Intra-regional strategies and interregional dynamics:
A study of pottery production in prehispanic Colima, Mexico
(550-1000 CE)

Submitted by Carlos Andrés Salgado Ceballos to the University of Exeter
as a thesis for the degree of
Doctor of Philosophy in Archaeology
In June 2017

I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

Signature: ………………………………………………………..

ABSTRACT

This research evaluates the degree of political integration in Colima during the Late Classic/Epiclassic period (550-1000 CE) and the historical depth of three 16th-century regional polities through an examination of the political strategies embedded in pottery technology. Pottery samples covering three regional polities (Provincia del Colimotl, Valle de Tecomán, Provincia de Tepetitango) and corresponding to four geographical micro-regions (Colima Valley, Salado River basin, Tecomán coastal plain, western coast) were analysed.

In this research, polities are conceptualised as webs of authoritative relationships, which are created and contested by political strategies. Pottery produced in the same polity should therefore be in the same network of authoritative relationships. Political strategies are uncovered by identifying the technological patterns, material and socio-technological constraints of production, sourcing-distribution patterns, organisation of production, and social contexts of the consumption of pottery.

Compositional and fabric variability was assessed through the archaeometric characterisation of 215 pottery samples from 17 different sites distributed throughout the research area. The statistical analysis of the geochemical results revealed 10 compositional groups; an eleventh group was identified through petrographic analysis. Pottery and raw clay (14 samples) compositional data, together with the analysis of distribution patterns and the local geology, permitted the identification of the location (at the micro-regional level or less) of clay sources for seven of the compositional groups. The room left for technological choices/styles was determined through reconstruction of the pottery production sequence within its contextual factors.

The results indicate that pottery production was not centralised, even at the micro-regional level. Potters from the four geographical micro-regions used different clay sources to produce both distinctive wares and some shared types. However, with the probable exception of the Colima Valley, at least a couple clay sources were simultaneously exploited in each micro-region. In some instances, this reflects product specialisation; in others, it indicates production of the same pottery types by competing workshops.

Though the two geographical micro-regions in the Provincia del Colimotl did not escape the micro-regional pattern of the use of local resources and manufacture of distinctive wares, they do offer the only example of pottery-related, deliberate economic interdependence in this study.

The pottery was produced by independent specialists who made use of distribution networks restricted to the limits of each polity. However, the red-on-cream jars made in the Salado River basin were widely distributed throughout all of the regional polities. It is argued that these jars were obtained at the Salado River basin during communal feasts that involved the consumption of *pulque*.

The results indicate the historical depth of the known 16th-centruy regional polities. Despite providing evidence for close interregional interactions and shared ideological beliefs and social practices within the whole Colima region, pottery analysis offers no solid proof that Colima functioned as a single polity during the Late Classic/Epiclassic period.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

AKNOWLEDGMENTS

I am greatly indebted to my two supervisors, Marisa Lazzari and Hajnalka Herold, for their critical guidance and continuous support. This thesis benefited much from their constructive criticisms. I also wish to thank Peter Day and Gill Juleff, who provided valuable and generous comments and contributed to a very enjoyable and stimulating *viva*. Warm thanks are also due to Bruce Bradley, who acted as my second supervisor for a good year and a half; he was always a helping hand and would go out of his way if needed. Appreciation is expressed to José Iriarte, who acted as my mentor and assisted me in many ways.

My doctoral studies were financed by a scholarship grant from the National Council for Science and Technology (CONACyT) of Mexico. To this institution I am genuinely grateful.

Neutron activation and X-ray diffraction analyses were supported by two grants from the National Institute for Nuclear Research (ININ) of Mexico. I was granted access to their facilities for two six-month research stays. Thanks are extended to Dolores Tenorio, Melania Jiménez Reyes, and Jesús Muñoz Lujano, for their professional advice and technical assistance, respectively.

I wish to acknowledge a grant from the Fox Fund (University of Exeter) to undertake two weeks of thin-section preparation at the Wolfson Archaeological Science Laboratories of the UCL Institute of Archaeology. Patrick Quinn and Harriet White were more than generous in sharing their expertise during those weeks. It felt good to be back.

Pottery analysis was authorised by the Instituto Nacional de Antropología e Historia (INAH), Mexico. Andrés Saúl Alcántara Salinas, Marco Antonio Cabrera Bello, María Judith Galicia Flores, Pavel Carlos Leiva García, María de los Ángeles Olay Barrientos, and Ligia Sofía Sánchez Morton, of the Colima Centre of INAH, generously provided pottery samples from several sites across the Colima region, as well as unpublished information on these sites. Pablo Quezada, formerly of CENCADAR, Universidad de Colima, allowed me to sample clays from the storage room of the old CENCADAR facilities in Nogueras, and assisted in the collection of samples in the field. Otto Schöndube first alerted me, many years ago, to Carl Sauer's proposal of political subdivision in prehispanic Colima, and the potential of this topic. Thanks also to

Juan Jorge Morales for sending over his geological maps of Colima, and for the many stimulating talks about West Mexican archaeology and pots.

Figures III.18 and IV.1 were made by Jonas Gregorio de Souza from the University of Exeter; Figure III.1 was made by Teresa Martínez from the Universidad de Colima; and Figures IV.2-IV.11 and VII.1-VII.4 were made by Francis Levy based on my own photographs and drawings. Francis also kindly provided a couple of his photographs of the Colima Volcanic Complex (Figures III.3 and III.4).

I would like to thank my colleagues at the Department of Archaeology, Brice Girbal, Jonas Gregorio de Souza, Alice Lowson, Tathagata Neogi, Tine Schenck, and Jennifer Watling, for all kinds of help, from sharing relevant papers to the very printing of this document. Thanks to Malene L. Lauritsen for keeping half an eye on my piles of books and records while I was away from the office.

Verónica Velasquez helped me with so many things that I have lost count. Simply put, I would not have finished this thesis without her love, company, and encouragement. For this, I will be forever grateful.

Especially, I want to thank my mother and late father for their unconditional love. I dedicate this work to them.

CHAPTER I. INTRODUCTION

I.1. RESEARCH QUESTIONS

By the early Colonial period, the New Spanish province of Colima was divided into a handful of minor provinces (Lebrón de Quiñones 1952 [1554]). Carl Sauer (1948:64), along with other historians (Reyes Garza 2000:20-21; Sevilla del Río 1973:41-44), supported the idea that these early New Spanish divisions represented prehispanic political groupings, fostering the debate about whether the whole Colima area was politically unified in prehispanic times. These claims have yet to receive archaeological attention.

This research tackles both the historical depth of the regional polities mentioned in the 16th-century historical sources, and the degree of political integration between these polities. This is done by outlining networks of authoritative relationships (Smith 2011b:417; VanValkenburgh and Osborne 2012) in Late Classic/Epiclassic Colima (550-1000 CE) through an exploration of the connections between the realm of the political and pottery technology, production, and circulation.

I.2. BACKGROUND OF RESEARCH

The early New Spanish province of Colima was divided into a handful of minor provinces (Lebrón de Quiñones 1952 [1551-1554]): the Cihuatlán Valley, the Tecomán Valley, the Alima Valley, the Provincia de Tepetitango, and the Provincia del Colimotl. This political division arguably originated in prehispanic times (Sauer 1948:64). The political divisions in Colima at the time of the Spanish conquest (1523) could have emerged at the beginning of the Late Classic/Epiclassic (550-1000 CE), the archaeological period that marks a break between West Mexico's Old Tradition and the start of the New Tradition (Hers 2013b; Olay Barrientos 2012:9-14) that lasted until the European contact (Schöndube Baumbach 1994:227-33).

It is possible to assume that, at the time of the Colima and Armería phases of central Colima (550-1000 CE), society was organised around hierarchical political organisations with specialised economic systems in which craft specialist production played a significant role; this is indicated by a widely distributed, limited range of pottery stylistic types (Appendix A) and disparities in both burial offerings and facilities and the size of sites (Olay Barrientos 2012:58-61). It is argued that social groups were organised in chiefdoms constituted by clusters of villages under the control of regional political centres (Olay Barrientos 2012:162-63; Schöndube Baumbach 2005:19).

A traditional approach to the subject of politics and ceramics relies on the study of technological standardisation to establish the degree of centralised control over pottery production (e.g. Morgan and Whitelaw 1991; Postgate 2007; Sinopoli 1991:145-49). However, since there is no direct correlation between political centralisation and control over craft production (Foias and Bishop 2007:214; cf. Brumfiel and Earle 1987), the usefulness of this approach for assessing political organisation through craft production and technology is very limited. Moreover, the degree of centralised control over production cannot be established solely by technological standardisation. Technologically homogenous pottery can also be a result of cultural conditioning and 'communities of practice' (e.g. Livingstone Smith and Viseyrias 2010; Pérez Lambán et al. 2014; Roux and Courty 2005; Sassaman and Rudolphi 2001). Likewise, technological variability does not necessarily stem from political decentralisation. This is often the case for regional polities that are spread over large geographical areas and make use of different resources (Arnold et al. 1999:68; Gosselain 1998:100; Pollard 1994:86-87).

I argue that pottery technologies embedded in a context of centralised polities and specialised economic systems are negotiated and reproduced through political strategies. To understand the political organisation in Colima during the Late Classic/Epiclassic period, this research proposes the examination of political strategies through reconstructing pottery technology, sourcing-distribution patterns, the organisation of production, and the social contexts of consumption. Using a theoretical perspective that defines political units through networks of authoritative relationships created, contested, and reproduced by political strategies (Davenport and Golden 2016; Smith 2011b, 2012; Kurnick 2016; Tomaszewki and Smith 2011; Van Valkenburgh and Osborne 2012), I further argue that, regardless of technological variation, pottery produced in the same regional polity would be part of the same web of authoritative relationships and political strategies.

To identify the political strategies involved in pottery technology, it is necessary to first uncover the technological choices made by the potters and to assess the conditioning of such choices (Gosselain 1998:82-87). To do this, it is mandatory to first reconstruct the *chaîne opératoire,* or production sequence, starting from the securing of raw materials (Costin 2005; Hegmon 1998; Lemmonier 1986; Tite 2008). The identification of technological styles and traditions—or the particular series of technological choices taken to produce something—permits the interpretation of technological knowledge transmission, adoption, and distribution, and provides direct insight into the political strategies behind these processes.

Consequently, this research aims to empirically establish compositional and petrographic groups of pottery through the use of archaeometric data, along with the location of their raw material sources, the levels of inter- and intra-micro-regional variability present in their production, and any patterns of circulation and consumption. With the integration of this information, it will be possible to determine the technological styles and *chaînes opératoires* used in the production of the pottery of this period, the manufacture-distribution patterns, and the political strategies in play—as well as examining any correlations between these patterns and the political entities tested in this research. Ultimately, the value of a combined pottery technology/political strategies approach as a means of distinguishing between geopolitical formations in complex prehistoric societies will be assessed.

I.3. CHAPTERS SUMMARY

The second chapter of this thesis, Theoretical and Methodological Frameworks, discusses the realm of the political, establishes the definition of 'political entity' that is used in this research, and introduces the body of key concepts that orient the current research on the archaeology of the political. It also provides an overview of the concepts developed in recent decades for the archaeological study of the organisation of craft production and pottery technology. It highlights the socially and politically active role of crafts, technology, and production, and how their study can help in understanding the constitution and organisation of polities. It ends with a review of archaeometric approaches to the study of pottery provenance, technology, and production, focussing on the techniques used in this research.

The third chapter, Geographical, Archaeological, and Historical Settings, first describes the geographical setting of Colima, highlighting the micro-regions studied in this research: the Colima Valley, the Salado River basin, the Tecomán coastal plain, and the western coast. It then provides an archaeological background to the research material. It discusses the concept of West Mexico as a Mesoamerican cultural area, and the early definition by Kelly (1947b, 1968) of Colima as a ceramic province. It also offers a discussion of the cultural rupture that occurred around the start of the Late Classic/Epiclassic period, which involved changes in the local pottery repertoire. A summary of the limited previous research devoted to the Colima and Armería phases of central Colima is provided, as are descriptions of the sites from which the pottery samples studied in this research were collected. Finally, this chapter ends with a debate on the political organisation of Colima, based on 16th-century historical accounts of the Spanish conquest of the territory. The three regional polities studied in this research (Provincia del Colimotl, Valle de Tecomán, and Provincia de Tepetitango) are also introduced.

The fourth chapter discusses the sampling strategy and samples used in this research. It explains how the sampling strategy was developed to determine the technological variability of pottery between and within the research areas. It also shows how the sites from which pottery and raw clay samples were collected are distributed, with respect to the four geographical micro-regions and three regional polities studied in this research. The types of pottery sampled are presented, and the available data for the raw clay samples is summarised.

The neutron activation analysis of pottery and raw clay samples is tackled in Chapter V. The geochemical results indicate the existence of ten groups of pottery, as established through the application of multivariate statistics methods to the compositional data. An initial evaluation of the relationship between compositional groups, the stylistic typology of the pottery samples, and their spatial distribution, is presented. This chapter discusses the strong correlation between geochemical groups, ceramic stylistic types, and specific geographical micro-regions. The link between raw clay and pottery samples is also explored.

Chapter VI presents the petrographic analysis of selected pottery samples from the geochemical groups established in the previous chapter. Petrographic fabrics are determined and characterised. The evidence for certain forming and finishing methods, paste preparation, and firing strategies, is discussed. The validity of the geochemical groups is assessed. The chapter demonstrates how, for the most part, the petrographic analysis supports the compositional groups obtained through chemical analysis, and examines the nature of the discrepancies between the two sets of results.

The discussions in Chapter VII integrate the results of the geochemical and petrographic analyses of the pottery samples, as presented, respectively, in Chapters V and VI. The results are first evaluated in terms of pottery provenance and technological choices/styles. The evidence for the organisation of production and the relationship between technological styles and the territories occupied by the regional polities is then discussed. Networks of authoritative relationships related to pottery production and technology are established, and I highlight how they provide better insight into the organisation of polities than is possible with simple correlations between technological styles and polities. The historical depth of the known regional polities is also validated. Finally, through the analysis of pottery function, I offer an interpretation of why a single type of jar from a specific source is widely distributed and how this reflects inter-polity interactions in a feasting context.

Finally, Chapter VIII offers a summary of the main findings and conclusions of this research. It stresses the potential of a political strategies approach for the study of the constitution and organisation of polities. It also offers some directions for future research.

