

MOLYBDENUM, UNUSED CHANCE FOR RBB BOR

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Abstract

Possibility for valorization of molybdenum from copper ore, which is excavating in RBB Bor (Copper Mines Bor), was analyzed several times. The most serious analyze was done in 1982nd, during the preparations for starting exploitation in "Veliki Krivelj" mine. That was the time when Copper Institute in Bor made "Techno-economical study of possibility for producing and treatment of molybdenum concentrates", and the facility for extraction of molybdenum from copper-molybdenum concentrates in flotation plant "Veliki Krivelj" was built. Production of molybdenum in this facility has never started because of the various justified and unjustified reasons. Second, not so serious, analyze of possibility for valorization of molybdenum was done in 2005th, when "RIVS" institute from St. Petersburg, Russia, showed, in its "Study of technological processes for enrichment of smelter slag and underground pit ore in flotation plant "Bor" and copper ore in flotation plant "Veliki Krivelj" ", that it would be interesting to discuss again economical justification of valorization molybdenum in "Veliki Krivelj" mine. However, that statement was based on wrong conclusions from the data of molybdenum concentrations in ore, more then twice greater then real. On the other hand, they did not see or comment very high concentration of molybdenum in slag. Because of that, but also several other inconsistencies, that study showed many weaknesses. Therefore, that is why the need for taking more serious analyzes of possibility for valorization of molybdenum in RBB Bor, and to show its potentiality, appeared.

Key words: *molybdenum, molybdenite, potentiality, alloys, ore, slag.*

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1. Introduction

According to "International Molybdenum Association" reports, proven reserves of molybdenum in the world are 12 million tones of metal. "The U.S. Geological Survey" operates with more than 19 million tones of reserves, adding to those significant quantities in China. No matter which of this figures are correct, it is quite probable that it can "satisfy more than hundred years of current needs", according to "Resource Investor.com". Same source also said that " molybdenum market is one of the obscurest in the world, where real information about bids and demands are hard to get, and the information which can be found could easily mislead its user" That is why long-term predictions and prognoses about molybdenum market behavior are very uncertain.

During last decades, molybdenum price raised from about 6 USD/kg during 90's to 35 USD/kg in 2004th and further on to 60-70 USD/kg in 2005th, with constant rise of spending. Before that, highest average price of molybdenum was about 16 USD/kg in 1995th . That increase of demands for the metal is also strictly connected with use in steel sector and its special alloys, while its offer was mainly the result of its parallel production with copper production. One percent of molybdenum is equivalent of 3% of chrome in steel alloy and stainless steel construction, which usually has 2-3% of molybdenum. Increase of other metal's alloys and non-metallurgical compounds equally affect molybdenum spending, and also because of its characteristics and fact that its toxic attribute, unlike most of the other heavy metals, is on very low level.

2. Basic facts about molybdenum

Molybdenum was discovered in 1782. by scientist called Hjelm. Until that time, it was mistaken with graphite and led ore. In nature, molybdenum does not occur as free and most occurrences are in form of molybdenite (MoS₂). Other less commercial ores of molybdenum are powellite and wulfenite.

Like molybdenite, they can be also extracted as by-product in flotation concentration of copper and tungsten. Pure metal is produced from the powder

made by the hydrogen reduction of purified molybdic trioxide or ammonium molybdate.

The metal is silvery white, very hard, but is softer and more ductile than tungsten. It has very high elastic modulus and only tungsten and tantalum, from all metals, which are industrially produced, have higher melting point. It is valuable compound of carbonated and alloyed steel, because it increases their hardness and toughness. It also improves the strength of steel at high temperatures.



