# Tarascan Copper Metallurgy:

## A multiapproach perspective

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# Preface

The present volume is based on my PhD dissertation, which I completed at The Pennsylvania State University in 2006. It outlines the design, implementation and results of an archaeological project carried out at Itziparátzico, a Tarascan locality near Santa Clara del Cobre, Mexico, where evidence indicates that copper metal production took place from the Late Postclassic (AD 1350-1520) throughout the Contact period, and continues until today.

At the time this research project began, there seemed to have been very few attempts to carry out systematic studies on primary metallurgical production at Mesoamerican sites. These include the work of Dorothy Hosler (2009) at El Manchón and other sites in Guerrero, which was only partially published several years later. The results presented in this work, for the first time characterize smelting byproducts (slag). Based on multiple sources of data, including archaeological, ethnohistorical, and archaeometrical, a model for copper metallurgical production at the local and regional level is proposed. Although there has been a considerable increase in research on Mesoamerican metallurgy during the past twelve years, the overall picture of metallurgical processes has not changed considerably.

After the conclusion of the thesis, further analyses of the results were produced, and derived in a journal article on the scale of copper production at Itziparátzico (see Maldonado and Rehren 2009). The work concludes that copper smelting at the site was done by part-time specialists embedded in a predominantly agricultural economy, and formed part of a centrally organized network of mining, smelting and processing of copper to supply the Tarascan state.

Perhaps one of the most exciting research developments to date involves new studies of smelting slags from seven archaeological sites in the surroundings of Santa Clara del Cobre, which have allowed us to, for the first time in the Mesoamerican region, obtain dates of metallurgical materials by archaeomagnetic means. The results obtained thus far suggest a continuity of metallurgical production in this area, from prehispanic times to the Colonial period. The dates obtained for Itziparátzico go as far back as 100 years before the Spanish conquest (Morales et al. 2016; Punzo et al. 2015). While not directly related to metallurgical processes, these data have allowed us to confirm the chronological framework of the site.

In terms of chronology, it is also important to address recent developments related to the dates established by Hosler (1994) for the early spread of metallurgy in Western Mexico. While her estimated time frame for copper production is A.D. 600-800, new assessments based on regional data suggest an initial date around A. D. 875 (see Nelson et al. 2015: 43).

Another important contribution to our understanding of primary smelting is provided by Aaron Shugar and colleagues (see Urban et al. 2013), who report the presence of a copper-processing area at the site of El Coyote, northwestern Honduras (A.D. 800-1000). The authors recorded a number of features that they argued represent evidence of a workshop, including slag fragments, and a presumed copper-smelting furnace. The available data are inconclusive, particularly with respect to chronology, as certain components of the workshop may postdate the early sixteenth century. Regardless, the data produced would be equally relevant to the study of preindustrial metallurgy.

Further attempts to contribute to an hypothetical reconstruction of the *chaîne opératoire* for copper smelting are currently being made in collaboration with one of my Master's students, Patricia Castro. This ongoing research involves smelting experiments conducted in purpose-built workshops, modeled from archaeological and ethnoarchaeological data. We seek to establish a technological link between the method utilized by local artisans today for melting scrap copper and the archaeological deposits near Santa Clara del Cobre. This method involves the use of shallow holes (known locally as *cendradas*) covered with ash, where alternate layers of charcoal and pieces of copper are deposited. This type of 'furnace' is mentioned in Colonial documentary sources as a native method for copper smelting. Some of the goals of the experimental program include the smelting of copper ore using the *cendrada* and the production of slag, followed by comparison of the microstructural, mineralogical, and chemical characteristics of the archaeometallurgical and experimental residues. The main objective of the research is the development of a model for the Late Postclassic Tarascan process of copper production.

In conclusion, evidence for Mesoamerican extractive copper Mesoamerican metallurgy is as elusive as it was twelve years ago. Further archaeological work is needed at Itziparátzico and other sites in the region, as well as in the mining areas. A comprehensive regional investigation of metallurgical technology would allow further testing of some of the premises advanced in the study presented here. Plans for further research are in progress.

