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Anachronism of the obligatory copper ores recoverability criteria in Pre-Sudetian Monoclyne considered in aspect of high metal prices

Key words

Copper ore mining, recoverability criteria, deposit resources, economy of resources

Abstract

A fact that in spite of more and more often affords aimed to correction of actually obligatory recoverability criteria related with poli-metallic ore deposits do not follow current increase of the deposit value resulting from high copper prices on the World markets was pointed out in the present study. Based on the analysis of two geological bore-holes it was proved in the study that actual value of $1m^2$ of the deposit occurring around the bore-hole, from which the data are classified according to current and former criteria as non-recoverable (because of small efficiency or too low equivalent percentage content of Cu), is comparable to value of $1m^2$ of the deposit classified according to criterions from the year 1977 (and actual) as recoverable resources. Some doubts were also pointed out with respect to calculation procedure of equivalent Cu percentage content taking under consideration rigid parity Cu versus Ag, as the value of silver is usually overestimated, and moreover, price fluctuations of these both metals are not mutually correlated.

Introduction

In the last two years copper prices reached very high level, 250% higher than maximal prices observed up to the year 2005. Thus a question related with possibility and profitability of exploitation of deposit classified according to actually obligatory criteria as non-reco-

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verable deposit is arisen. In the present study actual (according to current metal prices) value 1 m^2 of non-recoverable deposit was compared with a value of 1 m^2 of recoverable deposit calculated according to former metal prices. However, it is a question about necessity of acceptance of actually obligatory recoverability criterion as the only right criterion of selection of the deposit to exploitation under conditions of the current production realization. This question is particularly important in situation of decrease of documented resources of individual mines, including perspective of their depletion in 20–25 years. Exploitation of non-recoverable deposit in conditions of actual prosperity for copper allows extending of mines operation period, including whole region.

In the authors opinion, which was suggested in their former works, recoverability criteria of polimetallic resources are useful already during stage of documentation of the resources, as well as during designing works related with first working of the resources. Since exploitation is started, according to mining rules, i.e. without leaving of a deposit part within abandoned workings, a rule of excavation of possibly poorly metallized zones of the deposit should be followed, however constant and stable profit level should be assered.

1. Recoverability criteria obligatory for copper ore deposits of the Pre-Sudetian Basin

Resources belonging to Mines, which are subjected to exploitation should be determined on a basis of objective criteria allowing from one side economical profitability of excavation and from the other side they should mobilize for clean excavation of the resources, including minimization of loses resulting from abandoning exploitation in conditions of economical profitability. In Polish mining industry, this function should be replaced by recoverability criteria determined for individual deposits of useful minerals.

Recoverability criteria of mineral resources are needed for proper execution of works in stage of designing of mining field management, building new Mines and execution of studies related with development of already existing mines. Based on long-term prognosis of the world prices of individual useful minerals an average level of these prices can be determined, including their extreme values (minimal and maximal). Knowing prognosis of the deposit exploitation we can determine critical values related to minimal parameters of a deposit classified as non-recoverable resource. Recoverability criteria should as a rule keep their topicality during such long time interval, as defined by already existing prognosis being a base of the criteria defining.

In Poland, recoverability criteria for copper ores occurring in Pre-Sudetian Monocline were for the first time determined in the year 1959, two years after the deposit was found. Next criteria were determined in 1965, 1977, 1993 and 2001. Recently determined recoverability criteria in Poland, including copper ores, have been published in the year 2005, and they are identical with those determined in the year 2001. Essential requirements of these criteria are shown in Table 1.