CHAPTER II. THEORETICAL AND METHODOLOGICAL FRAMEWORKS

This research examines the operation of political strategies on the production and circulation of pottery in ancient Colima and, more broadly, the degree to which the organisation of polities can be evidenced and understood by studying pottery technology. This chapter explores and integrates the battery of conceptual tools that have been developed by archaeologists concerned with the socially active role of production and technology, on the one hand, and the study of political strategies, on the other.

This research therefore shifts from West Mexico's archaeology traditional focus on pottery as a static typological indicator of material culture diversity (e.g. Kelly 1980; III.2.2 of this thesis), to a more comprehensive view of pottery as a socially active technological product. It also considers the operational sequence of production to be socially embedded, particularly in relation to the organisation of polities and the elaboration of political strategies.

A material-based understanding of production makes it possible to identify both the physical and social constraints of production (Dobres 2010:106-07; Martinón-Torres and Killick 2015). Since I am interested in understanding how political strategies may surround the production of craft, this research employs a *chaîne opératoire* framework integrated with specific archaeometric methods that help to reconstruct the production sequence stages. I consider the comparative location of the raw materials, the manufacture technology, and the distribution of compositional groups to establish the levels of interregional and intraregional standardisation of the pottery-making process and the distribution and circulation patterns of pottery types. I explore what technological choices relate to, how and when technological standardisation may be associated with political strategies, and under what conditions marked changes in technological styles could relate to different networks of authoritative relationships. This research aims to go beyond the simple identification of technological styles to reveal the processes behind the transmission of technological knowledge, the decision-making of technological choices, and the sharing of resources. In this way, the goal is to not only map technological styles but also to identify the political meanings embedded in those technological patterns.

This study aligns with other scholarly writing that addresses the social implications on the *chaîne opératoire* of the production of artefacts (Arnold 2000; Overholtzer and Stoner 2011; Roux and Courty 2005). This focus provides the information needed to tackle several lines of research, such as the reasons behind technological choices and innovations (Gosselain 1998; Hilditch 2014), the extent and associations of craft specialisation (Arnold 2000; Costin 2005), and the mode and organisation of production (Martinón-Torres et al. 2014). On a larger scale, it helps to understand the formation of cultural and technological traditions (Wells and Nelson 2002); social identities (Roux and Courty 2005); regional distribution, exchange and trade patterns (Mills and Crown 1995); and the extent of social, political and economic formations and boundaries (Stark 1998, 1999).

To understand how the social dimension of technology can be embedded in political strategies, this chapter first discusses the scholarly definition of 'political', what can be understood as a political entity or unit, and the nature of political strategies. I then review the theories and concepts pertaining to production and technology, initially leaving aside their political significance, and then pondering the relationship between technology and the realm of the political. Finally, I provide examples of research that integrates archaeometric approaches (with a focus on the techniques used in this study) with the assessment of technological practices in the archaeological past.

II.1. THE REALM OF THE POLITICAL AND POLITICAL STRATEGIES

This study of the political strategies surrounding the production, technology and circulation of pottery in ancient Colima (550-1000 CE) was designed in the hope that the identification of such strategies would shed light on the existence of multi-community polities during the research period.

The central sense of 'political' always refers to the political community, polity or *polis*, which is the primary instance of the term (Miller 1980:61-62). Political units can be composed of one or many communities within a single, regional polity (e.g. Clark 2007:20-21). This collective body or polity is assembled through the sanctioning of authority (either distributed or centralised) and the resulting relationship between authority and subjection by which people establish social differences and ties (Bauer and Kosiba 2016:116; Joyce and

Barber 2015). In other words, even though there are many diverse aspects of politics (e.g. political organisation, integration, etc.), the realm of the political always revolves around given and obeyed commands, which differentiate the will of the individual from that of the sovereign authority (Smith 2011a:358). A polity or political entity is thus those people who follow orders from the same authority, or who are in the same network of authoritative relationships (Smith 2011b:416), regardless of ethnic variations or other factors usually associated with polities (Pollard 1994:79-80).

Ancient polities were mostly delimited by contested political relationships and interpersonal obligations, not in absolute territorial terms. These relationships marked shared but dynamic physical environments and boundaries (Davenport and Golden 2016; Joyce and Barber 2015:820). Political relationships were thus continuously built and deconstructed through the social practices and networks of people, places and objects at different spatial and temporal scales (Smith and Janusek 2014:696). These dynamics may have created shifting political 'mosaics' rather than contiguous, tightly bounded political territories (Smith and Janusek 2014:684; VanValkenburgh and Osborne 2012). Then, the implication of legally defined, fixed borders in modern nation-states disqualifies them from acting as models for political landscapes of the past (Davenport and Golden 2016:184).

Among the negotiations and reciprocal obligations practiced between diverse groups across the social spectrum are: communal economic and religious practices, ideas, and materials, such as the control of trade circuits; the organisation of the military; large- and small-scale ritual feasting; public performances; cemeteries; and projects related to the construction and use of shared public spaces and monumental buildings (Angulo 2007:83; Borgna 2004; Joyce et al. 2016:62-66; Murakami 2016:155-56; Smith 2011b:420; Smith 2016:5-15; e.g. Baron 2016:143; Morgan and Whitelaw 1991:86; Smith and Janusek 2014). Crucially for archaeologists, the exercise of authority, like technology and the organisation of production activities, is always a physical process with a material dimension; authority operates through the material world (Kurnick 2016:5; Murakami 2016:154).

Authority can be defined and constrained by heterarchical or horizontal communal relationships, as well as hierarchical ones (Joyce and Barber 2015; Smith 2011b:417). Additionally, authoritative relationships can have a hierarchal structure at one scale or in one interaction context, while also being embedded in a heterarchical political landscape, or the other way around (Small 2009; Smith 2016:30-31).

Authoritative relationships are always created, perpetuated and resisted by political strategies (Beekman 2016; Kurnick 2016:13; Inomata 2016). Blanton et al. (1996), in their elaboration of the dual-processual model, described two major patterns of strategies in Mesoamerica: one exclusionary or network in character, and the other more group-oriented or corporate. Exclusionary or network strategies are defined as attempts to monopolise control over various sources of social power (e.g. material resources, technologies, ritual practices, etc.), while corporate strategies are those employed to inhibit or challenge the possibility of monopolisation. This initial definition has been subsequently modified: the corporate/network has since been defined as a continuum rather than a typology or dichotomy (Feinman 2000:221), where a pattern can fall in the middle ground between the two extremes, despite their antagonism.

Since authority has a dynamic nature, political strategies, like the authoritative relationships they create and resist, are not fixed and can change over time (Blanton et al. 1996:5-6; Smith 2016:30-31; Smith and Janusek 2014). Moreover, both network and corporate strategies can co-exist (Blanton et al. 1996:2) at any scale (see Joyce et al. 2016 for a micro-regional example). For example, a community can be a mix of corporate and exclusionary strategies that are implemented in separate—or even the same—interaction contexts (e.g. Small 2009). Interaction contexts are the physical spaces used for the construction and reproduction of authority through political strategies; corporate contexts tend to be larger in size and provide enough space for communal gathering, while exclusionary contexts are smaller and include some form of restricted access (Small 2009:209).

Social actors implement political strategies based on, and constrained by, their roles or positions (Feinman 2000:221). Drawing from Smith (2011a), Kurnick (2016) and other archaeologists (Inomata 2016; Joyce et al. 2016) have recently advised scholars to leave behind the emphasis on rulers' actions and consider the importance to the operation of political authority of the social institutions of rulership, the social groups that constitute the communities (and the intersections of both), as well as of the extra-local connections and the historical contexts in which rulers were embedded. Smith (2011a, 2011b:421-

22) argues for a deinstitutionalisation of the political that demands scholars to look beyond government and institutional facades and expose the political practices or strategies of everyday activities.

Smith (2011a, 2011b) has also challenged the reduction of the political to the economic. This tendency is based on the political economy framework that dominated the past century, and which considers ancient power and authority to be associated only with the monopolisation of resources (Pollard 1994:85; see Scarborough and Clark 2007 for relatively new examples of this perspective), and political institutions to be only concerned with resource domination and the concentration of economic surplus (Beekman 2016; Smith 2011b:417-18). In the words of Martin (2016:242), 'politics can be seen not simply as the pursuit and maintenance of status and resources but as a power-inflected process that works to resolve, ameliorate, or mask inherent and constantly arising contradictions'. Kurnick (2016) argues that, in addition to the monopolisation of social power, archaeologists should consider the operations of political authority as the rulers' attempts to emphasize their differences from, and similarities to, their subjects (Baron 2016:143-45), foreign rulers, and their own past leaders. In other words, Kurnick (2016; see Johansen and Bauer 2011:2; Murakami 2016; Smith 2016:14-15) argues that the successful operation of political authority promotes both social inequality and social similarities through contradicting and unresolved political strategies that are open to negotiation.

A post-evolutionary approach toward the political also challenges the static nature of materialism as understood by the social evolutionary approaches of the 1960s and 1970s, which searched for correlations between specific stage-types of socio-political organisation and craft production types of organisation and technology, among other processes (Johansen and Bauer 2011:1-2). In these theoretical frameworks, craft production only *reflected* stages of political complexity, while artefacts and things in general could not participate in the political life (Smith 2011a:355, 2011b:418-19; my own emphasis). Post-evolutionary analyses, on the other hand, focus on what a polity actively creates rather than what type of political organisation it resembles (Johansen and Bauer 2011:3; Smith 2011b:419). Recent scholarship offers new archaeological perspectives on how things are essential to the constitution of polities and how they affect the politics of a communal body—not only as the material equipment of a community but also through their social roles (Bauer and Kosiba 2016). Quoting Bauer and Kosiba (2016:134), ‘if politics by necessity involves people and materials in entrained actions, they by implication, to understand politics we must inquire into local and situational flows of people, things, and their characteristics’.

II.2. THE ACTIVENESS AND SOCIAL SIGNIFICANCE OF ARTEFACTS AND CRAFT PRODUCTION

II.2.1 THE SIGNIFANCE OF ARTEFACTS

Objects are understood as material things people encounter, use and interact with (Woodward 2007:3). Artefacts are the physical products of human activity, and thus symbolise aspects of prior social activity (Woodward 2007:15). Craft is the material expression of crafting, or the experienced and skilful making of objects. A commodity is an object produced under specific market relations and that can be exchanged (Woodward 2007:15). The term ‘material culture’ emphasises how things have social functions and provide symbolic meaning to human activity (Woodward 2007:3).

The passive/active role of artefacts in the social and economic domains of human interaction has been a primary interest within archaeology for the past four decades (Gosden 2005; Hodder 1982; Lemonnier 1986; Stark 1999). Ancient artefacts and their production and circulation have since come to be recognized as socially active and embedded in social, economic and environmental webs (Costin 1998; Gosselain 1998; Michelaki et al. 2002:313). Material culture innovations and continuities were often considered to be passive markers of social, cultural or political change and/or permanence, or as only the material result of people’s adaptation to environmental constraints (e.g. Childe 1925:294; 1956; see Gosselain 1998:81-82; Lemonnier 1986:152-53; Miller and Tilley 1984:2-3). At worst, artefacts were regarded as archaeological entities with no relationship to social realities or anthropological significance *per se* (Clarke 1968; see Hodder 1982:1-6). Yet, as many anthropologists have emphasized (Appadurai 1986; Tilley at el. 2006) and several archaeological case studies (Gaitán Ammann 2005; Lazzari 2005, 2016; Meskell 2005; Overholtzer and Stoner 2011) have demonstrated in the past few decades, raw materials and artefacts are embedded in webs of significance through their cultural biographies. Artefacts capture, materialise and bear social meaning, even though these meanings are not fixed and may mutate from the original intentions of the makers (Kopytoff 1986:74; see Skibo and Schiffer 2008:12). As Hodder (1982) and Gosden (2005) argued, artefacts and raw materials are not merely the passive reflection of social phenomena, but are also their active sources.

All artefacts have a socially significant dimension in the sense that they are necessary to sustain life and/or reproduce social relations; they also provide a mode of communication (Tilley 2006:7). Ancient artefacts, like things in general, were therefore involved in the social construction of reality (Bauer and Kosiba 2016:120-21; Gosden 2005; Hurcombe 2007) and were used to communicate beliefs. For example, as demonstrated by both the current practice of some Mesoamerican indigenous groups (e.g. Stross 1998) and archaeological evidence from the same area (Meissner et al. 2013), pottery and other kinds of artefacts can and could be seen as non-human animate beings. In Colima, several specimens of Late Classic/Epiclassic red-on-cream vessels used as burial offerings show marks of termination, such as a small hole in their lower half, that impede their further use as containers (Figure VII.7); it can be said that this pottery went through a ritual of termination and 'killing', and probably a complete human-like life cycle. The same practice has been reported for the Classic period in the American Southwest (Hegmon et al. 2016:58). Artefacts also create, signify, and legitimize ideas about roles, statuses, identities, and social relationships and organisations (Costin 1998:9-10). During the Late Formative and Classic periods in western highland Mexico, for example, the placement of uncommon burial furniture in family tombs, including fine vessels, was considered to be materialised cultural capital, which exposed the wealth and social ties of the family as part of a lineage ritual (Beekman 2016:102).

Artefacts also mediate different values (Tilley 2006:7). The value of artefacts is constructed through their life history (Flad and Hruby 2007). As the resulting physical entities of productive activities, artefacts are captors of immediate value through the materials and labour invested in their creation; additional economic value can be generated through commodity exchange, in which both ends of the transaction calculate and determine the object's value (Appadurai 1986). As archaeological research has demonstrated, regardless of the primary extraction or production costs involved, there are non-economic factors related to social relationships and prestige, ideological associations, or even plain desire, that contribute value to products (Lazzari 2016; Stark 2007). Moreover, production sponsors, producers, and users can individually add external value to items through their own high statuses or reputations (Costin 1998:9), and vice versa (Day et al. 2010:220). The value of artefacts could have had considerable implications for the scale and context of craft production (e.g. conspicuous production, attached specialisation), while the social meaning of technologies could also have generated value (Stark 2007).

II.2.2 THE SIGNIFICANCE OF CRAFT PRODUCTION

Production is defined as the premeditated transformation of raw materials into functional objects (Costin 1991:3). Costin (1998:10) links production with distribution and consumption as not only the components of every economic context, but also as the creators of social identities for everyone involved and as settlers of social relationships (e.g. Brumfiel 1998). She defines specialised craft producers as both the active creators of wealth and style and the creators and maintainers of social networks and social legitimacy (Costin 1991:1-31).