### References cited


Hosler, Dorothy 2009 West Mexican Metallurgy: Revisited and Revised. *Journal of World Prehistory* 22: 185-212.

Maldonado, Blanca and Thilo Rehren 2009 Early copper smelting at Itziparátzico, Mexico. *Journal of Archaeological Science* 36 (9): 1998–2006.

Morales, Juan, María del Sol Hernández-Bernal, Avto Goguitchaichvili, and José Luis Punzo-Díaz 2017 An Integrated Magnetic, Geochemical and Archeointensity Investigation of Casting Debris from Ancient Metallurgical Sites of Michoacán, Western Mesoamerica. *Studia Geophysica et Geodaetica* 61: 1-20.

Nelson, Ben A., Elisa Villalpando Canchola, José Luis Punzo Díaz, and Paul E. Minnis 2015 Prehispanic Northwest and Adjacent West Mexico, 1200 B.C.–A.D. 1400: An Inter-Regional Perspective. *Kiva* (81): 1-2, 31-61.

Punzo Díaz, José Luis, Juan Morales and Avto Goguitchaichvili 2015 Evidencia de Escorias de Cobre Prehispánicas en el Área de Santa Clara del Cobre, Michoacán, Occidente de Mexico. *Arqueología Iberoamericana* 28: 46-51.

Urban, Patricia, Aaron N. Shugar, Laura Richardson, and Edward Schortman 2013 The Production of Copper at El Coyote, Honduras Processing, Dating, and Political Economy. In *Archaeometallurgy in Mesoamerica: Current Approaches and New Perspectives*, edited by Scott E. Simmons y Aaron N. Shugar: 77-112. Boulder: The University of Colorado Press.

# Chapter 1

# Introduction

Metals have played a significant role in society throughout the ages, their use often affecting the course of civilization and thus human history. However, because 'technologies and their products shape and are shaped by economic and political interests, social values, and other elements of culture' (Hosler 1994: 3), the form and degree of this impact can be highly variable. By the sixteenth century, Old World metallurgy had evolved into a science whose development foreshadowed the Industrial Revolution. In the New World, metallurgical technologies were less fundamental but they had established their important role in the political economy of Pre-Columbian Polities. Eurasia is the area in which technology started its post-Pleistocene acceleration and resulted in the greatest accumulation of inventions (Diamond 1999). Mesoamerica, in contrast, lacked domesticated large mammals and native societies had to rely on relatively simple technologies. For this reason, they are considered low-energy societies (Webster et al. 1993). Nevertheless, although limited by a relatively simple technology, prehispanic metalworkers developed a sophisticated non-ferrous metallurgy.

Mesoamerican copper metallurgy developed in West Mexico sometime between AD 600 and 800, and over the next 900 years a wide variety of artifacts was produced. At the time of the Spanish Conquest the main locus of metal production in Mesoamerica was the Tarascan region of western Mexico. Scholars have argued that mining and metallurgy evolved into a state industry, as metal adornments used as insignias of social status and public ritual became closely associated with political control. In spite of its importance, however, Tarascan metallurgy is poorly documented. The extractive processes involved and the organization of the different aspects of this production are virtually unknown. The present work outlines the design, implementation and results of an archaeological project carried out at Itziparátzico, a Tarascan locality near Santa Clara del Cobre, Mexico, where evidence indicates that copper metal production took place from the Late Postclassic throughout the Contact period, and continues until today.

This pioneer research has required the employment of multiple strands of evidence, including archaeological survey and excavation, ethnoarchaeology, experimental replication, and archaeometallurgy. Intensive surface survey located concentrations of manufacturing byproducts (i.e. slag) on surface that represented potential production areas. Stratigraphic excavation and subsequent archaeometallurgical analyses of physical remains have been combined with ethnohistorical and ethnoarchaeological data, as well as comparative analogy, to propose a model for prehispanic copper production among the Tarascans. The goal of this analysis is to gain insights into the nature of metal production and its role in the major state apparatus. Although small in scale, this study provides valuable insights into the development of technology and political economy in ancient Mesoamerica and offers a contribution to general anthropological theories of the emergence of social complexity.