TABLE 1

Recoverability criteria requirements for copper ores in Pre-Sudetian Monoclyne

TABELA 1

Wymagania kryteriów bilansowości dla złóż rud miedzi w monoklinie przedsudeckiej

No.	Parameter	Unit	Recoverability criteria value				
			1959	1965	1977	1993	2001–2005
1	Limit content of copper (Cu) for bore-hole or excavation	%	n.d.	0.7	0.6–0.8 [1)]	0.7	0.7
2	Minimal average content of copper in bore-hole or excavation profile (Cu_e)	%	1.0	0.9	1.0–1.3 [1)]	0.7	0.7
3	Minimal average content of copper in the deposit	%	n.d.	1.5–1.7 [1)]	1.7–2.4 [1)]	n.d.	n.d.
4	Minimal reserves of deposit per sq.m (Cu_e)	kg/m^2	30 [2)]	42 [2)]	n.d.	50	50 (35)
5	Minimal thickness of the deposit	m	n.d.	n.d.	2.0	n.d.	n.d.
6	Minimal resources	mln Mg	n.o.	n.o.	200	n.d.	n.d.
7	Maximal depth of the deposit floor	m	1000	1500	2000	1250 (1500) [3)]	1250 (1500) [3)]
8	Conversion factor silver – equivalent copper	–	n.d.	10 g Ag = = 0.58 kg Cu	10 g Ag = = 0.08% Cu	1g Ag/Mg = = 0.01% Cu	1g Ag/Mg = = 0.01% Cu

n.d. – not determined.

[1)] Depending on the deposit occurrence depth (later interpreted as depth of occurrence of mine excavation levels).

[2)] Minimal reserves of deposit per sq. m (efficiency) for copper content in ore higher or equal then in the years 1959 and 1965 respectively 1.0% i 0.9%; reserves of deposit per sq. m of 20 kg/m^2 are also permitted for minimal content of Cu in deposit profile of 1.5%.

[3)] Permissible depth of 1500 m in – for a case when possibility of deposit management is proved. In case of developed fields the floor depth is determined with respect to floor of the lowest drawing shaft.

Values in brackets refer to non-recoverable resources.

As seen from the above comparison, the criteria were elaborated in long time intervals, amounting for consequently 6, 12, 16, 8 and recently 4 years. Long time intervals between consequent actualizations of recoverability criteria till the year 1990 can be explained by specific attitude to economical problems in the past in Poland, as well as by apparent stabilization of metal prices. Copper prices on World markets oscillated within the range 1300–2400 USD/Mg, whereas silver prices oscillated from 0.10 to 0.20 USD/g respectively. After the year 1990 when State economical policy was changed, World prices should be taken into consideration during current activity of Mines, especially that in the year 1995 and 1997 copper price reached level of 3000 USD/Mg. This price fluctuation reaching to 150% of minimal price motivated authors (Jasiewicz, Magda 1998) to test rightness of the calculation of so called equivalent copper based on constant conversion factor, according to which beginning from the year 1993 up to the present time 1 g Ag in one tone of ore is equivalent to 0.01% Cu. It was proved that use of this conversion factor overprices value of silver in the deposit.

During recent two years, copper prices on World markets made nice surprise to Polish copper mining. Copper price in the year 2005 exceeded 3000 USD/Mg and after a jump in the year 2006 up to almost 9000 USD/Mg it actually reaches average level of 7500 USD/Mg (Fig. 1). It is almost 500% increase as compared to minimal price (1500 USD/Mg) and 250% as compared to prosperity period of the year 1995.

The last recoverability criteria were determined by the end of the year 2005 that is before rise of the copper prices. In the light of this fact we can propose hypothesis that resources assumed as non-recoverable can actually be treated as profitable subject of exploitation.

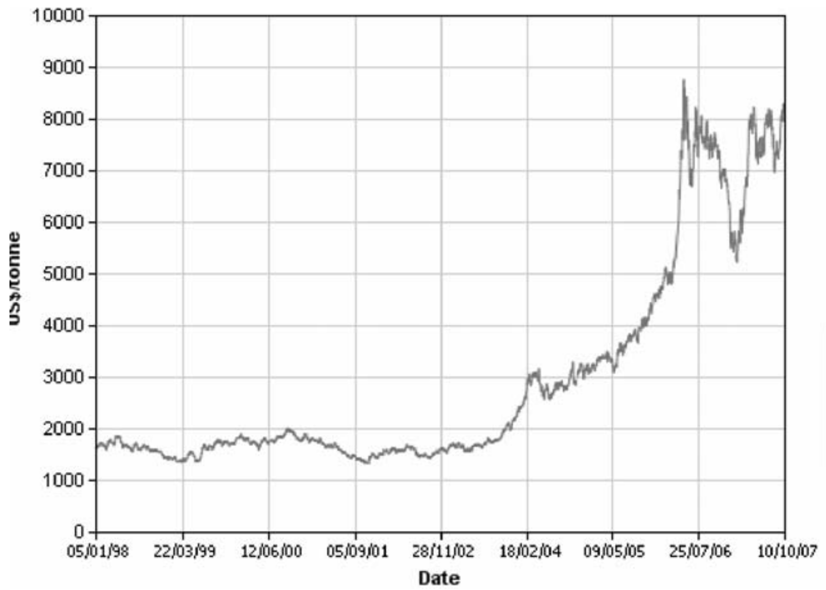

Fig. 1. Copper price graph for the years 1998–2007 (www.lme.co.uk)