The social significance of production resides in its organisation (Flad and Hruby 2007), the structure and social implications of the productive relations between producers and consumers (Costin 1991:3, 1998:4-9). Together with consumers, specialised producers help define the social organisation of production by creating, accepting or negotiating the legitimacy and conditions of craft production and distribution (Costin 1998). This agreement is usually expressed in terms of social identities or personhoods, the defining of social categories, and the generating of social relationships. For example, the definition and prerogatives of the artisan social category—or any other specialised job— can regulate people’s access to material resources, knowledge of technical processes, and the social positions required to produce crafts (Costin 1998).

II.2.2.1. The organisation of production: modes

Based on ethnographic accounts, there are two modes under which production has been structured and systematised: specialised and non-specialised. In a specialised system, it is traditionally argued that producers depend on outer-household exchange relationships, and consumers depend on goods that they do not themselves produce (Costin 1991:3-4). In such a case, the productive activity or the individual performing such activity is usually defined by a job title of some kind (Costin 1991:3; see Hruby 2014:55 for an example). It is assumed that the amount of time spent on the productive activity and the proportion of one's subsistence needs obtained from such activity would be notably higher in specialised production (Arnold 1991:92-93), but others have argued that specialisation can also relate to a part-time activity (cf. Clark and Parry 1990; Clark and Houston 1998; see Brumfiel 1998), or even one that is full-time but occasional (Day et al. 2010:217). Full-time specialisation has been linked to the production of elite goods, which are sustained by steady demand (Brumfiel 1998:147). Yet another assumption is that the production output of a non-specialised system is low, generally of low quality, and not influenced by market demands and competition, since it only involves personal choices and consumption (Arnold 1991:92).

The difference between these two modes of production has been simplified as 'production for members of one's own household versus production for others' (Clark 1995:279), a view supported by Arnold (2000:334) in relation to pottery. This is the definition used in this research. According to this definition, contrary to what Arnold (1991:92) argues, seasonal potters who practice agriculture as their main subsistence activity are still defined as specialised pottery producers. For example, most of the rural specialists in colonial Huejotzingo, in central Mexico, did not make their living entirely from their craft; instead, they combined production and trade with subsistence agriculture (Brumfiel 1998:146). Based on this, a light concentration of tools and production-related waste products in the material record is taken as archaeological evidence of part-time specialisation (Brumfiel 1998:146).

Definitions of specialisation range from regularised behaviour and material variety as part of restricted extractive and productive activities (Rice 1981:220,263), to differentiated, and perhaps institutionalised, 'repeated provision of some commodity or service in exchange for some other' (Costin 1986:328). The latter definition can be summarised as production that leads to exchange, an idea that is also implied in the former definition (see Flad and Hruby 2007). Day et al. (2010:210) highlight technical expertise and skill ('skilled practice') as the defining elements of craft specialisation, and in fact some claims of craft specialisation rely solely on assertions of skilled crafting that would have required the potters' apprenticeship (Clark 2007:28; López Mestas Camberos 2007:45; Roux and Courty 2005:211). Skill is defined as 'the ability to perform the proper action in the proper sequence at the proper time', thus involving 'the right conduct of movements, timing, and organization' (Wendrich 2012:3). In response to the restricted and differentiated production described in Costin's (1986) original definition, Clarke and Houston (1998:38-39) have noted that a singular, specialised production activity can be shared by a whole community of non-competing specialised producers, as was the case among the post-Conquest lowland Maya women devoted to spinning thread. Therefore, specialised productive activities may be not limited to a household or a group of workshops, and restriction and differentiation may not exist at the community level, where a particular productive activity can be pervasive (i.e. community specialisation).

II.2.2.2. The context of production: models

Types of craft specialisation are normally categorised by the context of production. The context of production describes, among other aspects, the degree of elite control over production and who retains the rights over the finished products (Costin 1991:4-6,11; Clarke and Parry 1990). Thus the type of specialisation should be evident in the kind of transaction between the producer and the consumer (Clarke and Houston 1998:37).

The most influential typology of specialisation involves two extremes: independent and attached specialisation (Earle 1981). On the one hand, independent craft specialisation implies that the artisan retains the rights to exchange the product; production may be generally oriented toward the market (Brumfiel 1998:147) or to other types of non-restricted exchanges. This type of specialisation is usually associated with the production of utilitarian goods (Costin 1991). Attached specialisation, on the other hand, has been defined as the production of prestige goods for the consumption of powerful individuals (Brumfiel 1998:147), who both sponsor the production and control the distribution of the goods (Costin 1991:7).

Van der Leeuw's (1977, 1984) production model focuses on the scale and intensity of production rather than on who controls the production process and has rights over the goods; in his model, modes of production are differentiated by levels of specialisation and output. He proposed different states of pottery making, ranging from household production (small-scale production to supply one's own household), to household industry (part-time, low-scale production for the use of the immediate group), to full-time specialisation, high-intensity workshop industry, and large-scale industry (which among other things involved the use of distant, hard-to-obtain raw materials).

Peacock (1982) established eight modes of production by mixing the already mentioned variables and adding a geographical factor: the location of production facilities. The first six are ordered in increasing complexity, from part-time household production to factory production (Peacock 1982:7-12). These modes mostly derive from the Roman pottery industry and products.

Costin (1991) finally developed a multidimensional typology by abstracting four parameters from the specialisation typologies described above: context of production, concentration of production facilities, scale of production, and intensity of production. The context of production deals with the affiliation of the producers and the degree of elite sponsorship: it can be either independent (producing usually utilitarian products for a general market, i.e. non-restricted distribution) or attached (sponsored/controlled production and restricted distribution of highly valuable goods). Second, the concentration of production facilities can be either dispersed or nucleated (see Brumfiel 1998). The scale of production concerns the size and constitution of the producing organisation, ranging from small, kin-based production to factory production. Fourth, the intensity of production is the degree to which the productive activity is practiced, and can be part- or full-time. More recently, Flad and Hruby (2007:6) added the relationship among workers (e.g. kin, slaves) and the meaning of production (e.g. ritual, secular) to Costin's model, providing two more parameters for the analysis of specialised production.

As underlined by Costin (1991:9), the utility of such analytical typologies, more than organisational, is the distinction of parameter values that can explain the occurrence of particular types of organisation of production. For example, Brumfiel (1998) explored how the concentration of production in *calpulli* units, regardless of whether they were attached or independent specialists, promoted the creation of a social identity that made the negotiation of social status through collective action and public ritual possible.

As pointed out by Clark and Houston (1998:37-38) and shown by several archaeological and ethnographic case studies, many productive activities are analytically ambiguous when compared with the current ‘monolithic’ models (Feinman 1999), failing to fall squarely into a defined analytical category. For example, Hruby (2014:56) remarks that goods consumed by elite consumers can be non-elite, while Arnold (2000:358) highlights that elite control over resources can exist in non-specialised production, and that regardless of the organisation of production, control of resources does not necessarily result in control of production. Additionally, Feinman (1999) proves that high-intensity craft manufacture can take place in domestic contexts, while Costin (1991:7) herself calls for caution when dealing with craft sponsorship, noting that is not necessarily elite-patronised or indicative of an unequal power or status relationship between the artisan and patron. Furthermore, she thinks that distinctions between individual and attached specialisation are blurred in the case of middle-range and chiefdom-like societies, where, for example, it is possible much of the production within an elite household was accomplished by its members (Costin 1998:11). Day et al. (2010:205-06) argue that in this effort to categorise the components of the productive process, there has been a tendency to isolate craft production from its historical context, limiting scholarly understanding of production and its role within the society in question.

II.3. THE ACTIVENESS AND SOCIAL SIGNIFICANCE OF TECHNOLOGY

In its broadest sense, technology is not restricted to the visible results of action techniques, but embraces all facets of technical activity, including cognition, knowledge transfer, and the social circumstances of technology (but see Ingold 1990 for a different notion that separates technique and technology). This broad conceptualisation avoids turning the finished artefacts into the centre of discussion (Lemonnier 1986:147-49; see Dobres 2010). A technological approach to material culture seeks to discern meaningful technological choices through the study of the *chaîne opératoire*, focusing on the physical aspects of technology (transfers of energy and matter) rather than relying on the visible characteristics of artefacts (Lemonnier 1986).

Like production, technology is not autonomous and can only be understood by exploring its origin and role within its own socio-cultural context (Dobres 2010; Gosselain 1998; Hegmon 1998; Lemonnier 1986). The dynamics of technological variability and change can be comprehended through a social constructivist approach that identifies technological choices and the deeper processes surrounding those choices (Eglash 2006:333; Winner 1993:366-71; see Martinón-Torres and Killick 2015).

Like all technology, pottery technology has a cultural dimension and is bound as much by social constraints as physical limitations (Day et al. 2006:28; Gosselain 1998:81; Sillar and Tite 2000). In this section I will review why it is necessary to study the *chaîne opératoire* to identify and understand technological choices and technological style, as well as how the identification of standardisation (i.e. patterns of technological choices) within a *chaîne opératoire* allows insight into the transmission of technological knowledge. Considering these aspects enables a more comprehensive discussion of the formation of pottery traditions and communities of practice, as well as the political strategies that underlie the social activities of technology more broadly.

II.3.1. CHAÎNE OPÉRATOIRE, TECHNOLOGICAL STYLE AND TECHNOLOGICAL CHOICES

The *chaîne opératoire,* or operational sequence, was defined by Cresswell (1976:6) as '*une série d'opérations qui mène une matière première de l'état naturel à un état fabriqué*', that is the series of operations which transforms a raw material into a manufactured product. This series of operations includes the elements of the technical process: 'raw materials, sources of energy, tools, actors, where and when things should take place' (Lemmonier 1993:4). A study of pottery's *chaîne opératoire,* then, entails the reconstruction of its production sequence from the collection of raw materials to the finishing and firing of the vessels, and the transmission of knowledge about these operational steps (see Wendrich 2012:3-4). Under the *chaîne opératoire* framework, the production stages are seen as co-dependent technological choices of raw materials, tools, energy sources, and techniques, a view that facilitates comparisons between the stages (Hilditch 2014:26; Sillar and Tite 2000:3,5).

Closely related to *chaîne opératoire*, the concepts of technological style and technological choice are 'founded upon the ethnographically verified assumption that similar aims can always be reached in different ways' (Gosselain 1998:82; Lechtman 1977; Sillar and Tite 2000:2; van der Leeuw 1993:241). This view constitutes a rejection of determinism and supports the fact that technological choices and innovations are not only driven by technological considerations, not only delimited by material constraints (Eglash 2006:333; Renfrew 1986:142-43; Sillar and Tite 2000:3). Technological style 'reflects the conscious and unconscious elements' that influence the sum of the technological choices (Sillar and Tite 2000:8; see Stark 1999:27-28). The investigation of technological choices must therefore transcend functionalist interpretations and concentrate on answering why a certain choice was made, how it was achieved, and what its consequences were (Sillar and Tite 2000:3,15-16; van der Leeuw 1993:241).

Archaeologists have taken two opposing theoretical stances on technological variation. The first favours a practical, materialistic reasoning for technological variability that is based on economic efficiency and performance; from this perspective, technological decision-making is mostly based on natural and physical constraints, and technology is believed to shape most other aspects of culture, including social and political organisation (Dobres 2010:104-05; Livingstone Smith 2000:21). The second view emphasizes a cultural interpretation of technology, in which technical reasoning and action are pondered by culture (Livingstone Smith 2000:21; e.g. van der Leeuw 1993:241); under this perspective, research usually begins by discussing the roles of beliefs, cultures, political organisations, etc., in shaping ancient technology (Dobres 2010:105-07). This research does not choose either of these stances and, more importantly, resists drawing a line between them, since the interdependency of material and cultural influences has proved to be very clear (Sillar and Tite 2000:6-7; see Skibo and Schiffer 2008:11-12).

Since a technological style only exists when a choice is made between equally viable technological options at any stage of the *chaîne opératoire*, style must be rooted in choices made by the artisans (Lemmonier 1986; Sillar and Tite 2000:9-10; van der Leeuw 1993:241). However, the technological choices taken by artisans depend on the social contexts in which they learn and practice their craft (Gosselain 1998:94-99; Roux and Courty 2005:202; Sillar and Tite 2000:10-11; van der Leeuw 1993). The potter is culturally shaped to follow a series of preconceived technical choices, and 'the potter's repeated actions form part of the broader sphere of social reproduction' (Day et al. 2006:39-40). Without negating individual agency through conscious or unconscious actions, from a macro-temporal approach Shennan (2006:7-14) argues that individuals are born into a flow of technological traditions that partly condition their choices.

Technological style may be not evident in the artefact's appearance and thus is hard to copy; its spread implies teaching and learning and, therefore, human interaction (Hegmon et al. 2000:219; Zedeño 1995:120). Long continuities in technological choices are hence the result of social and technical learning, and the reproduction of knowledge and practice passed down by generations of craftsmen or 'communities of practice'. The concept of 'communities of practice' focuses on the learning of the individual through the sharing of knowledge and experience among the members of a social group, structured precisely around the learning activity in question (Wenger 1998:63-71). In conclusion, technological choices arise from social systems; the decisive factors behind technological variability and innovation are not always technological, but may instead reflect social preferences rather than economic or technical issues (Martinón-Torres and Killick 2015; see Sillar and Tite 2000:2; Stark 1999:30-32).

The main concern of most studies of technological style is the social construction of material culture, as assessed through analysis of the overall technological context (Sillar and Tite 2000:4; Welsch and Terrell 1998). First, there is need to evaluate how much space for technological choices is left by the limitations present in all steps of the *chaîne opératoire*, such as environmental and technological constraints, i.e. the availability of resources, tools, and energy sources; intended artefact use and function; and the possibilities of alternative techniques (Sillar and Tite 2000:4-5). If there is room to choose between technological choices, there is also room for stylistic expressions and features (Gosselain 1998:82-85).

The second step is determining the factors that influence and underlie the technological choices: social, political and historical contexts; the origin of knowledge; technological behaviours and traditions; the organisation and context of production; ideology or belief systems; and so on (Gosselain 1998:85-87; Sillar and Tite 2000:4-5; see Arnold 2000:363-64). Basically, 'who performs the techniques, where, when, and under what relations of production' must be established (Sillar and Tite 2000:7).