## Problem definition and research design issues

Prehispanic Mesoamerican societies were characterized by a highly complex organization with relatively simple technologies. Although the region experienced major transformations in culture, especially in its social, political, and economic institutions, technology proved surprisingly persistent. A reason for this may be that the prestige system, as a regulator, played a key role in the functioning and dynamics of ancient Mesoamerican technologies. In western Mexico, scholars believe that the development and control of copper and bronze metallurgy was a critical factor in the consolidation of the ruling dynasty in the Tarascan Empire (Gorenstein and Pollard 1983: 115-116; Pollard 1993: 102, 1997: 741, 750; Weigand 1982: 2). Nevertheless, the data on metallurgical processes and the organization of the industry are extremely fragmentary. Two major problems stem from this central issue: first, the knowledge of the technology itself is incomplete, and second, nothing is known about its associated resource control and contexts of production. Understanding Tarascan metallurgy and its social context, however, requires not only the acquisition of new information, but also the use of an adequate theoretical framework that encompasses both the technical and cultural aspects of this important industry.

### *Methodology*

The present study was formulated with the above concerns in mind. The initial goal of this project was to examine the technology and organization of metallurgy at a Tarascan locale, relating the evidence for the size and organization of the industry to the character

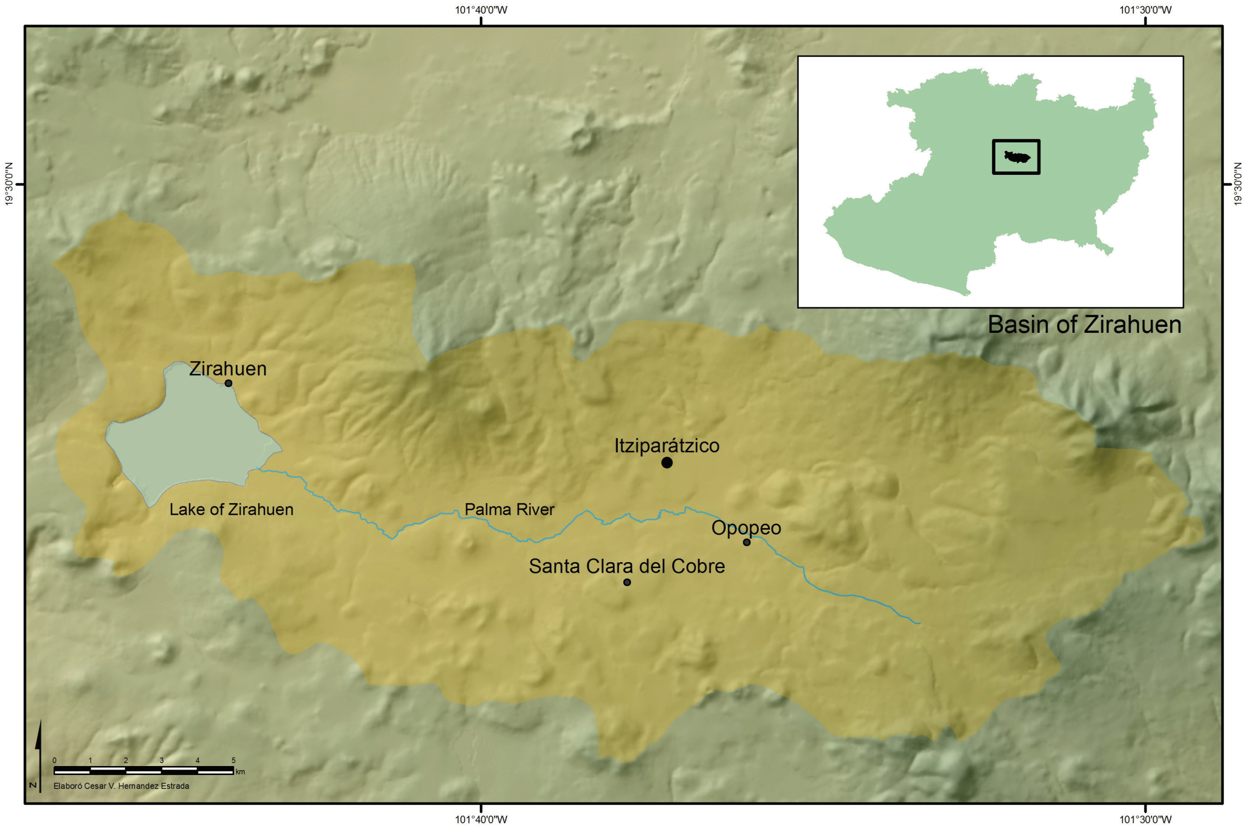


Figure 1.1 Location of Itziparátzico within the Zirahuén Basin and the state of Michoacán

of technological processes, resource requirements, demand, and potential and actual production levels. These goals were addressed in a program of surface survey, test excavation, and laboratory study of the archaeological evidence for early metallurgy at Itziparátzico, Michoacán.

This archaeological zone is located between the communities of Santa Clara del Cobre and Opopeo, in the Zirahuén Basin, in the modern state of Michoacán, Mexico (Figure 1.1). This research program was preceded by preliminary ethnoarchaeology and experimental replication at Santa Clara del Cobre (Maldonado 2001, 2002, 2005) and by the investigation of relevant ethnohistorical sources. An effort was made to systematically collect data on the history of metallurgy in the study area, although the ambitious character of these goals was tempered by limitations in time, personnel, and money.

