

INDUSTRY AND INDUSTRIALISM IN THE LATE ANTIQUE AND EARLY ISLAMIC NEAR EAST

Edited by Fred M. Donner



INSTITUTE FOR THE STUDY OF ANCIENT CULTURES
OF THE UNIVERSITY OF CHICAGO
LATE ANTIQUE AND MEDIEVAL ISLAMIC NEAR EAST • NUMBER 7

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Late Antique and Medieval Islamic Near East (LAMINE)

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INDUSTRY AND INDUSTRIALISM IN THE LATE ANTIQUE AND EARLY ISLAMIC NEAR EAST

Studies presented at a conference
organized by Fred M. Donner and Richard E. Payne
and held at the University of Chicago on October 18–19, 2018

Edited by

Fred M. Donner

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LATE ANTIQUE AND MEDIEVAL ISLAMIC NEAR EAST • NUMBER 7

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Grape harvesting, a stage in wine production, as depicted in a sixth-century mosaic floor
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Preface

THE ESSAYS IN THIS VOLUME were presented at a conference titled “Industry and Industrialism in the Late Antique and Early Islamic Near East,” held at the University of Chicago on October 18–19, 2018. The driving force behind the event came from now-emeritus Professor Guity Nashat, a University of Chicago graduate who for many years taught Middle Eastern history at the University of Illinois at Chicago. Professor Nashat long felt that the economic history of the classical Islamic Near East has been insufficiently studied and discussed with us possibilities for encouraging such study. It was decided that the most effective way to stimulate this research was to organize a series of conferences dedicated to different aspects of the economic history of the Near East in the early to medieval Islamic period and the centuries immediately preceding it—that is, in the late antique and early Islamic Near East. Professor Nashat agreed that the the University of Chicago’s Oriental Institute (now the Institute for the Study of Ancient Cultures, or ISAC), of which we are faculty members, would be the ideal sponsor for these conferences, because ISAC has long supported a wide range of research on the Near East and has, since its founding more than a century ago, maintained a series of distinguished publications based on such research. Professor Nashat was so dedicated to this vision that she generously agreed to underwrite the basic costs of three conferences on this subject—generosity for which we are deeply grateful.

We also wish to recognize others who provided support for the conference on which this volume is based, including several entities at the University of Chicago that helped defray expenses. They include the Franke Institute for the Humanities, Booth School of Business, Institute for the Study of Ancient Cultures, Division of Humanities, Department of History, and Department of Near Eastern Languages and Civilizations (now the Department of Middle Eastern Studies). We are most grateful to all these units for their support and encouragement. Additionally, we benefited from the kindness of International House at the University of Chicago, which provided a convenient and pleasant venue in which the conference could be held. And we offer our special thanks to Professor John Haldon (Princeton University), who on relatively short notice agreed to prepare and deliver a public lecture at the conference—a requirement of the program under which International House embraced our event, and a lecture Professor Haldon gave in addition to the paper he had already prepared for the conference, the latter of which is published here.

Fred M. Donner
Richard E. Payne

List of Abbreviations

AH	<i>Anno Hegirae</i> , in the year of the Hijra
b.	<i>bin</i> , son of
BCE	before the Common Era
ca.	<i>circa</i> , about, approximately
cal	calibrated
CE	Common Era
cf.	<i>confer/conferatur</i> , compare
ch(s).	chapter(s)
d.	died
ed.	edition, editor, edited by
e.g.	<i>exempli gratia</i> , for example
esp.	especially
fig(s).	figure(s)
ha	hectare(s)
i.e.	<i>id est</i> , that is
kg	kilogram(s)
km	kilometer(s)
lit.	literally
m	meter(s)
mm	millimeter(s)
n(n)	note(s)
no(s).	number(s)
n.s.	new series
pl(s).	plate(s)
r.	reigned
trans.	translator, translated by
vol.	volume

List of Conference Participants

“Industry and Industrialism in the Late Antique and Early Islamic Near East”
University of Chicago, October 18–19, 2018

Gideon Avni	Head, Archaeology Division, Israel Antiquities Authority, and lecturer, Institute of Archaeology, Hebrew University of Jerusalem
Fanny Bessard	Associate professor in medieval Eurasian history, Trinity College, University of Oxford
Richard W. Bulliet	Professor emeritus of history, Columbia University
Jamsheed Choksy	Distinguished professor emeritus of Central Eurasian and Iranian studies, Hamilton Lugar School of Global and International Studies, Indiana University Bloomington
John Haldon	Shelby Cullom Davis '30 Professor Emeritus of History, Princeton University
Ian W. N. Jones	Clinical assistant professor of liberal studies, New York University
Hugh Kennedy	Professor of Arabic and medieval Islamic history, School of Oriental and African Studies, University of London
Marie Legendre	Senior lecturer in Islamic history, University of Edinburgh
Konstantinos D. Politis	Chairman, Hellenic Society for Near Eastern Studies, Chakis, Greece
Jérémie Schiettecatte	Researcher in Arabian archaeology, Centre national de la recherche scientifique, Paris
Maya Shatzmiller	Professor of history, Western University, Ontario, Canada
Donald Whitcomb†	Research associate professor, University of Chicago

† Professor Whitcomb died on February 8, 2024.

Introduction

Fred M. Donner

THE ESSAYS IN THIS VOLUME deal with an aspect of the economic history of the Near East and eastern Mediterranean lands during late antiquity and the early and medieval Islamic era, which, collectively, we can roughly delimit as lasting from circa 300 to 1000 CE. They thus treat a topic that has received insufficient serious study until fairly recently.¹

Economic history as a field of study emerged in the nineteenth century, and it has been so inextricably intertwined with the systematic study of economics that it is probably impossible to separate them neatly. The field of economics itself consists of two distinct components; one branch is theoretical, seeking to discover and describe the abstract principles or laws that shape economic phenomena, while the other branch attempts to analyze the economic realities that are at play in particular situations—often moments of economic, political, or social crisis. Both components are essential to the study of economics, but it is obvious that the latter, in particular, is deeply enmeshed in the study of history and provides the indispensable raw evidence needed to confirm (and perhaps even inspire) the abstract ideas advanced by economic theorists. The works of most foundational economic theorists, such as Adam Smith and Karl Marx, were deeply involved in the economic analysis of historical evidence. On the other hand, some historians in the nineteenth century, even those with no training or interest in economic theory, began for their part to consider economic aspects of history as part of a comprehensive effort to look beyond the kinds of narrowly political, military, and intellectual (including religious) history that had been almost the exclusive focus of historians until that time.² Rather, these historians strove also to understand broader trends in history, including how economic forces and cultural norms shaped the lives of people of all social stations—not just the aristocracy or the clerical and intellectual elites. This interest in history “from below,” as social and economic history was later aptly characterized by the English historian E. P. Thompson,³ spread broadly in the early twentieth century, finding perhaps its most enduring manifestation in the French “*Annales* school,” a group of social and economic historians loosely affiliated with the journal *Annales d’histoire économique et sociale*, founded in 1929 by Lucien Febvre and Marc Bloch.

1 I am grateful to Professor Antoine Borrut for helpful advice and bibliographic suggestions. All remaining deficiencies remain my responsibility.

2 Mommsen’s famous *History of Rome* (originally published in German in 1854–56), for example, focused mainly on political and military events; in the realm of Near Eastern history, Carl Brockelmann’s *History of the Islamic Peoples* (German original 1939) followed a similar approach.

3 Thompson, “History from Below.”

It was from a controversy within the fields of Roman and western European history that economic history first impinged on the history of the Near East. Throughout the nineteenth and into the twentieth centuries, historians of Europe had debated the question of when and why the Roman Empire fell and when the so-called European “Dark Ages” began—a debate that had been inaugurated by the 1776 publication of Edward Gibbon’s classic *The Decline and Fall of the Roman Empire*. Some historians after Gibbon argued that the crucial factor in the “fall of Rome” was the so-called “barbarian invasions”—the migration of the northern Germanic peoples into the empire. Other historians, however, stressed the growing decrepitude of Roman institutions, the impact of epidemic disease, the influence of Christianity, and other factors. Similarly, some historians saw the rise of medieval European states as linked to the vigor of the Germanic migrants, while others perceived in them the shadow, still, of ancient Roman and Christian institutions and practices. This debate was transformed dramatically, however, by the work of the Belgian historian Henri Pirenne (1862–1935), appearing in the 1920s and 1930s, which explained the decline of the late Roman world and the beginnings of the so-called “Middle Ages” through an analysis of the history of Europe and the Mediterranean that was essentially economic and expanded the frame of analysis beyond Europe and the Mediterranean.⁴ Pirenne argued that, with the rise of Islam in the seventh century, Muslim rulers closed their ports in the Levant and North Africa to Christian merchants, thus sundering the formerly unified Mediterranean world, and that this action is what caused the final fall of the Roman Empire—which Pirenne thus dated to the seventh century CE. Pirenne’s hypothesis was based on the very limited evidence available in his day and also often on flawed assumptions (for one thing, Muslim-controlled ports were not closed to Christian shipping); but it was nevertheless compellingly argued and highly engaging, and so sparked a controversy that produced hundreds of learned responses, setting the agenda for generations of scholarship right up to today.⁵ From our point of view, one key aspect of Pirenne’s hypothesis is that it broadened the framework of analysis by linking the fall of Rome to developments in the Near East—specifically, the rise of Islam. Related to this, or perhaps emerging from it, was another historical debate, one about whether the Mediterranean basin could be considered over the long term a single economic, cultural, or ecological unit—a discussion that may have culminated in Fernand Braudel’s massive *The Mediterranean and the Mediterranean World in the Age of Philip II*, even though that work ostensibly was limited to the sixteenth century.⁶

These important contributions, and many others, touch on and sometimes offer valuable insights into the economic history of the Near East, but our understanding of Near Eastern economic history in the period from circa 300 to 1000 CE remains unbalanced and often profoundly incomplete, for two reasons. One reason is the unavoidable unevenness

4 Pirenne, *Medieval Cities; Mohammed and Charlemagne*.

5 A mid-twentieth-century overview of the debate can be found in Havighurst, *Pirenne Thesis*. As a salient example, McCormick’s massive *Origins of the European Economy* (2001) explicitly took Pirenne’s analysis as its point of departure, as did many earlier works, such as Hodges and Whitehouse’s *Mohammed, Charlemagne, and the Origins of Europe* (1983). A recent resurgence of interest in it is discussed in Effros, “Enduring Attraction of the Pirenne Thesis.”

6 Braudel, *Mediterranean and the Mediterranean World*. A useful discussion of the historical debate over Mediterranean unity is Horden and Purcell, *Corrupting Sea*, esp. 26–49.

of the sources, both literary and material, on which historians must rely. For some places and certain spans of time (such as the eastern Mediterranean in the sixth century) we have numerous literary sources, while for others (such as the seventh century in the same region) almost no literary sources survive. Even when literary sources are available, moreover, they almost never provide precise economic information, and even general hints about the economic situation in the form of scattered anecdotes are rare; in any case, such hints cannot be compared well with other hints—they are certainly not to be considered statistical evidence and are perhaps best at providing us with a sense of the attitude of earlier people toward different kinds of economic activity.⁷

As for material evidence, it too suffers from uneven distribution. Careful archaeological excavation has been concentrated in particular areas, while other archaeologically promising locations have languished virtually untouched because of political or cultural sensitivity or the continuing occupation of historically important sites, including by modern populations that cannot simply be evicted from their homes so that archaeologists can hunt for the centuries-old remains that lie beneath the residents' feet. Papyrus documents from the fourth to tenth centuries provide rich evidence, but they tell us almost exclusively about Egypt—or, to be more exact, about a few localities in Egypt—because even though papyrus was widely used in the ancient world, papyrus documents are perishable and have only rarely survived in places with climates that do not share Egypt's year-round aridity. Coins are more durable, and numismatic evidence has been used to gain important insights into commerce and other economic phenomena, but scholars are, again, limited by the vagaries of coin finds. All these factors contribute to the patchwork nature of existing reconstructions of the economies of this vast region.

The second reason modern scholars have struggled to gain a coherent view of the economic history of the premodern Near East is the way in which much existing scholarship has been framed. In the case of the late antique world, many studies have focused, reasonably enough, on the territories that once formed part of the Roman Empire—indeed, this has been the object of the lion's share of work on economic history in this region, including especially the many works that appeared in the wake of Pirenne's thesis.⁸ There is, of course, nothing wrong with this framing, but like any decision relating to historical periodization and spatialization, it bears distinctive consequences.⁹ In this case, focusing research on the lands that had formerly been part of the Roman Empire meant that while North Africa, Egypt, Syria-Palestine, and Anatolia were included (along with Italy, Gaul, Britain, and other former Roman territories), other important parts of the region of interest

7 An interesting case is Swain, *Economy, Family and Society*, which edits and translates a Hellenistic text on estate management that contains considerable economic information, giving us considerable information on how agriculture, manufacturing, moneylending, commerce, and other economic activities were viewed by the aristocratic class but offering little sense of changing economic realities over time. The text, originally in Greek, is known only from a medieval Arabic translation and had some influence on how medieval Islamic writers approached such subjects—but, again, no statistics are provided.

8 E.g., McCormick, *Origins of the European Economy*; and Wickham, *Framing the Early Middle Ages*. Among the few exceptions, we might note especially Ashtor, *Social and Economic History*; Hodges and Whitehouse, *Mohammad, Charlemagne, and the Origins of Europe*; and Lewis et al., *Wirtschaftsgeschichte des Vorderen Orients in islamischer Zeit*.

9 On periodization and spatialization, see Donner, "Periodization as a Tool of the Historian."

in this volume—notably Arabia, Mesopotamia, Iran, and areas farther east—received no consideration whatsoever, since they lay outside the Roman imperial frame of reference. In short, the framing of such work around the ex-Roman lands clashes with the framing we have adopted in this volume, focused on the Near East between roughly the fourth and tenth centuries CE. A related issue is whether early Islam should be considered part of late antiquity at all; Peter Brown’s seminal *The World of Late Antiquity* (1971) virtually created the field of “late antiquity studies” and boldly included the beginnings of Islam at the end of the volume, but scholars steeped in the study of classical antiquity have not always been enthusiastic about this expansion of the concept of “antiquity,” and the full implications of this revision in periodization have hardly been realized.¹⁰ Compared to the wealth of scholarship on the lands of the former Roman Empire, separate studies of late antique Iran under the Parthians and Sasanians and of Arabia in late antiquity exist but are far fewer in number, and many of them do not look closely at economic factors.¹¹ Moreover, because archaeological excavation in those regions has been much more limited than in the circum-Mediterranean lands, and because literary sources from late antique Iran, Mesopotamia, and Arabia are relatively few, those studies that do take late antique Iran, Mesopotamia, or Arabia as their focus have, overall, far less data to draw on than those dedicated to the formerly Roman west.¹² Furthermore, because these studies are severed from their congeners dealing with the former Roman territories, they generally are not enmeshed in the same robust scholarly debates that, over the past century, have refined and enriched both the questions asked and the ability to formulate cogent answers, or at least cogent hypotheses. Indeed, perusing even cursorily the robust literature on the later Roman Empire and Mediterranean, one cannot fail to sense how anemic and lacking in sophistication, by comparison, most scholarship on premodern Near Eastern economic history has been. This sensation is, if anything, only reinforced by reading the occasional work that does attempt to grapple with the economic history of the caliphate in broad terms, such as Michael Bonner’s thoughtful essay on the early Islamic economy, where a good part of its intellectual penetration is grounded in comparison with work on the Roman, Byzantine, and other economies.¹³

The study of the Near East since the rise of Islam in the seventh century might be said to have the advantage of viewing most of the region as a more or less unified whole, stretching from Egypt and North Africa through Mesopotamia and Arabia to Iran, Afghanistan, and the fringes of Central Asia—although Anatolia, still under Byzantine control, is

10 Brown, *World of Late Antiquity*. Thoughtful reflections on this question are Borrut, “An Islamic Late Antiquity?” and Robinson, “Reconstructing Early Islam.”

11 Most works on the history of Iran under the Sasanians focus on political and cultural issues and say almost nothing about the Iranian economy; Daryaee, *Sasanian Persia*, is an exception, but even its treatment of the economy is cursory. On Arabia, see now especially Borrut, “An Islamic Late Antiquity?”

12 This balance may change, however, as the hundreds of thousands of new Arabian inscriptions from the fourth to seventh centuries CE, collected over the past several decades by Michael C. A. Macdonald, Laïla Nehmé, Ahmad Al-Jallad, and many others, are gradually integrated into the Online Corpus of the Inscriptions of Ancient North Arabia (OCIANA), a database now supervised by Ahmad Al-Jallad at The Ohio State University (see <https://ociana.osu.edu>). When this new material is fully processed, it is possible we will have more detailed documentary evidence about Arabia than about many other parts of the late antique world.

13 Bonner, “In Search of the Early Islamic Economy.”

severed from scholarly vision by this optic. But sundering the history of the broader region at the rise of Islam in the seventh century—that is, viewing the “pre-Islamic” separately from the “Islamic”—is, again, likely to detach scholars studying the economy of the early Islamic lands from the rich debates developed by scholars of the post-Roman world.¹⁴ Severing “late antiquity” from “early Islam” in this way also makes it difficult to see longer trends of development and continuities spanning the seventh century, extending from late antiquity into the Islamic centuries.¹⁵ Historians long chose to see the seventh century not only as the border between two periods in political and religious terms but also as a watershed in terms of many developments in society, economy, and culture. This bifurcated vision of the past as divided sharply between the “ancient” and the “Islamic” may have seemed confirmed in historians’ minds by the rapid rise to prominence of a new official language of state—namely, Arabic, which replaced the Greek, Latin, and Middle Persian of the Roman-Byzantine and Sasanian regimes. Perhaps more important, this bifurcation reflected the Islamic tradition’s own cosmological view of the past, according to which the appearance of Islam represented the single most important turning point in human history between the Creation and the Last Judgment, thus emphasizing sharply the division between the *jāhiliyya* or “age of barbarism” and the age of Islam. It is therefore hardly surprising that modern historians of the early Islamic centuries long tended to replicate in their own conceptualizations this entrenched bifurcation, if only subconsciously, because it was foundational to the Islamic literary sources on which they mainly relied.¹⁶

However, the assumption that with the rise of Islam all earlier traditions and practices were swept away engendered some severe distortions in perception. A simple example can be seen in the way scholars understood the chronology of ceramics—so crucial for archaeologists’ efforts to date their finds. Certain types of pottery found in the Levant were long categorized by archaeologists as “Byzantine” because they were prominent in fifth- and sixth-century archaeological contexts, but it was also simply assumed that these wares ceased to be produced after the loss of Byzantine control in the region around 640. Consequently, all stratigraphic layers that contained such pottery were dated to the sixth century or earlier. But more recent work—by Donald Whitcomb, Alan Walmsley, Jodi Magness, and others—has shown that in fact some of these ceramics continued to be produced deep into the Umayyad and even the early Abbasid eras¹⁷—that is, until the late eighth or ninth

14 A striking example is provided by Ashtor’s *Social and Economic History* (published in 1976); the extensive documentation in its notes is almost entirely drawn from literary sources or, occasionally, documents from the Islamic world, and it does not engage with the scholarship treating the questions raised by Pirenne and his many successors.

15 Among the limited number of works that address the importance of this continuity are Bessard, *Caliphs and Merchants*; Bonner, “In Search of the Early Islamic Economy”; Morony, *Iraq after the Muslim Conquest*; and Tannous, *Making of the Medieval Middle East*. Fowden, *Before and after Muḥammad*, is almost unique in adopting a chronological framework that spans the entire first millennium CE; unfortunately for our interests, it concerns itself mainly with political, religious, and philosophical matters and has little to say about the economy.

16 On the Islamic view of history as divided in this way, and its implications for modern scholarship, see Donner, *Narratives of Islamic Origins*, esp. 291–96.

17 A good overview of these debates is Walmsley, *Early Islamic Syria*, the notes to which reveal the important contributions of the others.

century—a realization that transformed our understanding of the settlement history and economic vitality of these regions in the early Islamic era.

Despite its unevenness, however, recent scholarship has begun to clarify some major trends in the economic evolution of the regions under discussion here. As for all premodern societies, the fundamental bases of economic life were agriculture and pastoralism or stock-rearing, which provided the food needed to sustain human communities. For this reason, scholars have naturally sought to understand the relationship of states to the lands they controlled—in particular, how states and their elites exploited their territories via taxation, including both taxes on the people holding or working the land and taxes on goods the land produced.¹⁸ Starting in the 1970s, scholars showed that the Mediterranean world in general experienced not an unremitting economic decline and impoverishment in late antiquity, as had earlier been believed, but rather a more varied and complex economic evolution—a change in perception due especially to careful analysis of newly available numismatic, papyrological, and archaeological evidence.¹⁹ The western Mediterranean, Italy, the Aegean, and Anatolia did suffer economically between the fourth and seventh centuries, partly because of a declining population ravaged by malaria, leprosy, and plague.²⁰ On the other hand, Egypt and much of Syria-Palestine show evidence of robust economic activity in the fourth, fifth, and sixth centuries CE, even as cities were transformed because of their changing role in late Roman society (largely, perhaps, because of the impact of Christianity). In the city centers, which had been the focal points for civic life in Roman times, the major public monuments and buildings—the forum, amphitheater, bathhouses, and wide, straight streets—became dilapidated or subdivided, or were gradually abandoned, but in their place (often within their shells) arose clusters of workshops and market stalls reflecting vibrant economic activity, in terms of both productive industry and commerce.²¹

The economy of Iran in the late antique era, under the Sasanian dynasty (224–651 CE), is much less well known; far fewer literary sources survive from Sasanian Iran, and consequently there has been much less scholarly engagement with the subject than is the case for the former Roman provinces to the west. The limited evidence available suggests that Iran was moving toward a monetized economy during this period, as shown by the widespread use of copper coinage. The Sasanians also founded many new cities that served as centers for artisanry and long-distance trade, and they invested heavily in irrigation works to increase agrarian production. Sasanian merchants traded with China and with the Roman Empire—via the famous Silk Road—but were also deeply involved in commercial activity in the Indian Ocean basin; important Sasanian merchant colonies were established in India and Ceylon, as well as in Oman, and eastern (and, for a while, southern) Arabia came to be Sasanian protectorates. But the economic life of the Iranian countryside in the

18 See, e.g., Delattre, Legendre, and Sijpesteijn, *Authority and Control in the Countryside*, part 3 of which, “Land Use and Resources,” offers several essays on agriculture in Egypt, Arabia, and Mesopotamia during the early Islamic centuries.

19 See especially Banaji, *Agrarian Change*, 16–22 and passim; McCormick, *Origins of the European Economy*, 38–63, 782.

20 This recession for North Africa is mentioned in Fenwick, “Economic Life” (esp. 105 and 127), as background to a notable surge in economic activity, including industry, that occurs in North Africa from the mid-ninth century CE onward.

21 Wickham, *Framing the Early Middle Ages*, esp. 609–35, “Urban Economies in the Eastern Mediterranean.”

Sasanian period remains largely obscure, and by the late sixth century the prolonged wars with Rome seem to have undermined long-distance trade and prosperity in Iran generally.²²

Following the rise of Islam, Egypt and Syria-Palestine continued to show real vitality in many places during the seventh century—especially in cities, where since the sixth century industrial workshops (pottery, glass, etc.) tended to be concentrated in disused buildings in the urban cores.²³ This prosperity was not universal, of course, and some areas, especially rural districts such as the so-called “Dead Cities” region of northern Syria that had relied on the production of wine and oil, clearly went into decline after 650 if not before.

In the seventh century and later, on the other hand, Anatolia and the Aegean—still under Byzantine control—seem to have undergone a severe economic retrenchment. The fundamental causes of this breakdown were changes in Roman-Byzantine society, but the collapse was capped especially in Anatolia by the destruction wrought by a series of major earthquakes and, after the 640s, by the regular raids launched into Byzantine territory from the caliphate, which disrupted the stability needed for interurban commerce and devastated the agrarian and pastoral hinterland that supported many cities.²⁴

With a quickening interest in social and economic history in the years after World War II, significant contributions to the social and economic history of the Near East in the Islamic centuries began to appear. A pioneering study was produced by ‘Abd al-‘Aziz al-Duri already in 1948,²⁵ but probably the most important was the magisterial *A Mediterranean Society* by the Islamic historian Shelomo Goitein (1900–1985). Goitein drew for the first time on the vast trove of documents from the Cairo Geniza to describe the social and economic life of the Jewish community of Fustāt and the broader Near East in the tenth to twelfth centuries.²⁶ Goitein’s work inspired further studies based on the Geniza materials, some of which, such as Jessica Goldberg’s recent *Trade and Institutions in the Medieval Mediterranean*, deal with aspects of economic history. Other important works on economic history include

22 Daryaee, *Sasanian Persia*, 133–48, provides a brief overview, but only far more extensive archaeological exploration will provide the new evidence needed to illuminate the economic trends more clearly.

23 Bessard, *Caliphs and Merchants*, esp. 59–67; Haldon, “Greater Syria in the Seventh Century”; Wickham, *Framing the Early Middle Ages*, 617–18.

24 Haldon, *Byzantium in the Seventh Century*, 96–124 (= ch. 3, “Social Relations and the Economy: The Cities and the Land”), esp. 105–8, 120.

25 Al-Dūrī, *Ta’rīkh al-‘irāq al-iqtisādī*.

26 Goitein, *A Mediterranean Society*, appeared in six volumes between 1967 and 1993. It should be noted that these documents from the Geniza (storeroom) of the Ben Ezra synagogue in Fustāt/Old Cairo had been known to and used by Western scholars for more than a century when Goitein commenced his work. The Geniza materials, consisting of thousands of personal letters, legal contracts, official decrees, memoranda, and other day-to-day documents, were apparently given to the synagogue piecemeal by their original owners when they no longer deemed the originals to be of value so that the blank backs of documents could be used by rabbinical students to practice copying the text of the Hebrew Bible as part of their training; because they now contained the Holy Writ, they could not be destroyed but instead needed to be guarded in perpetuity by the synagogue. Nineteenth- and twentieth-century Western scholars interested in the transmission of the Masoretic text of the Bible were therefore drawn to study the documents’ biblical texts, which were among the oldest surviving copies of the Bible; a good example of this kind of work is the book *The Cairo Geniza* (1947) by Paul Kahle, a specialist in biblical transmission. Goitein was the first to “turn the documents over,” so to speak, and to realize their value for the study of the social and economic history of the Jewish community of Old Cairo and of the medieval Middle East. Noteworthy among these studies is Rustow, *Lost Archive*.

Maya Shatzmiller's *Labour in the Medieval Islamic World* (1994) and several edited volumes collecting papers devoted to aspects of the economic history of the medieval Near East, including those by Abraham Udovitch and Michael Morony.²⁷ Until recently, the only attempt to provide a comprehensive survey of the economic history of the early Islamic period was that of Eliyah Ashtor, published a half century ago (1976) and reliant primarily on evidence drawn from literary sources.²⁸ Ashtor's survey, welcome as it was when it appeared, nonetheless reflects the limitations of its sources and the paucity of deep articulation of the region's economic history; for example, except for one chapter—"Agricultural Conditions in the Moslem Empire"—all its chapters are structured not around themes of economic history, such as commerce, labor, or manufacturing, but instead around the political evolution of the Near East up to about 1500 CE. Ashtor's book thus seems to be concerned more with questions of statecraft and how it is related to the economy than with the realities and development of the economy itself. By comparison, Bonner's aforementioned essay "In Search of the Early Islamic Economy," despite its brevity, attempts to tackle fundamental economic issues for early Islamic history head-on.²⁹ A recent essay surveying slavery in the medieval Islamic world offers a glimpse of this economically significant institution, including its roots in late antiquity and its deep-rootedness in many aspects of Islamic society.³⁰ The 2020 study by Fanny Bessard titled *Caliphs and Merchants*³¹ draws fully on the past half century of archaeological research in the Near East and shows notable sophistication in its articulation of economic issues; it thus represents a definite step forward, and we can hope that further work of this kind will be forthcoming.³²

For the Islamic centuries after about 700 CE, then, the outlines of the development of the economy in the Near East are beginning to emerge, with a general picture of significant economic vitality in production and trade resulting from continued concentration of industrial production in urban centers (apparently at the expense of household production), as well as from the gradual rise after about 800 of a new class of prosperous entrepreneurs with their hands in long-distance and local commerce, finance and moneylending (including to high government officials), and investment in both land and industry.³³ However, this picture remains in many ways incomplete, partly for reasons already described; our evidence is strongest for developments in Egypt, Syria, and a few other areas, such as parts of Central Asia, where robust archaeological excavation has been actively pursued for fifty years or more. Other areas, however, including much of Iraq, Iran, Arabia, and parts of North Africa, have received far less archaeological exploration, and what we know of these regions therefore relies more on literary evidence, which often lacks specificity: we may find literary

27 Shatzmiller, *Labour*; Udovitch, *Islamic Middle East*; Morony, *Manufacturing and Labour*; *Production and the Exploitation of Resources*.

28 Ashtor, *Social and Economic History*.

29 The article was merely a sketch for a much more detailed treatment of the subject, of which we have been deprived by the author's untimely death.

30 Gordon, "Slavery in the Islamic Middle East." Although dealing with a later period, Hannah Barker's monograph on the Black Sea slave trade (*That Most Precious Merchandise*) is noteworthy for its cogent illumination of an important aspect of the Middle Eastern economy during the Mamluk era.

31 Bessard, *Caliphs and Merchants*.

32 See now Kennedy and Bessard, *Land and Trade in Early Islam*.

33 The only overview of these processes to date is Bessard, *Caliphs and Merchants*.

references telling us what kinds of economic activities were pursued but derive from them very little sense of how important these activities were in particular localities or of their changing vitality over time in a given place. So although we may have a bit of evidence that confirms the bare presence of a certain kind of economic activity, it is like an unlabeled snapshot, the exact date and even location of which often cannot be determined.

There remains, then, a need for many more detailed studies of issues related to the economic history of the late antique and early Islamic Near East generally; in particular, there is a need for more work on industry, which among economic topics has been even more neglected than agriculture or commerce.³⁴ From this realization came the decision to focus the conference that produced this volume on the question of industry in the late antique and early Islamic Near East and its relationship to the various states that dominated the region. Many questions quickly came to mind, and they were sent to the invited participants to help focus their thinking.

First, just what exactly do we mean by “industry”? In common English usage, the word can mean any focused and sustained effort, as in “he applied himself to his studies with great industry.” But the word has long—perhaps as early as the sixteenth century or before—been used metaphorically to refer to institutions dedicated to commercial manufacture, which today is the way the word “industry” is most commonly used. The organizers made no effort to impose on the participants in the conference a common definition of industry, but the papers published here suggest that most authors use the term in this latter sense. However, much still remains to be clarified. For example, there is the question of scale: should industry be considered as essentially synonymous with “commercial manufacture,” so that any productive enterprise that yields goods for sale or trade—even activities such as someone’s knitting mittens at home or cooking a pot of stew—can be considered an industry as long as the products are made available for sale or barter? Or should industry apply to those forms of commercial manufacture that involve some specialization of labor, or coordination of numerous laborers, or investment in tools and equipment beyond what is routinely available to most people? This application would to some extent place industry in a category separate from much traditional home production (with “cottage industry,” involving the coordination of many households making a common product, standing as a kind of bridge between home production and industry proper).³⁵ Or should the term be used for only large-scale operations concentrated in one place of production, using substantial productive capital and tools, and employing a labor force displaying discrete specializations?

However we choose to understand it, the question of industry’s role and importance in the late antique and early Islamic Near East remains for the most part only dimly understood. To what extent was industry a factor in economic growth in the Near East in these centuries? How was industry organized and capitalized? Did the production of goods occur mainly in small-scale workshops, or were larger factories, involving substantial investment in equipment, working quarters, and specialized labor, part of the picture? Was

34 An excellent overview of recent work on the economic history of the Islamic Near East is Palombo, “Studying Trade and Local Economies,” which, however, focuses especially on works dealing with the vexed question of why “the West” took off economically around 1600 while the Islamicate world did not, and on works exploring matters of intraregional and regional commerce. Industry is hardly addressed.

35 Banaji, “Islam, the Mediterranean, and the Rise of Capitalism,” 69, argues that such dispersed production, if coordinated, may be considered a form of capitalism.

industrial production supported mainly by single investors, private families, or groups of private investors, or were state patronage and organization also involved? Can we discern trends and changing patterns of investment in industry over time during this period? Can we ever speak of a state policy of “industrialism” in this period, with the enhancement of industrial production as a conscious goal of state policy?³⁶

The authors of the essays in this volume attempt to grapple with these and other questions. There clearly remain vast areas where our documentation and theorization about these matters remain woefully inadequate, but acknowledging such limitations is a crucial first step in overcoming them, and the studies assembled here help refine our understanding of aspects of the subject and give us important leads guiding us toward future work.

Maya Shatzmiller’s chapter reviews the evidence for the textile and service industries in the early Islamic world, relying mainly on literary sources (although also drawing on evidence from the Cairo Geniza). She makes a compelling case for increasing labor specialization and an intensifying economy in the Islamic world from Iraq to Spain.

John Haldon’s study deals with the question of state-controlled industries in the later Roman (Byzantine) Empire. After grappling with the question of how industry should be defined, he points out that parts of the empire—in particular, Anatolia—suffered a severe decline in population and economic vitality in the sixth to eighth centuries but showed a substantial recovery by the early ninth century. He then examines three markedly different industries as case studies—pottery (a mass-market product), silk (a luxury product), and weapons (a highly specialized product)—addressing for each the questions of labor specialization, the prevalence of free versus slave labor, and the degree of state intervention. Each industry, of course, follows a somewhat different trajectory, with one possible constant being the importance of the imperial capital at Constantinople as a primary locus of demand, especially for high-value products.

Jamsheed Choksy explores the economic activities of the large Zoroastrian communities of Iran during the early Islamic centuries, relying on literary sources in Middle Persian as well as on Middle Persian papyri, parchment documents, and ostraca—sources that have seldom been tapped to address these questions. He offers myriad insights into specific areas of production and suggests that the sources provide evidence for monetization, which indicates industrial-scale enterprises.

Gideon Avni’s essay traces the oil, wine, and textile industries in Palestine between the third and ninth centuries CE. Literary and especially archaeological evidence shows that the oil industry continued to flourish throughout this period, but the wine industry declined sharply after about 650 CE, with the rise of Islam, after which date the economic focus shifts more to the cultivation of cotton and flax rather than grapes. While influences from areas farther east (Mesopotamia and Iran) became more prominent in Palestine by the eighth and ninth centuries, Palestine’s close economic and commercial ties to Egypt seem to have remained important in all periods.

Konstantinos Politis’s contribution relies on archaeological evidence from sites near the Dead Sea to draw a detailed picture of the sugar and indigo industries—both the

36 For example, was some Sasanian kings’ policy of establishing in various cities colonies of captives who were skilled artisans, in order that the state might benefit from their production, exceptional? See Payne, *State of Mixture*, 64, which mentions this possibility in passing.

cultivation of the raw materials and the industrial processes of sugar and indigo refining. These sites offer clear evidence of industrial arrangements, and the presence of official seals suggests a measure of state sponsorship in some cases.

Ian Jones's article deals with copper-smelting sites in the Wādī 'Araba area south of the Dead Sea dating from the eighth and ninth centuries CE. The archaeological evidence presents various puzzles; for example, how are we to understand the presence of some very small smelting sites when much larger ones were not far away? Do we see the large ones as sponsored by the state or the result of elite investment and the small ones as run by independent freelancers similar to "wildcatters" in the modern petroleum industry? The nature of labor—whether free, slave, or *corvée*—is also considered. Jones surmises that the decline of this industry after the ninth century may be linked to its close ties to the port of Ayla (modern 'Aqaba) and the port's shifting focus to the Red Sea trade.

Jérémie Schiettecatte's chapter argues that Arabia in late antiquity and the early Islamic period exhibited the preconditions for the rise of industry: adequate food supplies, appropriate natural resources, sufficient manpower, and a stable political and economic environment. Nevertheless, only in Oman do we find evidence for a mining and smelting industry, and it dies out by the third century; elsewhere, only handicrafts and cottage industries can be seen. A collapse in settlement size (and hence of population) in most of Arabia in the second through fourth centuries seems to have been linked to a decline in the incense trade caused by the spread of Christianity and the closure of pagan ritual sites that had used incense heavily. The exception was the central Ḥijāz and the Najd, which appear to have suffered no population decline in this period. The sixth century CE saw an increase in economic vitality caused by the intervention in Arabia of the Sasanian Empire, which invested in the mining, textile, leather, perfume, and goldsmithing trades. This process of state sponsorship seems to have continued during the Islamic era, with increased monetization under both the Umayyad and Abbasid caliphs.

We are pleased to present these studies, which together address many of the still-unresolved questions surrounding the status of industry in the economic history of the late antique and early Islamic Near East. We hope the publication of this volume stimulates other researchers to try to fill these gaps and pursue in greater detail questions about the status and development of industry and industrial planning in these periods.

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1

Identifying Root Causes of Economic Development in the Middle East: Structural Change, Division of Labor, and Smithian Growth Theory

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INTRODUCTION

Adam Smith recognized the division of labor as an indicator of economic development and growth, and a leading factor in higher labor productivity, with additional dimensions in the expansion of the markets, urbanization, trade, and human capital. In this essay, I identify an episode of Smithian growth in the Middle East, where the division of labor occurred early and remained on full display during the entire medieval period, and I compare it with the transition to economic growth in premodern Europe beginning in the seventeenth century. I provide quantitative and qualitative evidence to substantiate the prevalence of the division of labor and occupational specialization in the manufacturing and service sectors and demonstrate it by using evidence from the textile industry. The division of labor and occupational specialization are then linked to the extension of the markets and aggregate demand through the exploration of human capital, urbanization, and commercialization.

DIVISION OF LABOR AND SMITHIAN GROWTH

In *The Wealth of Nations* (1776), Adam Smith was the first to suggest a link between the division of labor and the origins of economic growth: “Subdividing production into separate tasks and letting different producers specialize in each will improve the efficiency of all.” He observed that the process of shifting the labor force from rural occupations to urban ones was accompanied by the specialization of each trade, which improved labor productivity and lowered production costs. However, he also linked this shift to demand, since the division of labor is conditioned by “the extent of the markets”—the growth of the aggregate demand for goods and services, itself a function of population size, income level, trade efficiency, social order, and law. That entire construct is known as “Smithian growth theory” and is used in reference to various cases analyzing economic growth.¹ Accounting for the role of human capital in the growth process, Smithian growth theory is frequently

1 Barkai, “Formal Outline.”

associated with “Schumpeterian growth.”² Like Smithian growth, Schumpeterian growth shares postulations about the role of the division of labor but highlights improvements in the stock of human knowledge and technological progress in it, and links knowledge to capital investments in technological innovation.³

Economic historians of ancient and medieval societies do not usually refer to Smithian growth when debating whether economic development occurred, and with good reason—they cannot demonstrate the existence of the division of labor as defined. Indeed, claiming Smithian growth in societies that lived on a subsistence level, or slightly better than subsistence, is tricky. Even as the investigation improves and findings suggest comparative levels in terms of real wages and standards of living, at no time could quantitative evidence be offered to point to the division of labor before the sixteenth century.⁴ Using the methodology known as “occupational classification in economic sectors,” Carlo Cipolla showed deepening specialization in sectors through evidence dating from late sixteenth-century European cities.⁵ He approximated and supplemented such specialization with urbanization rates, which were rising in Italy, England, and Holland between 1500 and 1600, but he was unable to find earlier evidence.⁶ Gregory Clark and others provided lists of occupations in sectors for sixteenth- and seventeenth-century England in a study of farmworkers.⁷ These lists show that more than a third of rural workers were engaged in nonfarm activities in the years before 1700, but again not the urban division of labor favored by Smith.⁸ Karl Persson and Paul Sharp, who recently argued for early medieval economic revival in Europe (earlier than previously thought), point to economic change in late medieval Europe using numbers of occupations in several European cities beginning in 1300.⁹ Morgan Kelly returned to Smith’s China case as being a society that experienced the early division of labor and supported the case for Smithian growth there by pointing to the impact of a new river transportation system.¹⁰ It was the building of a system of water canals that brought small and less developed production systems together to form a unified trade network. In his analysis, Kelly supplied the Smithian requirement of the “extension of the markets” and aggregate demand.¹¹ Smith’s notion that the division of labor is limited by the extent of the markets may have been inspired by England’s eighteenth-century commercial development, a product of an earlier phase of increased commercialization and international

2 Mokyr, *Lever of Riches*; Zachariadis, “R&D.” Barkai, “Formal Outline,” highlights the dynamism in the interaction between labor and technology.

3 Mokyr, *Lever of Riches*, 4–5.

4 Allen, Bengtsson, and Dribe, *Living Standards*, 1–6.

5 Cipolla, *Before the Industrial Revolution*, 76–78 with table 2-7.

6 Persson and Sharp, *Economic History*, 41, fig. 2.3 (“Urbanization in Europe and China: Urban population as a percentage of total population”).

7 Clark, Cummins, and Smith, “Malthus.”

8 Clark, Cummins, and Smith, “Malthus,” 388–89 (“Appendix: Assignment of Occupations to Sectors”).

9 Campbell, *Great Transition*, 125–26; Persson and Sharp, *Economic History*, 25–46 with table 2.1 (“Increasing division of labour as measured by number of occupations”).

10 Kelly, “Dynamics of Smithian Growth.”

11 Kelly, “Dynamics of Smithian Growth,” 960.

trade.¹² Yet Kelly argued that the Chinese division of labor occurred in the agrarian sector, as the new transport system allowed rice shipments to move efficiently to the markets.

Smithian growth theory remains close to the economic genesis of Europe in the later Middle Ages through the economic powers' initially being absent but then appearing. For instance, at first an unstable supply of money hindered the volume of trade; markets were imperfect, information flowed slowly, and it was distorted along the way.¹³ The Dark Ages in Europe were also characterized by political disorder, which harmed market exchange and made it costly and risky. Persson and Sharp attributed a major role to the division of labor. European society in the post-Roman period relied on a thin basis of knowledge and on human capital; the division of labor was crude and extracted from experience—"domestic knowledge"—which constrained production.¹⁴ Earlier gains in Europe were made from repetition or practice—"economies of practice" for short—and learning by doing, thereby allowing producers to specialize.¹⁵ By the ninth century, the division of labor was an extension of useful knowledge and artisans' promoting technological change. Increases in population levels, monetary circulation, transport and trade routes, urbanization, production, and technology changed the economic environment and allowed specialization to trigger a decrease in opportunity costs and an increase in output per worker. Once achieved, skills that the division of labor helped grow continued to improve, but at a decreased rate during Europe's rebound from the Dark Ages. At the same time, the accumulation of knowledge stimulated by theoretical inquiry occupied a central place in Europe's version of Smithian growth theory; not only does this theory explain the role of technological innovation in the division of labor, but it also shows how a decrease in demand limits accumulated knowledge, thus leading to economic decline.

I have used the same methodology for the Islamic case with more than adequate results for understanding economic development. Not much is known or understood about the details of economic life in the premodern Islamic world, and until recently the main criterion for economic growth—namely, a rise in living standards and their maintenance in the long run—could not be substantiated. A recent study I coauthored with Şevket Pamuk has changed our concept of living standards in the medieval Middle East through the study of wages, and while more evidence is always needed, our estimates of wages and purchasing power strongly suggest higher living standards in the cities.¹⁶ Using numeric data from the Arabic sources, it was possible to build a consumer price index for the eighth through fifteenth centuries and to calculate the purchasing power of wages in terms of basic goods. The study demonstrated that real wages of unskilled workers in medieval Iraq and Egypt ranged from two to three times the subsistence level for most of the medieval period, a stretch of 700 years. When compared to workers in ancient Mesopotamia,¹⁷ Rome,¹⁸

12 Britnell, *Markets, Trade and Economic Development*; Britnell and Campbell, *Commercialising Economy*.

13 Persson and Sharp, *Economic History*, 26–28.

14 Persson and Sharp, *Economic History*, 30.

15 Persson and Sharp, *Economic History*, 26.

16 Pamuk and Shatzmiller, "Plagues, Wages, and Economic Change."

17 Foldvari and van Leeuwen, "Comparing Per Capita Income."

18 Scheidel, "Real Wages"; Scheidel and Friesen, "Size of the Economy."

Byzantium,¹⁹ and medieval Europe,²⁰ unskilled workers in the Middle East most likely enjoyed the highest standards of living among contemporary societies.²¹ These findings are significant, with important consequences for our understanding of economic performance and the economic history of the medieval Middle East.

In the same study, the high wages in the Middle East were linked to the tremendous decline in population levels after the Justinianic plague and its recurrences (541–750) and to the rising demand for labor. The findings presented in the current essay go beyond the initial demographic shock of plague in the Middle East and help explain why wages remained high even after population levels began to recover. Smithian growth theory is also supported by rising literacy rates and the use of books, which were the basis for technological innovation in Europe, and much is explained by the improvements in the quality of human capital and transformations in the accumulation and transmission of knowledge.²² In the case of the Middle East, the increase in human capital was strongly supported by developments in literacy tools, mostly the invention of Arabic paper.²³ The adoption of paper made of linen rags changed writing and reading practices forever; it directly affected levels of literacy and numeracy in society, helped move information from a stage of oral preservation to written texts, and affected the ways knowledge was stored and technological data transmitted.

Investigation of knowledge accumulation, knowledge transmission, literacy, and numeracy, as well as of human capital in general, in relation to economic development will benefit from a comprehensive exploration of Schumpeterian growth patterns in the Middle East. Until such an exploration takes place, I have used qualitative and quantitative evidence to demonstrate the division of labor and specialization in the medieval Islamic economy.²⁴ A large database of occupational trade names collected from numerous Arabic sources made it possible to apply the methodology of occupational classification in sectors of employment and determine degrees of specialization in each industrial branch.²⁵ The statistical work revealed significant division of labor in the urban centers, a division that persisted during the entire medieval period, albeit with a slight decline in the later Middle Ages. The findings alerted me to the existence of other indicators of Smithian growth in the Islamic Middle East, such as the expansion of markets, urbanization, transportation, and capital infusion. The rest of this essay is devoted to exploring them, as well as adding insights to Smithian growth from the Islamic case.

19 Milanovic, "Estimate of Average Income."

20 Goldstone, "Efflorescences"; North, *Structure and Change*; Persson and Sharp, *Economic History*.

21 Bolt and van Zanden, "Maddison Project."

22 de Vries, "Between Purchasing Power"; Mokyr, *Lever of Riches*, 5; Ogilvie, "Consumption"; Reis, "Economic Growth."

23 Shatzmiller, "Adoption of Paper."

24 Shatzmiller, "Early Knowledge Economy."

25 Shatzmiller, *Labour*. The database is accessible online at https://www.medievalislamicconomy.uwo.ca/labour/occupational_classification_in_sectors_of_employment/index.html.

DIVISION OF LABOR IN THE ISLAMIC CITY

Occupational classification consists of grouping and ranking jobs in various sectors in the economy and measuring the degree of the division of labor.²⁶ Using an extensive number of Arabic sources from Egypt, Iraq, Syria, Muslim Spain, and North Africa, I have conducted a statistical analysis of trades in various Islamic cities, including capital cities. It was possible to generate a new database of Arabic trade names and divide them into two chronological segments, the eighth to eleventh and the twelfth to fifteenth centuries. The statistical results are presented in table 1.1. We can now make observations about the degree of the division of labor and, by extrapolation, the size of the labor force in each industry under the assumption that greater division of labor represents more artisans. Persson and Sharp did their survey of the Middle East by counting occupations in the Bible; the Arabic sources arguably provide better documentation.²⁷

Table 1.1. Unique (total cases of) occupations in sectors of employment.

Employment sector	Number of unique occupations		Percentage change
	8th–11th centuries	12th–15th centuries	
Extractive	49 (63)	29 (35)	–40%
Manufacturing	432 (697)	406 (679)	–6%
Service	522 (736)	883 (1,175)	+69%

Source: Shatzmiller, *Labour*, 170.

The spread of specialized occupations suggests several conclusions—first, that the “unique” cases in table 1.1 of a single trade name or occupation represent an extensive division of labor; second, that the number of times each occupation is cited in all sources is indicative of its wide spread in the urban centers. Since the sources derive from various cities in the Islamic Middle East and North Africa, an observation of general specialization in the urban sectors is sustained. Specialization in the primary sector was limited and declined further in the later Middle Ages. Mining occupations, for reasons of an early mining boom, expanded but then contracted. As for the effect of human capital, Andrew Watson has laid the foundations for linking agrarian knowledge to productivity through the existence of agrarian manuals.²⁸

In comparison, division of labor in the manufacturing and service sectors was considerable. The numerical representation of food-processing occupations—namely, trade names producing ingredients and making dishes and processed foods—shows that they

²⁶ Shatzmiller, *Labour*, 11–13 (discussion of the methodology), 169–323 (detailed analysis); “Artisans: Pre-1500.”

²⁷ Persson and Sharp, *Economic History*, 40. For a list of the sources, see <https://www.medievalislamic.economy.uwo.ca/datasets/MedievalIslamicOccupationalClassifications.xlsx>.

²⁸ Watson, *Agricultural Innovation*. More studies of technological improvements are required.

occupied the largest share of the labor force: 21 percent of the city producers. They were followed by occupations in the textile industry (19 percent of the total) and the metal industry (16 percent) (fig. 1.1). As we move from the early period to later, between the twelfth and fifteenth centuries (fig. 1.2), almost all sectors and most types of occupations show a drop in numbers, as presented in table 1.2. The number of occupations by type in the manufacturing sector followed the raw material used and the nature of the activities undertaken in processing it. The numbers indicate that contraction occurred in almost

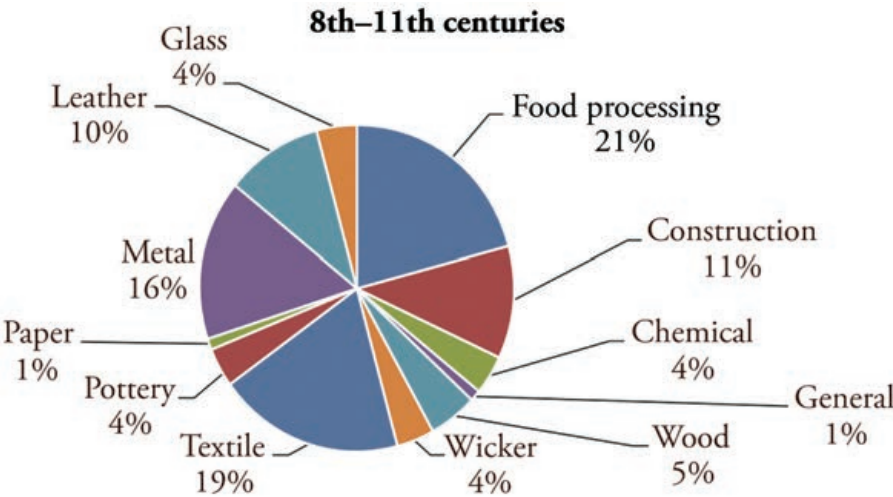


Figure 1.1. Distribution of the labor force in manufacturing in the eighth through eleventh centuries. The percentages represent the share of total manufacturing occupations (after Shatzmiller, *Labour*, 215).

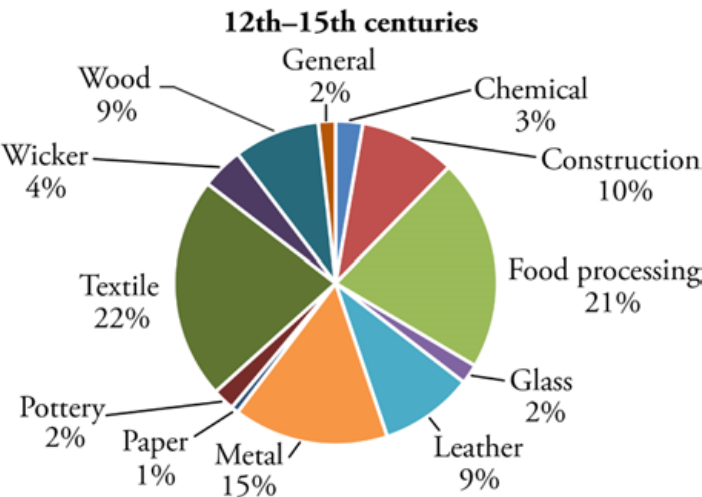


Figure 1.2. Distribution of the labor force in manufacturing in the twelfth through fifteenth centuries. The percentages represent the share of total manufacturing occupations (after Shatzmiller, *Labour*, 215).

Table 1.2. Number of unique occupations (cases) in manufacturing, by type.

Type	Number of unique occupations (cases)	
	8th–11th centuries	12th–15th centuries
Chemical	16 (29)	11 (26)
Construction	50 (64)	39 (58)
Food Processing	88 (156)	86 (170)
Glass	13 (20)	8 (13)
Leather	39 (72)	38 (64)
Metal	68 (111)	63 (100)
Paper	4 (8)	3 (9)
Pottery	17 (26)	9 (10)
Textile	80 (128)	90 (145)
Wicker	20 (26)	17 (22)
Wood	32 (50)	35 (53)
General	5 (6)	7 (9)

Source: Shatzmiller, *Labour*, 201.

every type of manufacturing occupation over the second term (the period covering the twelfth through fifteenth centuries) except for occupations in the textile, wicker, wood, and general categories.

The results are not at odds with precedence. By the end of the eleventh century, the expansion in specialization and the division of labor had slowed. As predicted by Smithian growth theory, an increase in the division of labor would be difficult to maintain. Persson and Sharp suggested that the decline in division of labor was a result of a decrease in population, as well as other factors such as political instability.²⁹ The ready availability of written sources in the Islamic world stands in strong contradistinction to the scarcity of written sources in early medieval Europe. In the Islamic case, the decline of specialization was not universal but selective, with some branches actually increasing in specialization.

By establishing the numerical relationship between the types of industries, occupational classification methodology assists us in estimating the percentage of the labor force employed in each one. Cipolla used the methodology to determine the distribution of the “economically active urban labor force” in fifteenth- to seventeenth-century European cities. He concluded that the labor force employed in the food, construction, and textile types

²⁹ Persson and Sharp, *Economic History*, 32–33.

accounted for 55–65 percent of the urban labor force in seventeenth-century Europe.³⁰ The food, textile, and construction industries in Islamic cities amounted to 51 percent of the labor force.

DIVISION OF LABOR IN THE MANUFACTURING SECTOR AND THE TEXTILE INDUSTRY

The textile industry provides evidence for the case I am making. Not only does it demonstrate a wide degree of evidence for specialization and the division of labor, but the prices of textile items also may be used to demonstrate aggregate demand and the expansion of markets.³¹ The list of trade names compiled from the Arabic sources contains eighty occupations related to textile manufacturing (see list 1 in the appendix). In comparison, evidence from textile-related occupations in sixteenth- to seventeenth-century England shows ninety occupations, including leather-making occupations such as shoe making.³² Our classification divided trade names according to the raw material used, so it distinguished between textile and leather, with the leather-making trade names providing thirty-nine distinct occupations (see figs. 1.1 and 1.2). Other reasons for the differences in numbers may be related to the different environments studied, the Islamic environment being that of cities and the English environment being rural—farmworkers still on the farm. Furthermore, the urban environment meant that the list from Islamic cities included sellers of textiles, who reflected a mature textile manufacturing apparatus. The extensive specialization in textile occupations is matched by the range of prices of garments found in the Cairo Geniza documents. I have used two sources to compile the price list in table 1.3: one of regular garments compiled by Eliyahu Ashtor from Geniza sources,³³ the other of expensive garments derived from the bridal trousseau lists compiled by Yedida Stillman from the same provenance.³⁴ The combined lists produced a database of hundreds of items of different garments, from which twenty-three items were selected to represent average prices.

The prices of textile items were determined by a range of market factors, including the price of raw materials and the cost of labor. The price and quality of the raw material used reflect the pigments and dyes used to stain it. Garments made of linen, cotton, and wool used raw materials produced in Egypt, to which must be added the price of their

30 Cipolla, *Before the Industrial Revolution*, 76–78.

31 For similar links between textile production and growth in medieval England, see Campbell, *Great Transition*, 126–30. To avoid repeating the details of the textile evidence, see previously published material on the primary sources and the literary qualitative evidence of growth in textile production: Shatzmiller, *Labour*, 118–23, 240–49. On the Islamic textile industry, see, among other works, Lombard, *Les textiles*; Serjeant, *Islamic Textiles*.

32 Clark, Cummins, and Smith, “Malthus,” 364–92 with appendix for details. The list from England also contains makers of leather clothing items not included in our list, which used the raw material as a classification criterion. Obviously, adding makers of leather clothing would have increased our database even further.

33 Ashtor, *Histoire des prix*, 152–74.

34 Stillman, “Female Attire.”

Table 1.3. Average prices of clothing items, Egypt, eleventh to thirteenth centuries (in gold dinars).

Regular consumption item (Ashtor)	Price	Expensive item (Stillman)	Price
Simple <i>thaub</i> (cloth)	1–2	<i>Thawb</i>	6.20
Elegant <i>thaub</i> (cloth)	3–4	<i>jukāniyya</i>	3.37
Simple <i>ghilāla</i> (cloth)	1.50	<i>Mindil</i>	3.04
Elegant <i>ghilāla</i> (cloth)	4	<i>Mukallaf</i>	2.72
Simple <i>jukāniya</i> (cloth)	0.50	<i>Niqab</i>	1.25
Elegant <i>jukāniya</i> (cloth)	1–3	<i>Radda</i>	2.18
Simple <i>mindil</i> (scarf)	0.33–0.50		
Elegant <i>mindil</i> (scarf)	1–2		
Simple <i>wasat</i> (waist wrap)	1–1.50		
Elegant <i>wasat</i> (waist wrap)	2.50–3		
Simple <i>mal'a</i> (outer wrap)	1		
Elegant <i>mal'a</i> (outer wrap)	3–4		
Simple <i>milhafa</i> (coat)	1		
Elegant <i>milhafa</i> (coat)	2–3		
Simple <i>ridā</i> (cloak)	1		
Elegant <i>ridā</i> (cloak)	3		
<i>Makhtūma</i> (dress)	≥5		
<i>Khil'a</i> (robe of honor)	10–15		
Turban	2–3		
Elegant <i>mi'jar</i> (head cover)	2–3		
Simple skullcap	1		
Elegant skullcap	2		
Head cover	1		

Source: Based on Ashtor, *Histoire des prix*, and Stillman, “Female Attire.”

transport. The price of items made of brocade and silk, and those decorated with embroidery, gilding, or borders in a range of colors including yellow, blue, ruby, reddish violet, sand, and wax, which may have used pigments imported over a distance, were higher because they included the transport price. Such items could be sold for tens of dinars as

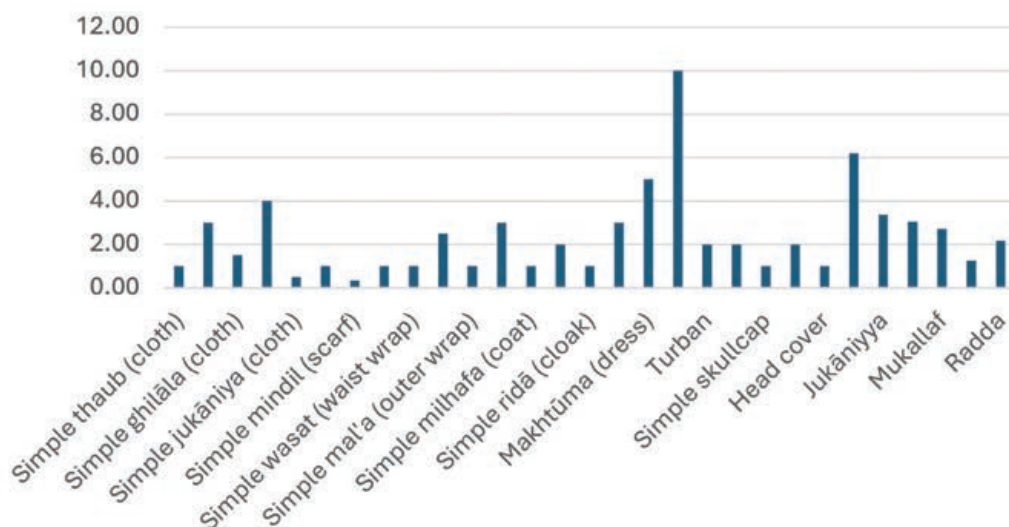


Figure 1.3. Average prices of clothing items in Egypt, eleventh to thirteenth centuries.