The final step is to explore potential correlations between technological styles and identities of any kind (e.g. Roux and Courty 2005). Even though both technological and aesthetic choices conform to technological traditions (Esposito and Zurbach 2014:40), technological styles rely on unconscious and automated behaviours and, as such, can be quite stable through time and space; they are also difficult to manipulate and imitate, as opposed to ornamental styles (Gosselain 1998:82; Stark 1999:42-43). Because technological style can be seen as a normative cultural behaviour, part of a cultural tradition, or a lasting expression of cultural ideas and social relationships (Gosselain 1998:102-03; Hegmon 1998; Lechtman 1977:12), it can provide information about the interplay between technology and lasting social identities and boundaries (Stark 1998, 1999:29-30). Roux and Courty (2005) agree that it is possible to distinguish between social groups through the study of the *chaîne opératoire*. They argue that the technological gestures of two operational steps, fashioning and finishing, are acquired through apprenticeship and thus both express the tradition to which the potter belongs and provide a means to discriminate between technological traditions (Roux and Courty 2005:202). By using this technological approach at a macro-regional scale, they were able to identify technical groups and their associated social identities, in this case different categories of ceramic producers; one of the groups of ceramic producers appears to have had special skills and to have been itinerant, producing vessels at different sites across the South Levant during the Late Chalcolithic (Roux and Courty 2005:211-12).

Since the *chaîne opératoire* framework understands technological choices to be causes of pottery variability, it can also be used to understand technological standardisation.

II.3.2. STANDARDISATION

In archaeological research, standardisation is defined as a relative homogeneity in the production and characteristics of artefacts (Rice 1991). Rather than absolute states, standardisation and variation are understood to be the opposite ends of a continuum; as relative concepts, they can only be assessed through comparison between (preferably related) artefact assemblages, both geographically and chronologically (Esposito and Zurbach 2014:39; Ilieva

2014:85; Kotsonas 2014:8-9). This relativity means that there can be a standardised assemblage from a single site that at the same time shows notable variation when comparing material from different households (Pérez Lambán et al. 2014).

There are two different but related notions of standardisation (Esposito and Zurbach 2014). The first, and the one most used in this research, is what Hilditch (2014) calls technological standardisation: it is related to production, and can be defined as standardisation of the various steps of the *chaîne opératoire* through time and space. The second notion refers to the standardisation of uses and consumption practices, and has to do with the reduction of vessel shapes per product or functional form (Day et al. 2010:215; Fargher 2007:317).

The attributes subjected to pottery standardisation studies include morphological aspects, such as vessel form or shape; aesthetic aspects, such as decorative variability; and compositional characteristics (Esposito and Zurbach 2014:39; Kotsonas 2014:10-11). These attributes are measured under one of three traditional indexes: metric, compositional, and technological (Hilditch 2014:27; see Longacre 1999). Some attributes can be standardised while others are not; for example, morphology can be consistent while the decoration can display variation (e.g. Pérez Lambán et al. 2014:109).

The so-called 'standardisation hypothesis' (also known as the 'specialization hypothesis') holds that the technological standardisation of vessel attributes is evidence of producer specialisation and specialised workshop production (Arnold 1991:95; Esposito and Zurbach 2014; Kotsonas 2014:12). Turning this argument around, it has been assumed that the outcome of specialised production will be technologically more stable than that of non-specialised production (Hegmon 1998:268-69; Hilditch 2014; Longacre 1999). The link between specialisation and technological standardisation is mostly based on the regularised motor habits and general behaviour expected from specialists, which would be reflected in less mechanical and intentional variation (Rice 1981:220,263).

Arnold (2000) assessed the validity of this presupposed link between standardisation and specialised production by evaluating paste variability within its contextual factors from a comparative ethnographic perspective. He argued that in order to interpret the social dimensions of ceramic production, in this case those responsible for variability in ceramics pastes, the *chaîne opératoire* needed to be fully understood (Arnold 2000:335). He concluded that paste variability was more related to environmental (i.e. variability of the local geology and the number, extension, and natural variability of the available raw material sources), technological (e.g. intended vessel use and shape, paste preparation, etc.) and non-related social factors (e.g. settlement pattern in relation to the raw material sources, land tenure and ownership) than to the organisation of its production (i.e. specialised vs. non-specialised). Moreover, Arnold (2000:358) discovered that paste variability derived from changes in the production organisation (from non-specialised to specialised) was actually reflected by *increased* paste variation due to the increasing diversity of raw material sources that were used, related to increases in the scale and intensity of production and the consequent exhaustion of the original sources of raw materials. His argument can be summarised as follows: specialisation leads to an increase in both the scale and intensity of production and the exploitation areas of raw material sources, which then leads to an increase in paste variability within the producing community. However, Arnold does not address the effect of modifications in the production organisation on paste variability when there are no changes in the raw material sources. In fact, in the same paper Arnold (2000:368) suggests the existence of community specialisation based on a homogenous chemical group linked to a specific product by a single community.

Contrary to Arnold's arguments, Rice (1989) has discovered that regional groups of craftsmen tend to repeatedly use the same raw material resources more than isolated individual potters do, and suggests a link between standardisation and high intensity or scale of production. For her part, Hruby (2014) concluded that the observed lack of metrical standardisation among Mycenaean vessels from the pantries of the Palace of Nestor in Pylos (Greece) reflected, among other things, high speed of production.

To put it simply, not all pots produced by specialists—even by a single specialist—are standardised, and there are reports of standardised ceramics produced by non-specialised potters (see Hruby 2014 and Pérez Lambán et al. 2014 for opposite cases). The correlation between specialisation and standardisation becomes even more complicated if the many definitions of specialisation discussed in II.2.2.1 are considered. In conclusion, standardised ceramic output does not by itself constitute evidence for neither the organisation nor intensity of production (Arnold 1991:95-96), and the correlation between specialisation and standardisation should be understood as more of a tendency than a rule.

The 'standardisation hypothesis' remains a useful framework if inserted within its environmental, social, economical and archaeological/historical context, in which the many variables that might impact the standardisation of ceramic output are considered (Arnold 2000; Esposito and Zurbach 2014; Hruby 2014). Among these contextual factors that influence pottery standardisation are environmental factors such as the variety and availability of raw materials, like those mentioned by Arnold (2000); social factors such as the skill of the potters (Longacre 1999), how careful they are, and other conscious decisions (e.g. the disposal of substandard goods and the creation of highly variable goods for elite consumers, see Hruby 2014:52-56); technological traditions (e.g. the use of measurement aids and moulds, see Hruby 2014:53); vessel size and function (Volioti 2014); and the need to communicate group affiliation (Pérez Lambán et al. 2014; Stissi 2014:128). The economic factors include consumption patterns (e.g. varying degrees of demand or the use of vessels as units of volume, see Ilieva 2014 and Pérez Lambán et al. 2014, respectively), competition among potters (Arnold 1991:96-97), and any regulations imposed on production (Kotsonas 2014:11-12; Velasquez and Salgado-Ceballos 2016).

What technological standardisation indicates without doubt are the development, transmission and adoption of technology, as conditioned by specific social, historical and geographical contexts (Esposito and Zurbach 2014:43). Besides being the passive reflection of social phenomena, however, the standardisation of technological practices could also have played an active role. For example, through diachronic analysis of the technological variability of Kemares Ware in Bronze Age Mesara (Crete), Day et al. (2006) discovered that pottery traditions played a crucial role in articulating (and probably sustaining) a regional identity by remaining largely unaltered in their production and consumption patterns through major local socio-political frictions and transformations.

As with the concept of 'technological style', the social implications of standardisation and variation can be interpreted through an understanding of the *chaîne opératoire* (Arnold 2000:335; Jorge 2009:37-39). For example, Hilditch (2014) was able to place Middle Bronze Age Cycladic ledge-rim bowls within the range of technological choices employed for other pottery types found in the local (Akrotiri) assemblage, differing only at the forming stage. Since these ledge-rim bowls represent the first vessels to have been made locally using the potter's wheel (in contrast to the handmade ceramics that constitute the rest of the assemblage at Akrotiri), she was able to suggest that local potters had sustained contact with Minoan potters, which allowed the former to learn this new technique. The use of the potter's wheel was necessary to conform to a foreign (Minoan) ideal, while still using the local traditional recipe. Furthermore, she related the production of these vessels to consumption uses: they were required for Minoan ritual practices.

II.4. POLITIES AND TECHNOLOGY

The preceding sections introduced the notion of political strategies, and underlined the social significance of artefacts, craft production and technology. In this section, the concepts used in the archaeological study of craft production and artefact technology will be integrated into the realm of the political by exploring their political significance. I will also discuss how this approach can contribute to this research.

II.4.1. ARTEFACTS AND CRAFT PRODUCTION AS POLITICALLY SIGNIFICANT

Artefacts are active participants in the production, reproduction, and transformation of political practices (Johansen and Bauer 2011; Morgan and Whitelaw 1991:93). The academic interest has traditionally focused on the role of the material world in representing and altering the practices of vertical power or authority (Miller and Tilley 1984:5). For example, at Gulf Olmec sites during the Early Formative period, iconographic motifs, materials and artefact technologies were restricted by elites to support their political authority through differentiation (Stark 2007:55-56,60-61). Nonetheless, artefacts can also have an integrating role in the organisation of polities. In the Terminal Formative polity of Río Viejo, Oaxaca, for example, the interment of socially valuable items in public buildings demonstrated the social connections of their donors and, at the same time, expressed communal principles and identities by creating communal resources and helping constitute the polity (Joyce and Barber 2015:823; Joyce et al. 2016:78).

These are two clear examples of the involvement of artefacts in the operation of exclusionary and communal political strategies, the implementation of which actively promotes social inequalities and similarities, respectively. As evident from the second example, authoritative relationships are not restricted to the actions of rulers or even the elites: groups across the social spectrum participate in political practices. Furthermore, the second example also illustrates that the realm of the political transcends the desires to monopolise social power and control economic resources.

Furthermore, Bauer and Kosiba (2016:118-20) argue that the activeness of things do not solely rely on their relationships with people, since their physicality and dynamism also contribute to social and political practices directly. By studying how political practices combine living beings and matter, these authors have explored the extent to which things have the possibility to act and instigate action based on the material properties they possess, the perceptions they provoke, and the historical circumstances of people, things, environmental processes and cultural practices (technologies, cultural values, etc.) in which an action is situated (Bauer and Kosiba 2016). Actions become political when people consider them and explain them as social, collective problems (Bauer and Kosiba 2016:122).

Political interference in craft production is most commonly discussed in terms of the centralised control and monopolisation of resources (e.g. Brumfiel and Earle 1987; Sommer 2011). Because the emergence of social complexity and the development of the state have both been linked to an economically centralised and specialised organisation (Clark 2007:11; Longacre 1999), it has been traditionally deducted *a priori* that the production context of complex polities must be one of attached specialisation. Day et al. (2006, 2010), however, observe that specialisation does not lead to social complexity or the other way around and, importantly, that social complexity and production specialisation can exist outside the framework of a centralised economic system or the financing of political institutions through the control of material resources and labour (see for example Feinman and Nicholas 2007:139-41).

In this research, the importance of identifying the context of production does not lie in its categorisation, but rather in understanding its implications for the articulation of political strategies and how these dynamics relate to the practice of sovereign reproduction and the constitution of polities. Building on Costin's (1998) social view of specialised craft producers and production, I argue that, if indeed producers and consumers are immersed in a series of negotiations and interpersonal obligations, these must result in authoritative relationships and are therefore the subject of political strategies (Smith 2011a:358). In short, I am extending the arguments supporting the social significance of production into the realm of the political.

Without stating it in these terms, Brumfiel's (1998) analysis of the social identities of Aztec craft specialists provides a good example of how attached specialised production can be embedded in exclusionary/networking political strategies, and how the same social actors can participate in both ends of the spectrum of political strategies. In Tenochtitlan, attached specialists of elites goods worked in rooms contained in palaces more often than utilitarian specialists did (Brumfiel 1998:148). The rights to the produced objects belonged to the ruler; they were used as gifts for important visitors when political alliances were made. The sponsorship of craft production thus enabled rulers to improve their public image and reputation (Brumfiel 1998:147). In this particular case, exclusionary/networking political strategies for the acquisition/reproduction of authority are not only evident in the sponsorship of production and the use of the objects produced, but also in the interaction context. The palace is the quintessential exclusionary/networking interaction context: an enclosed space with restricted access, made for individual recognition, and where knowledge was controlled (Small 2009:209). However, attached specialists worked with independent specialists in the same collective strategies and ritual activities, such as the practice of human sacrifice (Brumfiel 1998:149-51). These examples attest to the importance of the interaction context for social actors in relation to the dynamics of authoritative relationships.

While the political significance of attached production lies at its root, due to the ruling political classes or institutions' sponsorship and control over distribution, the conditions of independent specialisation have been deemed primarily economic, with suppliers driven by profit and consumers making decisions based on cost and quality (Costin 1991:11-13). Yet independent specialised production can also be politically significant and embedded in political strategies. For example, the specialised production of pottery at Myrtos (Crete) was not controlled centrally, but during multi-community, collective eating and drinking events, ceramics may have been used as both community identity markers and part of a performance of hospitality to promote the individual households of the hosts—at the same time. In this way, pottery production's involvement in practices of conspicuous consumption and display ensured its central role in the regional political landscape and importance to the reproduction of political strategies (Day et al. 2010:219-21).

In any case, specialised craft manufacture necessarily involves the existence of some kind of political organisation, required by economic interdependency and a specialised economic system. By specialised economic system I do not necessarily mean a political economy in the sense defined by Earle (2002:1), i.e. a centralised economic system involving the channelling of goods and labour to create wealth and to finance institutions of rule. Likewise, by political organisation I do not mean a state-level organisation, but rather an organised group of people living under the same authority or in the same network of authoritative relationships and interpersonal obligations (see Small 2009:218 for how political strategies may be unrelated to political economy).