***Data collection and sampling***

With the support of FAMSI and the Pennsylvania State University, I initiated systematic archaeological investigations at Itziparátzico during the summer of 2003. Intensive surface survey was used to locate production areas represented by slag concentrations. GIS technology was employed to map an area of approximately 15sq km and record archaeological materials and features. Archaeological test excavations were conducted over a nine-week period in three major sectors of Itziparátzico. Seven test-pits were excavated through deposits of silt and clay in different parts of the site to confirm the existence of *in situ* craft activity and to obtain stratigraphic samples of material remains to date metallurgical production deposits. Regrettably, no identifiable metalworking structures (furnaces, hearths, and pits) were found during the test-pitting. Slag samples recovered from the excavation, therefore, represent the most relevant data for the purposes of this project. While these smelting waste products were recovered in large amounts, only a representative sample of 2.1kg was selected and exported for metallographic analysis.

***Significance***

Western Mexico has been largely overlooked in ethnohistorical or archaeological investigation. Recent research, however, has helped to define the characteristics of civilization as it appeared in the region. One particular aspect of West Mexican culture that has been studied is the development of metallurgy, in which the recent work of Dorothy Hosler (1985, 1988a, 1988b, 1994) on metalworking technology, and that of Dora Grinberg (1990, 1996, 1997) and others (e.g. Roskamp 2001; Warren 1968, 1989) on ethnohistorical documents, have been of great influence.

Tarascan studies have also played a major part in West Mexican studies. A great deal has been learned about the Tarascan culture in recent years, in good part from the research of Helen Pollard (1983, 1987, 1993, 1997) around the Pátzcuaro Basin, in Michoacán. The purpose of my research is to link multiple lines of evidence, using a comparative approach, to produce as complete a picture as possible of prehispanic copper production in ancient Michoacán. The results of this research represent a contribution to Mesoamerican studies and to the anthropological theory of craft specialization, by leading us to a better understanding of the dynamics of technology and political economy in the Tarascan state.

## The approach: metallurgy as technology

Metallurgy has often been a source of speculation for scholars of diverse disciplinary backgrounds. Classical and medieval writers were among the first to systematically consider the nature of metals, their value, the means by which they could be won from the earth, and the cultural implications of metallurgy for human society. This interest continued in the thought of the founders of modern anthropology and archaeology. The use of the terms 'Bronze Age' and 'Iron Age' by Thomsen in the early nineteenth century marked a concern with the cultural significance of metallurgy and technology that was maintained in the evolutionary thought of V. Gordon Childe, Leslie White and others in the twentieth century. The very foundations of archaeological classification betray a preoccupation with the significance of materials, particularly that of metals.