Source: Based on Ashtor, *Histoire des prix*, and Stillman, "Female Attire."

compared to the same item made of cheaper materials. For instance, a *thawb* made of cotton, linen, wool, silk, or a combination of two of these fabrics was a staple, indispensable item of clothing that was regularly and commonly worn and had the standard price of one dinar (fig. 1.3).³⁵ The price of the two most common items, the *thawb* and the *jukāniyya*, a staple outfit for men and women, ranged in price from 1 to 2 dinars, but a luxury item of clothing cost 6.2 dinars. As elsewhere, the price of expensive garments indicates to us that luxurious, expensive garments became a depository of wealth.

The quality and time of work involved in producing the garment or cloth included weaving and sewing, embroidery or gilding, and fashioning the elaborate decorations on the borders. Yet the price of labor was influenced by the efficient, gender-sensitive division of labor that developed after the entry of women into the labor force. At first, women drove specialization by taking over a multitude of tasks in the textile industry; later, women exercised a monopoly over the spinning of all threads—wool, cotton, flax, silk—and over the manufacturing techniques of some of the fancy clothing items, such as dyeing silk and sewing. An upsurge in income distribution to women changed labor organization in the cities. A putting-out system was established to accommodate spinners and seamstresses working at home. Networks of male and female brokers appeared for distributing threads, cloth, and raw materials; collecting the finished items; and disbursing payments.³⁶

Women's wages, while lower than those of men, affected economic development in other ways, too. Just as significant as women's entry into labor markets was the accumulation of wage income in women's hands—it created an upsurge in income distribution

³⁵ Ashtor, *Histoire des prix*, 173; Goitein, *Mediterranean Society*, 229.

³⁶ Goitein, *Mediterranean Society*, 127–30; Shatzmiller, *Labour*, 347–69. Compare England's sixteenth to eighteenth centuries: Cipolla, *Before the Industrial Revolution*, 72–73; Muldrew, "Th'ancient Distaff."

to women and increased household income.³⁷ As female wage earners garnered income in addition to other capital transfers coming to them at marriage or through inheritance, they began to play a considerable role in the household's finances and contributed to the aggregation of consumers in the markets. The growing purchasing power of wages affected the level and structure of demand. There is evidence as early as the ninth century that cultivation of textile plants and expansion of the textile industry responded to a rise in demand for luxury items (or, in economic jargon, "income-elastic" items) by people earning wages above the subsistence level, and not only in Baghdad and Fustāt.³⁸ Commercialization of the industry followed these changes in the ninth century, a development we became aware of from contracts signed between weavers in the countryside and merchants in the Egyptian Fayyum.³⁹ Expansion in the cultivation of textile plants provided additional stimulus, which permitted the reorganization of linen production geared for export markets.

The rising demand for cloth and garments was not the only factor in the expansion of the markets—it was also fed by growing manufacturing capacities in the provinces. For instance, the first Abbasid list of taxes from 785 names various garments and carpets sent from the provinces to the capital as a share of taxes due, a sign of a lively textile industry in the provinces:⁴⁰ "300 checkered garments from Sijistan, 27,000 garments from Khurasan, 600 Tabaristân carpets, 200 robes, 500 garments, 300 napkins, 20 robes from Jilan, 20 embroidered carpets, 20 variegated cloths from Armenia, 120 carpets from Ifriqiya." While received as taxes, the textiles may have been sold in the markets and thus represent both demand and income. The Cairo Geniza documents show that in the eleventh century Egypt's flax was traded over new commercial arteries in North Africa, Sicily, Syria, and India.⁴¹ New markets were inaugurated in response to growing demand, bringing improvements in financial institutions, written contracts, and increases in literacy and numeracy. The countless letters exchanged over the trade routes by the Geniza traders reveal the new dimensions of the economy's commercialization.

To sum up, growth in the textile industry occurred because of changes in various input factors. First, there was an increase in the supply of raw materials because of the amplified cultivation of textile plants—cotton and flax; second, there was an increase in demand for fine textiles as a result of rising incomes in the early period;⁴² and third, the entry of women (and children) into textile production increased the size of the labor force. Together, these factors—a rise in demand, income elasticity and income distribution, an upsurge in the labor force, and the expansion of textile-plant cultivation and raw materials—may be unique to the textile industry and not representative of the whole economy, yet it justifies and provides a rationale for the claim made here of an intensive expansion of the markets. The extensive division of labor in the service sector provides additional evidence.

37 Shatzmiller, *Her Day in Court*.

38 Bulliet, *Cotton, Climate, and Camels*; Frantz-Murphy, "New Interpretation"; Shatzmiller, "Adoption of Paper"; cf. Cipolla, *Before the Industrial Revolution*, 3–63.

39 Rāgib, *Marchands*.

40 Ibn Khaldun, *Muqaddimah*, 1:362–63.

41 Goitein and Friedman, *India Traders*; Margariti, *Aden and the Indian Ocean Trade*.

42 Pamuk and Shatzmiller, "Plagues, Wages, and Economic Change."

Table 1.4. Number of occupations (cases) in the service sector, by type.

Type	Number of unique occupations (cases)	
	8th–11th centuries	12th–15th centuries
Industrial services	262 (361)	243 (350)
Professional services	144 (214)	162 (252)
Public services	127 (161)	481 (573)

Source: Shatzmiller, *Labour*, 257.

DIVISION OF LABOR IN THE SERVICE SECTOR

The division of labor in the service sector revealed by occupational classification offers more links to urbanization, transportation, trade, and human capital that supported the division of labor through the extension of the markets.⁴³

Our database contains 522 unique occupations for the first period and 883 for the second. Table 1.4 presents the results of occupational classification in the service sector in three categories; occupations were divided into three types, then into six branches, with each one providing a different kind of service. In the industrial service category, 262 occupations were related to commerce and transport, 144 to professional services, and 127 to public services mostly representing activities in state institutions. In the second period, the division of labor increased and its focus changed. Specialization in service occupations was already considerable during the early period in the Middle East (eighth to eleventh centuries) and increased further (by 69 percent) in the second period. The number of unique occupations in industrial services, commerce, and transport declined, but unique occupations in professional and especially public services increased, so that their share of the labor force in services increased from 51 percent in the first period to 66 percent in the second. The increase in professional and public occupations improved trade and market transactions and administrative services, as well as the work of the courts when enforcement was required. All were the results of overall improvements in the quality of human capital.⁴⁴ These improvements included, for instance, the expansion of national bureaucracies of the Mamluk regime in Syria and Egypt and of the Marinid regime in Morocco. They reflect, in turn, an increase in literate and numerate personnel.

URBANIZATION, OVERLAND TRANSPORT, AND CAPITAL ALLOCATION

Studies of the urbanization patterns in the Middle East have determined that urbanization expanded there after the end of the Justinianic plague and the arrival of Arabs from the Arabian Peninsula. But comparative urbanization rates indicate that Islamic urbanization

43 Persson and Sharp, *Economic History*, 28–29, 33.

44 For a detailed discussion of the distribution of the labor force in the service sector, see Shatzmiller, *Labour*, 255–323. There is no room here to expand on the various reasons for these improvements, which include indicators ranging from literacy and numeracy to manuals and transaction technology.

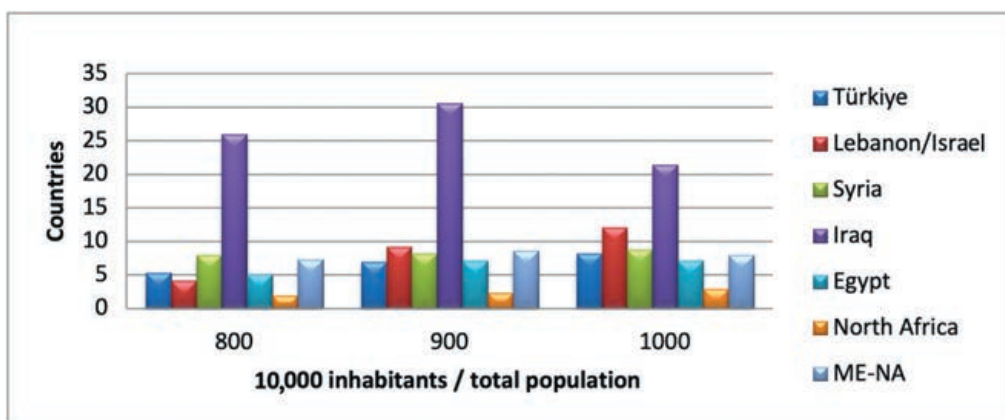


Figure 1.4. Urbanization rates in Middle Eastern countries between 800 and 1000. Data from Bosker, Buringh and van Zanden, “From Baghdad to London,” 1418–37.

exceeded urbanization rates in the Roman period and in contemporary Europe, and that cities in the Middle East were larger than European cities.⁴⁵ The statistical approximation displayed in figure 1.4 demonstrates the case especially for Iraq.⁴⁶ However, in addition to the expansion in urbanization in the Middle East, a process of commercialization of labor markets also took place, as demonstrated by market specialization in cities along the trade routes. But before looking at the evidence, some caveats need to be mentioned. Advocates of Smithian growth theory and division of labor point out that the greater the intervening distance between towns or between center and periphery, the smaller the trade between them and the smaller the number of people employed in producing exchangeable goods.⁴⁷ As a result, with each town occupied with producing self-sufficiency items and not benefiting from items produced elsewhere, the division of labor will not expand. It must be recalled that Smith related bilateral trade volumes to each economy’s size and distance from others, thus integrating trade volumes into his growth theory.⁴⁸ In the Islamic case, the relationship between smaller towns connected by interregional trade routes to large urban centers in the Middle East shows that they achieved a great degree of specialization in manufacturing. We can use as evidence the genre of Arabic sources known as the “Routes and Kingdoms” (*al-masālik wa’l-mamālik*), which describe the long-distance trade routes linking the empire and its provinces. Muḥammad ibn Aḥmad al-Muqaddasī, a tenth-century geographer, recorded the names of towns established along the northeastern trade route and carefully noted their production and exports, some of them secondhand but most locally manufactured.⁴⁹ List 2 in the appendix provides a sample of these northeastern towns and their specialties, an indicator of specialized urban markets, and how they coalesced into a network of trading communities.

45 Bairoch, *Cities and Economic Development*, 370–78; Bosker, Buringh, and van Zanden, “From Baghdad to London”; Ennahid, *Political Economy*.

46 Bosker, Buringh, and van Zanden, “From Baghdad to London.”

47 Persson and Sharp, *Economic History*, 35–36.

48 Elmslie, “Retrospectives.”

49 Al-Muqaddasī, *Best Divisions*.

The Middle East was also unique in its heavy reliance on overland transportation rather than on maritime shipments. Robert S. Lopez's vision of a commercial revolution in the thirteenth century was centered on maritime transportation and shaped our view of what medieval trade could bring to economic growth.⁵⁰ Overland routes are more expensive, entailing heavy costs for animals, beasts and their drivers, porters, and desert navigators and requiring the crossing of rivers. Nonetheless, Herman Van der Wee and Theo Peeters have shown that while the twelfth, thirteenth, and sixteenth centuries were indeed periods of global economic expansion, they coincided with prosperous transcontinental European commerce. Conversely, the fourteenth and fifteenth centuries, as well as much of the seventeenth century, saw the intensification of maritime expansion but also of economic regression characterized by retreat, recession, or decline of transcontinental European trade.⁵¹ Thus a different view of overland transport and its impact on the "extent of the markets" interprets what is normally taken to be a limitation—overland trade—as, instead, an economic driver. The cities situated on the Islamic trade routes experienced the same trend.

Finally, the ultimate condition required for the expansion of the markets was sufficient monetization, and in this respect no medieval economy can compare with the Islamic case.⁵² The Islamic administration's early efforts to monetize the economy by setting up a unified monetary system, beginning with the Umayyads in the seventh century and continuing with the Abbasids in Baghdad, was later to be maintained by successor states in the different provinces. It is a testimony to the efficiency of the monetary system that it was kept long-term.⁵³ Independence from Baghdad permitted each region to mint its own coins and explore the mines within its borders while keeping the initial structures in place. One of the better-known episodes of a successful monetary system is that of the Samanids, known in the literature because of coins unearthed in Scandinavia—millions of silver dirhams acquired in trade deals by the Vikings.⁵⁴ The Viking dirhams, Samanid dirhams produced in northeastern Iran that were buried in hoards, have been used to construct a large database. Table 1.5 provides an overview of the amounts of silver dirhams traded northward.⁵⁵

Table 1.5. Number of dirhams in hoards.

7th century	8th century	9th century	10th century	11th century
158	16,640	66,946	183,116	62,027

Source: Kovalev and Kaelin, "Circulation of Arab Silver," 560–80.

⁵⁰ Lopez, *Commercial Revolution*.

⁵¹ Van der Wee and Peeters, "Un modèle dynamique."

⁵² Persson and Sharp, *Economic History*, 33–35.

⁵³ Shatzmiller, "Prices and Price Formation."

⁵⁴ Noonan, "Volga Bulghāria's Tenth-Century Trade."

⁵⁵ Kovalev and Kaelin, "Circulation of Arab Silver."

Table 1.6. Number of occupations (cases) in industrial services.

Occupations	Number of occupations (cases)	
	8th–11th centuries	12th–15th centuries
Commerce	232 (318)	220 (314)
Transportation	30 (43)	25 (36)

Source: Shatzmiller, *Labour*, 259.

The hoards were found along Russian rivers leading to northern Europe, thus backing the reports in literary sources about an intensive exchange occurring along regional and international trade routes that continued uninterruptedly for 200 years between the ninth and the eleventh centuries. The hoards provide confirmation of and information about the long-distance overland trade, its monetization, and markets. They also establish the existence of a silver-trading zone as a characteristic of the intensive and expanding markets on the northeastern route.⁵⁶ The monetization of the markets there was based on an unparalleled availability of silver and on the specialization and division of labor, including in mining occupations. A corresponding trade movement based solely on gold unfolded at the same time in the Mediterranean, one that combined the Saharan overland routes for gold and maritime transport for manufactured goods.⁵⁷ The import of Islamic gold from North Africa, which created the Mediterranean gold zone, incorporated southern Europe, North Africa, and Egypt, as did the silver incorporating northern Europe and Islamic Central Asia.⁵⁸ The link between urbanization, trade, and monetization is provided by archaeological excavations that have unearthed mining towns with shops, markets, schools, mosques, and manufacturing facilities to supply the needs of the population. However, as table 1.6 suggests, the contraction in commercial and transport occupation types may reflect a vulnerability in the Smithian growth model when it comes to the transportation branch in the Middle East.⁵⁹

Saving on transport costs was a concern for Muslim traders who managed to have the point of exchange closer to their location inside the Islamic territories or very close to the border. To save on transportation costs, including those for animals, people, and subsistence, traders also arranged to have their needed dirhams minted in the mines rather

⁵⁶ Shatzmiller, “Role of Money.”

⁵⁷ Shatzmiller, “Islam and the ‘Great Divergence.’”

⁵⁸ Spufford, *Money and Its Use*, 163–86; Watson, “Back to Gold.” The Swedish numismatist Gert Rispling confirmed in a private communication (September 10, 2007) that the northeastern regions of both Europe and Islam show a total lack of gold currency in circulation during the period under consideration. He said, “The gold [that] tourists admire in the Museum of National Antiquities in Stockholm is mainly pre-Viking age and post-Viking age,” an observation that confirms the dominance of Islamic silver in the local economy. The Islamic-type imitations in gold from Europe are centered on western Europe and hardly came to the north. He is also unaware of any imitation coin in gold coming from the west via Russia, whereas the reverse is common.

⁵⁹ For a detailed analysis of the decline in commercial and transport occupations, see Shatzmiller, *Labour*, 259–75.

than procuring them from the government mint in the capital. The central administration showed a keen understanding of their needs and promptly shipped the dies to the mines. The intensity and rapidity of the exchange is confirmed by the speed with which dirhams arrived in northern Europe following only the shortest intervals of time after being struck in the mines.

CONCLUSION

In contrast to what would be expected of medieval sources, the evidence provided by medieval Arabic sources on the division of labor was more than just adequate. It enabled occupational classification in employment sectors to be conducted with statistical outcomes similar to those achieved by the same methodology applied to European cities of the sixteenth and seventeenth centuries. Our sources enabled us to conduct a study of occupations in employment sectors and to substantiate the statement that specialization and the division of labor were common in the manufacturing and service sectors. The discovery of a well-developed division of labor encouraged us to look for other structural changes in the economy that would have sustained it and to suggest how these structural changes were related to an early episode of Smithian growth in the medieval Islamic Middle East. High urbanization rates, intensive monetization, specialized production along trade routes, commercialization, and human capital were put in evidence to fulfill the Smithian requirements of aggregate demand and the extension of markets needed to corrolate it with division of labor in economic development.

We were able to show the presence of agglomeration effects by extending our sources to include cities of various sizes across the Islamic Mediterranean and by recording the frequency with which a particular trade name appeared in all the sources. By extending our coverage over seven centuries, we could conclude that the degree of division of labor observed in the manufacturing and service sectors was long-term, widespread, and common. The findings thus suggest an efficient process in operation across the Middle East, Spain, and North Africa, standardizations through which manufacturing techniques could be efficiently diffused. Thanks to the spread of literacy and human capital, but equally through trade and commerce that linked commercial centers, a rise in productivity in the agrarian sector occurred as well.

The case of the Middle East offers clues to answering some questions frequently asked about the process of Smithian growth. Authors question the dynamics of the process—for instance, what is the “takeoff point” of Smithian growth? How, why, and at what stage did the process of the division of labor begin? In what order did economic changes initiate the process? When do small markets with limited division of labor coalesce into an extensive division of labor and economic growth? Until more research is done, the Middle East case highlights one factor above all: the accumulation of capital, both human and financial, which grew productivity. The impact of the early availability of money—namely, the presence of financial capital expressed in monetization, liquidity, and the velocity and dimensions of the money supply—demonstrates how the productivity of financial capital grew in the Islamic economy and that it was more substantial and occurred at an earlier stage than in Europe, thereby greatly enhancing the efficiency of the markets. Most importantly, however, the evidence examined here reminds us that an exogenous event, the Justinianic

plague, was a trigger point of economic development but that endogenous factors enabled the structural change that were essential to the process.

APPENDIX

LIST 1: OCCUPATIONAL DISTRIBUTION OF TEXTILE PRODUCTION

Button Maker, Female Lace Maker, Maker of Turbans, Seller of Turbans, Rope Maker, Rope Seller, Hemp Worker, Maker of Silk Head Veil and Sturdy Turbans, Felt Maker, Skirt Maker, Button/Tassel Maker, Sheer Maker, Maker of Tight-Sleeved Coats, Maker of Hats, Seller of Hats, Maker of Shrouds, Seller of Shrouds, Maker of Bed Coverings, Seller of Bed Coverings, Purple Dye Maker, Purple Dye Seller, Maker of Women's Veils/Covers for Animals' Eyes, Seller of Women's Veils/Covers for Animals' Eyes, Maker of "Batt" Garments (Pieces of Rough, Square, and Usually Green Cloth), Seller of "Batt" Garments (Pieces of Rough, Square, and Usually Green Cloth), Maker of Tall Headgear, Seller of Tall Headgear, Maker of Large Carpet, Seller of Large Carpet, Beater of Cloths, Maker of Caps, Seller of Caps, Maker of Silk Brocade, Seller of Silk Brocade, Maker of Cereal Bags, Seller of Cereal Bags, Maker of Socks and Stockings, Seller of Socks and Stockings, Cloak Maker, Seller of Woolen Broadcloth, Maker of Garment/Veil, Dyer Using Lapis-Lazuli, Weaver, Weaver of Headgear, Weaver of Lining Materials, Carpet Weaver, Weaver of Aprons and Silk Fabric for Headgear and Belts, Silk Weaver, Flax Weaver, Weaver of Sacks and Tents from Canvas, Weaver of Cloths with Fur, Weaver of Cotton, Weaver of Delicate Cotton, Quilt Weaver, Towel Weaver, Wool Weaver, Weaver of Fabric from the Village of 'Akraba near Damascus, Weaver of Loin Cloths, Braider, Maker of Rope Soles for Light Footwear, Carder, Silk Merchant, Maker of Silk Cloth, Seller of Silk Cloth, Silk Dyer, Silk Weaver, Dress Liner, Silken Shawl Maker, Headgear Maker, Headgear Seller, Maker of Cloth Caps, Seller of Cloth Caps, Children's Blanket Maker, Maker of Pads Carried on the Back by Porters (or Used to Expand Dough), Maker of Soft Garments, Seller of Soft Garments, Fuller, Bleacher, Laundryman, Laundryman Who Bleaches the Laundry, Cutter, Maker of Cutting Instruments, Flax Manufacturer, Flax Seller, Flax Spinner, Flax Comber, Cotton Spinner, Cotton Seller, Cotton Manufacturer, Cotton Carder, Kerchief Maker, Kazz Silk Maker, Kazz Silk Weaver, Kazz Silk Seller, Low-Grade Flax Weaver, Low-Grade Flax Seller, Dyer, Tailor, Teamster, Female Dressmaker, Coat Maker, Coat Seller, Maker of White Linen Cloth Made in Egypt, Seller of White Linen Cloth Made in Egypt, Dyer Who Uses Crimson, Crimson Dye Maker, Felt Maker, Felt Seller, Maker of Felt Hair (or Wool Mingled and Compacted Together), Maker of Quilts and Quilted Garments, Maker of Women's Scarves, Maker of Women's Head-Veil (Made of Silk or Linen), Seller of Women's Head-Veil (Made of Silk or Linen), Fan Maker, Flax Comber, Maker of Belts, Maker of Women's Veils, Seller of Women's Veils, Clothes Presser, Peeler of Silk, Dyer Who Uses Vermilion, Maker of Vermilion, Embroiderer, Dyer Who Uses Oxidized Copper, Wool Carder, Cotton Carder, Mattress Maker, Carder, Maker of Cushions/Beds, Unraveller (of Raw Silk), Maker of Coats of Mail, Garment Mender, Embroiderer of Garment, Maker of Garment, Seller of Garment, Female Embroiderer, Garment and Leather Dyer, Textile Dyer, Dyer of Silk and Yarn, Silk Cloth Maker, Silk Cloth Seller, Dyer Who Uses Sumac, Silk Producer, Manufacturer of Blue Cloth (for Uniforms), Manufacturer of Ribbon/Cord/String, Maker of Veil, Maker of

Underclothing, Seller of Underclothing, Maker of Wool and Woolen Garments, Maker of Halters Made of Hair, Seller of Halters Made of Hair, Maker of Mamluk Hats, Tassel Maker, Maker of Baghdadi Cloth, Maker of Curtains/Veils/Screens, Maker of Carpets/Mats, Seller of Carpets/Mats, Female Embroiderer, Female Bonnet Maker, Maker of Wool Article (Worn by Persians or Foreigners), Seller of Wool Article (Worn by Persians or Foreigners), Maker of Turban/Cloth Made in Tustar, Seller of Turban/Cloth Made in Tustar, Dyer Who Uses Saffron, Downer, Embroiderer in Gold and Silver

Source: Shatzmiller, *Labour*, 118–23.

LIST 2: COMMODITIES PRODUCED IN THE TOWNS OF THE NORTHEAST

“ . . . As regards merchandise the following was exported:

from *Tirmidh*, soap and asafetida [a natural resin];

from *Bukhara*, soft fabrics, prayer-carpets, woven fabrics for covering the floors of inns, copper lamps, Tabari tissues, horse girths (which are woven in places of detention), Ushmuni fabrics, grease, sheepskins, oil for anointing the head;

from *Karminiya*, napkins;

from *Dabusiya* and *Wadhar*, Wadhari fabrics, which are dyed in one color. I have heard that one of the sultans of Baghdad called them the satin of Khurasan.

From *Rabinjan*, winter cloaks of red felt, prayer carpets, pewter ware, skins, strong hemp, and sulphur;

from *Khorezmia*, sables, miniver, ermines, and the fur of steppe foxes, martens, foxes, beavers, spotted hares, and goats; also wax, arrows, birch bark, high fur caps, fish glue, fish [walrus] teeth, castoreum, amber, prepared horse hides, honey, hazelnuts, falcons, swords, armor, khalanj wood [birchwood], Slavonic slaves, sheep, and cattle. All these came from Bulghar, but Khorezmia exported also grapes, many raisins, almond pastry, sesame, fabrics of striped cloth, carpets, blanket cloth, satin for royal gifts, coverings of mulham fabric, locks, Aranj fabrics, bows which only the strongest could bend, rakhbin (a kind of cheese), yeast, fish, boats (the latter also exported from *Tirmidh*).

From *Samarqand* is exported silver-colored fabrics (simgun) and Samarqandi stuffs, large copper vessels, artistic goblets, tents, stirrups, bridle-heads and straps;

from *Dizak*, fine kinds of wool and woollen clothes;

from *Banakath*, Turkistan fabrics;

from *Shash*, high saddles of horsehide, quiver, tents, hides (imported from the Turks and tanned), cloaks, praying carpets, leather capes, linseed, fine bows, needles of poor quality, cotton for export to the Turks, and scissors;

from *Samarqand* again, satin which is exported to the Turks, and red fabrics known by the name of mumarjal, Sinizi cloth, many silks and silken fabrics, hazel and other nuts;

from *Farghana* and *Isfijab*, Turkish slaves, white fabrics, arms, swords, copper, iron;

from *Taraz* (Talas), goatskins;

from *Shalji*, silver;

from *Turkistan*, horses and mules are driven to those places, and also from *Khuttal*.

There is nothing to equal the meats of *Bukhara*, and a kind of melon they have called ash-shaq (or ash-shaf), nor the bows of *Khorezmia*, the porcelain of *Shash*, and the paper of *Samarqand*.”

Source: Barthold, *Turkestan*, 235–36 (with minor adaptations).

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2

State Control and Industry in the Medieval East Roman Empire: Myths and Realities

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INTRODUCTION

The later Roman world was one of lively international commerce and multiple overlapping and intersecting networks of trade, exchange, and production. Certain key products were regulated relatively strictly by the state (although the reasons for this regulation varied according to the industry and products in question), but most production, whether in luxuries or day-to-day household goods, was organized privately and at many levels, from individual craftsmen through to substantial workshops and manufactories engaged in mass production. The degree to which this situation changed as a result of the developments of the seventh century remains unclear. This essay comments on some examples of industrial production in the later Roman and early Byzantine periods (sixth to ninth centuries) and suggests how they fit into the broader pattern of late ancient and early medieval production and economy.

To begin, a statement of the obvious: The medieval East Roman state comprised the surviving parts of the late Roman state in the central and eastern Mediterranean region. Its heartland was central and northern Anatolia, but it also included parts of the southern Balkan region and the Aegean Islands, as well as parts of Italy and the island of Sicily. Until the last quarter of the seventh century it also included much of North Africa west of Egypt and, until the middle of the eighth century, the Balearic Islands and Sardinia. It continued to function administratively and with respect to resource extraction, distribution, allocation, and consumption in exactly the same ways that the empire of the sixth and early seventh centuries did. The changes that took place between the seventh and mid-ninth centuries represent no more than the ongoing evolution of the state's social, political, and economic structures, on the one hand, in combination with a series of ad hoc reactions and occasionally proactive responses to the changes in its circumstances. It is worth emphasizing this point at the outset, since the artificial periodization that historians impose on their material often leaves us with the impression that "Byzantium" is not "Rome"—when, in fact, the inhabitants and rulers of the East Roman world continued to understand themselves as Romans to the very end of the empire in the fifteenth century.¹ The degree of

1 Anthony Kaldellis (*Byzantine Republic*; "From Rome to New Rome") has made a strong case for this understanding, although his further argument has met with some criticism (Haldon, "Res publica Byzantina?"; Stouraitis, "Roman Identity in Byzantium").

continuity in every aspect of “Byzantine” society and culture should not surprise, therefore; but by the same token, it also offers a starting point for understanding how the East Roman state, society, and economy evolved between the sixth and tenth centuries—that is to say, across a period for which our written sources are sparse in comparison to the preceding and subsequent centuries. In the following, I briefly survey some aspects of economic and productive life within the East Roman world from the sixth into the eighth and ninth centuries, with a focus on “industry,” to illustrate the range and character of activities that were carried on and to put them in their broader cultural and economic contexts.²

PRODUCTION IN GENERAL

We can pursue this discussion at two levels. The first, focusing on the economy of the imperial state (what we might call the fiscal economy of empire) would entail discussion of the arrangements for taxation—for the extraction, distribution, and consumption of resources in money, in kind, in labor, and in other services, including the production, circulation, and recovery of both precious-metal and base-metal coinage.³ That is the subject of a very different study, however; the present essay focuses on a second level, that of the appropriation of raw materials (e.g., wood, stone, clays, leather, various metals, weaving materials and cloths), their transformation through craft skills and various forms of organizational structures into goods, and the organization of production in various contexts (e.g., private, state, church).

Productive industry in general falls into many categories and subcategories—from mining, quarrying, forestry, and a range of other forms of extracting, managing, and working naturally found resources through building, shipbuilding, metalworking, ceramics, glass-making, weaving and textile production, clothing and leatherwork manufacture, carpentry and joinery, engineering, and a whole range of intermediate and minor processes⁴ to the fine arts, painting, and jewelry making, to name but a few areas we might consider.⁵ At the same time, the term “industrial” usually implies a more structured metafamilial production system, one greater than simply an agglomeration of artisanal workshops producing similar goods, however specialized the production processes involved. Rather, “industrial” implies economies of scale and coordination, division of labor and skill specialization, and structured sequencing of the process of production. In this essay I cannot deal with many of these factors, or even every aspect of any one of them, but I aim to offer indicative

2 For the general framework, see Laiou, *Economic History*; Laiou and Morrisson, *Byzantine Economy*; Morrisson, *Trade and Markets*; Oikonomidès, “Role of the Byzantine State”; for a shorter survey focused on commerce and exchange, see Howard-Johnston, “Le commerce à Byzance.”

3 For recent discussion, see Brandes, *Finanzverwaltung*; Brandes and Haldon, “Towns, Tax and Transformation”; Brubaker and Haldon, *Byzantium in the Iconoclast Era*, chs. 6–11.

4 On some of these aspects, see, e.g., Bouras, “Master Craftsmen”; Decker, “Agriculture” and “Everyday Technologies”; Drauschke, “Non-ferrous Metals”; François and Spieser, “Pottery and Glass”; Grossmann, “Timber”; Günsenin, “Harbours and Shipbuilding”; Mundell Mango, “Metalwork”; Parani, “Fabrics and Clothing”; Pryor, “Shipping and Seafaring”; Tobias, “Ironworking”; Veldmeijer, “Leather Goods.”

5 See, e.g., Bosselmann-Ruickbie, Fourlas, and Greiff, “Goldsmithing and Silversmithing”; Bosselmann-Ruickbie, Greiff, and Albrecht, “Precious Stones.”

examples that cast some light on Byzantine industry and production in the widest sense, examples we might compare with neighboring medieval societies.⁶

We must begin by noting the general economic context within which Byzantine industrial production should be considered. Between the early seventh and the middle of the ninth century, the commercial networks of the Mediterranean and circum-Mediterranean worlds changed dramatically. There is little doubt that commercial exchange continued throughout the empire and beyond or that it thrived, albeit on a different scale. International commercial routes shifted, market networks shrank, and urban social and economic life, along with many other features of late Roman culture, changed radically. But by the middle of the eighth century the situation had been stabilized, politically and economically, and by the early ninth century the beginnings of real economic recovery can be detected in both the archaeological and textual evidence.⁷ Most importantly, proxy data for agricultural output and demographics suggest that the population of the Anatolian provinces of the empire fell by more than 70 percent across the period from the later sixth to the eighth century before it began to recover. This decrease varied by region, of course, but it clearly must have had a dramatic impact on both market demand and production at all levels. In comparison with the flourishing and cosmopolitan environment of late antiquity, out of which early and middle Byzantine organizational and industrial forms evolved, this population drop marks a significant change in conditions and the availability of labor power and other resources.⁸

From the later fourth century, production in the Balkans and Anatolia in particular was dominated by one peculiarity above all—namely, the imperial state’s focus on Constantinople, which became even more marked after the middle of the seventh century. In other respects, from the acquisition of raw materials to their delivery to workshops and centers of production, the producers and sellers of Byzantine wares of all sorts faced the same issues of access, communication, and transportation as did craftsmen and entrepreneurs anywhere else. Where the East Roman Empire obtained its raw materials has been the subject of a good deal of research—especially precious metals and other metals relevant to weapons, building, and so forth (e.g., iron, lead, copper). For some of these materials, sources have been identified in both the Balkans and Anatolia, as well as farther afield. This issue is treated here, but it is worth noting that with the loss of its eastern provinces to Islam from the 640s—and of the central and northern Balkans to various incomers at roughly the same time—the resource base of the East Roman state was radically reduced, with a possible negative impact on technique in some aspects of mining, for instance, although the evidence is ambiguous.⁹ Inevitably, the loss of what had been the richest provinces—greater Syria and Egypt—had an impact. For example, Egypt was a

6 See, e.g., Feinman, Upham, and Lightfoot, “Production Step Measure”; Strobel, *Forschungen*.

7 Haldon, “Commerce and Exchange”; Koder, “Regional Networks.”

8 Cassis et al., “Evaluating Archaeological Evidence”; Hodges and Bowden, *Sixth Century*; Roberts et al., “Not the End of the World?”; Sodini, “Marble and Stoneworking”; Ward-Perkins, “Specialized Production.” For discussion of the reasons for the survival of the East Roman state, see Haldon, *Empire That Would Not Die*.

9 Edmondson, “Mining in the Later Roman Empire”; Mango and Dagron, *Constantinople*; Matschke, “Mining,” 117–20; Mundell Mango, *Byzantine Trade*, 444–46; Pitarakis, “Mines anatoliennes.”

major source of steatite, alabaster, and red porphyry,¹⁰ and the very limited later evidence suggests that these materials became more expensive in later times.

On the other hand, the loss of territory and access to some types of natural resources encouraged the exploration and exploitation of new sources, such as the marble quarries of Dokimion in Anatolia, among many others.¹¹ Bullion was a particularly sought-after commodity, and the empire spent a good deal of resources defending sources of gold and silver in the Caucasus and Balkans as well as southern Anatolia at various times, as often reflected in the warfare of the period.¹² One industry that did not suffer was Byzantine silk manufacturing, already a flourishing independent industry by this time and one that went on to produce a significant luxury export to both the Islamic and the western and northern neighbors of the empire.¹³ Much industrial and artisanal production was highly localized in terms of both its raw materials and its market, and as a result production was often located in districts close to the source of the materials needed. Ceramic production was, of course, an activity that functioned at all levels, from the highly local to the international, and I will return to this subject later in this essay. One obvious aspect of production that was affected is the manufacture of arms and armor, which had been organized on an industrial basis in the late Roman world and which suffered after the 640s from the loss of a number of key manufactories in Antioch and elsewhere in the eastern provinces, as well as in the Balkans. I will return to this subject also below.

In the East Roman world until the middle of the seventh century, the acquisition of many key raw materials took place under state auspices and often through the operation of large enterprises with many levels of specialism—from the laborers and their foremen in a quarry or mine, for example, through the more skilled stonemasons and master craftsmen to the enterprise managers who were responsible for organizing the transport of the materials to their customers, whether a state organization such as the military, a town council, the church, or a private individual. But alongside these larger operations also existed smaller, private enterprises that were financed by joint investment contracts and employed professional, skilled craftsmen and seasonal workers, as well as individual private workers (depending on the industry in question, and especially where the extraction of ores was concerned).¹⁴ Some aspects of the state-managed operations can be gleaned from the evidence for the various officials who were in charge of mines of diverse sorts, as well as the evidence for how they were manned; for bullion mining and quarrying in particular, the

10 Seidlmayer et al., “Stadt und Tempel”; Sodini, “Marble and Stoneworking,” 132; Wefers and Mangartz, “Millstones.”

11 Niewöhner, *Aizanoi, Dokimion und Anatolien*; Peschlow, “Kapitell.”

12 Afanas’eva and Ivanov, “Unexpected Evidence”; Bryer, “Question of Byzantine Mines”; Matschke, “Mining,” 115–16; Mundell Mango, *Byzantine Trade*, 222–24; Nerantzis, *Byzantine and Ottoman Mineral Exploration*; Petković, “Traces of Roman Metallurgy.”

13 Jacoby, “Silk in Western Byzantium”; Muthesius, *Byzantine Silk Weaving*.

14 Holtmeyer-Wild and Mangartz, “Stone Working and Processing”; Matschke, “Mining.” For an example of a local, town-based masonry operation requiring a substantial investment in equipment and resources, compare the late sixth- to seventh-century water-powered masonry saw from Ephesus (Mangartz, *Die byzantinische Steinsäge*).

ancient tradition of employing slaves appears to have continued unbroken, although not all workers in these areas were unfree.¹⁵

ORGANIZATION OF PRODUCTION

There is unfortunately very little evidence for the details of manufacturing organization, but studies of premodern production have long perceived that the unit of production as it can be understood from the material-cultural record was a complex network of social, cultural, economic, and technological interactions.¹⁶ Production types have been classified according to the level of organizational complexity: household production, household industry, workshops, nucleated workshops, manufactories, estate production, and production by (political) authorities.¹⁷ The day-to-day management of production in the Hellenistic and Roman worlds depended on the specific industry and on the organizational level, and we have evidence for the organization of production ranging from individual craftsmen or producers right up to major, manufactory-based industries using standardized mass-production techniques. In late Rome and Byzantium, the general tendency (inherited from the Roman world) persisted for craftsmen and artisans to organize themselves in legally recognized corporate bodies.¹⁸ “Guilds” is not the right word to employ here, since it may mislead us into seeing these groups as comparable to the later western European craft guilds.¹⁹ Nevertheless, there are similarities: an internal hierarchy depending on skill and experience, rules of exclusion and inclusion (although we know hardly anything about them), and formally recognized functions, in some cases with specific limitations on the type of activity, location of activity, and access to materials and markets. In the East Roman Empire, membership in such bodies was also often hereditary and affected an individual’s legal status. The best-known regulations come from the early tenth century in the so-called *Book of the Eparch* (city prefect), which regulates in twenty-two chapters the activities of two major groups—producers and traders in luxury goods, such as silk, on the one hand, and dealers in livestock and foods, including general grocers, fishmongers, bakers, and butchers (grouped according to the type of meat butchered: pork, mutton, etc.), on the other hand.²⁰ But these regulations, which both protected the rights and potential of the different specialist groups and regulated their role in provisioning Constantinople, seem to have been restricted to the imperial capital. Although similar groups or corporate bodies existed elsewhere, at least in other major cities, there is no evidence that they were regulated by the state, even if self-regulation and demarcation were important aspects of their organization and activities; in fact, there are plenty of indications that even in the

15 Afanas’eva and Ivanov, “Unexpected Evidence”; Asgari, “Proconnesian Production”; Gassmann, Körlin, and Klein, “Römischer Erzbergbau”; Holtmeyer-Wild and Mangartz, “Mineral Resources”; Matschke, “Mining,” 116.

16 Hruby and Flad, *Rethinking Craft Specialization*; essays in Mattingly and Salmon, *Economies beyond Agriculture*.

17 Peacock, *Pottery in the Roman World*.

18 Kislinger, “Professional Associations”; Lund, “Economy of Consumption”; Graeber, *Untersuchungen*.

19 Malich, “Wer Handwerker ist”; Schmidt-Wiegand, “Gilde und Zunft.”

20 Dagron, “Urban Economy”; Koder, “Delikt und Strafe” and *Eparchenbuch Leons des Weisen*; Schreiner, “Die Organisation byzantinischer Kaufleute.”

capital, a great deal of production was carried out by individuals or small groups in private workshops and household establishments.²¹ And just as with other legally recognized corporate bodies in the late Roman and Byzantine world, the members of these groups were also subject to state *corvées* of one sort or another, often being required to provide specific services or goods for imperial needs—whether for the palace or in support of some other imperially sponsored activity, such as a military expedition.

That factory-like “industrial” production systems continued to exist after the sixth century in some sectors (e.g., ceramic production) is clear, although the extent to which such arrangements existed in other spheres remains uncertain. The production of all types of finished goods is determined, to a large degree, by the nature of the economy within which production takes place. In the case of the late Roman and early Byzantine world, therefore, we must bear two key points in mind: first, the importance of the Mediterranean Sea as a major means of transport and communication and as the focus of most medium- and long-distance exchange, as well as the nature of communications and transport more generally; and second, the imbalance in both production and demand between coastal regions and inland zones.²² This difference was important, but it should not be exaggerated, and its impact was nuanced by a range of factors, including the overall economic situation, the nature of the road and transport system, and security. I will now look at three types of enterprise that operated on what we would recognize as an industrial basis—that is to say, in large workshops, on a large scale, and with a mass market in view: ceramics, silk, and weapons / military equipment. One of these enterprises—silk—reflects a luxury and semi-luxury product; the other two—ceramics and weapons / military equipment—represent, respectively, a mass-consumer product and a highly specialized product.

POTTERY AND GLASS

Ceramic production took place at several levels, and in addition to pottery vessels, the ceramics industry involved the mass production of tiles for buildings, oil lamps, and a wide range of other utilitarian products. From the local potter or a family enterprise serving the immediate needs of a village community, small town, or estate through larger establishments that produced a wider range of wares for local, regional, and sometimes distant markets to specialist enterprises that concentrated on specific wares and types with distinctive decoration and glazes, we know remarkably little, it has to be said, about the actual process of production at any of these levels. But based on socio-anthropological models, it is possible to draw some conclusions from archaeological data.²³ Indeed, only a single Byzantine source, ascribed to a certain Theophilus Presbyter and written in the early twelfth century, makes any reference to the techniques deployed in the production of pottery. Glass production was more specialized and less widespread, with centers at Constantinople and a

21 Maniatis, “Domain of Private Guilds,” 351–57; Mundell Mango, “Metalwork”; Wessel, *Byzantine Enamels*.

22 Braudel, *The Mediterranean*; Horden and Purcell, *Corrupting Sea*.

23 Bintliff and Vroom, “Ceramics and Village Life”; Ionas, *Traditional Pottery and Potters*; London, “Continuity and Change”; Peacock, *Pottery in the Roman World*.

few other major towns, such as Amorium, Trebizond, Ephesus, and Thessaloniki, although by no means confined to them. Like pottery production, the production of late Roman and Byzantine glassware was influenced by technological developments in neighboring regions, a good example being the introduction and proliferation of glazed ceramics after the seventh century.²⁴

Using the archaeological evidence, we can say quite a lot about centers of production, technique, and technology, as well as about typology and function.²⁵ Large-scale pottery production was located in regions where suitable clays were to be found. Red and white clays were the most popular, with the white clays of the region around Constantinople and Nikomedeia being especially prominent from the later seventh century and the reddish clays of the Phokaia region in western Anatolia becoming especially popular in the course of the sixth century and beyond.²⁶ The evidence suggests that initial production generally took place because of local demand, even if this demand then grew and expanded to become a transregional or international trade. An excellent example for the early and middle Byzantine periods comes from the excavation of parts of an industrial-scale complex for the production of cooking wares at Dhiorios on Cyprus.²⁷ Here, an extensive series of workshops functioned from the sixth century to the later eighth or ninth century and exported its products across the Levant and southern Anatolia, while for the middle Byzantine period an extensive pottery production center—evidenced by kilns, wasters, and other artifacts associated with ceramic production—in the Ganos region on the northern shores of the Sea of Marmara is illustrative of a similar large-scale, widely exported output. In this case, monastic communities developed an extensive viticulture, and while it appears that pottery production was initially a direct response to the demand for transport vessels, the production of widely traded, glazed semifine wares soon followed.²⁸ These complexes seem to fulfill at least some of the criteria for “industrial” production, with sequences of the production process within the same premises or closely associated buildings and spaces, thus maximizing the benefits of economies of scale, movement and handling of materials around associated loci of production, and access to a range of specialist skills found in close proximity. Whether we refer to such arrangements as “industrial” or “industrial-type” processes, there seems to be little doubt that they could be found in several key centers of production, although it is not yet possible to say whether, in the sixth to eighth centuries, the mass-produced and widely distributed Phocaean slipwares from the Aegean

24 See Antonaras, “Production and Uses of Glass”; Colangeli and Sacco, “La produzione di vetro e ceramica”; Drauschke and Greiff, “Glass”; Schibille et al., “Comprehensive Chemical Characterization”; Stern, “Glass Producers.”

25 Böhlendorf-Arslan, “Pottery”; Kontogiannis and Skartsis, “Ceramic Vessels”; Piéri, *Le commerce du vin oriental*; Sodini, “Production”; Valente, “Continuity and Change”; Waksman, “Provenance Studies”; Waksman et al., “Middle Byzantine Production”; Zanini, “Artisans and Traders.”

26 Crane, “Traditional Pottery Making”; Heimann, “Mineralogische Vorgänge”; Tekkök-Bıçken, “Pottery Production.”

27 Armstrong, “Ceramics”; Catling, “Early Byzantine Pottery Factory.”

28 Armstrong and Günsenin, “Glazed Pottery Production”; Günsenin, “Ganos: Centre de production” and “Ganos Wine and Its Circulation.”

region were also produced at such centers or on a much more fragmented, dispersed, and regionalized pattern of smaller artisanal workshops.²⁹

In the later Roman and early Byzantine period, there is ample evidence for mass production on an industrial scale of both coarse wares—such as different types of amphorae, cooking wares, and storage vessels—and fine or semifine wares used in household contexts for dining and kitchen use. Major centers in the late Roman period were North Africa, whence came the famous red-slip wares that dominated the Mediterranean market well into the fifth century, and the central Aegean, whence came the Phocaeen slipwares with which the North African wares had to share the market from the sixth century onward until their eclipse in the later seventh century. Cyprus, the Gaza region, the Jordan Valley, and Egypt also produced considerable quantities of fine and semifine wares, as well as transport vessels.³⁰ Notably, these centers of production all had access to the sea or a navigable river. But there were some inland centers, such as Sagalassos, whose products dominated central and western Anatolia into the fifth century, thus proving that where there was a strong demand, the constraints of overland transport could be overcome despite the attendant increase in costs and market prices. The Sagalassos pottery industry faded over the course of the fifth century and survived on a more limited basis, only to succumb to new market pressures from other regions of Anatolia.³¹

One indication of the relative health of a productive industry is the rapidity with which it responds to significant changes in market and demand. For the period from the mid-sixth to the ninth century, we now have enough archaeological data to say quite a lot on this topic for the Byzantine world. While the changes and fluctuations in very local patterns of exchange remain difficult to detect, it is possible to pick out some important extended connections as a number of new circuits evolved both for the movement of goods carried in ceramic vessels and for finer table wares, as the larger-scale commercial patterns of the sixth and early seventh centuries were transformed. A synthesis of the archaeological data suggests at least the following routes for the movement of these goods: from Constantinople into the Aegean and Peloponnese and around the coast of Asia Minor across to Cyprus; from Cyprus to Egypt and the North African littoral to the west of Egypt, north to the southern and southwestern coast of Anatolia and a little inland, and across to Syria/Palestine; a South Italian and Sicilian network that evolved and reached across to the eastern shore of the Adriatic; another network emanating from Cherson and the Crimea via Constantinople, around into the Adriatic, and onward from Constantinople to Cherson or into Asia Minor along major routes; from Constantinople along the southern Pontic coast; from Constantinople north and west into Thrace, with less heavily used routes from Constantinople to Sicily, central Italy and Rome, Ravenna, and the Adriatic region; and from a southern and central Adriatic zone that connected with the northern Adriatic, especially after the later eighth century. Yet these routes were not constant—on the contrary, it is clear that whereas the connection between Cherson, the Adriatic region (Butrint),

29 Abadie-Reynal, “Céramique et commerce”; Anagnostakis and Poulou-Papadimitriou, “Η πρωτο-βυζαντινή Μεσσήνη”; Bonifay, “Observations”; Poulou-Papadimitriou, “Βυζαντινή κεραμική.” See also Saradi, “Privatization”; Veikou, “Encroachment”; and for medium-scale urban workshop industries, see the case of Thessaloniki in the middle Byzantine period in Antonaras, *Arts, Crafts and Trades*, 41–60.

30 Abadie-Reynal, “Céramique et commerce”; Panella, “Merci e scambi.”

31 Vionis, Poblome, and Waelkens, “Ceramic Continuity”; Vroom, *Byzantine to Modern Pottery*.

and northeastern Italy (Commacchio) seems to have survived across the eighth century and into the ninth (as evidenced by the presence of Crimean transport amphorae), the relationship between the Aegean and the Adriatic became increasingly tenuous around the year 800 or so as the western and eastern Adriatic coastal zones developed a closer commercial or exchange-based association with each other. Similar shifts within the broader patterns and continuities may also become apparent as the evidence comes to be better appreciated. As far as the links between Constantinople and some of the inland centers of Anatolia are concerned, it is unclear to what extent they reflect any sort of commerce in this period. Nevertheless, all this evidence points to a wide, productive network with industrial-scale production line output from several key centers alongside smaller and less ambitious enterprises.³²

During the Roman period, the manufacture of fine wares in particular took place in large workshop complexes, structured on industrial lines and producing a range of standardized products. Both fine and coarse wares can be readily classified and dated according to fabric, style, function, and form. There is no reason to think that such organizational arrangements changed in the medieval period, even if the scale and intensity of production, as well as distribution patterns, did change in several respects, as the examples of Dhiorios and Ganos, noted above, indicate.³³ Certainly, there seems to have been this level of organizational capacity in or near Constantinople, responsible for the glazed white wares that are found throughout the Byzantine world from the later seventh to the eleventh centuries.³⁴ Given the vast quantities reflected in the excavated material from many urban sites, many of the workshops that produced this material in Byzantine times must have operated on a clear division of labor, just as we know the producers of the earlier Samian wares of the first and second centuries did. This assumption is, to a degree, supported by comparative studies on craft production elsewhere that look at issues such as ritualized production, social value, and control over and transmission of knowledge, as well as gender and the social standing of artisans.³⁵

But we do not know to what extent, or in what periods, the labor force was free, unfree, or a mix of the two; at the lower, local levels of production, independent producers (household and community production) seem to have been free, even if they also employed a slave or two in their workshops. In the eleventh and twelfth centuries, the major production center at Ganos on the Sea of Marmara seems largely to have been managed and staffed by members of a monastic community and their hired workers, and there is no evidence at all for slaves involved in the production process.³⁶ In all these cases of large-scale production, the archaeological evidence for the fabrication and decoration of pottery suggests an effective division of labor among potters, firers and kiln specialists, glazers, decorators, and packers and shippers. Regardless of specifics, therefore, it is possible to say that in specialist industries that served a mass market, both regionally and internationally,

32 Material summarized in Haldon, "Commerce and Exchange."

33 See also Armstrong, "Trade in the Eighth Century"; François, "Les ateliers de céramique byzantine."

34 Armstrong, "Ceramics," 431–33.

35 Hruby and Flad, *Rethinking Craft Specialization*.

36 Günsenin, "Ganos: Centre de production."

the limited evidence indicates an effective division of labor among specialist artisans or producers, with multiple production sequences in shared productive spaces and facilities.

SILK

The preceding points can be seen a little more clearly in the case of cloth, especially silk weaving and clothing production, although I will look at this case from the point of view of a slightly different set of questions. First, where were the cultivation of the mulberry tree and the production of silk carried out in the East Roman world, especially after the Arab-Islamic conquest of the eastern provinces? Second, what role did East Roman silk production play in the economy of society broadly and, more especially, in the fiscal economy of the state? And third, what impact did it have on the world around the empire, both east and west?³⁷

MULBERRY CULTIVATION AND SILK PRODUCTION

Until the reign of Justinian, it is clear that silk-garment production, based in and around cities such as Tyre and Beirut, relied on imports of raw silk from Persia, a lucrative source of income for Persian middlemen and probably for the Persian state—and important politically, too, in light of the high symbolic value of silk as a fabric. While there has been a lot of debate about when exactly the silkworm was introduced, recent work has persuasively reinterpreted the account given by Procopius of Caesarea about this development: Silkworms were introduced in the early 530s, and a silk-producing industry established during the subsequent fifteen to twenty years rendered East Rome independent of the silk route and of imports from Persia. Thus, attempts by Sogdian traders to persuade the East Roman government to import silk through the steppe route, which the traders managed under Turkish oversight in the late 560s, failed apparently because the Roman court was well supplied with raw silk produced within the empire (in northern Syria/Phoenicia) and made into fabrics and garments at workshops there and in the capital, Constantinople.³⁸

From the East Roman perspective, therefore, the silk route was, after the 550s, far less relevant to foreign policy either with Persia or with the Turkic powers that controlled the steppe. Nevertheless, there is an argument to be made for the continued import of non-Byzantine raw silk and silk cloth and garments thereafter, given the relatively high demand. By the tenth century, imperial workshops were producing considerable quantities of silk garments of a range of qualities and colors both for imperial persons and for courtiers and officials of varying grades and ranks. Silk production as such was never an imperial monopoly, even if the market was to some extent controlled or at least supervised by the state, especially at Constantinople, although the use and sale of silks dyed with certain expensive purples was strictly controlled.³⁹

37 For textile production in general, see Fulghum, "Under Wraps"; Linscheid, "Textiles"; Morrisson and Sodini, "Sixth-Century Economy," 204–5; Parani, "Fabrics and Clothing"; also Cutler, "Industries of Art"; Martiniani-Reber, *Soieries*.

38 Zuckerman, "Silk 'Made in Byzantium.'"

39 Jacoby, "Silk Production." For the question of where mulberry trees were cultivated and silkworms bred, see this essay's appendix.

There is not much direct evidence for silk production in the provinces, but it seems to have taken place for the most part in small, family-based workshops, although some of them must have been quite extensive. Again, comparative material from more recent periods, as well as from other parts of the premodern world (including China), provides evidence and suggests a significant division of labor, with a specialist monoculture dedicated to mulberry cultivation and silkworm breeding and other sectors devoted to processing the raw silk and preparing it for the weaving process. Loom construction represented another key facet, while design and weaving were likely carried out by the weavers themselves. But for the imperial *blattia* (silk workshops) in Constantinople, a little more evidence indicates a managerial and administrative hierarchy with a fairly formal division of labor, production sequencing, and at the very least industrial-type processes in regular operation.⁴⁰

SILK AND THE ECONOMY

Following the loss of the silk-producing areas of northern Syria, Constantinople became the main focus for silk production until the tenth and eleventh centuries. At the same time, the Arab conquerors brought the silk industry to their new territories, especially North Africa (Tunisia, then Spain, and eventually, after the ninth century, Sicily), while the existence of a number of production centers meant a fertile interaction among the different regions in terms of both technology and style and form. For the eastern empire, we have a good deal of information about the disbursement of silk garments and fabrics of varying quality and value to imperial officials, as well as about the ways the court supervised or at least intervened in the production of silk garments and the use of precious dyes. The early tenth-century *Book of the Eparch*, mentioned above, includes detailed regulations concerning the production and commercial trade of silks. From the middle of the tenth century, there is evidence for the growth of a flourishing silk-production industry in central Greece, around Thebes, and we now have archaeological evidence for the associated port and production facilities.⁴¹ Imperial control over certain categories of silks and dyes was strict, especially as regards those dyes restricted to imperial use. The *Book of the Eparch* outlines these regulations, and the account of a western diplomat to Constantinople in the 960s, Liudprand of Cremona, shows that the regulations were applied. Liudprand attempted to export a number of special silks dyed in the imperial purple or woven with imperial motifs, all therefore prohibited items, but they were confiscated when he was preparing to depart from the city, thus illustrating the effectiveness of the imperial customs control over such items.⁴² Along with many other goods, silks were taxed internally through the offices of *kommerkiarioi*, officials who supervised the movement of goods across provincial boundaries and from outside the empire, as well as the export of goods to other parts of the Mediterranean and the Balkan and Levantine worlds.⁴³

40 Dunn, "Rise and Fall of Towns"; Jacoby, "Silk in Western Byzantium."

41 Dunn, "Rise and Fall of Towns."

42 Becker, *Liudprandi Opera*, 204–5; Wright, *Works of Liudprand*, 267–68. For discussion of governmental control over a range of crafts and trades in Constantinople in the tenth century, see Howard-Johnston, "Le commerce à Byzance," 316–35; Maniatis, "Organization."

43 Brandes, *Finanzverwaltung*, 394–406; Jacoby, "Silk Production."

Apart from the role of silks as diplomatic gifts, one of their major functions in the eastern empire was as a form of remuneration for imperial officials, who were rewarded with silks of varying value according to a strict hierarchical order. A tenth-century treatise, based on contemporary and ninth-century practice, describes the elaborate arrangements and the types of distributed silk garments, which varied in style, coloring, weight, and quality in a range of ways according to the type of weave. There has been a good deal of discussion about the exact interpretation of some of the technical terms that appear in Byzantine texts, but the written documentation indicates both the central importance of silk garments as a form of payment for imperial officials and the complexity of the vocabulary employed to describe their various and contrasting qualities.⁴⁴

EAST ROMAN SILK AND THE WIDER WORLD

By the eighth century, and therefore probably in the preceding century, Byzantine silks of high quality were being exported westward and probably also eastward. Before the eleventh century, consumption was limited for the most part to elite court circles and similar contexts, but a number of silks in Western museums and other places demonstrate the extent and quality of the material that ended up there—more than twenty locations today preserve Byzantine silks, and there is no doubt that this is, so to speak, merely the tip of a now-lost iceberg.⁴⁵ One commentator has noted that the influence of East Roman silks in the West cannot be overestimated: The West imitated the silks that were imported either as gifts or commercially, as well as the uses to which silks were put. They served as items of clothing, shrouds for holy relics, hangings and furnishings for ecclesiastical or palatial uses, and ecclesiastical and courtly vestments. Byzantine fashions in silk garments were followed in the West well into the late medieval period, thus entailing also the transfer of exemplars and modes produced farther east via the Byzantine world to the medieval West. Perhaps less predictably, a similar situation applied to the lands to the east and especially on the steppe.