Finally, it is generally acknowledged that most local and regional social-political transformations imply changes in practices, networks, and structures of control over material and human resources (Costin 1998; see Hegmon et al. 2016:63-64). For example, around 1300 BCE, Mazatan chiefdoms reorganised into a single regional polity by the influence of San Lorenzo; Olmec control of Mazatan involved the replacement of local ceramic serving vessels and figurines with Gulf Olmec styles, many actually imported from San Lorenzo (Clark 2007:20-21). Likewise, in Xolalpan-phase Teotihuacan, the increase in the depiction in pottery of state bureaucrats parallels the expansion of administrative organisations; this is believed to attest to the close association between bureaucrats and the intermediate elites associated with this craft, to which the former probably originally belonged (Murakami 2016:166-67). Nonetheless, as a study of Bronze Age Mesara (Crete) shows, pottery production practices may remain for the most part unchanged through major socio-political changes, thereby attesting that straightforward links between production practices and socio-political changes should not be established carelessly (Day et al. 2006).

II.4.2. TECHNOLOGY AS POLITICALLY SIGNIFICANT

Distinct technological styles may not always be related to intended expressions of differentiation (i.e. emblemic uses of style, see Shennan 1994:20-21); instead, they can be the unconscious effect—epiphenomenon—of the use of different resources (e.g. Arnold 2000:341-42), techniques, and other aspects of technological variation, similar to Wiessner's (1983:258) definition of assertive style. However, technological diversity is rarely a purely materialistic phenomenon (Gosselain 1998:100).

Pottery standardisation has previously been associated with political entities and the extension of their rule (e.g. Morgan and Whitelaw 1991; Postgate 2007). This correlation between polities and the distribution of technological standardisation could derive from the intention to herald or materialise political identities and/or boundaries (e.g. Day et al. 2010). In this way, craft could have acted as a physical marker maintaining the limits of a polity (see Davenport and Golden 2016:189-96 for non-craft examples).

Postgate (2007) found that the extension (over distances of 500km) of a standardised ceramic repertoire in second millennium Anatolia coincided not with the extension of Hittite culture, but rather with the territory under centralised Hittite rule. Notably, standardisation in vessel shapes, surface treatments, and production techniques was missing in vassal states that were not directly administered by the empire based in Hattusa (Postgate 2007:144). Since the ceramic repertoires seem to have been locally produced in all cases, Postgate (2007:144) suggests that standardisation may have been accomplished through control over the training of craftsmen. As for the reason behind this standardisation, he suggests an administrative model, with the pottery repertoire representing the ware used by the administrative and military establishment, who were dependant on the central authorities (Postgate 2007:145).

Standardisation can also be the manifestation of a political strategy of cultural homogenisation via the reduction of product diversity and the simplification of production (Glatz et al. 2011). Morgan and Whitelaw (1991) found that the reduction in pottery variation in the Argive plain (Argolid, Greece) during the Iron Age was related to the rise of the hegemony of the city of Argos over the region. They believe that the variability of decorative styles initially reflected different degrees of site interaction in a passive manner; thereafter, starting in the Geometric period, technological style was actively used as a political tool within the plain, showing increasing standardisation as Argos seized control of the region (Morgan and Whitelaw 1991:101). The standardisation of form, manufacturing techniques, and surface treatments of simple vessels arguably emphasises group affiliation rather than individual identity, thereby fostering a sense of community (Borgna 2004:262).

Technological standardisation can also be the outcome of normative, learned patterns of behaviour or 'communities of practice' (e.g. Livingstone Smith and Viseyrias 2010; Roux and Courty 2005; Sassaman and Rudolphi 2001). Pérez Lambán et al. (2014:108-109) argue that the pottery of the Early Iron Age sites of the Middle Ebro Valley (Spain) shows a high degree of standardisation as a result of cultural conditioning: a cultural model was shared by the local communities through technological tradition, social practices and particular needs, and 'the mimetic learning of the potter's craft through training and repetition within the household becomes one of the social mechanisms of transmission and perpetuation of these models'. The transmission and spread of knowledge through space is related to the mobility of teachers and apprentices; it can be limited to the household or to short distances inside cultural boundaries (Gosselain 1998:95-99), or distributed across a large region by itinerant potters or other means (Roux and Courty 2005).

Can it then be presumed that there is always a correlation between technological styles and political entities? The short answer is no. Although hard to copy, itinerant potters, intermarriage, small-scale migration, and other transmission mechanisms were able to transfer technological knowledge over long distances and across political units (Zedeño 1995). Consequently, many steps of the *chaîne opératoire* can be shared by potentially competing communities (Day et al. 2006), to the extent that in some cases a single stage of the manufacturing process can be a geocultural marker (Gosselain 1998:92). Gosselain (1998:99) downplays the importance of the raw material-exploitation stage of the *chaîne opératoire* in his definition of a technological tradition, stating that two potters exploiting different resources but using the same tools and procedures belong to the same tradition; the same is evident in the examples of spatial correlation between the extensions of political rule and technological standardisation noted above (cf. Morgan and Whitelaw 1991; Postgate 2007).

It could be argued that any intent to correlate technological styles with political formations needs to take into account the complete *chaîne opératoire*, including exploitation of the same resources (Stark 1999:30-31). However, even when considering the complete *chaîne opératoire*, there is no straightforward link between technological style and political entities. This would be the case for regional polities whose territorial space might include several 'source zones' (Arnold et al. 1999:68). For example, within the Tarascan state of West Mexico, the wide distribution of clay resources combined with a lack of mass production meant that, while manufacturing techniques were shared, resources and ceramic types were not; Pollard (1994:86-87) suggests that material variability within this regional polity could reflect micro-regional ecological adaptations or specific socio-political roles of different zones.

All things considered, it is possible to postulate that pottery produced in different political units would involve distinctive *chaînes opératoires* (if the exploitation of particular clay resources is included), even if distinct *chaînes opératoires* do not often equate with different polities or other types of boundaries (Gosselain 1998:100).

Given the complexities surrounding the relationship between technologies and polities, this research proposes a political strategy-based perspective to assess the political underpinnings of pottery technology. To understand the constitution and organisation of polities through the analysis of pottery technology, I will look to expose the political strategies in which pottery technology is embedded, rather than simply seeking correlations of territorial space shared by technological styles and polities. I argue that even if material culture varies in ways unrelated to a political territorial space, it would still remain within the same network of political strategies if produced in the same polity. Without completely getting rid of the territoriality of spatial politics, this is a less rigid and potentially more successful approach to the study of the constitution and organisation of polities through pottery technology, and one that goes hand in hand with the conceptualisation of polities as webs of authoritative relationships (VanValkenburgh and Osborne 2012:9).

II.5. POTTERY STUDIES THROUGH ARCHAEOMETRIC METHODS

The application of scientific methods in the analysis of archaeological pottery has contributed enormously to the knowledge of its social significance, while at the same time new understanding of the social nature of technology has led to greater appreciation for materials science approaches to archaeological materials (Sillar and Tite 2000:14-17; Stark 1999:24-25; Tite 2008). Thanks in good part to the rise of archaeometry, pottery has started to be understood as more of a social technological product than something with only aesthetic value; consequently, it has gained importance in studies of ancient production and technology and related social, economic and political issues (Day et al. 2006:24-25). Moreover, starting with Anna O. Shepard's (1971 [1954]) pioneering work, archaeometric data has constantly challenged early assumptions that were exclusively based on the macroscopic analysis of surface treatments and vessel shape.

This section focuses on the discussion of archaeometric approaches to the study of pottery's provenance and production technology. The discussion concentrates on the techniques used in this research (i.e. INAA and thin-section petrography), providing examples of their use in similar studies to demonstrate the benefits they provide to this research.

II.5.1. PROVENANCE AND TECHNOLOGICAL STUDIES

A crucial aspect of this research is determining the locus of production of the wares under study, to differentiate between local production at the micro-regional level and material coming from outside the micro-region. Provenance studies, at the most straightforward, revolve around trying to match the compositions of pottery and raw material sources. If a match between pottery and a raw material source proves successful, the source location also suggests the probable loci of production, at least at the micro-regional level. Compositional analyses have been an integral part of sourcing for the past 50 years, nowadays a major and common goal in material culture analysis and a default way of evaluating production and, through distribution, past human interaction (Arnold 2000:368-69). Analytical work relies on the mineralogical and elemental compositions of pottery and raw materials, and both types of composition are analysed in this research.

The composition of clay is mainly the result of the composition of the parent material, the environmental conditions prevailing during its formation and, in the case of sedimentary/secondary clays, the transport, deposition and post-deposition conditions (Shepard 1971:vi). The basic difference between elemental and mineralogical analysis is that the former identifies (and often quantifies) chemical elements in the sample, while the latter identifies (and more rarely quantifies) minerals and rocks. For this reason, the two forms of analysis can supplement each other (Day et al. 1999). Bulk chemical composition analysis refers to obtaining an elemental composition of a powdered and homogenised sample, as opposed to the compositional analysis of a particular chemical phase in the same sample. In this way, the resulting elemental composition derives equally from the clay minerals, the natural inclusions/impurities, and any intended non-plastic additions (i.e. temper). The mineralogical composition of a pottery sample can be assessed optically by identifying minerals (and how are they are combined in rocks), through petrographic analysis of pottery fabrics (Shepard 1971:x). Plus, optical analysis of the microstructure and texture of the pottery fabrics under a microscope can provide useful information for reconstructing the vessel-forming and -shaping techniques, as well as the overall paste recipe. Finally, mineralogical analysis can also identify crystalline minerals in the sample in a non-optical way through X-ray diffraction (XRD). The presence/absence of certain minerals can help in identifying the maximum temperature reached during the firing stage.

Chemistry-based and mineralogy-based provenance studies are both grounded in the same postulate, known as the ‘provenance postulate’: raw material sources can be determined by characterisation as long as the qualitative and quantitative differences between natural sources exceed the variations within a single source (Weigand et al. 1977). In other words, the sources need to be diagnostic.

Thus, to source the raw materials used in pottery production it is necessary to rely on the geology of the research area and determine the range of variation of bedrock, sand, and clay deposits. The greater the geological variation and the finer the geological resolution, the more precise sourcing can be (e.g. Abbott 2000; Fowles et al. 2007; Hegmon et al. 2000:230-31; Miksa and Heidke 2001). For example, Minc and Sherman (2011) mapped natural clay variability within the Valley of Oaxaca through the analysis of 135 samples, each representing a different location, to support the determination of pottery provenance. By analysing (using INAA and thin-section petrography) 135 clay samples/locations and observing trends in the resulting trace element and mineralogical compositions, they concluded that a continuum of variation exists within the valley, regardless of the bedrock/surficial geology. Thus, their model of chemical and mineral variability provides a greater resolution to predict sourcing in the Valley of Oaxaca than the information provided by bedrock/surficial geology alone, allowing a more solid approach to related concerns such as production and exchange studies. The reconstruction of the environment of production (i.e. the natural variability of raw materials in the local geology) also helps to establish whether the fabric and/or chemical variability in a sample set is related to technological or environmental factors, and enhances the validity of any socio-political explanations of production (Arnold 2000).

However, unlike stone and other raw materials used in the ancient production of artefacts, clay often suffers from fundamental alterations of its original elemental and mineralogical profile during the manufacture, use, and post-depositional stages (see Arnold et al. 1991; Day et al. 1999:1027; Maggetti 1982:121-22; Summerhayes 1997). In this way, pots made from the same clay source may differ in their bulk chemical concentrations and/or mineralogical profiles (i.e. show a difference greater than the natural within-source variation) if they were processed or mixed differently, or if they were eventually deposited in different soil conditions (see Arnold et al. 1991; Maggetti 1982:129; Stoner et al. 2014). In all cases but the last, it would still be possible to straightforwardly identify pottery made with the same recipe; in the last case, it would only be possible through optical mineralogical analysis.

Post-depositional compositional changes introduce qualitative and quantitative variability to the results that have no direct relationship with technological choices (Neff 2000:108). Some post-depositional alterations can be optically identified through petrographic analysis and caution the interpretation of bulk chemical analysis (Shepard 1971:x). In chemical analysis, certain measured elements are more prone to be affected by post-depositional contamination. To name but a few: Na levels can be affected in deposits rich in common salt concentrations (e.g. Martínez et al. 2008:247; Tite 2008:225); S levels can be altered due to gypsum salts present in arid soils (e.g. Goren et al. 2011:689); Ba may suffer from enrichment in ancient lake deposits (e.g. Goren et al. 2011:689; Martínez et al. 2008:247); P, Mn and Ca can be precipitated onto the fabric matrix (e.g. Cultrone et al. 2011:344; Freestone 2001:622-623; Martínez et al. 2008:247); and Ca concentrations would rise in the case of shell tempering.

Although in some cases, cultural-related variability by potter's additions or modifications, such as levigation, tempering or clay mixing, may be readily detected in thin-section petrographic analysis and used beneficially to identify and classify specific pottery recipes, in bulk chemical analysis these cultural alterations create what is referred to as 'chemical noise' (see Day et al. 1999; Neff et al. 1989). For example, in chemical quantitative analysis, tempering will increase the abundance of the elements present in the temper material, and consequently dilute the proportional abundance of the rest of the measured elements (Arnold et al. 1991:75; see Baxter and Freestone 2006: 520-23). This effect can be erased by statistical procedures if the tempering materials and the enriched elements are known (Arnold et al. 1999:80-81). Regardless of the problems inherent to its use in compositional/provenance studies, pottery is still one of the preferred choices for analysis—mainly thanks to its long history as a man-made product and omnipresence in the archaeological record (Skibo 1999), which permits easy comparisons within and between regions.

Due to some of the issues already discussed, the employment of more than one analytical technique is recommended in provenance research. Petrographic analysis can help to explain chemical differences in the samples (Summerhayes 1997:109), and the integration of petrographic and geochemical information allows the researcher to distinguish between samples with similar chemical compositions but different mineral structure. The use of petrography can reassess assumptions made solely on the base of geochemical analyses, or even provide conflicting information. The now-classic example of this concerns the provenance study of Olmec style pottery. One team of researchers (Blomster et al. 2005) chemically analysed (INAA) pottery and clay samples, concluding that the San Lorenzo region was the only exporter of Olmec-style ceramics, which were copied in other sites for local consumption; another team of researchers (Stoltman et al. 2005), by studying pottery samples through petrographic thin-section analysis, argue that pottery exchange was two-way between San Lorenzo and its Mesoamerican neighbours. Thus, the results and their respective interpretations provide contrasting explanations of the relationship between contemporaneous sites (see also Neff et al. 2006 and Sharer 2007).

