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Silver Mining in Cerro Rico

Introduction

In 1545, Diego Huallpa discovered the famous silver deposit – Cerro Rico de Potosí – in the southern Bolivia mountains (Lane, 2015). Although Peruvian, Huallpa worked for a European overseer at the mines in Porco. Porco was the Incan Empire's main silver source from 1538 to 1539 (Lane, 2015). While traveling between Porco and their self-established capital, La Plata, Huallpa climbed a nearby mountain to look for an Inca shrine. On the side of this mountain, he uncovered a section of silver similar to that in the mines of Porco. Huallpa then collected some of this material to bring to Porco for further analysis. One year later, that mountain became known as the Cerro Rico – or "Rich Hill – of Potosí (Lane, 2015). Thousands of Spaniards, indigenous, and enslaved Africans swarmed to stake claim in the mountain. As a result, the city of Potosí emerged and Carlos I – the king of Spain – exploited its community members through silver taxation to fund his war efforts.

Silver mining in Cerro Rico, Potosí, exemplifies the intersection of economic ambition and the early scientific attitude, where meticulous documentation, innovative mining techniques, and empirical observations fueled the Spanish colonial economy. However, the relentless pursuit of wealth also highlighted the environmental and social costs, shedding light on the necessity for scientific integrity and sustainable practices in exploiting natural resources.

Historical Context

Potosí's first mines looked like shallow pits (Lane, 2015). Its workers then dug out the ore with iron bars. Many of these workers had stories similar to those of Huallpa – indigenous people who depended on foreign overlords. After the ore was dug out, the "indios varas" – or "Indians by the yard" – sorted it by grade and transported it down the mountain to nearby refineries (Lane, 2015). The Andeans designed a furnace called a "huayrachina" or "huayra" – the Quechua word for "wind" or "ventilate" at these refineries (Lane, 2015). It was made from stone and clay and more than six thousand populated the hillside of Potosí. It had a conical shape with a fire at its base and openings around its sides to guide airflow (Bigelow, 2016). As air tunneled through its openings, it simulated the effects of a bellow. Although they produced high-grade silver ore at impressive rates, these huayras required fuel – a scarcity (Lane, 2015). To combat this, they burned llama droppings and yareta moss.

The Andean Cordillera – where Hullapa was from – was the most developed mining region in the sixteenth century (Lane, 2015). In 1532, however, Spain assumed all of their technology and knowledge after it conquered the Incan empire (Lane, 2015). With this information, they innovated the Andean mining system by implementing iron and steel tools and mercury amalgamation. This improved efficiency in the mines by quickening the extraction, crushing, and refining processes. It is important to note that although these new tools were implemented in Potosí during the Incan conquest, mercury amalgamation was not until 1572 – forty years later (Lane, 2015).

In 1572, Potosí adopted a mercury-based refining process from a Seville merchant, Bartolomé de Medina (Lane, 2015). This method was called the "patio process" – an open-air system that mixed ground-up silver ore with mercury that was then stirred periodically

throughout its weeks of amalgamation (Lane, 2015). The patio process was a ten-step method as follows:

- **Step 1:** Crush minerals and arrange them into piles that hold two to four thousand pounds of material.
- **Steps 2 - 4:** Treat piles in several stages of incorporation, mixing reagents like salt, iron sulfide, or copper sulfate into silver mounds and allowing the mixture to harden.
- **Step 5:** Carefully add mercury.
- **Step 6:** Have the refiners stomp the mixture with their feet to allow for greater incorporation.
- **Step 7:** Wash the solution.
- **Step 8:** Remove the partially-formed amalgams of silver and mercury that were fired in forty-five-pound molds.
- **Step 9:** Separate the incorporated metals.
- **Step 10:** Melt the metals into bars and send them to be minted and taxed (Bigelow, 2016).

They did not discriminate what types of silver this amalgamation process was tested on – they manipulated all types of ore including mixes of copper, iron, and sulfur (Bigelow, 2016). Potosí integrated the patio process with industrial-scale technology after the Peruvian viceroyalty – Francisco de Toledo – visited (Lane, 2015). He instructed thousands of workers to build dams in the Kari-Kari mountains to accomplish this. This would serve as the water supply for the countless new crushing mills required for the patio process. The success of this project proved to be a cornerstone for Potosí's wealth restoration. Toledo also organized a new labor system for the

mines called the “mita” – from the Quechua word “mit’a” for “turn” (Lane, 2015). This forced labor and constant exposure to toxins soon collapsed the Andean domination of mining.

