

The Patio Process and Early Methods of Silver Extraction in Latin America

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The Process of extracting silver from ore called the Patio Process(sometimes called the Mexican Method) is one of the first methods that uses mercury amalgamation to recover silver from ore. It successfully replaced smelting as the main method of silver extraction before the 17th century. The Patio in Spanish is the courtyard within the building and was major feature in architecture of Spain. The patio process uses the patios to spread the ores that were previously crushed to dust and combines it with mercury, salt and copper sulfate. Before this method was created, the mining of silver was done by digging vertical shafts into the ground. The patio process was used from 17th century and contributed to rapid economic and scientific development in Latin America. Even though the archeological studies show that the process has been used by Indians before arrival of Europeans, the famous merchant Bartolome de Medina has been named the founder of Patio process in Pachuca, Mexico, 1554. Since mining was one of the main driver of early economy of Latin America, it is important to mention the significance of silver trade as well as discuss the main mining lands and their locations around early Latin America. In this paper I am going to refer to different methods of silver extraction and talk about the chemistry and mechanics of the Patio Process. I am also going to refer to the enlightenment era and discuss how it affected mining and how it pushed to develop new methods of silver extraction.

Silver, smelting, and Bartolome de Medina

“Silver (Ag) is a soft metal which can be polished to produce an appealing lustre, two factors which made it ideal for ancient metalworkers to employ in their production of high-value goods.”(Bakewell, 96)) Even before the arrival of European nations, silver was traded among different tribes, “it had great value and aesthetic appeal in many

ancient cultures where it was used to make jewelry, tableware and ritual objects and also rough-cut pieces known as hack-silver which were popular in trade and were also used to store wealth”(Ancient History Encyclopedia). Silver was usually produced from ores with high amounts of lead carbonate PbCO_3 . Ores usually contain less than 1% silver and therefore it takes a lot of hard work to get the silver out of it. Before inventing the Patio Process and developing the mining sector in Latin America, people did not have enough technologies and lacked the knowledge of chemistry to make silver extraction as profitable as it have become in 17-18 centuries. The process of smelting was popular, it involved melting the ore in the presence of oxygen or coke to separate valuable metals from impurities. Heat and a chemical reducing agent decomposes the



silver ore and drives gases and other impurities out, leaving just the metal. Coke, charcoal, and coal are the most popular reducing agents used. Some disadvantages of smelting is that it uses lots of energy and creates a lot of by products that harm the environment. The process releases impurities,

which can be released through smokestacks and contaminate surrounding environments. “The smelting of sulfide ores results in the emission of sulfur dioxide gas, which reacts chemically in the atmosphere to form a sulfuric acid mist.” (Encyclopedia Britannica.) Exposure to airborne pollutants can lead to serious health issues. Some of the advantages of smelting is reliable equipment, ability to work with different qualities of ore .

Bartolome de Medina was a merchant who saw future in mining and always searched for a method to improve the efficiency of silver mining. 16th century mining was in crisis due to the depletion of valuable ores, and also due to the laws prohibiting the enslavement of Indian people. Mining lands were not making profits because of high cost of labour and ore depletions, that is why Bartolome de Medina started researching about new methods of silver extraction. The story tells that when Bartolome de Medina was working on his scientific research about mining, when some unknown German by the name "Maestro Lorenzo" have told him to try mixing mercury, and salt water into the ore dust to separate silver from other products. Having this valuable information Medina has traveled to New Spain 1554 and have established a mining factory that was the first one to use the patio process of silver extraction. Even though it was not his idea to use mercury and salt water, he contributed to the efficiency of this method by adding "trunk" (a type of copper sulfate derived from pyrite) that helps the amalgamation process to take place. Some critics argued that copper sulfate was not a required product for amalgamation, since there was enough of copper sulfate in most types of ores already. But some argue that adding additional copper sulfate helped mining silver in large quantities. Whether it was Bartolome's original idea or not, this method has proven to be the most efficient method of 17th through 19th centuries and allowed to produce 1.5 ounces of silver from 100 pounds of ore. The method was so successful that when German professionals were sent to America to introduce a new method called Barn's method in the beginning of 1700's, the superiority of the patio process was proven. Barn's method was too complex and the cost of maintaining such method was too expensive compared to the patio process. German fossil fuel company Friedrich

Sonneschmidt have said that there is possibility that no other method can be created that will surpass the process of patio.