Rys. 1. Kształtowanie się ceny miedzi w latach 1998–2007 (www.lme.co.uk)

2. Analysis of the ore value for chosen bore-holes

Recoverability criteria are reasonable during a period of preliminary and designing works covering whole mining fields or mining regions. However, different situation occurs in case of current mine operation. In this case current decisions should be taken with respect to exploitation of concrete field. While taking such decisions in conditions of market economy (such economy was introduced formally after the year 1989) current level of the World prices in value of excavated useful mineral should be taken under consideration. Studies of this type were already made by the authors of the present study (Jawień, Jasiewicz 1991) and (Jasiewicz 1993, 1994). Based on internal formula for ore price which is sent to Ore Enrichment Company (ZWR) and on World market prices of copper and silver, a relation between exploitation height and value of ore excavated from 1 m^2 of the deposit was determined. Exploitation costs can be estimated both on the basis of data monitored by the Mine, or in case of change of exploitation technology, mathematical modeling can be used (for example Jasiewicz 2000). In situation when value of the deposit exceeds cost of its exploitation, the field exploitation can be treated as profitable, even if it cannot be proved due to recoverability criteria.

In order to prove this thesis, calculations of ore value in region of two bore-holes S-27 and S-124 were executed. According to obligatory recoverability criteria, bore-hole S-27 is considered as recoverable bore-hole, whereas bore-hole S-127 is considered as non-recoverable one. Geological data characterizing the deposit near these two bore-holes are shown in Tables 2 and 3. For each of selected layer (38 in case of bore-hole S-27 and 41 in case of bore-hole S-124) depth of the layer roof and floor, copper content, silver content, lead content, and type and volume weight of the rock are listed.

Studies of the deposit value in both bore-holes according to selling price of ores sent to Ore Enrichment Company ZWR were made for the following values of copper and silver prices on international markets:

— for copper two extreme values were selected: 1500 and 7500 USD/Mg,

— for silver: 0.20, 0.40, 0.60, 0.80 and 1.00 USD/g.

Graphical relation between exploitation height and value of ore occurring on the area of 1 m^2 within the range from 0.10 do 4.00 m for examined copper prices and silver price of 0.40 USD/Mg for bore-hole S-27 is shown in Figure 2. As was expected, copper price increase caused consequent increase of the resource value within whole range of examined exploitation height. Maximum of the resource value for copper price of 1500 USD/Mg (marked on the figure as P3 = 1500) was observed for exploitation height of 2.59 m, whereas for copper price of 7500 USD/Mg (P3 = 7500) this maximum was observed for the exploitation height of 2.82 m. From the other side, reserves of the deposit per sq. m. increased proportionally to increase of the exploitation height, reaching value of 123.09 kg/m^2 for the exploitation height of 4.00 m.

Analogically, graphical relation between exploitation height and value of ore occurring on the area of 1 m^2, within the range from 0.10 to 4.50 for examined copper prices and silver

