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Incorporating indigenous knowledge into extractive economies: The science of colonial silver

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ABSTRACT

Historians of mining in colonial Latin America are faced with a deep and persistent methodological tension in our field. From census records, surveys, and tribute tallies, we know that indigenous men and women represented the majority of miners and refiners in the silver centers of Potosí and Zacatecas, but because they left little written evidence of their work, their intellectual and technical contributions remain underappreciated in the historiography. By tracing terms that European translators of Álvaro Alonso Barba's _Arte de los metales_ (Madrid, 1640) understand (which tend to reflect familiar concepts in natural philosophy) and misunderstand (which tend to reflect Hispanized forms of Quechua and Aymara), we can use the language of colonial mining and metallurgy to identify where and how indigenous ways of knowing provided key technical vocabularies in the science of American silver. Recovering some of the Andean intellectual and etymological roots of colonial amalgamation technologies also provides a new way of thinking about the incorporation of indigenous knowledge into extractive industries that figured prominently in the early modern making of the black legend.

1. Introduction

Historians of mining in colonial Latin America face a deep and persistent methodological tension. From census records, surveys, and tribute tallies, we know that indigenous women and men formed the majority of miners and refiners in the silver centers of Potosí and Zacatecas, but because they left little written evidence of their work, their intellectual and technical contributions remain underappreciated in the historiography (Sánchez Gómez, 1989, 321). Silver was one of the most lucrative industries in Spanish America, outpacing gold in most of Spanish America after the early-sixteenth century's initial strikes (TePaske, 2010:16). As Tutino (2011) shows, the silver industry integrated regions like the Mexican Bajío into transpacific commerce with China, transatlantic exchanges with Africa, and permanently shaped the cultural architecture of Mexico. According to Bakewell (1987, 249), the same is true for all of colonial Latin America, where the "external consequences" of mining are "almost beyond measure." Because American silver became the standard currency of global commerce, as Iberian traders used profits from East Asian markets to buy and sell people and goods in Africa and Europe, Flynn and Giráldez (1997, 1995) argue convincingly that colonial silver helped to inaugurate global trade in the early modern era. We cannot fully appreciate how silver reshaped these global currents without first understanding how it was produced in the Americas, and how indigenous natural knowledge contributed to that process.

In an attempt to recover the intellectual and technical contributions of indigenous miners and refiners, scholars from diverse research areas have developed innovative modes of multidisciplinary inquiry, including archaeometallurgy, ethnohistory, and oral history (Cruz and Vacher, 2008). This article joins that effort by suggesting a linguistic-discursive method grounded in a literary scientific tradition, one exemplified by the work of priest-metallurgist Álvaro Alonso Barba (1569–1662). According to Salazar Soler (1997), Barba's book followed the Greek doxographic tradition, beginning with theoretical concepts (book I) before proceeding to practical application (books II–V). This narrative organization allowed Barba to show important continuities between European and indigenous knowledge systems on matters such as embryological theory, or the idea that metals grew like plants underground, creating a kind of "mestizaje cognitivo" (Salazar Soler, 1997, 296). We can more thoroughly appreciate such intellectual hybridity by examining the book's hybrid language. Specifically, by tracing the translation and mistranslation of Hispanized forms of Quechua in the English (London, 1670) and German (Hamburg, 1676) editions of Barba's *Arte de los metales* (Madrid, 1640), we can identify where and how indigenous miners provided determinative vocabularies and knowledge in colonial Andean mining and metallurgy.

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Unfortunately, no book on mining in New Spain experienced such widespread or quick translation in the early modern Atlantic. This essay thus focuses on the Andes, though I include examples from Mexico when the textual record allows.

Recuperating indigenous and creole ways of knowing not only allows us to better understand the history of colonial mining and refining; it also suggests a way to think about extractive industries as innovative sites of the production and dissemination of hybrid knowledge. Extractive colonial industries built upon tribute labor that fed imperial, mercantile economies have often been blamed for underdevelopment in Latin America (Moore, 2010; Engerman and Sokoloff, 1997), but new work in economic history suggests that the silver industry allowed for important areas of macroeconomic expansion in Mexico and Peru, including increased GDP per capita, real wages, urbanization, and market integration (Arroyo Abad and van Zanden, 2014, 17–22; Grafe and Irigoin, 2012; Irigoin and Grafe, 2008; Tutino 2011).

Likewise, while images of enslaved and tribute miners once dominated our view of Potosí, what one of its governors called "un pueblo levantado tumultariamente por la codicia al pie de la riqueza que descurbrió una casualidad" (a town raised in tumult by greed at the foot of wealth discovered by accident), new research in colonial labor history shows otherwise (Arzáns 1965 [1737]: I.cxxxiArzáns 1965 [1737]: I.cxxxi). By 1600, the majority of miners and refiners in Potosí and Zacatecas, roughly 60–70% of the workforce, were independent wage laborers (Bakewell, 1984: 128, 181; Lane, 2005: 174–175). In the Andes, independent miners who could and did migrate widely and negotiate wages were called *yanaconas*; they were subject to tribute, even though they did not live in tribute-paying towns or enjoy the benefits of community membership, such as shared agricultural resources, kinship networks, and ritual celebrations. Because the suffix *yana* appears in terms for color ("Negro color moreno") and servitude ("los criados") in early colonial dictionaries (González Holguín, 1989 [1608], 364), scholars have long debated the term's origins. Rodolfo Cerrón-Palomino's (2008, 75–88) recent summary of the debate reviews insights from John Murra and María Rostworoski to suggest that *yanacona* derives from the Quechua **yana(yaku)-kuna*, or *yana* [person who serves] + *ya* [continually] + *ku* [dative; for me]. Over time, through haplology, and in Spanish conflations of Quechua sounds, the term became *yanacona*, suggesting how labor frameworks and technical knowledges from the Inca empire were repurposed into Hispanic empire.

