

## Chapter 15

# Some Thoughts on Mining and Quarrying in the Ancient Andes

Richard L. Burger

In the following discussion, I offer some thoughts stimulated by the papers brought together in this volume. At the suggestion of the editors, I emphasize the themes in the initial portion of the volume dealing with the extraction of non-metallic deposits.

In my opinion, *Mining and Quarrying in the Ancient Andes: Sociopolitical, Economic and Symbolic Dimensions* represents a milestone in Andean archaeology. It demonstrates that for the first time there is a critical mass of high-quality research on Prehispanic mining and quarrying. One of its strengths is that it is not limited to Peru; on the contrary, it is also drawn from field investigations in Ecuador, Chile, and Bolivia. This new wave of research on Prehispanic mining and quarrying has been complemented by fresh ethnographic work on contemporary extraction practices among traditional indigenous groups, as well as a critical appreciation of relevant historical documents. This advance in research on mining and quarrying has been a long time coming, considering that its foundations were laid down decades ago by a relatively small number of archaeologists and geologists.

Perhaps most notable among these pioneering scholars was Georg Petersen (1898–1985), a geologist of German birth and Peruvian nationality who spent most of his life in Peru, first working in the oil and mining industries, and then as a professor of geology in Lima at the Universidad Nacional de Ingeniería and the Pontificia Universidad Católica del Perú (C.R. Petersen 2010). Unlike many Peruvian geologists, Petersen's interests extended well beyond economic concerns and much of his scholarship focused on the interface between archaeology and geology. A personal friend of Julio C. Tello, Jorge Muelle, Junius Bird, Duccio Bonavia, and other archaeologists, Petersen pioneered the study of Prehispanic mining and metallurgy, with interests that reached beyond metals to the full range of

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R.L. Burger (✉)

Anthropology, Yale University, P. O. Box 208277, New Haven, CT, USA  
e-mail: richard.burger@yale.edu

rocks and minerals utilized by the people of the ancient Andes. And he was as interested in the procurement of the raw materials via quarrying and mining, as he was in the subsequent production of tools and other objects. As far back as the 1953 he worked with Junius Bird at the American Museum of Natural History in New York City on the investigation of the Prehispanic Chilean miner known as the Copper Man (Petersen 2010: 39)

Petersen's decades of research culminated with the publication of *Minería y Metalurgia en el Antiguo Perú* by the Museo Nacional de Antropología y Arqueología in Pueblo Libre in 1970. Forty years later, an English edition of Petersen's book was published by the Geological Society of America as a result of the efforts of geologist William Brooks (Petersen 2010), and the volume still has much to offer.

Although an earth scientist by training, Petersen developed into a true Peruvianist, who was almost as comfortable with the Spanish chronicles and archaeological evidence as with geological stratigraphy. He traveled throughout the Peruvian highlands and coast and had an encyclopedic knowledge of Peru's metal and mineral deposits, as well as an extensive professional network that gave him access to a large body of unpublished information. All this is summarized in his remarkable 1970 volume (Petersen 1970). When I began my research on obsidian, I naturally sought Petersen out in Lima and received valuable advice as well as encouragement and support. As a testimonial by Duccio Bonavia (2010) demonstrates, I was just one in a long line of scholars to benefit from Petersen's generosity.

Considering Petersen's scientific background, it is noteworthy that he wrote the following passage in the Prologue of his monograph:

Mining during ancient times was mystical and religious. The ancient Andeans felt intimately connected with nature and the mines that provided the metals were worshipped and given offerings. Padre Calancha (1638) described how the ancient Peruvians worshipped their gold mines (*chuqui*), their silver mines (*coya*), and mines that yielded other metals (*corpa*). Pyrite, cinnabar (*llimpi*), and the furnaces (*huayras*) used for smelting were also revered. Padre Bernabe Cobo (1653, Libro XIII, c.XI, p.166) observed that those who worked the mines also worshipped the hills and the mines, which were called *coya*, and were asked to yield their mineral wealth. The miners danced, drank and left candles in order to glorify their prayers

(Petersen 2010: xix)

It should be emphasized that despite the technical orientation of Petersen's work, he did not lose sight of the human experience reflected in the archaeological record. For example, in his account of a mummified miner discovered in 1899 at Mina Chuquicamata in the province of Antofagasta, Chile, Petersen (2010: 40) wrote "Copper Man" is a mute testament to human tragedy and a symbol of uncounted generations and sacrifices during millennia of ancient mining."