The process in details:

If gold can be found as a solid and in most cases does not need further processing,

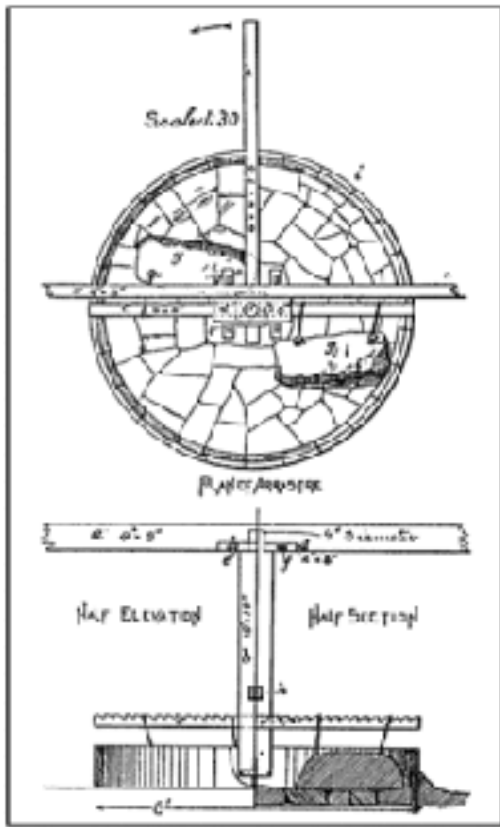


Figure 2. Arrastra

silver is usually found as compound, most common are silver chloride and silver sulphide, therefore the amalgamation is required. Sometimes the amalgamation is used for gold too but is rarely required. Before the silver ore is sent to a factory called Ingenio, the ores need to be crushed into ore dust called Harina. To crush the ores, without engines and machines is a hard work, people used Arrastras, from Spanish Arrastrar- to drag along the ground. This mechanism is basically a mill for pulverizing ores that uses stones on the sides to crush the ore. The stones are usually flattened and are connected to the center by the long arm as it can be seen on the figure 2. At the other end of the arm is where the mule or human power was used, by dragging the arm along

the circular pit, the stones moved and crushed the ores into dust called Harina.

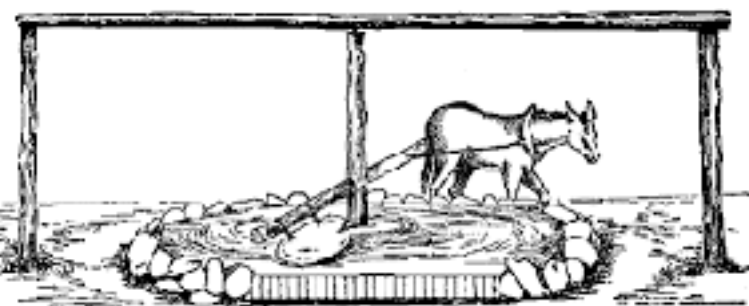


Fig. 21.