This influence extended also eastward. Rather than being a recipient of eastern goods and especially silks after the middle of the seventh century, the medieval East Roman Empire served as a center from which cultural goods were diffused outward, as well as a center for the exchange of forms and concepts. A good number of Central Asian silks have been identified as exemplifying the considerable impact that Byzantine silk weaving and design had on the steppe region from the eighth century into the eleventh, if not beyond. A number of so-called Sogdian silks, referred to under the headings Zandanji 1, 2, and 3 (after the regional center of Zandana near Bukhara), are indicative. Closely related from the perspective of style, but with differences in weaving technique, group 1 employs largely Central Asian motifs, whereas groups 2 and 3 employ a mixed repertoire of Central Asian and Byzantine motifs and were likely produced in a series of different workshops. They can be dated to the eighth and ninth centuries in part because some of them were recovered from dated archaeological contexts, and it has been argued that Zandanji 1 silks certainly date

44 Galliker, "Terminology"; Haldon, *Constantine Porphyrogenitus*, Text [C] 225–60, 501–11.

45 Muthesius, "Silken Diplomacy."

from the seventh century into the ninth. In the case of Zandanji 1 silks, many of the motifs, while Byzantine in form and style, also reflect Sasanian models.

Analysis of the silks in all three groups suggests that Byzantine influence was present in motifs and design into the eighth century but, thereafter, major technical changes following Byzantine practice and production techniques were also introduced. One result of detailed technical research in this respect has been to demonstrate that Byzantine looms and weaving technology were more sophisticated than those available to Sogdian and other Central Asian weavers; the fineness and high production standards of the Byzantine silks may thus partly explain their preeminence in the West until the late medieval period, as well as their influence and presence in Central Asia.⁴⁶

ARMS, ARMOR, AND MILITARY EQUIPMENT

Finally, we come to a particularly specialized area of production. Although the exact number of soldiers in the late Roman and the early and middle Byzantine armies remains debated, the need to produce very substantial numbers of weapons, and to protect those soldiers and leaders most exposed to hostile action with defensive equipment, is clear. Even at a conservative estimate, the annual production of thousands of edged weapons of one sort or another and of hundreds of thousands of missiles, such as arrows, plus the need for effective maintenance of both weapons and equipment, constituted a major logistical burden on the state. Quite apart from this, of course, was the demand for cavalry horses, beasts of burden, wheeled vehicles, artillery, and siege machinery of various kinds, most of which required considerable technical skill and specialist knowledge, as well as the production of vast amounts of foodstuffs to support these soldiers and their animals—topics not addressed here.

The provision of raw materials for weapons had been achieved in the late Roman period through various forms of regular taxation, often extracted in kind and calculated at a given tariff according to state demand as well as market value (e.g., iron ore formed part of the tax burden, or *synteleia*, of those who extracted ore in the Taurus mountain region), together with compulsory levies in wood and other materials such as charcoal, leather, and felt. Much of our detailed data comes from the tenth through twelfth centuries, where we have much better documentation; but demonstrable continuity of administrative structures means that this evidence can be applied, with caution, to earlier periods, and incidental references across the seventh through tenth centuries make it clear that a combination of levies (wood, charcoal, etc.) and purchases (or compulsory purchases) operated similarly to that in the preceding and later periods.

Until the period of the early Islamic conquests, the state exercised a quasi monopoly over the production and distribution of weapons and also managed a series of *fabricae*, or imperial workshops, that produced other equipment, such as shields and helmets, among other items.⁴⁷ But there is no way of knowing to what extent this monopoly was either observed or enforced, and it seems very likely that smiths and other craftsmen with the appropriate skills were able, on occasion, and if supplied with the appropriate raw materials,

46 Grierson, "Commerce in the Dark Ages"; Muthesius, *Byzantine Silk Weaving*, 94–100.

47 Jones, *Later Roman Empire*, 834–39.

to produce various items of military equipment, including weapons of different types, when commissioned by a patron with the resources to pay for them. After the 640s, few of the state workshops remained within the imperial frontier, and of those that did remain—at Sardis, Nicomedia, Adrianople, Caesarea, and Thessaloniki—nothing is known, although slight evidence suggests that there existed a workshop at Caesarea whose craftsmen and workers had recognizable status within the community. That these *fabricae* also specialized in the production of specific items, such as shields or helmets, implies that their workers possessed considerable specialist technical skill and know-how. Constantinople had an arms workshop (or workshops), but the relationship between the official in charge of it (or them)—the *archōn tou armamentou*—and provincial production is obscure.⁴⁸ The regulations for supplying soldiers with their equipment, as well as for the replacement of lost or damaged items, were complicated and enshrined in imperial laws and rescripts—an aspect not needing to be addressed here. But by the early eighth century, the evidence shows that provincial soldiers could be responsible for obtaining their own weapons and armor, hence marking the abandonment of the state’s monopoly (however notional) that had been introduced by Justinian.⁴⁹

There is some evidence in inscriptions and texts for provincial armorers and weapon makers. By the ninth century, provincial military officers were commissioned with raising the necessary extra weapons and equipment, a responsibility carried out by applying compulsory levies on provincial craftsmen and artisans.⁵⁰ Thus, for an early tenth-century expedition, the military governor (*stratēgos*) of Thessaloniki had to provide 200,000 arrows, 3,000 spears, and “as many shields as he could manage”; the governor of the province of Hellas was ordered to prepare 1,000 spears; and the governor of the island of Samos was to raise the cash to pay for the production of nails for warships. Central government departments appear in the records as major repositories and suppliers of a whole range of requirements for the fleet and the army, with their own warehouses and workshops, depending on the materials required, alongside the armories established in Constantinople itself. Documents forming part of the dossier of records from a large-scale maritime expedition mounted in 949, for example, show that one department operated a storehouse that maintained supplies of raw materials, including iron ore, lead, and a range of other items for the equipping of both land forces and warships; another department stored items of naval equipment, clothing, and even cooking utensils.⁵¹

In contrast to the relatively centrally managed production arrangements of the period up to the middle of the seventh century, therefore, much of the production of different types of weapons was commissioned and passed on to provincial craftsmen and manufacturers—local smiths, for example, as well as other specialist workers—who were tasked with the delivery of items such as spears, arrows, bows, and shields. This burden was set against their annual tax liability, and again there survives a fairly complete record of how this accounting worked, although letters of complaint show that the government’s debt was not always made good.

48 Haldon, *Byzantine Praetorians*, 318–21.

49 Haldon, *Empire That Would Not Die*, 266–74; “Military Service,” 21–23.

50 Haldon, “Some Aspects,” 291–94.

51 Haldon, *Constantine Porphyrogenitus*, Text [C] 131–35; *Warfare, State and Society*, 139–48.

This truly major shift in the management of this vital aspect of imperial resources reflects to a large degree the transformed geopolitical situation, on the one hand, and the much-reduced fiscal resource base of the imperial government at Constantinople, on the other hand. Arms workshops continued to exist in Constantinople, as noted above, but whether the official in charge of them was also in charge of the provincial establishments is unclear. Given the widespread availability of weaponry and items of military equipment, therefore, as well as the omission of references to prohibitions on the private possession of weapons from later Byzantine recensions of Justinianic (i.e., sixth-century) law, it seems the state had abandoned its monopoly through force of circumstances.

The evidence thus suggests that the industrial-scale mass production of weapons and armor also disappeared after the middle of the seventh century or a little later, except at Constantinople and perhaps Caesarea in Cappadocia. At Constantinople, centrally managed armories producing a range of equipment and weaponry continued to function, and we may reasonably assume that, as with silk production and some ceramic production, factorylike establishments that combined efficiencies of scale with a hierarchy of expertise and craft skills were in operation. But on the whole, it seems that the production of military equipment became both provincialized and individualized as it responded to specific peaks in demand and reflected the degree to which military forces and their leaders were present or absent from a given area at a given time. Even in the sixth century, military handbooks had underlined the need for individual commanders to keep an eye on the state of their soldiers' equipment and to take appropriate measures for the repair or purchase of new equipment in the districts in which their forces were quartered.⁵² The massive loss of revenue after the 640s and the general tendency to flatten out the imperial administrative machinery, thus placing greater emphasis on provincial resources and in response to political and military needs, can have only exacerbated this tendency.

On the other hand, it is possible that the constant demand for items such as edged weapons (spearheads, swords, knives), arrows, and arrowheads encouraged an overall increase in the skills required to produce such material among provincial smiths and those engaged in similar, nonmilitary industry—skills hitherto largely restricted to imperially managed and funded manufactories and workshops, so far as the evidence indicates. Certainly, there is no evidence anywhere to suggest that the imperial armies were under-equipped or that their weaponry and equipment was inferior to that of their enemies, whether in the West, the Balkans, or the East. One important way of pursuing the question of weapons production would be a more detailed inquiry into armament production in those neighboring cultures for which there may be more documentary or archaeological evidence, since from the point of view of both technology and production technique there is likely to have been a high degree of comparability across political-cultural boundaries. At present, however, this is all that we can say with any degree of certainty about the subject, although recent work on the production process itself has produced some interesting, if still provisional, conclusions about outputs, rates of production, time required to produce particular items, and so forth.⁵³

52 See Haldon, *Byzantine Praetorians*, 117–18; Jones, *Later Roman Empire*, 834–39.

53 Dills, "Logistical Considerations."

The archaeology of the arms and armor of the middle and later Roman periods—roughly from the second to the mid-fifth century CE—has made considerable progress in recent years. We now have reasonably good, broadly based typologies of late Roman helmet and shield-boss types, as well as swords and belt fittings; buckles and decorated plates; spear-, lance-, and arrowheads; and a certain amount of information about defensive armor and related equipment for both men and horses. But such material-cultural data is unfortunately far more limited for the subsequent period. Indeed, hardly any specifically “Byzantine” military equipment is to be found on public display in the museums of the Balkan lands (including Greece) or modern Türkiye, territories that formed the heartlands of the medieval East Roman state, although enough late Roman material from the western, Balkan, and eastern frontier regions has been recovered to give some idea of the situation at the beginning of the period.⁵⁴

This situation is simply a reflection of the failure to identify artifacts found at excavated sites as possibly East Roman, on the one hand, and their accidental destruction, on the other. Battlefield archaeology is nonexistent, and—with the exception of warriors’ graves or interments belonging to non-Christian soldiers serving on imperial territory—Christian inhumations in clearly military contexts are likewise almost nonexistent in the excavated record. In addition, Christian burial practices generally discouraged the deposition of grave goods, especially of a military nature, so that even in cemeteries excavated within the Byzantine area it is difficult to distinguish soldiers’ graves, since no military equipment is included. Excavated cemetery sites in the “barbarian” regions of both the Balkans and the West show that as the process of Christianization took hold, fewer and fewer military grave goods accompanied interments.⁵⁵ With one or two exceptions mostly outside the empire’s territory, we are heavily dependent on non-Christian burials for information about the nature and development of Byzantine arms and armor.

Remarkably few military artifacts—swords or blades of any sort, arrowheads, shield bosses, buckles, pieces of armor, or helmets—can be firmly identified as Byzantine for the period after the sixth century in Asia Minor or the southern Balkans, although recent results of excavations in both Anatolia and the Balkans are beginning to improve this picture. (Italy up to the later seventh century is an exception.) The result is that Byzantine weapons technology, especially for the period from the middle of the seventh century onward, has had until very recently to be reconstructed almost entirely on the basis of literary accounts of often dubious, or at least problematic, reliability, as well as on the basis of illustrations in manuscripts, frescoes, mosaics, and reliefs carved in stone—all of which media again bring problems of stylization and archetype with them—while the comparative evidence from outside the empire’s lands must be used with care.⁵⁶ Within the past thirty-five years, only two monographs dealing with the subject of personal arms and armor in the Byzantine world have appeared, of which the older one makes only minimal reference to

54 Bishop, *Production and Distribution*; Bishop and Coulston, *Roman Military Equipment*, 122–82; Southern and Dixon, *Late Roman Army*, 89–126.

55 Deloghu, in Paroli, *L’Italia centro-settentrionale*, 425–30.

56 Haldon, “Some Aspects.”

archaeological documentation.⁵⁷ As with the production of ceramics, archaeological data can tell us a great deal about production technique, organization, and technological development, yet for this significant aspect of medieval East Roman culture and society we are still in a very impoverished situation.

CONCLUSION

In this essay, I hope to have cast some light on some aspects of industrial production and organization in the East Roman world from the sixth to the eighth or ninth century, on the impact on these activities of the transformation in the political and socioeconomic situation of the empire across that period, and on the relevance and degree of control exercised by the imperial government. The obvious outcome of the inquiry is to note (1) the predominance of private production and independent market-oriented enterprises, which, to judge from the evidence for ceramic production, distribution, and use, responded rapidly to shifts in market conditions and demand; (2) the relatively limited but functionally easily explained nature of state controls or restrictions in areas such as the production of and commerce in silks; and (3) the reduction in scale, on the one hand, and in government oversight, on the other, of major industries such as arms and weapons manufacture. These aspects all need to be considered in light of the dramatic, but as yet only crudely quantifiable, impact of demographic decline, economic retrenchment, and reconfiguration of urban society and space that took place from the seventh century onward. In turn, the political and fiscal requirements of and pressures on the East Roman state also played a significant role, especially with respect to the production of silk and weaponry / military equipment. It seems reasonable to assume that this pattern serves as a broadly accurate guide to the history of other industrial enterprises on the territories of the East Roman state over the same period.

APPENDIX: BYZANTINE SILK PRODUCTION

Sericulture (silk production) involves the cultivation of silkworms to produce silk fiber from the larvae of the silk moth, which feeds off mulberry leaves. The moths spin cocoons from a single continuous thread of raw silk, and the cocoons are harvested, boiled (to kill the pupae), and reeled to create silk thread. The question of where silk was produced after the Arabic-Islamic conquests of the seventh century remains to be resolved. The regions formerly at the heart of silk production were now lost to Constantinople, yet it is clear that during the eighth and ninth centuries and beyond, silk played an important role in the court's fiscal economy both as a source of prestigious gifts to foreign potentates and as a form of remuneration for imperial officials. The key lies in the conditions necessary to cultivate the mulberry. Silk production is a long-term and costly investment requiring specific climatic conditions (or at least carefully controlled and relatively expensive artificially maintained conditions) for both the mulberry trees and the silkworms themselves. The mulberry tree (*morus alba*), which can be grown up to 800 m above mean sea level, requires well-drained and relatively rich loamy conditions, as well as adequate

57 Grotowski, *Arms and Armour*; Kolias, *Byzantinische Waffen*.

moisture.⁵⁸ For optimum growth and good sprouting of the buds, the mean atmospheric temperature should be in the range of 13.0–37.7 degrees Celsius, with an ideal temperature of 24.0–28.0 degrees; the relative humidity should be between 65 and 80 percent; and the tree should receive five to twelve hours of sunlight per day. The mulberry can be grown in an annual rainfall range of 600–2,500 mm, with an average of 50 mm of rain every ten days considered ideal; under low rainfall conditions, growth is limited and requires supplemental irrigation.⁵⁹

Few regions in Anatolia meet these conditions. Western and southwestern Anatolian coastal regions, with their standard Mediterranean climate, would be suitable, and they were the likely centers of production until the ninth century, whereas—apart from sheltered valleys—most of Lycaonia, the Cappadocias, and the provinces of Armenia, which have extreme seasonal variations and much lower average precipitation, would not be. During the seventh to ninth centuries, political instability and insecurity would have rendered an industry that depended on the cultivation of the mulberry extremely vulnerable and possibly cost-ineffective. At present, no palynological or other proxy data from any of the empire's regions indicate the presence of mulberry cultivation, although such data may become available in the future.

It is notable that silk production seems to have played no role in early Ottoman Anatolia, although there were major centers of silk-textile production at Amasya, Mardin, Diyarbakir, Bursa, and Istanbul, and only with political and economic difficulties related to the import of raw silk from northern Iran during the sixteenth century did the silk industry around Bursa in western Asia Minor appear.⁶⁰ Today, the districts that can support a silk industry and the requisite mulberry plantations are chiefly in the region around Bursa (ancient Prousa) in northwestern Anatolia and around Antakiya (Antioch on the Orontes) in the Hatay region. In the Balkans, it was only after the later ninth century that political conditions made the establishment of a silk-producing industry viable. Thereafter, a flourishing silk industry developed in central and southern Greece—indeed, mulberries became so widespread in the Peloponnese that in the medieval period the peninsula was known as the Morea, deriving from the Greek word for the mulberry tree (*mouria*).⁶¹

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⁵⁸ Muthesius, *Byzantine Silk Weaving*; "From Seed to Samite."

⁵⁹ Dewdney, *Turkey*, 40–43 (table 11).

⁶⁰ Inalcik, *Economic and Social History*, 219–25.

⁶¹ Dewdney, *Turkey*, 135–36; Haldon, *Byzantium in the Seventh Century*, 236–37; Jacoby, "Silk in Western Byzantium," 453–54; Kazhdan, *Oxford Dictionary of Byzantium*, 1409.

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3

Parthian and Middle Persian Textual Evidence for Production, Industries, and Commerce

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INTRODUCTION

Medieval sources, including geographies, local histories, and even hagiographies by Muslim authors, noted aspects of ancient or pre-Islamic industry (*tukhshishn* lit. “endeavor”) and commerce (*pēshagīh*) among Iranians.¹ Less has survived about production (*barishn*), distribution (*bakhshishn*, *dahishn*), and trade (*wāzārgānīh*) of commodities (*tāgān*) in the Parthian and Middle Persian or Pahlavi documents.² This essay examines those pre-Islamic Iranian written sources to gain insight into items, occupations, and industries under the Parthian or Arsacid (247 BCE–224 CE) and Sasanian (224–652) dynasties, along with additions to the Middle Persian corpus from the time of the Umayyad (661–750) and Abbasid (750–1258) caliphates. Evidence elucidated here is intended to augment the much larger datasets provided by Achaemenid official inventories, Silk Road trade records, and medieval Islamic texts, as well as by archeological finds, which will be alluded to in this study when they are relevant.

GRAINS

The *Chīdag Handarz ī Pōryōtkēshān* “Select Counsels of the Ancient Sages,” written in Middle Persian during the ninth century and known as the *Pand Nāmag*, “Book of Advice,” listed as the third among peoples’ foremost duties “to sow and till the earth.”³ Farmers (*wāstaryōshān*, technically herders but used interchangeably with the more specific *dahigān*) were ranked alongside priests, warriors, and artisans as fundamental to society and industry, and they are thanked after the Zoroastrian creator deity Ahura Mazdā in a Pahlavi-language *Sūr Sakhwan* “Banquet Speech” dating to the sixth century or slightly earlier.⁴ However, a lower-class wage earner was permitted to own only a small plot of

1 All dates are Common Era (CE) unless otherwise specified. In the transcription of Middle Persian terms, ch = č, dh = δ, gh = γ, sh = š, and kh = x.

2 Broadly, see Lukonin, “Political, Social, and Administrative Institutions,” 738–44. For technical terms, see entries in MacKenzie, *Concise Pahlavi Dictionary*; and Nyberg, *Manual of Pahlavi*.

3 *Chīdag Handarz*, §6.

4 *Sūr Sakhwan*, §18a.

land (*kardag*), according to information preserved in the Middle Persian *Mādayān ī Hazār Dādestān* “Book of One Thousand Judgments” dating from the late sixth and early seventh centuries.⁵ So individual agrarian production would have been small in scale—that is, farming for family and local consumption—with only estates (*dastkard*) of nobles, village landlords (*dehgān*), and the state being capable of producing crops on an industrial scale.⁶ Parthian ostraca found at Dura Europos suggest that a swath of such estates, granted to nobles, surrounded that trading city—as well as cities on the Iranian plateau—and regularly provided grain deliveries to urban residents.⁷

Indeed, agrarian production of food items was the major industry in late antique Iran on both individual and large scales; it reached its highest levels of yield during the sixth century.⁸ Not surprisingly, the renowned fourth-century Sasanian high magus Ādurbād ī Māraspandān, writing in Middle Persian, echoed a standard maxim: “Till the soil and [you will] do good, for all persons live and are nourished by the tilling of the earth.”⁹ A Middle Persian ostrakon from Dura Europos listed the plowman (*kashtgar*) as a professional worker.¹⁰ Moreover, Ādurbād ī Māraspandān stressed that one day per month should be set aside to “train oxen to the plow (*ēsh, kasht*),” one day to “till your land,” and one day to “dig your irrigation canals.”¹¹ The hydraulic network was well developed and in places such as Shushtar well maintained by the state. One brief Pahlavi document mentioned a series of thirty reservoirs (*warm*) being filled in a village.¹² Another record, a Pahlavi papyrus from Egypt dating to 619–29, noted that a group of Iranian expatriate workers who maintained an irrigation canal was supplied with nine pecks of wheat.¹³ Those man-made waterways (*jō, jōy*) facilitated high agricultural yields, which in turn provided revenues to fuel commerce and industry.¹⁴ Consequently, the souls of “those who laid many canals (*kahas*), waterways (*rōd*), and springs (*khānīg*) for cultivation” were described as lounging on resplendent couches within the Abode of Song, or highest heaven, by the anonymous author of the *Ardā Wirāz Nāmag* “Book of Righteous Wirāz,” which was based on Sasanian-era materials but redacted in the ninth or tenth century and described a spiritual voyage through heaven, limbo, and hell.¹⁵

On a more practical note, Ādurbād ī Māraspandān emphasized the agrarian and economic value of cultivatable land (*ābādān*) by suggesting, “If you acquire property, start by purchasing well-irrigated agricultural land (*warz-deh*, also called *warz-būm*), for even if it

5 *Mādayān ī Hazār Dādestān*, §55.7, A1.

6 For a discussion of the *dehgān*, see Tafazzoli, *Sasanian Society*, 38–43.

7 Harmatta, “Parthian Parchment” (Dura parchment 12).

8 Adams, *Heartland of Cities*, 2, 5, 7, 19, 22, 30, 33, 104–5, 175–88, 207–18, 233; Daryaei, “Bazaars, Merchants, and Trade,” 401; Morony, “Economic Boundaries,” 183–84.

9 *Pahlavi Texts*, §63 (“Some Sayings of Ādurbād ī Māraspandān”).

10 See further MacKenzie, “Dura Europos: Inscriptions.”

11 *Pahlavi Texts*, §§132, 123, 124, respectively (“Counsels of Ādurbād ī Māraspandān”).

12 Gignoux, “Six documents pehlevis,” document 2.

13 Weber, “Pahlavi Documents,” P.Pehl. 572v.2.

14 *Mādayān ī Hazār Dādestān*, §19.6. See also Gyselen and Gasche, “Suse et Ivān-e Kerkha,” 31.

15 *Ardā Wirāz Nāmag*, §15.12.

fails to yield interest, the capital will endure.”¹⁶ The *Handarz ī Ōshnar* “Counsels of Oshnar,” a Pahlavi collection of sayings dating from the sixth century but credited to a legendary Kayanian sage, built on the industrial and commercial importance of agriculture (*warz*) by stressing the value of “not letting go of a fertile plot of land.”¹⁷ Legal disputes surrounding underground aqueducts (*kahas*, later *kāriz*, also Arabic *qanāt*) to and from agrarian properties occurred frequently, as discussed in chapter 34 of the *Mādayān ī Hazār Dādestān*.¹⁸

The centrality of cereal cultivation (*ābādānīh*, *wāstaryōshīh*), harvesting, distribution, and consumption was captured in the ninth- to tenth-century *Dēnkard* (“Acts of Religion”) by the phrase “cultivation for nourishment of the world.”¹⁹ The importance of working hard for the best possible agrarian yield was reflected by a line in the Middle Persian *Mēnōg ī Khrad* “[Book of the] Spirit of Wisdom” dating to the sixth century, when it was composed as an imaginary dialogue between the Spirit of Wisdom and a sage. That catechism claimed that “the creator Ahura Mazdā produces no grain for a person who is lazy.”²⁰ Corn specifically and grain generally (both termed *jōrdā*) were mentioned as widely grown crops (*bar*), as were their “kernels of grain” (*tōhmag ī jōrdā*), in the *Zand ī Wahman Yasn* “Exegesis on the Devotional Poem to Vohu Manah,” a compilation of apocalyptic material authored anonymously in the ninth century with later updates over the next few centuries.²¹ The importance of barley (*jaw*) and wheat (*gandum*) as dietary and economic staples was acknowledged in the *Sūr Sakhwan* through the wish “May there be much barley and wheat.”²² A second-century BCE ostrakon label from Old Nisa referred to a gift or donation (*NDBT*) of 2,000 heaps of barley made by a great-grandson of Arshak I.²³ Wheat and barley were primarily winter crops, though the texts did not distinguish seasonal crops.²⁴ Sorghum or giant millet (*gahl*) was grown and consumed as well, although regular millet (*alum*, *cham-bag*) was praised, probably because of consumer preference, as the “chief of small-grained cereals,” while long-grain wheat was specified as the “chief of [all] cereals” in the Pahlavi *Bundahishn* “[Book of] Primal Creation” compiled and revised between the seventh and twelfth centuries.²⁵ Barley and alfalfa or lucerne (*aspast*) were commercially produced and traded as animal feed, too, especially for horses, donkeys, and mules.²⁶

The “stacking of wheat” and “grinding of corn . . . on a millstone (*sang ī āsyāg*)” as widespread, apparently commercial, practices were mentioned—within the context of ensuring that those edible items did not become religiously unclean—in the *Pahlavi Rivāyats* (“Treatises”) of Ādurfarrōbay and Farrōbaysrōsh, which contain replies by those two Zoroastrian priests or magi to questions posed by laypeople in the years 800 and 1008,

16 *Pahlavi Texts*, §43 (“Counsels of Ādurbād ī Māraspandān”).

17 *Handarz ī Ōshnar*, §42.

18 *Mādayān ī Hazār Dādestān*, §§85.7–86.15. See further de Menasce, “Textes pehlevis sur les qanats.”

19 *Dēnkard*, §8.13.5.

20 *Mēnōg ī Khrad*, §21.29.

21 *Zand ī Wahman Yasn*, §§4.18, 4.44.

22 *Sūr Sakhwan*, §17b.

23 Livshits, “Three New Ostraca,” no. 2-L.

24 On the evidence for seasonal cultivation, see Bulliet, *Cotton, Climate, and Camels*, 16, 32–34.

25 *Bundahishn*, §17.22–23.

26 Weber, “Studies in Some Documents (4),” Berk. 71.2, 148.8, 233.13, 234.5–14.

respectively.²⁷ The commercial pounding of barley and rice (*brinj*) to produce flour (*ārd*) was mentioned in the first-century BCE Parthian poem *Drakht ī Āsūrīg* “The Assyrian Tree.”²⁸ A Sasanian-period Pahlavi papyrus from Egypt dating to the second decade of the seventh century, during the reign of Khusrō II, referred to “management (*rāyēnishn*) there at the mill (*ārdan*) . . . in Babylon,” suggesting state involvement in the production and distribution of ground grain.²⁹ Moreover, even earlier, thirty-one Parthian ostraca from Old Nisa captured considerable documentation for the sale and delivery of flour in 89 BCE.³⁰ Similarly, Parthian-language ostraca from Dura Europos listed deliveries of pecks (*grīw*) of grain to officials including the satrap Rashn around the year 256.³¹ The sale of wheat, paid for by check (*chak*), was recorded in a late-seventh century Middle Persian receipt.³²

The importance of correctly adhering to standards in the sale of grains was given spiritual valence as well, for in the *Ardā Wirāz Nāmag* salespeople who “did not use the correct grain-measure (*kabīz*) . . . [or] put dust into grain” faced an afterlife in hell, where their souls “were constantly forced to consume dust measured by the grain-measure.”³³ Profiting from trade in grains was regarded as acceptable practice—“it is allowable to buy low and sell high”—unless profiteering occurred at a time of scarcity and thereby harmed the survival of other people, according to Manushchihr ī Juwānjamān, a chief theologian among the magi of the late-ninth century as recorded in his *Dādestān ī Dēnīg* “Book of Religious Judgments.”³⁴

VEGETABLES, FRUITS, AND OTHER PLANT PRODUCTS

Cash crops included sesame (*kunjid*), peas (*girgir*), pulses (*mash*), lentils (*wēnōg*), and chickpeas (*nakhōd*). The growing of herbs and vegetables such as rue (*sudāb*), coriander (*kishnīz*), celery (*karafs*), and leeks (*gandanāg*) occurred on both household and industrial scales. These and other types of vegetation linked to daily production and consumption were recorded in the *Bundahishn*’s chapter on plants.³⁵ The harvesting of beans for boiling (*garmak*) was recorded in a Middle Persian estate memorandum (*ayādgār*);³⁶ the sale of thirty pecks of such beans, paid for by check, was noted in another late seventh-century receipt.³⁷

Those men and women who toiled in arboriculture often worked on orchards (*bāgh*) growing apples (*sēb*), oranges or citrons (*wādrang*), prickly lemons (*khār-wādrang*) from

27 *Pahlavi Rivāyats of Ādurfarrōbay and Farrōbaysrōsh*, §§83.1, 87.1.

28 *Drakht ī Āsūrīg*, §7.

29 de Menasce, *Ostraca and Papyri*, P. 45/Straßburg Pehl. 1.

30 MacKenzie, *Parthian Economic Documents*, ostracon 2593/2167.

31 Details in MacKenzie, “Dura Europos: Inscriptions.”

32 Weber, “Pahlavi Documents,” Berk. 228.2.

33 *Ardā Wirāz Nāmag*, §27.1–6.

34 *Dādestān ī Dēnīg*, §48.1–10; quotation from §48.10.

35 *Bundahishn*, §16.

36 Weber, “Studies in Some Documents (2),” Berlin 34.1.

37 Weber, “Pahlavi Documents,” 130, Berk. 226.1–2; see also the listing in “Studies in Some Documents (4),” Berk. 16.8.

which they also manufactured lemon balm (*wādrang-bōy*), limes (*chārūg*, *limūg*), quinces (*bēh*) including silver quinces (*bēh ī āsēmēn*), peaches (*shiftālūg*), apricots (*zardālūg*), pomegranates (*anār*), and figs (*anjīr*). They squeezed juices from many of those fruits. Orchard workers harvested dates (*khōrma*), walnuts (*gōz*), hazelnuts (*fandag*, *pondik*), chestnuts (*shāhbalūt*), almonds (*wādām*), and pistachios (*pist*), from which they churned nut butters and nut fillings for pastries. These products, and occasionally their consumers, were noted in the *Bundahishn*,³⁸ in *Khusrō ud Rēdag* “Khusro and the Page,” a Middle Persian didactic prose work centered on the Sasanian monarch Khusrō I (r. 531–79);³⁹ and in the *Drakht ī Āsūrīg*, which though composed as Parthian poetry was preserved in Book Pahlavi script and portrayed a fanciful bragging session between a date palm (*mugh*) and a goat (*buz*).⁴⁰

Arboriculture lay at the heart of orchard formation. Walnuts serve as a specific example of arboriculture in ancient and medieval Iran, with their planting at and around urban areas for dietary and economic reasons traceable from the mid-third millennium BCE forward.⁴¹ The same may be true of other nut trees—that is, their spread across Iran was intentional and related to production and distribution on industrial scales for economic reasons. Olive trees (*zaytun*, a loanword from Semitic languages), too, had been imported to the Iranian plateau from the Levant by about 3000 BCE and quickly became central to the food industry. After harvesting the olives (*zayt*), workers would press olive oil, which served as a favored marinade for meat dishes.⁴² Orchards changed ownership for cash, and crops would be switched to more profitable ones—such as from grape vines to fruit trees—as a Pahlavi papyrus from Dura Europos recorded.⁴³

For the most part, if the *Drakht ī Āsūrīg* is accurate, dates—and possibly other fruits and vegetables—were cheaper than bread (*nān*) made from cereal flour.⁴⁴ However, supply chains brought dates from Herat and hemp (*shan*) seeds from Nishapur to discerning consumers in other regions of Iran who could afford to pay higher prices for superior quality and better taste.⁴⁵ A memorandum and its annexures dating to circa 699/700 from an estate at Windādburzmihirābād—a village near Qom named for a Zoroastrian businessman whose activities were well attested during the late seventh century—referenced not only the prosperity (*padēkhīh*) from the harvest but also the transport of six measures of beans and 1,000 walnuts.⁴⁶ Not all fruits and nuts were produced within Iran, however. Peaches from Armenia and pistachios from Hyrcania were especially valued. Ginger (*sēnjibīl*) was imported from China and coconuts from the Indian subcontinent, the latter therefore being termed “the Indian nut” (*gōz ī hindūg*). These items, discussed in *Khusrō ud Rēdag*, suggest robust supply chains both overland and by sea for regional and long-distance food trade.⁴⁷

38 *Bundahishn*, §16.9, 11, 17, 19, 26.

39 *Khusrō ud Rēdag*, §§21, 26, 39–41, 52.

40 *Drakht ī Āsūrīg*, §§20, 40–42, 45; see also Gyselen, “Economy,” 104.

41 Potts, “Arboriculture in Ancient Iran,” 102, 105.

42 Floor, “Olive Tree.”

43 Harmatta, “Parthian Parchment,” 307 (papyrus no. 101).

44 *Drakht ī Āsūrīg*, §20.

45 *Khusrō ud Rēdag*, §§52–53.

46 Weber, “Pahlavi Documents,” Berk. 43A.2, 43C.6, and 43D.8, respectively.

47 *Khusrō ud Rēdag*, §§46, 50–52.

According to the *Drakht ī Āsūrīg*, *dahigān* produced sugar (*shekar*) for peasants and honey (*angubēn*) for nobles.⁴⁸ Honey, although originating from pollen, was regarded as an excrement of bees and therefore considered unclean for consumption by the magi, as it would vitiate their ritual purity; laypeople, however, were less constrained by the prescription to abjure that sweet substance.⁴⁹ Sugar was extracted from cane (*khuz, nay*). Of Indian subcontinental origin, sugarcane was grown in Sasanian Iran—it was mentioned in the seventh-century *Geography* of Ananias of Shirak as producing “fine sugar” and possibly even earlier in the mid-first-century, anonymously authored *Periplus Maris Erythræi* as “honey from sugar cane.”⁵⁰ Sugar was a particularly important cash crop for producers along the Persian Gulf coast between Makran and Khuzestan, the “place of [sugar]cane,” and especially its cities Gondeshapur, Shushtar, Ahvaz, and Haft-Tepe, from where it was exported as far north as Khurasan and Balkh. Despite its original, foreign source, sugar was quickly indigenized in Iranian lore through attribution of its discovery to the mythical king Jamshid at the time of Nowruz or New Year. Therefore, white sugar (*shekar ī spēd*) served a symbolic role during that vernal-equinox festival, with kings and commoners expected to sweeten their lips, tongues, and mouths before speaking.⁵¹ Decorated white sugar cones also became a staple at wedding ceremonies for Zoroastrians (and later Iranian Muslims) to symbolize hopes for the sweetness and bliss of union.

ANIMAL FOOD PRODUCTS

The two designations *wāstaryōshān* and *dahigān* were probably interchangeable because those workers not only produced crops but also tended livestock (*gōspand*), especially goats, which yielded milk (*shīr*, termed *jīwām* after consecration during Zoroastrian rites), dried or powdered milk (*kask*), curd (*māst*), and cheese (*panīr*)—all listed in the *Drakht ī Āsūrīg* poem.⁵² These animal products supplemented basic grains by adding protein to the diet of the working classes. The sale of cheese, paid for by check, was recorded in a transactional memorandum.⁵³ The manufacture and sale of edible oils or butter (*rōghn*), both domestically consumed and likely exported, were recorded in the Parthian poem.⁵⁴ Ostraca receipts from Old Nisa also documented trade in these oils.⁵⁵ Oil filtered using

48 *Drakht ī Āsūrīg*, §16.

49 Choksy, *Purity and Pollution*, 15, 104.

50 Potts, “Spurious Fifth Century Date,” 114 with references to the textual sources.

51 Details in Christensen, *L'Iran sous les sassanides*, 100, 147; Ehrlich, “Celebration and Gifts,” 99, translating from al-Jāhīz (d. 868), *Kitāb al-mahāsin wa 'l-aqdād*; Le Strange, *Lands of the Eastern Caliphate*, 238; Schwarz, *Iran*, 347–48. Tenth-century Muslim geographers such as al-Iṣṭakhri, *Kitāb al-masālik wa 'l-mamālik*, 88, and Ibn Ḥawqal, *Kitāb ṣūrat al-arḍ*, 251–52, plus the anonymous author of *Ḥudūd al-'ālam* (writing around the same time in Khurasan), 138, provided primary documentation for sugarcane growth and sugar processing in Iran.

52 *Drakht ī Āsūrīg*, §46.

53 Weber, “Pahlavi Documents,” Berk. 65.2.

54 *Drakht ī Āsūrīg*, §42.

55 MacKenzie, *Parthian Economic Documents*, ostracon 2629/Nova 355.

comb filters (*shānchak*) for burning in lamps was specifically designated as “lamp oil” (*rōghn ī chiragh*).⁵⁶

A lamb-breeding station run for Sasanian troops stationed in Egypt between the years 619 and 629 was documented in a Pahlavi papyrus record in the context of supplying the breeders with wheat.⁵⁷ The sale of salted meat (*namak-sūd* “salt-rubbed”), with payment received by check, was recorded on the Iranian plateau in a late seventh-century Middle Persian memorandum.⁵⁸ The taxation of livestock is attested by a document dating to the period of the Arab conquest, specifically the years 680/81 to 681/82, where the herd (*ramag*) totaled 2,100 male and female sheep (*mēš*), lambs (*warrag*), and wild sheep (*pāzen*).⁵⁹

The economic divide that existed between those who could afford to consume meat and those who could not is clear from the *Drakht ī Āsūrīg*, wherein the goat boasted, “My flesh is eaten by kings, mountain lords, and nobles.”⁶⁰ Young goat (*wahīg*) and beef (*gāw*) brisket were regarded as the tastiest of animal meats.⁶¹ Other animals consumed by the noble classes included the horse (*asp*), deer (*gawazn*), gazelle (*āhūg*), camel (*ushtar*), buffalo (*gāwmēsh*), onager or wild ass (*gōr*), domestic ass (*khar ī kadagīg*), wild boar (*warāz*), domestic pig (*khūg ī kadagīg*), hare (*khargōsh*), and marten or sable (*khaz*).⁶² A variety of exotic and common birds (*murw*) including the peacock (*frashmurw*), francolin (*pōr*), hen or chicken (*kark*), pheasant (*tadar*), partridge (*tīhōg*), lark (*chakōk*), crane (*kulang*), bustard (*charz*), black starling (*khashēn-sār*), and waterfowl (*murw ī ābīg*) were eaten by those who could afford such culinary luxuries.⁶³ The tastiest bird, however, was deemed to be the male domestic fowl (*kark ī kadagīg ī gushn*) fattened on hemp seeds and olive oil.⁶⁴ In addition to these animals and birds being hunted by the nobles themselves, their availability as commercial commodities suggests specialized enterprises that catered to the kitchens of the wealthy.⁶⁵ Free-range and caged birds, including geese (*sī*) and pigeons (*kabōtar*), and staffing problems at estate and industrial poultry (*ambaragān*) farms were documented in Pahlavi commercial records.⁶⁶

ALCOHOLIC BEVERAGES

Vineyards (*raz*) and wine (*mad*, *may*) were mainstays of production, consumption, and socialization. The fourth-century Sasanian high magus Ādurbād the son of Māraspand proposed, “An old friend is like an aged wine, which becomes better and more suitable

56 Weber, “Studies in Some Documents (2),” Berk. 247.8–9.

57 Weber, “Pahlavi Documents,” P.Pehl. 572r.1.

58 Weber, “Pahlavi Documents,” Berk. 68.2.

59 Weber, “Studies in Some Documents (2),” 99–100, Berk. 229, 230.

60 *Drakht ī Āsūrīg*, §45.

61 *Khusrō ud Rēdag*, §21.

62 *Khusrō ud Rēdag*, §§30–35.

63 *Khusrō ud Rēdag*, §25.

64 *Khusrō ud Rēdag*, §26.

65 Perhaps a precursor model is evidenced in the Persepolis Fortification tablets, as discussed by Henkelman, “Consumed before the King,” esp. 671, 673.

66 Weber, *Berliner Pahlavi Dokumente*, document 6; “Studies in Some Documents (3),” Berk. 55, 184, 246.

for consumption by rulers the maturer it is.”⁶⁷ Yet the virtues and vices of consuming wine were much debated in Middle Persian texts—especially in terms of moderate and excessive consumption—for instance, in the *Mēnōg ī Khrad*.⁶⁸ Even Ādurbād ī Māraspandān cautioned against the lure of wine, “for whoever drinks it immoderately falls into sin.”⁶⁹ As late as the ninth century, Ādurbād ī Ēmēdān was warning about the dangers of intoxication when writing his portion of the *Dēnkard*.⁷⁰

Vineyards and wine production were the best documented of Iranian industries in late antiquity. More than 2,000 ostraca with at least 2,758 texts have been recovered from Old Nisa. The ostraca date mainly from the first century BCE (as late as 29 BCE) but range back to the early second century BCE.⁷¹ More than a dozen estates were mentioned, many of which had several distinct vineyards. Some vineyards were categorized as new, others as old.⁷² Irrigation of the vineyards by canals was recorded.⁷³ These grape-producing estates had watchmen or vineyard guardians (*razbānān*). Several vineyards were controlled by regional satraps (*khsahrapān*)⁷⁴ and fortress commanders (*dizpatān*, *dizbēdān*)—therefore, wine sales likely contributed substantially to each administrator’s income. A Parthian-language parchment found at Dura Europos and dating from after the year 256 indicates that owners such as the satrap Rashn received written reports from employees on the conditions of each vineyard—for example, “All possessions of the lord are in order in the vineyard called *b*aghān.”⁷⁵

Regarding the pressing process, Ādurbād ī Māraspandān wrote of picking “grapes (*angūr*) from the vine (*raz*) and throwing them into the winepress (*karkhōsh*).”⁷⁶ A twenty-one-line guide to winemaking, preserved on parchment, documents the process of fermenting in amphora (*gildān*) and even indicates a shelf life for the wine of at least six years.⁷⁷ Interestingly, the term *yazadān*, which customarily denotes Zoroastrian “spiritual beings/spirits worthy of worship,” was used to refer to “alcoholic spirits.” Old Nisa ostraca occasionally specified whether the wine was a rosé (*khshētak*) or a white (*wagūnag*)⁷⁸—white wines were noted more frequently than colored ones. The sales ostraca recorded whether each batch’s production was recent (*ḥDT*, *nōg*)—which was far more common—or had been

67 *Pahlavi Texts*, §101 (“Counsels of Ādurbād ī Māraspandān”).

68 *Mēnōg ī Khrad*, §§15.10–18, 16.16–63.

69 *Pahlavi Texts*, §112 (“Counsels of Ādurbād ī Māraspandān”).

70 *Dēnkard*, §6.C3.

71 E.g., MacKenzie, *Parthian Economic Documents*, ostracon 2673, dated to 152–151 BCE; see further Huyse, “Inscriptional Literature,” 88–89.

72 MacKenzie, *Parthian Economic Documents*, ostraca 399/Nova 175, 92 BCE, and 417/Nova 233, 93 BCE, respectively.

73 MacKenzie, *Parthian Economic Documents*, ostracon 593/1565, 76 BCE.

74 MacKenzie, *Parthian Economic Documents*, ostracon 64/1743, 71 BCE.

75 Harmatta, “Parthian Parchment,” 261, 263, 293, 302, 305, 307 (Dura parchment 12.3). For an earlier, different translation, see Henning, “Aramaic and Iranian Documents,” 414–15.

76 *Pahlavi Texts*, §133 (“Counsels of Ādurbād ī Māraspandān”).

77 Weber, “Studies in Some Documents (2),” Berk. 107.

78 MacKenzie, *Parthian Economic Documents*, ostraca 2/29, 100 BCE, and 201/970, 68 BCE, respectively.

aged (‘TYQ).⁷⁹ Middle Persian papyri also mentioned the trade of “white wine” (*may ī spēd*), “distilled, enhanced wine” (*may ī wirāstag*), and “wine of fine vintage” (*may ī gōhr*).⁸⁰ Indeed, vintages seem to have been well known. The protagonists of *Khusrō ud Rēdag* rated “the wine of Herat, the wine of Mervrud, the wine of Bust, and the must (*bādag*, i.e., grape juice) of Hulwan as good and fine” but added that “none can compare with Assyrian wine and the must of Wazrang.”⁸¹ Even aged vinegar was sold as an epicurean item, as listed on an ostracon from Old Nisa.⁸²

Brief, quotidian ostraca regularly documented the delivery of wine from named, “share-rented” (*uzbari*) vineyards located in specific villages.⁸³ Specific wine cellars (*ma-dustān*) at particular locations were routinely noted on these receipts as well. The names of more than eighty wine traders and wine bearers/transporters (*madubar*) based at more than thirty villages and towns, some of which had several alcohol traders active at any one time, and the quantity (*mari*) and its fractional units (*kapiṭhe*) traded were customarily logged—for example, “From the estate Appadān. In this jar from an *uzbari* vineyard, from the store 1 *mari* 2 *kapiṭhe* of wine, 13 *mari* of wine. Brought by Warhagnak, wine trader, delivered for the year 172 [76 BCE].”⁸⁴ Sometimes notations indicated that the wine had gone “sour” (*witrishfak*, *witriṣhshak*)—that is, turned to vinegar (*sik*).⁸⁵ Other ostraca acknowledged the consolidation of wine and vinegar from one jar or pithos (*khumb*) with that of another before or after the sale.⁸⁶

Wine, must, and vinegar were retailed and even gifted to a wide range of social classes (*pēshag*) including scribes (*dipīrān*, *dibīrān*) and seal setters/cutters (*muhrwartān*, *muhrwardān*), in addition to institutions such as palaces and temples and those centers’ officials, such as Zoroastrian high theologians (*mahist-radān*).⁸⁷ Middle Persian sales memoranda, from an estate near Qom and elsewhere in late Sasanian and early Islamic Iran, indicate that payment was often made by check and a receipt (*padīrāy*) issued for each transaction on behalf of the vineyard manager (*dastgird*).⁸⁸ Not just grape products but also the estates themselves were bought and sold. Three Avroman parchments—two written in Greek and dating from 88 BCE and 22–21 BCE, and one in Parthian dating from 53 BCE—bear contracts for the sale of named vineyards.⁸⁹ A parchment from Dura Europos also refers to the sale of a vineyard in a nearby village. In each case, the transactional costs were recorded, the documents signed, and the signatures witnessed.⁹⁰

79 MacKenzie, *Parthian Economic Documents*, ostraca 225/2076, 87 BCE, and 42/Nova 16/1956, 87 BCE, respectively.

80 Brunner, “Review,” 135.

81 *Khusrō ud Rēdag*, §§56–58.

82 MacKenzie, *Parthian Economic Documents*, ostracon 2538/9.

83 On the term *uzbari*, see Brunner, “Review,” 133.

84 MacKenzie, *Parthian Economic Documents*, ostracon 17.706. A *mari* was approximately 9.32 liters.

85 MacKenzie, *Parthian Economic Documents*, ostracon 190/129, 83 BCE.

86 MacKenzie, *Parthian Economic Documents*, ostracon 644/Nova 218, 66 BCE.

87 Weber, “Pahlavi Documents,” Berk. 43E.4–5.

88 Weber, “Pahlavi Documents,” Berk. 74.2; *Berliner Pahlavi Dokumente*, document 13.2–3.

89 Minns, “Parchments of the Parthian Period,” 28–32; Nyberg, “Pahlavi Documents,” 208–9.

90 See also Huyse, “Inscriptional Literature,” 89–90; Harmatta, “Parthian Parchment,” 307 (Dura parchment 2).

As an added safeguard, the importance of correctly adhering to standards and volumes in the sale of wine was given spiritual valence. Thus the *Ardā Wirāz Nāmag* depicted souls of those vintners who “did not use the correct wine-measure (*dōlag*) . . . [or] mixed water with wine” as being “constantly forced to consume ashes measured by the wine-measure.”⁹¹ Likewise, joint production and trade in wine by Zoroastrians, Jews, Christians, and, later, Muslims clearly occurred frequently, for it was frowned on by Manushchīhr ī Juwānjamān in the *Dādestān ī Dēnīg*⁹² and by Ādurfarrōbay and Farrōbaysrōsh in their *Pahlavi Rivāyats*.⁹³

Beer (*washag*) was recorded in Middle Persian texts. This term for beer was preserved even in the post-tenth-century compilation *Frahang ī Pahlawīg* “Glossary of Pahlavi” (i.e., in the medieval Islamic period, during the Abbasid caliphate).⁹⁴ Beer served as a substitute for wine during a grace recitation before a meal when Ardashīr (who subsequently founded the Sasanian dynasty) was fleeing the last Parthian monarch, Ardawān IV, around the year 224; according to the *Kār-Nāmag ī Ardakhshīr ī Pāpakān* “Book of Feats of Ardashīr of the Lineage of Papak”: “They brought forth beer and served the meal.”⁹⁵ Beer had been mentioned even earlier, in the Parthian poem *Drakht ī Āsūrīg*, as “fitting for the consumption of rulers, mountain lords, and free people.”⁹⁶ So beer seems to have been a part of the daily life of those who could afford it. However, Parthian and Middle Persian texts have preserved few details about its production and distribution, the use of goats in these activities being an exception.

Koumiss (*hur*), or fermented goat’s milk, was another alcoholic beverage consumed and probably traded during Parthian and Sasanian times. The *Drakht ī Āsūrīg* fable recorded a goat as claiming, “People make delicacies like koumiss from me.”⁹⁷

CRAFT GOODS AND LUXURY ITEMS

The encyclopedic *Dēnkard*, which conserved selections from the collective wisdom of the medieval magi as edited by two leading magi in Fars province—Ādurfarrōbay ī Farrokhzādān (lived early ninth century) and Ādurbād ī Ēmēdān (lived early tenth century)—recorded in Middle Persian that “the class of artisans” (*hutukhshān*), one of the four basic social divisions, was integral to the Good Religion (*Wēh Dēn*)—that is, Zoroastrianism or Mazdeism.⁹⁸ The *Shkand Gumānīg Wizār* “Doubt Dispelling Exposition,” written by Mardānfarrokh ī Ohrmazddādān during the ninth century to critique Judaism, Christianity, Manichaeism, and Islam while defending Zoroastrian tenets (later rendered into Pāzand with commentary), emphasized the importance of artisans: “The four branches are

91 *Ardā Wirāz Nāmag*, §27.1–6.

92 *Dādestān ī Dēnīg*, §49.1–4.

93 *Pahlavi Rivāyats of Ādurfarrōbay and Farrōbaysrōsh*, §125.1–2.

94 *Frahang ī Pahlawīg*, §5.2 = §31.2–3.

95 *Kār-Nāmag*, §7.8.

96 *Drakht ī Āsūrīg*, §45. Noted also by Henning, “Middle-Persian Word for ‘Beer,’” 603–4. Presumably, goat by-products included fining agents such as gelatin to improve clarity or adjust flavor or aroma.

97 *Drakht ī Āsūrīg*, §45.

98 *Dēnkard*, §3.190.

the four classes through which faith and secular life are sustained—namely, the priests, warriors, herdsmen, and artisans.”⁹⁹ The author added, “Industry corresponds to the class of artisans, for it is the greatest stimulant of their trade.”¹⁰⁰ This fourth estate of humans, basic professions, and industries was mentioned as well in the *Tōsar Nāme* “Letter of Tōsar [or Tansar],” a third-century document revised in the sixth century, then translated into Arabic by the eighth century and later into New Persian during the thirteenth century.¹⁰¹

An Abbasid-period Pahlavi-language defense of Zoroastrianism, supposedly set at the court of Caliph al-Ma’mūn (r. 813–33) and titled *Gizistag Abālish* “[Book about] the Accursed Abalish” (referring to a convert to Islam who challenged the high magus Ādurfar-rōbay ī Farrokhzādān), listed four artisanal (*dastwarzīg*) industries or trades of craftsmen (*pēshag-kārān*) as essential to urban centers. Those avocations were the blacksmith (*āhangar*), shoemaker (*kafshgar*), carpenter (*durgar*), and tailor (*darzīg*).¹⁰² The *Dēnkard* added the tanner (*kūrwārgar*) and the fuller or garment cleaner (*gāzar*) to the list.¹⁰³ Other notable professions and industries included those of potter (*kulwārgar*), builder (*rāz-kirrōg*), ironsmith (*chēlangar*), silversmith (*asēm-paykar*), goldsmith (*zarīgar*), painter (*nigārgar*), and book or manuscript illustrator (*nibēgān-nigār*).¹⁰⁴ The category of artisans, or “those who engage in good endeavors” (*hutukhshān*), apparently was also used to designate scribes (i.e., *dibīrān*), as suggested by a Pahlavi papyrus from the Fayyum Oasis dating to the Sasanian occupation of Egypt between 619 and 629.¹⁰⁵ Another document, a Middle Persian ostrakon from Dura Europos, included the baker (*nānbāg*) among its list of twenty-seven professions.¹⁰⁶

The *Drakht ī Āsūrīg* recorded the commercial production of wooden implements and items (*dastwarz*) used in households and manufacturing facilities, such as brooms (*gyāg*), pestles (*gawāz*), bellows (*damēnag*), and ropes (*rasan*).¹⁰⁷ Leather water bottles (*mashk*, *āb-dān*) and tablecloths (*mashkīzag*) were also listed.¹⁰⁸ This Parthian poem mentioned personal items including wooden sandals (*wārīn*) for the poor; wooden shoes (*mōg*) for workers (*warzīgarān*); leather goods such as belts (*kamar*), boots (*mozāg*), and gloves (*angūst-bān*); and fine clothes of goat’s wool (*pashmag*, *barak*) for nobles.¹⁰⁹

The *Mēnōg ī Khrad* recorded that cloth was usually manufactured of cotton (*pambag*), “which is good for the soul,” and silk (*abrēshom*) or damask (*damask*), “which is good for the body”; it differentiated between cotton and silk on the basis that “cotton is nourished by water and grows from the earth,” whereas “silk comes forth from a noxious creature

99 *Shkand-Gumānīg Wizār*, §§1.16–17, 1.20.

100 *Shkand-Gumānīg Wizār*, §1.29.

101 *Tōsar Nāme*, §§4, 12.

102 *Gizistag Abālish*, §5.2.

103 *Dēnkard*, §6.E22f.

104 As noted by Tafazzoli, “List of Trades and Crafts,” 193–96.

105 Zeini, “Unique Pahlavi Papyrus.”

106 See also MacKenzie, “Dura Europos: Inscriptions.”

107 *Drakht ī Āsūrīg*, §§6, 7, 8, 11.

108 *Drakht ī Āsūrīg*, §§36, 37.

109 *Drakht ī Āsūrīg*, §§10, 9, 34, 35, 33, respectively.

(*khrafstar*).¹¹⁰ The magi or Zoroastrian priests were therefore forbidden to don silk clothing or sleep on silk sheets.¹¹¹ The Parthian and Middle Persian texts captured little about the production of cotton and silk, however, although the available evidence points to cotton as first being grown commercially on the Iranian plateau during Sasanian times.¹¹² Silk would have been traded by Sogdian merchants to their Persian counterparts along the frontier with Central Asia. Sasanian authorities regulated that trade by issuing permits to merchants in Bukhara, Samarkand, and other northeastern cities. In one instance, around the year 568, King Khusrō I apparently prohibited Sogdian silk traders from peddling their raw product directly within the Sasanian Empire, perhaps to protect those traders and weavers who produced the finished product for consumers.¹¹³ Indeed, the purchase of “clothing (*jāmag*) from the market (*wāzār*) . . . clothing that had been brought from the suburbs of a city” is cited in the *Pahlavi Rivāyats* of Ādurfarrōbay and Farrōbaysrōsh,¹¹⁴ suggesting not only manufacturing facilities in urban settings but also mercantile networks that transported the commodities to buyers in villages.

Bedclothes were made of “cotton, hair [or fur of large-mammals] (*mōyēn*), and wool,” according to the *Rivāyat* of Ēmēd ī Ashawahishtān (compiled during the mid-tenth century) in a question and answer that suggests use of those materials in this manner was widespread and hence likely to have been an industry at cottage and commercial levels.¹¹⁵ Technically, hair (including fur) once separated from the body was regarded as unclean according to Zoroastrian purity and pollution codes.¹¹⁶ So while fur and wool were used out of practical necessity, since they ensured warmth, the advent and spread of cotton clothing and bedding would have been regarded as far more preferable from a religious point of view—“good for the soul” rather than solely “good for the body,” in the words of the author of the *Mēnōg ī Khrad*.¹¹⁷ Fur was exported as well, especially to the Byzantine Empire, where these materials were labeled “Parthian furs” in the sixth-century Latin *Code of Justinian*.¹¹⁸

The dyeing of cloth with indigo (*nīl*), turmeric (*zard-chōbag*), and saffron (*kurkum*) was referenced in the *Bundahishn*, thus attesting to the industrial production of colored cloth at least by late Sasanian times.¹¹⁹ Indigo shrubs were grown on a small scale in Khuzestan, Kerman, and Baluchistan. Saffron was produced in Khurasan, Kerman, and Fars provinces. Turmeric, on the other hand, was imported from the Indian subcontinent and Southeast Asia. Saffron and turmeric would eventually be added to Persian cuisine as well, although when that practice began is uncertain; neither spice was mentioned by the pageboy during

110 *Mēnōg ī Khrad*, §16.64–66.

111 Choksy, *Purity and Pollution*, 15.

112 Bulliet, *Cotton, Climate, and Camels*, 6–8, 16, summarizes the introduction of cotton growth and production from India to Iran and its popularity there as a summer crop. See also Álvarez-Mon, “Introduction of Cotton,” 46 with n15.

113 Morony, “Trade and Exchange,” 5–6.

114 *Pahlavi Rivāyats of Ādurfarrōbay and Farrōbaysrōsh*, §91.1.

115 *Rivāyat ī Ēmēd ī Ashawahishtān*, §16.1.

116 Choksy, *Purity and Pollution*, 80–84.

117 *Mēnōg ī Khrad*, §16.64.

118 See Frye, “Commerce,” 62.

119 *Bundahishn*, §16.20.

his discussions with King Khusrō I on the seasonings of stews, for which olive oil was the most frequently mentioned dressing.

The manufacture of specialized items was documented by lists in the *Drakht ī Āsūrīg*; these items included wooden cudgels (*chōb*), wooden chests (*tabangōg*) and medicine boxes (*dārūgdān ī shas*), and leather harnesses and saddles (*sūkhtag*).¹²⁰ Particularly insightful is the notation that “rolled book pages for scribes” (*nāmag ī parwardag ī dibīrān*) were produced from goat hide.¹²¹ Indeed, allusion to widespread parchment production—for books, tabulations, and contracts—is found in the same poem.¹²²

If the list of scents (*bōy*) described and ranked in the *Khusrō ud Rēdag* is even remotely accurate, an extensive perfume industry existed. Those aromatics included extracts of jasmine (*yāsaman*, *yāsmīn*), narcissus (*nargis*), rose (*gul*), dog rose or sweet briar (*nas-taran*), irises (*hērīg*) of various colors, violet (*wanafshag*), lily (*sōsan*), lotus (*nīlōpal*), wild thyme (*sīsīambar*), royal basil (*shāhesprahm*), and clover (*samān*); camphor-scented perfume was listed as well.¹²³ Imported luxury goods and their transportation figured in the *Drakht ī Āsūrīg*, notably camphor (*kāpūr*), black musk (*mushk ī syā*), and furs of small mammals such as martens.¹²⁴ Ambergris (*ambar*, *anbar*), the waxy aromatic discharge of sperm whales, was used in Iranian perfumes and burned as an aerial purifier alongside frankincense and fragrant woods. Obtained through trade from Baltic Sea and Indian sub-continent coastal communities, ambergris was not categorized negatively as excrement, as silk and honey were. Rather, Zoroastrians believed that this aquatic mammal, which they termed *xar ī sē pāy* “three-limbed ass”—referring to its two flippers and one tail and its blowing of air similar to snorting—was a semimythical beneficent creature that kept seas and oceans purified with its fragrant regurgitant.¹²⁵

The “scattering of pearls” (*morwārīd*, later *dorr*), which would become a staple image in classical Persian poetry (e.g., that of Hafez [d. 1390]), appears to have been a well-known metaphor¹²⁶ based on that semiprecious gem’s use in Parthian and Sasanian jewelry. The pearls were probably harvested domestically from the Persian Gulf’s pearl banks in addition to being imported from pearl beds (*pārs*) along the western coast of India and especially in the Gulf of Mannar and the Palk Strait of Ceylon (earlier Serendib, now Sri Lanka). The pearls were then traded to Byzantium from Persian Gulf coastal towns such as Siraf—probably via overland routes, including one that ran through Nisibis.¹²⁷ Amber or fossilized tree resin (*kahrubāy*), also imported from the Baltic region and India, was turned into stamp seals and jewelry. However, for much of Iranian history, amber was not identified distinctly as a plant by-product but thought of as a subgroup of ambergris, because

120 *Drakht ī Āsūrīg*, §§12, 17, 35, 41.

