



ԳՈՐԾԱՐԱՐՈՒԹՅՈՒՆ ԵՎ ՁԵՌՆԱՐԿԱՏԻՐՈՒԹՅՈՒՆ

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POSSIBILITIES OF CONSTRUCTING A COPPER SMELTER IN THE REPUBLIC OF ARMENIA

Nowadays, the export volume of copper concentrate from the Republic of Armenia equals more than 500 thousand tons per year. This extent fully satisfies the minimum requirements for constructing a copper smelter in our country.

Calculations show that the copper production capacity of the Republic of Armenia is estimated more than 120 thousand tons per year. Although it is considered to be a modest result in the context of copper mining scale worldwide, it is of significant importance for our country.

The production and export of pure copper will contribute to the flow of currencies into our country. Meanwhile, it will enable to construct and exploit a cable factory, which, in turn, will create favorable grounds for new working places and for the rise of overall economic activation.

The necessity for constructing a copper smelter has also been stated by the government of the Republic of Armenia.

One of the concerns remains the realization of sulfuric acid extracted in the process of copper production. A solution could be transporting it to the port by railway through the area of Georgia. Still, according to some viewpoints, it is possible to recycle sulfuric acid on the spot and convert to fertilizers, varnish, paint, clay etc.

The paper takes into focus the possibilities of constructing a copper smelter in the Republic of Armenia demonstrating the efficiency of investments and their buyback deadlines on current copper price conditions.

Keywords: *copper ore, copper concentrate, pure copper, copper smelter.*

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Introduction: A copper smelter can be constructed in the Republic of Armenia, if the annual export volume of copper concentrate exceeds 400 thousand tons. At present, the export volume of copper from the Republic of Armenia exceeds 500 thousand tons per year, which will make it possible to produce maximum 120 thousand tons of refined pure copper if treated on the spot.

To give the big picture, let us represent copper global market. The leading country in world copper production is Chile with an estimated 5.7 million tons per year. Chile is followed by Peru and China with an estimated 2.2 and 1.7 million tons, respectively. Congo, the USA, Australia, Russia are also among the ten major countries in world copper production. The last country on the list is Canada with only 570 thousand tons of copper production per year¹.

Obviously, in the context of the above mentioned rankings, the production capacity of 120 thousand tons of copper of the Republic of Armenia is rather a modest result for the global market; however, it will have a significant importance for our country.

Particularly, copper production will contribute to setting up a wide range of industrial sectors in our country, for instance, cable production. Despite some fluctuations in global industrial markets, the demand for copper is expected to remain stably high over the upcoming years.

Also, it is interesting to forecast, that the volume of metal ore mining will be increasingly growing in our country over the next few years. In this case, an estimated 600 thousand tons of copper concentrate can be mined ensuring 170 thousand tons of copper production per year.

This forecast is conditioned by a necessity of new strong investments.

The necessity for constructing a new copper smelter has also been stated by the government of the Republic of Armenia. It requires as much as 1 billion dollars of investment.

One of the concerns remains the realization of sulfuric acid extracted in the process of copper production. A solution could be transporting it to the port by railway through the area of Georgia. On the other hand, a question arises, whether an investor could be found, ready to recycle the sulfuric acid and convert to phosphorus fertilizer, varnish, paint, clay, etc. These are still unsolved problems.

Literature review: A number of analytical data and publications exist on the necessity of constructing a copper smelter in the Republic of Armenia.

The problems of mining sector of the Republic of Armenia as of 2003, the development perspectives, the necessity and possibility of constructing a copper smelter were discussed in the report of Japan International Cooperation Agency, in 2003, entitled “Study on Mining Sector Development Master Plan in the Republic of Armenia”. Specifically, it is stated in the report that 250 million

¹ <https://www.statista.com/statistics/264626/copper-production-by-country/>

dollars of investment will be necessary to construct a pyrometallurgical copper smelter with a capacity of 30 thousand tons of production per year, and 130 million dollars of investment for a hydrometallurgical copper smelter with the same capacity. Meanwhile, the unfavorable conditions for constructing a hydrometallurgical copper smelter in the Republic of Armenia due to some restrictions, such as its close location to mines for an effective exploitation, have been highlighted in the report².