Another example of how language indexes these scientific and economic changes is the word *guayra*, a shortened Spanish form of *huayrachina*, a traditional refining oven in the Andes. Their design – conical in shape, with a fire at the base and openings along the sides to facilitate airflow (Van Buren and Cohen, 2010, 31–33) – proved especially beneficial for the refining of high-grade silver ores. After mineral crushing and washing, miners in the pre-Columbian and early colonial periods added two parts of silver to one part of the silver-lead alloy *soroche* (derived from the Aymara *suruxchi*and Quechua *suruchiq*, meaning "to drip," after its low melting point) with some slag metals from earlier rounds of processing, into conical-shaped ovens that they placed on mountaintops (Cerrón-Palomino 2008: 111–119). As strong winds blew against the mountains, air passed through the openings and simulated the effects of a bellows. The Quechua term *huayrachina* is usually interpreted as "wind" + "ventilate" (Money, 2004, 60), and sometimes as "wind" + [feminine marker] (Téreygeol and Castro, 2008, 16), which highlights discursive and symbolic links between women and the ovens. After the transfer of amalgamation technologies from Mexico in the mid-sixteenth century, Andean men turned increasingly toward independent wage labor (*yanaconaje*), and women processed greater quantities of silver in *huayra* or *tocochimbo* ovens in or next to the home (Van Buren and Cohen, 2010; Bakewell, 1984, 140–141).

As these coeval shifts suggest, wage labor was not separate from the larger, coercive system of colonial mining. It was central to it. So many Spanish property holders took advantage of their uncertain status that legal theorist Gaspar de Escalona y Agüero (1675: 201) complained of a "nueua especie de esclauitud" (new kind of slavery) taking form in Potosí. Movement, migration, and coercion were part of an expanding colonial silver industry that removed indigenous, African, and mixed-race women and men from their ancestral communities, and at the same time allowed them to use technical and commercial skills to provide for their families (Harris et al., 1995; Tandeter, 1992). In addition to these forced resettlements, the development of the silver industry was made possible by legal policies that facilitated the discovery of new mines by standardizing mine sizes, operational conditions, and registration protocols in the viceroyalties of Mexico (González, 1996) and Peru (Vergara Blanco, 1989). In 1542, both viceroyalties were reorganized to cohere with new policies about land and Indian labor, and, as Pérez Melero (2009: 54) has argued, to promote the production of silver in the colonies and its export to Spain. These elaborate projects of political redistricting were supported by new metallurgical technologies that allowed refiners to process mixed silver ores on a cost-effective, industrial-size scale (Bargalló, 1969).

While we better understand the conditions of Andean women's and men's labor in mines and refineries, we know far less of their intellectual and technical contributions to the colonial silver industry. Miners and refiners did not just labor in Spanish America's market-oriented economies. They also developed technical methods and insights that supported increasingly interconnected knowledge economies, as well as key technology transfers among indigenous and colonial mining communities (Salazar Soler, 1997; Salazar Soler, 2007), and between Europe and the Americas (Castillo Martos, 1994; Hausberger, 2009). The most important of these was the amalgamation of silver (Ag) with mercury (Hg).

2. New and not new: colonial amalgamations

Amalgamation was not a new metallurgical method. Archaeologists have documented nearly 3500 years of mercury use among human societies, ranging from the application of cinnabar (HgS) as a pigment or dye in Andean communities and coastal Mediterranean regions, to its 2000-year old use as a reagent in refining gold and silver ores (Lacerda and Salomons, 1998, 1). Pliny the Elder (23–79), chronicling Roman imperial mining operations in the southern Spanish region of Andalucía, some 600 years before the region was conquered by the Moors (Umayyad conquest), provided elaborate descriptions of the costly, time-intensive process through which refiners used mercury to extract gold (Au) from partially-processed ores. According to Pliny (2004, 301/33.99), when "repeatedly shaken together in earthen vessels, the mercury draws out all the impurities in the gold. After the impurities have been driven out, separation of the mercury from gold is achieved by pouring both on to well-dressed hides; the mercury is exuded through the hides like a kind of sweat and the gold is left pure."

Early modern refiners, still closely following Pliny's descriptions, rubbed mercury with steel to activate its humid properties ("in humiendola cō aceto") before incorporating it with soliman ($HgSO_4$), green copper (oxidized (Cu) after exposure to elements), and salt (NaCl) into vats of partially-processed metals (Biringuccio, 1540, 14v, 22v, 142). Although he was based in Rome and Siena, Vannoccio Biringuccio (1480–1539) had studied in Germany, where refiners Georgius Agricola (1494–1555) and Lazarus Ercker (1528–1594) explained gold amalgamation in similar terms. Agricola (1950 [1556], 298) described pouring mercury "into a bag made of leather or cloth woven from cotton, and when this bag is squeezed, as I have described elsewhere, the quicksilver drips through it into a jar placed underneath," such that "pure gold