Compositional studies can still be useful in provenance determination if the sourcing of raw materials proves difficult. Even before the physical and chemical compositional characteristics of the pottery under study are compared to the geology and geochemistry of the study area, compositional analyses provide data variability and compositional patterns that allow the grouping of samples (Orton et al. 1993:144-45). Once compositional and petrographic fabric groups are established, they can be interpreted in several ways. For example, the finding of a large and homogeneous compositional group would strongly suggest a single source origin. Moreover, if this group has a restricted spatial distribution it would strongly indicate the use of endogenous raw materials, at least at the micro-regional level, assuming raw clays or tempering materials were not traded between regions in high volumes (Arnold 2000:368; Mommsen 2001:658). In turn, this scenario would also point to local production. In contrast, the wide distribution of a compositional group provides evidence for craft specialisation (Skibo 1999:2-3).

Roux and Courty (2005:203-04) argue that, theoretically, the homogeneity of petrographic fabrics can provide information about how homogenous the production was, since it entails the use of the same production technology including the exploitation of the same raw material sources, whereas high variability within and between petrographic fabrics groups correlate with the number of production units and the area under study (e.g. micro-region, meso-region, macro-region). Arnold (2000) has called for a consideration of other factors, such as exploitation of a different area of the same source due to the exhaustion of the original mining spot, which could increase fabric variations but does not necessarily imply the existence of distinct production units.

Needless to say, identification of the raw material sources used for pottery manufacture is the easiest way to make a distinction between local and non-local pottery (Arnold 2000:367-68). A local source is usually defined as one located in the surroundings of the site, while a micro-regional source would be one located not more than a few kilometres away; more distant sources are considered exogenous and are commonly related to pottery that is defined as imported at the micro-regional level (Roux and Courty 2005:209; see Zedeño 1995:119).

Source determination sorts out ceramics that are effectively the same in their compositional characteristics from those that just look similar due to copying or learning (Hegmon et al. 2000:218). If sourcing is done over a vast area, it will provide a pottery distribution map that will make it possible to confidently address questions related to the direction and scale of circulation between regions (Neff 2000; Orton et al. 1993:197-202). In other words, sourcing data might potentially surpass the basic goals of provenance studies, and could additionally help to reconstruct production strategies such as specialisation, circulation patterns, trade relationships, population movements, and related concerns (Arnold 2000:368-69).

For example, Hegmon et al. (2000) were able to identify small-scale population movements by sourcing pottery through petrographic analysis, in combination with analysis of the morphological attributes of technological styles. Ethnographic research conducted by Arnold (2000:368) was able to identify community and product specialisation with the help of bulk chemical composition analysis (i.e. INAA). Arnold (2000:368) inferred community specialisation by the diagnostic chemical signature of the tortilla griddles (*comales*) made by one particular community in relation to the rest of the pottery made in the same valley. Stoltman (1999) confirmed through petrographic thin-section analysis that the suspected non-local gray ware vessels recovered in Chaco Canyon were imported from the Chuska region, located 70-80 km to the west. Stoltman (1999) compared the clay fraction from these vessels with that of established Chaco and Chuska ceramics under the microscope, finding an identical match with the latter and strong differences with the former. The importation of high numbers of these vessels was interpreted in relation to their use in large pan-regional public events taking place in Chaco Canyon: these feasting and bartering ceremonies eventually demanded large amounts of pottery, leading to production in participating zones where fuel for firing was more plentiful (Stoltman 1999:23-24).

In conclusion, pottery provenance studies concentrate on answering, on the basis of chemical and mineralogical composition, two intrinsically linked questions: if pottery recovered from a certain place or site was locally produced or imported; and the geographical location or geological source of the raw materials used in its production. Besides raw material selection, related research aims such as the establishment of pottery recipes, ware specialisation by area, or distributional and circulation patterning, are certainly enriched by solid sourcing. The application of analytical techniques from the material sciences is now fundamental to the investigation of these questions.

Compositional and technological analyses of pottery also provide data that allows the study of pottery production in the absence of direct evidence (Zedeño 1995:119-20). Besides resource selection and exchange-related concerns, popular lines of inquiry include the organisation and mode of production (e.g. specialisation) and production technology patterns (e.g. pottery traditions, standardisation), evidence for which can be gathered through scientific analysis of robust sample sets.

Material science approaches can contribute to the study of the social construction of ceramic technology through reconstruction of the *chaîne opératoire* and analysis of culture-material interactions (Sillar and Tite 2000:14-17). Laboratory analyses integrated with geological data can show whether environmental, technical, or functional constraints determine certain technological choices, or if, on the contrary, flexibility in technological choices is allowed (Gosselain 1998:89; Sillar and Tite 2000:16). For example, using granulometric data, Gosselain (1998:89-90) showed that potters in southern Cameroon used several varieties of manufacturing techniques regardless of the fact that they exploited raw clays of a similar texture, evidencing that technical behaviours cannot be explained in purely materialistic terms and that symbolic and economic pressures influenced such decisions.

Besides helping the identification of what raw materials were used, petrographic analysis of pottery samples can provide information on how raw materials were processed and how pottery was manufactured and fired, which in turn permits the assessment of technological choices in the production process. For example, Michelaki et al. (2002) documented the pottery production sequence of the Maros group of southeastern Hungary during the Early Bronze Age. By combining INAA, petrographic analysis and other archaeometric techniques on pottery and local clays, the team was able to identify both variation and standardisation, and technological choices driven by both environmental and social constraints, for a period of almost a thousand years. Standardisation is represented by the use of the same local clay and temper resources, and the same forming and decorative techniques used throughout this period of time. Such standardisation was interpreted as the outcome of limited shared resources, and knowledge transmission. The choice of grog temper was also dependent on an environmental factor: a lack of mineral alternatives (Michelaki et al. 2002:316). Contemporaneous variability was explained in terms of different producers. Most importantly, chronological variability between the Early and Late Maros phases evidenced a shift in the potters' focus and care from the raw material preparation stages to the appearance-related (i.e. forming and firing) stages. The increased proportion of burnished and more decorated vessels was, in turn, linked to a newfound role of ceramics as a way of displaying wealth (Michelaki et al. 2002:317). This important conclusion was partially based on petrographic information that revealed two patterns of temper use: at the Early Maros site, the temper was sorted into two sizes, depending on how thick the vessels were to be; at the Late Maros site, what varied was not the temper's size but its amount, a less time-consuming task.

Petrographic analyses of pottery have also been used to address specialised ceramic production and its role in the organisation of polities. Through the petrographic analyses of pottery samples, Fargher (2007) analysed changes in the production of gray ware pottery through time to demonstrate corresponding changes in the organisation of production in Monte Albán. During the Late-Terminal Formative period, there was high variation in the gray wares consumed in Monte Albán, of which the majority was probably imported from the surrounding valley (an inference based on their composition and the regional geology); he linked this fabric variability to household producers or low-intensity specialised production and the increasing demand from a rising Monte Albán, then functioning as a 'disembedded' capital (Fargher 2007:323-24,26-28). For the transition to the Classic period, nearly all of the examined gray ware appears to have been produced at or near Monte Albán, based on the match between the petrographic composition of the majority of the samples and the local geology; excavated kilns from the same period support the start of major specialised craft-production at Monte Albán during this period, when it was shifting its focus from military to economic concerns (Fargher 2007:324-28).

The study of standardisation and variation also benefits from the use of archaeometric methods and techniques (e.g. Hilditch 2014). The variability in pottery fabrics is studied by acquiring textural and mineralogical information through petrographic analysis, and by obtaining geochemical profiles through characterisation techniques such as INAA. For example, Jorge (2009) found in a comparative analysis of pottery from the Upper Mondego Plateau, Portugal, that the fabric groups defined by petrographic analysis crosscut typological categories based on vessel shape and size, including both Chalcolithic typologies and new shapes emerging during the late third millennium BCE. The new types seem to have conformed to existing forming traditions and paste recipes, regardless of the changes in shape and decorative styles (Jorge 2009:37-38).

II.6. SUMMARY

The study of diverse modes of sociability embedded in politics has been increasing over the past few years. Numerous recent works deal with the implementation of political strategies (e.g. several examples in Kurnick et al. 2016; Smith 2016), but none investigate this topic through the analysis of pottery technology. This research focuses on the political contexts of artefact technology and how its reproduction is embedded in political strategies from the corporate/exclusionary spectrum.

This research argues that, beyond the transmission of knowledge and the complex social interactions involved in the creation of technological styles, there is a political dimension that can help reveal ‘what it all means’ (Winner 1993:375). The main argument of this research is based on three premises: (i) political strategies are embedded in pottery’s production and technology; (ii) political strategies can be evidenced by understanding pottery’s *chaîne opératoire* within its socio-historical, technological and environmental context; and (iii) the revelation of micro-regional political strategies is fundamental to understanding regional political organisation.

It has been argued that technological choices and technologies are both a product of economic systems and one of the ways in which such a system is reproduced (Sillar and Tite 2000:7); this research applies this view to political systems. This chapter has demonstrated how material culture and production technologies not only reflect and reproduce social and political processes; they are also active tools of social interaction, which sustain and promote the formation of such processes through political strategies.

In sum, since organised political units integrate networks of authority, specialised craft-production systems, and technological traditions (i.e. with access to specific sets of resources, technological knowledge, and so on), and have an interest in the bounding of spaces (Pollard 1994:79), they offer an interesting and not yet adequately explored avenue to study how and when differences in technological style can be used to discern between specimens produced in different polities, how and when technological variability is simply based on environmental factors, artefact function and/or use, etc., and what a potential correlation between technological styles and restricted territorial space accounts for.

However, as underlined in this chapter, rather than search for a reflection of political units into material culture and trying to bound technological traditions and technological styles to fixed political territories, the aim of this research is to explore the kind of political strategies embedded in pottery production technologies and what they indicate about ancient political organisations, understood as webs of authority. More than creating labels, the importance of political strategies lies in understanding how they may have been reproduced in the contexts of pottery production and consumption (Small 2009:219).

CHAPTER III. GEOGRAPHICAL, ARCHAEOLOGICAL, AND HISTORICAL SETTINGS

This chapter describes the geographical, archaeological, and historical backgrounds of this research. The first section (III.1) describes the geographical characteristics of the four micro-regions relevant to this study: the Colima Valley, the Salado River basin, the Tecomán coastal plain, and the western coast. The second section (III.2) provides the archaeological setting, placing this research's ceramic material within its West Mexico and Colima contexts. Finally, the third section (III.3) focuses on the earliest (i.e. first half of the 16th century) known written references to Colima, and the debate about the political organisation and integration of the research area in prehispanic and historical times.

III.1. GEOGRAPHICAL SETTING

The Mexican state of Colima is located on Mexico's central Pacific coast, between the coordinates 18°41' and 19°31' North latitude, and 103°29' and 104°41' West longitude (Figure III.1). It is surrounded by the state of Jalisco to the north, east, and west, and borders the state of Michoacán to the east and south, and the Pacific Ocean to the south and west (Instituto Nacional de Geografía y Estadística [INEGI] 1998:3). Its continental territorial extension is 5,542km^2, with an additional 141km^2 belonging to the Revillagigedo Archipelago in the Pacific Ocean (Secretaría de Agricultura y Recursos Hidráulicos [SARH] 1990:10-11).

The state of Colima is cut in half by the Armería River (Figure III.1). The Armería River is formed in neighbouring Jalisco by the confluence of the Tuxcacuesco, Capula, and Ayuquila rivers; it enters Colima through a narrow and deep gully between the Colima Volcano and the Cerro Grande and runs for almost 300km until feeding the Pacific Ocean at Boca de Pascuales (SARH 1990:20; Secretaría de Programación y Presupuesto [SPP] 1981:22). Its most important tributaries in Colima are, from the east, the Juluapan River and the Agua Zarca, El Chino, and Charco Verde streams; and from the west, the La Lumbre, Comala, and Colima rivers (SARH 1990:20; SPP 1981:22). The latter

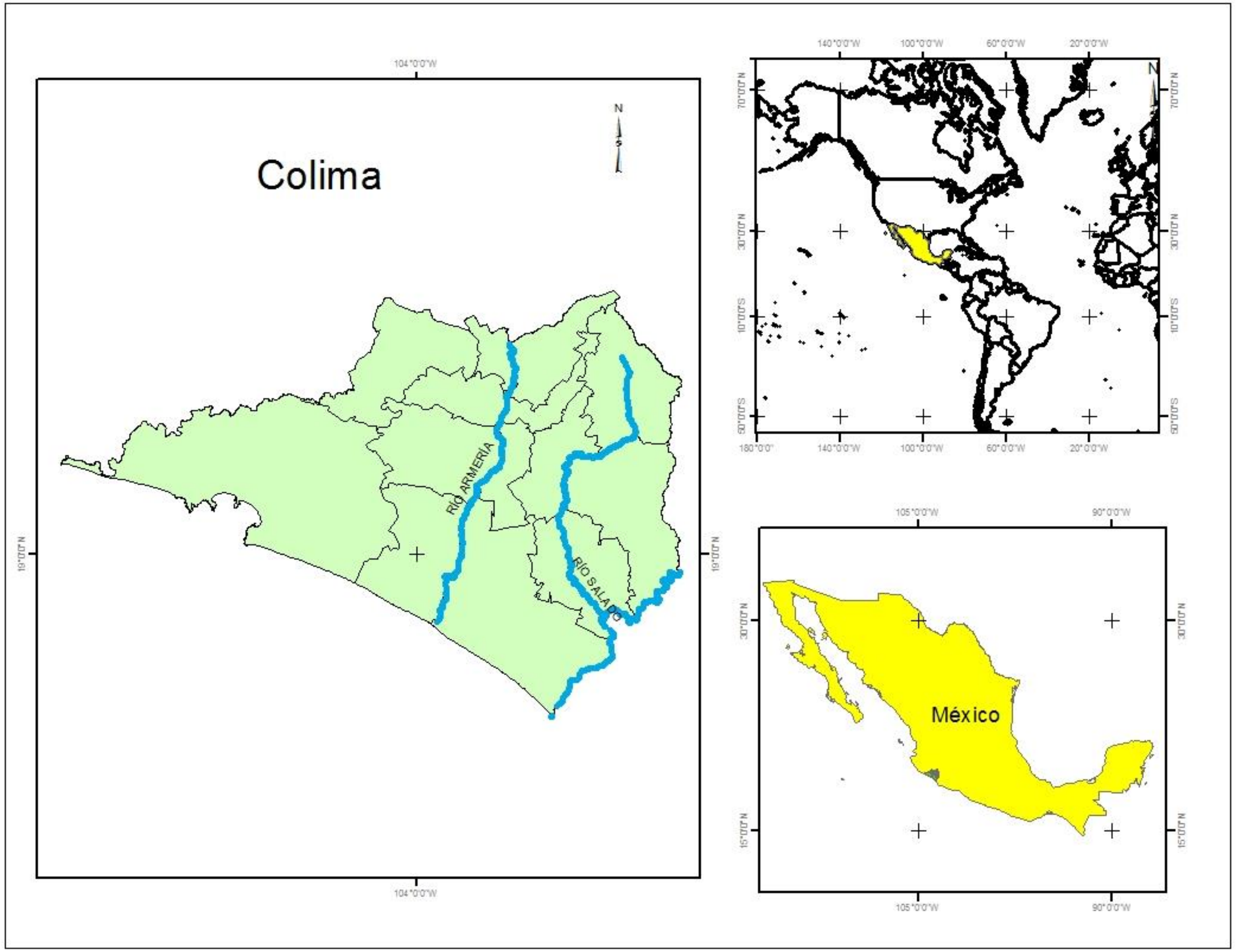

Figure III.1. Location of Mexico within the Americas, of Colima within Mexico, and of the two major rivers (Armería and Salado) and ten municipalities within Colima.

flows through the state’s capital city (Colima City) and joins the Armería River downstream of Jala before reaching the Armería Valley (Figure III.2).