The numerous contributions gathered together in this volume follow in the tradition of Petersen, as well as that of Junius Bird, Heather Lechtman, and other pioneering scholars. Lechtman's work has been particularly influential in drawing attention to the cultural construction of technology, and she has used Andean metallurgy to illustrate the powerful ideological forces at work in the choices that are made in all technological processes (Lechtman 1980). Lechtman also followed Petersen's lead in searching for and investigating ancient mining areas using insights

drawn from both archaeology and materials science (e.g., Lechtman 1976). After reading Lechtman's work, Prehispanic mining and quarrying cannot be understood without detailed reference to the society and cosmology of ancient Andean peoples. Bird's special interest in mining technique and the tools that were used was also a valuable contribution (Bird 1979).

While the work of these early investigators has been a source of inspiration, the sudden surge of interest in mining and quarrying may also be interpreted as a function of the changing political and economic realities in Peru and its Andean neighbors over the last decade. Bruce Trigger (1994) has argued that attempts to understand the history of archaeology can be divided into internalist and externalist approaches. Internalist approaches concentrate on the changing understanding of a problem within archaeology, whereas externalist approaches focus on the relationship between archaeological understanding and the sociocultural context in which archaeology is practiced. While an internalist approach would emphasize the pioneering research of early scholars and their accomplishments, as I have done above, an externalist approach would focus on other factors outside of archaeology (Trigger 1994: 118). An externalist approach would note how the end of nationalistic military regimes and civil strife in Chile and Peru eventually led to the widespread adoption of neo-liberal economic policies encouraging large foreign investments in mining and the extraction of oil and gas. In many Andean nations, most notably Peru, this policy has fueled an economic boom. As William Brooks recounts (2010: ix), by 2009 Peru led the world in silver production, was the world's second leading producer of copper, and was the leading producer of gold in Latin America. From an externalist perspective (e.g., Patterson 1995), the quantum leap of research on mining and quarrying seems to be a result of this general phenomenon. Trigger ultimately concluded that the internalist and externalist approaches are complementary rather than antithetical, and that a rounded explanation requires both (Trigger 1994: 118).

The current boom in mining and quarrying is of relevance not only to understanding the timing of intensification of archaeological interest in the subject, but also because of the threat these economic developments pose to surviving Prehispanic mines and quarries. The enormous scale of investment and landscape modification by foreign mining companies in Peru and elsewhere in the Andes cannot be exaggerated, and the search for new zones to exploit is ongoing, often impacting mining areas abandoned since colonial times. The opportunity to study mining and quarrying is diminishing each year, as the activities of mining companies become more pervasive.

On the other hand, many of these enterprises sponsor archaeological surveys and excavation as part of their environmental and cultural impact statements and subsequent mitigation efforts, so it might be argued that the affect on archaeological research is not altogether problematic. Unfortunately, the results of these sponsored projects are little in evidence in this volume. This may reflect the emergence of an archaeological "gray literature" consisting of technical reports prepared to comply with government regulations but never adequately disseminated or incorporated into academic discussion. This is particularly tragic in the case of the work funded by mining enterprises, since these are often located in remote high-altitude locations

rarely studied in depth by archaeologists. In at least one case, that of the Yanacocha gold mine in the highlands of Cajamarca, contract archaeologists have encountered abundant evidence of religious rituals carried out at or near the mines, but to date, this information has remained unpublished (Jose Pinilla Blenke, personal communication).

The economic prosperity in Peru and several of its neighbors has stimulated an upsurge in local demand for a multitude of consumer goods, such as stone kitchen counters and wall veneers that require the quarrying of materials from what were once ancient quarries. For example, a visit in 2012 by the author to the well-known andesite deposit of Huaccoto near the modern city of Cuzco encountered workmen with electric saws and generators rapidly obliterating evidence of this Inca quarry (see Chap. 3), despite a commitment from the Ministry of Culture to protect it. As new four-star hotels and luxury homes are built in many Andean cities as a result of increased tourism and local prosperity, the impact on a range of mines and quarries is sure to rise. In reality, the intact sites relevant to the study of Prehispanic mining and quarrying have survived until today due to the underdevelopment of many Andean regions rather than the government policies protecting the cultural patrimony.

