lateral relation is most distributed stratigraphic unit in the Volynska Series composition within the Zhyrychi area. Its thickness practically completely consists of basalts with amygdaloidal type with total absence of breccias which separating individual basalt flows. Comparably deep rocks bedding of the Suite cause weaker knowledge of its copper-bearing.

Since native copper mineralization occurrences in the underlying (Gorbashivska Suite) and overlying (Chartoryiska Suite) volcanogenic-terrigenous deposits are not discovered, the volcanogenic rocks of the Volynska Series limit the age range.

Copper-bearing horizons, ores and ore bodies

There are 5 ore-bearing horizons defined on the "Zhyrychi" site. In its turn, particular ore bodies with 0.2% content on ≥1.0 meter interval are defined in those horizons.

The productive horizons (from top to bottom): 1A (Zabolitvska Suite), 2A, 2B (Babynska Suite) and 3A (Luchichivska Suite), 3B (Ratnivska Suite) [8,11]. At the same time, only 2A horizon is presented by tuffs, and the others – by basalts. The occurrence depth of the ore horizons is between 164 and 530 meters. The dipping seam of the ore bodies is subhorizontal. There are possible minor changes of inclination angles in tectonic fragmentation zones.

The basalts of the horizons 1A and 2B often have amygdaloidal texture except their low-crystalline, aphanite types, which distinguish them in volume density from Ratne generally cryptocrystalline types.

Mineralogical composition is feldspar (40-55 %), monoclinic pyroxene (25-45%), magnetite (5-6%), basalt glass (up to 10%) and chlorite (up to 5%). In small amount, it contains ilmenite, hematite, zircon, staurolite, garnet. Of the secondary elements are present zeolite, palagonite, carbonates.

The tuffs are presented by different clastic (from pelitic to agglomerate) types with fragments of basalt, volcanic glass, which are cemented with altered (chloritization, zeolitization, ferrum oxides) pyroclastic material. The terrigenous impurity is less than 1.5-2%. Pyroclasts amount 80-85%, cement mass - 40% from the rock mass.

The lava-breccia part, which separate define basalt flows, is insignificant. They present only in horizons 3A and 3B. In general, ore-bearing rocks are monolithic. Although, differently oriented fractur-

ing (sometime cured with secondary minerals) is detected on some near-fault areas.

The area of the ore horizons distribution is a few tens of meters. The length of particular ore bodies reaches hundreds of meters by both strike and dip. The ore bodies have generally strata shape. The copper-containing interval thickness ranges from several decimeters to 1-1.5 meters, 19.3 meters in particular cases (down hole 5827). The highest average weighted copper content is 2.01% per 1.1 meter in some places. The maximal content is 4.15% per 0.3 meter (5815 down hole) - 2B horizon.

By the technical and economical considerations for the "Zhyrychi" ore occurrence have been accepted the following temporary conditions: 0.2% cut-off grade copper content in a sample; 0.172% minimum mining copper content in the estimation block; for these conditions the ore bodies have been delineated by 0.2%, 0.3% and 0.4% cut-off grades. The copper resources belong to a medium deposit (over 0.5 million tons) with 0.379%; 0.457% and 0.596% average contents and with 1.26-5.7; 1.6-4.5 and 1.0-3.75 meters ore body thickness accordingly.

Under the division of copper by rock types [8] the basalt has 63%, and tuff has 37% from general amount (n=113) of the productive intervals (with over 0.2% copper content). The division of copper by concentration conditions (morphotypes) looks as follows: blotches in main rock mass - 55%, streaks and faces of fissures - 20%, amygdales - 10%, combinations of above types - 15% (figure 3).