A detailed analysis of the current state of the mining sector of the Republic of Armenia with appropriate proposals were stated in the report entitled “Armenia: Strategic Mineral Sector Sustainability Assessment” published by the World Bank, in April, 2016³.

The necessity for constructing a new copper smelter was also referenced in the scientific article entitled “The Construction of a New Copper Smelter in Armenia is a Demand” published in the magazine “Finances and Economics”, in 2017, authored by Professor, Doctor of Economics of the State Economic University of Armenia M. Melkumyan and Associate Professor, PhD in Economics of the same university A. Arakelyan.

Having studied the global price of copper, copper ore treatment and copper concentrate export volume from the Republic of Armenia, the authors made a comparative analysis and evaluation of the process of copper concentrate production and export, as well as pure copper extraction from copper concentrate. The article highlights the fact that, for the time being, the volume of copper concentrate exported from the Republic of Armenia makes it possible to process on the spot in a pyrometallurgical copper smelter.

The Deputy Minister of Economy of the Republic of Armenia discussed a number of issues regarding the mineral sector sustainability of the Republic of Armenia with the Executive Director of the company “GeoProMining”, as it is stated in the report of the government of the Republic of Armenia on the business trip to the Russian Federation, in October 4-6, 2021. An agreement was made to continue the negotiations aimed at clarifying cooperation mechanisms and moving to the stage of practical steps towards the construction of a copper smelter in the Republic of Armenia⁴.

Research methodology: The research object is the possibility of constructing a copper smelter in the Republic of Armenia. The research methodology encompasses monitoring, analysis, synthesis, comparative analysis, deduction, generalization and forecast. Through the analytical method the research object has been split and each element has been studied. The research results have been synthesized and appropriate conclusions have been drawn.

² Study on Mining Sector Development Master Plan in The Republic of Armenia, Japan International Cooperation Agency (JICA), Mitsui Mineral Development Engineering Co., LTD., https://openjicareport.jica.go.jp/pdf/11734415_01.pdf

³ Armenia: Strategic Mineral Sector Sustainability Assessment, The World Bank, April 2016 <https://documents1.worldbank.org/curated/en/289051468186845846/pdf/106237-WP-P155900-PUBLIC.pdf>

⁴ Report of the RA government on the results of the business trip to Russia, October 4-6, 2021, <https://www.gov.am/files/docs/4622.pdf?c=720502>

The theoretical, methodological and informational basis of the research underlies Armenian and foreign literature as well as the decisions of state bodies of the Republic of Armenia, data submitted by Statistical Committee, State Revenue Committee of the Republic of Armenia, international data, international organization's reports, evaluations and reviews.

Press publications referring to national and foreign experts' standpoints on constructing a copper smelter in the Republic of Armenia have also been largely utilized in the research.

Specifically, the report "Armenia: Strategic Mineral Sector Sustainability Assessment" published by the World Bank, in April, 2016, states water pollution with sulfuric acid as one of the risks of mining sector.

In the Republic of Armenia there is not any production sector with an appropriate capacity to afford the realization of released sulfuric acid. In the report of the government of the Republic of Armenia and Japan International Cooperation Agency it is noted that there is no demand for sulfuric acid in the Republic of Armenia and its export could not be profitable due to high costs⁵.

The studies and conclusions are based on a wide range of discussions with the representatives of mining sector carried out by the author, the synthesis of their viewpoints and opinions, the author's own considerations and calculations and the overall evaluation of possibilities and restrictions of constructing a copper smelter.

Analysis: According to the United States Geological Survey (USGS), world copper reserves currently amount to around 870 million tons (Mt). Identified and undiscovered copper resources are estimated at around 2,100 Mt and 3,500 Mt, respectively. Refined copper usage (usage by semis plants or the first users of copper) in 2020 reached 25.0 million tons. China was also the largest consumer of refined copper in 2020 with apparent usage of around 14.4 million tons⁶.