A corollary of this observation is that the mines or quarries of those rocks and minerals of least interest to contemporary populations are the ones most likely to have survived undisturbed. The studies of the Quispisisa obsidian source (Chap. 2, Tripcevic and Contreras 2011) and the Mina Primavera hematite quarry (Chap. 8) are good illustrations of this phenomenon. Since colonial times obsidian has had little if any economic value, since its main function as a raw material used for cutting implements was made almost obsolete by the European introduction of inexpensive metal tools. Most Peruvian geologists do not even bother to mention the presence of obsidian in their survey reports because of its irrelevance to the modern economy. But even in a case such as obsidian, the remote but vast quarry area has come under threat from a proposed government hydroelectric project (Chap. 1), in response to the demand for power touched off by rapid economic expansion.

Despite all of the current forces threatening mining and quarrying sites, it is difficult to read the contributions to this volume without being impressed by the richness and potential of the numerous sites that have been investigated and the many more that remain to be studied. A good illustration of this was the chapter devoted to hematite mining at the Mina Primavera mine in Nasca (Chap. 8). Initially, the quarry site appeared to be unpromising from an archaeological perspective since the mouth of the mine was closed by a modern masonry wall within a concrete frame. Yet excavations behind the entryway revealed not only evidence of Prehispanic mining, but also the hammerstones used in this quarrying and ground stone mortars and other artifacts used to produce red pigment from the hematite. In this, and several of the other chapters, excavation has proved essential for uncovering intact evidence of extractive activities hidden by mining debris and later deposits.

One of the distinctive contributions of this volume is to demonstrate the power of archaeology to document changing patterns of mining and quarrying. In many cases, what emerges is the unique life history of a mine or quarry, with its trajectory of initial use, its period of intensive exploitation, followed by its eventual decline and

abandonment. In some cases, a single mine might experience more than one such cycle over the *longue durée*. In the cases documented in this volume, what accounts for the timing of these cycles often seems to be a function of local socioeconomic forces, rather than broad pan-regional cultural or evolutionary trends. In the case of the hematite mine in Nasca, for example, there is meager evidence for initial use in late Early Horizon times, followed by intensification during the first few centuries of the first millennium; the latter corresponds to the apogee of the Nasca ceremonial center of Cahuachi, a site known for the abundance of fine polychrome ceramics bearing images of temple's religious cosmology. As Vaughn and his colleagues hypothesize, it is likely that the demand for a high-quality hematite used in the fine clay slips in Early Nasca ceramics at Cahuachi and other sites probably goes a long way to explaining the timing of the fluorescence of the Mina Primavera mine. It is intriguing and significant, however, that the exploitation of the mine decreased precipitously in Late Nasca times with the decline of Cahuachi and only rebounded weakly during the Middle Horizon, despite evidence at the mine of pottery styles often associated with Huari. Even though the Huari state had the power to mobilize large amounts of labor for public ends, as exemplified by sites such as Pikillaqta, this did not have any direct impact on the exploitation of the Mina Primavera hematite mine.

The general observation of the relevance of local economic forces in interpreting the life histories of mines and quarries raises the frequently mentioned issue of the relation of quarries and mines to Prehispanic elites and government rulers. In the Andes, the image of Tahuantinsuyu as a totalitarian state controlling a wide range of resources and activities, including the mining of precious metals, has had a profound impact on archaeological interpretation of pre-Inca archaeological remains. While this image of Inca power was initially based on Spanish historical accounts, it has received some archaeological support.

Judging from the chapters in this volume, the Incas did have a direct and deep involvement in mining activities, and not just of precious metals. As the chapters on the exploitation of copper ores at sites in the Atacama Desert of northern Chile (Chap. 12) and of chryscolla and opaline silica at Los Infielos Mining Complex in north-central Chile (Chap. 9) vividly demonstrate, Inca impact was powerful and unprecedented at these mineral deposits. At Los Infielos the Inca presence involved the imposition of buildings planned according to Inca architectural canons, the supply of food and provisions to those involved in the mining, the introduction of Inca pottery forms and designs to symbolize the role of the Inca state as the provider of food and drink in the contexts of public feasting associated with the mines, and the promotion of Inca state religious practices and paraphernalia at the mines. Salazar and his colleagues made similar observations about the Inca presence at late prehistoric mining sites in Atacama. Significantly, they also note Inca construction of small posts in strategic locations in order to control goods and people coming in and out of the mining complex. These findings not only strengthen confidence in the descriptions of Inca state involvement chronicled by Sancho de la Hoz and other early Spanish writers (Petersen 2010: 41–43) but also provide an enriched appreciation of the strategies and tactics implemented by Inca administrators as they expanded their political and military power into the mineral-rich southern Andes.