121 *Drakht ī Āsūrīg*, §39.

122 *Drakht ī Āsūrīg*, §§65–66.

123 *Khusrō ud Rēdag*, §§69–93.

124 *Drakht ī Āsūrīg*, §42.

125 *Bundahishn*, §24.10–21. See also Mottahedin, “Anbar”; Choksy, “Annotated Index,” 233. Anklesaria (*Bundahishn*, 197) and Malandra (*Bundahishn*, 160), correctly identified the substance.

126 *Drakht ī Āsūrīg*, §56.

127 Sources cited in Morony, “Trade and Exchange,” 5–6.

the hardened resin was imported from the same western and eastern locales where the marine by-product also washed ashore after having been swept downstream to the coast.¹²⁸

METAL AND JEWELRY WORK

Iranians likely served as intermediaries in the trade of crucible Indian steel (*pōlāwad ī hindūg* / *pōlāwad ī hindīg*), manufactured in India and Ceylon, via cities such as Herat across the Caspian Sea to the Volga River and onward to Scandinavia. Military armor and weaponry were likely produced on an industrial scale from that imported steel, although little attestation of such survives.¹²⁹ The early-seventh century Middle Persian *Abar Wīzārishn ī Chatrang ud Nihishn Nēw-Ardakhshīr* “On the Explanation of Chess and Backgammon” mentioned the manufacture of coats of “seven-fold mail armor” (*zrēh ī haft-gardag*) and “swords produced of Indian steel” (*shamshēr ī pōlāwadēn ī wirāst hindūg*) in large numbers.¹³⁰ Helmets, “hats,” or other military headgear (*kulāf*) worn by troops were cited in the *Zand ī Wahman Yasn*.¹³¹ Interestingly, the *Zand ī Wahman Yasn* contains a very early Middle Persian reference to muskets (*bandūg*), attesting to the spread of gunpowder westward from China.¹³² Ostraca dating to the sixth century from the Varamin area, southeast of Ray, served as receipts for the distribution (*dād*) of spears (*frash, sel*).¹³³ Sasanian monumental sculpture has preserved the best example of military metalwork to buttress the textual data: The grotto at Taq-e Bostan contains a carving of *Shāhānshāh* “King of Kings”—Khusrō II (r. 590, 591–628)—mounted in full mail armor on an armor-protected horse while bearing a lance, shield, and sword.¹³⁴ Ceremonial military weapons have also survived from the Sasanian period—for example, sixth- to seventh-century swords whose hilts and scabbards were covered in gold and silver foil. Bronze helmets, sometimes adorned with silver, have been preserved as well.¹³⁵

Parthian and Middle Persian texts—for instance, the *Zand ī Wahman Yasn*—mention gold (*zarr*), silver (*asēm, sēm*), copper (*rōy*), iron (*āhan*), lead (*arzīz, srub*), clay (*gil*), salt (*namak*), emeralds (*uzumburđ*), and rubies (*yākand*, rather than the later term *la’l*). However, the extant written sources allude to royal workshops and official mints rather than preserve details about industrial-scale manufacture involving those precious materials.¹³⁶ One exception is a line in the *Abar Wīzārishn ī Chatrang ud Nihishn Nēw-Ardakhshīr* that mentions large numbers of “belts with seven jewels” (*kamar ī haft chashmag*);¹³⁷ such waistbands seem to have been part of imperial Sasanian regalia, as attested on official

128 Agostino and Thrope (*Bundahishn*, 122) continue the conflation of ambergris with amber in their translation.

129 Williams and Fry, “Metallurgical Sleuthing,” 4.

130 *Abar Wīzārishn*, §32.

131 *Zand ī Wahman Yasn*, §6.3.

132 *Zand ī Wahman Yasn*, §7.14.

133 Huyse, “Inscriptional Literature,” 103.

134 Fukai and Horiuchi, *Taq-i-Bustan*, pls. v, xxvii.

135 Harper, *Royal Hunter*, 83–84, 89.

136 Pigulevskaya, *Les villes de l’État iranien*, 160–68.

137 *Abar Wīzārishn*, §32.

rock-relief imagery, symbolizing that the monarchs' majesty extended to the then-known seven celestial bodies of the solar system and to the Pleiades or Seven Sisters stars.¹³⁸ Zoroastrian miners, possibly from Iran, even worked in central, eastern (Oman), and southern (Yemen) Arabia up to the ninth century to extract gold, silver, copper, and iron.¹³⁹ The extant ancient Iranian documents are again silent about mining and quarrying for metals, minerals, and gems and about processing those extracts for commercial uses. However, the archaeological data are quite rich on the deposits exploited, techniques and tools used, and processing methods employed during Parthian and Sasanian times.¹⁴⁰ Moreover, a Roman account, attributed to Cicero, indicated that Parthian mineworkers in royal mines of the first century BCE included branded slaves.¹⁴¹ Additionally, the *Mādayān ī Hazār Dādestān* suggests that watermills were utilized in the mining process.¹⁴²

Of course, the best-attested commercial products of metalwork are numerous silver vases, plates, bowls, rhytons, and other silver and gold vessels. The poorly known provenience of most of those objects, however, limits their value for the study of industrial processes—although inscriptions on them do record names and weights, and they bear embossed smith's marks. Royal hunting plates suggest state-supervised production. However, the Central Asian origins of many pieces, as indicated by the use of Sogdian and Khorazmian for the engravings, suggest that regional workshops existed and even copied the official ateliers. Overall, motifs suggest that precious-metal vessels, like base-metal ones, were turned out during all periods of the Sasanian Empire.¹⁴³

PETROCHEMICALS

Petrochemical collection, use, and distribution were part of the industrial framework of pre-Islamic and early Islamic Iran. The Phanom Surin shipwreck, at Samut Sakhon on the north-central shoreline of the Gulf of Thailand, included large transport pithoi, or *khumb*—so-called torpedo jars—also attested from production and distribution sites in southern Iran and Iraq. Still-viscous bitumen is present in the bases of several of that shipwreck's pithoi. One of the pithos sherds bears an engraving written in a late cursive Middle Persian, almost Book Pahlavi, script, which correlates well with seventh- to eighth-century radio-carbon dates from the wreck. The inscription was a quotidian label, essentially a bill of lading (*bār nāmag*), that records *40 tb QYR*, that is, *40 tab ghīr* "40 hot/viscous bitumen."¹⁴⁴

138 Fukai and Horiuchi, *Taq-i-Bustan*, pls. xxvii, l, lxiv, xc.

139 Morony, "Economic Boundaries," 184.

140 Cf. Hallier, "Fort, Atashgah und Chahar Taq"; Qorbani and Kani, "Mining in Iran"; Raschke, "New Studies," n747. One specific example is the Sasanian-period salt mine at Chehrabad in the northwestern province of Zanjan, where production occurred also in Achaemenid and Islamic times, on which see Aali et al., "Salt Men of Iran"; Stöllner, "Salzmänner von Zanjan." See also Meyers, "Technical Study," 146–52.

141 Cited by Perikhanian, "Iranian Society and Law," 635.

142 *Mādayān ī Hazār Dādestān*, §§105.11, 106.12–15.

143 Grabar (who also cites Abbasid-period textual sources that mention Sasanian vessels), "Introduction to the Art of Sasanian Silver," 32, 34–37; Harper, *Royal Hunter*, 24–27.

144 Details in Choksy and Nematollahi, "Middle Persian Inscription"; contra Guy, "Phanom Surin Shipwreck," 188; "Long Distance Arab Shipping," 1651, where Oktor Skjærvø's reading of the letters as a personal name is quoted.

Third- through ninth-century pithoi recovered at the inland capital city of Anuradhapura in Ceylon (Sri Lanka) appear to have contained bitumen (*ghīr*), left behind as a fine lining or sediment inside the jars, specifically from petrochemical seeps close to Susa. If they were sealed or waterproofed with a bitumen coating, pithoi could have held oils and perfumes for transportation and sale—and even potable (drinking) water for sailors (although leather was the lighter and thus preferred material for water bottles, as mentioned previously)—between Iran, the countries of South Asia and Southeast Asia, and mainland China. However, bitumen use was not limited to waterproofing the interior of liquid-bearing trade jars. As early as the fifth century BCE, Herodotus referred to the use of “asphalt [i.e., hot or viscous bitumen]” (Greek *asphaltos*) as a mortar during construction of the city walls of Babylon.¹⁴⁵ Due to its liquid-proofing, adhesive, and binding capabilities, use in embalming for preservation, and the belief that, despite its toxicity, it aided in maintaining and regaining health, bitumen was traded by weight in solid form and by volume in liquid (molten) form across the ancient and medieval Middle East and Asia. South Asia, Southeast Asia, and China do not have any substantial petrochemical deposits, so these areas would have to have imported bitumen for local use in construction, waterproofing, medicine, and the like. Examination of the pithoi from the Phanom Surin shipwreck clearly indicates that the jars were used to transport bitumen as a trade item, as evidenced by clumps of the petrochemical still present in the abandoned jars and reinforced by the absence of plant or animal products and by-products for personal or commercial uses (at other sites, the jars’ contents were used upon receipt, and only a lining residue of bitumen is preserved).¹⁴⁶ It is likely, therefore, that on an industrial scale the torpedo jars of Iranian origin shipped across Asia contained hot bitumen or viscous asphalt as a liquid trade commodity—exported from Iran and the Persian Gulf—for a range of applications, from use as adhesives and sealants during the construction of buildings, walls, boats, and containers to pavings, embalmings, curatives, and even weaponry. Byzantine use of naphtha, from sources east of the Black Sea, as an incendiary liquid weapon (“Greek fire”) is as an example of its martial application.¹⁴⁷ So essentially, the pithoi, bitumen, and Middle Persian label on one of the jars from Thailand serve as markers of late antique and early medieval maritime transport and trade in yet another essential and luxury commodity—petrochemicals.

COMMERCIAL SETTINGS

All manufacturers were expected to “request wages (*mīzd*) lawfully” (i.e., commensurate with their production), according to the *Mēnōg ī Khrad*.¹⁴⁸ Even an average worker could acquire modest wealth over several years of toil. A register of income and investments,

145 Herodotus, *Histories*, 1:179.

146 Komoot, *Maritime Connections*, broadly 157–94, 319–85, 394–96; specifically 333, 348, 366, 384–85 with further references. Plant materials were used as a binder for the bitumen in the jars.

147 On the transportation and use of liquid petrochemicals by the East Roman Empire, specifically the military deployment of naphtha in “Greek fire” sprayed from Byzantine naval vessels onto invading Arab ships starting in the mid-seventh century, see Haldon, Lacey, and Hewes, “‘Greek Fire’ Revisited.” The Byzantine petrochemicals came from seeps in the southern Ukrainian steppe and in the Caucasus and were transported across the Black Sea to Constantinople.

148 *Mēnōg ī Khrad*, §32.7.

recorded between the years 662 and 664 and listing the assets of a Zoroastrian carpenter who worked during late Sasanian and early Islamic times, has survived.¹⁴⁹ It was recorded by an accountant (*haftānbād*) as a “calculation based on a memoir of transactions according to the spoken words of Zādōy,” the carpenter employed by the builder Windād-Burzmihr, who appears to have been an entrepreneur of many ventures (as evidenced by his previously cited estate, Windādburzmihrābād) from the town of Karmar, possibly south of Qom.¹⁵⁰ The two-sided, four-part leather document bears a bulla as well—attesting to sealing as proof of validity. The assets listed included not only coinage of staters (*satēr*, *stēr*, often abbreviated as *s.*) and drachmas (*drahm*) but also linen (*karbās*), hemp stems, hemp fibers, and wheat, totaling 124 staters in value. In addition to acquiring some degree of wealth while alive, those who performed their jobs diligently and honestly were said to be accorded respect in heaven, for “the souls of (good)-artisans (*hu-tukhshāyān*), who while in the world served lords and masters, sat at a splendid place,” according to the vision described in the *Ardā Wirāz Nāmag*.¹⁵¹

The *Mādayān ī Hazār Dādestān*, compiled during the reign of Khusrō II by one Farokhmard ī Wahrām, who seems to have been a jurist, regarded profit (*abzōn*) and the rise of prices (*abzāy*) as necessary for commerce and industry to exist and flourish.¹⁵² This and other Parthian and Middle Persian texts suggest that Zoroastrianism, as the state religion, supported, legitimized, and even encouraged a market economy with profit-making. Thus Zoroastrian guidelines deemed profit acquired through industry as appropriate: “Even if his/her wealth is very great, even then it is proper.” But people who acquired wealth through production and distribution also were expected to assist others during lean times: “At that time when people are in need then he/she ought to make appropriate use of the capital and profit.” Due to the historically conservative nature of the text’s author, those two lines, although written in the *Pahlavi Rivāyat Accompanying the Dādestān ī Dēnīg* during the late ninth or early tenth century (i.e., under the Abbasid caliphs), summed up the earlier Parthian and Sasanian approach to industry and commerce.¹⁵³

Value or cost (*arz*) and market or local price (*arz ī shahr*) at the bazaar, determined in silver coins (*drahm*) and gold coins (*dēnār*), were basic to the success of industries. For instance, the *Drakht ī Āsūrīg* cataloged some comparative prices from the first century BCE: “Children buy dates and palm leaves for a mere two copper coins; but without ten silver coins one cannot buy a goat.”¹⁵⁴ The register of a carpenter’s income and investments yields the value of a peck of wheat as 0.6 *drahm* between the years 662 and 664.¹⁵⁵ The same document permits determining that 4 drachmas equaled 1 stater in value during the mid-seventh century. Moreover, the register demonstrates that accounting of commodities was kept as value in currency—for instance, hemp stems worth 1 stater plus

149 Weber, “Accountancy of a Zoroastrian Craftsman,” Berk. 231.

150 On the various designations and roles of accountants, see Tafazzoli, *Sasanian Society*, 31–33.

151 *Ardā Wirāz Nāmag*, §14.15.

152 *Mādayān ī Hazār Dādestān*, cf. §54.14.

153 *Pahlavi Rivāyat Accompanying the Dādestān ī Dēnīg*, §42.5.

154 *Drakht ī Āsūrīg*, §49; cf. the *Pahlavi Rivāyat Accompanying the Dādestān ī Dēnīg*, §§17.16–18.1.

155 Weber, “Accountancy of a Zoroastrian Craftsman,” Berk. 231B10–11.

1 drachma, and hemp fibers worth 5 staters.¹⁵⁶ Thus it is safe to conclude that the economy was monetized—yet another basic marker of an industrial society. Payment would be made using ingots (*bun*) of copper and other metals in addition to coins.¹⁵⁷ Bookkeeping by deputies (*gumārdag*) was required for transactions, as was subsequent reporting to managers.¹⁵⁸

Just like the currency that served as the medium of exchange, commercial and industrial transactions also were regulated by the state bureaucracy. Although written contracts were not absolutely necessary under Parthian and Sasanian law, they served as legal proof of obligations. The Parthian and Middle Persian languages had several terms for contracts, bonds, and agreements, including *pashn*, *pasht(ag)*, *pādikhshīr*, and *paymān*. The contractual document itself was called a *dib*, *nāmag*, *nibēg*, *nibishtag*, *wizīr*, or *frawardag*. Each document had an original (*mādag*, also *bun*), plus copies (*hampachēn*, *pachēn*). The cost of preparing contractual documents was regulated by the state.¹⁵⁹ Moreover, “a copy which [has been] written and sealed . . . should be deposited at the Office of the Registry,” according to the *Mādayān ī Hazār Dādestān*.¹⁶⁰ The most common transactional documents used in Parthian and Sasanian Iran were purchase or sales agreements (*khṛīdagīh*, also called *pad wahāg dād*, *pad wahāg frōkht*) and receipts (*nibisht*, *padīrāy*).¹⁶¹ The item for sale could be of any value. A transaction’s validity was not based on the type or price of the item but on the seller’s having a legal right to sell it. Proof of ownership for purposes of sale was possession of the item and a lawful title to it. But even a questionable or dubious title (*warōmand*) would often be considered valid or sound (*sahih*, *sahīg*, *wābarīg*) if the item itself was marketable.¹⁶²

According to the *Mādayān ī Hazār Dādestān*, industrialists worked in guilds (*pēshag*, a term that was also employed more broadly to refer to social classes, because they were occupation based).¹⁶³ Zoroastrian merchants shared lodging with traders of other faiths at caravansaries (*kārawān-sarāy*) during overland journeys, especially along the Royal and Silk Roads, as noted in questions about the appropriateness of that practice posed to the magi in the *Pahlavi Rivāyats* of Ādurfarrōbay and Farrōbaysrōsh.¹⁶⁴ They may also have shared the storehouses mentioned in the *Mādayān ī Hazār Dādestān*.¹⁶⁵ Camels often were the preferred beast of burden for long-distance overland trade. In one instance, a Zoroastrian merchant, writing in Pahlavi on papyrus during the second half of the seventh or first half of the eighth century while he was in Egypt, sought the assistance of his coinvestor (who was referred to as his brother) “so that camels could be hired” for transportation of

156 Weber, “Accountancy of a Zoroastrian Craftsman,” Berk. 231A.6–7.

157 Weber, “Pahlavi Documents,” Berk. 43B.5–8.

158 Weber, “Pahlavi Documents,” Berk. 43A.8.

159 Choksy, “Loan and Sales Contracts,” 193–94; Perikhanian, “Iranian Society and Law,” 670–76.

160 *Mādayān ī Hazār Dādestān*, §§6.13–17, 15.17–16.4, 30.8–9, 56.8–12, 65.9–11, 99.1–8. On witnesses’ seals, see Weber, “Pahlavi Documents,” Berk. 43C.12–13.

161 *Mādayān ī Hazār Dādestān*, §7.10. On receipts, see Weber, “Pahlavi Documents,” Berk. 43A.3; also Choksy, “Loan and Sales Contracts,” 199–200. On sales contracts on Pahlavi papyri, see Huyse, “Inscriptional Literature,” 105 with references.

162 *Mādayān ī Hazār Dādestān*, §§6.2–6, 12.15, 32.7, 93.12–13, 99.1, A16.6.

163 *Mādayān ī Hazār Dādestān*, §A.27.6.

164 *Pahlavi Rivāyats of Ādurfarrōbay and Farrōbaysrōsh*, supplement 1.1.

165 *Mādayān ī Hazār Dādestān*, §19.1–2.

trade goods, “because profit (*sūd*) is completely [available] here.”¹⁶⁶ Donkeys (*khar*) were used for hauling cargoes such as straw (*kāh*), alfalfa or lucerne (*aspast*), wheat, and barley over shorter yet multiday distances, often in donkey trains.¹⁶⁷ The movement of a “load [of unspecified goods] toward the Tigris [River],” probably from Dura Europos, during the mid-third century was commanded in a Middle Persian parchment letter.¹⁶⁸ While references were made in various texts to transit taxes and tolls, the amounts levied are unknown.¹⁶⁹ The technical term for commercial partnerships (*hambāyih*) was documented, however.

The construction of wooden boats (*makōg*) deployed in maritime transportation of commodities was cited in the *Drakht ī Āsūrīg*.¹⁷⁰ Those cargo vessels sailed from Persian Gulf ports such as Bokht-Ardashir (Bushehr), mentioned in the *Kār-Nāmag ī Ardakhshir ī Pāpakān* and connected by road to Kazarun and Shiraz, and Siraf, connected by road to Firozabad and Shiraz.¹⁷¹ Iranian merchants, mariners, and military officers also shipped goods on the Nile River and possibly the Mediterranean Sea and Red Sea, as documented in early seventh-century documents that listed rations of barley and wine being loaded.¹⁷² The traders and sailors on the sea and river routes came from different parts of Iran and its conquered territories and from different religious communities.¹⁷³

An additional detail should be noted as attesting to the established nature of industry in the Parthian and Sasanian empires: items would be tested for quality before being delivered or upon delivery. One document recorded the examination of woolen or cold-weather garments (*sard-pōsh*) prior to their acceptance.¹⁷⁴ Another record noted the rejection of goat meat (*buz-gōsht*) sent to the governor of a district south of Qom during the late seventh or early eighth century, because of its unusually dark-red color.¹⁷⁵

As examples cited in this essay indicate, the division of labor was ever present. Similarly, later Islamic-period records from the eighth through thirteenth centuries preserve central-government tax assessments for western provinces in Sasanian Iran during the sixth century—yet another indicator that a regularized system was in place that the state could rely on to stabilize markets and ensure continuity of production and trade to generate revenues even when economic, social, or political flux occurred.¹⁷⁶ The transformation of items such as fruit extracts into juices and balms and fibers into cloth denotes processes of value addition. Most importantly, the commercial items were not produced by cottage industries, which sustained individuals and families, but on large scales involving

166 Weber, “Pahlavi Papyrus from Islamic Times,” BM 1303/065541.

167 Weber, “Villages and Estates,” Berk. 80, 87.

168 Henning, “Aramaic and Iranian Documents,” Dura parchment 37v.1.

169 Frye, “Commerce,” 62.

170 *Drakht ī Āsūrīg*, §§4–5.

171 *Kār-Nāmag*, §6.7. More generally, see the discussions in Daryaei, “Bazaars, Merchants, and Trade,” 406; Potter, *Persian Gulf*, esp. 27–87.

172 Weber, *Ostraca, Papyri, und Pergamente*, P. 69; *Berliner Papyri, Pergamente, und Leinenfragmente*, P. 137 and P. 141; discussed in Harmatta, “Laisser-passes en Égypte.”

173 Choksy, “Sailors, Soldiers, Priests, and Merchants,” 380–83.

174 Weber, “Testing Food and Garment,” Berk. 77.

175 Weber, “Testing Food and Garment,” Berk. 149.

176 Christensen, *Decline of Iranshahr*, 34–39. On the role of state-introduced stability in markets during the Achaemenid period, see Kozuh, “Hand Anything but Hidden,” 92–95, 100.

organizational complexity. Ostraca from Old Nisa dating to between the second century BCE and second century CE indicate trade in quantities, such as 500 *ēphā* (ca. 17,500 liters) of commercial fat or oil (*charb*) and 110 *mari* (ca. 1,025 liters) of wine.¹⁷⁷ All these facets are standard indicators of an industrial society.

THE HISTORICAL RECORD

Why, by and large, have fewer records and references of commerce, industries, and industrialization been preserved in Parthian and Middle Persian texts as compared to those of other contemporaneous Middle Eastern societies and especially the subsequent Islamic period?

The limited nature of these still-extant texts in number, scope, and genre appears to be a primary reason. Many documents may have been destroyed, accidentally or deliberately, by the victors during the seventh-century Arab conquest. The shift of the official language to Arabic during the late seventh and early eighth centuries, followed by the adoption of the Arabic script for writing New Persian, would have further limited knowledge of the cumbersome Parthian and Middle Persian scripts and hence made the earlier records less useful. As the transmission and use of Parthian and Middle Persian declined, eventually becoming restricted to learned Zoroastrians within the Umayyad and Abbasid caliphates, those minority-faith authors deployed their written skills toward producing, recopying, and synopsizing theological, judicial, and religiohistorical materials relevant to their own Iranian religion. Older economic documents lost their bookkeeping value and would have been discarded and destroyed or perished naturally.¹⁷⁸ Often, only abridged references were made, such as that found in the *Dēnkard* mentioning the existence of codes or rules (without providing details) “about the types of shops in the market belonging to various artisans.”¹⁷⁹ Consequently, only a limited number of detailed records have survived to provide direct evidence of industry and industrialization from Parthian and Sasanian times.

Geographies, regional and local histories, and perhaps even industrial records that may have existed in the Parthian and Middle Persian languages likely found incorporation into revised, updated accounts in Arabic and New Persian that claimed to preserve regional memories. Infused with pride in their area’s history and driven by a desire to document the past, various medieval Muslim authors sought to convey the uniqueness and distinguishing features of their cities and surrounding regions in terms of their munificent rulers, learned residents, religious institutions, public spaces, long history (including that of the pre-Islamic period), and local industries.¹⁸⁰ A few examples serve to make this point. The geographers al-İṣṭakhrī (d. 957) and Ibn Ḥawqal (d. 978), who elaborated his predecessor’s work, described an active lead mine near Yazd.¹⁸¹ The regional historians of Yazd—namely, Jaʿfarī (writing in 1441) and al-Kātib (writing in 1458)—traced the valley’s cotton, corn,

177 Livshits and Pilipko, “Parthian Ostraca,” no. 18.

178 Partially suggested in Macuch, “Pahlavi Literature,” 118–19; Zeini, “Middle Persian Papyri, Ostraca and Parchments,” 3.

179 *Dēnkard*, §8.38.21.

180 Choksy, “Yazd,” 231–32 with references.

181 Al-İṣṭakhrī, *Kitāb al-masālik*, 77, 101, 112, 125; Ibn Ḥawqal, *Kitāb ṣūrat al-arḍ*, 196, 294, 295.

and silk-textile industries back to the Sasanian era.¹⁸² Similarly, when recounting the life, times, and missionary activity of Shaykh Abū Ishāq al-Kāzarūni (d. 1034), his biographer also mentioned the mining industry among Zoroastrians at Kazarun.¹⁸³ Thus those medieval texts preserved additional, often more detailed glimpses into industries that had commenced before the Arab conquest and subsequent Islamization of Iran. The later Arabic and Persian documents thus confirm and expand on available earlier documentation in Parthian and Middle Persian indicating a mixed industrial system of production and distribution on small or local and large or interregional scales.

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182 Al-Kātib, *Tārīkh-i jadīd-i Yazd*, 38; Ja'farī, *Tārīkh-i Yazd*, 26–29, 50. On the lead mine and the fabrics, see also Choksy, "Yazd," 234–35 and 228, respectively. For examples of Sasanian-era textiles, see Harper, *Royal Hunter*, 128–40.

183 Broadly in Uthmān, *Firdaus al-murshidiya*.

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4

From Wine and Oil to Flax and Cotton: Patterns of Change in the Agricultural Industries of Palestine in the Early Islamic Period

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INTRODUCTION

The history of industrial agricultural production in late antique Palestine has not been addressed to date in a comprehensive manner, despite numerous excavations that have revealed evidence for agricultural industries and many references to those industries in historical sources and administrative documents. More particularly, the process of change in agricultural industries between 500 and 1100 CE has been discussed in only a limited way. The abundant data on the developed wine and oil industries in the Byzantine period (fourth to seventh centuries) and the patchier evidence for the linen and cotton industries of the early Islamic period (eighth to eleventh centuries) provide the basis for the present discussion. The term “agricultural industries” used in this study refers to the massive growing of a single crop used in the industrial production of a widely used commodity consumed by local populations and in some cases exported to faraway destinations, thus forming a major component in the regional economy. This work focuses on the production of wine and oil in Palestine—major industries in the Byzantine period—and on the manufacture of textiles, mainly linen and cotton, in the early Islamic period.

A brief overview of the available data on the agricultural industries of the sixth century, in relation to those of the tenth century, presents significant differences in both crops and modes of production. Most distinguishable is the shift from the large-scale wine and oil industries that prevailed in the Byzantine period to new crops and industries, among them the growing of flax and cotton and the production of linen and cloth. It is agreed that the decline of the international wine trade in the seventh century affected the centers of wine production in Palestine and caused the abandonment of large agricultural estates. A gradual shift in agricultural industries began in the eighth century with intensive cultivation and production of new species, among them sugarcane and cotton. This profound change is expressed in the tenth-century description of the Palestinian countryside by Shams al-Dīn Abū ‘Abd Allāh Muḥammad al-Muqaddasī, which relates to the new crops, particularly along the coastal plain and in the Jordan Valley.¹

¹ Al-Muqaddasī, *Aḥsan al-taqāsīm*, 180–81.

What was the mechanism behind this change, and how were the new crops introduced into early Islamic Palestine? Was it the result of a preconceived decision of a central government? Or did the forces of the consumer market perhaps trigger the introduction of new crops and industries as a response to the declining international trade in the renowned Palestinian wine? Based on abundant archaeological evidence retrieved from excavations in Israel in the past four decades, with additional information from neighboring regions, it seems that this change entailed wider implications as to the overall view of shifting industries and commercial patterns in other regions of the Middle East, from Egypt to Iran. The accumulating data from excavations enable the establishment of regional and chronological sequences that provide a good basis for evaluating patterns of change in agricultural industries.

The large number of excavations conducted in the central and southern Palestinian coastal plain, particularly within the hinterlands of Ramla, Yavne, Ashkelon, and Gaza, provide the basis for the following observations on changes in agricultural industries between the sixth and tenth centuries. The data from southern Palestine are used as comparative material for the evaluation of other regions in the eastern Mediterranean—for example, the Lebanese coast and the northern Syrian massif. The change in the agricultural economy is particularly evident in and around Ramla, the new capital of Jund Filastin, where excavations have revealed many industrial installations that were probably part of the flax and linen industry. Excavations and surveys in the hinterland between Ramla and Yavne/Ashkelon provide further evidence for the introduction of new agricultural industries, primarily installations comprising multiple water-holding pools and channels.²

When gathering the archaeological data to support this argument, one faces a major methodological problem: the visibility of industrial sites. The infrastructures of the wine and oil industries, mainly large wine vats and oil presses, are highly visible in the archaeological record and have been extensively researched in the Levant. Hundreds of installations have been excavated and accurately dated, and the production process has been reconstructed in detail.³ The number of large wine vats excavated or surveyed in Israel/Palestine alone is estimated at about 1,450 installations, including several large complexes; the number of large oil presses has been determined to be 1,024.⁴ In sharp contrast, the flax, linen, and cotton industries are hardly visible in the archaeological record. The evidence of industrial installations related to the production of the raw material for textiles is minimal and includes mainly shallow pools that were used for the production of linen, which requires large amounts of water.⁵ The lack of substantial archaeological evidence

2 For Ramla, see Avni, “Ramla 1990–2018.” For large-scale excavations of industrial estates in the southern coastal plain, particularly around Yavne and Ashkelon, see respectively Seligman, Haddad, and Nadav-Ziv, “Yavne,” and Israel and Erickson Gini, “Remains at the ‘Third Mile Estate,’ Ashqelon.”

3 For the main comprehensive summaries on the wine and oil production, see Ayalon, Frankel and Kloner, *Oil and Wine Presses*; Frankel, “Presses for Oil and Wine”; *Wine and Oil Production*, 76–14; Waliszewski, *Elaion*. For the wine presses and wine industries, see Kingsley, “Economic Impact,” 43–48; for an updated view of northern Syria, see Zerbini, “Landscapes of Production.”

4 Waliszewski, *Elaion*, 289. This estimate is based on 2010 data; since then, the count has risen to approximately 1,100 presses.

5 See Wild, “Textile Production,” for the manufacturing process; and for descriptions of these installations, see Gorzalczy, “History and Urban Planning” (at Ramla); Safrai and Lin, “Economic Structure” (at Tell Abu Shusheh); Tal and Taxel, *Ramla (South)* (at Ramla).

has resulted in neglect of comprehensive discussions on the role of textile industries in the Byzantine and early Islamic periods, thus leading to tentative assumptions and sometimes conclusions that the flax-growing and linen industries declined following the Byzantine period. As presented below, a new evaluation of the archaeological findings calls for these conclusions to be revised.

WINE AND OIL IN BYZANTINE AND EARLY ISLAMIC PALESTINE

WINE PRODUCTION

In reviewing the archaeological and textual data, it is agreed that large-scale wine and oil industries formed the main economic basis of Palestine between the fourth and seventh centuries and that, together with wheat, wine and oil were the major ingredients of the Mediterranean diet. Particularly notable were the wineries of Gaza and Ashkelon, which met the needs of the local populations and provided a large surplus that was exported to faraway destinations in the Mediterranean.⁶ The impact of Palestinian wine production was reflected in the large quantities of late Roman amphoras found in the coastal cities of the western and central Mediterranean.⁷ This lively industrial and commercial network faced a sharp decline in the later sixth or early seventh century, following the Persian raids and the Arab conquest that terminated the export of Palestinian wine to the West.⁸

The production of wine in Palestine was connected to a vast network of agricultural villages and farmsteads, which contained extensive systems of industrial wine vats. Many of these systems have been studied in recent decades through excavations and regional surveys.⁹ The exceptionally large size of some farmsteads indicates that they were used as industrial complexes for the production of large volumes of wine exceeding the needs of the local populations and thus intended for export.¹⁰ The expansion of the industrial production of wine in the Byzantine period included the desert-fringe areas, such as the large villages on the Negev highlands, particularly Shivta, Ruheibeh, and Avdat, which included industrial wine vats in their vicinities and an extensive network of agricultural fields.¹¹

Wine vats constitute one of the most common finds in the agricultural landscapes of Byzantine Palestine. Archaeological surveys have identified about 600 large industrial vats that were related to villages and farmsteads from the late Roman and Byzantine periods.¹²

6 Avni, Bar-Oz, and Gambash, "Sweet Gifts of Bacchus"; Decker, *Tilling the Hateful Earth* and "End of the Holy Land Wine Trade"; Fuks, Avni, and Bar-Oz, "Debate on Negev Viticulture"; Kingsley and Decker, *Economy and Exchange*; Mayerson, "Wine and Vineyards"; contra Seligman, "Central Negev Settlements."

7 Decker, "End of the Holy Land Wine Trade," 107–11; Kizhner et al., "Distribution Patterns"; McCormick, "Movements and Markets"; Pieri, "Regional and Interregional Exchanges."

8 Avni, Bar-Oz, and Gambash, "Sweet Gifts of Bacchus"; Decker, "End of the Holy Land Wine Trade"; Pieri, "Regional and Interregional Exchanges"; Seligman, "Central Negev Settlements."

9 For comprehensive summaries, see Decker, *Tilling the Hateful Earth*; Hirschfeld, "Farms and Villages."

10 Huster, *Ashkelon 5*; Israel and Erickson-Ginni, "Remains"; Waliszewski, *Elaion*, 302–20.

11 Avni, Porat, and Avni, "Byzantine–Early Islamic Agricultural Systems"; Rubin, *Negev as Settled Land*.

12 See the basic studies of Decker, *Tilling the Hateful Earth*, and Kingsley, "Economic Impact"; the comprehensive survey by Avrutis, *Wine Presses*, which tallies 550 industrial vats in addition to 3,400 domestic installations (these numbers, needless to say, represent only a fraction of the total number of wine vats); and Seligman, Haddad, and Nadav-Ziv, "Yavne," for data from large industrial estates in Yavne.

Regional surveys in the hinterland of Jerusalem, in Samaria, and in the Judaeian lowlands have revealed a large number of wine vats both within and outside the settlements.¹³ For example, a large-scale rescue excavation southeast of Lod-Diospolis exposed a medium-sized village that was surrounded by an extensive network of wine vats, among them four very large industrial vats that functioned throughout the Byzantine period.¹⁴ Perhaps the most impressive evidence for large-scale industrial wine production in Palestine was found at Yavne, where continuous rescue excavations conducted since 2020 have revealed a huge industrial estate containing an outlying industrial complex with eight large wine vats, kilns for storage jar production, and spacious buildings for the storage of wine awaiting delivery to the sea ports of Ashkelon and Gaza.¹⁵

That wine production was a main component in the local economy is evident also from numerous artistic representations of vines in the mosaic floors of Byzantine churches throughout Palestine and Jordan. Among the depictions are the pressing of grapes in vats and the transportation of wine jars on camels and donkeys.¹⁶ In addition, textual sources and historical descriptions praise Palestinian wine, especially the wine produced in southern Palestine around Ashkelon and Gaza. And indeed, one of the largest concentrations of villages and farmsteads with large industrial wine vats was found in the hinterland of these two cities, whose wines were internationally famed and exported to numerous destinations around the Mediterranean.¹⁷ The pattern of production in southern Palestine provides one of the best examples of an extensive agricultural and industrial infrastructure designed for the mass production of wine to be exported outside the region. The closest comparisons for this system in the Mediterranean are in North Africa and northern Syria.¹⁸

A comprehensive survey of the Ashkelon hinterland revealed about thirty-six industrial wine vats that functioned between the fifth and seventh centuries, thus reflecting the large-scale production of wine in this area.¹⁹ Many pottery kilns were located adjacent to these industrial complexes; they were used to produce typical Gazan amphorae, which contained the wine exported by sea to destinations in the central and western Mediterranean. Archaeological excavations at several agricultural estates have shown that some of them were abandoned during the seventh century and, following a short gap, were resettled in the early Islamic period, but with no evidence for massive wine production. For example, the excavations at the “Third Mile Estate” northeast of modern Ashkelon, which proved to be one of the largest industrial estates in Byzantine Palestine, exposed a network of large wine vats, oil presses, and storage buildings. This large agricultural-industrial

13 See Dagan, *Ramat Bet Shemesh*, for the Judaeian lowlands; Dar and Appelbaum, *Landscape and Pattern*, 153, for Samaria; Seligman, “Rural Hinterland,” 380–84, for the Jerusalem area.

14 Avrutis, *Wine Presses*.

15 For a preliminary report on this complex, see Seligman, Haddad, and Nadav-Ziv, “Yavne.”

16 Cohen, “Church and Mosaic Floor”; Dounceel-Voûte, *Pavements des églises*, fig. 23; McCormick, “Movements and Markets,” 70–72 with references.

17 Decker, “End of the Holy Land Wine Trade”; Mayerson, “Wine and Vineyards”; McCormick, “Movements and Markets.”

18 For North Africa, see Barker and Mattingly, *Farming the Desert*; Hobson, *North African Boom*, 63–99. For northern Syria, see the basic work of Tate, *Campagnes de la Syrie*, and Tchalenko, *Villages antiques*; for an updated summary, see Wickham, *Framing the Early Middle Ages*, 442–50.

19 Huster, *Ashkelon 5*, 42–51.

complex was established in the third century CE and flourished through the Byzantine period, only to be abandoned in the early seventh century. It included two exceptionally large wine vats, one large oil press, five pottery kilns to produce storage jars, and an extensive system of warehouses to store wine and oil in the process of production.²⁰ It seems this estate represented a number of similar farmsteads that produced huge amounts of wine and oil, both for local consumption and for export.

This extensive system of wine industry in southern and central Palestine was dramatically reduced in the late sixth and early seventh centuries. The combined effects of the decline of markets in the West, perhaps as an outcome of the Justinianic plague and the emergence of a new political order in the Middle East, dealt a fatal blow to the flourishing Palestinian wine industry of the Byzantine period.²¹ The main indication for this decline is the dramatic reduction in the number of Palestinian storage jars (mainly the Late Roman Type 4) in the markets of the central and western Mediterranean.²²

Several excavations in large villages of the coastal plain and northern Negev offer detailed insight on this process of change at the local level. A large Byzantine–early Islamic village excavated in Sderot, east of Gaza, showed a distinguishable change between the sixth and ninth centuries.²³ In its Byzantine-period phase, it contained at least one industrial wine vat and evidence for adjacent pottery production. The village was abandoned in the late sixth century and then resettled in the mid-eighth century, but with no evidence for continuity of the wine industry. The early Islamic settlement was inhabited until the eleventh century, when it was again abandoned, not to be settled again.

Another indication for the chronology of change in agricultural industries was revealed in excavations at Khirbat Khatra, in the central coastal plain between Ramla and Ashkelon. The stratigraphic and chronological sequences indicated its shift from a pottery-production site, probably connected with the wine industries of the fifth and sixth centuries, to an industrial site that involved a massive installation of shallow water pools and channels that were perhaps related to the linen industries of the early Islamic period.²⁴

Yet it should be noted that the production of wine in Palestine and Jordan did not terminate completely with the Arab conquest. Evidence for the continuation of wine production has been found in Christian monasteries that also functioned in the early Islamic period in the Judean hills and lowlands,²⁵ in central Jordan, and in southern Syria.²⁶ The production of wine in the early Islamic period was noted at Islamic sites as well—for

20 Israel and Erickson-Ginni, “Remains.”

21 Avni, Bar-Oz, and Gambash, “Sweet Gifts of Bacchus”; Decker, “End of the Holy Land Wine Trade,” 110–13.

22 Kingsley, “Economic Impact” and *Shipwreck Archaeology*; Kizhner et al., “Distribution Patterns”; Pieri, “Regional and Interregional Exchanges.” The results of the Negev Byzantine Bio-Archaeology Research Program indicate that the decline in wine production occurred already in the second half of the sixth century; see Bar-Oz et al., “Ancient Trash Mounds.”

23 Varga and Kobrin, “Settlement.”

24 The excavations at this site were conducted in 2017–18. I thank Alla Nagorsky, who headed the excavations, for allowing me to mention this hitherto-unpublished information.

25 E.g., in the Judean lowlands, see Taxel, *Kirbet es-Suyyagh*; in the central hills, see Magen, “Oil Production.”

26 Decker, “End of the Holy Land Wine Trade,” 113; Schick, *Christian Communities*, 261, 280, 286.

example, at Khirbat al-Mafjar, the caliphal palace complex near Jericho, where an elaborate industrial wine vat was discovered.²⁷ It seems that these wines were consumed mostly by the local population, with some surplus exported to Egypt. In any case, the intensive growing of vines continued throughout the early Islamic period. In the tenth century, al-Muqaddasī lists grapes as an important crop in several villages and districts of Palestine, particularly in the Galilee and the Hebron area. He also mentions the export of raisins to Egypt.²⁸

OIL PRODUCTION

The systematic documentation of hundreds of oil presses enables the reconstruction of their typological, technological, and chronological characteristics. The late Roman and Byzantine periods mark a peak in the distribution of oil presses in the Levant. Most of the installations were based on two technologies—the beam-and-weights press, used from the Iron Age and popular in the Hellenistic period, and the screw press, which was introduced into the region in the early Byzantine period.²⁹ The continuity in use of oil presses in the early Islamic period was indicated in numerous excavations.³⁰ The exceptionally large number of oil presses in rural areas of Palestine and Jordan was emphasized by several regional studies; the Ramat Beth Shemesh Regional Project, for example, included a meticulous survey followed by excavations over an area of 35 km² south of Beth Shemesh. More than forty industrial oil presses were revealed in this region, in addition to more than 100 small domestic installations.³¹ A survey of the Golan Heights revealed about 100 oil presses, one press per approximately 6 ha of built area—a ratio showing that each press could produce a large surplus for export out of the region.³² Detailed research on the average production of oil presses in relation to the local population was conducted in the village of Sheem in Lebanon.³³ It concluded that the production of the oil presses in the village was about twice the consumption needs of the local population of about 2,000 inhabitants. It seems that the surplus oil produced in Palestine was exported to faraway regions, such as Pelusium in northern Sinai.³⁴ Similar mass production of oil for export is evidenced in Roman North Africa, where calculations of olive-oil production and consumption indicate that the production of olive oil for export was one of the main sources of income for the local rural population.³⁵

27 Whitcomb and Taha, “Khirbet al-Mafjar.”

28 Al-Muqaddasī, *Aḥsan al-taqāsīm* 162, 172. See also Avni, “Between Ramla and Fustāṭ,” for an updated discussion on the commercial contacts between Palestine and Egypt.

29 For comprehensive summaries, see Frankel, “Presses for Oil and Wine” and *Wine and Oil Production*; Ayalon, Frankel and Kloner, *Oil and Wine Presses*; Seligman, “Rural Hinterland”; Waliszewski, *Elaion*.

30 Magen, “Oil Production”; Taxel, “Olive Oil Economy.”

31 Dagan, *Ramat Bet Shemesh*, 53–78.

32 Ben-David, “Oil Presses and Oil Production.”

33 Waliszewski, *Elaion*.

34 Gagos, Burns, and MacKay, “Oil for Pelousion.”

35 Mattingly, “Oil for Export?” and “Olive Boom.”

In contrast to its effect on wine production, the transition from Byzantine to Islamic rule in Palestine and Jordan had no effect on the volume of olive-oil production. The production of oil, both for local consumption and for export, even increased in early Islamic times. The use of industrial olive presses in many villages and countryside monasteries continued well into the eighth and ninth centuries.³⁶ New olive plantations were installed—for example, at Humayma in southern Jordan, where the Abbasid settlers planted an olive grove of about 500 trees.³⁷ The transportation of oil is reflected in an extensive repertoire of stamped amphora handles bearing the Arabic inscriptions “from Deir Samwil” and “The (or my) best production” found in several early Islamic sites in Palestine.³⁸ These stamps are common in the main settlements around Jerusalem and along the coastal plain, particularly in Ramla. They were produced in Nabi Samuel, northwest of Jerusalem, where a large pottery-production center was excavated.³⁹ It seems that the stamped jars were used for storing olive oil, which was distributed for sale in local markets and also exported to faraway destinations.⁴⁰ The export of Palestinian oil to Egypt is mentioned in an early Islamic papyrus from there.⁴¹ Evidence of export to central Arabia is found in early Islamic texts, which mention the transportation of oil from Palestine to al-Madīna by caravans of camels.⁴² This industry continued throughout the early Islamic period and up to the eleventh century. Nasir i-Khusraw, who visited Palestine in 1047, mentions the wealth of the Palestinian oil industries.⁴³

DEVELOPMENT OF THE FLAX AND COTTON INDUSTRIES

In sharp contrast to the extensive evidence of wine and oil production, with many industrial installations excavated and well dated, the archaeological findings relating to the flax and cotton industries are meager because of their “low visibility” in the archaeological record. The production of linen involves the soaking of fibers and seeds for several days, either in running water in streams and rivers or in artificial, plastered pools. The existence of an extensive network of plastered pools requiring a permanent water supply may indicate the presence of a linen industry.

Flax (*Linum usitatissimum*) was widely cultivated in Roman and Byzantine times, and its seeds and fibers were used to produce both oil and a variety of linen clothing. Given the large-scale production of olive oil in Byzantine Palestine, flax was used there mainly to produce linen fibers rather than flaxseed oil. In many regions around the Mediterranean, flax was sown in autumn following the first rains, while in Egypt it was grown as a summer crop and sown at the end of winter or in early spring. The production of linen from flax was complicated and required large amounts of water. It included removing the flax

36 Magen, “Oil Production”; Taxel, “Olive Oil Economy.”

37 Foote, “From Residence to Revolutionary Headquarters,” 464.

38 Amitai Preiss, “Arabic Inscribed Pottery”; Sharon, *Corpus Inscriptionum*, 123; Torge, “Ramla.”

39 Magen, “Oil Production,” 331–34.

40 Sijpesteijn, “Making the Private Public”; Gascoigne and Gilian, “Nebi Samwil-Type Jars.”

41 Sijpesteijn, “Making the Private Public”; and see the discussion below.

42 Gil, *History of Palestine*, 345.

43 Gil, *History of Palestine*, 236–37.

seeds by combing, and soaking the seeds and fibers in water for several days in open pools to separate the fibers from the peel of the stalk. This stage produced bad odors (as did other industrial processes, such as tanning, which involved soaking leather in open-air pools) and was followed by the drying process, in which the fibers and seeds were laid on special platforms to be sun dried for a few days or, in some cases, were dried in ovens. Next was the hacking process, in which the fibers were freed from the woody portion of the plants. The end product, the raw material for linen cloth production, amounted to only 10–15 percent of the original harvested flax plant.⁴⁴

The industrial production of flax and linen was a well-known component in the economy of Palestine from the third and fourth centuries CE. The *Codex Theodosianus* mentions specifically the linen workers of Scythopolis-Beth She'an, who were employed in government workshops,⁴⁵ and the price edict of Diocletian (301 CE) ranks the linen of Scythopolis at the top of the list of linen commodities. The *Expositio totius mundi et gentium* of the fourth century mentions several cities in Palestine and Lebanon that were renowned for their linen industries: "The following are famous for linen clothes: Scythopolis, Laodicea, Byblos, Tyre and Berytus, which export linen to the whole world and excel in the richness of all these productions; likewise Sarpeta, Caesarea and Neapolis, as well as Lydda, export high-quality purple."⁴⁶ In addition, local rabbinic sources praise the flax and linen of northern Palestine.⁴⁷ This industry was probably connected with the rising flax industry in Egypt, the cloth of which, though of lower quality than that of Palestine, was one of the main products of the Egyptian economy in late Roman and Byzantine times.⁴⁸

The production of cotton (*gossypium arboretum*, *gossypium herbaceum*) is less complicated than that of linen and does not require large amounts of water except in the growing phase, which is usually undertaken in hot surroundings and needs abundant water. Following the collection of cotton from the fields, production includes removing the seeds and combing the fibers of the cotton plant for spinning.⁴⁹ In the period under discussion here, the fibers were spun to make thread, which was woven into cloth, sometimes combining threads of silk, linen, and wool. Other uses of cotton were as stuffing for quilts, pillows, and mattresses, as well as in making paper, which from the late eighth century became the principal writing material in the Islamic world.⁵⁰

The cradle of ancient cotton cultivation was the Indian subcontinent in the second millennium BCE. It gradually diffused to other regions in Southeast Asia, China, the Middle East, Africa, and Europe.⁵¹ Indian cottons were imported to Egypt from the first century, and the growing of cotton spread in Ethiopia and Arabia in the first centuries of the

44 Safrai and Lin, "Economic Structure," 132–35; Wild, "Textile Production," 467–68; see also Bulliet, *Cotton, Climate and Camels*, 11.

45 Mommsen and Meyer, *Codex Theodosianus*, 10.20.8; Rosenfeld, "Linen Production and Trade"; Sperber, "Objects of Trade," 134.

46 Rougé, *Expositio totius mundi*, 31.

47 Rosenfeld, "Linen Production and Trade," 102–3; Sperber, "Objects of Trade," 135.

48 Mayerson, "Role of Flax."

49 Bulliet, *Camels, Climate and Cotton*, 11; Watson, *Agricultural Innovation*, 31–35.

50 Bloom, *Paper before Print*; Shatzmiller, "Adoption of Paper."

51 Mazzaoui, *Italian Cotton Industry*, 3–31.

Common Era. Cotton products, probably locally grown, have been found in Qasr Ibrim and other Byzantine-period monasteries in Upper Egypt,⁵² yet it seems that cotton was not grown in Egypt in pre-Islamic times. Hebrew sources of the late Roman and Byzantine periods mention the growing of cotton in Palestine, particularly around the Sea of Galilee and in the Jordan Valley, yet cotton was not a major item in the local agrarian economy, and it remained a marginal crop until the early Islamic period.⁵³

A major “cotton boom” identified in the eastern parts of the Islamic world, particularly in Iran and Mesopotamia, is dated to the eighth and ninth centuries.⁵⁴ It seems that it originated in Sinjiang and the Turpan basin in western China, where *gossypium herbaceum* was largely cultivated in the time of the Tang dynasty and gradually penetrated westward to Iran and the Mesopotamian plains, spreading later to Egypt and Palestine and eventually to southern Europe and North Africa.⁵⁵ Several historical sources mention the growing of cotton in early Islamic Palestine,⁵⁶ and there is no doubt that it was part of a much larger economic industrial change that affected many regions of the Islamic world. Cotton became the major economic product of the agrarian economy of early Islamic Iran⁵⁷ and was widely reflected in the agricultural manuals of the tenth century.⁵⁸ The prosperity created by the new industry was most visible in the steppe regions of the Middle East, where large areas were dedicated to growing cotton—an endeavor that involved the introduction of new irrigation technologies, such as qanats.⁵⁹ The impact of this cotton boom and its products was expressed in the division of labor in the Islamic world, with a large number of professions related to cotton and textile industries and to commerce.⁶⁰

Although the archaeological “visibility” of both flax and cotton is minimal, the installations associated with linen production, mainly the plastered water containers and channels, have been identified at a few sites in Palestine. One site that has revealed an extensive system of water-holding installations, interpreted as part of the flax and linen industry, is Abu Shusheh–Geva in the Jezreel Valley.⁶¹ A section of this large village, inhabited between the Hellenistic and early Islamic periods, contained many water channels leading to shallow plastered pools. The water for the installations was supplied by diverting rainwater from nearby slopes and from numerous water cisterns at the site. The channels and pools were constructed along the slope in such a way as to allow surplus water to overflow from the upper installations to the lower ones.⁶² One section of the industrial area included all components of the linen-production process: in addition to the plastered pools and water channels, it contained crushing stones, similar to those found in oil presses, which

52 Watson, *Agricultural Innovation*, 34 with references.

53 Amar, “Revolution in Textiles,” 40–41.

54 Bulliet, *Cotton, Climate and Camels*; Watson, *Agricultural Innovation*, 39–40.

55 Mazzoui, *Italian Cotton Industry*.

56 E.g., al-Muqaddasī, *Aḥsan al-taqāsīm*, 176–77.

57 Bulliet, *Cotton, Climate and Camels*.

58 E.g., in Ibn Wahshiya and others; see Watson, *Agricultural Innovation*, 40.

59 Avni, “Early Islamic Farmsteads”; Bulliet, *Cotton, Climate and Camels*.

60 Shatzmiller, *Labour*, 118–31.

61 Mazar, *Geva*.

62 Safrai and Lin, “Economic Structure.”

were probably used to press the seeds and dry them of water; platforms on which the wet seeds and fibers were laid to dry in the sun; and an oven used for the final drying of flax seeds and fibers. A large building nearby was designed to store the final product before it was shipped to workhouses, where the linen textile was manufactured. It is interesting to note that alongside these installations, the village also had wine and oil presses, indicating that the local economy was based on a combination of several agricultural industries.

The village of Abu Shusheh flourished in Roman and Byzantine times and continued to function well into the early Islamic period. Yet its later chronology is obscure because of the unclear methodology of the excavations there and the fact that the published finds were not correlated to a solid stratigraphic sequence.⁶³

The existence of similar installations in other rural or urban settlements of the Byzantine period has not yet been clarified, and it seems that either the production of flax was restricted to certain regions and sites in northern Palestine or archaeologists could not identify the nature of production at similar industrial sites. Nevertheless, recent research in the Byzantine village of Umm al-Qanatir in the Golan Heights has revealed an industrial area near a spring that contained similar plastered pools and has been interpreted as a flax- and linen-production site.⁶⁴

RAMLA AS AN INDUSTRIAL CENTER OF FLAX AND COTTON PRODUCTION

The most conclusive archaeological evidence regarding new industries that involved the use of water in plastered pools comes from early Islamic Ramla. The foundation of this commercial and industrial hub in circa 715 CE set the tone for a new concept of urbanism in Palestine. Whereas other cities in Palestine and Jordan were based on Hellenistic and Roman prototypes, early Islamic Ramla was founded *ex nihilo* in an area surrounded by villages and farmsteads that formed the hinterland of Byzantine Diospolis (Lod/Ludd). The new city developed around its main congregational mosque, the “White Mosque,” and the urban street pattern was oriented according to the layout of the mosque and its surroundings. Historical sources mention two other large buildings near the White Mosque: the *Dār al-Imāra*, a palatial complex that formed the residence of the local ruler and the city’s administrative center, and the *Dār al-Ṣabbāghīn* (“House of the Dyers”), an enigmatic public building, known only from historical sources, that reflected the main industry developed in early Islamic Ramla—the manufacture and dyeing of textiles.⁶⁵

Unlike other historical cities, in which the ancient remains are visible in their present-day layout, the physical evidence of early Islamic Ramla seems to have vanished into thin air except for two standing monuments: the White Mosque and the “Arches Pool,” a large, public water cistern. Other remains of this large city are invisible, hidden under the buildings of the modern town.

63 In the preliminary report, Safrai claims that the flax industry declined in the sixth century and was replaced by an oil press, yet the published finds from the excavations include a significant number of early Islamic oil lamps.

64 Ben-David, Gonen, and Drey, “Umm el-Qanatir”; Ben-David and Zingboym, “Umm el-Qanatir, Area A.”

65 Luz, “Construction of an Islamic City,” 43–45 with references.

In response to accelerated development in modern Ramla in the past forty years, around 400 rescue excavations were conducted throughout and around the modern town. Yet the main problem in excavating Ramla is the poor state of preservation of its architectural remains. As a result of massive looting of stones, only the foundation trenches of walls indicate the layout of ancient buildings. Nevertheless, extensive excavations have revealed fragmentary remains of the hitherto-invisible ancient Ramla, providing substantial archaeological data for the reconstruction of its topographical layout and chronological sequence. Major excavations conducted north and west of the Old City and around the White Mosque, and others at the southern and western outskirts of the modern town, have delimited the area of the early Islamic city. Especially notable were several large excavations south of Ramla that revealed evidence of an outer residential and industrial quarter.⁶⁶

The main feature exposed in the excavations was an exceptionally large number of industrial installations and water cisterns. They were better preserved than other features, as they were dug into the ground, paved with stones, and coated with plaster. The numerous industrial installations incorporated within the residential quarters of the city suggest massive industrial activity there. The remains included many plastered pools, some of them preserving traces of red paint, together with numerous water cisterns and clay pipes. These complexes point to industries involving large amounts of liquids, and it has been suggested that they were associated with the dyeing of linen and the production of textile fibers.⁶⁷ The nature and large extent of these plastered water containers, which were interconnected by channels, show that the main industrial activity in the city entailed soaking materials in water, as in the process of linen production from flax. Although the nature of these installations and their use were not entirely clarified, it seems more than reasonable to assume they were connected with this industry. Another aspect of the vast industrial activities reflected in the archaeological finds in Ramla is that together they provide an excellent example of urban change—from the strict separation between residential and industrial zones in the Roman and Byzantine periods to the crowded surroundings of the early Islamic city, which witnessed a massive penetration of commercial and industrial zones into residential quarters.⁶⁸

The early Islamic textile industries of Ramla may be a direct continuation of the well-known industries of Lod-Diospolis in the Byzantine period,⁶⁹ industries that were famous both locally and outside Palestine. The role of Ramla in the textile industry in later times also, during the tenth and eleventh centuries, is suggested by several textual sources. Al-Muqaddasī mentioned the city as a regional center of textile and cloth production,⁷⁰ and Mujīr al-Dīn described a special section in the markets of Ramla that was dedicated to

66 For recent summaries on early Islamic Ramla, see Avni, *Byzantine–Islamic Transition*, 159–90; “Ramla 1990–2018”; Gorzalczy, “History and Urban Planning”; Shmueli and Goldfus, “Early Islamic City of Ramla.”