Figure 3. Arrastras using mule/horse

After the silver ores were crushed into harina, the workers put the ore dust into piles of approximately 2000 pounds where it was mixed with salt water, mercury, copper sulfate. "For a ton of ore, 4-10 pounds of copper sulfate and salt was used"(Encyclopaedia Britannica.). The mercury is the main substance that catalyzes the amalgamation process that separates silver from other impurities. It is important to understand that before the amalgamation can take place even more processing of the ores is required. After the piles of ore were mixed with mercury, salt and water, the ores are spread around the patio, a courtyard on the open air. The ores are spread around the patio, 1-2 feet width above the ground. The patio was used to crush the ores to even smaller pieces, as well as to allow the chemical reaction to happen under the sun. People used horses or mules to walk on patio's to further crush the ores and mix the chemicals with each other. After 6 weeks of such processing, the silver, which is usually a compound, starts amalgamating with mercury and creates a new bond, the bond that frees the silver from its compounds and causes it to dissolve in the mercury. "The precious metal bonds with the mercury to form the metal laden mercury AMALGAM and the waste (barren) ore pulp are caused to travel different paths to effect separation."(911metallurgist)"The amalgamation process, where mercury breaks silver's atomic structural bonds and forms an alloy at low temperatures, also happens between it and almost all other metals, including zinc, potassium and gold."(Michaud L.D)

After 6-8 weeks of being in patios, the ores are later washed and filtered. Sometimes the watering is done in large tubs where mud is supposed to run off, but sometimes the solution was filtered through a canvas bag. After washing the mercury-silver solution, the amalgam was delivered to the Ingenio, the factory where the last part of the patio

process is taking place. After the solution was washed and only solid silver metal and mercury was present, the amalgam was put in “hooded oven” where it was heated to the point where mercury would vaporize out and leave the silver in

it’s purest form. The use of mercury was very efficient, since later on, people learned how to collect the mercury that was

vaporized and can reuse it again, lowering the costs of production and also decreasing environmental pollution since mercury is a very toxic substance. Before the method of reusing mercury was created, mining factories poured the mercury and other by-products in the rivers and other water objects.

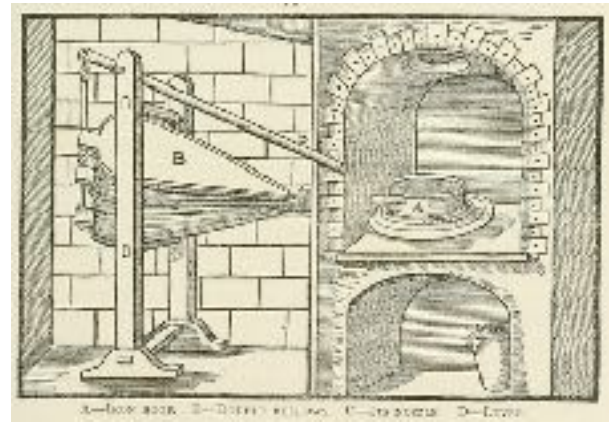


Figure 5 Ore roaster
A)Iron hoop B)Bellows



Figure 4
Hacienda Nueva de Fresnillo Zacatecas, Pietro Gualdi, 1846.

The enlightenment period, specifically scientific revolution had played an important role in allowing silver to be produced cheaply and effectively. During the enlightenment era in Latin America, people have switched from scholastic view on life and have developed new scientific thinking, it became the one of the main reasons for America to become the main producer of silver in the world, in particular Mexico was producing three fifth of all silver on the planet.

In the late 18th -19th centuries, the silver and other mining metals were used as a currency(1mine could get up to 200000 pesos). When the Patio Process was found, the silver extraction became more sufficient and have become one of the key factors that led to the formation of world trade in those times. The rapid expansion of silver production and minting, made possible by the invention of patio process, was often identified as the main engine of the price revolution, a period of high inflation that lasted in Europe from the sixteenth to the early seventeenth century.

"By the 16th century, Spanish conquistadores had discovered and developed silver mines in Mexico, Bolivia, and Peru."(Britannica)

Main silver mining lands, Potosi, Pachuca

The most prominent mining land that is known to use patio process is Potosi, it is located in Bolivia. This region was found in 1545 and is still active today. The richest silver deposit was found by native Peruvian named Diego Huallpa, Cerro Rico de Potosi, high in the mountains of southern Potosi. The story of how the silver ores were

found is pretty amazing . An administrative capital called La plata was formed in the flats of the Potosi and Huallpa was ordered to climb the Cerro Rico mountain in search of Incan shrine. On the way back, Huallpa caught strong wind and accidentally dug his hands on the side of the hill and discovered that the dirt is rich in silver. He carried some of that ore down the hill and that is how the region became known.