Yet it is dangerous to apply the Inca model to earlier times. The empire of the Incas appears to be an anomalous phenomenon in the Prehispanic history of the Andes. Few if any earlier states appear to have exercised coercive power to the degree practiced by the Incas. It is noteworthy that none of the examples of quarrying and mining discussed in this volume show evidence of direct state involvement or control prior to the Incas. Nor, with the exception of the account of Tiwanaku stone quarries (Chap. 4), do they seem to require positing the involvement of the large numbers of workers that we associate with Inca mining and quarrying. On the contrary, most of the mines and quarries described here seem to indicate the participation of small numbers of workers using relatively simple tools and simple methods that changed little over time.

In fact, as more time is spent exploring quarries and mining areas, the model of “elite control” comes increasingly hard to accept in most cases. For example, the obsidian mining pits documented at Quispisisa are spread over a 90-hectare area, and the zone in which obsidian can be quarried is much larger (Chap. 2; see also Burger and Glascock 2002; Tripevich and Contreras 2011). The other major obsidian sources in Peru, Chivay in the Colca Valley and Alca in the Cotahuasi canyon, are also massive (Tripevich and Mackey 2011; Rademaker 2012). Kurt Rademaker has estimated that the Alca source extends over an area that is roughly 320 km<sup>2</sup>. It is probably significant that none of the recent surface surveys carried out at Peru’s three major obsidian sources has encountered state buildings or a government administrative presence of any kind, despite the excellent preservation of these obsidian deposits areas and the exploitation of these deposits for over 10,000 years.

The same observations could be made about the Prehispanic exploitation of salt deposits. The famous salt source at Cerro de Sal in the Tarma area discussed in passing by Jennings and his colleagues (Chap. 6) ran for 16.5 km. Given the scale of these deposits, it is hard to imagine how a local *curaca* or state administrator could “restrict access” to these deposits. Many of the stone, salt, copper, and other deposits utilized in prehistoric times were similarly too large to control, except, perhaps, with the kind of hegemonic power possessed by an imperial state such as Tahuantinsuyu. Even at salt deposits covering a more limited area, such as the salt production from brine at San Blas in Junin or the quarrying of salt blocks along central Huallaga in San Martin, archaeological surveys and excavations have failed to find any evidence of state involvement in salt extraction during Prehispanic times (DeBoer 1984; Morales 1977).

Given my doubts about the applicability of the Inca model to pre-Inca mining and quarrying, it is interesting that so many ethnographic observations in this volume document the role of communal organization of extractive activities. As the chapter describing the extraction of salt from the Huarhua Salt Mine vividly illustrates, salt was traditionally considered an open resource and salt production was organized and carried out effectively by the salt makers themselves (Chap. 6); a similar pattern seems to have characterized salt production at Maras in Cuzco.

Indeed, judging from the contributions to this volume, the assumption that large numbers of workers or a high degree of complexity needs to be posited for Prehispanic quarries where considerable material has been removed is simply

unwarranted. For example, it is clear from the case of the red hematite mine in northern Chile exploited between 11,200 and 11,500 BP that the extraction of large quantities of minerals does not require a complex sociopolitical structure or a well-developed economic system. As documented at the San Ramón 15 Mine (Chap. 7), Preceramic hunters, gatherers, and fisherfolk were responsible for extracting some 3,000 metric tons of rock during the Early Holocene. After processing the hematite and goethite, this mass of rocks would have ultimately produced about 300 tons of red and yellow pigment. Given this accomplishment by the very ancient small-scale groups of northern Chile, it is not unreasonable to attribute many of the later mining activities in the Andes to the communal or individual efforts linked to modestly sized and relatively unstratified rural communities.

Since the seminal work of John V. Murra, Andean archaeologists and ethnographers have had a special fascination with the possibility of multi-ethnic involvement in the extraction of scarce raw materials, and this theme appears repeatedly in this volume (e.g., Chap. 6). Murra (1972) concluded that the interviews in the 1562 *Visita de la Provincia de León de Huánuco* attested to multi-ethnic salt production. Based on archaeological evidence, Daniel Morales (1977) likewise argued that his excavations at San Blas salt deposit in Junin confirmed that this pattern of multi-ethnic exploitation of minerals dated to long before Inca times. Nonetheless, despite these assertions, this model has never been rigorously tested. A convincing demonstration of this model will require larger-scale excavations and more thorough analysis of remains. The studies summarized here demonstrate that such a critical evaluation is now feasible with the appropriate field methodology.