67 Tal and Taxel, *Ramla (South)*, 123–24.

68 Avni, *Byzantine–Islamic Transition*, 98–106; Kennedy, “From Polis to Madina.”

69 Schwartz, *Lod*, 271.

70 Al-Muqaddasī, *Aḥsan al-taqāsīm*, 181; Amar, “Revolution in Textiles,” 41 with references; Gat, “Thriving Muslim City,” for a summary of the industries in Ramla.

flax, linen, and cotton producers. A Cairo Geniza letter mentions the production in Ramla of colored silk clothes and a Damascus-style robe.⁷¹

Ramla's central position in the manufacture and trade of linen and cotton products is also reflected in its close contacts with Egypt and the fact that many artifacts of Egyptian origin have been found in Ramla. For example, the pottery assemblages include, besides the common household types (mainly bowls, cups, cooking vessels, jugs, storage jars, and oil lamps)⁷² also a variety of Egyptian types.⁷³ In addition, the discovery of the epitaph of an Egyptian cloth merchant entombed in Ramla on July 18, 918,⁷⁴ provides further evidence of the central position of the textile industries, as well as of Ramla's commercial connections with Egypt. Another indication of the local commercial prosperity is the Ramla mint, probably established shortly after the foundation of the city, which was the largest in the country. Coins with the mint mark *Ramla Filastīn* were widely circulated in Palestine and neighboring regions.⁷⁵ Ramla's position as a commercial center is attested by a unique hoard of gold—376 coins of wide geographical origin, from the Maghreb to Iran (but none from the local mint in Ramla). The coins, minted between 761 and 979, were probably the property of a local money changer.⁷⁶

Apart from Ramla, flax was widely distributed in other locations in Palestine—for example, along the coastal plain. It seems that the intensification of textile production as a major economic pursuit in Palestine was connected with the industrial boom of flax and textile production in Egypt during the ninth and tenth centuries.⁷⁷ Several sources mention the export of textiles from towns in Palestine, among them Ashkelon, Ramla, Jerusalem, and Qedes in the northern Galilee.⁷⁸

TEXTILE FINDS IN BYZANTINE AND EARLY ISLAMIC PALESTINE

The increased production and consumption of textiles in early Islamic Palestine is reflected in the considerable number of textiles found in excavations compared to the number found from the Byzantine period. It should be noted, though, that despite the extensive archaeological work of the past decades, textiles have been found mainly in the steppe and desert regions of the Negev and in the Rift Valley (Jordan Valley and the 'Araba), where the dry climate enabled their preservation. Excavations in cities and villages in the Mediterranean region, on the other hand, have yielded only sporadic finds.⁷⁹ Textile fragments from the Byzantine period have been found in the Judean Desert, the Beersheba area, and the

71 Goitein, *Mediterranean Society*, 417.

72 Cytryn-Silverman, "Ceramic Evidence"; Tal and Taxel, *Ramla (South)*.

73 E.g., Torge, "Ramla." For an updated summary, see Avni, "Between Ramla and Fustāt."

74 Gorzalczany, "Ramla."

75 Gat, "Thriving Muslim City," 59–60.

76 Levy and Mitchel, "Hoard of Gold Dinars."

77 Frantz-Murphy, "New Interpretation"; Gil, "Flax Trade"; Udovitch, "International Trade."

78 Amar, "Revolution in Textiles," 55 with references.

79 See Shamir, "Byzantine and Early Islamic Textiles"; Amar, "Revolution in Textiles," for summaries of textile finds in the Roman through medieval periods.

Negev highlands. Other fragments have been discovered in tombs, where linen shrouds were used.⁸⁰

A large variety of textiles, including some pieces of imported silk, were found at Nessana and Avdat in the Negev highlands. The 1930s excavations at Nessana revealed an extensive assemblage of textiles, most of them clothes, and work in Avdat in the 1990s and later has unearthed additional textile fragments. Their dating to the early Islamic period, rather than to Byzantine times, was established with the new chronological framework suggested for these sites.⁸¹

Excavations at early Islamic sites in the 'Araba Valley revealed a much larger number of textiles.⁸² Particularly significant were the rich finds from Nahal Omer, a settlement in the central 'Araba Valley that was inhabited between the eighth and eleventh centuries. Excavations at the site in the 1990s and in 2020–24 revealed thousands of cloth fragments, which form the largest collection in the Middle East from the early Islamic period.⁸³ The fragments include hundreds of pieces made of cotton, more than a hundred of linen, eighty of wool, and three of silk, all of them imported from outside the region. Particularly notable were eight pieces of cotton cloth made in the ikat technique. This find is the earliest dated evidence of cloth made by using this technique, which probably originated in India, and the pieces found in the 'Araba may represent an import from either Yemen or India.⁸⁴

Other collections of cloth pieces were discovered in the central Jordan Valley—for example, at a mass grave from the early Islamic period at the Monastery of Saint John the Baptist in Qasr al-Yahud, a pilgrimage site on the Jordan River east of Jericho. This mass grave was probably related to the treatment of pilgrims infected by disease, as most of the skeletons contained evidence for tuberculosis and leprosy. Along with the human remains, hundreds of textile fragments dated to the ninth century were discovered. The anthropological context of the deceased, together with the textile finds, shows a strong Egyptian and Nubian affiliation.⁸⁵ Among the approximately 250 textile pieces analyzed, 170 were made of linen and 77 of cotton. The technique and style of textile decoration point to an Egyptian origin. A carbon dating of several textiles provided a range of dates between 787 and 877 CE.⁸⁶

Nearby in the Jordan Valley, an assemblage of 768 textile pieces was found in a cave in the cliffs of Qarantal, east of Jericho, all of them dated to the ninth to thirteenth

80 Shamir, "Byzantine and Early Islamic Textiles," 93–96; Shamir and Baginski, "Medieval Mediterranean Textiles."

81 For Nessana, see Avni, *Byzantine–Islamic Transition*, 265–66; Colt, *Excavations at Nessana*; Urman, *Nessana*. For Avdat, see Avni, *Byzantine–Islamic Transition*, 261–63; Shamir and Baginski, "Medieval Mediterranean Textiles," 147–48. One carbon-14 test from this context provided a twelfth-century date for a textile fragment. However, recent excavations conducted in a residential unit on the western slope of Avdat revealed large quantities of organic material that was dated to the sixth to ninth centuries CE. I thank Tali Erickson-Ginni for this information.

82 Ben-Michael, Israel, and Nachlieli, "Nahal Omer"; Porat, "Tunnel-Well (*Qanāt*) Systems"; Shamir et al., "Trash or Cache?"

83 Bar-Oz et al., "Treasures in the Trash Mounds"; Shamir, "Byzantine and Early Islamic Textiles," 99; Shamir et al., "Trash or Cache?"

84 Shamir and Baginski, "Earliest Cotton Ikat Textiles," 72.

85 Shamir, "Byzantine and Early Islamic Textiles," 99–102.

86 Shamir, "Egyptian and Nubian Textiles"; Shamir and Baginski, "Medieval Mediterranean Textiles," 152.

centuries CE. This assemblage was part of a cache hidden in the cave, perhaps by refugees from the Jerusalem area.⁸⁷ The pieces found were mostly torn, patched, cut, and reused fragments of cotton and linen, some of them from high-quality products.⁸⁸ Within the cache were also thirty-eight fragments of silk. While most of the linen and cotton seems to have been produced locally, the high quality of some pieces and the technique of manufacture point to a foreign origin, both east in Iran and south in Egypt.

The ratio of linen to cotton in the finds from the Byzantine and early Islamic periods shows that the use of linen predominated from the fourth to the seventh century. This fact further emphasizes the role of linen products in the local economy and accords with the historical sources regarding the quality of Palestinian linen. The use of cotton became more frequent in the early Islamic period, particularly in the ninth through eleventh centuries. Most of these textiles were locally made and reflect the growth of the linen and cotton industries. Imported silk is rare among the finds from archaeological contexts. Two silk fragments were found in Nessana, one in Avdat, and three in Nahal Omer. The largest number of silk pieces (thirty-eight fragments) was retrieved in Qarantal.⁸⁹

It seems that these rich finds reflect the growing wealth of textile industries in the early Islamic world, from Egypt to Iran.⁹⁰ These textiles, preserved mainly in the dry fringe regions and not in the populated areas of the coastal plain and central hills, bear witness to growth in the production and consumption of textiles. The textual evidence of the Geniza documents and the descriptions found in tenth- and eleventh-century historical sources provide conclusive evidence for the role of textiles in the eastern Mediterranean world. The finds from the Jordan and 'Araba valleys emphasize the "eastern connection" of textile consumption, with influences coming from areas as far away as Iran and India, probably reflecting the growing impact of eastern cultural influences on Palestine and Jordan in the early Islamic period.

SUMMARY

The picture emerging from this brief survey of archaeological data on agricultural industries shows that following the Arab conquest, local rural societies in Palestine gradually shifted their economies to new agricultural industries catering to changes in consumption preferences.⁹¹ The transformation of industries in early Islamic Palestine was triggered mainly by the sharp decline of the international wine trade. It resulted in an abatement of production and a diversion of wine products mainly to local consumption. Yet contrary to previous assumptions, it seems that the production of wine in Palestine and Jordan

87 For the preliminary report and interpretation of the finds, see Shamir and Baginski, "Medieval Mediterranean Textiles."

88 Shamir and Baginski, "Medieval Mediterranean Textiles"; 282 pieces of cotton and 270 pieces of linen were analyzed.

89 Shamir, "Byzantine and Early Islamic Textiles," 102–3.

90 Bulliet, *Cotton, Climate and Camels*; Frantz-Murphy, "New Interpretation"; see also Shatzmiller, *Labour*, for the central role of the textile industries and commerce in textiles in the early Islamic world, and Kelley, "Weavers, Merchants and the Taxman," for an evaluation of textile circulation in late antiquity and the early medieval period.

91 This shift also affected other fields, such as dining habits; see Magness, "Early Islamic Pottery."

continued well into the early Islamic period. At the same time, continuity in the olive-oil industry is evident, including some exported to Egypt and Iraq. The gradual penetration of the linen and cotton industries, which replaced wine production as the main branch of local economies, is evident from the second half of the eighth century.

The rise of the linen and cotton industries was reflected in the expansion of cultivated fields, the introduction of new irrigation and agricultural techniques, and the construction of novel industrial installations. This gradual transformation of local industries is expressed both in archaeological findings and in textual sources. It seems that the growing impact of the linen and cotton industries between the eighth and eleventh centuries was significant to the local economy in Palestine, which formed a branch of the larger economic network of industrial production in the Middle East during this period.⁹²

Reevaluation of the archaeological findings can contribute significantly to evaluating the shift from wine and oil production to the flax and cotton industries. The chronological sequences provided by large-scale excavations, particularly those around Ramla and Ashkelon, enable a refined view of both settlement processes and the change in agricultural industries. For example, the extensive network of villages and estates in the hinterland of Ashkelon declined in the seventh century, in conjunction with the abatement of the international wine trade. It was partially renewed in the eighth century based on a different economic system, one aiming its products to local consumption and short-range export. Within this system, the growing impact of the flax and cotton industries provided an alternative economic basis for the local population. A somewhat similar process can be distinguished in the Ramla-Lod area with the intensification of the linen and cotton industries in the early Islamic period, as is well reflected both in the large numbers of industrial installations revealed in Ramla and in the textual sources, which address the shift to textile industries. Excavations at several sites in the coastal plain between Ramla and Ashkelon provide evidence of the local aspects of this shift.

It seems that the economic transformation in Palestine during this period was an integral part of the wider network of industrial economies in the Middle East, and it was particularly connected with and affected by the Egyptian market.⁹³ I suggest that this economic transformation should be considered in the broader context of commercial market changes in the Mediterranean basin and the Middle East.⁹⁴ The shift from the wine industry, which formed a major source of income in the Byzantine period, to the extensive manufacture of linen and cotton may be connected to a much wider paradigm of technological and agrarian changes in the region following the Arab conquest. These changes included a gradual shift in production and consumption patterns, mainly influenced by areas to the east (Iran and Iraq) and south (Egypt). This paradigm is also represented in other fields of material culture, such as the diffusion of irrigation technologies from the east—particularly the use of underground irrigation galleries (qanats), a system introduced to the region from Iran.⁹⁵

92 Bulliet, *Cotton, Climate and Camels*; Frantz-Murphy, "New Interpretation"; Watson, *Agricultural Innovation*, 38–41.

93 See Sperber, "Objects of Trade," for the commercial connections between Palestine and Egypt in the Roman period, and Frantz-Murphy, "New Interpretation," for the impact of the flax industry on the Egyptian economy. See also Shatzmiller, *Labour*, for the major role of textile industries in the division of labor.

94 See Bessard, *Caliphs and Merchants*, for an updated evaluation of the early Islamic market economy.

95 Avni, "Early Islamic Farmsteads."

It seems that these technological changes in agrarian industries affected agricultural production for centuries to come. The change was gradual, spanning more than 300 years, and was formalized only in the ninth and tenth centuries. The realities of economic life in the eastern Mediterranean basin, as reflected in the Geniza documents of the eleventh century, show that the commercial products of Palestine and Egypt were, as in the fifth and sixth centuries, once again major factors in the commercial life of the Mediterranean.

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5

The Industrialization of Agriculture during the Late Antique and Medieval Islamic Periods in Southern Palaestina Tertia / Bilād al-Shām, with an Emphasis on Indigo and Sugar Production in Zoara/Zughar (Ghor as-Safi, Jordan)

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INTRODUCTION

Throughout history, the development of agriculture, involving the cultivation of plants and nurturing of animals for exploitation, has been a key factor in the expansion of human settlements. During the late antique and medieval Islamic periods, farmers in the Near East and North Africa used classical-period agricultural systems but brought in new methods from Asia. They maintained dams and reservoirs built during Greco-Roman and Byzantine times, but they also constructed new systems following Sasanian-Persian irrigation techniques (such as qanats and acequias) to advance agricultural efficiency. Additionally, they improved ancient systems based on hydraulic and hydrostatic principles (such as water-raising machines called norias) (figs. 5.1 and 5.2). These advances, combined with the development of a *trimestre* (three-field) system of crop rotation and the moldboard plow, greatly augmented agricultural productivity. Meanwhile, new plants and animals were also introduced from Asia, resulting in an unprecedented agricultural boom recently hailed as an “Islamic Agricultural Revolution.”¹

This study reviews the major agricultural advances during the seventh to eleventh centuries CE in the Near East. It focuses on indigo and sugar production in southern Palaestina Tertia / Bilād al-Shām—particularly at Zoara/Zughar (modern Ghor as-Safi in Jordan), where recent excavations have revealed significant new discoveries and evidence.

THE ECONOMIC CONTEXT OF THE LATE ANTIQUE PERIOD: POLITICAL TRANSITION WITH ECONOMIC CONTINUITY

The early Byzantine or “late antique” period was a time of great economic prosperity in the “classical” Greco-Roman world. Agriculture reached its acme during the fifth and sixth

¹ Watson, *Agricultural Innovation*.



Figure 5.1. Water-lifting wheel depicted on a circa fifth-century CE mosaic pavement. Hama Archaeological Museum. Photo by K. D. Politis.



Figure 5.2. Noria water-lifting wheels, originally constructed in early Islamic times. Hama on the Orontes River, Syria. Photo by H. Frank, Wikimedia Commons.

centuries CE in terms of the amount of tillable land that was exploited.² Contributing to this process of intensification, soldier-settlers were given plots of land to cultivate and tax reductions in addition to their regular payments.³ The fact that the fifth century was a period of intense state and private investment explains such prosperity during the early Byzantine period. Apart from substantial investment in the construction of churches and monasteries, there was also a significant input of capital from Christian pilgrims.⁴

Rural settlements in the early Byzantine period (fifth to seventh centuries) can be divided broadly into three kinds: villages fortified by enclosures or built near military installations, agricultural villages, and agricultural monasteries where the monks, like the peasants of the nearby villages, lived by exploiting the land.⁵ The Nessana papyri provide a wealth of information on the variety of crops grown, including wheat, barley, grapes, olives, figs, and dates. Although these products may mostly have been consumed locally, a series of *entagia* for requisitions of wheat and oil by the Arab governor in the late seventh century indicates that a surplus of crops beyond the needs of the local population may sometimes have been produced, though it may have been subject to taxation by the Byzantine state.⁶

The general picture perhaps confirms the idea that after the Islamic conquest, the new Umayyad rulers left the peasantry to continue to farm the fertile countryside. Archaeological surveys and excavations carried out in the Ḥawrān and al-Balqā' demonstrate that farmland continued to be settled into the Umayyad period (seventh to eighth centuries), prolonging the occupation of the same areas in early Byzantine, Roman, and earlier times.⁷ Indeed, this pattern of Umayyad settlement on Byzantine sites is known throughout Bilād al-Shām.⁸

Archaeological work has highlighted the waves of agricultural expansion even into the arid, desertlike areas of the Negev during the Byzantine period, followed by a second wave of expansion during the Umayyad period.⁹ This growth has been attributed to state policy that deliberately encouraged agricultural settlements on the frontier, as well as to the gradual shift by seminomads from nomadic to spontaneous settlements, culminating in state-sponsored settlement. An examination of the archaeological evidence for early Islamic occupation in the southern Negev and the Wādī 'Araba suggests that new settlements were established and flourished throughout the region during the eighth to tenth/eleventh centuries. Their economic base included large-scale agriculture using sophisticated irrigation systems and the introduction of new crops, copper and gold mining and production, stone quarrying, and the development of a road network used by traders and pilgrims.¹⁰ In further support of this hypothesis of economic continuity from the early Byzantine to

2 Patrich, "Church, State, and Transformation," 483.

3 Jones, *Later Roman Empire*, 649–54, 660–61.

4 Politis, *Sanctuary of Lot*, 17.

5 Piccirillo, "Rural Settlements," 258.

6 Glucker, *City of Gaza*; Kraemer, *Excavations at Nessana*, 175–79.

7 King, "Distribution of Sites and Routes."

8 King, "Archaeological Re-assessment."

9 Haiman, "Agriculture and Nomad-State Relations."

10 Avner and Magness, "Early Islamic Settlement."

Islamic periods, excavations at modern al-ʿAqaba have uncovered significant portions of the Nabataean, Roman, and Byzantine city of Ayla, which flourished from the first century BCE to the Islamic conquest.¹¹ Here it is clear that part of the Byzantine settlement continued to be occupied even after the construction nearby of the new, Islamic-period walled town in the mid-seventh century CE.

THE NEW MEDIEVAL ISLAMIC AGRICULTURAL REGIME

During the early Islamic period, an important change was the opening of a virtually new agricultural season. The traditional growing season of the classical world in the Near East and the Mediterranean had been winter, with crops being sown around the time of the autumn rains and harvested in the spring; in the long, hot, dry summer the land almost always lay fallow, usually even in irrigated regions where at least some of the crops available to the ancients could, with special care, have given satisfactory yields. The so-called “summer crops” of the Greco-Roman period, such as *trimestre* wheat, millet, sesame, various legumes, and some garden crops, played a minor role in parts of the northern Mediterranean, where summer was relatively cool. But in the southern and eastern parts of the Mediterranean, they were virtually never grown.

Since many of the new crops arriving after the Islamic conquest had originated in the tropical regions of India, Southeast Asia, and Central Africa, they could be grown in only hot climates. In particular, rice, cotton, sugarcane, colocasia, aubergine, melons, and sorghum were all new summer crops in the Islamic world. Other important new crops included indigo, henna, safflower, and the green gram (mung bean). The introduction of such summer crops on a wide scale radically changed the rhythm of the agricultural year as land and labor that had previously been inactive were made productive.

Furthermore, the opening of a significant summer agricultural season was one of several factors allowing rotation systems, which in turn allowed much more intensive land use. Although classical sources, chiefly the *Geoponika*,¹² reveal sophisticated agricultural systems, in reality traditional practice had been to crop the ground only once every two years or, in exceptional circumstances, once a year. Even in Byzantine Egypt, where the flooding of the Nile would seem to make prolonged resting of the land unnecessary, fields were often sown only once every two years; they sometimes bore a legume crop in intervening years but never grain crops in consecutive years. In the Islamic world, however, these periods of rest for the land were often done away with. Fallowing was not recommended or even discussed in most Islamic agricultural manuals. Instead, most land seems to have been cropped at least once a year and given no period of rest. Still more intensive cropping of the land became common in places that were fertile and well watered, because in these areas a summer crop could be planted immediately after the spring harvest. Ibn al-ʿAwwām even seems to suggest that summer cropping was preferable to summer fallowing.¹³ In certain areas, three or more harvests per year could be had from the same plot

11 Parker, “Preliminary Report.”

12 Dalby, *Geoponika*.

13 Watson, *Agricultural Innovation*, 127.

of land. Although the new crops were of fundamental importance in opening the summer season, the summer crops that were known but little used in antiquity also played a role—in particular *trimestre* wheat, barley, and catch crops, which were used much more by Muslims than by the ancients.

The possible combinations were countless, as new crops could be combined in rotation with old ones. An irrigated season could follow a dry one. Like most of the new crops, the system of multiple cropping seems to have reached the Islamic world from India. But of course, such heavy cropping depleted the soils of their fertility. One solution was to fertilize using animal dung, blood, urine, and even pulverized bones. Vegetal by-products from olive oil, lees, seeds, straw, husks, leaves, shavings, and ashes were also used. Added minerals included different types of soil, sand, gravel, chalk, marl, lime, and even crushed pottery. Frequent and much plowing was employed, and the choice of the sequence of crops was important so as not to deplete the nutrients in the earth.

The so-called Islamic Agricultural Revolution¹⁴ was not exclusive to well-irrigated, fertile soils farmed using multiple-crop Indian methods. Although they served as the model, all regions were tilled by peasant farmers and state-sponsored cultivators. Furthermore, land use was increased by broadening the variety of available crops and by an emerging awareness of the requirements of and possibilities offered by individual crops. Islamic agriculturalists seem to have had a better understanding of how to choose crops to suit particular conditions than did their predecessors.¹⁵ They also seem to have been determined to expand agriculture even on lands not deemed appropriate in antiquity.

These new farmers had flexible cropping patterns based on new irrigation systems—such as the Sasanian-Persian qanats and acequias that relied on perennial rivers, man-made wells, and accessible aquifers (fig. 5.3)—unlike the patterns of antiquity, which usually had rigid and limited rotations determined by varied rainfall; the underground Gadara and Samos aqueducts were exceptions.¹⁶ As a consequence, the new farmers were able to grow crops successfully in arid conditions and in poorer soils, with sorghum and sugarcane being two good examples. The outcome was higher productivity, which was more rewarding financially and offered long-term stability. This return allowed further investments in major projects such as irrigation construction, plowing, and fertilizing—a kind of state-sponsored venture that was a feature especially of the Ayyubid-Mamluk period.

The fact that processed sugarcane, *durum* (“hard wheat”), and sorghum could be stored for very long periods allowed speculators and governments to build up surpluses in years of high production and low prices—reserves that could be released onto the market in years when production was low and prices were high.¹⁷ This relative price and income stability was not only good economic policy but also politically savvy, as it won favor among the peasantry (excessive taxing being a major source of political discontent in late antiquity).

14 Watson, *Agricultural Innovation*.

15 Watson, *Agricultural Innovation*, 126.

16 Doering, “Qanat Fir‘un”; Kienast, *Aqueduct of Eupalinos*.

17 Lapidus, *Muslim Cities*, 51–55.



Figure 5.3. An enormous Sasanian-Persian water system at Shūshtar.
Photo by Razie Amirian, Wikimedia Commons.

CLASSICAL ZOARA, ISLAMIC ZUGHAR IN SOUTHERN PALAESTINA TERTIA / BILĀD AL-SHĀM

Roman and Byzantine sources indicate that Zoara (modern Ghor as-Safi) was a city based on an agricultural economy that roughly paralleled that of ‘Ain Gedi and Jericho with date-palm groves and balsam vines, as noted by Jerome (d. 420 CE) (fig. 5.4).¹⁸ In the second century CE, Zoara is also mentioned as a farming center.¹⁹ It is depicted on the sixth-century CE mosaic map in Madaba as surrounded by date palms and labeled “Zoora,” a name derived from Old Testament Zoar (Genesis 19), which has been identified as Tuleilat Qasr Musa Hamid, a major Iron Age site based on agriculture.²⁰

Within the district of Zoara also lies Deir ‘Ain ‘Abata, an important early Byzantine site that continued to be occupied through the early Islamic period. Recent archaeological excavations there and consequent scientific research have verified agricultural production in the region.²¹ Deir ‘Ain ‘Abata includes an early Christian (fifth to seventh century CE) monastic complex complete with a basilical church dedicated to Saint Lot flanked by a large reservoir to the south and a refectory and pilgrims’ hotel to the north. On the

18 Schaff and Wace, *Select Library*, 200 (letter 108.11).

19 Bowersock, *Roman Arabia*, 76–77.

20 Politis, “Ghawr al-Safi Survey,” 546.

21 Politis, *Sanctuary of Lot*, 518–22.

western slopes, agricultural terraces formed a substantial garden irrigated by water channels from the reservoir (fig. 5.5).²² This garden would have helped the monastic community be self-sustaining in fruits and vegetables, the mainstay of its vegetarian diet.

Studies conducted on the plant remains and animal bones from the archaeological excavations provided the first scientific evidence regarding the dietary practices of monks and pilgrims, as well as of the wider early Byzantine community during the fifth to seventh centuries CE. The botanical finds identified included olives, dates, bitter vetch, grapes, lentils, barley, bread wheat, fava beans, and, most tellingly, peaches and watermelon, which indicate Asian connections. Other monastic sites in Palaestina Tertia have also revealed evidence of figs, grapes, carob, dates, peaches, and watermelon, which would similarly have been produced under irrigated cultivation in monastery gardens or in small plots adjacent to the monastery to supplement the production of bread, the staple foodstuff.²³

The Islamic medieval-period name Zughar derives from the Roman-Byzantine town of Zoara, thus indicating a long period of uninterrupted occupation in the town that is also evidenced by recent archaeological excavations. During the Abbasid and Fatimid periods (ninth to twelfth centuries), Zughar was described as a busy market town; Muḥammad ibn Aḥmad al-Muqaddasī classified Zughar as the capital of the al-Sharāt district in Bilād al-Shām.²⁴ It was renowned for its indigo and date production.²⁵ Ayyubid-Mamluk Zughar has also been described as a flourishing commercial town with an economy based on sugar production.²⁶ Indigo, which is known to have grown in Zughar,²⁷ was an important agricultural precursor to sugarcane, with close similarities in processing requirements that are comparable to processing techniques in later centuries.²⁸



Figure 5.4. Zoara surrounded by date palms, as depicted on the late sixth-century mosaic map at Madaba. Photo by K. D. Politis.

22 Politis, *Sanctuary of Lot*, 121–22 and fig. 193.

23 Hirschfeld, *Judean Desert Monasteries*, 196.

24 Al-Muqaddasī, *Kitāb aḥsan al-taqāsīm*, 11.

25 Ibn Ḥawqal, *Kitāb Ṣūrat al-Arḍ*, 184.17–185.3; Muqaddasī, *Kitāb aḥsan al-taqāsīm*, 178.5; *Best Divisions*, 149.

26 Walmsley, “Fatimid, Ayyubid, and Mamluk Jordan,” 518, 542.

27 Schick, “Southern Jordan,” 75; Walmsley, *Early Islamic Syria*, 116.

28 Kelly, “Historical Archaeology,” 7; Whitcomb, “Islamic Period,” 117.



Figure 5.5. Reconstruction of the Monastery of Saint Lot with water system and agricultural terraces at Deir 'Ain 'Abata. Image by J. M. Farrant.

Yāqūt al-Ḥamawī, the eleventh-century CE geographer, reported: “The little Jordan is a river that begins from Lake Ṭabariyyah and passes toward the south through the valley (*ghor*), where it irrigates the villages of the valley, and most of their harvest is sugar, which is carried from there to the other countries of the East.”²⁹ The well-watered Jordan Valley, and specifically the spring at Zughar, which “the people used to irrigate the land,” are mentioned in the hadith report of Fāṭimah bint Qays, thus highlighting their importance.³⁰

During the Crusader period, two chroniclers of Baldwin of Jerusalem’s winter campaign of 1100–1101 refer to Ghor as-Safi. William of Tyre mentions that the town was on the route leading east from Hebron and the Dead Sea, and he notes that it was then named “Palmer.”³¹ Fulcher of Chartres, who accompanied Baldwin on this campaign, was both more detailed and more impressed: “We came upon a village that they call Segor, most pleasantly situated and very abundant in palm fruits, which they call dates, of which we

29 Yāqūt al-Ḥamawī, *Muʿjam al-Buldān*, 1:147.

30 Ibn Mājah, *Sunan*, 438, no. 4074.

31 William of Tyre, *History of Deeds*, 412.

blissfully ate a meal all day long. We found other rare things in the same place.”³² Presumably indigo and sugarcane were among these “rare things.” The site, labeled as Zo‘ara, was centrally located on the *Tabula Rogeriana* by Muhammad al-Idrisi for Roger II of Sicily in 1154 CE, thus highlighting its importance during the medieval period (fig. 5.6).

DATE CULTIVATION

Although dates were widely cultivated during classical and medieval times in Zoara/Zughar, they are not discussed in this study because they did not require sophisticated processing beyond their collection, nor did they involve industrialization. Their importance as a product should not be underestimated, however, as is manifest from the depiction of date palms surrounding the city on the late sixth-century CE mosaic map at Madaba (fig. 5.4).



Figure 5.6. Zo‘ara on the *Tabula Rogeriana* (1154 CE).

INDIGO PRODUCTION

Indigo dye derives from processing the plant *Indigofera tinctoria*, which is indigenous to Southeast Asia. Its production is evident in the eastern Mediterranean area as early as the Greco-Roman period. The association of India with indigo is reflected in the Greek word for the dye: *indikon* (ινδικόν). The Romans used the term *indicum*, which passed into Italian and eventually into English as the word “indigo.”

Greek dye recipes are mentioned in the *Graecus Holmiensis* papyrus from Egypt, and an indigo dyer’s workshop was identified at Athribis near Sohag in Egypt.³³ Indigo-dyed textiles were found at Qumrān and in the Cave of Letters by the Dead Sea shore. These textiles may have been produced at neighboring ‘Ain Feshkha, where Roman-period dyeing vats were discovered,³⁴ though the vats, or pools, may have had multiple uses.

The earliest evidence of fine ikat textiles dyed with indigo comes from the early seventh century CE in the church of Saint Lot at Deir ‘Ain ‘Abata near the shores of the Dead Sea (fig. 5.7). But it was only in the early Islamic period that indigo production reached an industrial scale. The Egyptian indigo-dyed textile trade during the Fatimid period is well documented. At Damietta in the Nile Delta, the Cairo Geniza documents mention that

32 Fulcher of Chartres, *Historia Hierosolymitana*, 378–79. As Heinrich Hagenmeyer, the editor of Fulcher’s history, notes, the phrase “that they call Segor” occurs in only some manuscripts.

33 Balfour-Paul, *Indigo*, 12.

34 Humbert and Chambon, *Fouilles de Khirbet Qumrān*, 250.



Figure 5.7. Ikat textile fragment from Deir ‘Ain ‘Abata with strips of brownish-red, yellow, and green stripes alternating with indigo blue. Photo by T. Springett.

the best-quality indigo (*tekhelet*) to dye tassels (*tzitzit*) was bought in and brought from Zughar. These manuscripts reveal that Zughar was trading between northern Arabia and the Mediterranean during the eleventh century.³⁵ A letter written in 1065 CE records that indigo was brought from Zughar but that the road was dangerous; one Jewish merchant from North Africa who had considered going from Hebron to Zughar decided not to go.³⁶ Other documents record Jewish merchants living in Zughar in the tenth and eleventh centuries.³⁷ One Geniza document from 1044 CE mentions grain from Ghor as-Safi in connection with determining the Jewish leap year.³⁸

Recent excavations in Ghor as-Safi³⁹ have uncovered two large, perforated pots—in situ in ninth- to tenth-century contexts—comparable to *khabiyah* jars traditionally used in Bahla, Oman, for indigo processing (fig. 5.8).⁴⁰ Two copper-alloy indigo crucibles similar to eleventh-century CE ones from Khurasan (Iran) were also found and are now in the British Museum (1881 7-1 3401; OA+ 1348; 1955 7-6 11) and the Victoria and Albert Museum (M.132-1929) (fig. 5.9).

Large, stone-built plastered tanks at Birkat just outside the urban center have been interpreted as dyeing vats for processing indigo.⁴¹ This interpretation makes sense, since the initial fermentation stage of indigo production is a difficult and bad-smelling task best done on the periphery of settled areas. The addition of potash, an agent for fixing the dye (and of which there is an ample supply in the Dead Sea), would have intensified the toxic odor. This archaeological discovery indicates that an indigo workshop was present, and

³⁵ Goitein, *Mediterranean Society*, 45n228.

³⁶ Gil, *History of Palestine*, 203, 206.

³⁷ Gil, *History of Palestine*, 202–3.

³⁸ Gil, *History of Palestine*, 797.

³⁹ Politis, *Ancient Landscapes of Zoara I and II*.

⁴⁰ Balfour-Paul, *Indigo*, 67, pl. 2.

⁴¹ Whitcomb, “Islamic Period,” 117.



Figure 5.8. Abbasid-period perforated pot for indigo production.
Drawing by C. Schofield. Photo by K. D. Politis.

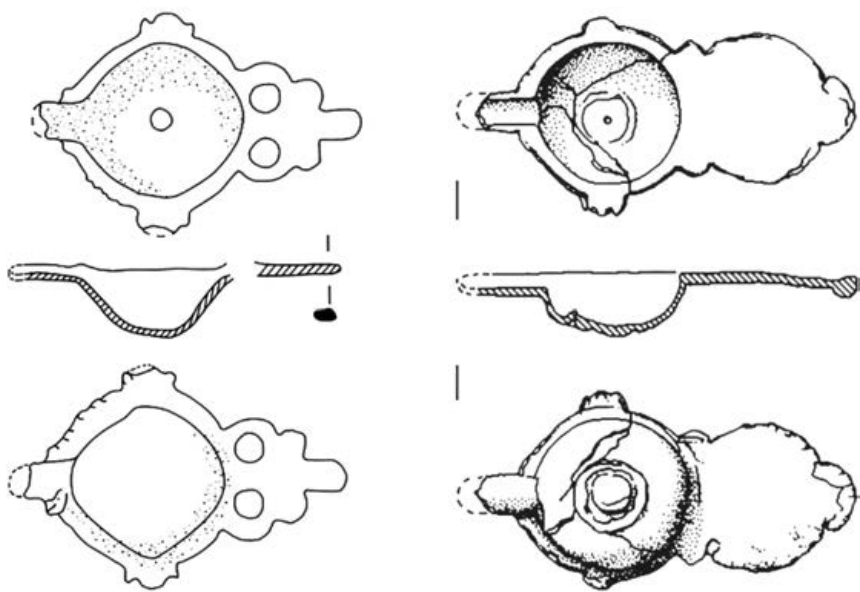


Figure 5.9. Two cast copper-alloy indigo crucibles. *Left*, GS.KSI.IX.103.2016.7; drawing by A. Ariotti. *Right*, GS.KSI.II.120; drawing by C. Schofield.



Figure 5.10. Indigo-dyed threads embroidering Kufic letters on a tenth-century cloth from Dayr al-Qattar. Photo by K. D. Politis.

it is likely where the historically known superior indigo was produced. Finally, at Dayr al-Qattar on the Lisan Peninsula of the Dead Sea, the threads embroidering Kufic letters on a tenth-century cloth,⁴² similar to other Fatimid *tiraz*, were also dyed with indigo (fig. 5.10).

These archaeological finds demonstrate that indigo was being produced on a significant scale in Zoara/Zughar for local use as well as for export. Although the demand for indigo for dyeing finer textiles is apparent, its use for coloring everyday clothing is also probable. A more recent parallel can be seen in traditional Arab clothing, which is often dyed in indigo blue.⁴³

SUGARCANE PLANTATIONS AND SUGAR INDUSTRY IN THE SOUTHERN BILĀD AL-SHĀM

The processing of sugarcane on an industrial scale was first introduced into the Near East in Khuzestan during the fifth century CE. From there, it later spread to Bilād al-Shām.

There is documentary evidence in both European and Arab literary sources during the period between the eleventh and the fifteenth centuries that Ayyubid/Mamluk rulers promoted sugarcane plantations in the Jordan Valley by undertaking major irrigation schemes.⁴⁴ However, it is clear that an understanding of how the steps of production were carried out and controlled must have been in place before sugar manufacturing could expand on an industrial scale.

In Palestine and Transjordan, forty-three sugar factories have been identified, thirty-four of which are in the eastern Jordan Valley,⁴⁵ with an additional three in the southern Ghors (Safi, Mazra‘a, and Feifa) and one in Jericho.⁴⁶ These sites are usually referred to er-

42 Holmgren and Kaliff, “1995–1996 Excavation,” 332.

43 Balfour-Paul, *Indigo*, 126–53, pls. 13–16.

44 Hamarneh, “Sugar Cane Cultivation”; Stern, “Sugar Industry.”

45 Abu-dalo, “Sugar Mills,” 27, fig. 2; “Technology of Sugar Mills”; Hamarneh, “Sugar Cane Cultivation”; Stern, “Sugar Industry.”

46 Taha, “Ausgrabungen von Tawaheen es-Sukkar” and “Some Aspects of Sugar Production.”

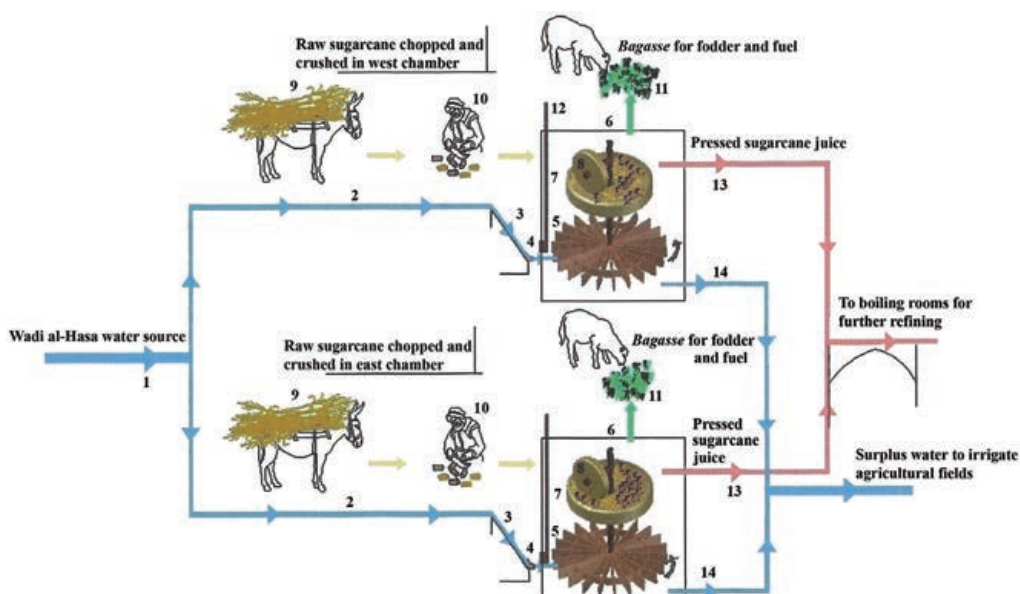


Figure 5.11. Schematic flowchart of sugarcane processing. Image by A. Kapetanios.

roneously as *ṭawāḥīn*, which literally implies “grinding” or “pulverizing” (as in wheat into flour). However, the correct term is *maʿasir*, meaning “crushing” or “pressing,” as in olives or sugarcane.⁴⁷ Furthermore, since pressing is only one step in sugar processing, *maṣānīʿ al-sukkar* “sugar factories” is the most accurate term for describing the overall function of these sites (fig. 5.11).

The sugar industry reached its peak in the Jordan Valley during the Mamluk period (twelfth to fifteenth centuries) and proved to be highly profitable. Sugar factories and plantations were declared to be royal property, and the sultan appointed a special supervisor of the Jordan Valley, called an *astadar al-aghwār*, to collect the sugar products and manage their finances (fig. 5.12).⁴⁸ Some of these factories were notably put under the *nāʾib* of Damascus (the delegate of the sultan), who went to the Jordan Valley during the sugarcane harvest for inspections and to promote irrigation projects for the plantations.

THE ZUGHAR MASNAʿ AL-SUKKAR (SUGAR FACTORY)

The Masnaʿ al-Sukkar (sugar factory) in Ghor as-Safi is important because it is the largest in Palestine and Transjordan. The nearby Khirbat Sheik ʿIsa site was the major Islamic-period market center in southern Bilād al-Shām where sugar was traded and exported via an east–west road network leading to Gaza and access to the European markets.⁴⁹

The structures at the Masnaʿ al-Sukkar can be generally divided into three areas: north-northwest, south, and east (fig. 5.13). They are variously built from well-hewn and

47 Abu-dalo, “Technology of Sugar Mills”; Nashef, “L’industria dello zucchero.”

48 Abu-dalo, *Sugar Refineries*, 8.

49 Politis, “Sugar Industry,” 478.

roughly shaped local limestone and sandstone, adobe brick, and fired brick.

THE NORTH-NORTHWESTERN AREA

It has been suggested that the so-called *qaṣr* area in the north and the presses in the south date to two different periods.⁵⁰ This assertion may be true, considering that the vaulted rooms in the north do not immediately appear to have had an industrial function and were built using different techniques. However, the *qaṣr* might originally have been the location of a *dār al-qaṣab* (“house of canes”), where the sugarcanes were cleaned, chopped into “fingers,” and then stored.⁵¹

The north-northwestern part of the site consists of two vaulted rooms, made of roughly shaped stones and lime mortar with adjacent adobe-brick walls, which were originally referred to as “Qasr al-Tuba” or “Qasr Safi.”⁵²

The northern room, measuring 8.1 m (south) × 9.4 m (north) × 7.7 m (center), was clearly built over an Ayyubid-Mamluk arched entranceway made of well-hewn sandstone blocks. A long, vaulted room measuring 9 × 5 m on the northwestern side of the site was similarly founded on Ayyubid-Mamluk structures, as affirmed by many broken sugar pots on an ashy floor surface.⁵³

THE SOUTHERN AREA

In the southern part of Ghor as-Safi, the surviving architecture is dominated by two pressing chambers powered by oblique penstocks operated using high-powered water jets. Two parallel aqueducts, best described as acequias, transported the water and were each



Figure 5.12. Inscription dated 836 AH/1432 CE on a column in the Umayyad mosque of Damascus, in which Sultan Barsbay abolishes the unjust forced sale of sugar from the Jordan Valley (*aghors*). Photo by H. Saad.

50 King et al., “Survey of Byzantine and Islamic Sites,” 446.

51 Nashef, “L’industria dello zucchero”; Peled, “Local Sugar Industry,” 252.

52 Frank, “Aus der ‘Araba I,” 210; Glueck, *Explorations*, 7n19.

53 Politis, “Ghawr eṣ-Ṣāfi Excavations,” 195–96.

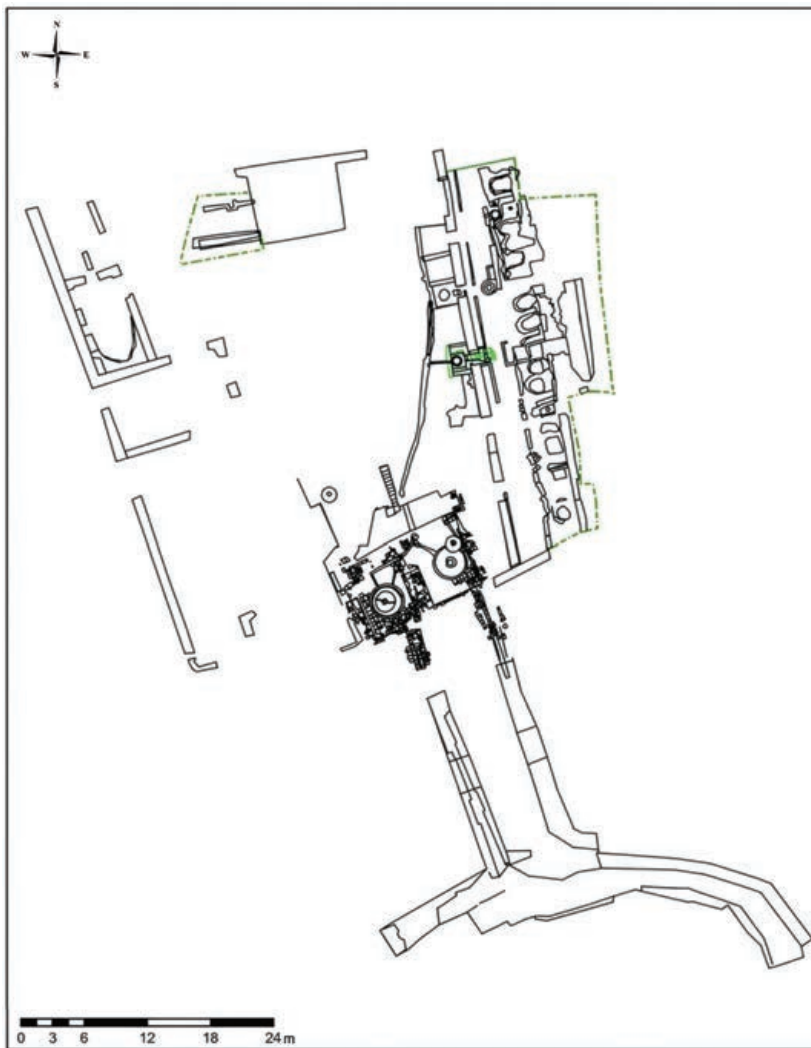


Figure 5.13. Plan of Masna' al-Sukkar, 2018. Drawing by Q. Dasouqi.

supported by a pointed arch. The pressing chambers were associated with two subterranean, vaulted gearing rooms. These rooms would have contained some type of overshot waterwheel⁵⁴ operating a horizontal press base by a gearing mechanism,⁵⁵ possibly a vertical one like that at Kouklia on Cyprus,⁵⁶ to drive the cane-pressing process (see figs. 5.17, 5.19, and 5.20 below).

The substructure walls of the two parallel acequias still stand as high as 4 m in places. The channels remain visible along the tops of both acequias, where they are defined by well-hewn sandstone blocks. The substructure walls are constructed using a mortared-rubble

54 For a good sixth-century representation, see Seigne, "Scierie hydraulique," 436, fig. 3; for a hypothetical Ayyubid-Mamluk model, see Abu-dalo, "Story of Sugar Production," 46, fig. 2.

55 Al-Hasan and Hill, *Islamic Technology*, 52–53.

56 Von Wartburg, "Medieval Cane Sugar Production," 155, fig. 9.

core faced with rough courses of natural stones of similar size and shape. Each acequia incorporates a single arch approximately 2 m high. On approaching the press-house installation, the acequias descend sharply and obliquely, while the channel widths narrow to increase the force of the water. Both channels are lined with series of U-shaped sandstone troughs covered by slab stones along this vertical descent into the installation. Although the water could have been stopped at the base of the chute by a sluice, it is more likely that the water flow was cut off (and thus controlled) along the main branch of the channel behind the parallel acequias, thereby allowing it to be diverted to whichever press house was in operation. Such an arrangement has been outlined in four distinct segments along the main aqueduct branch behind the parallel acequias.⁵⁷ These channel divisions were supported by substantial buttressing and possibly facilitated sluice devices at this point.

THE PRESSES

The eastern upper pressing chamber measures 3.93 m (internally) and 6.90 m (externally) north-south × 4.92 m east-west. The center of the room was occupied by a substantial, base crushing limestone with a diameter of 3.20 m. The upper crushing stone has fallen over the northeastern lip of this base stone but would originally have sat on its edge and rotated over the base stone with the aid of wooden beams and a securing collar stone. The floor of the entire room was originally paved with flagstones, now surviving in situ mostly in the southeastern corner of the room. Isolated examples survive at the base of the eastern and western walls of the room (fig. 5.14).

The western upper pressing chamber measures 4.25 m (internally) and 7.1 m (externally) north-south × 4.75 m east-west. The center of the room was occupied by a substantial, base crushing granite stone with a diameter of 3.25 m. The upper crushing stone, now fallen over and broken, would have functioned in the same way as the one in the eastern chamber. The floor would have been similarly paved with flagstones, about half of which survive in the southern and northwestern parts of the room.

Below the pavers of both chambers were conduits for the pressed sugarcane juices to flow across an arched bridge toward the processing area (fig. 5.15). Directly below each of the lower, base crushing stones was a vaulted chamber that would originally have housed the gearing mechanism and gear-wheel emplacement (figs. 5.16–5.20), similar to those found in the second complex at Kouklia on Cyprus,⁵⁸ Jericho,⁵⁹ and Tell es-Sukkar.⁶⁰ The gravity-flow aqueduct system would have terminated in a covered pressure channel tapering narrowly toward a spout to increase the power of the water significantly. The water jet issuing from this spout would have operated a horizontal wheel that drove the upper crushing stone by means of a wooden vertical shaft and crossbeam. The shaft may also have engaged with some kind of wooden gear, as suggested by corresponding sockets in the eastern wall elevation of the upper story. The tail stream exited the complex through a subterranean conduit that runs northward from the complex. The rooms were accessible

57 Jones et al., “Ṭawāḥīn as-Sukkar and Khirbat ash-Shaykh ‘Isa Project,” 527.

58 TST 1; see Maier and Karageorghis, *Paphos*, 334.

59 Taha, “Sugarcane Industry,” 60, fig. 8.

60 Abu-dalo, “Sugar Mills,” figs. 4, 5, 9, 10.

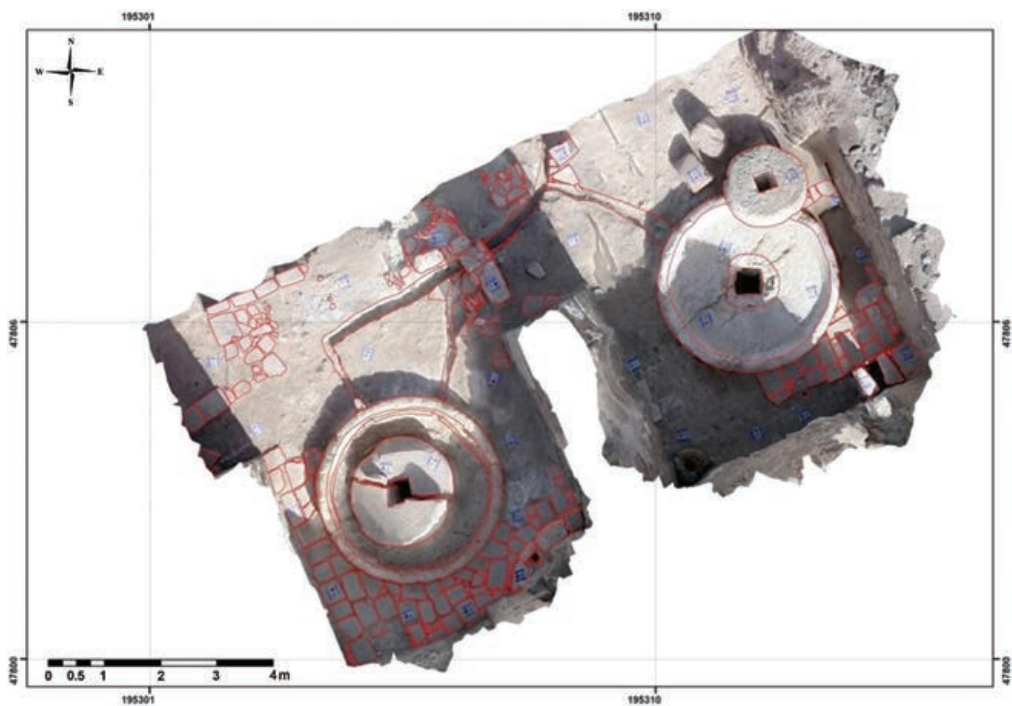


Figure 5.14. Horizontal composite photo of upper pressing chambers, with pavers outlined in red. Image by Q. Dasouqi.



Figure 5.15. The outflow of pressed sugarcane juices from the presses across an arched bridge to a channel leading northeast. Photo by K. D. Politis, with graphics by Y. Dray.

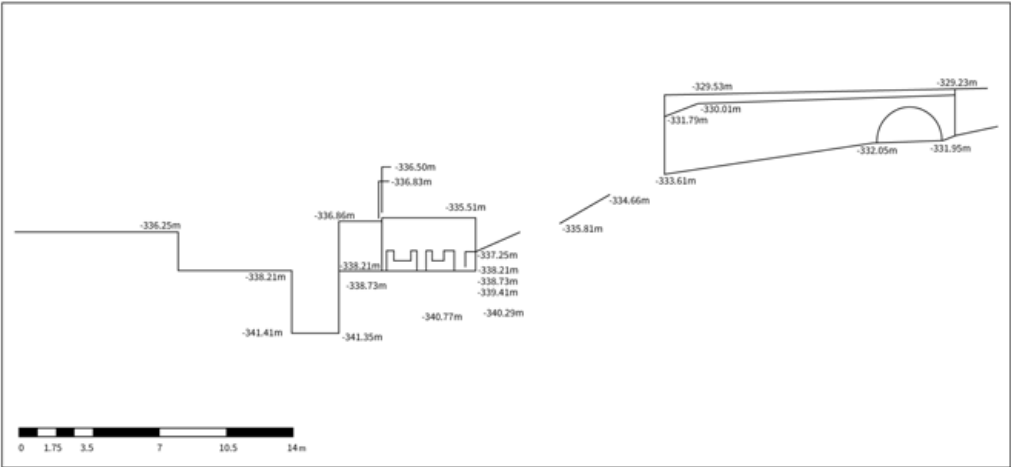


Figure 5.16. North-south elevation of aqueduct, pressing, and gearing chambers. Drawing by Q. Dasouqi.

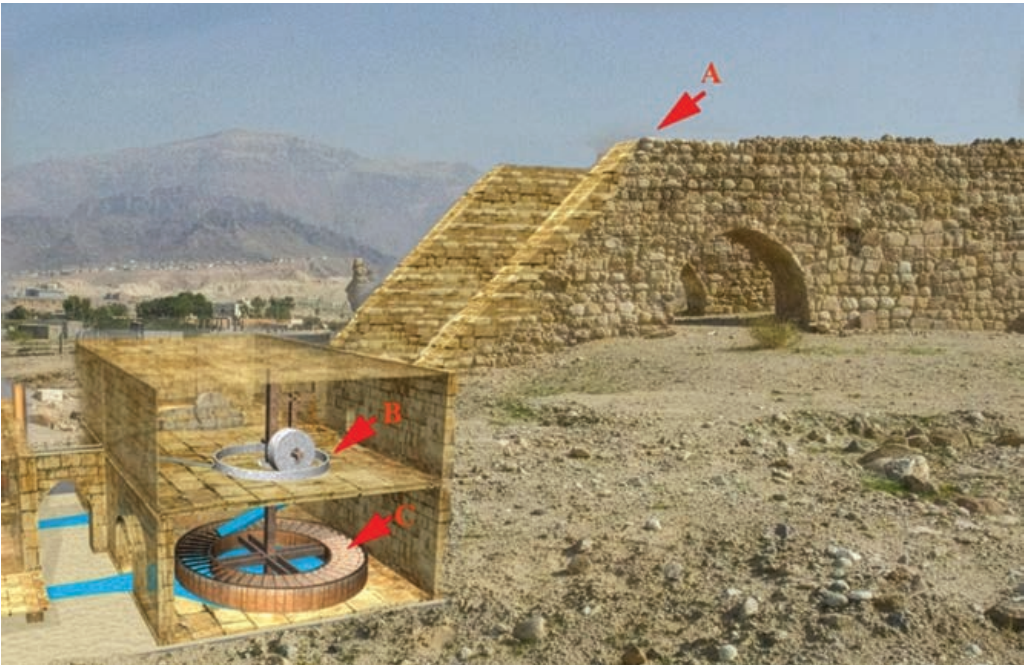


Figure 5.17. Illustration of proposed reconstruction of aqueduct, pressing, and gearing chambers: A, oblique shafts; B, roller presses; C, paddle wheel. Photo by K. D. Politis, with graphics by S. Witkin.

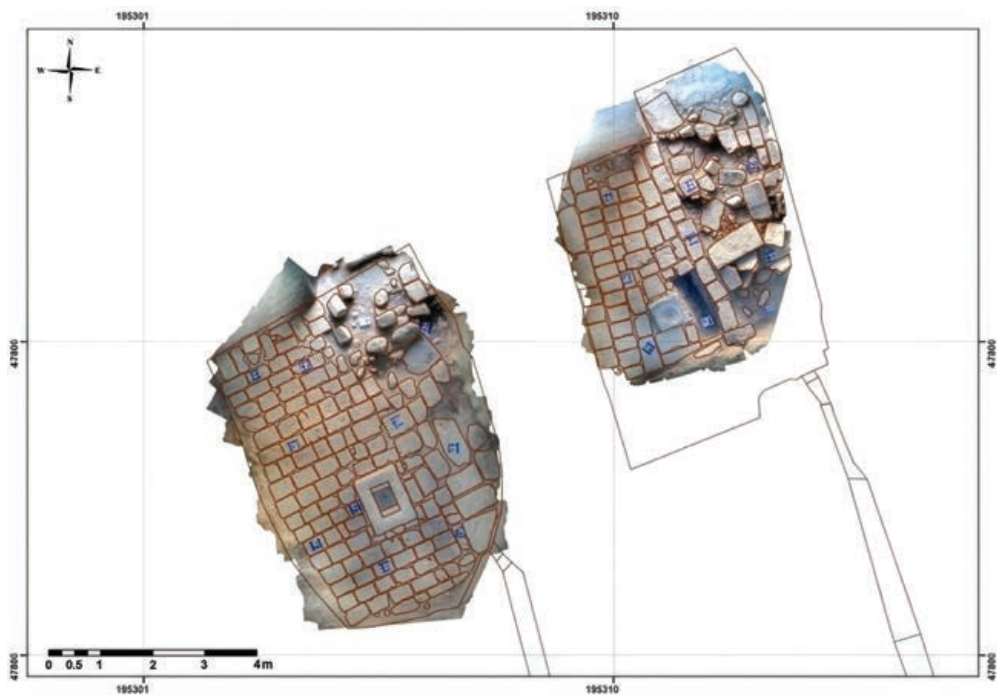


Figure 5.18. Horizontal composite photo of lower gear room, with pavers outlined in red. Image by Q. Dasouqi.