The tendency of this thought, at least among anthropologists and archaeologists throughout the nineteenth and early twentieth centuries, was toward a sort of technological determinism. A concern with the material basis of economic and social life, paralleling the development of the dialectical materialism of Marx and Engels, led some to attribute primary or exclusive causal importance to technology. In the nineteenth century the correlation of technological advance with cultural evolution in the archaeological record supported such a view. In particular, the apparent link between the appearance of complex societies in the Old World and the development of metallurgy reinforced the technological determinist viewpoint. Cultural complexity seemed somehow a result of technological advance.

Metallurgy, among various human technical endeavors, has often been given a prominent role in cultural evolution. The common presupposition has been that metallurgy, as an inherently more complex technology than, say, lithics or pottery manufacture, required a correspondingly complex administrative or organizational apparatus (e.g. Childe 1930, 1942). The complexity of metallurgy presumably derived from its more diverse and specialized requirements for natural resources, equipment, and facilities involved in the smelting procedure.

Implicit in this view of metallurgy were models of both the technological process and the organization of technology drawn from modern industrial metallurgical production. Despite ethnographic and archaeological evidence to the contrary, archaeologists have persisted in interpreting the archaeological evidence of early metallurgy in terms of metallurgical processes and technological organization in current or historically known use.

Ethnographic research during the late nineteenth and early twentieth centuries (especially in Africa: see Cline 1937, for example) demonstrated that metallurgy could exist as a fully developed technology in a wide variety of cultural contexts and environmental conditions. Metal production could occur in both tribal and state-level societies as either an occasional occupation for part-time specialists or as a full-time specialization whose production was mobilized for the purposes of the state. Research has demonstrated that industries using similar technological processes can differ widely in the organization and scale of resource procurement, production, and distribution. Chinese iron production during the eleventh century may provide an example of this dynamic.

In eleventh-century China, the development of the iron industry resulted in two contrasting and coexistent modes of production. The first productive mode was characterized by self-sufficient villages operating on a small scale, and was originally typical of all Chinese iron mining and smelting. The second mode of production was based on a large-scale industry organized in terms of state and market demands which emerged during intensive economic expansion in the eleventh century. These contrasting modes of production developed in different areas of China and the differences appear to have been accentuated by geographical isolation. This variation, however, was economic rather than geographical or geological in nature (Hartwell 1962, 1966).

It was (or should have been) apparent from these data that technological innovation and intensification of production occurred in widely varying economic, social, and political contexts. Yet there has been a continuing tendency to interpret the evidence of early metallurgy in terms of models of modern metallurgical production, attributing to these early industries an economic significance analogous to that of modern industries. The problem is similar in many respects to the interpretation of early irrigation technology (cf. Wittfogel 1955, 1957; Sanders and Price 1968; Downing and Gibson 1974; Hunt and Hunt 1976).

In the New World, the development of technology followed its own path, one both similar to and different fromthat of the Old World. The knowledge of metallurgy and metalworking evolved and spread over much of the area occupied by high civilizations in the Americas. Copper, gold, silver, and their alloys were the main metals involved. These materials were fashioned primarily as ornaments used in religious ceremonies and for the enhancement of elite cultural status. The manufacture of metal tools and weapons was secondary and occurred relatively late.

Rethinking the materialistic approach to history and anthropology along with a great expansion in archaeological data, has led anthropologists to reject technological determinism and the primacy of technology in cultural evolution. But a viewpoint emphasizing the fundamental importance of technology in cultural change persists in non-anthropological thought and even among some anthropologists. This tendency can be seen in our common usage of terms like the 'Space Age' or 'Computer Age'. Few would deny that technological changes (the development of electronics, computers, communication systems, etc.) are important motivating forces behind much contemporary cultural change.

