

Sonora State Producer and Strategic Exporter of Copper

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This paper presents a study on the importance of copper production in the State of Sonora, Mexico. Important data will be presented with total relevance to the current economic framework in which it will be possible to determine through a thorough investigation the reason why Sonora as a state is a great potential producer, as copper exporter in comparison to the other producing states of Mexico. The main producing states of the country will be presented using statistics that show the production of each of them in the time-frame of 2011-2016.

Keywords: copper production, exportation, producer, Sonora, States, mine, municipalities

JEL Classification: R11, R33, L61, L72

1. Introduction

In Mexico, copper production is an important part of the country's economy, and it is in this framework that Sonora projects have an important presence in the mining sector after being the second largest state in Mexico. Mining has been a major driver of economic and potential development since it is responsible for producing about 84% of the total production of the state of Sonora and that this percentage is part of the total 50% of the national production (Tojeira, 2011).

Sonora has a great wealth that nature has offered and that is why the state has been able to create its competitive position at the national level as a leader of copper. It is in Sonora where the two most important mines in the country are located, as well as in Latin America. The two mines mentioned above are Buenavista del Cobre S.A. of C.V. located in Cananea, Sonora and Minera La Caridad S.A. of C.V. with its location in the municipality of Nacoziari, Sonora.

The Buenavista del Cobre mine produces 400 thousand tons per year (Villegas, 2016) which is almost 50% of what is produced in the state, such operations are carried out through Minera de Mexico S.A. of C.V. which is dedicated to the extraction and processing of copper, as well as it is also operating with the subsidiary Mexicana del Cobre S.A. Of C.V. which is located in La Caridad and in Cananea.

Although the mine of Buenavista del Cobre had a murky and obscure period in which they suffered lost grids that were replaced millions of dollars, it was due to a flood that the mine suffered and caused great environmental impact and due to external issues to had to close its facilities, leading to a difficult situation to

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their economy. To continue avoiding losses, the operations moved to the La Caridad mine in the municipality of Nacozari, to support only minor losses.

Although Mexico has several copper mines around the country, Sonora did not stop being the best producer at national level and after the great losses that the Cananea mine suffered, and its great wealth counted in the state is great for the local economy.

For 2011, Buenavista del Cobre had to pay a large fine to be able to continue operating, and this was how the mine was able to reactivate itself and to slowly begin its operations. After its reopening, the mine was steadily increasing its copper volumes, which in turn caused a great leap to copper exports.

After two years of the mine's recession, irregularities were detected again, in which a high amount had to be paid back for the fine that had been applied to them, and as a result the exports managed to work in a more agile and efficient way helping the mine to reach the same levels of operation and thus to accumulate millions based on Asian demand, and thus was the reactivation was complete even the mine was closed for almost three years.

It is mentioned that the largest demand is from Asia, especially China, and mostly copper and copper concentrate is exported to the neighboring continent. The project will present important and relevant data in which it will be possible to determine through a thorough investigation the reason why Sonora as a state is a great potential producer, as well as exporter of copper in comparison to the other producing states of Mexico. The main producing states of the country will be presented and statistics will show the production of each of them in the last five years.

2. Research Methodology

For the objectives of this investigation article, this analysis was carried out according to the copper production from Mexico mines in the last five years, in the period 2011-2016 allowing to identify which state has the largest number of copper production.

Specific objectives of the paper involve:

- Identify states of Mexico producing copper
- Identify which municipalities in Sonora are more competitive in copper production
- Identify copper production between mentioned periods
- Know the logistics process and the way in which copper export processes are carried out nowadays
- Identify the destinations and export routes for copper.

To achieve the proposed objectives, various types of methodologies were implemented, such quantitative as well as qualitative methodology, in such a way that allows to analyze all that information for its correct interpretation with data collection strategies used in the research groups discussion, narratives, content analysis or documentary, participant observation and archival research.