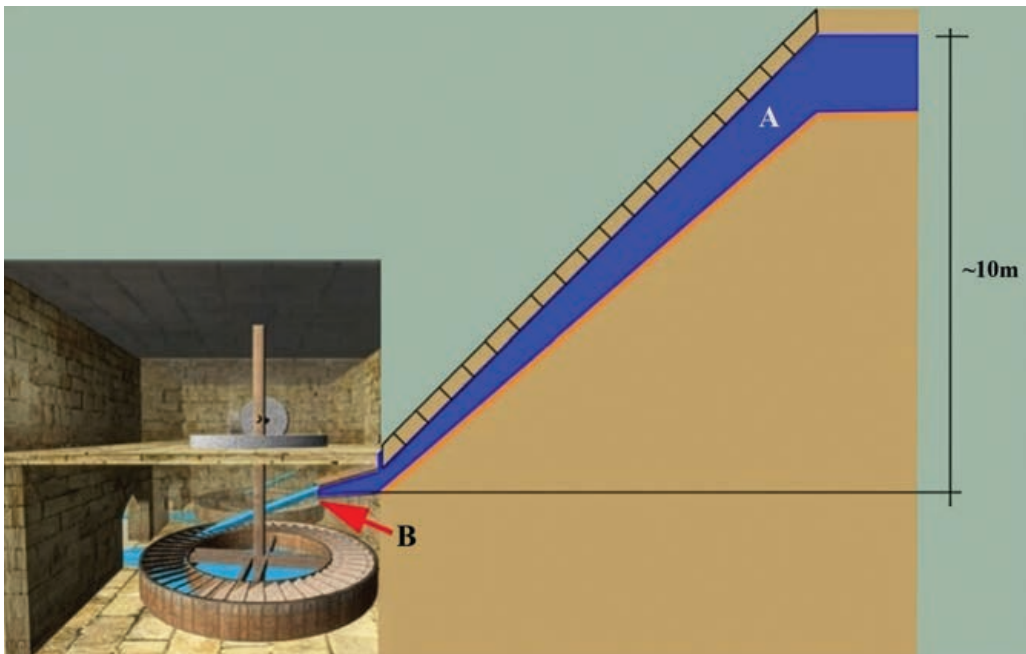


Figure 5.19. Proposed reconstruction of water-powered mechanism: A, oblique shaft; B, outlet. Image by Y. Dray.

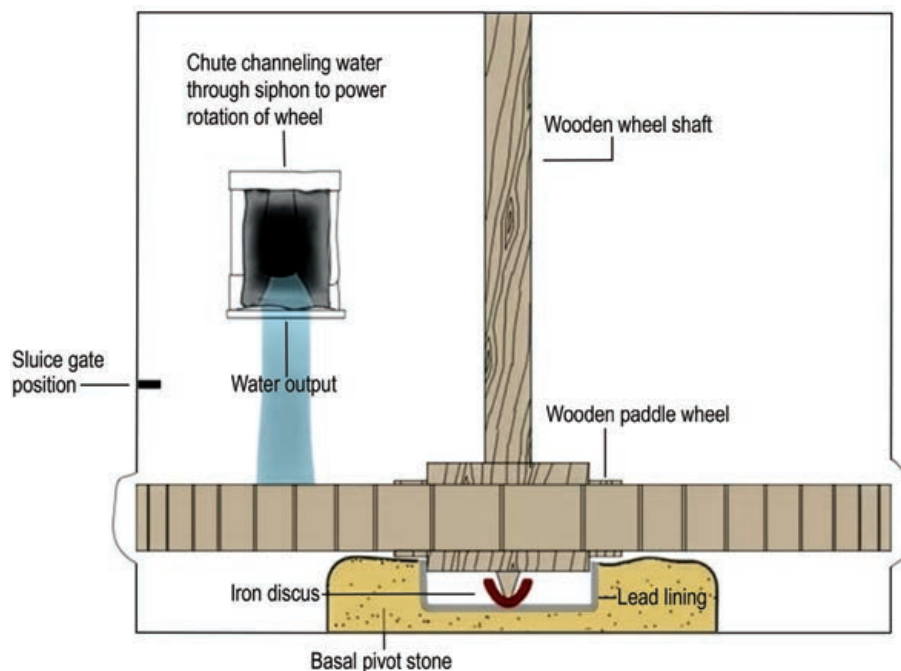


Figure 5.20. Schematic representation of gear system in lower rooms. Drawing by I. Tsomoukou after A. Kapetanios.

via arched doorways in the northern wall that were about 2 m wide, allowing access for the maintenance and supervision of the wheel mechanism (fig. 5.21).

THE AQUEDUCT OR ACEQUIAS

Both presses in the complex were fed by a substantial, contour-line gravity flow aqueduct that tapped the Wādī al-Ḥasā and descended along the southwestern contour of the wadi's mouth, using gravity flow to reach the press. High in the mouth of the wadi is a substantial, stone-carved conduit with a stone-carved specus measuring 1.5–2.0 m wide.⁶¹ A Nabataean inscription and niche on the southern escarpment of this tract of channel may mark the point at which the water was originally tapped, probably by a dam that has since been washed away. Smaller dams to the west dating to the early twentieth century were visible after a flash flood in 2007. The width of the aqueduct's channel, directly behind the parallel acequias, measures 1.35 m, while the channel widths of the parallel branches measure 0.95 m. The considerable dimensions of the channel itself (both in the wadi and directly behind the crushing installation); the presence of three large, water-driven presses; and evidence supporting a high degree of industrial activity at the site all suggest that a substantial amount of water was necessary for the installation to

61 Politis, *Origins of the Sugar Industry*, 320, fig. 13.

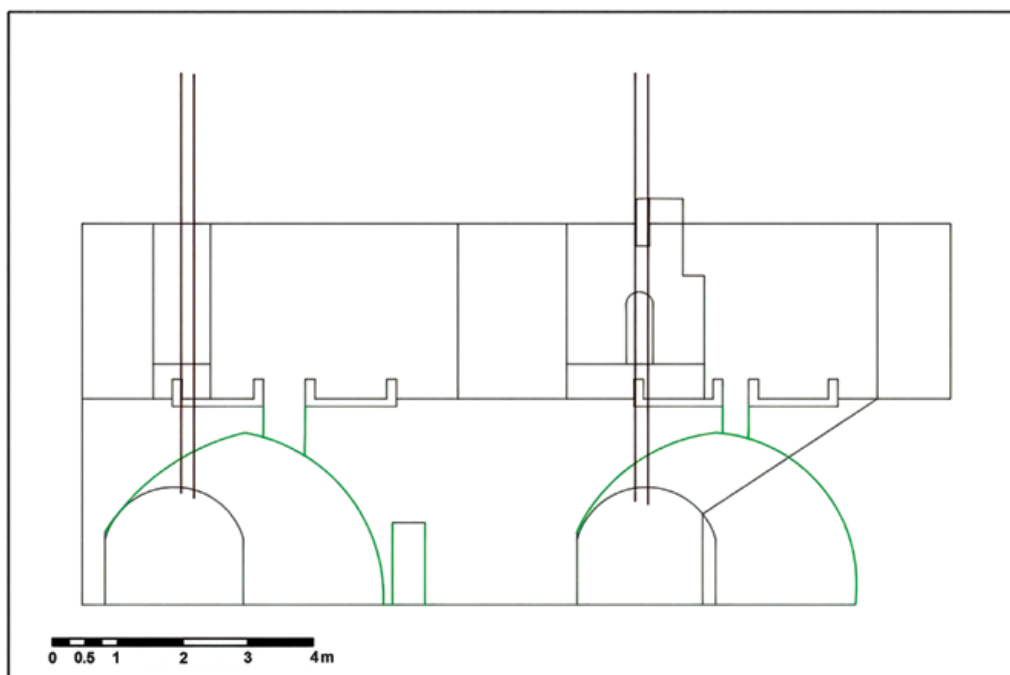


Figure 5.21. East-west elevation of pressing and gear chambers along northern wall. Drawing by Q. Dasouqi.

operate at its full potential. The scale of the overall installation is comparable with the second press at Kouklia on Cyprus. The major difference between the two installations is that the press at Kouklia is divided into two main parts—the pressing chamber and the grinding hall—and only the pressing-out of the cane mash was water powered, while the grinding of the cane was animal powered.⁶² The indications are that all three presses at Ghor as-Safi were water powered.

A buildup of sinter, a calcareous encrustation estimated to grow at a rate of 1 mm per year (at least in Roman aqueducts),⁶³ is evident in places along the substructure walls of the acequias and on the soffits of the voussoirs of the western arch. This evidence either reflects leakage during the operation of the press or, more likely, marks the point at which the press fell into permanent disrepair.

The vast amount of water directed toward the site was also used to irrigate the surrounding agricultural fields, where presumably cane was cultivated. In 1997, the corbeled vault of the underground water channel descending from the western press had partially collapsed at the northern end, and I was able to go down into it to record it (fig. 5.22). The channel was more than 1.5 m wide and more than 2.0 m deep, and its lower part was plastered. More than 100 m of the channel running on a north-south axis could be estimated, but it presumably ran much farther toward the town center and into the plantations.

62 Maier and von Wartburg, "Excavations at Kouklia," 303.

63 Kessener, "Aqueduct of Aspendos," 111.



Figure 5.22. Roughly corbeled vault of underground channel leading north. Photo by T. Springett.

THE EASTERN AREA

The eastern part of Masna' al-Sukkar was where the actual sugar processing, boiling, and curing took place (fig. 5.23). Covered conduits with lead piping channeled the pressed sugarcane juices to the first collecting vats (fig. 5.24). Then the juices were transferred to plastered bins, where additives could be mixed in before they were boiled in large, cast-copper cauldrons (*dusūt*, sing. *dist*) over furnaces, twelve of which were discovered (figs. 5.25 and 5.26).

The large accumulation of ash and cinder heaps immediately east of the furnaces testifies to low-temperature heating associated with the boiling process. This step reduced the sugar juices to a thick syrup, which was then poured into specially made pottery cones and jars to form crystallized sugar (fig. 5.27). Ten of these pots were found set into surfaces and bins plastered with hydrated lime, which has antiseptic properties, presumably to keep them as clean as possible for edible products (fig. 5.28).

This area must have had a roof apparently supported by two parallel rows of pointed arches, only one of which was discovered intact in 2018 (figs. 5.29 and 5.30). However, it is likely that the two rows stood at least until the mid-nineteenth century, when they were described as “a massive gateway built of dressed stone with pointed arches” (fig. 5.31).⁶⁴ Since the western arcade was higher than the eastern one, the roof would have sloped toward the east.

⁶⁴ Tristram, *Land of Moab*, 63.



Figure 5.23. Overhead composite image of eastern area in 2018. Image by Q. Dasouqi.



Figure 5.24. First collecting vats for pressed sugarcane juice in eastern area. Photos by K. D. Politis.

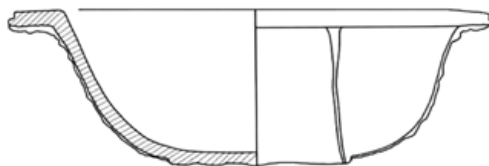


Figure 5.25. Cast copper-alloy *dist* cauldron for boiling pressed sugarcane juice. Photo by T. Springett; drawing by A. Ariotti.

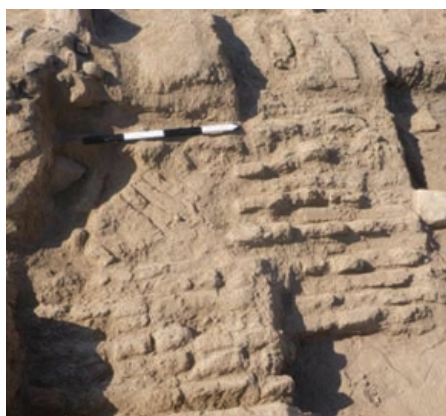
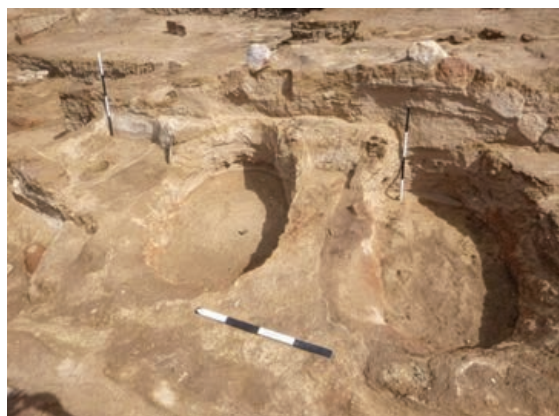


Figure 5.26. *Left*, two of the twelve furnaces. *Right*, stoke room brickwork superstructure in eastern area. Photos by K. D. Politis.

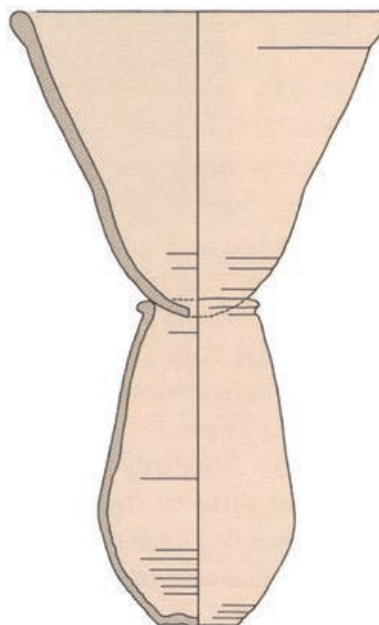


Figure 5.27. Upper perforated sugar cone and lower molasses-collecting pot. Photo by K. D. Politis; drawing by C. Schofield.



Figure 5.28. Sugar pots set into clean plastered surfaces. Photo by K. D. Politis.



Figure 5.29. Sugar-processing area viewed from the north in 2018. Photo by K. D. Politis.

Similar sugar-processing factories have been identified in the Jordan Valley⁶⁵ and excavated at Kouklia and Episkopoi on Cyprus, and they are known to have existed elsewhere in the Mediterranean (fig. 5.32). The significance of the Masna' al-Sukkar in Ghor as-Safi is that it is an early version (if not the prototype) of a sugar factory, and it is larger than the others (hence with greater sugar production). The production of sugar played a pivotal role in the economy of the Ayyubid-Mamluk period in Ghor as-Safi. Great wealth was

⁶⁵ Abu-dalo, "Story of Sugar Production," 44, fig. 4.



Figure 5.30. Sugar-processing area viewed from the south in 2018. Photo by K. D. Politis.



Figure 5.31. Schematic reconstruction of western arcade over sugar-processing area. Drawing by U. Bellwald.

generated from it, and profits went largely to the state, which sponsored the industry,⁶⁶ as the 2018 discovery of official seals or stamps on clay from a storeroom at Masna' al-Sukkar verified (fig. 5.33).

NEW RESEARCH AND STUDIES

Extensive studies conducted on the pottery types discovered at Ghor as-Safi have shown that although some pottery was imported, the vast majority of it was produced in the vicinity using local clays and fired on-site (pottery wasters and kiln linings were found in abundance). Metal slag also found there is evidence of smelting and casting.

⁶⁶ Politis, "Earliest Evidence," 31.



Figure 5.32. Illustration from *Nova reperta*, by Jan van der Straet (1570), showing sugarcane processing in Sicily.



Figure 5.33. Clay stamped with ختم (*khatm* “seal” or “sealed”). Photos by K. D. Politis.

For producing sugar, exceptionally large copper cauldrons (fig. 5.25) were cast and huge quantities of specialized pottery (fig. 5.27) made on-site. This additional manufacturing contributed to industrial-scale production not seen before.

Preliminary botanical analysis of the ash deposits in the sugar factory dumps revealed the remains of sugarcane fragments. It is hoped that ongoing study will determine the type of cane grown and whether it had a particularly good yield. Other identifiable plants will

help reconstruct the Islamic-period agricultural economy. A study of the animal bones retrieved from excavations at the site has shown that zebu (*Bos primigenius indicus*), a cattle species usually employed for draft and tilling (as opposed to meat and milk production), were kept there during the Ayyubid-Mamluk period.⁶⁷ Furthermore, the zebu's Indian origins complement sugarcane's South Asian derivation and highlight interrelations between the two regions.

The study also aimed to determine what kind of pack animals were used to transport agricultural and other products; initial bone analyses indicate that camels were used on-site. At Wādī Abrash, southeast of Ghor as-Safi, is a narrow track still used by camels today, as evidenced by fresh camel dung and graffiti.⁶⁸ Camels as work animals are also depicted in the Umayyad-period wall paintings at Qusayr 'Amra.⁶⁹ During the Umayyad period, a road network with regular stations was established in Bilād al-Shām, some of them along Roman-Byzantine imperial roads, to ensure good access for both pilgrims and trade. These roads are known to have passed through Zughar.⁷⁰ As a result of recent surveys, three routes from the eastern plateau down to Ghor as-Safi have been identified, including a main (former Roman-Byzantine imperial) road with three intermittent open-air mosques. A route west of Zughar can be found on the way to the Mediterranean port of Gaza via Me'ad Zohar just below Ma'ale Zohar ("Zohar Ascent"), which may have been a kind of "weigh station" for sugar on the basis of "sugar pot" fragments found there.⁷¹ This road may be the same one mentioned by the Crusaders.⁷² These routes could have been sections of a more extensive *darb al-sukkar* transportation network.

THE ZUGHAR SUGARCANE INDUSTRY IN PERSPECTIVE

Analysis of the pottery finds suggests that the sugar factory at Zughar may have functioned as early as the eighth century CE and was certainly fully operational by the Crusader and Ayyubid-Mamluk periods. The late fifteenth-century CE burials found in the pressing chamber demonstrate that operations there were abandoned by this time.

This evidence accords with events in the wider trade network. In the fifteenth century, the Spanish and Portuguese introduced sugarcane to the islands of Madeira, the Canaries, Santiago, and São Tomé. By the later fifteenth and early sixteenth centuries, sugar from these islands was flooding European markets, with ruinous effects on the sugar industry of both the Christian and Muslim Mediterranean littoral.⁷³

Alternatively, Anthony Luttrell argues that the Mamluk sugar industry fell into decline before such competitive market forces were introduced to the Mediterranean, and he points to an overarching crisis caused by recurrent plagues and civil wars leading to dramatic depopulation, a situation aggravated by government interference, overtaxation, and

⁶⁷ Martin, "Animal-Based Subsistence."

⁶⁸ Politis, "Agriculture in the Ghor es-Safi," 706.

⁶⁹ Walmsley, "Roads, Travel, and Time," 465.

⁷⁰ Walmsley, "Roads, Travel, and Time," 463.

⁷¹ Erickson-Gini, *Nabataean Settlement*.

⁷² William of Tyre, *History of Deeds*, 412.

⁷³ Watson, *Agricultural Innovation*, 145.

technological stagnation.⁷⁴ The palaeoenvironmental record of the Dead Sea region clearly demonstrates a marked decrease in rainfall after 1400 CE,⁷⁵ which would have contributed to agricultural and economic decline.

EPILOGUE

The processing of indigo and sugarcane required scientific knowledge, particularly that of alchemy. Medieval Islamic science continued and advanced classical Greek traditions by translating them into Arabic at the *Bayt al-Ḥikma* during the eighth century CE in Baghdad. The origins of the chemical industry are inexorably linked with indigo and sugar production, as both commodities required organic alterations of biological components and their compositions. These deliberate modifications were necessary to manufacture new products on a larger scale for both local consumption and trade. Furthermore, the making of specialized processing equipment augmented the industrial nature of the endeavors and thus led to an increase in complex manufacturing and commerce.

The recent studies at Ghor as-Safi make it apparent that the site was a major agricultural center during the early and middle Islamic periods (eighth to fifteenth centuries CE) in southern Bilād al-Shām based on the cultivation of dates, indigo, and—ultimately the most important—sugarcane. Furthermore, on-site processing of these products on a large scale indicates an unprecedented industrial level of production. For sugar, well-funded state sponsorship was fundamental to its success as a major international product. This new agricultural regime was founded on a change in the way land was used; labor was exploited and investment maximized with new products to increase food output. Although less arable land was available, there was more labor and more capital, which was consequently devoted to farming. The outcome was a brisk increase in agriculture that mirrored economic growth in general during this era.

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⁷⁴ Luttrell, "Sugar Industry," 169.

⁷⁵ Bookman et al., "Late Holocene Lake Levels," figs. 5 and 8.

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6

The Early Islamic (Eighth- to Tenth-Century) Copper Industry in Southern Wādī ʿAraba

Ian W. N. Jones

INTRODUCTION

Compared to the great Islamic-period mining districts of the Arabian Peninsula, the copper mines of Wādī ʿAraba, at the northern tip of the Arabian Shield, were undoubtedly of minor importance. Copper, while an important mineral, was not as important as gold or silver, and the amount of copper produced in Wādī ʿAraba was relatively small. Nonetheless, studies of minor manifestations of larger trends have the potential to provide considerable insight into both general processes and exceptions to these processes.¹ Indeed, one of the major strengths of archaeology is its ability to shed light on phenomena largely absent from historical sources. As such, the goal of the present chapter is not to suggest that the copper industry of southern Wādī ʿAraba was particularly crucial to the early Islamic economy but rather that situating this small industry within its broader economic context can generate insights into both.

WĀDĪ ʿARABA

Wādī ʿAraba, part of the northern portion of the Great Rift Valley, is the arid lowland region stretching from the Dead Sea in the north to the Gulf of ʿAqaba in the south (fig. 6.1). Although it forms part of the border between modern Israel and Jordan, it does not seem to have been a border at any point before the establishment of these modern states, and it certainly was not during the early Islamic period.² One of the primary mineral resources of Wādī ʿAraba is copper ore, concentrated primarily in deposits in the Faynān region of Jordan and the region around the Timna Valley in Israel, with more minor deposits located in Wādī Abū Khushayba and Wādī Abū Qurdiya, south of Petra, in Jordan.³ These deposits have been exploited since the early Neolithic period, when they were used primarily to make “greenstone” artifacts and pigments, and have been exploited for extractive copper

1 See, e.g., Eger, *Archaeology of Medieval Islamic Frontiers*, an edited volume on the “minor frontiers” of the Islamic world.

2 See Bienkowski, “Tribes, Borders, Landscapes and Reciprocal Relations.”

3 Hauptmann, “Mining Archaeology,” 125–27.

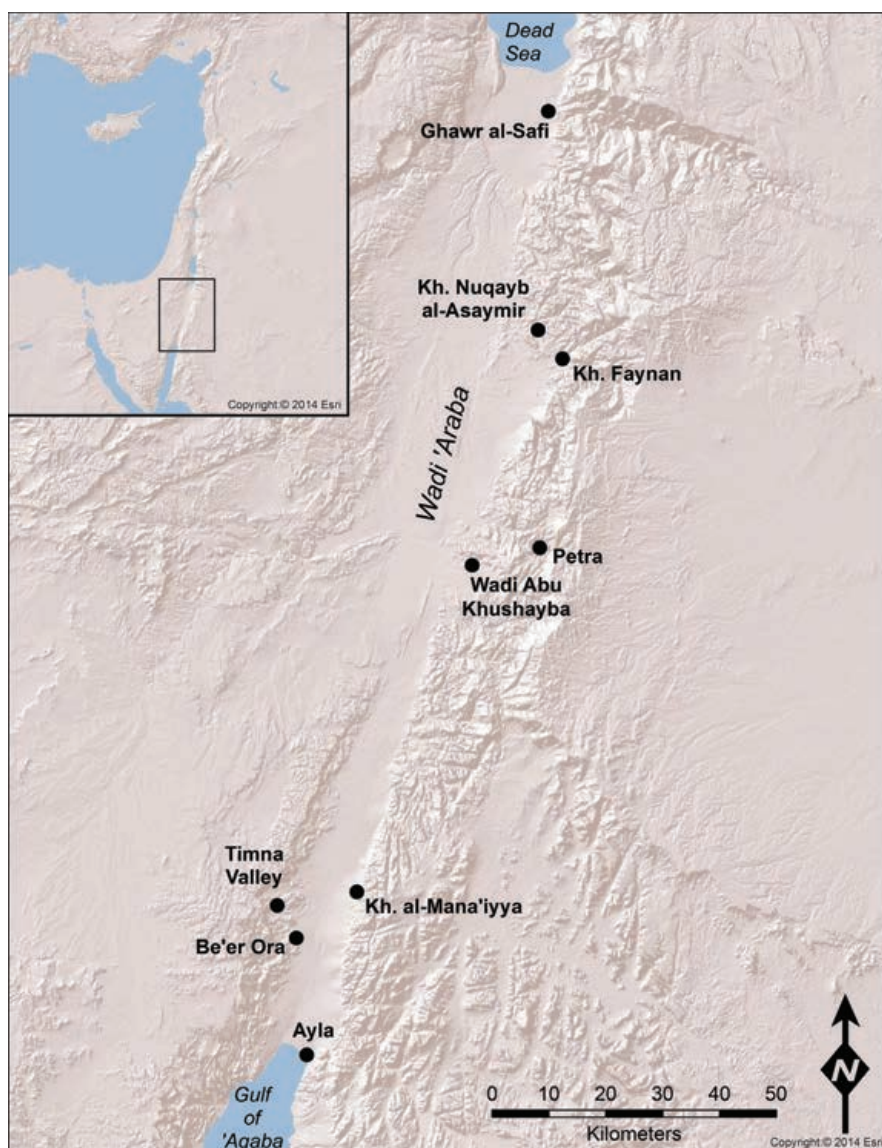


Figure 6.1. Map of Wādī 'Araba showing the locations of key sites and copper ore mining districts. Basemap © Esri.

metallurgy since the late fifth or early fourth millennium BCE.⁴ The most intensive period of copper production in Wādī 'Araba was the Iron Age (ca. 1200–586 BCE), when the region produced perhaps as much as 13,000 tons of copper.⁵ Although production never again reached that level of intensity, Wādī 'Araba continued to be important as a source of copper in the first millennium CE.

4 Hauptmann, *Archaeometallurgy of Copper*, 257–72; Weisgerber, “Mineral Wealth,” 5–8.

5 Hauptmann, *Archaeometallurgy of Copper*, 147, table 5.3.

Throughout the Roman and early Byzantine periods (second through fourth centuries CE), copper production in the southern Levant was concentrated in central Wādī ʿAraba, primarily in the Faynān region at the site of Khirbat Faynān, the Roman *metallum* of Phaino.⁶ While the precise dating is still unclear, at some point, probably in the early fifth century CE, this production scaled down considerably and, by the end of the fifth century, seems to have ceased entirely.⁷ During the early Islamic period, copper production was revived, but this time centered around the Timna Valley in southern Wādī ʿAraba, the hinterland of the burgeoning city of Ayla (modern al-ʿAqaba, Jordan). No evidence for smelting in this period has been found in the Faynān region, and the only post-Byzantine smelting activity occurred centuries later, during the middle Islamic period, specifically the Ayyūbid period (1187–1263 CE).⁸ Likewise, copper production elsewhere in central Wādī ʿAraba was minimal, being limited to several small sites on the opposite side of Wādī ʿAraba from Faynān, in modern Israel.⁹ The shift of production to the south indicates major changes in the economic organization of Wādī ʿAraba, as would be expected given the major political changes that occurred in the seventh century.

In terms of historical documentation of copper production in Wādī ʿAraba, our best evidence concerns Roman activities in Faynān, as several written sources, dating primarily to the fourth century CE, mention the state-run mines in the region.¹⁰ These sources, however, are concerned mostly with the punitive aspects of the mines, as Byzantine authors such as Eusebius of Caesarea were interested primarily in the Christian martyrs who had been sentenced to *damnatio ad metallum*.¹¹ Nonetheless, these sources shed some light, even if incomplete, on this industry. Unfortunately, similar documentation is not known for the early Islamic industrial sites in southern Wādī ʿAraba. Here we must rely instead on archaeological evidence, which allows for partial reconstruction of the copper production system.

THE ARCHAEOLOGY OF SOUTHERN WĀDĪ ʿARABA

At a basic level, the copper production sites in southern Wādī ʿAraba share a number of archaeological features. The first is the unique type of copper slag—often called “ring slag”—that so far has been found only at the early Islamic sites.¹² Its most distinctive fea-

6 See Mattingly et al., “Landscape of Imperial Power.”

7 Jones, Najjar, and Levy, “Not Found,” 182–85.

8 See Jones, Levy, and Najjar, “Khirbat Nuqayb al-Asaymir”; Jones, Najjar, and Levy, “Arabah Copper Industry,” 334–36; “Not Found,” 188–93.

9 These are Naḥal ʿArava sites 1, 2, and 3, near ʿEn Yahav (Nahlieli and Shemesh, “ʿEn Yahav”) and, about 10 km to the north, Naḥal Shahaq site 8, near Hazeva (Nahlieli and Shemesh, “Hatzeva”). The amount of copper produced at these sites is not estimated in the survey reports but, based on the descriptions of the sites, seems to have been quite small.

10 See Millar, “Condemnation to Hard Labour,” 140–41.

11 Knauf and Lenzen, “Edomite Copper Industry,” 83; see also Najjar and Levy, “Condemned to the Mines.”

12 Avner and Magness (“Early Islamic Settlement,” 52–53n7) suggest a date as early as the Nabatean period (ca. first century BCE–first century CE) for the emergence of this smelting technology. But there is no clear evidence for such an early date, and, at present, the evidence instead points to its use exclusively during the early Islamic period. See Jones et al., “Khirbat al-Manaʿiyya,” 299–300n5.

ture is the central cast-in hole that gives it a ring shape—hence its name—but it has a number of other diagnostic features, including prominent flow banding and a unique chemical signature.¹³ Second, all the copper production sites seem to be of roughly the same date. The ceramics—when they are present—date essentially without exception to the late eighth and early ninth centuries, and the radiocarbon dates cover a slightly wider range, between the seventh and eleventh centuries.¹⁴ This has led to some disagreement over the origins and longevity of the system, but below I argue that the evidence most strongly supports a short-lived boom in the later eighth century. The dating is only interesting, however, insofar as it illuminates more important questions about the industry's organization, primarily concerning the degree of elite investment in copper production and centralized control over the industry.

The spatial patterning and scale of the industry, likewise, reveal a considerable amount about its organization (fig. 6.2). One prominent aspect of the southern Wādī 'Araba copper industry is the rarity of comparatively large production sites. The largest smelting camp by far is Be'er Ora (Arabah Expedition site 28), which Uzi Avner and Jodi Magness estimate contains 5,000 tons of slag in its slag mounds, corresponding to perhaps 300–500 tons of copper.¹⁵ A second potentially large smelting site was located at Umm al-Rashrāsh, in the modern city of Eilat.¹⁶ Although the dating of the site was initially uncertain, with dates in the Bronze and Iron Ages proposed in the early to mid-twentieth century, the presence of ring slag points to an early Islamic-period date.¹⁷ While a photo published in 1935 appears to show a sizable slag mound, the site “was destroyed in the 1950s,” thus making it impossible to estimate with any certainty the amount of slag at the site.¹⁸ It should nonetheless be noted that while Avner and Magness have described the site as a “relatively large camp,” Beno Rothenberg calls it “a very small copper smelter of no more than local importance,” and it was, without doubt, much smaller than Be'er Ora.¹⁹ The second-largest smelting camp for which estimates can be made is, therefore, Khirbat al-Mana'iyya, the only identified smelting camp of the period on the eastern side of Wādī 'Araba. Together, the debris mounds at the site contain several hundred tons of slag, making it a larger smelting camp

13 Jones et al., “Khirbat al-Mana'iyya,” 298–99, 308; Rothenberg, “Archaeo-Metallurgical Researches,” 166–67.

14 Jones et al., “Khirbat al-Mana'iyya,” 305; Nol, “Fertile Desert,” 53–55, table 1.

15 Avner and Magness, “Early Islamic Settlement,” 42.

16 Glueck, *Explorations*, 47–48.

17 Avner and Magness, “Early Islamic Settlement,” 42; cf. Rothenberg, “More on Dating.” On another debate over whether the site should be dated to the Chalcolithic or Roman period, see Several, “Dating the Mrashshash Slag”; Rothenberg, “More on Dating.” Rothenberg's Roman date was based primarily on the similarity of the ring slag found at Umm al-Rashrāsh to the slag from Be'er Ora, which at the time was thought to be a Roman site. Later investigations demonstrated that the bulk of the smelting at Be'er Ora occurred during the early Islamic period, and ring slag has since been found only at early Islamic sites. It is therefore reasonable to date the activity at Umm al-Rashrāsh to the early Islamic period on this basis. On the dating of Be'er Ora to the early Islamic period, see Rothenberg, “Archaeo-Metallurgical Researches,” 166–68.

18 Glueck, *Explorations*, 47, fig. 23; Avner and Magness, “Early Islamic Settlement,” 42.

19 Avner and Magness, “Early Islamic Settlement,” 42; Rothenberg, “Ancient Copper Industries,” 61.

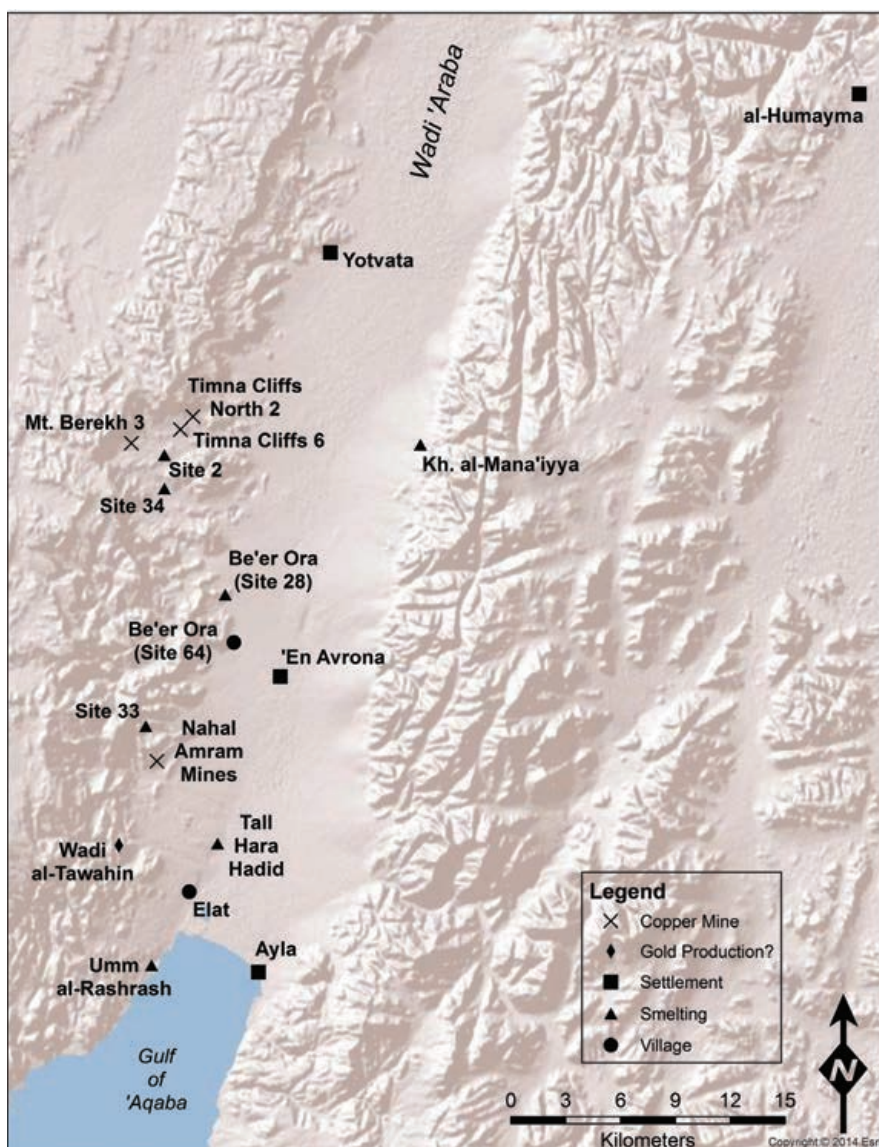


Figure 6.2. Map of southern Wādī ʿAraba showing the locations of sites mentioned in the text. Basemap © Esri.

than most others in southern Wādī ʿAraba, although a smaller one than Beʿer Ora by an order of magnitude.²⁰

The number of large smelting sites must be understood in relation to the industry as a whole. As a comparison, only two substantial middle Islamic-period copper-smelting sites are known in Faynān. While the presence of relatively few large production sites seems similar at first glance to the system described above for southern Wādī ʿAraba, these two production sites are the only ones of this period in the Faynān region. In contrast, small

²⁰ Ben-Yosef, “Environmental Constraints,” 64; Jones et al., “Khirbat al-Manaʿiyya,” 300.

production sites are relatively common in southern Wādī ‘Araba. Smaller production sites of this period are known at Tall Ḥāra Ḥadīd (Arabah Expedition site 4), where an estimated 50 tons of slag were found;²¹ at a number of sites in Naḥal ‘Amram, including Arabah Expedition site 33²² and Naḥal ‘Amram site 35/7, a slag mound containing an estimated 30 tons of slag;²³ and in the Timna Valley, where early Islamic-period smelting has been identified in several of the furnaces at site 2²⁴ and in two small slag mounds at the foot of site 34, the so-called “Slave’s Hill.”²⁵ The online publication of Rothenberg’s Wādī ‘Araba survey maps in the Archaeological Survey of Israel database²⁶—particularly the maps of Yotvata (no. 255), Timna Cliffs (no. 257), Be’er Ora West (no. 260), Har Amir (no. 263), En Netafim (no. 265), and Eilat (no. 266)—in combination with more detailed information about these sites entered in the Digital Archaeological Atlas of the Holy Land,²⁷ adds six additional small smelting sites of the early Islamic period and seven sites with undated smelting remains that were occupied in several periods, including the early Islamic.

There are, therefore, at least eleven to eighteen small smelting sites, compared to only two or three larger ones, and the number of small sites is likely a low estimate. While copper slag of the early Islamic period has a number of diagnostic features, industrial sites in southern Wādī ‘Araba are characterized by few other diagnostic artifacts. Even at large smelting sites such as Be’er Ora and Khirbat al-Manā‘iyya, ceramics are uncommon, as are architectural features.

At Be’er Ora, the architectural remains of a village—consisting primarily of “modular” square rooms²⁸—are concentrated several kilometers south of the smelting site proper, at Be’er Ora 1 / Arabah Expedition site 64,²⁹ Be’er Ora (Southeast),³⁰ Be’er Ora (A),³¹ and Be’er Ora (B),³² with a smaller “workers’ camp” located about 0.5 km south of the smelting site.³³ While limited smelting seems to have occurred at some of the “village” sites—and probably also at Eilat Village, a similar village farther south, probably associated with the Umm Rashrāsh smelting camp³⁴—the bulk of the smelting was concentrated to the north, at Be’er Ora (Arabah Expedition site 28) proper. No buildings were visible on the surface of site 28,

21 Ben-Yosef et al., “New Approach,” 2876; Rothenberg, “Ancient Copper Industries,” 63; *Were These King Solomon’s Mines?*, 211.

22 Avner and Magness, “Early Islamic Settlement,” 42; Willies, “Ancient Copper Mining,” 113.

23 Avner et al., “Ancient Copper Mines,” 169.

24 Avner, “Egyptian Timna,” 146, table 1, nos. 78–79; Avner and Magness, “Early Islamic Settlement,” 57, nos. 2–3; Ben-Yosef, “Technology and Social Process,” 671–72; Ben-Yosef et al., “New Chronological Framework,” 59n14.

25 Peters, Tauxe, and Ben-Yosef, “Archaeomagnetic Dating,” 566–67.

26 https://survey.iaa.org.il/index_Eng.html.

27 <https://gaialab.terrawatchers.org/DAAHL/Home.php>.

28 On this architectural style, see Whitcomb, “Archaeological Evidence,” 27, and discussion below.

29 Rothenberg, “Ancient Copper Industries,” 63; see also Avner and Magness, “Early Islamic Settlement,” 41, fig. 1, and 42; Nol, “Fertile Desert,” 56, table 2.

30 Yisrael, “Be’er Ora (Southeast).”

31 Israel, “Be’er Ora (A).”

32 Israel, “Be’er Ora (B).”

33 Erickson-Gini, “Be’er Ora.”

34 Avner, “Elat-Elot”; Rapuano, “Early Islamic Settlement.”

although excavations revealed that several apparent slag mounds were, in fact, the remains of architectural features built of slag.³⁵ At Khirbat al-Manāʿiyya, the only architectural feature recorded at the site was a single modular room.³⁶

At smaller smelting sites, architectural features and pottery are rarely found, thus making these sites more difficult to identify and date, particularly if the distinctive ring slag cakes have been broken up into smaller pieces. It is therefore reasonable to conclude that a greater number of small smelting sites have gone unidentified or misdated than large ones have, and that smaller smelting sites face a greater likelihood of having been destroyed without being recorded. A number of small, undated smelting sites were found in Israel by Rothenberg's surveys and in Jordan by the Southeast ʿAraba Archaeological Survey, including several in the vicinity of Khirbat al-Manāʿiyya.³⁷ Our understanding of the metallurgical landscape of southern Wādī ʿAraba is thus incomplete, but it is possible to characterize the overall industry accurately. The bulk of copper smelting took place at a small number of large camps, containing somewhere between several hundred and 5,000 tons of slag, but the majority of sites were smaller smelting camps, containing several to perhaps 50 tons of slag.

THE ORGANIZATION OF EARLY ISLAMIC COPPER PRODUCTION

One explanation for the pattern described above—tens of small smelting camps but perhaps only two large ones—is that the sizes and distributions of the camps were largely determined by the sizes and distributions of copper ore sources. In other words, it is possible that the largest camps clustered around the largest mines, while the smaller camps exploited more minor sources of ore. Cathy Lynne Costin points out that uneven distribution of raw materials can often lead to “nucleated” craft production, where production sites are aggregated in specific localities.³⁸ For archaeometallurgy specifically, Andreas Hauptmann refers to this scenario—smelting sites clustered around ore sources, to which other necessary resources (e.g., food, water, charcoal, labor) are transported—as “charcoal to the ore.”³⁹ In the case of southern Wādī ʿAraba, this argument does not hold up. While smelting sites in Naḥal ʿAmram and the Timna Valley are close to ore sources, the largest smelting sites are not. The smelting camp at Beʿer Ora seems to have sourced ore from Naḥal ʿAmram, 8 km to the south,⁴⁰ and the likeliest ore sources for Khirbat al-Manāʿiyya are about 15 km to the west, either in the Timna Valley proper⁴¹ or just north of the valley

35 Rothenberg, “Archaeo-Metallurgical Researches,” 166, 168.

36 Jones et al., “Khirbat al-Manāʿiyya,” 302.

37 Smith, “Southeast ʿAraba Archaeological Survey,” 217–19.

38 Costin, “Craft Specialization,” 14.

39 Hauptmann, *Archaeometallurgy of Copper*, 52.

40 Avner and Magness, “Early Islamic Settlement,” 43.

41 Jones et al., “Khirbat al-Manāʿiyya,” 306. More recently, Langford and colleagues (“Copper Mines,” 15) propose that workers at Khirbat al-Manāʿiyya may have exploited small deposits in eastern Wādī ʿAraba, including the Mughārat al-Ghūla mine in Wādī al-Khubat; Jones and colleagues consider this possibility but note that these sources are as far from the site as the Timna Valley and fairly insubstantial; it is, nonetheless, possible that at least some ore smelted at Khirbat al-Manāʿiyya was sourced from small deposits like these in the eastern Wādī ʿAraba.

at Timna Cliffs 6 (Arabah Expedition site 87), Timna Cliffs North 2 (Arabah Expedition site 186), and Mount Berekh 3 (Arabah Expedition site 212). Smaller camps near Yotvata and Ayla are, likewise, a considerable distance from the nearest ore sources.

Environmental factors and the distribution of non-ore resources may, however, explain the locations of at least the larger camps. The location of Khirbat al-Manā'īyya, opposite the Timna Valley in southeastern Wādī 'Araba, seems to have been chosen to take advantage of wood and water resources, both of which are rare closer to its ore sources.⁴² Sparse wood and water resources may explain why the largest volume of production took place at two or three nucleated centers but does not explain the spatial patterning of the entire industry—that is, why there are so many small camps, many of them located farther away from these resources.

The patterning of production sites is, of course, influenced equally by social, economic, and political concerns as by the distribution of raw material sources, a point that Keith Nicklin demonstrated ethnographically nearly fifty years ago for ceramic production.⁴³ In the examples he cites, nucleation or dispersal of production rarely reflected resource distribution but instead was determined by a variety of factors, including political and social inequality, conflict, ritual and craft specialization, and economic pressures.

To determine what underlying political, cultural, and economic factors explain the distribution of smelting sites in southern Wādī 'Araba, it is useful to draw comparisons with other systems, the most obvious of which is perhaps middle Islamic-period Faynān (fig. 6.3). At Khirbat Nuqayb al-Asaymir—one of only two production sites of this period—the nucleation of production at only two sites and the fact that the ceramic assemblage indicates the presence of elites suggests top-down organization.⁴⁴ During the Roman period, smelting was even more centralized, with 40,000–70,000 tons of slag concentrated in a single slag mound (Faynān 1) near Khirbat Faynān.⁴⁵ The same pattern may also hold for the early Islamic-period mines along the Darb Zubayda in Saudi Arabia, which Prentiss de Jesus and colleagues explain by noting “that the Abbasids were highly committed to the exploitation of copper and gold on the Arabian Shield.”⁴⁶ The fact that the distribution of the smelting settlements surveyed by these researchers had a limited number of large, nucleated centers clustered around mines suggests more centralized control. Detailed work, however, was conducted only at the large center of al-Nuqra, and other surveyed sites—for example, the undated copper-smelting site at Ṣubḥa and the “copper-mining area” at

42 Ben-Yosef, “Environmental Constraints”; Jones et al., “Khirbat al-Mana'īyya,” 306–7.

43 Nicklin, “Location of Pottery Manufacture.”

44 Jones, Levy, and Najjar, “Khirbat Nuqayb al-Asaymir,” 89–90.

45 Hauptmann, *Archaeometallurgy of Copper*, 96, 147. Hauptmann also suggests that this slag mound is the only Roman-period one in the entire Wādī 'Araba. This is an overstatement, as small-scale smelting probably occurred to the west in Wādī Fidān (see Levy et al., “Early Metallurgy,” table 2) and at 'En Yahav (Yekutieli, Shilstein, and Shalev, “'En Yahav,” 12), but the difference in scale between Faynān 1 and these very small slag scatters still suggests a high degree of centralization in a clearly state-organized system. While it seems highly unlikely that ore would have been transported from southern Wādī 'Araba to Faynān, it is also the case that evidence for smelting in southern Wādī 'Araba is limited in this period. See Avner et al., “Ancient Copper Mines,” 173.

46 De Jesus et al., “Preliminary Report of the Ancient Mining Survey,” 63; see also Power, *Red Sea*, 121–24.

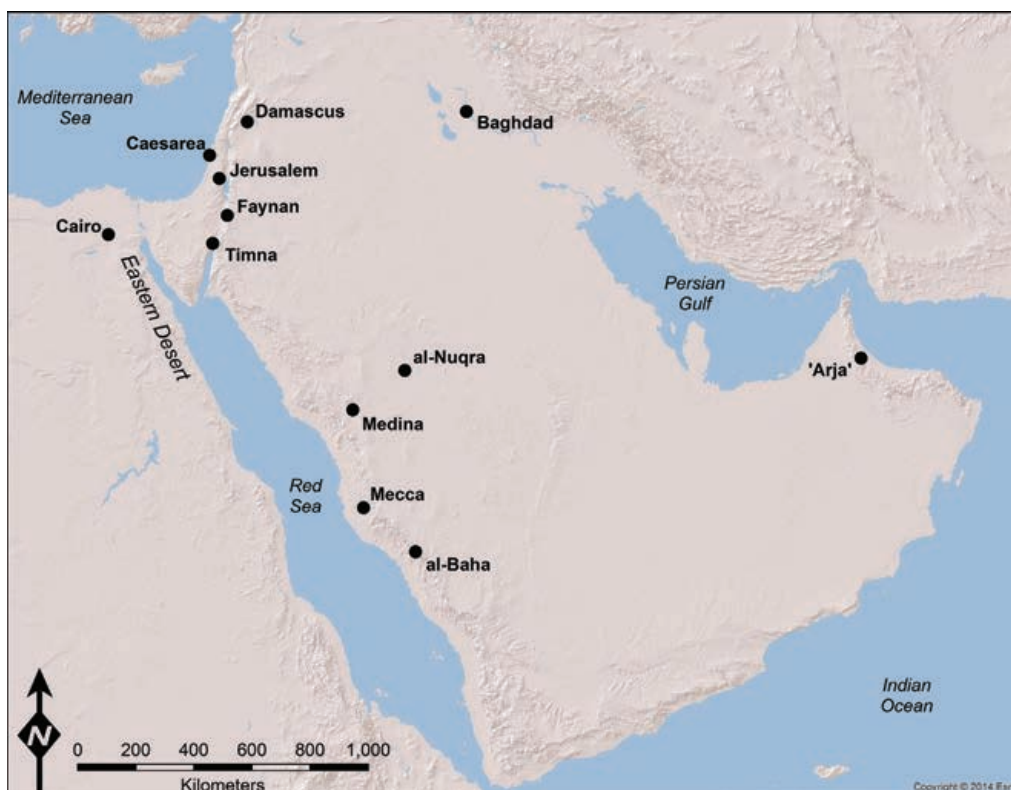


Figure 6.3. Map of the mining districts of the Arabian Peninsula in relation to Wādī ʿAraba and other sites mentioned in the text. Basemap © Esri.

Muṣaynaʿa—suggest a more complicated pattern, perhaps more similar to the distribution of sites in southern Wādī ʿAraba.⁴⁷

On the other hand, the early Islamic-period copper-smelting settlements at ʿArjā in Oman display a more dispersed pattern, with small smelting sites each containing roasting installations,⁴⁸ a single furnace, a slag mound, and a residential structure. Gerd Weisgerber interpreted this pattern of small, mostly self-contained smelting sites as evidence “that individual smelters were, to some extent, independent.”⁴⁹ It is worth noting, however, that this pattern seems to have been unique to the ʿArjā region, and other areas of Wādī al-Jizzī displayed different patterns.

The system in southern Wādī ʿAraba is not as nucleated as the examples from Faynān and Saudi Arabia, but it is also not as dispersed as the system in ʿArjā. The closest parallel—although on a larger scale, as with the cases cited above—is perhaps the distribution of early Islamic-period copper-smelting sites in al-Bāḥa, Saudi Arabia. There, three large copper-producing villages were found that seem to have housed a diverse community of

47 See de Jesus et al., “Preliminary Report of the Ancient Mining Survey,” 78, pl. 81B.

48 A roasting stage is required to smelt copper sulfide ores, as found in Oman and many other regions, but not the oxide ores that make up the bulk of the mineralization in Wādī ʿAraba.

49 Weisgerber, “Archaeological Evidence,” 158.

metallurgists and nonmetallurgists, as well as fifteen smaller, perhaps temporary settlements devoted entirely to smelting. Abdullah al-Zahrani interprets both types of site as belonging to a single system, overseen from a third type of settlement—densely nucleated gold production sites—and organized directly by the Abbasid state.⁵⁰

It may also be the case that the sites in southern Wādī ‘Araba were overseen by the state. The Abbasid family’s earlier connection to al-Ḥumayma, about 40 km northeast of the Timna Valley, is interesting here, although certainly not conclusive.⁵¹ The construction of qanats in Wādī ‘Araba and the southern highlands of Jordan likewise indicates investment in infrastructure in the region, perhaps on the part of the state.⁵² It is therefore possible that, like the mining settlements along Darb Zubayda and in al-Bāḥa, copper production in southern Wādī ‘Araba may have been organized by the Abbasid state—or, following the argument that these sites were associated with investment in the *hajj* routes, by the Umayyad state.⁵³ Dating these sites to the Umayyad period would, however, require privileging the radiocarbon dates over ceramics, as discussed below.

Direct state investment in or organization of the copper industry may not be the best explanation for the pattern of copper production sites in southern Wādī ‘Araba, however. The first issue is one of scale, both of the system and of the sites themselves. Compared with the copper-producing regions of Oman, where Hauptmann estimates at least 600,000 tons of slag (corresponding to 50,000–60,000 tons of copper) were produced in the early Islamic period,⁵⁴ the amount produced in southern Wādī ‘Araba—perhaps 6,000–8,000 tons of slag (corresponding to probably no more than 800 tons of copper)—barely registers. It is therefore not surprising that southern Wādī ‘Araba has no site on the scale of al-Nuqra. Likewise, of the southern Wādī ‘Araba sites, only Be’er Ora—if the smelting and village sites are taken to be a single unit—shows the intrasite organizational complexity of the larger village sites in al-Bāḥa.

Another issue concerns the types of metal being produced. While the system in Oman was dedicated to the production of copper, the primary interest in the trimetallic deposits of the Arabian Shield would certainly have been the production of gold and silver, with copper mining, as al-Zahrani argues, being an extension of this production.⁵⁵ By contrast, production of precious metals could not have been a large part of the southern Wādī ‘Araba system. Arie Gilat and colleagues identified an apparent gold production site in Wādī al-Ṭawāḥīn, a small tributary of Naḥal Roded, where, according to their argument, miners

50 Al-Zahrani, “Mining in al-Baha Region,” 119, table 4.5, and 120, 257–59; see also more recently al-Zahrani, “Islamic Productive Economic Landscape”; and discussion in Jones, “Mining and Metallurgical Labor,” 49–51.

51 See Schick, “Al-Ḥumayma.”

52 Abudanh and Twaissi, “Innovation”; Avni, *Byzantine–Islamic Transition*, 282–83; Porath, “Tunnel-Well (Qanat) Systems”; see also Nol, “Fertile Desert,” 59. Abudanh and Twaissi argue for a late Byzantine date for the construction of the qanats in the southern highlands, but the evidence from southern Wādī ‘Araba suggests they were likely not introduced to the southern Levant prior to the late seventh century.

53 See Petersen, “Archaeology,” 48.

54 Hauptmann, *5000 Jahre Kupfer in Oman*, 114–15.

55 Al-Zahrani, “Mining in al-Baha Region.”

exploited a nonvisible gold deposit in the local quartz.⁵⁶ Tim Shaw and Rothenberg argue that the site was unlikely to have produced gold at all, but more recently Hauptmann and Ingolf Löffler have argued for the “great probability” of its identification as a gold production site.⁵⁷ Even if this identification is accepted, the amount of gold that could have been produced using the methods described by Gilat and colleagues must have been small, and it is difficult to rule out the possibility that it was something of an experimental operation, working with difficult deposits containing a relatively small amount of gold, that met with relatively little success. Here it is worth remembering Peter Bell’s caution: “To describe the mining industry truthfully, historians must keep fixed in mind the reality that most mines are failures. Probably about one in a hundred attempts at mining makes a profit; the other ninety-nine are abandoned as failures.”⁵⁸ Regardless of its scale and profitability, the site in Wādī al-Ṭawāḥīn was, in all likelihood, not contemporary with the early Islamic copper production sites in southern Wādī ʿAraba (see below). Considering all this, if one major aspect of Abbasid investment in the Darb Zubayda mines was “the steady flow of gold to the mint of Baghdad,”⁵⁹ the interest of the state in the mines of Wādī ʿAraba would certainly have been lower.

Direct state investment is therefore not a particularly likely scenario. Other types of elite investment should, however, be considered. While Hugh Kennedy points out that provincial financial matters, particularly those related to taxation, were “sometimes in the hands of men responsible directly to the caliph,” elite investment was somewhat more complicated.⁶⁰ Kennedy also argues that during the late Umayyad and early Abbasid periods, elite revenues were often derived from investment in rural estates. Of particular relevance here are the rural *qaṭāʿi*, where an elite could be granted ownership of land in exchange for investment in improvements, often to irrigation infrastructure.⁶¹ We should probably understand the construction of the qanats in Wādī ʿAraba and the southern highlands in connection with this institution rather than with direct investment on the part of the state. It is possible that this institution also explains the organization of copper production sites, and it is interesting to note relatedly that al-Balādhurī and al-Bakrī both refer to mines being granted “to local entrepreneurs” as *iqṭāʿāt* by the Prophet Muḥammad.⁶² The dating of the *qaṭāʿi* is relevant here as well. Kennedy suggests that this system of landholding characterized elite economic activity primarily in the eighth century but began to change

56 Gilat et al., “Significance of Gold Exploitation”; see also Amar, “Gold Production”; Avner and Magness, “Early Islamic Settlement,” 44–45; Bogoch et al., “Roded Gold Occurrence”; Meshel, “Were There Gold Mines?” It is worth noting that Amar’s claim (“Gold Production,” 100–101) that the tenth-century *Hudūd al-ʿĀlam* makes reference to gold mining in Wādī ʿAraba cannot be supported, as the description of a region west of the Gulf of Ayla but south of the Qulzum Gulf must refer to the Eastern Desert, where much archaeological evidence of gold mining has been found. See, e.g., Klemm and Klemm, *Gold and Gold Mining*.

57 Hauptmann and Löffler, “Technological Innovations,” 83; Shaw and Rothenberg, “Early Islamic Gold-Mining Industry.”

58 Bell, “Fabric and Structure,” 28.

59 Power, *Red Sea*, 124.

60 Kennedy, “Central Government,” 38.

61 Kennedy, “Elite Incomes,” 141–46, 149–50.

62 Heck, “Arabia Without Spices,” 557.

during the reign of Hārūn al-Rashīd, and that during the ninth century most of the elite estates came under direct state control.⁶³

The correspondence between these dates and the dates of the southern Wādī ‘Araba smelting sites is suggestive. Pottery is not common at the smelting sites, but at both Be’er Ora and Khirbat al-Manā‘iyya the ceramic assemblage is made up primarily of Mahesh ware, identified by Donald Whitcomb at Ayla, who dated it to the late eighth and early ninth centuries CE, although recent research at Yotvata and al-Ḥumayma suggests an emergence in the early eighth century.⁶⁴ A similar pattern emerges at the village sites. All the published pottery from the Be’er Ora village consists of Mahesh ware or related wares, and at Eilat, Yehudah Rapuano identified the majority of the ceramics as Mahesh ware, with a small number of ninth-century glazed sherds belonging to an apparent postabandonment phase.⁶⁵ Avner and Magness argue that the southern Wādī ‘Araba system “flourished from at least the 8th to the 10th or 11th centuries,” a date that I have previously accepted; but as Rapuano points out, the available data from many of the sites, including Eilat, does not support such a late date.⁶⁶ As Hagit Nol notes, the only metallurgical settlement that seems to date to the later part of this period is the claimed gold production site in Wādī al-Ṭawāḥīn. While the ceramics, described as dating to the eighth to tenth centuries, have not yet been published, the fact that the two published radiocarbon dates from the site have calibrated ranges in the late tenth to early eleventh century suggests that Wādī al-Ṭawāḥīn actually postdates the abandonment of the copper production sites by at least a century.⁶⁷ It is also interesting to note that the ceramics collected by Yosef Porath at the agricultural settlement at ‘En ‘Avrona are primarily Mahesh ware and contemporary wares, while later molded Islamic cream wares were found only in the central Wādī ‘Araba, at ‘En Marzev.⁶⁸

While the end of production at the smelting sites is difficult to date, it seems reasonable to conclude that copper production in southern Wādī ‘Araba is a phenomenon primarily of the late eighth and early ninth centuries,⁶⁹ a date that suggests a connection to the system of elite rural investment described by Kennedy. This dating also provides a more concrete context for Nol’s interpretation of these settlements. She argues that the

63 Kennedy, “Elite Incomes,” 150.

64 Jones, “The ‘Abbasid Family Estate,” 401–3; Jones et al., “Khirbat al-Mana‘iyya,” 304, fig. 9; Rothenberg, *Were These King Solomon’s Mines?*, 222, fig. 72; Taxel, “The Pottery,” 247; Whitcomb, “Mahesh Ware.”

65 Israel, “Be’er Ora (A),” fig. 3; Rapuano, “Early Islamic Settlement,” 153; Yisrael, “Be’er Ora (Southeast),” 127, fig. 165, and 129, fig. 168; see also Avner, “Elat-Elot,” 30, fig. 12, and 32, fig. 13.

66 Avner and Magness, “Early Islamic Settlement,” 52; Jones, Najjar, and Levy, “Arabah Copper Industry”; Rapuano, “Early Islamic Settlement,” 161–62.