Figure III.2. The Armería River flowing through the coastal plain.

Colima state belongs to two physiographic provinces: the Trans-Mexican Volcanic Belt and the Southern Sierra Madre (INEGI 1998:5). This means that almost three quarters of its territory lies in ‘mountain-and-barranca country’ (Bell 1971:697).

The Trans-Mexican Volcanic Belt, also known as the Neovolcanic Axis, crosses Mexico from west to east at the latitude of Mexico City and Colima state (ca. 19°00’ to 21°00’ N); the *Nevado* of Colima (4320m above mean sea level) and the Colima Volcano (3820m amsl), jointly known as the Colima Volcanic Complex, are located at its western end (Luhr and Carmichael 1980) (Figure III.3). The segment of the Neovolcanic Axis in Colima belongs to the Sub-province of the Colima Volcanoes, and corresponds roughly to the southern slope of the Colima Volcano—accounting for 16% of the total state’s territory (INEGI 1998:5; SPP 1981:26) (Figure III.4).


Figure III.3. The Colima Volcanic Complex, as seen from the east.
Photograph by Francis Levy.

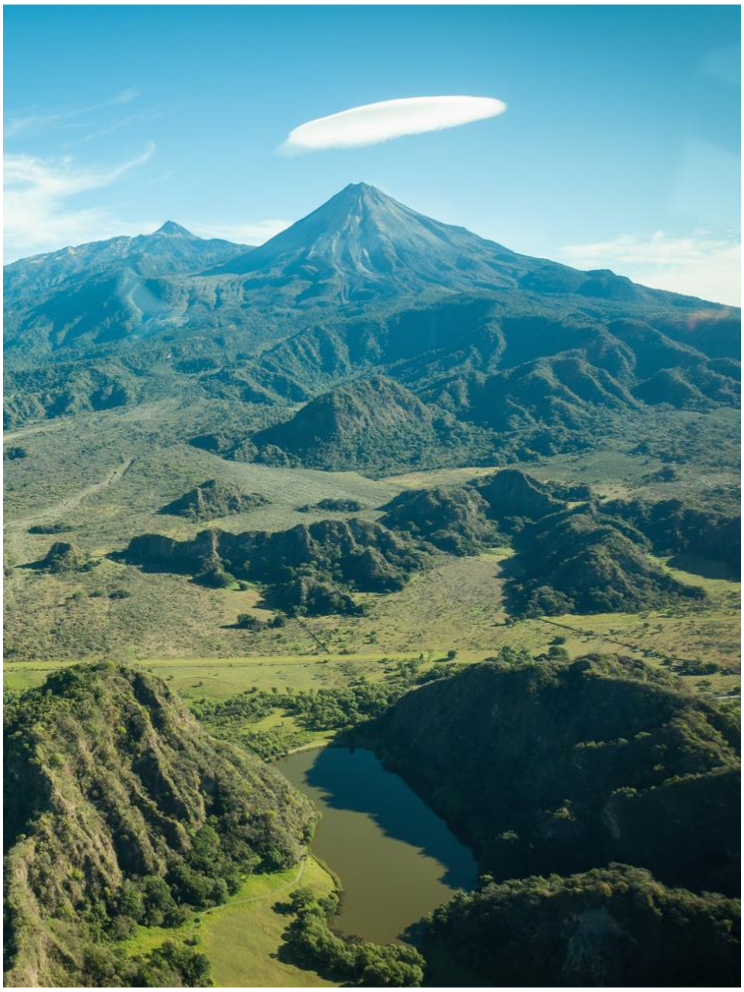
Figure III.4. Northern end of the southern slope of the Colima Volcano.
Photograph by Francis Levy.

The cone of the Colima Volcano, located in Jalisco, is 32km north of Colima City as the crow flies (INEGI 1998:4; SPP 1981:26). The andesitic Colima Volcano is historically one of the most active volcanoes in North America (Luhr and Carmichael 1980:343-45).

From the foot of the volcano, at 1700 to 2000m amsl, a system of rolling hills and ravines descends to 500m amsl (INEGI 1998:15) (Figure III.4). Towards the periphery of this area there are increasingly large flat areas, on which the municipal capitals of Cuauhtémoc (940m amsl) and Comala (600m amsl) are located (INEGI 1998:4; SARH 1990:14; SPP 1981:27). Colima City lies further south, on a plain that descends from 550 to 450m amsl. In sum, there is a difference in altitude of more than 1000m over a straight line of just 25km. The oldest rocks that surface in this part of the state—known as the **Colima Valley** (Figure III.5)—originate from the extrusive activity of the Colima Volcanic Complex, and date from the Pliocene epoch (SPP 1981:15,27). The soils on this massive slope are either alluvial or derived from volcanic rocks and ash (SPP 1981:26-27). The most important river in this Sub-province is the Comala River; it originates on the lower slopes of the Colima Volcano and runs to the southwest before joining the Armería River (SARH 1990:20).

There are two physiographic Sub-provinces enclosing the **Colima Valley** to the west and south: the Coastal Sierra of Jalisco and Colima, and the Southern Coastal Mountain Range. These two ranges are Colima's segment of the Southern Sierra Madre, which accounts for 84% of the state's territory (INEGI 1998:5); from these two mountain ranges descend a fair number of short rivers of swallow depth, most of a seasonal nature, which feed into the Pacific Ocean (SARH 1990:14; SPP 1981:41).

Colima's portion of the Sub-province of the Coastal Sierra of Jalisco and Colima comprises the territories of the western mountainous region and **western coast**, the Armería Valley, and the **Tecomán coastal plain** (SPP 1981:42) (Figure III.5).

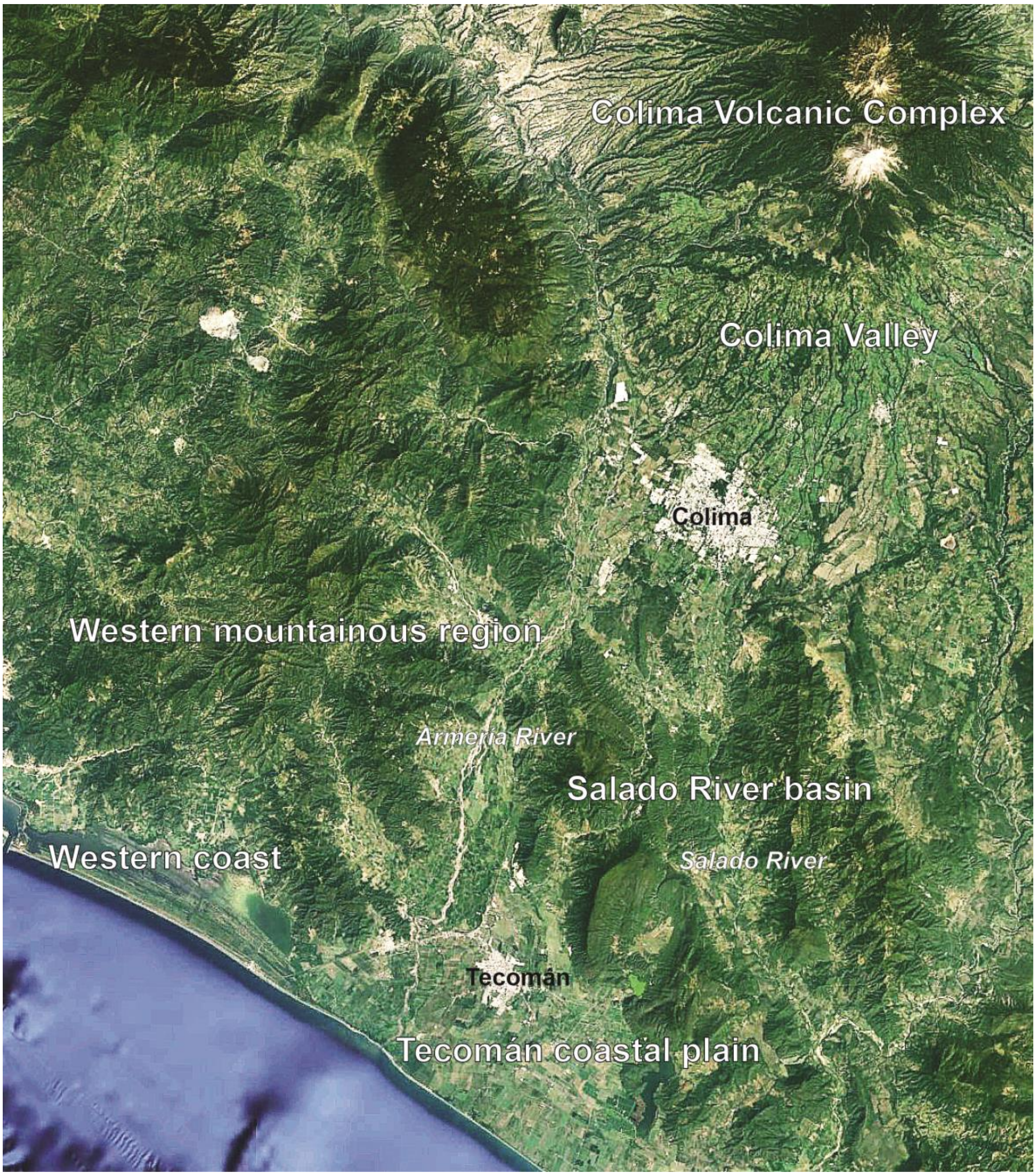

Figure III.5. Topographical map of Colima (modified from Google Earth).

The western mountainous region is constituted by sierras of a height between 500 and 2420m amsl, largely composed of Upper Cretaceous intrusive granite masses, and to a lesser degree by Lower Cretaceous limestone formations and Late Devonian schist; more recent deposits of volcanic origin, such as intermediate breccia and tuff, have partially buried the area (INEGI 1998:4; SARH 1990:14; SPP 1981:15). This region is characterised by fertile, shallow soils (SPP 1981:42,44).

Colima's coast is characterised by narrow plains of mixed origin (continental alluvial and surge), separated by low sierras that extend towards the coastline and create natural ports such as Salagua and Santiago. The widest is the **Tecomán coastal plain** in the south of the state, which has coastal lagoons and some estuaries (SARH 1990:14; SPP 1981:42).

Among the coastal lagoons, the salty Cuyutlán lagoon on the **western coast** is the state's biggest, with an extension of almost 70km^2, a length of 30km parallel to the coast, and a width of up to 3km; it receives fresh water inputs from the El Zacate and Agua Blanca streams, besides subterranean groundwater discharges (SARH 1990:24). The smaller Amela (12km^2) and Alcuzahue (3km^2) lagoons, located on the upper edge of the **Tecomán coastal plain**, lie on karst depressions and are fed by superficial and subterranean discharges, the latter coming from the neighbouring limestone formations of the Southern Coastal Mountain Range (SARH 1990:24). Most of the soils in these coastal plains date to the Quaternary period, and include clays, sands, gravels, and boulders (SARH 1990:19; SPP 1981:15).

Finally, the Southern Coastal Mountain Range Sub-province is dominated by Lower Cretaceous sedimentary rock formations of marine origin, mostly limestone (INEGI 1998:15,17; SPP 1981:86-87). The Colima portion of this Sub-province is known as the **Salado River** region (Figure III.6). It includes sierras (whose highest peaks do not exceed 1300m asml), branched valleys, low hills, and a rocky plain. The soils in the sierras have residual and colluvial origins; the soils in the valleys are of colluvial-alluvial origin; on the hills or *lomeríos*, they are of residual origin; and those on the plain are of an alluvial nature (SPP 1981:87-88). The Salado River is the main tributary of the Coahuayana River, which serves as Colima's boundary with the Jalisco and Michoacán states to the east. The Alcuzahue and Amela lagoons of the **Tecomán coastal plain** are sub-basins of the Salado River basin (SPP 1981:22).

The weather, pluvial precipitation, and vegetation found in Colima depend on the altitude. Warm climates are found in more than 85% of the state, whereas the exposition and altitude of the highest mountains provoke a larger number of precipitations and a semi-warm climate. The warm climates are mainly associated with tropical deciduous forests (*guásima*, *huizache*, *espino blanco*), tropical semi-deciduous forests (*cuajiote*, *guayaba*), mangroves, and secondary grasslands (INEGI 1998:12; SPP 1981:13,29). The more extensive type of warm climate is the warm sub-humid, featuring a summer rainy season and a minimum percentage of winter rain, for a mean annual rainfall of between 800 and 1200mm, and a mean annual temperature above 22°C (SPP 1981:13). Semi-arid climates are present in a transition zone between the coastal plains and the neighbouring mountain ranges, with a mean annual temperature above 24°C and annual precipitation below 800mm (SPP 1981:14).

Figure III.6. The Los Ortices area of the Salado River basin.

A good part of the rainfall is associated with the annual presence of tropical depressions and hurricanes. These are formed between May and November in the Mexican South Pacific and follow a northwest trajectory parallel to the coastline (Padilla Lozoya 2006:45). More than 65% of annual precipitation falls between July and September; the dry season is from November to May, with an average monthly pluvial precipitation below 15mm (SARH 1990:13).