“According to the recent studies, the Cerro Rico or “Rich Hill” of Potosí consists of a dome of volcanic material that spewed up through a narrow dike some fourteen million years ago and flowed out over old sedimentary deposits.”(Saldana, JJ) The enrichment from below was followed by a steadier process of oxidation, and enrichment from above, making the upper slopes of the mountain some of the richest and most easily exploited silver. The King Carlos the first

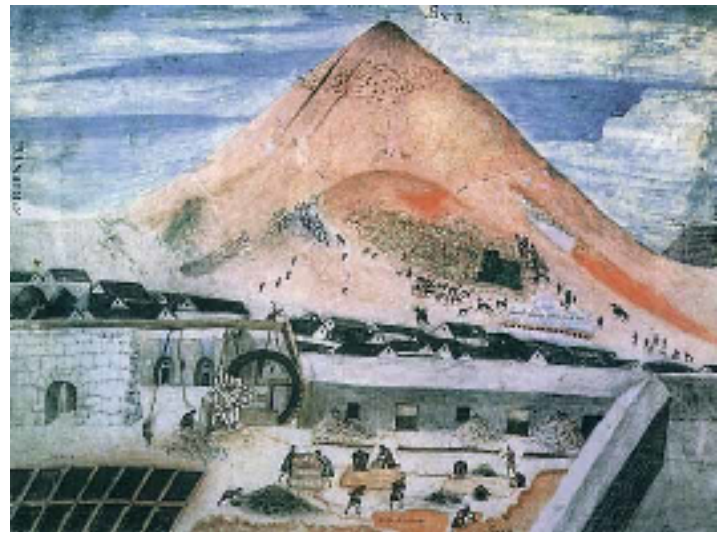


Figure 6 Cerro Rico, silver production landscape

has given this lands the title of Imperial Villa for it's help during the times of great need. Besides Charles the first, other Emperors like Philip the third and Carlos the second would rely on it as well.

The city of Potosi was one of the highest cities in the world (13,200 feet above the sea level) and the method of Patio has definitely played a role in allowing silver extraction to be possible in such a tall region. Mercury-based silver extraction process (patio) was introduced and brought to Potosi by Francisco de Toledo in 1574. The installment of

multiple crushing mills and water dams was required. To make this project possible, Francisco de Toledo hired thousands of native workers, which also had a negative effect on the families living there. The conditions to work there were tough, underground mining is dangerous and the toxicity of the mining process also had consequences on the health of the workers and habitants of Potosi. Francisco de Toledo have used “mita” which is a labor subsidy for mine and mill owners and a major cause for population decrease of the native indigenous population of Latin America. Native Andean’s of age between eighteen and forty were drafter there periodically and over 12 thousand mita workers were expected to be in Potosi in any given time.

The introduction of Patio Process into silver extraction in the Americas has ended the mid- sixteenth century silver crisis, but also started a rapid expansion of silver production in New Spain and Peru, as mining cities could now profitably extract lower grade ores. There are definitely a lot of good coming from mining silver, the development of universities was taking place due to the need of mining specialists, mining truly pushed economy and education to a next level. But it also important to count how many wars and dirt have been floating around the mining cities, a lot of workers were underpaid and had worsened health conditions due to the pollutants coming from the mining factories. Kings and Emperors were doing everything they could to ensure that the production of precious metals never stops and keeps them rich. Patio Process is an example how science was developing in that time, specifically chemistry that allowed the use of mercury for the process of amalgamation. Patio process is the proof how science can affect populations and how much power it actually has.

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