TABLE 2

Geologic data in bore-hole S-27

TABELA 2

Charakterystyka złoża w otworze S-27

No. of stratum	Depth interval		Contents			Density	Type of rock
	from	to	Cu	Pb+As	Ag		
	m	m	%	%	g/Mg	Mg/m^3	
1	642.67	642.86	0.05	0.51	0.0	2.4	dolomite
2	642.86	643.03	0.49	0.24	0.0	2.4	dolomite
3	643.03	643.18	0.10	0.87	0.0	2.4	dolomite
4	643.18	643.32	0.07	1.15	0.0	2.4	dolomite
5	643.32	643.45	0.08	0.84	0.0	2.4	dolomite
6	643.45	643.59	0.10	2.40	0.0	2.4	dolomite
7	643.59	643.73	0.10	4.01	0.0	2.4	dolomite
8	643.73	643.83	0.54	4.48	0.0	2.4	dolomite
9	643.83	643.93	1.97	0.17	200.0	2.5	shale
10	643.93	644.00	1.93	0.10	200.0	2.5	shale
11	644.00	644.12	11.64	0.07	200.0	2.5	shale
12	644.12	644.21	2.53	0.07	200.0	2.5	shale
13	644.21	644.31	3.54	0.03	150.0	2.3	sandstone
14	644.31	644.47	0.54	0.02	0.0	2.3	sandstone
15	644.47	644.61	0.45	0.04	0.0	2.3	sandstone
16	644.61	644.69	0.22	0.01	0.0	2.3	sandstone
17	644.69	644.82	0.21	0.01	0.0	2.3	sandstone
18	644.82	644.92	1.32	0.01	120.0	2.3	sandstone
19	644.92	645.09	1.09	0.01	120.0	2.3	sandstone
20	645.09	645.19	1.14	0.01	120.0	2.3	sandstone
21	645.19	645.31	1.42	0.01	120.0	2.3	sandstone
22	645.31	645.41	1.64	0.01	120.0	2.3	sandstone
23	645.41	645.48	1.39	0.03	120.0	2.3	sandstone
24	645.48	645.60	1.17	0.05	120.0	2.3	sandstone
25	645.60	645.71	1.00	0.01	120.0	2.3	sandstone
26	645.71	645.81	1.87	0.01	120.0	2.3	sandstone
27	645.81	645.94	1.45	0.01	120.0	2.3	sandstone
28	645.94	646.09	2.01	0.01	120.0	2.3	sandstone
29	646.09	646.25	3.18	0.01	120.0	2.3	sandstone
30	646.25	646.42	1.17	0.01	120.0	2.3	sandstone
31	646.42	646.55	0.35	0.03	0.0	2.3	sandstone
32	646.55	646.64	0.07	0.02	0.0	2.3	sandstone
33	646.64	646.73	0.12	0.01	0.0	2.3	sandstone
34	646.73	646.90	0.08	0.01	0.0	2.3	sandstone
35	646.90	647.03	0.10	0.02	0.0	2.3	sandstone
36	647.03	647.17	0.03	0.01	0.0	2.3	sandstone
37	647.17	647.29	0.15	0.01	0.0	2.3	sandstone
38	647.29	647.40	0.13	0.01	0.0	2.3	sandstone