67 Nol, “Fertile Desert,” 55; see also Avner and Magness, “Early Islamic Settlement,” 45, 57, nos. 14–15.

68 Porath, “Tunnel-Well (Qanat) Systems,” 21, fig. 25; 24–25, fig. 26; 26, fig. 27; 28, fig. 28; 30–31, fig. 29; 61, fig. 56.1–2. The cream wares belong primarily to Walmsley’s Islamic Cream Ware C, which he dates to the ninth century and later (Walmsley, “Turning East,” 309–10).

69 See Jones et al., “Khirbat al-Mana‘iyya,” 305. The radiocarbon dates from Be’er Ora complicate this dating slightly, as the calibrated means range from the later seventh to later thirteenth centuries, including dates with means in the late ninth, late tenth, and late eleventh centuries. On these dates, see Avner, “Egyptian Timna,” 146, table 1, nos. 80–88. How best to reconcile these dates with the earlier ceramic evidence is not yet clear, particularly as they are not from production contexts. Further investigation of Be’er Ora would no doubt help clarify these dating issues.

system was established by investment on the part of members of the Umayyad family⁷⁰ and ended as part of a broader shift to centralized administration in the ninth century, which apparently affected much of the southern Levant.⁷¹ As she points out, this development must also have corresponded to a shift in Ayla's economic organization. To use Kristoffer Damgaard's terminology, Ayla's economy seems to have shifted away from the "medio-hinterland" of Wādī ʿAraba and toward the broader "macro-hinterlands" of the Red Sea trade.⁷² The degree to which the late Abbasid and Fatimid ceramic assemblages at Ayla are unique for the region, particularly in terms of imports, may hint at this shift, although certainly the number of imported ceramics peaked during the Fatimid period, when Shams al-Dīn abū ʿAbd Allāh Muḥammad al-Muqaddasī called the city "the great port of Palestine and the emporium of the Hijjāz."⁷³ Somewhat counterintuitively, then, the increasing centralization of the ninth century may have undermined the economic logic of the Wādī ʿAraba industrial sites, even as it apparently contributed to Ayla's prosperity.⁷⁴

There remains the question of whether elites invested directly in copper production or this initiative was a more "local" one enabled or motivated by elite investment in irrigation and other infrastructure. These possibilities are difficult to distinguish archaeologically, and the best explanation is probably a combination of the two. As Nol argues, the nature of the settlement system—and, indeed, the nucleation of sites such as Be'er Ora and Eilat—suggests some degree of elite organization.⁷⁵ Elite organization does not, however, explain the prevalence of smaller smelting sites. Considering that miners were clearly capable of transporting ore tens of kilometers to Be'er Ora and Khirbat al-Manāʿiyya, there is no immediately obvious reason that small smelting sites in the Timna Valley would have been necessary as part of an elite-organized system. As in Roman and middle Islamic-period Faynān, most smelting took place at a small number of large, nucleated production sites.

The difference seems to be that, unlike Roman and Ayyūbid Faynān, in southern Wādī ʿAraba no central authority prevented small producers from establishing their own production sites. The small number of larger, nucleated production sites with associated villages may indicate competing elite investment in copper production, which also allowed

70 The late eighth-century date of most of the sites suggests an emergence after the Umayyad family had fallen from power in the southern Levant, but the continued prominence of families that had been Umayyad *mawālī* in Ayla's scholarly community into the tenth century is perhaps worth noting; see Cobb, "Scholars and Society," 428. More recent dating of the emergence of Mahesh ware, commonly found at these sites (see note 65 above), supports Nol's argument.

71 Nol, "Fertile Desert," 64.

72 Damgaard, "Palestinian Red Sea Port."

73 Al-Muqaddasī, *Description of Syria*, 64; on the ceramics, see Whitcomb, "Ayla at the Millennium," 174–75; "Fatimid Residence."

74 That this change may have occurred in the late ninth century, during the brief period of Ṭulūnid rule, should perhaps not be ruled out, and indeed Damgaard ("Finding Fatimid Jordan," 86) considers that changes to Ayla's urban plan may have occurred during this period, although they are more likely to date to the early ninth century. Although the Ṭulūnid period was one of revived investment in local infrastructure, it is also the case that much of this focus seems to have been on maritime sites and, during Aḥmad ibn Ṭulūn's life, particularly on those relevant to his northern holdings on the Byzantine frontier. See Bacharach, "Palestine in the Policies," 59; Schick, "Palestine in the Early Islamic Period," 77; Whitcomb, "Qaysāriyah," 79. Nonetheless, the dating evidence from copper production sites, although limited, seems to indicate that they went out of use before the beginning of Ṭulūnid rule.

75 Nol, "Fertile Desert," 64.

for smaller, local producers, generating much smaller quantities, to emerge at the margins of these mining areas. Further research is still required to determine whether different raw material sources were exploited by these two systems, however. One possibility, for example, is that small production sites in places such as the Timna Valley may have been resmelting ancient slag rather than newly mined ore, as has been suggested for middle and late Islamic Oman (and, incorrectly, middle Islamic Faynān).⁷⁶

THE NATURE OF THE LABOR FORCE

The last question that must be asked of the smelting sites in southern Wādī ‘Araba is who made up the labor force. Nol supposes that these workers must have been either *corvée* laborers or slaves, but there is no immediate reason for this assumption, and certainly we should not assume that all laborers were of the same status.⁷⁷ Recent research at Timna site 34 demonstrates that despite the apparently unpleasant nature of their work, Iron Age smelters enjoyed a relatively high-status diet compared to that of other workers at the site.⁷⁸ While not universally applicable, it is worth keeping in mind the basic insight that smelting—a difficult task involving a complicated “constellation of knowledge”⁷⁹ and with a relatively high risk of failure—is more likely to involve high-status labor than other tasks such as mining. Even if slave or *corvée* labor was used in mining and certain other tasks, smelting, refining, and similar work was likely done by free laborers.

It also cannot be assumed that those doing less specialized tasks, such as mining, were slaves—a matter that is difficult to assess archaeologically. Hannah Friedman, considering Roman Faynān, points out that even when a system of surveillance can be identified, the status of laborers is difficult to reconstruct, since from an administrative standpoint both free and slave laborers often require surveillance to ensure that work is being done.⁸⁰ In the case of the southern Wādī ‘Araba system, it is difficult even to determine the degree of surveillance that administrators considered necessary. This is not to say that slavery was not a source of mining labor in this period, however, and indeed it must be acknowledged that slaves could be skilled laborers and artisans. The question requires a much deeper engagement with the concept of slavery and the evidence itself than has been applied to it in the past. Nol notes, for example, that Anastasius of Sinai mentions, in the seventh century, Christian prisoners of war “working on the systematic sowing of public land,”⁸¹ and Robert Hoyland argues that this system of forced labor was probably widespread.⁸² It is unclear, however, whether this example can serve as a model for the organization of mining labor.

76 Weisgerber, “Archaeological Evidence,” 160–61; “Mineral Wealth,” 26; also Jones, “Beyond Iron Age Landscapes,” 122.

77 Nol, “Fertile Desert,” 58.

78 Sapir-Hen and Ben-Yosef, “Socioeconomic Status”; see also David et al., “Miner’s Diet,” 8, which argues that Roman-period miners in Naḥal ‘Amram enjoyed a high-status diet.

79 On this concept, see Sinclair, “Constellations of Knowledge.”

80 Friedman, “Surveillance and Control,” 211; this point is also made more generally by Fenoaltea, “Slavery and Supervision.”

81 Hoyland, “New Documentary Texts,” 402n37.

82 Hoyland, “New Documentary Texts,” 402–3; Nol, “Fertile Desert,” 58; see also Hoyland, *Seeing Islam*, 100.

Maya Shatzmiller, drawing primarily on descriptions of mining in al-Hamdānī, Abū al-Fidāʾ, and al-Qazwīnī, suggests that Islamic mining was generally a seasonal and mostly unregulated activity, and one “whose operations needed to be re-organized each season.”⁸³ This interpretation certainly does not rule out the presence of forced laborers in the mining workforce, but it does suggest that the organization of mining camps would have been much less centralized than work on public agricultural lands and that the principles of labor recruitment were probably rather different.

Another intriguing possibility can be suggested on the basis of the architectural features of the village sites. As noted previously, the southern Wādī ʿAraba sites are characterized by a “modular” style of architecture consisting of both single, square rooms and longer, linear structures made up of similar rooms. A number of archaeologists working in the region have suggested that this architectural style is associated with a process of sedentarization of groups of pastoral nomads in the eighth and ninth centuries.⁸⁴ Whitcomb, in particular, has argued that this development may have been “necessary and spontaneous” and initially a response to an increase in demand for traditional pastoral products.⁸⁵ If this is the case, the villages associated with smelting camps may have developed as part of a similar (or even the same) process, and some of the labor force of the mines and smelting sites may have been drawn from local pastoralist groups. The apparent lack of storage jars compared with cooking and serving vessels at these sites may add further weight to this claim—as archaeological research in the Negev has shown, this ratio reflects degree of mobility because mobile pastoralist populations generally have less need for storage vessels.⁸⁶ On the other hand, this similarity may be just an artifact of the nature of these sites. As noted above, copper production in the region was very likely a seasonal activity, and the inhabitants of the sites would thus have been itinerant regardless of their mode of subsistence during the rest of the year.⁸⁷ Consequently, villages such as Eilat and Beʿer Ora may simply represent a process of “sedentarization” analogous to that proposed for pastoral groups—as opposed to the villages necessarily being occupied by pastoralists—as groups of workers were brought together in seasonal settlements away from their homes.

CONCLUSION

Given the present state of investigation, it is possible to come to several conclusions about the organization of the southern Wādī ʿAraba industrial settlement system. First, it is likely that the more nucleated copper-smelting sites emerged as a result of elite investment in agricultural and probably industrial infrastructure in southern Wādī ʿAraba, primarily in the second half of the eighth century. While the majority of copper was produced at these larger sites, whoever organized these settlements did not have an exclusive claim

⁸³ Shatzmiller, *Labour*, 175–76.

⁸⁴ Avner and Magness, “Early Islamic Settlement,” 40; Haiman, “Agriculture and Nomad-State Relations,” 41; Magness, “Khirbet Abu Suwwana,” 20.

⁸⁵ Whitcomb, “Archaeological Evidence,” 41.

⁸⁶ Rosen and Avni, *Oded Sites*, 62–65; Saidel, “Vessel Functions.”

⁸⁷ See also Nol, “Fertile Desert,” 57–58; and more recently Jones, “Mining and Metallurgical Labor,” 51–52.

to production, and a larger number of small producers worked at the margins of these copper-producing areas.

Second, it is becoming increasingly clear that Avner and Magness's thesis regarding these sites must be reevaluated. Whereas they argued that the Wādī 'Araba "hinterland sites" were part of a system that "flourished from at least the 8th to the 10th or 11th centuries," as did Ayla, Nol is probably correct in suggesting that this dating is too broad.⁸⁸ Instead, the copper production sites seem to have been founded in the later eighth century and gone out of use at some point in the ninth century, as rural areas increasingly came under centralized state control and the economy of the region shifted, with Ayla apparently becoming increasingly oriented away from Wādī 'Araba and toward the Red Sea trade. The possible gold-mining site in Wādī al-Ṭawāḥīn, often considered part of the same system as the copper production sites, should probably be dated at least a century later than their abandonment and seems likely to have been an experimental undertaking. The suggestion that the copper-mining settlements were shorter-lived than previously thought should not be taken to mean that Ayla's early Islamic economy was any less vibrant. Indeed, rather than being a "resource frontier" that saw a brief boom generated by resource extraction followed by a bust,⁸⁹ Ayla's shifting economy seems to represent a series of successful adaptations to larger political-economic changes, some of which undermined the economic logic of copper mining even as they opened up other possibilities.

Third, although the question of labor is rather more difficult to evaluate, particularly in the absence of historical data, it is not safe to assume that our perceptions of copper production as difficult and unpleasant work necessitate the assumption of slave or *corvée* labor. As in other periods, the labor force likely included workers of differing status. Some of them may indeed have been slaves, some of them were almost certainly free laborers, and it should be considered that some of this free labor might have been drawn from local pastoral groups. Our understanding of labor recruitment principles in the southern Wādī 'Araba copper industry is still drawn primarily from assumptions and reference to a limited amount of historical data, most of it not contemporary with the system we wish to explain. Better answers to these questions require both more archaeological work and deeper engagement with historical and theoretical conceptions of slavery.

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88 Avner and Magness, "Early Islamic Settlement," 52; Nol, "Fertile Desert," 53–55.

89 For a general discussion of these processes, see Braun, "Revisited Frontiers."

90 Although the substance of this study reflects its original date of composition in 2018, some relevant references to research published since then have been added to the footnotes.

analyze the material from the ELRAP excavations at Khirbat al-Manāʿiyya, which led to some of the insights presented here. Finally, I am grateful to Erez Ben-Yosef for many productive discussions about the archaeology of copper production in southern Wādī ʿAraba and to Kathleen Bennallack for her insightful comments on an earlier draft of this study. All errors are, of course, my own.

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7

When Birds Fall Out of the Sky: A Study of the Industrial Phenomenon in Late Antique Arabia

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INTRODUCTION

In early Islamic Arabia, a symptom of industrial achievement was the pollution of the atmosphere in such a way that it became a deadly threat to birds:

There were in it 400 furnaces. When a bird flew over the village of the mine [al-Raḍrāḍ, Yemen], it dropped dead because of the fire from the furnaces.¹

Both these parts of the town [al-Tāʾif] had developed a tanning industry, and the stinking water of their tanneries flowed profusely into the valley and when the birds flew over the tanneries, they dropped dead because of the exhalations.²

The underlying aim of this essay is to determine to what extent this industrial development had its origins in the pre-Islamic period. In preindustrial economies, the standard of living depended on subsistence activities, handicraft/cottage industries, and trade. Industrialism—as “an organization of society characterized by large-scale mechanized manufacturing industry rather than trade, farming, etc.”³—took place only when premodern societies fulfilled the basic requirements of abundant natural resources, abundant and cost-effective labor, investment, and political stability. This study’s goals, therefore, are to determine the stage in this evolutionary process reached by Arabia in the centuries prior to Islam and to consider the economic phenomena against a background of permanent tribal and political changes: Himyarite territorial expansion, the Aksumite and Sasanian subjugation of southern and eastern Arabia, the rejection of supratribal authorities by Arab tribes, the emergence of the first Muslim community, and the rise of the Umayyad caliphate.

At first sight, such an undertaking seems doomed to failure, considering the lack of epigraphic sources on production and economy, the scarcity of archaeological data

1 Al-Hamdānī, *Kitāb al-Ġauharatāin*, 146.

2 Yāqūt, *Muʿjam al-buldān*, 3:496. Translation after Khan, “Tanning Cottage Industry,” 94, and Mounir Arbach, personal communication.

3 *Collins English Dictionary* (<https://www.collinsdictionary.com/dictionary/english/industrialism>).

concerning crafts and workshops, the limitations of early Islamic Arab sources,⁴ and the rare information in ancient classical sources. And although the latter are informative, they do not refer to an active Arabian manufacturing sector. In the mid-first century CE, according to the anonymously authored *Periplus Maris Erythraei*, southern Arabia imported many manufactured goods, whereas exports were mostly restricted to harvested natural products:

The port of trade of Muza, (. . .), offers a good roadstead for mooring (. . .). Merchandise for which it offers a market are: purple cloth, fine and ordinary quality; Arab sleeved clothing (. . .); saphron; cyperus; cloth; abollai; blankets (. . .); girdles with shaded stripes; unguent; (. . .); money (. . .); wine and grain (. . .). To the king and the governor are given: horses and pack mules; goldware; embossed silverware; expensive clothing; copperware. Its exports consist of local products: myrrh (. . .); alabaster (. . .).⁵

Ammianus Marcellinus (fourth century CE) in his *Roman History* depicts the people of Arabia alternatively as wanderers—

Among these tribes [Saracens], (. . .), all the men are warriors of equal rank (. . .) over-running different countries, with the aid of swift and active horses and speedy camels (. . .). Nor does any member of their tribes ever take plough in hand or cultivate a tree, or seek food by the tillage of the land; but they are perpetually wandering over various and extensive districts, having no home, no fixed abode or laws (. . .).⁶

—and as breeders, farmers, and traders:

Arabia Felix, so called because it abounds equally in corn, cattle, vines, and every kind of spice: a great portion of that country reaches on the right down to the Red Sea, and on its left extends to the Persian Gulf; so that the inhabitants reap the benefits of both. There are in that country many havens and secure harbors, and well-frequented marts (. . .).⁷

None of these accounts reflects a high level of industrial production or even the production of manufactured goods.

Turning to archaeology, towns in ancient Arabia were generally small, rarely exceeding 8–10 ha in area. The major buildings were not as monumental as those built in the neighboring areas of Egypt, West Asia, and the Mediterranean. And the sites uncovered so far have yielded virtually no evidence of districts devoted to specific economic activities.

Combined with the fact that Bedouin Arabs in the Arab-Islamic tradition often “poured scorn on handicraft occupations,”⁸ Ahmad Ghabin’s recent synthesis on crafts

4 Heck, “Arabia without Spices,” 550: “To attempt to portray the economic vitality of the sixth- to seventh-century Ḥijāz based on the early Arabic sources alone (. . .) is tantamount to attempting to reconstruct the economy of New York state based solely upon the archives of the *New York Post*.”

5 *Periplus*, §24. With regard to the port of Kané (ancient Qanī, modern Biʿr ‘Alī), exports were aloe and frankincense, and imports were wheat, wine, clothes, copper, tin, coral, silverware, coins, horses, and statues (*Periplus*, §28).

6 Ammianus Marcellinus, *Roman History* 14.4.3.

7 Ammianus Marcellinus, *Roman History* 23.6.45–46.

8 Ghabin, “Attitude of the Pre-Islamic Arabs,” 2.

and artisans in pre-Islamic Arabia provocatively asked: “Did Jāhili Arabs really despise crafts and craftsmen?”⁹ That said, there is nevertheless a way to judge industrial economic capabilities by raising two questions: Did pre-Islamic Arabia fulfil the conditions required to reach an industrial or even a protoindustrial stage of development? And, if so, did the general context of late antique Arabia—often described as a general decline—merely permit it? Once these issues have been examined, an overview of manufacturing production in Arabia in both late antiquity and the early Islamic period will allow general trends to emerge. The best-documented industries—leather production and ore mining—offer interesting case studies. Finally, the issue of scale, actors, and state patronage are discussed.

WAS (PROTO)INDUSTRIALISM EVEN POSSIBLE IN PRE-ISLAMIC ARABIA?

The prerequisites permitting a premodern industrialization process pertain to the availability of resources (food surplus, manpower, natural resources); context (political stability, commercial outlets, local and/or external trading capacities); and opportunities (investment, the prospect of an economic upturn). To a certain extent, pre-Islamic Arabia fulfilled these requirements.

FOOD SURPLUS

As early as the late fourth to early third millennium BCE, irrigated agriculture provided a subsistence level to sedentary communities in parts of Arabia. An oasis-based agriculture was developed in southeastern Arabia,¹⁰ southwestern Arabia,¹¹ and northern Arabia.¹² In the southern Hījāz and Yemeni highlands, terraced walls appeared as early as the early fourth millennium BCE. They stabilized the soil, facilitated the expansion of agriculture,¹³ and paved the way for the construction of monumental dams in the early Christian era.¹⁴ As a result, during the first millennium BCE and the early centuries CE, wide oases sustained urban communities in different parts of Arabia, including Taymāʿ, Dūmat al-Jandal, al-ʿUlā, Madāʿin Šāliḥ, Yathrib/Madinah, Qaryat al-Fāw, Najrān, Nashq/al-Bayḍāʿ, Nashshān/al-Sawḍāʿ, Maʿrib, Tamnaʿ, Shabwa, Hagar, Thāj, and Mleiha.¹⁵ In parallel,

9 Ghabin, “Attitude of the Pre-Islamic Arabs,” 1.

10 Tengberg, “Beginnings and Early History”; Tengberg, Battesti, and Newton, “Le palmier dattier.”

11 Brunner, “Geography and Human Settlements”; Brunner and Kohler, “Bewässerung im Jemen”; Wilkinson, “From Highland to Desert.”

12 Dinies, Neef, and Kuerschner, “Holocene Vegetational Development.”

13 Wilkinson, *Archaeological Landscapes*; “From Highland to Desert”; “Other Side of Sheba.”

14 Charbonnier and Schiettecatte, “Les barrages de l’Arabie”; Robin and Dridi, “Deux barrages du Yémen antique.”

15 Hausleiter, “L’oasis de Taymāʿ”; Charloux and Loreto, *Dūmat al-Jandal*; Loreto, “Results from the 2009–2016 Excavation Seasons”; al-Saʿīd, “Dédān (al-ʿUlā)”; Nehmé, al-Talhi, and Villeneuve, *Report on the Third Excavation Season*; Nehmé, *Les tombeaux nabatéens de Hégra*; al-Ansary, *Qaryat al-Fau* and “Qaryat al-Fāw”; al-Marih, “Najrān”; Schiettecatte, “L’antique Najrān” and *D’Aden à Zafar*; de Maigret and Robin, *Tamnaʿ (Yémen)*; Breton, *Fouilles de Shabwa IV*; Rohmer et al., “Thāj Archaeological Project”; Mouton, *La péninsule d’Oman*.

densely inhabited sites appeared in the Yemeni highlands—for example, Zafār, al-Miʿsāl, and Ṣanʿā'.¹⁶ Some of these cities provided shelter for as many as 50,000 inhabitants.¹⁷

The figures given in both Sabaic inscriptions and the early Arab-Islamic tradition sometimes give the impression of a land of plenty: Sabaic inscription Ja 576 + 577 (mid-third century CE) mentions 68 settlements, 60,000 irrigated fields, and 97 wells in the valley of Najrān, while the Arabic sources report that in the vicinities of Mecca and Medina the farms of Muʿāwīya b. Abī Sufyān (602–80 CE) “resulted annually in the production of 150,000 camel loads of dates and 100,000 camel loads of wheat.”¹⁸ It is highly likely that in both cases the figures were exaggerated to highlight either the amount of infrastructure destroyed by the Sabaean army in its campaign in Najrān or the estate of the first Umayyad caliph.

Yet a few pieces of evidence show the threat of shortages hanging over people, including a dedicatory inscription to the god Taʿlab for protecting a tribe from famine (Sabaic inscription CIH 575, ca. first century BCE/CE) and the frequent custom of asking a deity to grant good crops (more than 120 Sabaic inscriptions from the first century BCE to the fourth century CE). Even more significant is the mention in the *Periplus Maris Erythraei* of imported grain and wheat at the seaports of Muza (al-Makhāʾ) and Kané (Qanīʾ/Biʾr ʿAlī) in “limited quantity because the region produces wheat in moderate quantity.”¹⁹

To sum up, as I have shown elsewhere, farming remained the primary concern of the urban population in ancient Arabia, thus making these cities what Max Weber described as *Ackerbürgerstädte*.²⁰ Cottage industries may have spread and enabled the emergence of a protoindustry. However, it is unlikely that this kind of development took place outside areas showing a surplus of food, and it was possible in only the largest oases or those in suitable locations along the trading networks.

NATURAL RESOURCES

Arabia offered a wide range of natural resources, starting with minerals: silver and gold ore in the Ḥijāz, the Najd, and Yemen;²¹ copper ore in Oman, the Ḥijāz, and Yemen;²² soft stones (chlorite, steatite, calcite) in the same areas;²³ alabaster in Yemen;²⁴ stones for construction and lime production; and carnelian, obsidian, and clay for pottery production.

16 Schiettecatte, *DʿAden à Zafar*; Yule, *Late Antique Arabia*.

17 Schiettecatte, “Éléments pour une définition,” 141.

18 Heck, “Arabia without Spices,” 565 and sources cited.

19 *Periplus*, §§24, 28.

20 Schiettecatte, *DʿAden à Zafar*, 36.

21 De Jesus et al., “Preliminary Report of the Ancient Mining Survey”; Dunlop, “Sources of Gold and Silver”; Heck, “Gold Mining in Arabia”; Peli, “Les mines de la péninsule Arabique”; Power, “Mines, Mining, Late Antiquity”; al-Zahrani, “Mining in al-Baha Region.”

22 De Jesus et al., “Preliminary Report of the Ancient Mining Survey”; Kisnawi, de Jesus, and Rihani, “Preliminary Report on the Mining Survey,” 79; Power, “Mines, Mining, Late Antiquity”; Weisgerber, “Metallurgy in Arabia”; al-Zahrani, “Mining in al-Baha Region.”

23 David et al., “Les vases en chloritite”; Kisnawi, de Jesus, and Rihani, “Preliminary Report on the Mining Survey,” 78–79.”

24 Gerlach and Heckes, “Die Stadtanlage von Ṣirwāḥ,” 174.

Different plants offered potential for industrial use: the sap tapped from the *Boswellia* and *Commiphora* trees—frankincense and myrrh—in southwestern Yemen, Ḥaḍramawt, Mahra, and Dhufār was used on its own or in making perfume;²⁵ the red sap of the dragon tree (*Dracaena cinnabari*) was used as a dye; wood, available in reasonable quantities,²⁶ provided fuel and timbers;²⁷ acacia leaves (*qaraz*) were widely used for tanning; and cotton was grown for textile production.²⁸

Finally, breeding and husbandry fostered the development of several handicrafts: wool for textile production; camel, cattle, and gazelle hide for tanneries;²⁹ and bones for writing supports or various domestic items.³⁰ Domestic cattle, camels, and donkeys provided energy (e.g., for millstone rotation, water drawing) and carried loads.

MANPOWER

Although we cannot determine to what extent part of the pre-Islamic Arabian workforce was able to devote itself to any activity entirely unconnected with basic subsistence, such a category existed. In southwestern Arabia, the epigraphic material lists different corporations and craftsmen: most towns had defensive works, cultic and domestic structures built of dressed stones, wooden beams, and mudbricks. Such architecture required the competence of specialists, as attested in inscriptions from the seventh century BCE onward.³¹

Moreover, slaves and prisoners of war played a significant role as a cheap workforce. Slavery is well attested in both pre-Islamic inscriptions and classical sources. Slavery, or at least servitude, appears as early as the first South Arabian monumental inscriptions through the clear-cut distinction between free men (Sabaic *ʿhrr*) and those enslaved (Sabaic *ʿbd*, *ʿdym*, *ʿḥmr*, *ʿqny*; Qatabanic *wmy*).³² The enslavement of Arabian natives took place during wars³³—a practice that continued in the sixth and seventh centuries CE in the course

25 Groom, *Frankincense and Myrrh*.

26 Gerd Weisgerber (“Patterns of Early Islamic Metallurgy,” 119) has shown that wood requirements for the Omani production of copper were extremely high and that deforestation and woodcutting led to dramatic changes in the landscape. See also Hepper and Wood, “Were There Forests in the Yemen?”

27 Darles, “L’usage du bois.”

28 Bouchaud, Tengberg, and Dal Prà, “Cotton Cultivation and Textile Production.”

29 Ibn al-Mujāwir, *Tārīkh al-mustabṣir*, 42.

30 Barbier, “L’atelier de tabletterie.”

31 Quarrymen are mentioned in two inscriptions from the Jawf (*RÉS* 3371, *RÉS* 3821, ca. fifth to first centuries BCE). Stonecutters, most often qualified by the nisba *grbyn*, are the most frequently attested socio-professional category (Frantsouzzoff, “Le tailleur de pierre”). This craft corporation was organized into a hierarchy and sometimes had as its leader a “head of the stonecutters” (*kbr nhmtn*—inscriptions Haram 16, 17, and 19, ca. seventh century BCE) or a “work manager” (inscriptions KR 2, KR 3, Haram 38, ca. first century BCE to first century CE). Alongside these specific categories are general terms designating laborers or a class of workmen, usually linked with construction activities: *sʿfr* “labor, duty” (*RÉS* 3343, Haram 18, 38, ca. fifth to first centuries BCE); *msʿkm* “salaried workers” (Maʿīn 6, ca. sixth to fifth centuries BCE).

32 *RÉS* 3945, ca. 680 BCE; *RÉS* 3879, ca. fourth to third century BCE; *CIH* 80, ca. fifth to first century BCE.

33 *RÉS* 3945; Arbach-Sayūn 1; Ja 576 + 577.

of intertribal raids.³⁴ The slave trade is mentioned on several occasions.³⁵ Finally, slavery was also enabled through international trade: the *Periplus Maris Erythraei* mentions the trade of slaves from India (Barygaza) and Somalia (Malaô/Berbera; Opônê/Rā's Ḥafūn) bound for Socotra island (Dioscuridēs), Arabia, and Egypt.³⁶ The only evidence concerning their economic role in pre-Islamic Arabia also comes from the *Periplus Maris Erythraei*, where royal slaves are in charge of the harvest of frankincense.³⁷ In this respect, the social stratification in pre-Islamic Arabia—at least in the south of the peninsula—was similar to that of the sixth and seventh centuries as reported by Arab-Islamic sources.³⁸

A POLITICAL AND ECONOMIC CONTEXT FAVORABLE TO INDUSTRIAL DEVELOPMENT

Except for the fifth to sixth centuries CE—discussed below—the first millennium BCE and the first centuries CE may have offered an ideal context for industrial development, whatever this development really was. The growth of oasis-based agriculture in central and northern Arabia and the settlement of the Omani piedmont plain and of the Yemeni valleys and highlands were primarily the result of local private and collective investment in the construction of irrigation networks (wells, *aflāj*/qanats, diversion structures, canals, terraced walls, dams), which resulted in wide-scale agricultural planning.³⁹ At the same time, these areas built relationships with one another and with the outside world through caravan and maritime trade networks. Both processes contributed to the federation of tribes within each of the developed landscape features (oasis, valley, plateau), thus establishing the pre-Islamic Arabian kingdoms: Liḥyān, Dadān, and Nabaṭ in the northern Ḥijāz; Ghas-sān and Nizār in western Arabia; Kinda, Qaḥṭān, Madhḥij, and Asd in the southern Ḥijāz; ʿUmān and Hagar in eastern Arabia; and Muḥa'mir, Amir, Ma'īn, Sam'ī, Saba', Qatabān, Awsān, Ḥaḍramawt, and Ḥimyar in southern Arabia.⁴⁰ As a result, these economic, social, and political processes offered the following opportunities.

34 Crone, *Meccan Trade*, 106.

35 Two Sabaic inscriptions, one of them dated to the seventh century BCE, mention the trade by a father of the girl(s) he had with a servant (Arbach, “Le commerce d’esclaves”; Stein, “Was There a Slave Trade?”). Furthermore, the late third-century CE monumental inscription RĒS 3910 from Ma'rib is a regulation of the local trade in livestock and slaves.

36 *Periplus*, §§8, 13, 31.

37 *Periplus*, §29.

38 Ibrahim, “Social and Economic Conditions,” 346: “The lowest social status was that of the *qinn*, slaves (. . .). They also could be Arab or non-Arab in origin as they were either captured in war, lost their freedom because of debt (usually as a result of *ribā*, usury), or were bought as slaves.” See also Crone, *Meccan Trade*, 80; Power, *Red Sea*.

39 Mouton and Schiettecatte, *In the Desert Margins*.

40 The kingdoms are listed irrespective of their chronology. To them can be added a long list of smaller kingdoms of short duration in southern Yemen (Dahas, Yanhagū, Radmān, Yaḥīr, Yuhantīl, Wusr), southwestern Yemen (Ma'dhin), the Yemeni Jawf valley (Kaminahū, Nashshān, Haram, Inabba'), and the southwestern Ḥijāz (Khaṣāṣatān). See Nebes, *Tatenbericht des Yiṭa'amar Watar*; Schiettecatte and Arbach, “Political Map of Arabia.”

Investment Capacity

Monumental architecture (ramparts, hydraulic structures, temples) attests to the existence of a permanent collective and individual investment capacity from the eighth century BCE onward. The South Arabian monumental dams built during the first to fourth centuries CE provide a good example. They resulted from the setting up of a dual system of agricultural production in the southern Arabian highlands:⁴¹ next to the terraces and rain-fed fields (managed at the household or clan level), irrigation systems supplied by monumental dams were gradually developed in narrower valleys, less suitable for terracing, that had so far been left undeveloped. Such large hydraulic projects could be undertaken, within a specific social context, only by someone who could call on a large workforce and coordinate and finance the project. The Himyarite state played this role through the direct intervention of either the king (or the *qayls* who represented the king at the head of tribal federations) or members of the tribal aristocracy who were under the direct authority of the king or the *qayls*.⁴² Several inscriptions allude to dam building carried out by either a king⁴³ or a *qayl*.⁴⁴ The close proximity of dams to the centers of Himyarite power also reveals the relationship linking these structures to the Himyarite elite.⁴⁵

Local and External Trading Capacities

The domestication of the donkey⁴⁶ and camel⁴⁷ above all led to the establishment of a caravan trade network connecting southwestern and eastern Arabia with northern Arabia, Mesopotamia, Egypt, the Levant, and the Mediterranean.⁴⁸ Both the classical sources and South Arabian inscriptions document the products, taxes, itinerary, and actors involved in this trade.⁴⁹ The progressive shift to a sea trade—in the third to first centuries BCE⁵⁰—increased the trading network's range by involving new countries (India, East Africa, Ethiopia) and new products.⁵¹ A revival of the land trade, starting with exchanges between

41 Wilkinson, *Archaeological Landscapes*, 192.

42 Charbonnier and Schiettecatte, "Les barrages de l'Arabie"; Robin and Dridi, "Deux barrages du Yémen antique"; Wilkinson, *Archaeological Landscapes*, 192.

43 Sabaic inscriptions MAFRAY-Makhliq 1 and MAFRAY-Hisāya 1.

44 Sabaic inscriptions MAFRAY-dhī-Ḥadīd 1 and 2, MAFRAY-al-Maktūba 1, *RÉS* 4196, BaBa al-Ḥadd 2 and 8.

45 Charbonnier and Schiettecatte, "Les barrages de l'Arabie."

46 Uerpmann, "*Equus africanus* in Arabia"; Uerpmann and Uerpmann, "Animal Labour and Beasts of Burden."

47 Fedele, "Camels, Donkeys and Caravan Trade"; Magee, "When Was the Dromedary Domesticated?"; Monchot, "From Palaeontology to Zooarchaeology"; Uerpmann and Uerpmann, "Appearance of the Domestic Camel."

48 Groom, *Frankincense and Myrrh*; Jasmin, "Les conditions d'émergence"; Liverani, "Early Caravan Trade"; Retsö, "Domestication of the Camel."

49 Robin, "L'état et les aromates."

50 Schiettecatte, "L'Arabie du Sud et la mer."

51 *Periplus*; Casson, "South Arabia's Maritime Trade"; Strauch, *Foreign Sailors on Socotra*.

Najrān and al-Ḥira, took place in the mid-fifth century CE and intensified in the late sixth century as a consequence of the weakening Byzantine presence in the Red Sea and a subsequent decline of maritime trade.⁵² Despite an interchange of land and sea trade, therefore, most of the Arabian Peninsula remained connected throughout the first millennium BCE and late antiquity, providing its inhabitants with access to local markets and a wide range of commercial outlets abroad.

A Political and Legal Framework to Secure Production and Trade

The existence of such a framework can be illustrated by the exploitation of frankincense. According to Pliny the Elder,⁵³ harvesting was the monopoly of a restricted number of families, and transportation was subject to a specific route and taxation, first by the temple administration of Ḥaḍramawt, then by the Qatabanian king while passing through his kingdom. Finally, transportation toward northern Arabia was the monopoly of the caravans of the kingdom of Maʿīn. As can be seen in the epigraphic material, the latter appears to have developed a network of trading posts in southern and western Arabia,⁵⁴ as well as matrimonial alliances with foreign partners (e.g., Egyptians, Greeks, Gazawī).⁵⁵

In the mid-first century CE, although the trading pattern had changed following the development of maritime routes, frankincense was collected in Dhufār by royal slaves and stored at the trading post of Moscha Limèn (Sumhuram/Khawr Rūrī),⁵⁶ a place controlled by a “chief of the Ḥaḍramī military detachment in the land of Saʿkalān (Dhufār).”⁵⁷ From there it was loaded on a ship heading to Qanīʾ (Biʾr ʿAlī), where the trade was again under royal control.⁵⁸

This example shows that whole sectors of the economy were handled, secured, and/or restricted by the ruling authorities of the different kingdoms. Other evidence of this economic administration is the presence of a “chief of the caravaners” (*kbr Mšrn*) in the kingdom of Maʿīn;⁵⁹ the presence of a Ḥaḍramī troop securing a South Arabian caravan in the first to second centuries CE;⁶⁰ and the royal regulation of trade in Tamnaʿ, the capital city of Qatabān,⁶¹ and of livestock and the slave trade in Maʿrib, the capital city of Sabaʿ.⁶²

52 Robin, “La reprise du commerce.”

53 Pliny the Elder, *Natural History* 12.30–32.

54 Mouton and Schiettecatte, *In the Desert Margins*, 239.

55 Robin, “La reprise du commerce,” 275; al-Saʿīd, “Les épouses étrangères.”

56 *Periplus*, §§29, 32.

57 Ḥaḍramitic inscription KR 2/6 (*qdm gys² Ḥḍrmt b-ʿrd Sʿklhn*).

58 See *Periplus*, §27, and Sabaic inscription Ir 13 (early third century CE), which mentions the “warehouses of the king of the Ḥaḍramawt in the cove of Qanīʾ” (*b-ḥyqn Qnʾ mkdḥ mlk Ḥḍrmwt*).

59 Minaic inscriptions RÉS 3022 and RÉS 3535 (fourth to third centuries BCE).

60 Sabaic inscription R 1850.

61 Qatabanic inscription RÉS 4337.

62 Sabaic inscription RÉS 3910.

NO PROSPECT OF AN ECONOMIC UPTURN

In general, most of the prerequisites for the start of a pre-Islamic Arabian industrialization process were fulfilled—though not completely. The food supply, for example, apparently did not exceed basic local demand. The level of preparedness also varied by location and the period; the sharp decline of regular long-distance caravan trade from the first to the fourth century CE may also have reduced central Arabian economic activity. Whatever the case, if we are to consider the situation of southern and western Arabia exclusively, then resources, context, and opportunities met the expected requirements for industrial development.

Nevertheless, only in the Omani piedmont did a mining industry develop, and it came to an end by the third century BCE.⁶³ Elsewhere, from a few areas attested or suspected at archaeological sites, we can only reconstruct the existence of handicraft and limited cottage industry in different economic fields. The following, nonexhaustive list provides a representative cross section of pre-Islamic Arabian cottage industries (ca. eighth century BCE to sixth century CE):

- Metalworking (copper and iron) at Sārūq al-Ḥadīd, Mleiha, Qalʿat al-Baḥrayn, Madāʿin Ṣāliḥ, Maṣnaʿat Mariya, Madīnat al-Aḥjur, Maʿrib, Hajar ar-Rayḥānī, Hajar Yahirr, Khawr Rūrī, and possibly at Raybūn⁶⁴
- Silversmithing at Shabwa⁶⁵
- Semiprecious-stone cutting at Hajar Yahirr⁶⁶
- Stone and salt quarrying at Shabwa and Ṣirwāḥ⁶⁷
- Lime production at Zafār⁶⁸
- Pottery making at Taymāʾ and Thāj⁶⁹
- Textile manufacture at Qaryat al-Fāw⁷⁰
- Soft-stone vessel production at Mleiha⁷¹
- Shell and bone processing at Mleiha⁷²

63 Weisgerber, “Mehr als Kupfer”; “Sites of Multi-Period Copper Production.” The sudden end of this industry is probably related to massive exploitation of the plant cover that led to a shortage of fuel.

64 Weeks et al., “Recent Archaeological Research at Saruq al-Hadid”; Ploquin, Orzechowski, and Briand, “Paléoméallurgie à Mleiha”; Højlund and Andersen, *Qalaʿat al-Bahrain*, 1:382–83, 2:165–74; Nehmé et al., “Mission archéologique de Madāʿin Ṣāliḥ,” 111; Lewis and Khalidi, “From Prehistoric Landscapes to Urban Sprawl,” 221; Antonini, “Site of Madīnat al-Aghur,” 45; Vogt, “Barʿān,” 141; Glanzman and Ghaleb, *Wadi al-Jubah Project*, 143–48; Cleuziou and Inizan, “Rapport préliminaire de la mission de prospection”; Buffa and Sedov, “Residential Quarter,” 19–22; Sedov, “Die archäologischen Denkmäler von Raybun,” 32.

65 Breton, “Shabwa (Yémen),” 873.

66 Cleuziou and Inizan, “Rapport préliminaire de la mission de prospection.”

67 Bessac, “Le travail de la pierre”; Gerlach and Heckes, “Die Stadtanlage von Sirwāḥ,” 174.

68 Yule, *Late Antique Arabia*, 243.

69 Hausleiter, “L’oasis de Taymāʾ,” 242; Rohmer et al., “Thāj Archaeological Project,” 296.

70 Al-Ansary, “Qaryat al-Fāw,” 360.

71 Mouton, “Le travail de la chlorite.”

72 Barbier, “L’atelier de tabletterie”; Prieur, “Coquillages et artisanat.”

Why is there no archaeological or epigraphic evidence of any (proto)industrial development? In the case of western and southern Arabia, it might well be because of the lack of prospect of an economic upturn. The driving force behind the economy of this region was primarily agriculture, specifically the harvesting of aromatics and their trade. Taking into account the value of these resources, their close control, and investment in their trade—as reported by epigraphic material and classical sources, from Euhemerus of Messina (fourth century BCE) to the *Periplus Maris Erythraei* (mid-first century CE)⁷³—frankincense and myrrh brought in considerable wealth. Pliny writes:

At the very lowest computation, India, the Seres, and the Arabian Peninsula, withdraw from our empire one hundred million of sesterces every year—so dearly do we pay for our luxury and our women. How large a portion, too, I should like to know, of all these perfumes, really comes to the gods of heaven, and the deities of the shades below?⁷⁴

Aromatics may well have hindered protoindustrial improvements, simply because the income they provided discouraged any attempt to develop a significant industry—all the more so if the latter had only a small profit margin. The game wasn't worth the candle.

To sum up, the general conditions (resources, context, opportunities) allowed, if not a global upturn in the economy, then at least the rise of industrial sectors. It took place in only a limited area (the Omani piedmont), where it came to an end in the fourth to third century BCE, but not elsewhere, partly because significant profit-margin sectors already existed—primarily the harvesting of aromatics and their trade. The reduced demand for aromatics in the Mediterranean by the end of the fourth century CE⁷⁵ may have encouraged investments in other economic sectors. However, Arabian settled communities went through critical changes that have sometimes been considered as constituting a major crisis or even a collapse. And one wonders whether the context was still favorable to any process of industrialization.

DID THE CONTEXT OF LATE ANTIQUE ARABIA ALLOW INDUSTRIALISM?

WHAT CHANGED IN LATE ANTIQUE ARABIA?

If we consider the quantitative data, three observations concern the fourth to sixth centuries CE. First, the number of inscriptions dwindled to just a handful because of (1) the abandonment of pagan temples in southern Arabia, (2) a decrease in the construction of

73 Cuvigny, “L’Arabie heureuse des classiques”; Macadam, “Strabo, Pliny the Elder and Ptolemy of Alexandria”; Rodinson, “L’Arabie du Sud.”

74 Pliny the Elder, *Natural History* 12.41.

75 Groom, *Frankincense and Myrrh*, 162: “The most specific cause of the collapse was the spread of Christianity, marked in particular by the conversion of the Emperor: until about the middle of the fourth century no incense was used at all in the ceremonies of the Church and by the end of the century Theodosius had forbidden the pagan practice of making offerings, including incense, to the household gods. But at the same time internal crisis and severe inflation were beginning to paralyse the Roman economy, while the weakening of Roman power and influence led to internal strife and insecurity not only along the incense route but also in southern Arabia itself. It is doubtful whether the overland aromatics trade survived the fourth century, while the sea-borne trade continued only on a very much smaller scale.”

monumental architecture (usually associated with inscriptions), and (3) the decline of epigraphic custom in favor of oral literacy, perhaps compounded by the popular use of perishable materials (e.g., leather, bones) as writing surfaces.⁷⁶

Second, money ceased to be used as a currency.⁷⁷ This change resulted from either an economic crisis or a simple demonetization in favor of other currency denominators or forms of exchange.⁷⁸

Third, in the fifth to sixth centuries CE, a majority of Arabian settlements became depopulated or abandoned,⁷⁹ echoing the anarchic situation described by the Arab-Islamic tradition under the concept of *jāhiliyya*.⁸⁰ In southern Arabia, the process started in the lowlands as early as the third to fourth century (e.g., at Tamna^c, Shabwa, Qaryat al-Fāw) and spread in the fifth to sixth centuries to most of the major cities (e.g., Ma'rib, Ṣafār). The only significant exceptions were Ṣan'a', Aden, and Najrān⁸¹ and to a lesser extent the smaller towns of the Yemeni highlands (e.g., Nā'iṭ, Baynūn, Ghaymān, Shibām al-Ghirās).⁸² To the east, on the islands of Failaka and Bahrain and on the western shore of the Persian Gulf, the settlements' depopulation took place as early as the third to fourth century.⁸³ In Oman, the culture of Samad vanished by the fourth century.⁸⁴ The only possible evidence of a late antique occupation might be at Ṣuḥār⁸⁵ and on small settlements whose size never exceeded one hectare (Kush, Khaṭṭ, Jazīrat al-Ghanam, and Fulayj).⁸⁶ In northern Arabia, the picture is the same: Taymā' has not yielded significant remains later than the third century,⁸⁷ and occupation at Madā'in Ṣālīḥ came to a rapid end in the sixth century.⁸⁸

76 Macdonald, "Decline of the 'Epigraphic Habit'"; Robin, "Inventaire des documents"; Schiettecatte, "À la veille de l'Islam," 16–17.

77 Kennet, "Decline of Eastern Arabia," 105; Schiettecatte, "À la veille de l'Islam," 17.

78 Gene Heck ("Arabia without Spices," 556) shows that the use of precious metals in their uncast state was a frequent transactional practice in early Islam; he calls it the "bulk bullion trading practice."

79 Kennet, "Decline of Eastern Arabia" and "On the Eve of Islam"; Schiettecatte and Robin, *L'Arabie à la veille de l'Islam*.

80 Robin, "Faut-il réinventer la *jāhiliyya*?" and "La péninsule Arabique," 5–8.

81 Schiettecatte, "À la veille de l'Islam."

82 These settlements were still occupied in the tenth century (al-Hamdānī, *Antiquities of South Arabia*, 8).

83 Cuny and Mouton, "La transition vers la période sassanide"; Hannestad, "Chronology of the Hellenistic Fort"; Kennet, "Decline of Eastern Arabia" and "On the Eve of Islam"; Kervran, "Un siècle obscur"; Mouton, "Settlement Patterns."

84 Yule, "Sasanian Presence and Late Iron Age Samad."

85 Cuny and Mouton, "La transition vers la période sassanide," 117; Kervran and Hiebert, "Sohar pré-Islamique"; pace Kennet, "Decline of Eastern Arabia," 97–100.

86 Cuny and Mouton, "La transition vers la période sassanide," 120–21; Kennet, "Transformations in the Late Sasanian Period"; al-Jahwari et al., "Fulayj." Although the Syriac lists of bishoprics mention the foundation of monasteries in Bahrain and on the shores of the Persian Gulf in the fifth to sixth centuries CE (Beaucamp and Robin, "L'évêché nestorien de Māšmahīg"; Brock, "Syriac Writers from Beth Qatraye"), their excavation yielded proof of an occupation only in the seventh to ninth centuries CE (Carter, "Christianity in the Gulf"), with only two exceptions: Ṣīr Banī Yās and Sinīya, where evidence of incipient occupation has been dated as early as the sixth century.

87 Eichmann, "Archaeological Evidence of the Pre-Islamic Period"; Hausleiter, "L'oasis de Taymā'."

88 Nehmé, "Quelques éléments de réflexion sur Hēgra," 52. Only a few sherds and Arabic inscriptions have been dated to the seventh to eighth centuries CE (Nehmé, "Hēgra d'Arabie heureuse," 303).

Finally, only the central Ḥijāz and central Najd do not show the same process of depopulation. Because of a lack of archaeological excavations, we depend mainly on Arab-Islamic sources, which provide a considerable amount of data on the dynamics of the local economy.⁸⁹ However, these sources mainly concern the last decades before the Hegira, and it is not possible to define what the situation may have been before the mid-sixth century.

THE REASONS BEHIND THE CHANGES

The various processes of decay in different parts of Arabia are the result of long-term environmental, economic, and political changes occasionally precipitated by localized events, such as the Justinianic plague and the military expeditions of the kings Yūsuf Asʿar Yathʿar and Abraha. I have already expanded on the subject elsewhere.⁹⁰ Here I summarize the main arguments.

The Environmental Factor: Aridification

The development of irrigated agriculture in an arid environment such as that of the Arabian Peninsula can lead to permanent risks: the smallest climatic variation may compromise the running of a wide-scale irrigation system and thus the food supply of an entire settled community, and it may lead nomadic groups whose subsistence depends on exchanges with these settled communities to reorganize a network of exchange and interdependence in a situation of precariousness and potential conflicts. This is what possibly took place in the Arabian Peninsula from the fifth century onward, when precipitation dropped significantly for about 300 years.⁹¹

89 It is not my intention to resume the historiographical debate on the reliability of Arab-Islamic sources for analyzing the economic and settlement dynamics on the eve of Islam (see Crone, *Meccan Trade*; Heck, “Arabia without Spices”; Serjeant, review of *Meccan Trade*). Provided that an account rests on a regular chain of transmission based on much older testimonies, there is much valuable basic evidence that, irrespective of distorted events or exaggerated figures, might provide a historical reconstruction with reliable place names, activities, and societal information. In this way, Michael Lecker (“Lost Towns: Zuhra and Yathrib”) has shown that sources such as Samhūdī’s history of Medina provide much valuable evidence on the eve of Islam because they quote from much older stories. Concerning the economic dynamics, in Mecca the anecdotal reuse of timbers from a ship that was wrecked at Shuʿayba to rebuild the roof of the Kaʿba (Yāqūt, *Muʿjam al-buldān*, 3:301)—sometimes considered evidence of a lack of means (Crone, *Meccan Trade*, 5) or even of a state of utter destitution (Robin, “La péninsule Arabique,” 6)—should be taken for what it is: readily available, previously used building material, probably of better quality than the local *Tamarix* or *Phoenix*. For comparison, the plundering of squared stones from the Giza pyramids for building medieval Cairo is not equated with an inability to quarry building stones.

90 Schiettecatte, “À la veille de l’Islam.”

91 This late antique aridification process is attested in the Dead Sea region (Enzel et al., “Late Holocene Climates”; Frumkin et al., “Holocene Climatic Record”; Heim et al., “Near East Desertification”; Hirschfeld, “Crisis of the Sixth Century,” 23), in eastern Arabia (Kennet, “Transformations in the Late Sasanian Period,” 157–59), and in southern Arabia (Fleitmann et al., “Holocene ITCZ and Indian Monsoon Dynamics,” fig. 8; “Holocene Forcing of the Indian Monsoon”).

A Difficult Economic Climate: Abandonment of Large Cultivated Areas and Loss of Maritime Trade Outlets

Major oases in the lowlands of southern Arabia were deserted between the third and sixth centuries CE.⁹² In the highlands, no inscriptions commemorating the building or restoration of a dam exist after the fourth century. Both phenomena were probably the consequence of environmental changes, on the one hand, and the progressive inability of an increasingly centralized tribal aristocracy to maintain ambitious irrigation networks over wide areas, on the other hand.⁹³

From the fourth century onward, the Arabian Peninsula became a marginal actor in the international trade network. Procopius mentions that a major portion of Indian exports were soaked up by Persian merchants toward the Persian Gulf and Mesopotamia, thus slipping out of Arabian and Aksumite hands. He also shows that maritime trade in the region of Aden was exclusively controlled by Aksum,⁹⁴ and the South Arabian economy no longer profited from it. Significantly, the port of Sumhuram (Khawr Rūrī) was abandoned, and the activity of the port of Qanī' (Bi'r 'Alī) declined sharply.⁹⁵

A Rejection of Supratribal Powers

A study of the Arab-Islamic tradition (especially the *Ayyām al-'Arab*) by Andrey Korotaev, Vladimir Klimenko, and Dmitry Proussakov has shown how supratribal powers generated tensions and how excessive taxations caused clashes between these supratribal authorities and subjugated tribes in the sixth to early seventh century CE. In these tensions—perceived as threats to the survival of communities in times of socioecological crisis—the authors see a cause for the collapse of the political structures of pre-Islamic Arabia.⁹⁶ A disturbed context favored the rejection of monarchical authority and the emergence of “Rahmanist” prophets, who offered an alternative form of supratribal authority and met the expectations of the moment.⁹⁷

A prefiguration of this process was already at work in sixth-century southern Arabia when the tribal rulers (*qayls*) were chosen from outside the tribe over which they ruled. The bond between the rulers, then appointed by the king, and the tribal federations they headed gradually weakened—all the more so in view of the fact that their legitimacy relied on a system of economic redistribution, which no longer operated in a context of environmental and economic constraints.⁹⁸ The fact that Aksum superseded and then subjugated the traditional Himyarite dynasties increased the loss of the rulers' legitimacy. At the local

92 Gentelle, “Le recul des terres cultivées.”

93 Mouton and Schiettecatte, *In the Desert Margins*, 276–78; Schiettecatte, “L'évolution du peuplement sudarabique.”

94 Procopius of Caesarea, *History of the Wars* 1.20.9–12.

95 Schiettecatte, “L'Arabie du Sud et la mer,” 256–60.

96 Korotaev, Klimenko, and Proussakov, “Origins of Islam.”

97 Korotaev, Klimenko, and Proussakov, “Origins of Islam”; Robin, “Les signes de la prophétie en Arabie.”

98 Schiettecatte, “L'évolution du peuplement sudarabique,” 243–45.

level, the consequences were the dissociation of the tribes from a sociopolitical structure they no longer trusted, the loss of attraction of the centers of power, and the disintegration of the ancient urban framework.

ROOM FOR A LATE ANTIQUE ARABIAN INDUSTRIAL PHENOMENON?

From the fifth century onward, economic diversification became a cost-effective prospect and may have promised an upturn in a deficient economic system. In many parts of the Arabian Peninsula (southern Arabia, eastern Arabia, northern Ḥijāz), any attempt of this kind would have been jeopardized by the unsuitable context described above: defective agricultural production compromising a surplus of food; labor shortage due to depopulation; disengagement of a tribal elite in infrastructure investments; disintegration of the former trading network, which cut Arabia off from the commercial outlets and slave providers; insecurity; and political instability.

As previously stated, however, the pattern did not apply everywhere equally, and it is highly likely that the central Najd (al-Yamāma), the central and southern Ḥijāz, and northern Yemen were less affected by the crisis. The reason is simple: these regions were less connected with the former economic and trading networks, less dependent on monumental and centralized irrigation systems, and not incorporated within the increasingly centralized Himyarite political system. Consequently, they were more resilient to the harsh context of late antiquity; it is no surprise that the Ṣanʿāʾ–Ṣaʿda–Najrān–Ṭāʾif–Yathrib corridor was the least depopulated.⁹⁹

The Ṣanʿāʾ–Yathrib corridor and al-Yamāma both benefited from a wide range of natural resources;¹⁰⁰ and located in the Ḥijāz–ʿAsīr–Yemen mountain range, they remained well watered. In the last quarter of the sixth century CE, Sasanian mining communities brought knowledge and investment capacities (see below); the Quraysh brought a local and external trading network and, with the institution of the *ilāf*, the legal framework to secure it.¹⁰¹ The prerequisites for industrial development were fulfilled.

The issue is whether we can agree with Gene Heck, who states that “it is clear that, by the first half of the seventh century, West Arabia was far more than a mere string of way-stations on the classic trade routes of antiquity. The region was instead a significant production center that manufactured commodities in surplus to be marketed by its merchants in regional commerce.”¹⁰²

In other words, what is the evidence for a rapid expansion of Arabian industry in the late sixth to early seventh century CE? I will explore this issue by examining the two most significant early Arabian Islamic industries: leather and ore.

99 We must bear in mind, however, that the almost total absence of archaeological data throughout this area does not help in drawing a detailed picture of the local settlement process on the eve of Islam. Except for Najrān, the continuity is revealed only by later Islamic sources.

100 Al-Askar, *Al-Yamama*, 7–27, 43–52; al-Zahrani, “Mining in al-Baha Region,” 32–58.

101 Ibrahim, “Social and Economic Conditions,” 344–45.

102 Heck, “Arabia without Spices,” 561.

THE LEATHER AND MINING INDUSTRIES IN LATE ANTIQUE ARABIA

Several key economic subsectors are clearly identified in early Islamic Arabia,¹⁰³ primarily from written sources because of the paucity of archaeological data.¹⁰⁴ These subsectors are textiles and weaving; perfumes; black-, silver-, and goldsmithing; tanning and leatherworking; and ore mining. The last two were the dominant industries,¹⁰⁵ and it has been a matter of dispute as to which one was the driving force behind the late antique Meccan trade. In 1999, Heck argued: “Regarding early medieval Makkah’s economic reason to exist (. . .) it may be asserted that, without question, it was gold and silver used as currency and the dynamic commerce that these twin precious metals underwrote.”¹⁰⁶ In 2007, Patricia Crone rejected Heck’s sound argument with nothing other than an anecdote about a “mediaeval scholiast” and made leather the driving force behind Meccan trade.¹⁰⁷ My intention is not so much to settle a dispute pertaining to the issue of Arabian trade but more to explore the supply capacity—an issue ignored in Crone’s model of an Arabian trade flooding both the Byzantine and Sasanian markets with leather¹⁰⁸—and the organization of these industries, both of which are assumed to be deeply rooted in the pre-Islamic period.

103 Crone, *Meccan Trade*, 85–108; Ghabin, “Attitude of the Pre-Islamic Arabs”; Heck, “Arabia without Spices.”

104 Only the mining industry is an exception, with several field reconnaissance surveys and excavations (Benoit et al., “Nouvelles recherches”; Christmann et al., “Résultats de trois années de prospection”; de Jesus et al., “Preliminary Report of the Ancient Mining Survey”; Heck, “Gold Mining in Arabia”; Hester et al., “Preliminary Report on the Third Phase of Ancient Mining Survey”; Kisnawi, de Jesus, and Rihani, “Preliminary Report on the Mining Survey”; Peli and Téreygeol, “Al-Raḍrād (al-Jabalī)”; Robin, “Mine of ar-Raḍrād”; Weisgerber, “Metallurgy in Arabia” and “Patterns of Early Islamic Metallurgy”; al-Zahrani, “Mining in al-Baha Region”).

105 Although less well documented than leather and mining, textile production was probably also a dominant activity and Najrān a major production center. According to al-Balādhurī, the diplomatic convention negotiated by the Christian delegation of Najrān coming to the Prophet Muḥammad included the delivery of 1,000 pieces of clothing twice per year, each being worth 40 dirhams, in exchange for protection and security (al-Balādhurī, *Kitāb futūḥ al-buldān*, 1:98–100; Massignon, “La Mubāhala,” 12). Excavations of early Islamic contexts in the southern Levant have also shown the importation of a large quantity of cotton textiles from Yemen (Power, *Red Sea*, 107). Goldsmiths were another active economic category, at least in Medina, where they would have numbered 300 in the area of Zuhra (Lecker, “Lost Towns: Zuhra and Yathrib,” 31).