Fig. 1. Molybdenite (MoS₂)

It is used in certain nickel-based alloys, such as the "Hastelloys(R)" which are heat-resistant and corrosion-resistant to chemical solutions. Molybdenum oxidizes at high temperatures. The metal has found recent application as electrodes for electrically heated glass furnaces. Molybdenum has also found its use in programs for producing nuclear power and in missile and aircraft industry. Use of molybdenum as catalyst is important in petroleum refinement. It has found applications as a filament material in electronic and electrical industry. Molybdenum is important element in food industry, some lands are barren for lack of this element in the soil. Molybdenum sulphide is useful as a lubricant, especially at high temperatures where oils would decompose. Almost all ultra-high strength steels with minimum yield points up to 300 000 psi (lb/in.2) contain molybdenum in amounts from 0.25% to 8%. Biologically, molybdenum is important element for nitrogen fixation and other metabolic processes.

3. Participation of molybdenum in resources of Copper Mines Bor

Only six elements are produced in plants of RTB Bor. These are metals of copper complex: copper, gold, silver, and metals of platinum group: platinum and palladium, as well as non-metal selenium. Until now, none of other elements was industrially produced in Bor, although they were present in ore, very often in economically interesting quantities. That is particularly case with molybdenum, as well as some other metals, for example germanium and titanium.

Participation of elements for which is, from economical point of view, interesting to analyze their potentiality for valorization is:

Table 1. Results of complete analyses of representative samples of ore and slag from RBB

Level of valorization	Element (mineral)	Jama			Smelter's slag	Veliki Krivelj
		Tilva Roš	Brezanik	P ₂ A		
	Cu, %	0.84	2.01	0.81	0.795	0.36
	Au, g/t	0.2	1.5	0.2	0.32	0.07
Producing in	Ag, g/t	1	1.2	1.3	4.33	0.60
RTB Bor	Pt, g/t	<1.0	<1.0	<1.0	<1.0	<0.05
	Pd, g/t	<1.0	<1.0	<1.0	<1.0	<0.02
	Se, g/t	<40	<40	97	<40	<40
	Mo, g/t	420	400	300	790	70
Not producing in	Co, g/t	32	32	50	50	/*
RTB Bor, but	Ti, g/t	840	800	720	1300	/*
could be	Ge, g/t	15	16	15	25	/*
economically	Te, g/t	40	40	40	130	/*
interesting	Cr, g/t	210	170	170	360	/*

* There are no valid results

4. Analyses of potentiality of producing molybdenum in Copper Mines Bor

In "Study of justification of short-term investment (period 2006. - 2011.) in production of copper concentrates in RBB Bor" yearly production schedule for all reproductive entities of mine production and flotation process: Jama, Veliki Krivelj and smelter slag was evolved.

Following table shows expected economical effects of copper production per year:

Table 2. Expected economical parameters of copper production in RBB

Name	Jama	Slag	Veliki	Total
			Krivelj	RBB
Production per year, tpy	1 000 000	1 000 000	8 000 000	10 000 000
Cu grade, %	1.06	0.795	0.36	0.47
Quantity of Cu in ore, t	10 664	7 950	28 800	47 414
Recovery of Cu, %	85	50	85	79
Quantity of Cu in concentrate, t	9 047	3 975	24 480	37 502
Cu price in concentrate, USD/t	3 000	3 000	3 000	3 000
Valorization value of Cu, USD	27 142 200	11 925 000	73 440 000	112 507 200

There is a big difference between value of ore in earth and metal which is excavated, processed in flotation, melted and refined. Key characteristic in long history of "deficiently production and selling" of molybdenum is in aspiration for preserving its price from rapid fall or jump. That is why are miners like "Adanac Moly of Canada" cautious and ready to speculate with forecast of molybdenum prices maximally up to 45 USD/kg, maximum up to year 2008th. In this paper, that price will be base for analyses of its potentiality. If analyze is done, same as in tab. 2, for expected economical parameters which could be achieved with possible valorization of molybdenum, on the basis of data from the tab. 1, then it will be:

Table 3. Expected economical parameters of molybdenum production

Name	Jama	Slag	Veliki Krivelj	Total RBB
Production per year, tpy	1 000 000	1 000 000	8 000 000	10 000 000
Content of Mo, g/t	378	1400	70	234
Quantity of Mo in ore, gr	377 600 000	1 400 000 000	560 000 000	2 337 600 000
Quantity of Mo in ore, t	377	1400	560	2337
Recovery of Mo, %	50	50	50	50
Quantity of Mo in concentrate, to	188	700	280	1168
Mo price in concentrate, USD/t	45 000	45 000	45 000	45 000
Valorization value of Mo, USD	8 460 000	31 500 000	12 600 000	52 560 000

Now, let's gather expected valorization values for copper from tab. 2 and for molybdenum from tab. 3, and show them graphically on following graph:

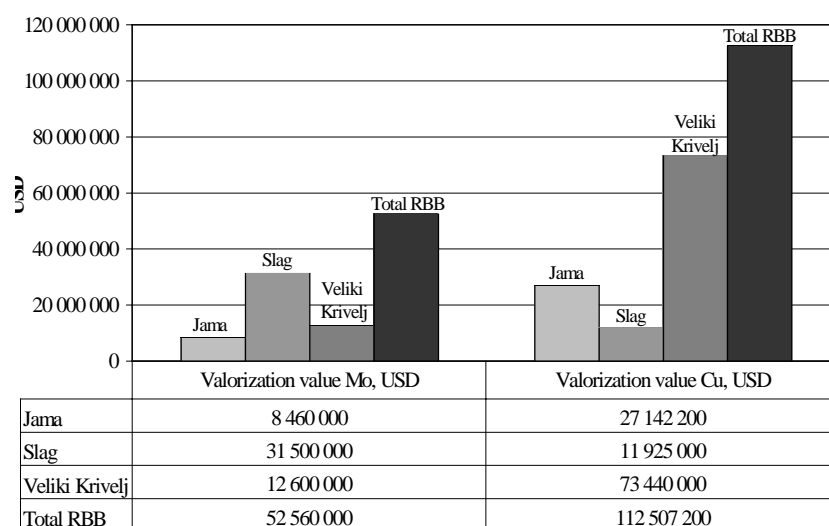


Fig. 2. Comparing relation of valorization values of Cu and Mo

From previous, it could be concluded that with valorization of molybdenum through next few years, RBB income could be raised up to unbelievable 50%. Because of that, this fact must be considered with respect. RTB Bor does not have any operative experience with extraction of molybdenum, so it would be necessary to employ a company with enough experience in that kind of production.

In favor for that goes the fact that it could be valorized three times greater income from molybdenum then from copper income in smelter's slag. In addition, if it is added to that economically very interesting content of germanium, titanium and some other rare metals in slag, then processing of smelter's slag must be shown in different way then it is shown nowadays. Now it is the right moment for considering this kind of analyses because investment for reconstruction of Bor's flotation plant for processing smelter's slag is expected in very near future.

5. Conclusions

RTB Bor is deeply in the process of restructuring and tender for privatization the whole company or its the most perspective parts will be announced very soon. Because of that, giving maximal importance to potentiality of each of its reproductive parts is very significant. Two recent World Bank studies pointed out very high potentiality for exploitation of ore deposit Borska Reka in Jama Bor as the most important for long-term mine production of copper in Bor.

In "Study of justification of short-term investment (period 2006-2011.) in production of copper concentrates in RBB Bor" it pointed on midterm potentiality of exploitation of copper from current underground works in Jama, open pit Veliki Krivelj and smelter's slag.

Copper mine Majdanpek has an interested buyer more than a year. Forming Joint Venture Company "JUBOS" between NIS JUGOPETROL and RTB Bor for exploitation and processing of smelter's slag opens possibility for analyzing molybdenum production together with copper production and together with planned reconstruction of flotation plant Bor to analyze the possibility for its extraction.

Beside all that, it could be added completely defined potentiality of hydrometallurgical copper production through cooperation with "Aero Aqua In enjering" company.

All of these arguments significantly raise chances for RBB Bor to go to process of privatization in near future with much more courage.

6. References

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