After two consecutive years of flat growth, mainly due to lower ore grades and production disruptions, the impact of COVID-19 on mining operations led to global copper production declining by 2.6% to 20.1Mt in 2020. Looking ahead, global copper production is expected to experience growth of 5.6% to 21.3Mt in 2021, supported by mines returning to full production, as well as the ramp-up of new mines starting in 2021. Production is expected to reach 24.6Mt in 2024. Chile, Peru, Australia, Indonesia, and the US will be the key contributors to the growth. The combined production from these countries is expected to grow from 11.2Mt in 2021 to 13.4Mt in 2024⁷.

As mentioned above, copper production decreased in 2020, however, as a result of the involvement of concentrate reserves, production of refined copper increased by 2%. As a result, the market moved into a state of an insignificant surplus of supply in the amount of less than 2% of annual consumption⁸.

⁵ There are obstacles of constructing a new copper smelter, Karine Khazaryan, April 15, 2021, <https://media.am/hy/verified/2021/04/15/27257/>

⁶ The World Copper Factbook 2021, International Copper Study Group, <https://icsg.org/wp-content/uploads/2021/11/ICSG-Factbook-2021.pdf>

⁷ https://mine.nridigital.com/mine_apr21/copper_production_2021

⁸ <https://ar2020.nornickel.ru/commodity-market-overview/copper>

The production of pure copper is characterized with strongly expressed vertical integration – from extraction of copper concentrate up to production of pure copper, cable and electric wires. Produced copper is utilized in machinery and consumer goods industry, in transportation, construction and electronics sectors.

The leading copper producing company worldwide is Codelco, set up in 1955, with a capacity of 1.73 million tons per year. BHP ranks second with a capacity of 1.72 million tons per year and is followed by Freeport-McMoRan with a capacity of 1.45 million tons per year.

Table 1

Leading Copper Producers Worldwide⁹

<i>N</i>	<i>Name</i>	<i>Production capacity, in million tons per year</i>
1	Codelco	1.73
2	BHP	1.72
3	Freeport-McMoRan	1.45
4	Glencore	1.26
5	Southern Copper	1.0

Two main ways of copper concentrate processing and pure copper extraction exist in the international practice – pyrometallurgical and hydrometallurgical¹⁰. Pyrometallurgy supposes extraction of pure copper at high temperatures¹¹. It is a more effective way and is applicable in the Republic of Armenia. Meanwhile, it requires an annual minimum capacity in order to be profitable. In contrast, the hydrometallurgy is applicable for a smaller scale. However, despite smaller initial capital investments, it requires bigger current expenses raising the product prime cost and making it non-competitive. Besides, it is not applicable for copper concentrate processing in the Republic of Armenia due to some technological characteristics.

Armenia's mining sector is a key contributor to the national economy. Ore concentrates and metals accounted for just over half of Armenia's exports in last years, solidifying their status as the country's most important export products. More than 670 mines of solid minerals, including 30 metal mines, with confirmed resources are currently registered in the state inventory of mineral resources. Among these around 400 mines, including 22 metal mines are exploited. Republic of Armenia is rich in iron, copper, molybdenum, lead, zinc, gold, silver, antimony, aluminum, as well as in scarce and scattered metals enclosed therein. Among metal minerals there are 7 copper-molybdenum mines, 4 copper mines, 14 gold and gold-polymetallic mines, 2 polymetallic mine, 2 iron ore mines and 1 aluminium mine¹².