3. Copper Production in Mexico

Mining is one of the economic activities of the primary sector, and nowadays, it represents one of the most booming activities in the world market, represented specifically by the exploitation and extraction of minerals that have been accumulating in the soil in form of deposits. The copper, as metallic mineral, is known of great importance since in the last years its presence in the economy has had a strong contribution and has been able to keep its position as such. Over time, with explorations, it has achieved a strong growth leading to a large mining production such that has allowed and driven the increase in production of refined copper with a large contribution. In order to achieve these results, market price rebuilding has been carried out through regulations that the mining industry, governments and international financial institutions have created through legislative reforms where they have allowed harmony and stability in the mining sector, and the best result came from the comments from the World Bank, a very important organization that considers mining as one of the basic indicators from which possibilities for economic growth are developed.

In 2013, it was observed that there was a great stagnation, but it in the following year the demand had a favorable economic evolution from the United States of America, the stage of recession of the Euro zone and the economic stabilization of China.

The process of urbanization and industrialization in nations like China and India will continue to be a major driver of future demand for copper. The combined population of these two countries represents 37% of the world's total population, both with a relatively low degree of urbanization, with 52% and 32% respectively (Sánchez López, 2014). China's current share of the global market is at least 40%. Market specialists have mentioned that a sustained price relationship promotes the substitution of copper for

aluminum. Threats to copper are mainly represented by the use of substitute materials such as plastics, aluminum, fiber optics, miniaturization of electrical-electronic equipment, and wireless communication.

The main threat facing copper is in commercial and heat exchange pipes, the latter affecting mainly the automotive type. There has also been displacement in the cable segment for energy (aerial) and there has been a selective substitution in the wires used in construction. In the telecommunications segment, fiber optics continues to expand and to dominate the market. Despite these aspects, there is a coincidence that the most important part of the substitution has already taken place. Mining production experienced several years of marginal growth over the past decade. The industry has begun to gradually incorporate the volumes of new projects and expansions deferred as a result of the crisis, marking the beginning of what is expected to be a period of accelerated expansion.

Copper reserves are expected to be available in millions of metric tons, equivalent to 38 years of total world production. The countries that top the list as the main copper producers are Chile, which is the world's leading producer and accounts for more than half of the world's reserves. Mexico is in third place with a great participation. As mentioned, the production of copper minerals and their concentrates have also shown a profit, when compared to the strong increase reported in mining production, as some treatment plants had operational problems or were subject to maintenance. The increase in treatment fees is proving to be an incentive for smelters to process as much volumes as possible, as a result of greater replacement of electrical / electronic equipment. Likewise, the additional entry of installed refining capacity in China is considered. The largest growth is expected in the primary sector, driven by the aforementioned, growth in concentrate production. This will result in a volume of refined copper that could exceed demand by 400,000 tons (Sánchez Lopez, 2014).

3.1. The Presence of Copper in Mexico

As already mentioned, Mexico is ranked third in the world's copper mining production and, as expected, mining in the country has grown in a rampant and totally remarkable way in recent years. Next, in Figure 1, the copper producing states that exist in Mexico are presented.

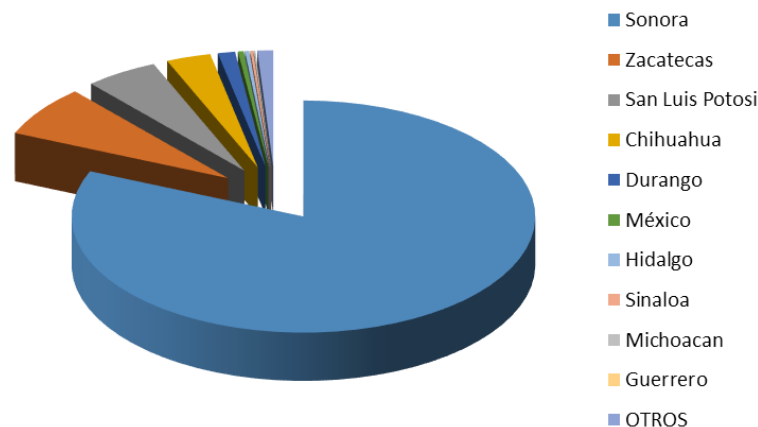


Figure 1. Copper producing states in Mexico

In Figure 1 it can be observed that the state with the greater copper production is the state of Sonora, having a large difference in numbers and proportional questions, which makes the figure have visual weight.