Economic Impact

A misconception has been established that Latin America is a peripheral country lacking independence and industrialization (Bigelow, 2016). On the other hand, its silver industry has historically impacted its macroeconomic expansion by increasing its GDP per capita, wages, and market integration (Bigelow, 2016). For instance, an estimated sixty percent of Potosí’s miners and refiners were independent wage laborers (Bigelow, 2016). The influx of people and resources transformed Potosí into one of the largest and wealthiest cities in the world during the sixteenth and seventeenth centuries. The city's population grew to over two hundred thousand, making it one of the most populous urban centers of its time. However, in the 1540s to 1560s, Potosí experienced its first boom-and-bust cycle (Lane, 2015). This provided the “huayradores” – or indigenous miners and refiners – an opportunity to thrive. Huayradores were also referred to as “yanaconas” – it derives from the Quechua word “yana(yaku-)kuna” (Bigelow, 2016). It translates to: “yana” (person you serve) + “ya” (continually) + ”ku” (for me) (Bigelow, 2016). It was eventually shorted to yanacona and implied that the Spanish empire inherited the Incan empire’s labor and technology knowledge. The yanaconas’ labor system triggered an economic impact, which resulted in a new labor system (Bigelow, 2016). Individualized wages created a new kind of slavery for mid-sixteenth century Potosí through movement, migration, and coercion (Bigelow, 2016). Despite having to give a portion of their silver earnings to their Spanish overlords, the smelters used however much was left to begin accumulating wealth (Lane, 2015). The yanaconas did not like paying tribute because they were not treated like community

members, but passersby instead (Bigelow, 2016). It is important to note that this behavior will only continue if Cerro Rico can supply the silver ore demand on time. After ten years, however, it seemed that Potosí would experience its first decline.

Cerro Rico supplied the world with a currency boost so much that Potosí was named the "treasury of the world" for some time (Lane, 2015). Silver became the key to globalization between the sixteenth and nineteenth centuries (Bigelow, 2016). Global trade used indigenous silver as their standard currency because Iberian merchants used the revenue they earned from the Asian Markets to purchase materials and labor from Africa and Europe. This was because silver and gold were the most universally traded forms of currency, and kingdoms all over yearned for a steady supply of these precious metals as they would establish dominance over others through glamour and warfare (Lane, 2015). Merchants also needed silver to trade their goods and pay off the investors of their commercialized ventures from every other corner of the globe. Potosí was able to facilitate both global trade and monarch happiness simultaneously. Most of their silver bars and coins found a home in China, and some in India. These Asian countries manufactured some of the most demanded products in the world – products that could only be paid for with American silver and gold. The king of Spain envied this – he was desperate to possess such a distinguished silver mountain. However, the influx of silver from Potosí profoundly affected Spain. The wealth generated from the mines allowed Spain to finance its military campaigns and maintain its status as a dominant European power. It even allowed them to pay for silks, noble palaces, and loans borrowed from neighboring European countries (Zoellner, 2014). The Imperial Villa of Potosí was also considered a hub for global trade. They imported huge quantities of Spanish iron and steel, and English, Chinese, and Indian textiles. The silver from Potosí had significant effects on the broader European economy. The silver trade

facilitated the development of global trade networks, connecting Europe with Asia and the Americas. This period is often considered the beginning of globalization, as silver flowed from the Americas to Europe and Asia, particularly China, where it was in high demand. The silver from Potosí played a crucial role in the global economy at the time. It supported the Spanish Empire's dominance and contributed to the rise of global trade networks.

Environmental Consequences

Cerro Rico's silver extraction method was a drill, blast, shovel, and haul (Zoellner, 2014). In the 1670s, Potosí began blasting their mines with black powder. Blasting minimized the manual labor needed to chip the rock by hand (Lane, 2015). Black powder also heightened the dangers of rock fall and toxin inhalation – something that could make miners develop life-threatening lung diseases. Despite these conditions, workers generally desired to develop their drilling and charge-placing skills to earn higher wages. Today, an estimated sixteen thousand miners actively work on the Cerro Rico mountain, with dozens of them dying and hundreds more of them diagnosed with severe cases of silicosis (Zoellner, 2014).

Socio-cultural Effects

The mining industry in Potosí relied heavily on forced labor, particularly through the Mita system, which required indigenous communities to provide labor for the mines. This led to significant social and demographic changes, as indigenous populations were displaced and subjected to harsh working conditions. The labor-intensive nature of silver mining also contributed to the exploitation and suffering of enslaved Africans and indigenous workers. The local Quechua were forced into slavery – they had to dig for twelve hours each day and sleep in

the underground tunnels for periods as long as four months (Zoellner, 2014). To make themselves feel better, they were told to pray to God, however, many of them saw this as an opportunity for traitors – they created the imaginary power "Tío," who served as the landlord and protector from the dangers of the mountain like cave-ins, silicosis, and a lack of silver (Zoellner, 2014).