I have already commented that one of the strengths of this volume is the focus on diachronic change in mining. Many of the mining and quarrying sites reported here show change over time in the intensity of extraction, the activities carried out at the mine or quarry, and the range of other activities associated with extractive process, such as the playing of music or the offering of exotics to the supernatural forces associated with the deposits. While direct evidence of patterns of long-term change is especially valuable, complimentary approaches have also begun to make a contribution. One promising new technique is the study of the elemental compositions in lake cores (Chap. 10). This approach is illustrated by Colin Cooke's study of mercury isotopes in the lakes close to the Huancavelica cinnabar deposits. In this study he is able not only to identify the beginning of cinnabar mining, but he is also able to document the increased intensity of extractive activities at the mines during Chavín and Inca times, followed by an even greater spike in the Colonial period (Cooke et al. 2009). The methodology used in this study is broadly applicable and will serve as a compliment to archaeological work at the mines themselves, and in some cases as the sole source of information when archaeological evidence at the mines has been badly damaged or totally obliterated.

It is also worth noting that there are many materials mined in the Prehispanic Andean world have yet to be researched. Anthracite coal, lapis lazuli, quartz crystal, and cinnabar, for example, were all valued commodities in the ancient Andes and were widely traded, but the mines and quarries from which they were extracted have yet to be located and researched. In the case of cinnabar, prior to the Spaniards,

due to its strong vermilion color, it (mercury sulfide) was used for body and face painting as well as a pigment in textiles, and it appears to have also been used in the amalgamation of precious metals (Chap. 10). There is an archaeological and historic evidence that the Santa Barbara mine above the town of Huancavelica was used before the Spaniards (Burger et al. 2002), but no field research has been conducted. While the Santa Barbara deposits were heavily exploited until 1825, it is likely that evidence of the Prehispanic mining activity remains somewhere in the vast mine complex.

Georg Petersen observed over 40 years ago, “The themes of mining and metallurgy in ancient Peru were aesthetic, utilitarian and religious,” and one of the richest themes in this volume is the symbolic and religious importance of mines and mining. This realization resonates with contemporary insights in Andean ethnohistory and ethnography. Carolyn Dean (2010), for example, recently has written an entire book exploring the Inca conception of stone as potentially animate, sentient, and sacred. The notion that stones or other minerals were imbued with supernatural forces appears to go back long before the Incas, judging from the stones dressed and treated as sacred at Late Preceamic sites such as Bandurria and El Paraiso (Fung 1988; Engel 1957).

In his contribution to this volume Dennis Ogburn (Chap. 3) observes that in Father Bernabe Cobo’s list of the sacred places (*wakas*) in Cuzco, three of the *wakas* were stone quarries. According to Cobo, these quarries were worshipped and offerings were made to them. Archaeological documentation of offerings and remains suggesting other ritual behavior at Prehispanic mines and quarries are described in several of this volume’s chapters; evidence for this has been recovered from Inca mines (Chaps. 3 and 12), but it is also found at quarries used a millennium or more before the Incas (Chap. 8). The symbolic significance of particular kinds of stone may even be crucial for understanding the selection of particular quarries or the reasons for why activity was shifted from one quarry to another, as appears to be the case for Tiahuanaco (Chap. 4). The discovery of three ancestral tombs (*chullpas*) at the Chivay source adjacent to obsidian quarries in the puna is evidence of the symbolic importance of these deposits of natural glass (Burger and Glascock 2002, 2011: 290). The discovery by Hiram Bingham III of an offering of small obsidian nodules brought to Machu Picchu from the Chivay source, hundreds of kilometers away as the condor flies, is another dramatic expression of the religious significance of materials frequently treated as “utilitarian” (Burger 2004). The documentation of *chullpas* at the Chivay source is paralleled by reports of *chullpas* at the Inca granite quarry near Ollantaytambo and a stone platform with religious offerings of Spondylus shell found overlooking the Inca turquoise mines at the San José del Abra complex in Atacama. The religious significance of mines and quarries is by no means limited to the Andes. The ancient Egyptians considered quarries to be sacred and built shrines there for worship, as in the case of turquoise quarries in the Sinai Peninsula (e.g., Valbelle and Bonnet 1996). Yet the special sensitivity that Andean archaeologists have shown to this theme is unusual and contrasts sharply with more narrow economic perspective of many Mesoamerican archaeologists (e.g., Cobean 2002).



The themes mentioned here and many others make the reading of this volume an exhilarating experience. It is my hope that these chapters will encourage a new generation of archaeologists to investigate an even broader range of quarries of mines and to delve still deeper into the technological, political, economic, and religious forces that shaped the complex life histories of Prehispanic Andean mines and quarries.

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