The information on which Figure 1 is based is shown in table 1, presenting each of the producing states of Mexico and displaying of what occurred in 2016 in each one of these states.

The information contained in Table 1 was obtained through data provided by INEGI, making comparisons and averaging the information found in at the Secretary of Economy, as well as the General Directorate of Mining Regulation, which shows the tons produced in year 2016, as well as the participation of each one of them in percentage.

Table 1. Participation of Copper producing states in Mexico

	Tons of Copper	Participation %
Sonora	483,510	81.3
Zacatecas	42,381	7.1
San Luis Potosi	30,041	5.1
Chihuahua	18,537	3.1
Durango	7,425	1.2

Mexico	2,264	0.4
Gentleman	1,932	0.3
Sinaloa	1,060	0.2
Michoacán	598	0.2
Warrior	70	0
Others	6,633	1.1
Total	594,451	98.9

Source: INEGI, General Direction of Mining Regulation, Secretary of Economy, 2016

According to the available data, it was possible to determine what has been produced at the national level of copper in each of the states of the country and to get more details and full information to show more specific data of the main municipalities producing copper.

3.2. Copper Producing Municipalities in Mexico

Mexico is a country rich in minerals and figure 2 shows all those municipalities where all that natural wealth is found.

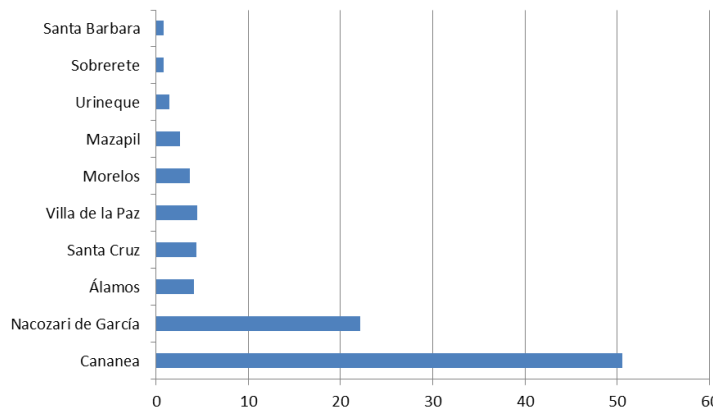


Figure 2. Major municipalities of copper in Mexico

Source: Own elaboration with information of Secretary of Economy, Mexico, 2016

Figure 2 shows the participation of each municipality of the producing states in Mexico. It was possible to observe the percentages by which each municipality is represented, thus: Cananea has a 50.6% participation, followed by Nacozari de García with a 22.1% in second place, then Álamos with a 4.1%, Santa Cruz 4.4 %, as the four previously mentioned municipalities dependent on the state of Sonora, followed by Villa de la Paz with 4.5%, Morelos with a share of 3.7%, Mazapil with 2.6%, Urineque with 1.4%, Sobrerete with 0.8% and Santa Barbara With a 0.8% share.

3.3. Major Copper Mines in Mexico

Sonora, San Luis Potosí, Zacatecas, Hidalgo, Michoacán and Chihuahua are producing states which are mentioned throughout the text, whose states have the main copper mines in the country (INEGI, 2015). States that have succeeded in positioning Mexico as one of the main copper producing countries in the world.