106 Heck, “Gold Mining in Arabia,” 389.

107 Crone, “Quraysh and the Roman Army,” 64: “Several gold mines are attested in the Ḥijāz, and Gene Heck suggests that gold and silver contributed to ‘the expansion of the local employment base’ and served, among other things, as input in industrial production, as the investment capital that underwrote that production, and as ‘the currency base for financing import acquisitions.’ A medieval scholiast, on the other hand, informs us that the caliph Umar wanted to cut camel hides in the shape of dirhams for use as currency ‘because of the scarcity of gold and silver (. . .). Leather, hides, woolens, and clarified butter rather than gold or silver are consistently identified as the star items of export from Mecca.”

108 Crone, “Quraysh and the Roman Army.”

CASE STUDY OF THE LEATHER INDUSTRY

Resources

Provided that a water source is nearby, the Arabian environmental context offers all the required components of the tanning industry—namely, the raw hides of breeding animals (e.g., camel, cattle, goats) and wild species (e.g., gazelles)¹⁰⁹ and vegetable tannins extracted from leaves (generally the *qaraz*, the leaves of *Acacia ehrenbergiana*).¹¹⁰

Uses

Leather was “the plastic of the age,”¹¹¹ given its highly diversified uses for riding (bridles, reins, saddles); weaponry (sword sheaths, shields, quivers, cuirasses); containers (knapsacks, bags, food containers, buckets, basins, bottles, gourds); and clothing (shoes, sandals, belts). Leather was used for coffins, of which finely preserved examples have been retrieved from archaeological contexts at Madā’in Šālīḥ (Saudi Arabia, first to second centuries CE)¹¹² and Shibām al-Ghirās (Yemen, fifth to first centuries BCE).¹¹³ It served as a building material: the *qubba*, a round tent made of leather, was the most costly and luxurious of Arab tents,¹¹⁴ and in pre-Islamic times the cover of both the *ka’ba* of Najrān and that in Mecca consisted of pieces of leather.¹¹⁵ As early as the late pre-Islamic period, it also served as a writing surface in the form of either raw leather or refined parchment.¹¹⁶

Local and External Demand

This variety of products shows how important local demand may have been. External demand may have been significant, too, if we give credence to the assertion that Hāshim b. ‘Abd Manāf, the Prophet Muḥammad’s great-grandfather, concluded an *ilāf* pact with the Byzantines involving the export of leather goods and clothing.¹¹⁷ Crone assumed, on this basis, that in the sixth century CE both the Byzantine and the Sasanian armies represented an enormous demand for leather reinforced by a downward trend in their own

109 Ibn al-Mujāwir, *Tārīkh al-mustabṣir*, 42: “The hides of camels, cattle and gazelles are tanned in Mecca and travellers from Khurasan buy the pelts of stallion mules from the district of Mosul and from the area of Irbil and they are tanned in Mecca.”

110 Ibn al-Mujāwir, *Tārīkh al-mustabṣir*, 42n3.

111 Conrad, “The Arabs,” 687.

112 Bouchaud et al., “New Discoveries in a Nabataean Tomb.”

113 Vogt, “Death and Funerary Practices,” 82–83.

114 Al-Balādhurī, *Kitāb futūḥ al-buldān*, 2:53; al-Mufaḍḍal, *Mufaḍḍalīyāt*, 11 with n3, 175, 305, 350; Qur’ān 16:80: “And Allah has made for you from your homes a place of rest and made for you from the hides of the animals tents which you find light on your day of travel and your day of encampment.”

115 In Najrān, the dome was made of 300 pieces of leather (Yāqūt, *Mu‘jam al-buldān*, 4:756; al-Iṣfahānī, *Kitāb al-Aghānī*, 7); for Mecca, see al-Balādhurī, *Kitāb futūḥ al-buldān*, 1:76.

116 Grohmann, “Djild”; Maraqtan, “Writing Materials in Pre-Islamic Arabia,” 290.

117 Ibn Ḥabīb, *Kitāb al-munammaq*, 42. See also Crone, “Quraysh and the Roman Army,” 64, 76; Ghabin, “Attitude of the Pre-Islamic Arabs,” 36.

local supplies.¹¹⁸ By Crone's own admission, such a hypothesis "involves an uncomfortable amount of guesswork,"¹¹⁹ not to mention the fact that she never wondered whether the local supply capacity could have met a demand of this kind. The point is that whatever the external demand, an important market for leather goods definitely existed.

Production Centers

It is no surprise that, at least in the thirteenth century CE, leather was tanned "in every province of the Yemen and the Ḥijāz and the surrounding areas."¹²⁰ In 1971, Ahmad Khan undertook to list the Arabian centers of leather production in a journal article titled "The Tanning Cottage Industry in Pre-Islamic Arabia," but surprisingly the article deals only with the Islamic sources and the Islamic period.¹²¹ Complemented by subsequent studies,¹²² the list includes two major production centers (al-Ṭā'if and Ṣa'da) and a few secondary centers (Aden, Muzdawiya al-Murra, Jarash, Najrān, Mecca, Medina, and Jedda).

Al-Ṭā'if

This city was the principal center of leather production, active in the Abbasid period according to the chroniclers of the late eighth and early ninth centuries CE (Ibn al-Kalbī, Ibn Hishām, al-Wāqidī, Ibn Sa'd).¹²³ In the tenth century, the Yemeni geographer Abū Muḥammad al-Ḥasan al-Hamdānī described al-Ṭā'if as a "land of tanners."¹²⁴ Production continued up to the thirteenth century CE and was admired by both Yāqūt and Ibn al-Mujāwir. The former describes a tanning industry that was divided into two neighborhoods, Waḥt and Ṭayf Thaḳīf, between which flowed the wadi whose foul smell caused the birds to fall out of the sky.¹²⁵ About the inhabitants, Ibn al-Mujāwir writes: "The whole of their work effort [goes into] tanning leather. Leather is tanned in al-Ṭā'if which is of excellent quality, heavy and well-known there."¹²⁶ Both al-Hamdānī and Ibn al-Mujāwir refer to the ancient history of the city and its tanning tradition.¹²⁷ However, none of these accounts is

118 Crone, "Quraysh and the Roman Army," 68–69, 74: "The wars will have served further to increase the imperial demand for leather while at the same time reducing the local supply; and from 541 onwards, the repeated outbreaks of plague on the Byzantine side will have reinforced the downward trend."

119 Crone, "Quraysh and the Roman Army," 86.

120 Ibn al-Mujāwir, *Tārīkh al-mustabṣir*, 41–42. See also Crone, *Meccan Trade*, 100 and references cited.

121 Khan, "Tanning Cottage Industry."

122 Crone, "Quraysh and the Roman Army"; Ghabin, "Attitude of the Pre-Islamic Arabs"; Heck, "Arabia without Spices"; Ibrahim, "Social and Economic Conditions."

123 Crone, *Meccan Trade*, 99; Heck, "Arabia without Spices," 569 and references cited.

124 Al-Hamdānī, *Ṣifat jazīrat al-ʿarab*, 120.

125 Yāqūt, *Muʿjam al-buldān*, 3:496; see also Khan, "Tanning Cottage Industry," 92; Lammens, *La cité arabe de Ṭāif*, 114–15.

126 Ibn al-Mujāwir, *Tārīkh al-mustabṣir*, 54.

127 Ghabin, "Attitude of the Pre-Islamic Arabs," 36; al-Hamdānī, *Ṣifat jazīrat al-ʿarab*, 120; Ibn al-Mujāwir, *Tārīkh al-mustabṣir*, 49: "The Nabataeans, descendants of the Christian Greeks—it is also said of the Byzantines—arrived. Some reminders of them remained: the casing of the canals and the spring-water channels, and also the millstones on which acacia leaves are ground for the tanning of leather. This is not

supported by useful testimonies, with the result that nothing is known about pre-Islamic tanning activity in al-Ṭāʾif.

Ṣaʿda

Ṣaʿda was considered a dominant setting for the tanning industry, partly because of its ideal location in a land of *qaraz* (acacia); this activity is reported by the tenth- to thirteenth-century CE geographers.¹²⁸ The tribe of Khawlān, settled in and around Ṣaʿda, was involved in tanning¹²⁹ and gave its name to a specific type of red leather (*al-adīm al-ḥawlānī*).¹³⁰ Khan assumed that the tribe of Madhḥij specialized in producing leather goods in Ṣaʿda, thus deriving their name from *ḍaḥaj al-ʿadīm* (“to soften the skin”).¹³¹ But this Arabic etymology is unlikely, because Madhḥij stems from the name of the pre-Islamic tribe Madhḥig^{um} (*Mdhg^{um}*) mentioned in a dozen Sabaic inscriptions from the first to sixth centuries CE.¹³² Here again, there is no information that sheds light on possible production in the fifth to ninth centuries CE.

Secondary production centers

Similarly, the testimonies of active secondary production centers are contemporaneous with the tenth- to thirteenth-century CE geographers (Ibn Ḥawqal, al-Muqaddasī, Yāqūt, and Ibn al-Mujāwir).¹³³ The only exceptions are Mecca and Medina, where a tanning cottage industry is highly likely at the time of Muḥammad (see below).¹³⁴

Evidence for Pre-Islamic Leather Production

In the thirteenth century CE, while reporting a visit to the ruins of the city of al-Muzdawīya al-Murra (ca. 120 km west of Aden) and describing tanning facilities there, Ibn al-Mujāwir says in an aside that “every town built by the Persians from Sirāf had tanneries constructed

the work of the Arabs (. . .). Rather, this and similar work is carried out by the tyrants of old [i.e., pre-Islamic rulers] and based on the wise ways of the ancients.”

128 Al-Hamdānī, *Ṣifat jazīrat al-ʿarab*, 66–67; Yāqūt, *Muʿjam al-buldān*, 3:389. See also Ibrahim, *Merchant Capital and Islam*, 24; Khan, “Tanning Cottage Industry,” 89.

129 Al-Ḥimyarī, *Shams al-ʿulūm*, 76; Khan, “Tanning Cottage Industry,” 89; Maraqtan, “Writing Materials in Pre-Islamic Arabia,” 291–92.

130 Al-Nisābūrī, *Ṣaḥīḥ Muslim*, hadith 1361.

131 Khan, “Tanning Cottage Industry,” 89. Khan’s assumption has been blindly repeated: Ibrahim, *Merchant Capital and Islam*, 24; Morony, “Late Sasanian Economic Impact,” 36.

132 In chronological order: Bāfaḥīh AF 1, Qaryat-Muʿāwiya, ʿInān 75, Ja 660, Ja 665, Ir 32, ʿAbadān 1, al-ʿIrāfa 1, Ry 510, Ry 508, Ja 1028. For another doubtful origin of the tribal name, see Caskel, *Ġamharat an-nasab*, 2:382: “Madhḥij sei der Beiname der Mutter des Erstlings Mālik b. Udad; sie heisse so nach dem Felsen, auf dem sie ihre Mutter geboren hatte.”

133 Khan, “Tanning Cottage Industry,” 95–97 and references cited.

134 Khan, “Tanning Cottage Industry,” 91.

in them.”¹³⁵ On the flimsy basis of this sentence, Adolf Grohmann, and Crone after him, assumed that the Persians, when conquering southern Arabia soon after 570 CE, greatly encouraged the leather industry and founded numerous tanneries in Yemen.¹³⁶ This is not what Ibn al-Mujāwir says.

The only evidence of possible Yemeni leather production in late antiquity, therefore, is the ninth-century CE historian Aḥmad ibn Yaḥyá al-Balādhurī’s mention of the Lakhmid king of Ḥira, al-Nu‘mān—probably al-Nu‘mān [IV] b. al-Mundhir (r. 580–602 CE)—who organized annual caravans to ‘Ukāz, where he bought leather from Yemen.¹³⁷

Nothing can be said about the volume or organization of the production in the sixth century CE, although five hadiths compiled in the ninth century by Aḥmad b. Ḥanbal and Abū al-Ḥusayn Muslim b. al-Ḥajjāj describe a tanning cottage industry in the Meccan/Medinan context of the early seventh century CE.¹³⁸ Whatever the historical authenticity of the anecdotes themselves, the action in the background is significant:

- *Qaraḥ* leaves are piled in the corner of a bedroom where a raw hide is hanging.
- A woman in mourning, having been visited by Muḥammad, tanned forty hides before kneading flour.
- A woman tanned hides with *qaraḥ* inside her own house.
- A woman tanned the skin of her goat, which had just died.
- A woman is asked to tan the hide of a goat.

In these five contexts, tanning is a domestic industry performed by women in a nonspecialized building and involving a single hide, the figure of forty hides in the second example being deliberately exaggerated for hagiographic purposes.

In sum, we can accept the following conclusions:

- All the requirements necessary for a tanning industry were fulfilled in western Arabia.
- In late antiquity and early Islam, the demand for leather products was already high at the local level; external demand is mainly a matter of conjecture.
- Before the eighth century CE, tanning is always depicted as a household industry divided into small units and located in at least three active production areas: Medina, Mecca, and the Najrān/Ṣa‘da area.
- In the early and middle Islamic periods, the tanning industry, although attested everywhere, was mainly located along a Ṣa‘da–Medina axis (including Jarash and Najrān), with two major industrial centers located at al-Ṭā‘if (eighth to thirteenth centuries CE) and Ṣa‘da (tenth to thirteenth centuries CE).

135 Ibn al-Mujāwir, *Tārīkh al-mustabṣir*, 122.

136 Grohmann, “Djild”; Crone, “Quraysh and the Roman Army,” 76.

137 Al-Balādhurī, *Ansāb al-ashraf*, 101. The identification of al-Nu‘mān of Ḥira with Nu‘mān b. al-Mundhir—Nu‘mān III or Nu‘mān IV, depending on the publication (Robin, “Les arabes de Ḥimyar,” 182n114)—is based on another mention of a caravan of al-Nu‘mān b. al-Mundhir to ‘Ukāz by Ibn Ishāq (*Sīrat Rasūl Allāh*, 710).

138 Details and references in Khan, “Tanning Cottage Industry,” 91.

CASE STUDY OF ORE MINING¹³⁹*A Critical Review of the Sources*

There is no doubt that Arabia was rich in gold, silver, and copper ore.¹⁴⁰ Omani copper extraction and processing is relatively well known, be it with respect to volume or chronology: the region flooded the Mesopotamian market with copper ingots in the third to early second millennia BCE. After an interruption, extraction resumed in the Iron Age. Slowing down and almost stopping in the late Iron Age, it resumed in the early Islamic period.¹⁴¹

In the case of gold and silver, the picture is rather blurred. Admittedly, Greek and Roman geographers (second century BCE to first century CE) emphasized Arabia's wealth in silver and gold,¹⁴² as is sometimes seen in eighth- to tenth-century Arabic sources on late antiquity.¹⁴³ Nevertheless, it is difficult to establish the historicity of these accounts, given that classical sources often repeat one another in a mix of fantasy and reality and Arabic sources often give a legendary flavor in which wealth is put to hagiographic uses. Late antique ore mining should not be examined on this basis.¹⁴⁴

139 Heck produced his pioneering work by synthesizing data pertaining to early Islamic mines and mining (Heck, "Arabia without Spices"; "Gold Mining in Arabia"; *Precious Metals of West Arabia*). I owe a great amount of data and many references to his work.

140 Al-Hamdānī, *Kitāb al-Ġauharatāin*; Heck, "Gold Mining in Arabia" and *Precious Metals of West Arabia*; Roberts et al., *Mineral Deposits in Western Saudi Arabia*; Weisgerber, "Metallurgy in Arabia."

141 Hauptmann, *5000 Jahre Kupfer in Oman*; Weeks, "Analysis of Late Pre-Islamic Copper-Base Artefacts," 240, 247; *Early Metallurgy of the Persian Gulf*; Weisgerber, "Patterns of Early Islamic Metallurgy"; "Sites of Multi-Period Copper Production."

142 Agatharchides of Cnidus, *On the Erythraean Sea* 5.97a: "The Debae inhabit the region that borders on the mountainous district. Some are nomads and some are farmers. Through the middle of their country flows a river that is tripartite in nature. It carries down gold nuggets that are so obviously abundant that the mud that is deposited at its mouth gleams from afar. The inhabitants of this region are unskilled in working this sort of metal." Polybius, *Histories* 4.13.9: "The Gerrhaeans passed a decree honoring Antiochus with the gift of five hundred talents of silver, a thousand talents of frankincense, and two hundred talents of the so-called 'stacte.'" Diodorus of Sicily, *Bibliothèque historique* 3.45: "La contrée qui suit est habitée par les Arabes Aliléens et les Gasandes (. . .). Ils retirent beaucoup d'or des entrailles de la terre; cet or n'a pas besoin d'être extrait du minerai par la fusion, car il y est à l'état natif (. . .). Mais comme ils n'ont ni cuivre ni fer, ils achètent ces métaux à des marchands étrangers contre un poids égal d'or." Strabo, *Geography* 16.4.26, on the Nabataeans: "Some things are imported wholly from other countries, but others not altogether so, especially in the case of those that are native products, as, for example, gold and silver and most of the aromatics." Pliny the Elder, *Natural History* 6.32: "The Sabæi are the richest of all in the great abundance of their spice-bearing groves, their mines of gold, their streams for irrigation, and their ample produce of honey and wax."

143 E.g., Ibn Ishāq, *Sīrat Rasūl Allāh*, 31: "Then he [Khosrow I] made him [the Yemeni Sayf b. dhī-Yazan] a present of 10,000 drachmae sterling and invested him in a fine robe. Sayf went out with the silver and began to scatter it among the people. When the king was told of this he thought it very extraordinary and sent for him and said, 'You mean to throw away a royal gift!' He answered: 'What use is silver to me? The mountains of my country from which I come are nothing but gold and silver.' This he said to excite his cupidity."

144 Power, "Mines, Mining, Late Antiquity." I could also mention the kingdom of Ophir (Genesis 10:29, 1 Kings 9:26–28), which supplied King Solomon with large amounts of gold. While some scholars have suggested that Ophir was located in central Arabia, many others have expressed reservations with solid arguments, starting with Étienne Quatremère ("Mémoire sur le pays d'Ophir") and more recently Gonzague Ryckmans ("Ophir").

Another difficulty is that archaeological data and textual sources are often contradictory. For example, the author of Sabaic inscription B-L Nashq (sixth century BCE) mentions a gift by the Sabaean king of 1,000 units of *wrq*—a precious metal,¹⁴⁵ perhaps gold or silver¹⁴⁶—for services rendered. In the second century BCE, Polybius mentions the delivery to Antiochus of 500 talents of silver by the Gerrhaeans.¹⁴⁷ Yet not a single active silver mine has been identified in the field for this period. As for gold, only one minor exploitation dated to the tenth to sixth centuries BCE has been surveyed—that at al-Marāziq, north of the Yemeni Jawf.¹⁴⁸

Further, in southern Arabia, the period from the first to the fourth centuries CE corresponds to a peak in the production of copper and silver coins,¹⁴⁹ as well as of bronze inscriptions and statues. Excavations have yielded more than 200 dedicatory inscriptions either cast in bronze or accompanied by the offering of one or several bronze statues.¹⁵⁰ Pairs of life-sized statues of kings and horses were cast in local workshops.¹⁵¹ Most of these pieces come from the South Arabian kingdoms of Saba' and Ḥimyar, for which nothing is known of ore mining at that time. Interestingly, the neighboring kingdom of Ḥaḍramawt was no better off, since, according to one of the unique firsthand classical sources—the *Periplus Maris Erythraei*¹⁵²—it imported both tin and copper from Egyptian ports.

To sum up, in the case of copper and bronze, there were active Arabian workshops casting artifacts and works of art in the early Common Era, but whenever an excavated workshop points to copper smelting in the first centuries CE,¹⁵³ the rare chemical analyses show either local, archaic, small-scale extraction with a low rate of copper recovery¹⁵⁴ or the import of copper, tin, and lead from outside Arabia.¹⁵⁵ There are no data showing any important Arabian copper extraction from the third century BCE to the fifth or sixth century CE. Regarding gold and silver, the pre-Islamic wealth in these ores is legendary, so it is not easy to disentangle fact from fantasy. The only way to analyze a potential mining industry in late antiquity is to examine the firm evidence available so far—an exercise that might, in turn, provide an idea of the volumes extracted and the pace of this extraction.

145 Robin and de Maigret, “Le royaume sudarabique de Maʿīn,” 91–92.

146 Bron and Lemaire, “Nouvelle inscription sabéenne,” 18.

147 Polybius, *Histories* 4.13.9.

148 Mallory-Greenough, Greenough, and Fipke, “Iron Age Gold Mining.”

149 Sedov, “Coins.”

150 Jändl, *Altsüdarabische Inschriften auf Metall*.

151 Stupperich and Yule, “Ḥimyarite Period Bronze Sculptural Groups.”

152 *Periplus*, §28. See also de Romanis, “Bronze in Ancient Yemen,” 67.

153 E.g., Taymā' (northern Ḥijāz): Liu et al., “Copper Processing”; Širwāḥ (Yemen): Gerlach, “Sirwah”; ed-Dur (United Arab Emirates): Weeks, “Analysis of Late Pre-Islamic Copper-Base Artefacts”; Mleiha (United Arab Emirates): Ploquin, Orzechowski, and Briand, “Paléométallurgie à Mleiha.”

154 E.g., Mleiha: Ploquin, Orzechowski, and Briand, “Paléométallurgie à Mleiha,” 180.

155 E.g., Taymā': Liu et al., “Copper Processing”; ed-Dur: Weeks, “Analysis of Late Pre-Islamic Copper-Base Artefacts.”

Discarding Wrongly Dated “Late Antique” Mining Sites

There are hundreds of early medieval Ḥijāzī-Najdī copper-, silver-, and gold-mining sites.¹⁵⁶ Many have been located in the field during mining prospection and archaeological surveys. Moreover, Arab and Persian authors from the seventh to twelfth centuries CE refer to more than 100 mines,¹⁵⁷ the most informative account being the tenth-century metallurgical treatise of al-Ḥamdānī, *Kitāb al-Ġauharatain*.¹⁵⁸ Most of these references are to gold mines; silver mines are mentioned less frequently and iron, copper, and lead mines only rarely in written sources.¹⁵⁹

On the basis of very scant material or weak arguments, it has been assumed that most of these mines were already exploited in the pre-Islamic period: “Just as today modern mining geologists look for ancient mines as a means of finding deposits, so did the miners of earlier times. We can therefore postulate that the Islamic mines are a continuation of earlier exploitation.”¹⁶⁰ This mere rhetoric proves little.

Further, in the al-Baha region, absent pottery and glass sherds, Robert Hester and colleagues dated mining sites to the pre-Islamic period on the basis of the presence of a specific architectural feature: the double-walled stone structure. This feature was considered pre-Islamic by comparison with the ancient sites of Hajar bin Humayd and Tamnaʿ, excavated in the 1950s.¹⁶¹ But this argument no longer stands, first because this kind of architecture has since been excavated in Islamic contexts (e.g., Fayd), and second because some of the sites considered exclusively pre-Islamic on this basis—for example, the mine of al-ʿAqīq—have proved to be of a later date.¹⁶²

Finally, in 1979, during a survey of central and western Arabia, fourteen gold- and silver-mining sites were discovered, and all were dated to the Abbasid period. Some were said to show a small, possibly pre-Islamic occupation on the basis of the presence of alleged pre-Islamic pottery.¹⁶³ However, this pioneering work lacked published assemblages

156 Heck, “Arabia without Spices,” 556–57; al-Zahrani, “Mining in al-Baha Region,” 241–47.

157 Peli, “Les mines de la péninsule Arabique,” table 1. Heck mentions 200 mining sites that are cited in the sources used for his study (Heck, “Gold Mining in Arabia,” 379).

158 Partly translated into English by Douglas Dunlop (“Sources of Gold and Silver”); extensively edited and translated into German by Christopher Toll (al-Ḥamdānī, *Kitāb al-Ġauharatain*).

159 Peli, “Les mines de la péninsule Arabique,” 33 and table 1.

160 De Jesus et al., “Preliminary Report of the Ancient Mining Survey,” 79. See also Heck, “Gold Mining in Arabia,” 385: “Just as modern geologists and prospectors now typically seek out historic mines as a means of finding new deposits, so did the miners of previous times, in so doing, obscuring the handiwork of their predecessors.”

161 Hester et al., “Preliminary Report on the Third Phase of Ancient Mining Survey,” 123.

162 In the case of al-ʿAqīq, ninth- and tenth-century pottery material, Kufic inscriptions (Heck, “Gold Mining in Arabia,” 382), and even an inscription dated to 1803 CE (al-Zahrani, “Mining in al-Baha Region,” 97) show how long-term mining activities might have looked. If al-Ḥamdānī alludes to the running of this mine in the time of Muḥammad (*Ṣifat jazīrat al-ʿArab*, 166), thus indicating pre-Islamic activity, it was definitely not the main period of activity at this site.

163 Zarins et al., “Comprehensive Archaeological Survey Program.” None of the pottery sherds was illustrated by a photo or drawing. The authors remained cautious in their chronological attributions, often using the conditional. On the mine of Waḍakhāʾ: “We recovered ribbed wares characteristic more of a pre-Islamic Byzantine tradition” (Zarins et al., “Comprehensive Archaeological Survey Program,” 27–28); on Ḍālim: “The bulk of this material can be placed in the Abbasid period. One sherd of a very thin, red

with which the pottery could be compared, and some chronological attributions proved to be inaccurate.¹⁶⁴

Absolute Dating of Mining Sites

Several mining sites have yielded artifacts, pottery material, inscriptions, and/or radiocarbon-dated samples that provide absolute dates. Together with Arab-Islamic sources, they highlight the chronology of the mining industry. The archaeological and written evidence is summarized here.

Ḥijāz

Maʿdin Banū Sulaym—also known as Mahd al-Dhahab (Ḥijāz), the largest gold-mining complex in the Arabian Peninsula:

- Carbon-14 dates: one sample dating to the early first millennium BCE; a second sample dating to somewhere between 430 and 830 CE¹⁶⁵
- Kufic inscriptions found among the tailings
- Pottery material dating to the ninth to tenth centuries CE¹⁶⁶
- A stela dating to 916–917 CE in the ore-processing area¹⁶⁷
- In use in 746, when the Umayyads appointed Kuthayr b. ʿAbd Allāh as its overseer
- Opened in the reign of Caliph Abū Bakr (r. 632–634), according to Ibn Saʿd

Maʿdin Nuqra:

- Carbon-14 date: a sample dating to 675–835 CE (calibrated?)¹⁶⁸
- Pottery material dating to the ninth to tenth centuries CE¹⁶⁹

Qabaliyya mines (Jabal Quds):

- Kufic inscriptions¹⁷⁰

ware may point to an even earlier period, the Roman-Nabataean” (Zarins et al., “Comprehensive Archaeological Survey Program,” 28); on al-Ṭawila: “Extensive remains belong to the Abbasid period, but at both sites possible Roman-Byzantine wares may be present” (Zarins et al., “Comprehensive Archaeological Survey Program,” 28); on al-Baʿthāt: “It could be possible that these mines operated within a South Arabic time horizon” (Zarins, Murad, and al-Yaish, “Second Preliminary Report,” 34).

164 A pottery category such as the steatite-tempered red ware considered as pre-Islamic, and used to date the mining sites of Shujna and Turba in the al-Ṭāʾif region (Zarins et al., “Comprehensive Archaeological Survey Program,” 28), was later found in an eighth- to eleventh-century context at the mining site of ʿAsham (al-Zahrani, “Mining in al-Baha Region,” 190).

165 Heck, “Gold Mining in Arabia,” 381. No details are given about the radiocarbon age and its calibration. Calibration might noticeably change the result of an uncalibrated given date.

166 Heck, “Gold Mining in Arabia,” 377, 381–83.

167 Peli, “Les mines de la péninsule Arabique,” 39 and references cited.

168 Heck, “Gold Mining in Arabia,” 381.

169 De Jesus et al., “Preliminary Report of the Ancient Mining Survey,” 71.

170 Heck, “Gold Mining in Arabia,” 382.

‘Asīr

‘Asham:

- Pottery material dating to the eighth to twelfth centuries CE
- Funerary inscriptions ranging in date from 774 to 1057 CE¹⁷¹

Al-‘Aqīq:

- Pottery material dating to the ninth and tenth centuries CE
- Kufic inscriptions¹⁷²
- In operation at the time of al-Hamdānī¹⁷³
- An inscription dating to 1803 CE¹⁷⁴

Al-Ḥamḍa:

- Kufic inscriptions¹⁷⁵

Jabal Makhiyyaṭ:

- Carbon-14 date: a sample dated to 1326–161 cal BCE (radiocarbon age: 2600 ± 250 BP)¹⁷⁶

Al-Maṣānī‘:

- Carbon-14 date said to have produced a medieval time frame¹⁷⁷

Najd

Shamām:

- Opened by the Persians in late antiquity
- Abandoned by the tenth century CE¹⁷⁸

171 Al-Zahrani, “Mining in al-Baha Region,” 132. Note that Timothy Power (*Red Sea*, 132) calls into question the identification of the archaeological site of ‘Asham with the mine of the same name mentioned by al-Hamdānī.

172 Heck, “Gold Mining in Arabia,” 382.

173 Dunlop, “Sources of Gold and Silver,” 38.

174 Al-Zahrani, “Mining in al-Baha Region,” 97.

175 Heck, “Gold Mining in Arabia,” 382.

176 Schmidt et al., *Gold Placer and Quaternary Stratigraphy*, 54. Calibration with the radiocarbon calibration program calib rev7.1.0, according to IntCal13 radiocarbon age calibration curves (Reimer et al., “IntCal13 and Marine13”).

177 Heck, “Gold Mining in Arabia,” 381.

178 Al-Hamdānī, *Kitāb al-Ġauharatāin*, 142: “Zu ihnen gehört die Silber- und Kupfergrube von Šamām im Lande Nağd. Und Šamām ist ein grosses Dorf, in dem, wie man sagt, Tausend von den Magiern [*Majūs* = Zoroastrians/Persians] lebten, und wo es zwei Feuertempel gab. Und Ibnā Šamām (Die Zwei Söhne von Šamām) sind zwei Berge dort. Und es liegt jetzt in Trümmern, nachdem es in der Ġāhiliya und der meisten Zeit des Islams bewohnt war.” See also al-Hamdānī, *Šifat jazīrat al-‘arab*, 149: “thousands of Magians who were working the mine.” The Shamām mine is known only from written sources. Its location is likely to be in the vicinity of the al-Dawādīmī region in central Arabia, which has a high concentration of early

Ḥillayit:

- Kufic inscriptions¹⁷⁹

Samīrāʿ:

- Coins of the late eighth century CE
- Ninth- to tenth-century CE pottery material¹⁸⁰

Al-Samrāʿ:

- Carbon-14 date: two samples dating to 670–968 cal CE and 689–974 cal CE¹⁸¹
- Ninth- to tenth-century CE pottery material¹⁸²

Oman¹⁸³

Yanqul area (Rākī 1, Rākī 2, Tawī Rākī):

- Rākī 2: copper production from 1300 to 800 BCE according to pottery material and carbon-14 dates¹⁸⁴

Al-Maysar area (Wādī Qatif, Jabal Salāyilī, Bilād al-Māʿdin):

- Iron Age artifacts and pottery material
- Early Islamic pottery material¹⁸⁵

Ṣuḥār hinterland (al-ʿArjā, Zahra, al-Samīda, “Lasail” [Wādī Nasīl]):

- Zahra 2: Iron Age copper mining and smelting¹⁸⁶
- ʿArja 1: nine carbon-14 dates ranging from the fifth to the thirteenth centuries cal CE¹⁸⁷

Islamic mining sites. An archaeological survey reported “Abbasid” pottery on the surface at some of these sites (Zarins et al., “Comprehensive Archaeological Survey Program,” 27).

179 Heck, “Gold Mining in Arabia,” 382.

180 Heck, “Gold Mining in Arabia,” 382. The Abbasid silver dirhams found at the site were struck in 760 and 778 CE.

181 Al-Shanti, “Geology and Mineralization,” 246. Radiocarbon age 1214 ± 68 BP, median probability 810 CE; and radiocarbon age 1188 ± 57 BP, median probability 834 CE. Calibration with the radiocarbon calibration program calib rev7.1.0, according to IntCal13 radiocarbon age calibration curves (Reimer et al., “IntCal13 and Marine13”).

182 Heck, “Gold Mining in Arabia,” 382.

183 Bronze Age mining sites are not considered here, as they lie outside the scope of this study.

184 Weisgerber, “Sites of Multi-Period Copper Production,” 196–97; Weisgerber and Yule, “Preliminary Report of the 1996 Season.”

185 Weisgerber, “Mehr als Kupfer,” 190; “Sites of Multi-Period Copper Production,” 197–99.

186 Weisgerber, “Sites of Multi-Period Copper Production,” 197. No details provided.

187 Weisgerber, “Mehr als Kupfer,” 251; “. . . und Kupfer in Oman,” 75. Calibration with the radiocarbon calibration program calib rev7.1.0, according to IntCal13 radiocarbon age calibration curves (Reimer et al., “IntCal13 and Marine13”).

- Active in the ninth to tenth centuries CE, according to al-Masʿūdī¹⁸⁸
- Ninth-century CE pottery material¹⁸⁹

Yemen

Al-Marāziq:

- Late Bronze Age and early Iron Age date according to thermoluminescence analyses, technological comparisons with Egypt, and a Sabaic inscription dated to the eighth to sixth century BCE¹⁹⁰

Al-Raḍrāḍ—the largest silver-mining complex in the Arabian Peninsula:

- Carbon-14 dates: two poorly published charcoal samples,¹⁹¹ the first said to date to 613 ± 70 CE, the second to 1052 ± 70 CE; but it is highly likely the dates are not calibrated, in which case a 2-sigma calibration indicates 581–873 cal CE (median probability at 693 CE) and 1021–1258 cal CE (median probability at 1129 CE)¹⁹²
- More recent carbon-14 analyses indicating incipient mining activity in the fourth to fifth centuries CE and final abandonment in the thirteenth century CE¹⁹³
- Pottery material from the ninth to tenth centuries CE¹⁹⁴
- Operated from before Islam to 883 CE, according to al-Hamdānī¹⁹⁵

Periodization of the Arabian Mining Industry

According to available field data, there were three distinct periods of the Arabian mining industry between 1200 BCE and 1300 CE. These periods probably correspond to industrial peaks, and limited mining activity between them is not precluded.

1. *First half of the first millennium BCE: Limited and scattered gold mining in western Arabia and intensive copper mining in Oman.* In western Arabia, three gold mines were running in the first half of the first millennium BCE: Maḥd al-Dhahab (Hijāz), Jabal Makhiyyaṭ (ʿAsīr), and al-Marāziq (Yemen). The production of the first one cannot be estimated for this period. The other two were modest in scale:

188 Al-Masʿūdī, *Les prairies d'or*, 1:242.

189 Weisgerber, “Patterns of Early Islamic Metallurgy,” 118; “. . . und Kupfer in Oman,” 74.

190 Mallory-Greenough, Greenough, and Fipke, “Iron Age Gold Mining,” 234.

191 Christmann et al., “Résultats de trois années de prospection,” 31.

192 Calibration with the radiocarbon calibration program calib rev7.1.0, according to IntCal13 radiocarbon age calibration curves (Reimer et al., “IntCal13 and Marine13”).

193 Téreygeol, “La mine de Jabali,” 252.

194 Peli and Téreygeol, “Al-Raḍrāḍ (al-Jabali),” 196.

195 After al-Hamdānī, *Kitāb al-Ġauharatāin*, 144, and Dunlop, “Sources of Gold and Silver,” 41: “Now the people of the mine were all Persians who had arrived there in the Jāhiliyya and the days of the Umayyads and ʿAbbāsids. They were called ‘the Persians of the mine.’ Of those in Ṣanʿāʾ were the Banū Sardūya, Banū Mihrūya, Banū Zanjūya, Banū Bardūya, and Banū Jandūya.”

Jabal Makhiyyaṭ produced at the very most an estimated 50 kg of gold,¹⁹⁶ while al-Marāziq was a small complex that encompassed five clusters of one to twenty stone structures each. The smaller clusters were outposts for mining prospection; the two largest ones were dedicated to the main extraction.

Conversely, in southeastern Arabia copper extraction was quite intense, considering the density of sites and the scale of their production. For instance, Rākī 2, the most important Iron Age smelting site in Oman, is estimated to have had 10,000 tons of slag deposits.¹⁹⁷

2. *Sixth to early seventh centuries CE: Sasanian ventures.* Only three sites were dated to this period either by archaeometry or by giving credence to al-Hamdānī:¹⁹⁸ the silver mines of al-Raḍrād (Yemen) and Shamām (Najd) and the copper mine of al-ʿArja (Oman). Mining activity resumed at a time when Sasanian Persia had taken control of these areas.¹⁹⁹ Interestingly, this revival corresponds to the Sasanian silver-mining renaissance in central Asia²⁰⁰ and thus reflects an enterprise of silver ore prospecting covering the entire Sasanian territory. Regarding copper, whose importation to Persia was possibly banned by the Romans, Oman's mines probably offered a resource scarcely extracted in the rest of the Sasanian empire.²⁰¹

It cannot be established whether the mining sites were already running before the Persians came. Nevertheless, technical improvements and a higher level of productivity may have accompanied their arrival²⁰² and increased the volume of traded goods.²⁰³

3. *Seventh to ninth/tenth centuries: The boom of the early Islamic mining industry.* Of seventeen mining sites dated by radiocarbon tests, fifteen were running in the early Islamic period (seventh/eighth to ninth/tenth centuries CE). They represent either the continuous growth of a previous occupation (al-Raḍrād, Shamām, ʿArja 1), a resumption of mining activity at long-abandoned sites (Maḥd al-Dhahab, al-Maysar area, Ṣuḥār hinterland), or start-ups from scratch (ʿAsham). Pre-Islamic mines not reoccupied are rare (al-Marāziq, Jabal Makhiyyaṭ). Some of the less well known medieval sites were possibly already operational in the pre-Islamic period, the former exploitation being hidden by the more recent one.

196 Schmidt et al., *Gold Placer and Quaternary Stratigraphy*, 53.

197 Weisgerber, "Sites of Multi-Period Copper Production," 197.

198 Al-Hamdānī, *Kitāb al-Ğauharatāin*, 142, 144; *Şifat jazīrat al-ʿarab*, 149.

199 Gajda, *Le royaume de Ḥimyar*, 157–67; Morony, "Late Sasanian Economic Impact"; Munt, "Oman and Late Sasanian Imperialism"; Potts, "Sasanian Relationship with South Arabia," 206–9; Ulrich, "Oman and Bahrain."

200 Blanchard, *Mining, Metallurgy, and Minting*, 15; Morony, "Early Islamic Mining Boom," 170.

201 Munt, "Oman and Late Sasanian Imperialism," 277.

202 Weisgerber, "Sites of Multi-Period Copper Production," 200: "The Sasanian period in ʿArja must not necessarily mean that Sasanians were here. But in case this is correct it would explain how the Iranian technique was introduced in Oman. The idea of organizing the de-sulphurization of the copper ores in a row of roasting pits seems to come from Iran. At least they occur also in Iran." See also Morony, "Early Islamic Mining Boom," 171–72.

203 Morony, "Late Sasanian Economic Impact," 35.

Nevertheless, the volumes of extracted ores in the early Islamic period are clearly unprecedented:

- 1 million tons of ore mined for an estimated 1.5 million ounces of gold (ca. 42.5 tons) produced at Mahd al-Dhahab²⁰⁴
- 120,000 tons of ore mined for an estimated 60 tons of silver produced at al-Raḍrād²⁰⁵
- 1 million ounces of gold (ca. 28 tons) produced at al-Ḥamḍa²⁰⁶
- 100,000 m³ of material extracted at al-Nuqra²⁰⁷
- 100,000 tons of slags and thirty smelting furnaces at “Lasail” [Wādī Nasīl]²⁰⁸
- 40,000 tons of slags at al-Samīda²⁰⁹
- As much as 60,000 tons of copper produced in the mines of Oman in the ninth to tenth centuries CE²¹⁰

Apart from myriad ancillary mines, numerous mining complexes were accompanied by large settlements ranging from 60 to 300 housing units²¹¹ and hosting as many as 1,000 manual laborers²¹² or slaves, for whose accommodation the barracks-type settlements visible on the ground may have served.²¹³ Therefore, it seems that the combination of cheap manpower (possibly maintained at a low cost through slavery²¹⁴), efficient extraction, new ore-processing technology (mercury amalgamation process, cupellation, cementation),²¹⁵ and a resulting by-product with a high market value made the mining industry sufficiently cost-effective to grow rapidly—all the more so when the Umayyad and then the

204 Heck, “Gold Mining in Arabia,” 379, 386.

205 Robin, “Mine of ar-Raḍrād,” 124. This estimate, based on the size of the heaps, amounts to about 200 kg of silver per year, assuming the mine was run for about 300 years. This figure is far below al-Ḥamdānī’s, which is around 3,000 kg per year (1 million dirhams) (al-Ḥamdānī, *Kitāb al-Ġauharatāin*, 146). The 400 smelting furnaces mentioned by al-Ḥamdānī may also be exaggerated (al-Ḥamdānī, *Kitāb al-Ġauharatāin*, 146).

206 Heck, “Gold Mining in Arabia,” 386.

207 De Jesus et al., “Preliminary Report of the Ancient Mining Survey,” 65.

208 Weisgerber, “Patterns of Early Islamic Metallurgy,” 116; “Sites of Multi-Period Copper Production,” 201.

209 Weisgerber, “Patterns of Early Islamic Metallurgy,” 116; “Sites of Multi-Period Copper Production,” 201.

210 Hauptmann, *5000 Jahre Kupfer in Oman*, 115.

211 Particularly well preserved in al-Bāḥa region: al-‘Ablā’, al-‘Aqīq (Hester et al., “Preliminary Report on the Third Phase of Ancient Mining Survey,” 135–36), ‘Asham, al-Masoda (al-Zahrani, “Mining in al-Baha Region,” 118–21).

212 Hester et al., “Preliminary Report on the Third Phase of Ancient Mining Survey,” 135. The figure, estimated on the basis of the dwelling density, echoes the number of Persians working in the mine of Shamām reported by al-Ḥamdānī (*Kitāb al-Ġauharatāin*, 142; *Ṣifat jazīrat al-‘arab*, 149).

213 They are mentioned in the northeastern Ḥijāz at Mahd al-Dhahab (Heck, “Gold Mining in Arabia,” 382), al-Shumṭā’, and al-Kawm al-Gharbī (de Jesus et al., “Preliminary Report of the Ancient Mining Survey,” 77).

214 Heck, “Arabia without Spices,” 570; Hester et al., “Preliminary Report on the Third Phase of Ancient Mining Survey,” 130; Power, *Red Sea*, 132.

215 Morony, “Early Islamic Mining Boom,” 171–72.

Abbasid powers developed their own monetization, thus creating a demand for metal.

The Issue of Ownership and Taxation: The Gradual Setting Up of State Control

In the Najd, it is not possible to confirm whether (1) the large community of Persians (*Majūs*) mentioned by al-Hamdānī in the mine of Shamām reflects a massive Persian colonial policy in the last decades preceding the spread of Islam or (2) their agricultural and mining land-use improvements took place over a longer period of time. Whatever the answer, it is likely that the purpose of this investment in silver mining was, in the first instance, to provide the royal mint with the large quantity of silver required by kings involved in recurrent conflicts. It more likely took place after the death of the Kindite al-Ḥārith (ca. 528 CE), when the central Arabian tribe of Maʿadd sided with al-Mundhir (III), the Lakhmid king of al-Ḥīra,²¹⁶ himself a vassal of the Sasanians.

In Yemen, it is only after Sayf b. dhī Yazan overthrew Masrūq son of Abraha, the Aksumite-born king of Ḥimyar, with the help of the Sasanians (ca. 570 CE) that the region was integrated into the Sasanian political dominion, first as a vassal and a few years later (ca. 575 CE) as a province.²¹⁷ Only then could the Persian community have settled down. This dominion over Yemen possibly stimulated Persian mining communities to prospect and exploit mineral resources for the benefit of their homeland, as the dispatch of silver by the Persian governor Wahrīz to Kisrā (Khosrow I) suggests.²¹⁸

After the last Persian governor, Bādhān, converted to Islam and pledged allegiance to Muḥammad (ca. 628–632), the Persian communities that remained in Yemen had to comply with specific forms of taxation.²¹⁹ According to al-Hamdānī, this community was still present in the tenth century CE.²²⁰

Outside the Persian dominion—in other words, in the Ḥijāz—most of the mines were owned and operated by tribal groups.²²¹ Heck has shown that in the seventh to eighth centuries CE, “the financing of these early medieval Arabian mining operations appears to have been a ‘hybrid’ individual/corporate system wherein private capital was employed.”²²²

216 Schiettecatte and Arbach, “Political Map of Arabia,” 190.

217 Gajda, *Le royaume de Ḥimyar*, 157–61.

218 Al-Ṭabarī, *History*, 289.

219 Al-Balādhurī, *Kitāb futūḥ al-buldān*, 1:110.

220 Dunlop, “Sources of Gold and Silver,” 41.

221 This system was perpetuated during the following centuries. The most famous mine, Maḥd al-Dhahab (Ḥijāz), was also named Maʿdin Banū Sulaym after its owners, the Banū Sulaym; the mine of Farān (Ḥijāz) was the property of the Banū Farān, a sept of the Banū Sulaym (al-Bakrī, *Kitāb muʿjam mā istaʿjam*, 28–29); the mine of al-Aḥsan (between al-Qaṣīm and al-Yamāma) belonged to the Banū Kilāb (al-Hamdānī, *Ṣifat jazīrat al-ʿarab*, 159, 291); Maʿdin Nuqra (northeastern Ḥijāz) belonged to the Banū ʿAbs (al-Bakrī, *Kitāb muʿjam mā istaʿjam*, 28); the mine of al-ʿAqīq (ʿAsīr) was the property of the Banū ʿUqayl (al-Hamdānī, *Ṣifat jazīrat al-ʿarab*, 166); al-ʿAwsaja (Najd) belonged to the Banū Ghani in the tenth century CE (al-Hamdānī, *Kitāb al-Ḍauharatain*, 140) and to the related tribe of the Banū Bāhila in the twelfth century CE (Yāqūt, *Muʿjam al-buldān*, 3:745), here showing the possibility of a transfer of ownership (Peli, “Les mines de la péninsule Arabique,” 40–41).

222 Heck, “Arabia without Spices,” 557.

And taking the example of Mahd al-Dhahab, he shows that the capital was shared between an original investor,²²³ the other members of the tribe, and the mine workers.²²⁴

The tribal mining concessions were acknowledged and secured by the regional power in return for taxes (*iqṭāʿ*) and then by the nascent Islamic state in exchange for taxation and charitable contributions (2.5 percent *zakāt* levy, 20 percent *khums* levy). It soon became a key private-sector industry in Muḥammad's era.²²⁵

Once the Umayyad caliphs started to strike coinage—from the reigns of Muʿāwīya (r. 661–680 CE) and especially ʿAbd al-Malik (r. 685–705 CE) onward—there is evidence of the private appropriation of a few mining sites by the ruling dynasty. For example, ʿUmar b. ʿAbd al-ʿAziz (r. 717–720 CE) purchased mines in the neighborhood of Mahd al-Dhahab from the offspring of its original investor, Bilāl b. al-Ḥārith al-Muzanī;²²⁶ this mine may be the one that Umayyad gold coins dated 723–724 CE and 724–725 CE refer to with the notation “Mine of the Commander of the Faithful in the Ḥijāz.”²²⁷ And in 746 CE, during the reign of Marwān II (r. 744–750 CE), is the mention of an Umayyad governor, Kuthayr b. ʿAbd Allāh, in charge of the mine of Mahd al-Dhahab.²²⁸

The peak of the activity of the late eighth and early ninth centuries observed in Arabia, as well as in most of the caliphate provinces,²²⁹ was stimulated by the efforts of the Islamic administration to monetize the economy²³⁰ and by the maintenance of a system of public taxation in coined money.²³¹ The development of Darb Zubayda under Abbasid governmental patronage and the taxation of the Arabian mines possibly facilitated a northward flow of gold from the Ḥijāz to Baghdad.²³²

From the mid-ninth century onward, the Ḥijāzī and Najdī gold mines were progressively abandoned because of their cost-inefficiency, a worsening security situation, and

223 Ḥajjāj b. ʿIlāṯ al-Bahizī al-Sulamī, a companion of the Prophet, at Mahd al-Dhahab (Casanova, “Une mine d’or au Ḥidjāz,” 78; Heck, “Gold Mining in Arabia,” 373); Bilāl bin al-Ḥārith al-Muzanī at the Qabaliyya mines near Medina (al-Bakrī, *Kitāb muʿjam mā istaʿjam*, 28–29; al-Balādhurī, *Kitāb futūḥ al-buldān*, 1:28).

224 Heck, “Arabia without Spices,” 561: “al-Bakrī, in turn, speaks of a dispute at Mahd al-Dhahab gold mine among the original investors, mine workers, and other Sulamīs in the caliphal reign of ʿUmar b. al-Khaṭṭāb. Hence, (. . .) the concept of ‘pooled investment capital’ to finance goods production was not unknown in the sixth and seventh centuries.”

225 Al-Balādhurī, *Kitāb futūḥ al-buldān*, 1:29. See also Heck, “Arabia without Spices,” 557; “Gold Mining in Arabia,” 372; Morony, “Early Islamic Mining Boom,” 176. According to Ibn Saʿd, benefits from the mines of Juḥayna and Qabaliyya were paid to the *bayt al-māl* at the time of its creation, under the caliph Abū Bakr (r. 632–634) (Peli, “Les mines de la péninsule Arabique,” 33).

226 Al-Balādhurī, *Kitāb futūḥ al-buldān*, 1:28.

227 These issues include the notation “Mine of the Commander of the Faithful in the Ḥijāz” (*maʿdin amīr al-muʿminīn bi ʿl-Ḥijāz*), which has long been considered proof of the caliph’s ownership of the mines (Casanova, “Une mine d’or au Ḥidjāz”; Heck, “Arabia without Spices,” 556–57); pace Peli, “Les mines de la péninsule Arabique,” 40.

228 Al-Ṭabarī, *History*, 53.

229 Morony, “Early Islamic Mining Boom.” For Wādī ʿAraba copper mining, see Jones, in this volume.

230 Shatzmiller, in this volume.

231 Hugh Kennedy, personal communication.

232 Al-Balādhurī, *Kitāb futūḥ al-buldān*, 1:29: “That is what the people of al-ʿIrāq say who at present impose one-fifth on the mines of al-Furuʿ, Najrān, dhū-l-Warwah, Wādī-l-Qurā and others”; Power, *Red Sea*, 104, 124.

the opening of the Sudanese gold fields to Muslim exploitation. A consequence was the emigration of entrepreneurs and miners across the Red Sea.²³³

In southern Arabia, while the rule of the Abbasid caliphs declined to the benefit of dynasties of local governors, the latter benefited from the control of mining sites and the collection of taxes. In Yemen, the Yufirid dynasty (Banū Yuʿfir, 847–997 CE)—once it had received the certificate of confirmation from the Abbasid caliph—controlled both the mint and tax collection on the mines of Shibām Sukhaym and al-Raḍrād.²³⁴ At the same time, in western Yemen, a silver mine located in the territory of Madhḥij was run by the Ziyadid dynasty of Zabīd (Banū Ziyād, 818–1059 CE).²³⁵ Al-Hamdānī reports that in his time the ore deposit of Ḍankān (southern Ḥijāz) was found by chance and that the sultan and people appropriated it.²³⁶ Similarly, two texts of Omani *fiqh* from the tenth and twelfth centuries mention that 10 percent of the benefit on mining production had to be paid to the governor of Ṣuḥār.²³⁷

Broadly, the development of the mining industry in the very late antique and early Islamic period can be divided into four stages:

1. Sasanian establishments were founded, first in the Najd (after 530 CE), then in Yemen (after 570 CE), with their primary goal probably to supply silver to the Sasanian mints; the resumption of a copper-mining industry in Oman at the same time could also be a consequence of Persian prospection campaigns. In parallel, an incipient tribal corporate mining activity developed in the Ḥijāz, being secured by local rulers through an *iqṭāʿ* system.
2. In Muḥammad's era and until the rise of the Umayyad dynasty, individual and corporate ownership and investments were acknowledged, encouraged, and secured in return for tax payment (*khums*, *zakāt*).
3. During the eighth century, in parallel with a galloping monetization of the economy, the Umayyad caliphs bought some of the most productive Ḥijāzī mines from their former owners and took control of production through a governor. They secured the supply of metal for the mints. Decades later, taxation and Darb Zubayda facilitated the supply of gold to the Abbasid capital.
4. From the mid-ninth century onward, gold mining slowed in western and central Arabia. In the rest of the Arabian Peninsula, the strengthening of provincial dynasties and taxation of the mining by-products benefited the local rulers of Yemen, ʿAsīr, and Oman. They controlled production through a local administration,²³⁸ and they happened to own some of the ore deposits. It certainly contributed to their emancipation from the caliphate.

233 Power, *Red Sea*, 143, 149–50.

234 Benoit et al., “Nouvelles recherches,” 63; al-Hamdānī, *Kitāb al-Ġauharatain*, 146; Peli, “Les mines de la péninsule Arabique,” 35.

235 Al-Hamdānī, *Kitāb al-Ġauharatain*, 150.

236 Al-Hamdānī, *Kitāb al-Ġauharatain*, 137–38.

237 Wilkinson, “Suhār in the Early Islamic Period,” 892.

238 Al-Hamdānī, *Kitāb al-Ġauharatain*, 146. Translated in Dunlop, “Sources of Gold and Silver,” 42: “That was known from one of the representatives of Muḥammad b. Yaʿfur, who were holding the right of the government.”

CONCLUSION: AN INCIPIENT ARABIAN INDUSTRIAL ACTIVITY IN LATE ANTIQUITY AND THE EARLY ISLAMIC PERIOD

Although still tentative, the picture I have attempted to draw of the industrial phenomenon in late antique Arabia reveals trends of development and contractions of craft activity and ore processing closely connected with the sociopolitical trajectory of the different areas.

- From the eighth century BCE to the fourth century CE, wide oases dotted the Yemeni lowlands, the Ḥijāz, the Omani piedmonts, and the Najd. These areas offered the prerequisites for economic rise: food surplus, manpower, natural resources, investment capabilities, trading networks, and commercial outlets.

This economic activity took the form of household industry and small-scale workshops. Moreover, corporations under the guidance of the South Arabian states invested in the harvesting and trade of aromatics, first by land and then by sea (from the first century BCE onward). Oddly, the high markup on this resource, which assuredly generated important revenues for the states, temples, and corporations, was not invested in any manufacturing activity—only monumental construction. Rather than serving as a stimulus, it slowed protoindustrial developments, possibly because technological development was not sufficiently advanced to offer the prospect of an upturn in the economy exceeding the one offered by aromatics themselves. Craft production was intended for the domestic market, as attested in the classical sources that mention the export of only raw material (frankincense, myrrh, alabaster, turtle shell, aloe).

Remote from the incense caravan routes, the Omani mountain range was the setting of a revived copper-mining industry (ca. eighth to fifth centuries BCE). But it came to a sudden end by the mid-first millennium BCE, possibly as a result of environmental deterioration and fuel shortage.

- By the late fourth / early fifth centuries CE, the falling demand in aromatics may have motivated a redeployment toward new sectors of the economy. However, it took place at only a slow pace. The political and legal framework was unsteady; the rerouting of the sea trade toward Persia and Aksum caused the decline of the southwestern and southeastern Arabian ports; and an environmental and social crisis, intensified by epidemics and conflicts, led to food shortages, ruralization, and the depopulation of several areas, at least in the north, the east, and parts of southern Arabia.
- From about 550 onward, a progressive economic recovery was accompanied by the development of important craft/industrial sectors (textile, perfume, gold-smithing, leather, mining) and the revival of the trans-Arabian caravan trade from Najrān to al-Hira and Syria.

The Ṣanʿāʾ–Ṣaʿda–Najrān–Ṭāʾif–Yathrib corridor, which offered greater resilience to the late antique crisis, was the framework for this developing economic recovery. Furthermore, new technology and Sasanian investments favored emergent gold and silver mining in Yemen, the Najd, and the Ḥijāz and copper mining in Oman. In the Ḥijāz, a tribal-based mining industry benefiting from cheap manpower (including slaves) developed. The Sasanian governorates and the *ilāf* pact in the Ḥijāz secured both production and exchanges, thereby allowing their

progressive rise. In turn, the taxation of production reinforced the local leading authorities, the first Muslim community, and then the nascent Islamic state.

- The prime mover behind the Arabian mining boom of the eighth to ninth centuries was the monetization of the economy by the Umayyad and Abbasid administrations. In turn, this industry developed for the benefit of these administrations and their rulers, either through taxation or by direct control, as in Maʿdin Banū Sulaym.
- From the mid-ninth century onward, gold mining declined in central and western Arabia to the benefit of Sudanese gold; silver and copper mining continued at a slower pace to the benefit of local governors, thus contributing to the enrichment and emancipation of local dynasties in Yemen and Oman. Then and only then do we have evidence of the development of other sectors of production on an industrial scale, as illustrated by the tanning complexes of Saʿda and al-Ṭaʿif.

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INSCRIPTIONS

Details of most of the inscriptions referred to in this essay can be found in the Corpus of South Arabian Inscriptions (CSAI) of the Digital Archive for the Study of Pre-Islamic Arabian Inscriptions developed by the University of Pisa (<https://dasi.cnr.it/>):

ʿAbadān 1	Haram 38	MAFRAY-Makhliq 1
Al-ʿIrāfa 1	Ir 32	<i>RÉS</i> 3022
Arbach-Sayūn 1	Ja 576 + 577	<i>RÉS</i> 3343
BaBa al-Ḥadd 2	Ja 660	<i>RÉS</i> 3535
BaBa al-Ḥadd 8	Ja 665	<i>RÉS</i> 3371
Bāfaḳīh AF 1	Ja 1028	<i>RÉS</i> 3821
B-L Nashq	KR 2	<i>RÉS</i> 3879
<i>CIH</i> 80	KR 3	<i>RÉS</i> 3910
<i>CIH</i> 575	Maʿīn 6	<i>RÉS</i> 3945
Haram 16	MAFRAY-al-Maktūba 1	<i>RÉS</i> 4196
Haram 17	MAFRAY-dhī-Ḥadīd 1	<i>RÉS</i> 4337
Haram 18	MAFRAY-dhī-Ḥadīd 2	Ry 508
Haram 19	MAFRAY-Ḥisāya 1	Ry 510

Inscriptions referred to in this essay but not included in CSAI:

- Qaryat-Muʿāwiya (al-Ansary, *Qaryat al-Fau*, 19–20, 46)
 R 1850 (Robin, “La reprise du commerce,” 277–79)
 ʿInān 75 (Robin, “Ghassān en Arabie,” 111–12)

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This volume examines forms of economic production in the late antique and medieval Islamic Near East that qualify as “industrial” in some sense— in particular because of their scale, the involvement of specialized stages of production, and capitalization beyond the means of the average household.

The book’s essays draw on literary, documentary, and archaeological evidence to examine labor specialization and economic growth, the relationship between industry and state authority, transformation in agriculture and agricultural products, the organization of sugar and indigo production, the structure of copper mining and metallurgical enterprises, and the economic conditions that promoted or constrained industrial development. Collectively, the essays enrich our understanding of the nature and presence of industry in the Near East in this period and confirm the region’s economic vitality.



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