According to the RA Customs Service data, the export volume of copper concentrate has abruptly risen in recent years, reaching 185 thousand tons,

⁹ <https://www.nsenenergybusiness.com/features/largest-copper-mining-companies/>

¹⁰ <https://en.wikipedia.org/wiki/Hydrometallurgy>

¹¹ <https://en.wikipedia.org/wiki/Pyrometallurgy>

¹² <http://www.minenergy.am/en/page/472>

in 2014¹³, up to 562 thousand tons, in 2020, at 626 million USA dollars customs value¹⁴. It means that an estimated 40 million tons of copper ore is being treated in the Republic of Armenia, as copper ore has a pure copper content of 0.4% and copper concentrate of 25%.

Armenia’s main copper ore exporters are Zangezur Copper Molybdenum Combine Closed Joint Stock Company (ZCMC), Teghout Armenia, Institute of Mining, Agarak Copper and Molybdenum Combine, Akhtala Mining and Processing Enterprise, Armenian Copper Program (ACP) and Chaarat Kapan¹⁵.

World prices for non-ferrous metals have been on the rise for a protracted period of time, creating favorable conditions for the mining industry of Armenia. International copper prices have been steadily increasing since April 2020¹⁶. The price of copper is more than 9,400 USA dollars for one ton in December 2021¹⁷.

Calculations show that the process of extracting copper concentrate from copper ore becomes profitable if copper price is 5000 USA dollars per ton. Let us present the above mentioned in the table below.

Table 2

Copper Ore Treatment Financial Assessment on Price Fluctuation Conditions

<i>Copper price</i>	\$4,000	\$5,000	\$6,000	\$7,000	\$9,000
Copper ore treatment, in tons	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Extracted copper concentrate, in tons	12,800	12,800	12,800	12,800	12,800
Content of pure copper in concentrate, per cent	24%	24%	24%	24%	24%
Amount of pure copper in concentrate, in ton	3,072	3,072	3,072	3,072	3,072
Revenue of copper ore sale, USA dollar	\$9,501,300	\$12,573,300	\$15,645,300	\$18,717,300	\$21,760,000
Product prime cost USA dollar	\$11,000,000	\$11,000,000	\$11,000,000	\$11,000,000	\$11,000,000
Profit, USA dollar	-\$1,498,700	\$1,573,300	\$4,645,300	\$7,717,300	\$10,760,000

Thus, the above mentioned business sector becomes profitable if copper price is 5000 USA dollars or more per ton. During 2021 copper price worldwide exceeded 9000 USA dollars¹⁸. If copper price is 9000 USA dollars per ton, 12.800 tons of copper concentrate will be extracted from 1 million tons of copper ore and 21.8 million dollars of revenue will be generated and the profit will account for 10.1 million USA dollars. In the same case, the revenue would increase by 27% and would account for 27.6 million USA dollars if not the copper concentrate but the pure copper was sold.

¹³ https://www.petekamutner.am/Shared/Documents/_cs/_ci/Customs_Statistics/Customs_Statistics_Archive/2015/vt_artar_exp_cucanish_2014_2015.pdf

¹⁴ Data of the RA Customs Service, Goods exported from the RA at a higher customs value by foreign trade. <https://www.petekamutner.am/Content.aspx?itn=csCIExportStatistics>

¹⁵ <https://hetq.am/en/article/114177>

¹⁶ http://arka.am/en/news/business/armenia_to_introduce_export_duties_on_copper_concentrate_and_molybdenum/

¹⁷ <https://markets.businessinsider.com/commodities/copper-price>

¹⁸ <https://markets.businessinsider.com/commodities/copper-price>

However, the most part of copper concentrate is exported from the Republic of Armenia, both to resellers and to copper smelters. Only a small part of extracted copper concentrate is processed at Alaverdi copper smelter.

Table 3

Annual Copper Concentrate Production Scale in the Republic of Armenia¹⁹

<i>Year</i>	<i>Annual Copper Concentrate Production Scale, in thousand tons</i>
2016	388.5
2017	428.5
2018	317.4
2019	400.0
2020	375.6

In Armenia copper is found in Qajaran, Kapan, Agarak, Akhtalay, Teghut, Armanis, Ajgedzor, Lidjk, Dastakert mines.