Table 2. Top 10 Copper Mine Mexico

Unity	Business	State	Thousands / ton
1. Buenavista del Cobre	Group Mexico	Sonora	162.0
2. The charity	Group Mexico	Sonora	103.9
3. NEMISA	Neg. Mra Sta.; Ma de la paz	San Luis Potosi	25.4
4. Cozamin	Capstone Mining	Zacatecas	15.7
5. Tayahua	Minera Frisco	Zacatecas	12.2
6. Bolvarí	Sierra Metals	Chihuahua	7.9
7. Sabinas	Peñoles Industries	Zacatecas	6.3
8. Zimapton	Carrizal Mining	Gentleman	6.1
9. The Baztan	AHMSA	Michoacán	4
10. Santa Btorbara	Group Mexico	Chihuahua	3
		Total	346.5

Source: Own elaboration with information of CAMIMEX 2016.



Map 1. Map of producing mines in Mexico

Source: own elaboration with information of CAMIMEX, 2016.

Table 2 shows the top 10 producing mines in Mexico, with each of its specifications such as positioning, location and productivity in 2016 represented in thousands of tons. Also, Map 1 displays the location of the top 10 of the main mines are visually displayed, from a geographical perspective.

3.4. The Three Main Copper Producers in Mexico

Sonora, Zacatecas and San Luis Potosí are the three main producers of copper found in national territory, which were previously shown in Table 1.

In the objectives of this investigation, it was commented that an analysis would be carried out according to the copper production that has been carried out in the mines that are in Mexico in the last five years, in the period 2011-2016 allowing the identification of which state has the largest number of copper production.

3.4.1. Sonora – Mexico Copper Producer

Sonora is located in the northwest region of the country. It is divided into 72 municipalities and its capital is Hermosillo.

It borders to the east with the state of Chihuahua; To the south, with the state of Sinaloa; To the northwest, with the state of Baja California; To the north, it shares an extensive border with the American state of Arizona and a smaller border with New Mexico, also in the United States; and To the west adjoins the Sea of Cortez or Gulf of California. It occupies the second national place in extension, after Chihuahua, with 9.2% of the total of the Mexican territory. Sonora is the main mining state of Mexico and this can be stated based on the total confidentiality granted through INEGI, mining as such is one of the main activities of which put the state as such national leader forming and building a large source of work.

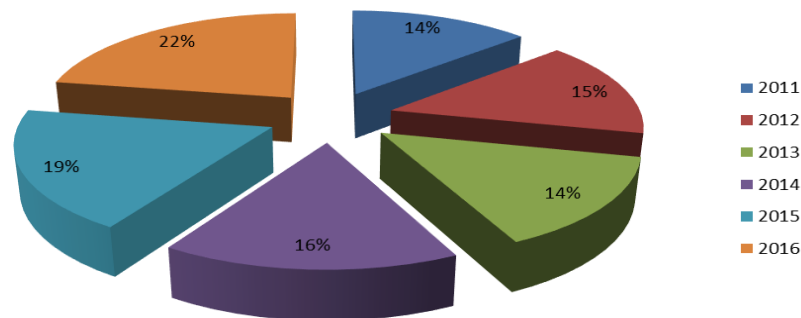


Figure 3. Copper production of Sonora

Source: Own elaboration, INEGI 2016.

Interpreting Figure 3, it can be seen that the annual productions have been kept in constant balance, where this gives favorable talk about the production of the state.

Through data from INEGI it was possible to know data of productions that have been carried out during the period 2011-2016. From the beginning of the period it was highlighted that in 2011 there was a production of 348,884 tons; in 2012 the production was 389,302 tons; in 2013 the production was 369006

tons; in 2014 the production was 415,462 tons; in 2015 the production was 483,510; and finally in 2016 there was an annual production of 577,259 tons, totaling a total of 2,588,223 tons produced in five years.

3.4.2. Zacatecas – Mexico Copper Producer

It has a territorial area of 75,484 km², is divided into 58 municipalities and the capital is the city with the same name: Zacatecas, where less than a million and a half people live, being located in the 25th most populous entity in Mexico. It limits the north with the state of Coahuila, the northwest with the state of Durango, the west with the state of Nayarit, the east with the states of San Luis Potosí and Nuevo Leon, and the south with the states of Jalisco, Aguascalientes and Guanajuato.

Zacatecas is distinguished as one of the most important producer states in the extractive sector, ranking second in the production of copper according to statistics provided by INEGI.