TABLE 3

Geologic data in bore-hole S-124

TABELA 3

Charakterystyka złoża w otworze S-124

No of stratum	Depth interval		Contents			Density	Type of rock
	from	to	Cu	Pb+As	Ag		
	m	m	%	%	g/Mg	Mg/m3	
1	864.41	864.58	0.02	0.47	0.0	2.4	dolomite
2	864.58	864.74	0.06	1.00	0.0	2.4	dolomite
3	864.74	864.92	0.20	5.86	0.0	2.4	dolomite
4	864.92	864.97	0.20	9.36	0.0	2.4	dolomite
5	864.97	865.07	1.90	4.33	151.0	2.5	shale
6	865.07	865.13	6.50	0.15	151.0	2.5	shale
7	865.13	865.19	1.04	0.74	151.0	2.5	shale
8	865.19	865.31	0.58	0.20	0.0	2.3	sandstone
9	865.31	865.47	0.25	0.00	0.0	2.3	sandstone
10	865.47	865.63	0.30	0.00	0.0	2.3	sandstone
11	865.63	865.73	0.25	0.00	0.0	2.3	sandstone
12	865.73	865.85	0.20	0.00	0.0	2.3	sandstone
13	865.85	865.97	0.20	0.00	0.0	2.3	sandstone
14	865.97	866.12	0.05	0.00	0.0	2.3	sandstone
15	866.12	866.24	0.35	0.00	0.0	2.3	sandstone
16	866.24	866.39	0.97	0.00	0.0	2.3	sandstone
17	866.39	866.55	0.96	0.00	0.0	2.3	sandstone
18	866.55	866.65	0.20	0.00	0.0	2.3	sandstone
19	866.65	866.76	0.25	0.00	0.0	2.3	sandstone
20	866.76	866.88	0.82	0.01	0.0	2.3	sandstone
21	866.88	866.99	0.84	0.01	0.0	2.3	sandstone
22	866.99	867.12	0.84	0.01	0.0	2.3	sandstone
23	867.12	867.27	0.69	0.01	0.0	2.3	sandstone
24	867.27	867.42	0.14	0.01	0.0	2.3	sandstone
25	867.42	867.57	0.94	0.01	0.0	2.3	sandstone
26	867.57	867.73	0.20	0.01	0.0	2.3	sandstone
27	867.73	867.90	0.25	0.01	0.0	2.3	sandstone
28	867.90	868.05	0.30	0.01	0.0	2.3	sandstone
29	868.05	868.19	0.35	0.01	0.0	2.3	sandstone
30	868.19	868.28	0.40	0.01	0.0	2.3	sandstone
31	868.28	868.39	0.20	0.01	0.0	2.3	sandstone
32	868.39	868.57	0.15	0.01	0.0	2.3	sandstone
33	868.57	868.76	0.20	0.01	0.0	2.3	sandstone
34	868.76	868.89	0.30	0.01	0.0	2.3	sandstone
35	868.89	869.05	0.40	0.01	0.0	2.3	sandstone
36	869.05	869.20	0.20	0.01	0.0	2.3	sandstone
37	869.20	869.36	0.14	0.01	0.0	2.3	sandstone
38	869.36	869.52	0.15	0.01	0.0	2.3	sandstone
39	869.52	869.72	0.15	0.02	0.0	2.3	sandstone
40	869.72	869.82	0.08	0.01	0.0	2.3	sandstone
41	869.82	870.00	0.06	0.02	0.0	2.3	sandstone

price of 0.40 USD/Mg for bore-hole S-124, is shown in Figure 3. Maximum value of the deposit resources for copper price of 1500 USD/Mg (marked on the figure as P3 = 1500) was observed for exploitation height of 0.22 m, whereas for copper price of 7500 USD/Mg (P3 = 7500) maximum value of the deposit resources was observed for the exploitation height of 2.60 m. Decrease of the ore price should be pointed out (price of ore, which is sold to

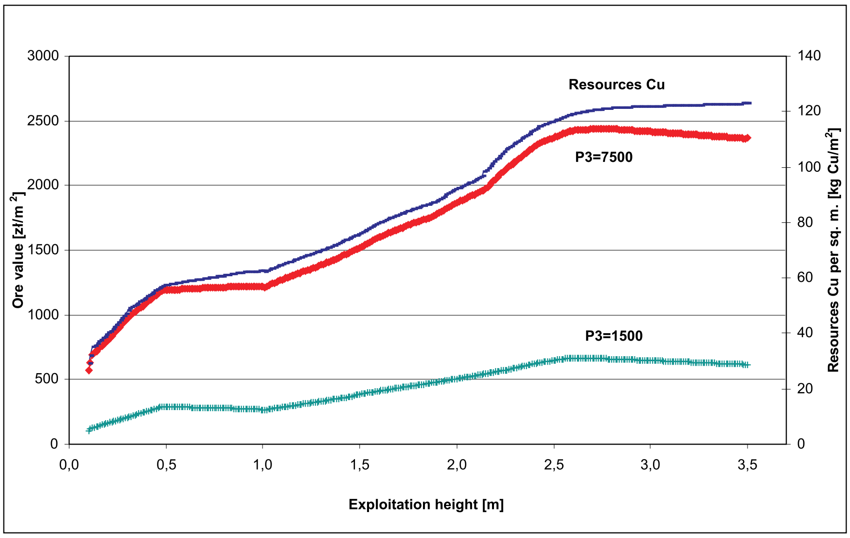

Fig. 2. Value of deposit and reserves per sq. m. versus exploitation height for bore-hole S-27

Rys. 2. Zależność wartości złoża i zasobności od wielkości furty eksploatacyjnej dla otworu S-27