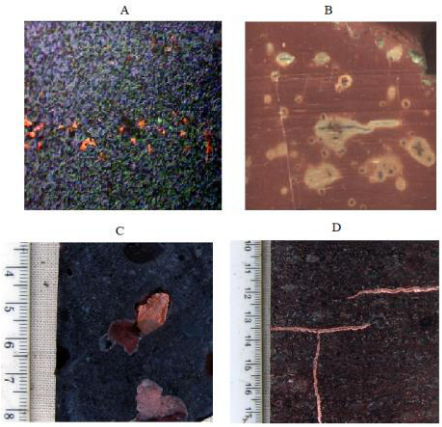

Fig. 3. Native copper mineralization morphotypes: A – banded blotch in phaneritic basalt (5-time zoom), B − nest-interspersed in spots of illumination of siltstones (increase in 6 times; C − basalt's amygdales, D – streaks among tuffs

The practical significance of copper mineral is native copper. Its ore formation and geological and industrial deposit type are identified [11]. Other copper minerals in par-

ticular chalcocite, digenit, chalcopyrite, bornite, covellite, cuprite, and tenorite present as accessory minerals and make no influence on the mineralization scale.

According to the microprobe analysis, (the total number of measures is 48) native copper has a high purity. The copper contents vary from 99.23 to 99.95%. The main impurity elements are Ag (0.01-0.37%) and Fe (0.01-1.04%).

A quite stable geochemical association of copper and silver was identified. The correlation coefficient between their contents is usually over +0.75. Silver is often detected in a native mineral form and characterized by high purity [3,5]. Based on the *X*-ray (microprobe) analysis data the average copper content in the native copper monofractions (n=51) is 706 grams per ton [10].

In the last years the ore occurrences prospects in relation to other noble elements - gold [9] and platinum group were confirmed.

Presence of native gold is revealed during developing of sample preparation scheme by IMR specialists (Simferopol) and in the crushed samples of tuffs (dawn hole 4382) and in the volcanic-sedimentary rocks, which superpose the traprock mass. The fineness of gold is within from 816 to 987. From the impurities are detected Ag (up to 10%), Cu (up to 15%), Fe (up to 0.4%), and Pt (up to 0.77%). They are presented as small spheres, unideal isomorphous crystals and films on native copper.

Except the native gold in the traprocks of the considering area during polished section studying detect such gold-containing minerals as cuproaurite (Cu_3Au), electrum (Au, Ag), rozhkovite (Cu, Au, Pd) and gold-containing pyrite (30 grams per ton).

Presence of gold (as chemical element) detected with all used analytic methods. Clear trends toward positive correlative geochemical relations with copper and silver are remarked. Gold content by the present microprobe analysis in native copper monofractions (n=49), extracted from the ore-bearing rocks of the occurrence, is 8.2 grams per ton in average.

The platinum group elements in relation to traprocks of the considering area and especially their copper-bearing are studied much weaker in comparison to before-mentioned noble metals. That is explained by underdeveloped analytic base for mass and express analy-

sis in the volcanic intervals and very low threshold of sensitivity most of the used laboratory methods.

Platinoid concentration in mineral form have not detected already. Perhaps some volume of native iron, that is often present as accessory mineral, might be tetraferroplatinum as a result of more detailed research.

Presence of platinum, palladium, rhodium and iridium is revealed by the results of microprobe analysis and ICP-MS method of copper-containing rocks studying. The first two elements are detected most often. Their contains for Zhyrychi and Rafalivka ore occurrences are 0.03 and 0.01 grams per ton for Pt and Pd accordingly (by the results of assay tests, n=42).

There total 53 down holes have been drilled on the ore occurrence territory (23850 linear meters). Reached network density is 1600×600×800 meters with concentration on some profiles to 800×800 meters. The evaluation and direct ore resources estimation for the "Zhyrychi" ore occurrence made in 2008 (M. I. Zhuykov and others, 2008). The prospective copper resources for the "Zhyrychi" ore occurrence counted by the P_1 and P_2 (Inferred Resources) categories. They approved in UkrRNRP and accepted in author's count. The potential copper deposit has prospects for increasing because it borders with the "Shmenky-Zalisy" ore occurrence and the Pivnichno-Girnytske copper-bearing field.

Its geometrization made on the grounds of structural and tectonic position in relation to Girnytskyi block. From the North and Northwest it is limited with the Lagozhanskyi sublatitudinal fault, from the west – with the feathering-out line ore-containing horizon 1A (Zabolotivska Suite), from the east - with feathering-line of the horizons 2A and 2B that coincide with ore-containing of the volcanic rocks mass (over 500 m thickness) submerge, from the South – the faults that belong to the Zabolottya-Bugska and Pivdenno-Ratnivska fault node.