3.4.3. San Luis Potosi – Mexico Copper Producer

San Luis Potosi borders to the north with the state of Nuevo Leon, to the northeast with the state of Tamaulipas, to the east with the state of Veracruz, to the southeast with the state of Hidalgo, to the west with the state of Zacatecas, and to the south with the states of Querétaro and Guanajuato.

It is divided into 58 municipalities. Its capital, and most populated and important city, is San Luis Potosí, has a great mining vocation as well as great wealth of it, which allows it to position itself in the third place of production of copper at national level, according to figures Preliminary reports of the mining by federal entity presented by the National Institute of Statistics and Geography (INEGI).

3.5. Copper from the Origin Point

When the copper is extracted from the mine, it goes to the refinery where it is given the right treatment after its exploitation, after it has obtained the right treatment, it is prepared to be taken to its point where it will depart, it will then be applied its reception and then carry out to export. Samples are taken to know the quality of the product they carry out to export. Since being prepared and after a meticulous methodology is accomplished it will be loaded into trucks, as well as in the railway which Ferrromex counts to take to the boarding destination of the copper. It starts to load hoppers, both from the trucks, as well as copper concentrate railway where after the hoppers are fully loaded and carried out, the completion of the paperwork occurs including the letter carrier to begin the plant journey to the export destination. The port of Guaymas was established in 1814 and the maritime traffic of cabotage by Guaymas was approved after six years, opening it for commerce at the port, as well as establishing its maritime customs. Over the years, the port of Guaymas has been making alliances by developing several shipping companies, thereby increasing the economy of the port (Guaymas Port Administration, 2016). Little by little the port was expanded due to its small capacity to receive boats like those that were docking and was thus constructed an access dock to receive different mineral bulk materials, utensils of the highest quality descending of Hamburg, fabrics of Liverpool, machinery for the railroad, etc. In the year 1972, Servicios Portuarios de Guaymas was established as a state participation company that was in charge of optimizing the loading and unloading times of the operations that were carried out inside the port, such as to give initiative to private companies to move their products via the Mexicana del Cobre company. In 1995, was established what is currently known as the Guaymas Integral Port Administration, replacing the services provided by Guaymas Port Services, which aims to manage, supervise, control and promote the goods, services and activities that are carried out within the port area which operates with profits and own resources achieving a self-sufficiency income result for all those concessions, port fees and other services. Currently the port of Guaymas has a total of 67 ha of land and 77 ha of water, which gives rise and allows a large installed capacity of 7, 644,606 tons, the port has 6 docking positions in two bands, and this different storage areas.

3.6. Location and Connectivity

The port of Guaymas is located to the north of Mexico on the coasts of the Pacific Ocean, and because of its privileged geographical location, the port is represented as one of the main ones in relation to its logistic chains, since it has competitive advantages for the movement of all type, especially in merchandising mineral bulk as its main line of business operation in the port contributing to sustained development and a large growth in Mexico's foreign trade.

The accesses to reach it are very complex, since it is only 1.8 km of federal highway no.15, in the northern part of the state is located the city of Nogales, Sonora that has a border with United States of America; Nogales Arizona and so-called Guaymas-Arizona logistic corridor, which is one of the most attractive options

for multimodal transport between countries with coastal areas in the Pacific Ocean, and such as the southern borders of United States of America and Northern Mexico.

There is the opportunity to be in the field within a logistics company of great position in the port of Guaymas, which is in charge and allowed to know its responsibilities, such the subject of this research. In this study, we aimed to present and know the logistics, supervision and redirection of exports of copper concentrates and where all the information obtained was processed and raised throughout the current research. It has been verified that the operations of the Cananea mine, Buenavista del Cobre are the oldest ones found in North America, as well as it is where the largest deposits of copper are found for later export to different parts of the world. It is worth mentioning that the constant growth that has given to Buenavista del Cobre since its productive speed with which it rose in a very short time and can exceed or even the mine in Escondi, located in Chile, positioning it as the number one mine in the copper production (Grupo Mexico, 2015). Most of the production is exported from the country and is destined to China as its main buyer, so the process is simple and complex.