The rejection of technological determinism by anthropological archaeologists and the recognition that technologies are cultural products have led to a more balanced approach to the relationship of technology and culture, an approach emphasizing their mutual influences. It should now be apparent that, as Childe (1944; McNairn 1980: 74-103) recognized, technological change occurs in a context of existing social and economic arrangements and that the causal arrow points in both directions. Something more fundamental than technology is involved in this relationship: energy transformations and the control of energetic transformations represent the basic link between humans and nature, as Richard N. Adams (1975) has noted.

Much of the confusion concerning the role of technology in culture has arisen from the weakness or absence of relevant anthropological or archaeological data. Archaeology, as an anthropological study with a unique perspective on time and cultural change, has much to offer to the discussion of technology's role in culture. The number of archaeological studies concerned with the cultural context of technology has grown in recent years. Archaeological interest in metallurgy, in particular, is evident in the increasing number of volumes reporting field and laboratory study of metallurgy, its products, and its cultural and environmental settings (e.g. Betancourt 2006; Craddock 1980, 1991; Juleff 1996; Lechtman 1980; Raber 1984; Oddy 1977; Wertime and Wertime 1982).

Probably the first and foremost need in the study of technology and culture is to rethink and make explicit the models applied to the interpretation of archaeological evidence for early metallurgy. Assumptions about both the possible technological processes in use and the possible range of organizational arrangements need to be reconsidered and clarified. Preconceived notions about technological processes may seriously color interpretations of the archaeological data and affect our understanding of resource requirements, the level of technical skill required, and production potential. Presumptions concerning the organizational requirements of metallurgy (or any other technology) can seriously overestimate the scale and necessary administrative arrangements of an early industry.

What is needed is a comprehensive contextual approach that links technology, technological change to the natural environment and the resource base and the historical and archaeological evidence for settlement patterns, trade, craft specialization, and political relations. Such an approach would avoid the myopic focus on technological products and the particularistic concern with origins and techniques in favor of a truly anthropological view of technological development.

The obvious problem with such an approach is the large amounts of time, labor, and money required for a comprehensive program of site survey, excavation, environmental study, and laboratory analyses. Ideally, the survey and testing of technological sites would be a part of an ongoing regional project. In the absence of large-scale projects, we must rely on small-scale initiatives focused on specific technologies, which address questions of resource procurement, production arrangements, administration, organizational scale, distribution, and the interaction of technological and cultural processes. In a small-scale project like the one presented here, the option was to incorporate multiple lines of evidence in a site-specific manner and to apply them in a weight-of-evidence approach focused at the regional level.

***Specific issues covered in this volume***

Several problems, questions, and assumptions concerning the technological and cultural background of copper metallurgy in the area of study and in the Tarascan region as a whole were defined and addressed during the development of the present study. In outline, they are as follows:

1. Theory of technology. The existing theoretical approaches to explore the dynamic relationship between technology and culture were *unsatisfactory* for a proper treatment of a multiple-perspective-based research. The study of the metallurgical industry at Itziparátzico required a theoretical approach that regards technology as an integral and active component of human systems, that interacts with other parts of such systems in diverse ways. The construction of a multi-approach framework in which the different conceptual parts are dynamically interrelated and interdependent was therefore required. This framework is presented in Chapter 2.
2. Archaeometallurgy. Given the paucity of data and limitations of available analyses, the archaeometallurgical record for Mesoamerica is fragmentary and dispersed. Most of the available information on metallurgical processes is largely based on metallographic analyses of finished products (e.g. Hosler 1994) and thus, often restricted to the final stages of production (i.e. fabrication, surface treatment, and finishing of metalwork). Chapter 3 develops a technological framework that encompasses the complete metallurgical operational chain including ore sources, mining technology, mineral processing and extractive metallurgy, and structures the interactions among these aspects of production.
3. 3. Archaeometalurgical Materials. The use of ores is invariably related to the formation of slags because slags act as collectors for impurities introduced into the smelting process (Bachmann 1982). For this reason, the composition and properties of metallurgical slags are influenced by variables such as the ore itself, the fluxes added, the process conditions (heat distribution, air intake, furnace profile and height retention time of slags within the furnace) and cooling conditions, among other factors. The analysis of slag and other smelting byproducts is therefore of particular importance to obtain technological information on the smelting process. No archaeological data on ore processing, extractive metallurgy, and descriptions of slags from Mesoamerican contexts were available until the year 2003, when the present research began. I was aware, notwithstanding, that similar projects were being carried out at other locations in western Mexico (e.g. Hosler 2002; Roskamp et al. 2003). Results of slag analyses from Itziparátzico are introduced in Chapter 4.
4. The Organization of Copper Metallurgy. The interpretation of the archaeological evidence for early metallurgy may be colored by implicit models of technological organization derived from modern industries or the large and well-known state-directed ancient industries of the Old World. Several explicit alternative models should be considered in evaluating the archaeological record. Two generalized models of organization of metals industries derived from ethnographic information are presented in Chapter 5, where the data from the study are considered as they relate to these models. The nature of local production in the region was related to larger economic and political patterns. The scale and the nature of demand and organization of the industry are all subject to the influence of external economic and political factors. A model of the organization of the Tarascan copper industry is developed to discuss the larger historical context of metallurgy in the region.