The total area of the ore occurrence amount 36.4 square km that meets the area of horizon 1A distribution.

Considering all available geological-prospecting data, it was advisable, that the reserve estimation of copper and associated noble metals within Zhyrychi ore occurrence was calculated by three variant. It made by accepting as basis three gradation of cut-off grade,

weight-average copper contain on the ore intervals thickness less than 1 m that is 0.2, 0.3, and 0.4%.

The resources estimation made with direct calculation by the following formula

$$P = \frac{S * m * c * d * k}{100},$$

where

P - copper resources (thousand tons);

S - ore body distribution square (square meters);

m - average thickness (m);

C - weight-average copper contain in ore body (%);

d - ore-containing rocks volume density (tons per cubic meter);

k - reliability (veracity) coefficient.

The ore-containing squares mapping which used during copper resources estimation made with considering of the dawn holes data and their position in definite blocks (structures) of the territory. In addition, geological-prospecting features (mineralization character, its genetic features, individual aspects of the volcanic rock mass and its separate parts, syn-ore fault confinedness, possible volcanic processes developing etc.) was used.

The ore bodies thickness accepted by the results of the drilling. The copper contains was calculated with considering the achieved analytical data as results of chemical drill core sampling.

Project data of ore occurrence prospecting

Intended purpose of the ore occurrence further geological study works consists of the prospecting evaluation completion and its exploration with preliminary geological and economical assessment and copper balance reserves estimation by C_1 and C_2 categories (Probable Reserves) to the depth of 500-600 meters with delineation of mineralization by the copper content from 0.1% and its industrial parameters determination concerning the developed conditions. The geological prospecting project realization will be committed in a staged manner.

At the preliminary phase of Stage 1 (prospecting evaluation), the works will be concentrated in the limits of the site of 1 square kilometer area. There the drilling network density will reach from 400x400 meters to 200x200 meters.

At the final phase of Stage 1 the accomplishment of drilling works foreseen according to the planned networks of 400×400 meters in the ore occurrence border and 200x200 meters (16 square kilometers) on the most prospective part. That will give an opportunity to complete the prospecting-evaluation works with resources evaluation by P_1 category (Inferred Resources) and reserves estimation by C_2 category (Probable Reserves) accordingly.

The drilling will be accompanied by the assaying complexes, geophysical researches (which have been determinated at first phase work as rational ones), analytical, laboratory and technological researches, mineralization features modeling with Mining GIS "MICROMINE".

During Stage 2 (exploration) the down holes drilling by 100x100 meters network (reserves of C_1 category, Probable Reserves) determined on the area of approximately 6 square kilometers. The evaluation will be by P_1 category after Stage 1 (Inferred Resources, 16 square kilometers area), C_2 (Probable Reserves) category (10 square kilometers) and C_1 (Proved Reserves) category in the limit of researched square (1 square kilometers).

The cost of the exploration works is 28.84 million USD as on November 2019. The approximate cost of Stage 1 (prospecting evaluation) is 15-16 million USD, Stage 2 (the exploration) - 13-14 USD.

The calculated (indicative) cost of a exploring mine for research and industrial extraction is 5.2-6.4 million USD (with mine depth of 450 meters and 2 horizontal working galleries of 1 kilometer each on 2 horizons).

Technical and commercial indicators of the ore occurrence industrial development

Geological and commercial indicators were calculated based on technical and commercial data for the "Zhyrychi" ore occurrence (M.I. Zhuykov and others, 2008) according to currency rate as of November 2019 (25 UAH per 1 USD) and the market prices of designed mining camp's commodity products considering modern methods [5].

The depleted deposit will be conducted by complex mining and beneficiation plant (MBP). The copper concentrate will be presented as a commodity product with 80.0% copper content. It will be exposed metallurgical procession for copper and noble metals (gold, silver, platinum and palladium) extraction. At the MBP it is possible

to receive basalt raw materials that applicable for stone casting (the beneficiation tailings meet the requirements of the TU-14-12-190-02. Stone-casted chutes). The deposit development anticipated in underground way.