Through the statistical yearbooks of Mexican Mining that the Mexican Geological Service granted year after year it was possible to develop Table 4 showing the trade balance with which it was handled in the matter of exports of copper and their concentrates in the last five years, during the period 2011-2016.

Table 3. Trade Balance of Copper Exports to China

Year	Exports (kg)	Value (dollars)
2011	387,913,891	1,001,916,136
2012	519,883,459	1,178,780,896
2013	599,982,954	1,176,525,522
2014	598,675,727	1,032,080,869
2015	593,722,889	822,445,840
2016	NA	NA

Source: Authors' compilation, information retrieved from Statistical Yearbooks of Mexican Mining of the Mexican Geological Service, 2017

It was observed that in the period from 2011 to 2012 exports increased by 131,969,568 and their value in that period increased to 176,864,760 dollars. During the next investigation period, that was from 2012 to 2013, exports increased by 80, 099,495, while their value decreased to 2,255,374 dollars. In the third period investigated that was from 2013 to 2014, exports decreased by 1,307,227, as well as their value decreased to 144, 444,653 dollars. In the penultimate and fourth period of the investigation in the years 2014 to 2015 exports decreased to 4,952,838, as well as its value also decreased by 209,635,029 dollars. The statistics for the period from 2015 to 2016 were not shown in the Yearbook that the Mexican Methodist Service granted since the 2016 edition has not yet come out, at the date of this article's publication.

4. Discussion and Conclusion

It was detected and verified that the state of Sonora has a large production participation at the national level with 81.3% and despite the fact that there are also copper producing states throughout the country, and are trying to give maximum production, statistical data shows that in order to allow the country's producing states to reach a high level of copper production, it would take years to achieve these results and it would depend on years of exploration and exploitation in the mining regions. It was observed that the production of the different producing states of the country does not reach the third part compared with the production of the state of Sonora. This information was explained in the figures and tables from reliable public sources, as well as confidential sources in some cases.

The exploitation of the copper mines in the state of Sonora over the years have showed different levels of production, and their distribution depends on the demand for copper and concentrates. After having carried out what is a field investigation and being a participant in all the processes that are carried out during and after the satisfaction of the demand of the copper ores and its concentrates, it was possible to determine that the largest purchaser of this mineral's origin comes from the Asian continent, especially the country of the People's Republic of China, which is a country involved in a massive process of a great industrialization. The study also reflected that new treatments of the minerals of copper and its concentrates later pass through the process of refinery and thus it is able to convert it into a refined mineral with added value. All exports of copper ore and its concentrates are made through the port of Guaymas, Sonora.

All of the aforementioned aims were achieved and the study also verified that the exports that were made in the timeframe examined in this paper have been of great support and contribution to the Mexican economy as one of the major contributors to Mexico's GDP. As a result of the agreements and the relationship that Mexico has with China all these favorable exchanges have facilitated a better relationship and ease of goods export with fewer barriers, leading to a long terms a successful exchange. It also showed that all exports to China have been maintained during the five years investigated in this paper, and despite the problems that have occurred over the past years, such as the spill occurred by Buenavista del Cobre in Cananea, Sonora, internationally known news for the great environmental catastrophe that has caused large losses of millions of dollars. Nonetheless, alternatives were found to combat this unfavorable situation and continue with productions, and thus in the years of 2012 and 2013 a constant value was observed, whereas in the next two years the price of the mineral experienced decreases to almost half of the years previously mentioned.

4.1. Limitations

The limitations that were had in this investigation were the few interviews and visits to the analyzed mines, since they have restricted access and do not allow views, nevertheless the interviews conducted with the managers and administrative of different mines of the State of Sonora, we also had another limitation that there is not enough public information and this limits the data for its interpretation. This research could be expanded by comparing a statistical model to mediate the competitiveness of copper exports in the State of Sonora.

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