**Chapter organization and content**

A major problem encountered during the development of the present study was a lack of a common theoretical framework that could address metallurgy as both a form of technology and a specialist produced craft. *Chapter 2* provides a theoretical background and a comparative perspective from which to draw useful frameworks for analysis. It also offers an overview of definitions, theoretical models and concepts relevant to this project, in order to build a shared language and logic for subsequent chapters.

*Chapter 3* introduces some of the key terms and technical descriptions of processes associated with both Mesoamerican metallurgy and preindustrial metallurgy in general. A brief discussion of the emergence of metallurgy in the New World, highlighting its differences and similarities to early Old World metallurgy is also presented. This is followed by an assessment of the evidence on mining and metallurgy currently available for West Mexico, presented in the framework of a hypothetical operational sequence.

*Chapter 4* presents a description of the investigations carried out at Itziparátzico and the methods used to analyze the data recovered. This chapter also offers an introduction to the area of study, including background information on both the environmental and historical patterns affecting Tarascan metallurgy and the archaeological interpretations of evidence for early metallurgy. The broad scope of this information is required for two reasons. First, the paucity of information on the region makes it necessary at several points to infer local conditions from general Tarascan or Mesoamerican trends. Second, as noted above, the nature of local copper production is related to wider economic and political contexts and cannot be understood without reference to these external factors.

Chemical data on the slags from Itziparátzico are also provided in this chapter.

*Chapter 5* briefly discusses the theory and methods used by archaeologists in the study of craft production, and two possible models of technological organization are presented to interpret the data on copper production at Itziparátzico. The evidence for organizational and technological change in the region's copper industry is summarized and discussed with regard to such organizational models. Based on these two formulations, a tentative model is proposed for the organization of the copper industry in the Tarascan state of prehispanic western Mexico.

*Chapter 6* contains the conclusions deduced from this investigation and suggestions for further research. The potential for alternative use of wind-powered smelting at Itziparátzico is also evaluated in this chapter.

*Appendix A* contains descriptions of the materials recovered from surface and the features recorded during the 2003 survey at Itztiparátzico.

*Appendix B* is an inventory of the materials recovered from test excavations at Itztiparátzico.

*Appendix C* presents the results of the scientific analysis of slag samples from Itziparátzico, as well as a brief explanation of phase diagrams.

*Appendix D* is an extension of Chapter 2, outlining previous theoretical and field studies in order to clarify the various approaches that have been applied to the problem of technology and culture. The effect of implicit or explicit theoretical approaches, including evolutionary theories underlying much of nineteenth and twentieth century anthropological thought, on field and laboratory studies of early or non-industrialized technologies is considered.

Finally, *Appendix E* summarizes the research methods and results of an investigation of the preindustrial use of wind power for smelting of metals, as a potential model for future research in the Tarascan region.