Ore beneficiation technology. The main ore beneficiation operations are crushing (to the limit piece of 0.04 millimeters), screening, hydraulic classification, gravity beneficiation, radiometric, electrical and magnetic separation. As a result of technology, probe beneficiation (0.313% mass fraction) was received the copper-containing concentrate with mass fraction of 81.18% and with initial ore extraction of 80.4% and the titanium-magnetite product with weight particles: Fe_2O_3-26.77%, FeO-26.1% and TiO_2-14.25% that is possible to use as ferriferous rare materials.

Using samples demonstrated by basalts (mass fraction of 0.14%) and their tuffs (mass fraction 0.46%) the beneficiation scheme was designed based on gravity (with receiving the coarse copper concentrate of 0.044 millimeters) and flotation (with receiving the fine copper concentrate) beneficiation cycles.

Expected capital costs of the industrial construction. In figure 4 the capital costs of the ore occurrence industrial development is given according to the basic (the first) evaluation option.

The mining camp construction investments calculated by analogy to the Bachtynske fluorite deposit.

The mining equipment cost calculated by analogy to the Saulyak gold deposit, the Bachtynske deposit, the Manuylivskiy iron ore deposit with appropriate amendment to the underground mines productivity and different time of the evaluation.

The capital investments cost in the beneficiation plant construction calculated by analogy to the Saulyak (the plant productivity is 200 000 tons of ore per year) and to the acting plant of the Muzhiivske mining and processing enterprise.

The capital investments cost in the Pobuzkiy nickel plant reconstruction for metallurgical processing of Volyn deposits is 23.1 million USD.

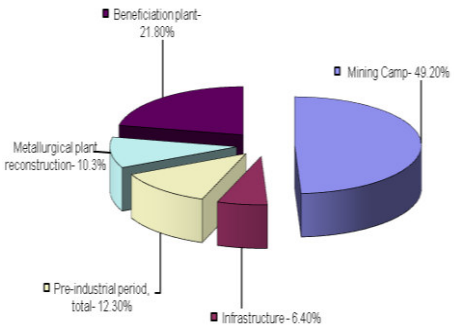

Fig. 4. The capital costs of the "Zhyrychi" ore occurrence industrial development

The possible operating cost of commodity production receiving calculated as the sum of cost mineral resource extraction and transportation from mine to beneficiation plant, its beneficiation, ore concentrate transportation to metallurgical plant where the final product is received (metallurgical copper and pure noble metals and alloys). The volumes of operating costs for commodity production receiving (commodity copper and gold, silver, platinum and palladium) are shown in the table and their structure is demonstrated in figure 5.

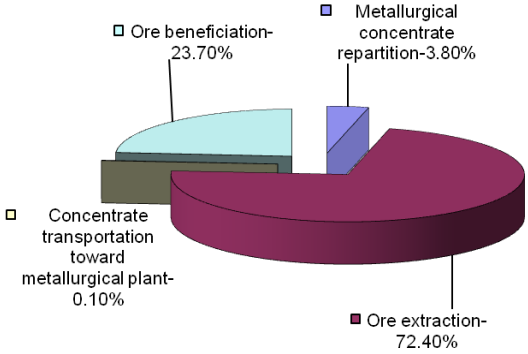

Fig. 5. The operation costs structure for commodity production receiving

The economic efficiency indicators of the ore occurrence industrial development

The commodity production price determined by three options of evaluation as a product of mining camp annual productivity figures, terms of deposit operation and the commodity production wholesale price which was on the global and domestic markets as of November 2019 (Table 1).

The balance (gross) income of the company was calculated as the difference between the annual volume of commodity production in realization price and the cost price of extraction and finished product transportation to warehouse without fees, taxes and charges stipulated by Ukraine current legislature, which were included into the production cost price. The company income was calculated as the difference between the price of commodity production annual volume in realization prices and the annual cost of production (with considering of depreciation charges). The profitability level determined as the ratio of company income to total cost of fixed assets (investments cost) and operating costs. The recoupment term was calculated as the ratio of their prices to company income.