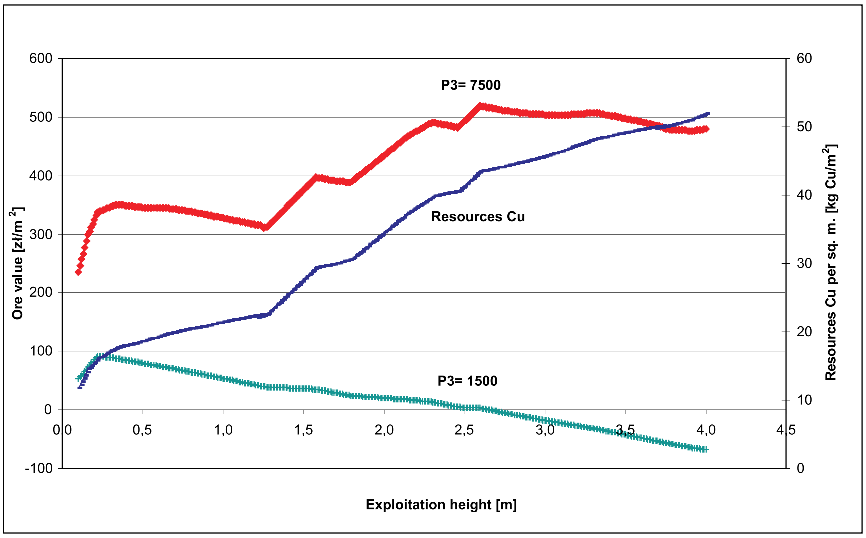

Fig. 3. Value of deposit and reserves per sq. m. versus exploitation height for bore-hole S-124

Rys. 3. Zależność wartości złoża i zasobności od wielkości furty eksploatacyjnej dla otworu S-124

ZWR), what means decrease of the ore value below the level of 0 PLN/m^2 for the exploitation height bigger than 2.65 m. Reserves of the deposit per sq. m., similarly as was observed for the bore-hole S-27, increased proportionally to exploitation height increase, reaching value of 51.82 kg/m^2 for the exploitation height of 4.50 m.

Values of the exploitation height, for which at the examined copper and silver prices value of the deposit reaches its maximal value, are cited in Table 4. Analysis of obtained results proved that for the copper price of 1500 USD/Mg the exploitation height of 2.59 m allows to reach maximal value of ore from 1 m^2, whereas for price 7500 USD/Mg the favorable exploitation level is 2.82 m. It should be noted that in both copper prices no change of exploitation height under influence of silver price increase was observed. In case of copper price of 1500 USD/Mg, copper reserves of deposit per sq. m at exploitation height of 2.59 m amounts for about 119 kg/m^2, and value of ore in dependence on silver price ranges from about 383 to 1525 PLN/m^2. In case of price 7500 USD/Mg reserves of deposit per sq. m at exploitation height 2.82 m amounts for about 121.3 kg/m^2, and ore value ranges from 2150 to 3290 PLN/m^2.

Analogically, values of exploitation height, for which, at the examined copper and silver prices, value of the deposit reaches its maximal value, are cited in Table 5, for non-recoverable bore-hole S-124. At copper price of 1500 USD/Mg exploitation height 0.22 m allows to reach maximal value of ore from 1 m^2, whereas for price of 7500 USD/Mg

TABLE 4

Exploitation height for which the value of deposit achieves maximum for different copper and silver prices bore-hole S-27

TABELA 4

Wielkość furty eksploatacyjnej, dla której przy danych cenach miedzi i srebra wartość złoża osiąga wielkość maksymalną – otwór S-27

Copper price	Silver price	Exploitation height	Copper content	Ore price	Ore value	Reserves Cu per sq. m.
USD/Mg	USD/g	m	%	zł/Mg	zł/m^2	kg/m^2
1500	0.2	2.59	1.97	63.47	382.89	118.98
	0.4	2.59	1.97	110.79	668.41	118.98
	0.6	2.59	1.97	158.12	953.92	118.98
	0.8	2.59	1.97	205.44	1239.44	118.98
	1.0	2.59	1.97	252.77	1524.96	118.98
7500	0.2	2.82	1.85	327.02	2149.17	121.32
	0.4	2.82	1.85	370.46	2434.68	121.32
	0.6	2.82	1.85	413.91	2720.20	121.32
	0.8	2.82	1.85	457.35	3005.72	121.32
	1.0	2.82	1.85	500.80	3291.24	121.32