In the early 1700s, the Spanish government became worried about the condition of Potosí (Lane, 2015). They believed Andean mine owners were not mentally fit enough to run such a city without supervision. The Bourbon kings decided to take action: all Potosí needed was the freshest tools, theories, and techniques, as well as a handful of tax incentives. The Spanish administration organized multiple technical missions with the first arriving in Potosí in 1789 (Lane, 2015). Polish Protestant Baron Thaddeus von Nordenflicht led the mission. With him, he brought barrel-type amalgamation machines designed by Austrian engineer Ignaz von Born. Unfortunately, they soon realized that this new tool would be considered impossible to build in Potosí as they lacked the quality of craftsmanship, engineering, and steel. Although Borns' machines produced positive results, their expenses were not feasible to keep the operation running. Yet in the early 1820s, the British government visited Potosí and discovered that Bolivia's miners were still cutting and transporting ore with their bare hands and backs (Lane, 2015). They were also still using mercury amalgamation – a technique from the days of Toledo. Potosí's crushing mills were repaired on occasion but barely improved upon. Although the British urged the implementation of new technologies, the mine owners' primary concern was cheap materials and labor. From the late eighteenth century to the early nineteenth century, Potosí's silver production declined greatly as European supplies were cut off due to naval warfare and Potosí struggled to obtain mercury. In the 1900s, Potosí finally accepted that they

were desperate for new technology (Lane, 2015). This was mainly achieved through rail line construction that connected mining towns along the Andean highlands. This meant that heavy machinery and equipment could be transported from countries like Europe or the United States, and therefore Potosí could begin to utilize local steel production.

The Scientific Attitude Towards Mining

Unfortunately, science in Latin America has been considered to be a secret throughout its entire history. To understand these underlying truths, scientists have banded together to investigate using archaeometallurgy, ethnohistory, and oral history (Bigelow, 2016). For instance, they utilized literary scientific tradition as a means of defining the language used by the indigenous miners. One example of this was 1600s priest Alvaro Alonso Barba who designed and wrote a series of novels about the theoretics and practical applications of linked European and indigenous understandings of how the world operates (Bigelow, 2015). He experimented and questioned authority frequently (Lane, 2015). He embodied the "New Science" movement during the seventeenth century. In 1640, his work *The Art of Metals* was published in Spanish and translated into English, German, and French until the end of the eighteenth century (Lane, 2015). This indicated the presence of "intellectual hybridity" – these somewhat mistranslated Hispanized forms of Quecha provide an understanding of how Andean miners founded a vocabulary for their knowledge and activity (Bigelow, 2016).

Conclusion

Today, Potosí would be considered a classic example of Dark Ecotourism as they proudly publicized their systematic destruction of mountainsides and human beings (Zoellner, 2014). The

term “dark tourism” was created in 1996 by two British academics: Malcolm Foley and John Lennon (Zoellner, 2014). Dark ecotourism in Potosí is evident within the mountain itself. It was once rich with silver but now stands as a symbol of exploitation and danger. Tourists are paying to experience the harsh working conditions of the miners. Visitors are taken into the tunnels to witness the laborious and hazardous environment firsthand. This form of tourism in Cerro Rico raises ethical questions about the commodification of suffering. Cerro Rico must implement sustainable mining practices and policies to mitigate environmental damage while considering its economic needs.

References

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Additions to be made…

Historical Context:
Pre-Colonial Period: Brief overview of the region before the Spanish arrival
Spanish Conquest (16th Century): The discovery of silver and its impact on Spain and Europe
Peak Production: Discuss the peak years of silver extraction and the influx of wealth to Spain

Economic Impact:
Local Economy: Analyze how silver mining shaped the economy of Potosí and the surrounding areas
Global Trade: Explore how silver from Cerro Rico influenced global trade networks, particularly with China and Europe

Environmental Consequences:
Mining Techniques: Describe the methods used for silver extraction and their environmental toll
Ecological Impact: Discuss deforestation, soil degradation, and water contamination resulting from mining activities
Health Issues: Address the health risks faced by miners and local communities due to exposure to toxic materials

Socio-Cultural Effects:
Indigenous Communities: Impact on local indigenous populations, including displacement and cultural changes
Labor Systems: Examine the use of indigenous labor, including the mita system and its implications
Modern Mining: Brief overview of current mining practices and their socio-economic implications

Scientific Attitude Towards Mining - TBD

Conclusion:
Summary of Findings: Recap the economic significance and environmental costs of silver mining in Cerro Rico
Future Considerations: Suggest the need for sustainable mining practices and policies to mitigate environmental damage while considering economic needs