The analysis of copper concentrate transportation expenses to the copper smelter indicates that it is more effective to locate a copper smelter in Alaverdi than in Qajaran.

In order to construct a copper smelter with a capacity of 400 thousand tons per year it is necessary to make 422 million USA dollars of investment, out of which 355 million and 67 million USA dollars for a copper processing and a copper extracting companies, respectively.

More importantly, the efficiency of pure copper extraction process is conditioned on incomes made from the realization of other metals contained in copper ore and of sulfuric acid released through some technological processes. The revenue generated from the realization of the above mentioned elements is also included in the calculations of pure copper extraction business profitability.

Calculations show that in the process of pure copper extraction 87.8% of the prime cost makes the industrial prime cost, the bigger part of which goes to copper concentrate extraction and energy expense. Administrative and realization expenses make 1%, amortization and financial expenses make 5.7% and 1.4% respectively. The profitability index is estimated 4.6% and the EBIDTA - 11.2%. Thus, if copper production is 100 thousand tons at 9000 USA dollars per ton, the revenue will make 900 million USA dollars, the profit – 41.4 USA dollars and the EBIDTA -100 million dollars. The investment buyback deadline will be over 4 years.

Conclusions: Taking into account today's copper ore treatment scale in the Republic of Armenia, as well as the currently increasing demand for pure copper and its expected stably high price, we can assert that copper ore treatment cycle can start and finish in the Republic of Armenia.

The annual export volume of more than 500 thousand tons of copper concentrate from the Republic of Armenia makes it possible to organize its

¹⁹ Statistical Committee of the RA, Output of Main Commodities in the Industrial Organizations (in Kind), 2016-2020, https://armstat.am/file/article/bnexen_12_2020.pdf

processing on the spot through effective technologies, specifically, through the pyrometallurgical way.

Calculations prove that in condition of today's copper ore mining scale, it is possible to produce more than 120 thousand tons of pure copper.

It will significantly increase the export volume from our country ensuring over 1 million USA dollars of income for copper export instead of today's 620 million USA dollars for copper concentrate export.

The production of pure copper will contribute to setting up new industrial sectors in our country, such as cable production. Moreover, recycling of the chemical substances released through the production process will make it possible to set up new enterprises of fertilizers, varnish, paint, clay, this way creating new working places in additional sectors.

Calculations of the prime cost and profitability of copper concentrate extraction show that the production is profitable if copper price is 5000 USA dollars per ton. In this case, 12.800 tons of copper concentrate is extracted from 1 million tons of copper ore, the revenue of its sale is estimated over 12.5 million USA dollars and the net profit – 1.5 million USA dollars.

Taking into consideration our calculations, synthesizing the current copper production scale and the global copper price level of 9000 USA dollars per ton, we can assert that the revenue generated from the sale of copper concentrate will make over 670 USA dollars.

If the whole cycle of copper ore treatment is organized in the Republic of Armenia, the revenue generated from the sale of pure copper will be estimated over 900 million USA dollars. If its profitability is 4.6 %, it will ensure over 41 million USA dollars of profit for a copper smelter.

According to our calculations the investment buyback deadline is up to 5 years, and the necessary investment amount is 422 million USA dollars.

The main obstacle or restriction for constructing a copper smelter remains the neutralization of sulfuric acid released through the production process. A range of specialists think that it is not desirable to recycle such a dangerous chemical as sulfuric acid in a small country. Other specialists are of the opinion that sulfuric acid could be transported by railway or recycled on the spot. Nevertheless, this problem remains unsolved and is considered to be one of the main restrictions for constructing a copper smelter in our country.