TABLE 5

Exploitation height for which the value of deposit achieves maximum for different copper and silver prices bore-hole S-124

TABELA 5

Wielkość furty eksploatacyjnej, dla której przy danych cenach miedzi i srebra wartość złoża osiąga wielkość maksymalną – otwór S-124

Copper price	Silver price	Exploitation height	Copper content	Ore price	Ore value	Reserves Cu per sq. m.
USD/Mg	USD/g	m	%	zł/Mg	zł/m^2	kg/m^2
1500	0.20	0.22	2.92	102.61	56.43	16.06
	0.40	0.22	2.92	167.33	92.03	16.06
	0.60	0.22	2.92	232.05	127.63	16.06
	0.80	0.22	2.92	296.78	163.23	16.06
	1.00	0.22	2.92	361.50	198.83	16.06
7500	0.20	2.60	0.72	80.27	483.55	43.48
	0.40	2.60	0.72	86.18	519.15	43.48
	0.60	2.60	0.72	92.09	554.75	43.48
	0.80	2.60	0.72	98.00	590.35	43.48
	1.00	2.60	0.72	103.91	625.94	43.48

the exploitation height amounts for 2.60 m. Similarly as was observed in case of bore-hole S-27 change of exploitation height under influence of silver price increase was not observed for both copper prices. In case of copper price of 1500 USD/Mg, copper reserves of deposit per sq. m at exploitation height 0.22 m amounts for about 16 kg/m^2, and ore value in dependence on silver price ranges from about 56 to 198 PLN/m^2. In case of price of 7500 USD/Mg, reserves of deposit per sq. m at the exploitation height of 2.60 m amounts for about 43.5 kg/m^2, and ore value ranges from 483 to 626 PLN/m^2.

The following conclusions can be drawn from executed examinations:

1. Value of ore excavated from 1 m^2 of the deposit area increases proportionally to rise of copper and silver price.
2. There is a definite exploitation height, for which value of the deposit occurring on area of 1 m^2 reaches its maximal value. Rising exploitation height over this value results in deposit value drop, thus exploitation of this deposit at higher exploitation height will not assure profit from a given field.
3. No change of exploitation height, for which deposit value reaches its maximal value in dependence on silver price fluctuations, was observed. However, change of exploitation height, for which deposit value reaches its maximal value due to copper price change, was observed.
4. Subconscious reasoning that increase of exploitation height allows excavation of greater amount of metal, i.e. receiving bigger ore value of ore excavated from 1 m^2 of the deposit

area is wrong because examination of maximal value of ore excavated from 1 m^2 of the deposit area prove existence of relatively narrow range of rationally determined exploitation height.

5. Ore occurring in bore-hole S-27 meets deposit recoverability criteria with respect to content of copper in ore, as well as with respect of reserves of deposit per sq. m,
6. Ore occurring in bore-hole S-124 does not meet deposit recoverability criteria with respect to reserves of the deposit per sq. m.
7. Value of ore occurring in bore-hole S-27 for the copper price of 1500 USD/Mg is comparable to value of ore occurring in bore-hole S-124 for copper price of 7500 USD/Mg, what proves exploitation profitability of this ore (non-recoverable ore!) for copper price of at least 7500 USD/Mg.

Summary

Necessity of obligation of the recoverability criteria is not disputable because the criteria constitute base for geological documentations of the deposits in question. Also at the stage of analytical and design works related with making technical documentations and management of definite deposit, a designer is obliged to take under his consideration the up-dated recoverability criteria. Making suitable deed, which contain or modify obligatory criteria, the employer should take under consideration value of mineral deposit and probable cost of its exploitation and processing.

In the last two years copper prices jumped up considerably on the World markets and after a jump in the year 2006 up to almost 9000 USD/Mg, they actually fluctuate around 7500 USD/Mg. It is 5-fold increase with respect to the minimal price (1500 USD/Mg) and almost 2.5-fold increase with respect to prosperity period of the year 1995. Meanwhile, the latest recoverability criteria have been introduced at the beginning of the year 2005, that is before this rise of copper prices. It means that a part of resources classified as non-recoverable can actually constitute a subject of profitable exploitation. It is confirmed by the described above analysis of deposit value in two bore-holes, from which one bore-hole is classified according to obligatory criteria as non-recoverable. From the other side it was proved by the calculations that actual deposit value in non-recoverable bore-hole is similar to the deposit value in recoverable bore-hole with reference to metal prices before the boom period. This proves no usability of the recoverability criteria during a stage of mine operation. Thus only current ore value from 1 m^2 of the deposit can be considered as a factor defining usability of the deposit for profitable exploitation.