Table 1

The calculation of the mining camp commodity production price

Indicator name	Units	Reserves estimation options		
		I	II	III
Cut-off grade copper content in one sample	%	0.2	0.3	0.4
Annual mining camp productivity				
copper ore	thousand tons	closed information	2 000.0	1 500.0
noble metals				
gold	kilograms	61.6	50.0	48.3
silver	kilograms	5301.7	4302.8	4156.4
platinum	kilogram	43.7	28.5	21.1
palladium	kilogram	14.6	9.5	7.0
building rubble	thousand cubic meters	208.9	139.3	104.5
stone casting raw materials	thousand tons	1500.0	1000.0	750.0
deposit operation term	years	76.3	75.3	65.0
Wholesale final product price (without AVT)				
metallurgical copper (1 ton)	USD	4 810.00	4810.00	4810.00
gold (1 kilogram)	USD	43050.0	43050.0	43050.0
silver (1 kilogram)	USD	639.0	639.0	639.0
platinum (1 kilogram)	USD	37522.0	37522.0	37522.0
palladium (1 kilogram)	USD	22835.0	22835.0	22835.0

Continuation of table. 1

1 cubic meter of building rubble	USD	16.3	16.3	16.3
1 ton of stone casting raw materials	USD	17.5	17.5	17.5
Income from annual volume commodity product realization				
metallurgical copper	thousand USD	37037.0	28860.0	26936.0
noble metals	thousand USD	8012.77	6188.26	5686.814
building rubble	thousand USD	3405.07	2270.59	1703.35
stone casting raw materials	thousand USD	26 250.0	17 500.0	13 125.0
total gross income	thousand USD	74704.84	54818.85	47451.16
the same for entire operation term	million USD	5699.98	4127.86	3084.34

The results of income calculation, production profitability level by the evaluation options are demonstrated in table 2.

Table 2

The results of income calculation, production profitability level and recoupment term

Indicator name	Units	Ore reserves estimation options		
		I	II	III
cut-off grade copper content in one sample	%	0.2	0.3	0.4
capital costs in deposit industrial development	thousand USD	118611.332	85935.828	72103.6
annual operation costs of commodity production receiving	thousand USD	29368.11	19561.87	16728.53
the same for entire operation term	million USD	2240.788	1473.0112	1087.356
Indicator name	Units	Ore reserves estimation options		
		I	II	III
cost of company deriving from operation	thousand USD	5929.67	4296.29	3604.03
total costs for entire operation term	million USD	2365.328	1563.244	1163.064
income from annual volume commodity product realization	thousand USD	74704.84	54818.85	47451.16

Continuation of table. 1

the same for entire operation term	million USD	5699.98	4127.86	3084.33
Company income without taxes				
annual	thousand USD	45336.73	35256.98	30722.63
for entire operation term	million USD	3459.19	2654.85	1996.97
investments profitability level to profits taxation	%	146	169	172

As it can be seen from the table, the future development of the "Zhyrychi" native copper ore occurrence is profitable by all of considered options of cut-off grade copper content. The profitability level of the production to investments in industrial construction by considered options is higher the higher cut-off grade copper content in one sample is.

Conclusion

The best of considered economic evaluation options (without taxes) for the entire operation term of future deposit for the "Zhyrychi" ore occurrence is as follows. Option 1-0.2% cut-off grade copper content (by company income of 3459.19 million USD). Option 3-0.4% copper content in one assay (by profitability level 172%). The operation of the deposit by those cut-off grades will provide 2.6 times increase the recoupment of primary capital investments. Considering the received geological and economical indicators and the employment opportunity of several thousand people for the long term (65-80 years). We can conclude about indisputable industrial importance of the "Zhyrychi" ore occurrence and its advisability further geological study and industrial development.

Significant necessary investments urge to searching ways of improve the investment attractiveness of copper mining in the Volyn. That might be achieved by increasing of the commodity production price, decrease of operation costs and creation of a favorable investment climate.

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