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ՄԻՔԱՅԵԼ ՄԵԼՔՈՒՄՅԱՆ

ՀՊՏՀ միկրոէկոնոմիկայի ամբիոնի վարիչ,
 րնտեսագիտության դոկտոր, պրոֆեսոր

ԱՐԹՈՒՐ ԱՌԱՔԵԼՅԱՆ

ՀՊՏՀ միկրոէկոնոմիկայի ամբիոնի դոցենտ,
 րնտեսագիտության թեկնածու

Պղնձաձուլարանի կառուցման հնարավորությունները Հայաստանի Հանրապետությունում.– Ներկա ժամանակներում Հայաստանի Հանրապետությունից տարեկան արտահանվում է ավելի քան 500 հազար տոննա պղնձի խտանյութ: Այդ ծավալները լիովին բավարարում են մեր երկրում պղնձաձուլարան կառուցելու նվազագույն պահանջները:

Հաշվարկները ցույց են տալիս, որ Հայաստանի Հանրապետությունում հնարավոր է արտադրել տարեկան մինչև 120 հազար տոննա պղինձ, ինչը, թեև պղնձի արտադրության համաշխարհային ցուցանիշների համատեքստում համեստ

ցուցանիշ է, այնուհանդերձ, չափազանց կարևոր նշանակություն ունի մեր երկրի համար:

Մաքուր պղնձի արտադրությունը և դրա արտահանումը կնպաստեն արտարժույթի ներհոսքին մեր երկիր, թույլ կտան տեղում կառուցել և արդյունավետ շահագործել նաև կաբելի գործարան, ինչը կստեղծի նոր աշխատատեղեր և կնպաստի տնտեսական ակտիվության մակարդակի բարձրացմանը:

Պղնձաձուլարանի կառուցման անհրաժեշտության մասին հայտարարվել է նաև Հայաստանի Հանրապետության Կառավարության կողմից:

Դեռևս չլուծված խնդիր է պղնձի արտադրության ընթացքում առաջացող ծծմբային թթվի օգտագործման կազմակերպումը: Տարբերակներից մեկը երկաթուղային ճանապարհով արտահանումն է Վրաստանի տարածքով դեպի նավահանգիստ: Սակայն կարծիքներ կան, որ համապատասխան ներդրումների իրականացման դեպքում ծծմբային թթուն կարելի է վերամշակել տեղում՝ ստանալով պարարտանյութեր, լաքեր, ներկեր, գիպս և այլն:

Հոգվածում քննարկվում են պղնձաձուլարանի կառուցման հնարավորությունները Հայաստանի Հանրապետությունում՝ ցույց տալով պղնձի ներկա գնի պայմաններում ներդրումների արդյունավետությունն ու դրանց հետզնման ժամկետները:

Հիմնաբառեր. պղնձի հանքաքար, պղնձի խտանյութ, մաքուր պղնձ, պղնձաձուլարան:

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Возможности строительства медеплавильного завода в Республике Армения. – В настоящее время объем экспорта медного концентрата из Республики Армения составляет более 500 тысяч тонн в год. Этот объем полностью удовлетворяет минимальным требованиям для строительства медеплавильного завода в нашей стране.

Расчеты показывают, что мощность производства меди в РА оценивается в более чем 120 тысяч тонн в год. Хотя это считается скромным результатом в контексте масштабов добычи меди во всем мире, оно имеет большое значение для нашей страны.

Производство и экспорт чистой меди будет способствовать притоку валюты в нашу страну. Между тем, это позволит построить и ввести в эксплуатацию кабельный завод, что, в свою очередь, создаст благоприятную почву для создания новых рабочих мест и повышения общей экономической активности.

О необходимости строительства медеплавильного завода заявило также Правительство Республики Армения.

Одной из проблем остается реализация серной кислоты, получаемой в процессе производства меди. Решением может стать его транспортировка в порт по железной дороге через территорию Грузии. Тем не менее, согласно некоторым точкам зрения, серную кислоту можно переработать на месте и превратить в удобрения, лак, краску, глину и т.д.

В статье рассматриваются возможности строительства медеплавильного завода в Республике Армения, демонстрируются эффективность инвестиций и сроки их обратного выкупа в условиях текущих цен на медь.

Ключевые слова: медная руда, медный концентрат, чистая медь, медеплавильный завод.

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