Second essential disadvantage of the discussed recoverability criteria results from calculation of equivalent percentage copper content in case of occurrence of silver minerals in given part of the deposit. As was proved, use of rigid formula according to which 1 g Ag in one tone of ore is adequate to 0.01% Cu usually surpasses content of silver in the deposit, what often exposes given mining company to economically non-profitable exploitation of some deposit fragments, which according to this formula were classified as recoverable. In case of drastic change of mutual price relation between these two metals, which is related with big increase of silver price and drop of copper price, this formula can also qualify a fragment of the deposit as non-recoverable, although it is highly metallized with silver minerals, which is such situation is useful for exploitation. Thus it is consecutive argument stating that decision about exploitation within given exploitation field should be taken on the basis of actual metal prices on the World markets.

Executed calculations suggest a thesis that obligatory recoverability criteria needed during analytical and design stage, during exploitation phase should not restrict free selection of fields selected to exploitation, because during market slump period, the criteria surpassing the deposit value, force mining companies to bear loses during exploitation of formally recoverable deposit, although its excavation in this period is not profitable, whereas in prosperity periods they can be reason of stoppage of exploitation of a part of the deposit classified as non-recoverable, despite of the fact that ore value is higher than excavation costs.

When sequence of exploitation of individual parts of the mining field is planned, mining rules aimed at avoiding situations favoring generation of stresses should be followed, i.e. leaving of not excavated deposit fragments within three-sided surrounding of the excavation, however these plans should be continuously monitored and corrected, based on the current value of $1m^2$ of the deposit. A pursuit of continuous excavation of relatively poorly metallized parts of the deposit assuring fixed profit level is also suggested. This attitude can protect mines against situations when during economical boom period and extreme big profits, there are many temptations to their consumption, and in the market slump periods, because of loses related to basal activities, mining companies can suffer of lack of assets for basal needs.

In situation of mutual settlements between mining companies and ore enrichment companies, assessment of ores sent to ore enrichment companies should be made with particular care. It could be rather strange if the ore enrichment companies (ZWR) tending to their own profits did not try to underrate the value of ore received, what could force some mines to stop excavation of poorly metallized ore, what from the other side could be profitable for KGHM Polska Miedź S.A. Such situation could be avoided in case of total settlement of technological process of the company, beginning from mines and ending on metallurgic plants. This idea has been already broadly described (Jasiewicz et al. 2007a and b).

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ANACHRONIZM OBOWIĄZUJĄCYCH KRYTERIÓW BILANSOWOŚCI RUD MIEDZI W MONOKLINIE PRZEDSUDECKIEJ W ASPEKCIE WYSOKICH CEN METALI

Słowa kluczowe

Górnictwo rud miedzi, kryteria bilansowości, zasoby złoża, gospodarka złożem

Streszczenie

Artykuł zwraca uwagę na fakt, że mimo coraz częstszych prób korygowania obowiązujących kryteriów bilansowości złóż rud polimetalicznych, nie nadążają one za wzrostem wartości złóż w wynikającym z wysokich cen metali na rynkach światowych. Analizując dane z dwóch otworów geologicznych dowiedziono w artykule, że aktualna wartość 1m^2 złoża w otoczeniu otworu z którego dane uznawane są według obecnych i wcześniejszych kryteriów za pozabilansowe (z powodu za małej zasobności, albo zbyt niskiej ekwiwalentnej zawartości procentowej Cu), jest porównywalna z wartością 1 m^2 złoża uznanego według kryteriów z 1977 roku (i obecnych) za złoże bilansowe. Podniesiono również wątpliwości co do zasady przeliczania ekwiwalentnej zawartości procentowej Cu z uwzględnieniem sztywnego parytetu Cu do Ag, jako że wartość srebra w tych przeliczeniach na ogół jest zawyżana, a nadto wahania cen obydwu tych metali nie są ze sobą skorelowane.