The last of the great hurricanes that strongly affected Colima happened in 1959, when the precipitation reached 625mm in 24 hours and winds reached 250km/h, provoking waves that altered the morphology of the coast (Padilla Lozoya 2006:46,56).

III.2. ARCHAEOLOGICAL SETTING

This section provides an archaeological background, placing the research material in context. It starts with consecutive discussions on West Mexico as a Mesoamerican cultural area and on Colima as a ceramic province. These are followed by a discussion of the cultural rupture that arguably happened around the start of the Late Classic/Epiclassic period (*ca*. 550 CE). The final sections summarize, respectively, the limited extent of previous research in the area and time period (including the definition of non-ceramic and ceramic characteristics), and the characteristics of the sites where the pottery samples studied in this research were collected.

III.2.1. WEST MEXICO AS A MESOAMERICAN CULTURAL AREA

The starting point for the definition of Mesoamerica was a widely cited seminal article written in 1943 by the German-born philosopher and ethnologist Paul Kirchhoff, who outlined Mesoamerica while defining its characteristics and those of the cultural areas that (according to him) comprised it (Kirchhoff 1992; Matos Moctezuma 1994:53-55).

Based on early colonial descriptive accounts of the local cultures, Kirchhoff mapped the distribution of cultural traits to establish cultural boundaries (Kirchhoff 1992:30-31). That is, in the best culture-historical fashion of the 1930s-40s, Mesoamerica as a cultural unit was defined by a long list of pan-Mesoamerican cultural traits, some of them then considered exclusive to this area, which included everything from manners of dressing to pantheons of gods (Kirchhoff 1992:36-37; Matos Moctezuma 1994:54-55). Since many of these features were first written down around the time of the Spanish Conquest, the characteristics that defined Mesoamerica were taken from a specific period (Kirchhoff 1992:31), making this spatial concept only confidently applicable in the temporal context of the early 16th century. Nonetheless, ever since Kirchhoff coined and conceptualised the term, the concept of Mesoamerica has been used regardless of the period of study to refer to a more or less fixed geographical region, ignoring that certain areas in certain periods lacked any so-called Mesoamerican features. Kirchhoff’s (1992:42) limits of Mesoamerica include today’s central and southern Mexico and most of Central America.

According to Willey (1992:46), this cultural area 'began to take form' around 1500 BCE.

Given that the notion of being Mesoamerican is inextricably linked to the presence or absence of certain specific traits, West Mexico's inclusion in Mesoamerica has always been problematic (López Mestas Camberos 2007:37). When Mesoamerica was first defined, West Mexico (or 'The West') was by far the least studied of the Mesoamerican areas (a sad fact that still holds true; see Olay Barrientos 2012:9-19). Initially, there were concerns that West Mexico was more a 'catchall' area for anything that did not fit elsewhere, rather than a proper cultural area like the others (Beckman 2010:42-43; Pollard 1997:348). Indeed, by the 16th century there were Mesoamerican elements in the area, but what exactly unified West Mexico enough to apply a single label to it? Is something West Mexican only because it is found, geographically, in the western territories?

Williams (1996:17) argues that West Mexico is not a geographical unit or even a cultural one, considering the large degree of ecological and cultural variation within it. Researchers sharing this view prefer the term 'western Mexico', which is used effectively to define the western territories of Mesoamerica or Mexico, without any implications of cultural unity (Pollard 1997; see Beekman 2010:42-43). While I agree with Pollard (1997:348) that West Mexico as a whole did not function as a fixed cultural unit at any point through the prehispanic period, archaeological work has made evident the presence of cultural traditions that seem to have characterised extensive areas of West Mexico at specific moments in time (Hers 2013a:11-12; see III.2.3 of this thesis, below).

The poor definition of what traits make a culture 'West Mexican' means that the very geographical extension of West Mexico is unclear (Oliveros Morales 2007:23-24). Williams (1996:15) and Hers (2013a:11) understand West Mexico as a vast and variable geographical area encompassing the present states of Jalisco, Colima, Nayarit, Sinaloa, and Michoacán. Beekman's (2010:41) non-culture-based definition of 'western Mexico' further includes the southern parts of Zacatecas, Guanajuato, and Querétaro, and leaves out northern Sinaloa. Pollard's (1997) geographical extension of 'western Mexico', on the other hand, leaves out northern Nayarit and the whole of Sinaloa and does not include any parts of Querétaro. A constant in all of these studies, however, is that the core of this cultural and/or geographical macro-region includes the states of Nayarit, Jalisco, Colima, and Michoacán.

For decades, West Mexico as a cultural unit was considered a marginal, backwater area in relation to the rest of Mesoamerica (Meighan 1974:1254; Schöndube Baumbach 2005:12). Moreover, it was deemed to be an area composed of chiefdoms almost exclusively devoted to ritual practices around ancestor cults (Hers 2013a:14; López Mestas Camberos 2007:37-38,40).

The vision of West Mexico as a marginal area resulted from the dominant, centralised model of Mesoamerican archaeology that considered the central valleys of Mexico to be originators, and the peripheries to be receptors (see Hers 2013a:12-13; Pollard 1997:349). Mostly due to a lack of research, the West was deemed to lack several Mesoamerican traits, such as monumental architecture, large urban centres, the use of the calendar, and writing systems (López Mestas Camberos 2007:37; Weigand 1996:185). The centralised model has led a lot of ink to be spilled on questions such when did the 'mesoamericanization' of West Mexico take place (i.e. when did The West begin to 'look' more like Mexico's central valleys), and how much influence did the Olmecs, Teotihuacan, Toltecs, and so on, exert in the western territories (Pollard 1997:348-53). As Hers (2013a:12) and Pollard (1997:348,370-71) put it, West Mexico has been mostly defined by its differences with the rest of Mesoamerica rather than by its own peculiar unifying characteristics.

However, recent archaeological work in western Mexico has finally escaped from this tendency and started to develop its own research agendas and paradigms, thereby revealing a far more complex picture of the societies that inhabited this large area. Contrary to initial theories, evidence of social complexity is found in this area since the Early Formative period (1500-900 BCE). For example, it is now known that western Mexican areas were engaged in early trade with the rest of Mesoamerica, as evidenced by the presence of obsidian sourced to Ucareo (Michoacán) in Early Formative contexts of central and southern Mexico (Healan 2004:33; Hers 2013a:12-13; Williams 1996:35). López Mestas Camberos (2007:40-41) sees the Formative societies of West Mexico as already ideologically complex, immersed in ideologically motived and elite-controlled trade networks of high-status artefacts. López Mestas Camberos (2007:40) offers as evidence of these elite trade networks the presence of exogenous materials, such as *Spondylus* seashells, among the offerings excavated in a Formative cemetery with a restricted access at the Salado River basin, in Colima, some 50km inland from the Pacific coast. Likewise, Oliveros Morales (2007:28) documents the presence of goods sourced to distant places at the Formative site of El Opeño, Michoacán—such as marine shells from both the Atlantic and Pacific coasts. Oliveros (2007:28) argues for the existence of organised merchant groups that would have managed the trade networks of these products.

III.2.2. COLIMA AS A 'CERAMIC PROVINCE' AND ITS REGIONAL CHRONOLOGIES

As with Mesoamerica and West Mexico, the establishment of Colima as a cultural area has roots in the classificatory-historical period of archaeology. The classificatory-historical approach was mainly concerned with cultural chronology and spatial distributions, especially of artefacts. This approach emphasised the use of seriation to determine the arrangement of archaeological materials in chronological series ordered by similitude, under the understanding that culture changes gradually through time (Willey and Sabloff 1980:83,93-94).

During the classificatory-historical period, typologies stopped being mere taxonomic descriptions and focused on inserting descriptive data onto the chronological table (i.e. relative chronologies), thus turning types of artefacts into historical types (Willey and Sabloff 1980:101). Artefact types, however, remained subjectively determined (Willey and Phillips 1958:12-13; see Kelly 1980:1 for an example).

The chronological order allowed not only the historical classification of artefacts, but also of 'cultures'. Under the culture-historical approach, cultures are constituted by 'phases' belonging to 'regions', which in turn form 'cultural areas'; all of these units (i.e. phase, region, area) were formed by the similarity of cultural traits between different sites (Willey and Sabloff 1980:83,104-05).

Following this theoretical approach, and based on shared ceramic characteristics (such as decoration and shape) in time and space, Isabel Kelly established Colima as one of the 14 'ceramic provinces' (which she equated to cultures) of northwest Mexico, and elaborated the ceramic sequence of Colima (Kelly 1947b:65-66, 1989:71-73; see Williams 1994:261). She further detailed how the ceramic provinces of northwest Mexico could be grouped in larger areas, one of which included, among others, the ceramic provinces of Sayula, Autlán-Tuxcacuesco (both in southern Jalisco), and Colima—all characterised by 'middle horizons' of red-on-brown or red-on-buff ceramics (Kelly 1947b:69).

The Colima 'ceramic province' included most of the current state of Colima, excluding the area of the volcanoes and the western coast, and including the Coahuayana Valley shared with Michoacán state and the area of Pihuamo, in southeastern Jalisco (Kelly 1947b:65-66).

However, after years of research, Kelly started to recognise a stronger regional patterning within Colima state, and suggested the existence of four 'subcultures' inside it, while warning that regional boundaries were not static and shifted from one phase to the next (Kelly 1968 cited in Olay Barrientos 1994; Kelly 1980:1-3). Her four subcultures were:

- The western coast of Colima, from Cihuatlán to Manzanillo
- The western mountainous region
- The central Colima archaeological region, formed by the Armería Axis (that is the Lower Armería drainage system that stretches all along the North-South axis of Colima state), together with the Higher and Middle Salado River basin
- The Coahuayana River basin or Colima East, with the exception of the aforementioned Higher and Middle Salado River basin

What is known about the archaeology of Colima applies primarily to the third of Kelly's subcultures (see Kelly 1980:3) and, to a lesser degree, the western coast. Instead of 'Armería Axis', which Kelly used 'for want of a better term' (Kelly 1980:3), I recently suggested the alternate name of 'Central Axis of Colima', to avoid any confusion with the Armería phase of the ceramic sequence of this area (Salgado Ceballos 2007:Chapter V). Geographically, the Central Axis of Colima corresponds to the western half of the Colima Valley, the Armería Valley, and the western half of the Tecomán coastal plain. The Colima ceramic sequence elaborated by Kelly (1944:218, 1947b:65-66, 1980:3-17) corresponds to the Central Axis of Colima and the Higher and Middle Salado River basin; during certain phases, it also includes the Lower Coahuayana basin and the western coast. The western mountainous region and most of Colima East (excluding the Lower Coahuayana basin) are, according to Kelly

(1980:3), archaeologically quite distinct throughout the sequence; there is, however, no published archaeological information on these two micro-regions.

From early to late, central Colima's ceramic sequence is as follows: Capacha, Ortices, Comala, Colima, Armería, and El Chanal/Periquillo; in the Mesoamerican chronology, they date to the Early Formative, Late Formative, Early Classic or Classic, Late Classic/Epiclassic, and Postclassic periods, respectively (Table III.1). This sequence, initially a pottery seriation based on stylistic variations, was relatively strengthened decades later by a handful of radiocarbon dates (Kelly 1980:4-5). Archaeological dating in neighbouring areas–Colima's western coast, Lower Coahauyana basin, and southern Jalisco–of stylistically related material culture has supported the general arrangement of this sequence (Beltrán Medina 1991; Meighan 1972; Novella et al. 2002; Valdez 1996; see Long and Taylor 1966).

Table III.1. Chronological table and Colima archaeological phases.

<table>
<tr><th>Mesoamerican chronology</th><th>Central Colima phases (Kelly 1980)</th><th>Western coast phases (Beltrán Medina 1991; Meighan 1972)</th></tr>
<tr><td>Postclassic
1000-1521 CE</td><td>El Chanal/Periquillo</td><td></td></tr>
<tr><td rowspan="2">Epiclassic (Late Classic)
550-1000 CE</td><td>Armería</td><td>Re-occupation</td></tr>
<tr><td>Colima</td><td rowspan="2">Late Morett/Tesoro</td></tr>
<tr><td>Classic (Early Classic)
100-550 CE</td><td>Comala</td></tr>
<tr><td>Late Formative
300 BCE-100 CE</td><td>Ortices</td><td>Early Morett</td></tr>
<tr><td>Middle Formative
900-300 BCE</td><td></td><td></td></tr>
<tr><td>Early Formative
1500-900 BCE</td><td>Capacha</td><td></td></tr>
</table>

Even though Kelly herself considered the ceramic sequence for central Colima that she developed over a span of almost 40 years to be 'in need of revision' and subject to 'some subdivision' with 'further study' (Kelly 1980:3), it was left untouched for almost 30 years (III.2.4).

The western coast has a different ceramic sequence (cf. Jarquín Pacheco and Martínez Vargas 2007). Meighan (1972:Figure 1) identified three phases based on excavations at Morett site: Early Morett (300 BCE-100 CE), Late Morett (150/200-700/750 CE), and Re-occupation (800-1000 CE). The last two are partially contemporaneous to the Colima and Armería phases defined by Kelly for central Colima (Table III.1). The Morett chronology is anchored by 16 radiocarbon dates and 115 obsidian hydration readings (Meighan 1972:12-21). The same ceramic sequence was confirmed through excavations at Playa del Tesoro site, some 25km east of Morett along the coast (Beltrán Medina 1991; Beltrán Medina and González Barajas 2007).

Archaeological research in Colima, as in the rest of West Mexico, still relies heavily on material culture as a static typological indicator of cultural diversity to explain degrees of interaction between fixed regional territories (Beekman 2010:45; Williams 1994:257,60-61; e.g. Olay Barrientos 2004a; Olay Barrientos 2012). Some arguments on trade and migration are still based on decorative similarities (e.g. Beltrán Medina 2005:43-45; Carot 2013:173-74; Oliveros Morales 2007:26-27). Archaeometric studies on western Mexican ceramics from a regional or micro-regional perspective are almost non-existent (Beekman 2010:48-49): the exception is the provenance and technological study of ceramics from La Quemada region of northwest Mexico (Wells and Nelson 2002). This is at odds with the extensive literature on West Mexico's regional 'styles' of pottery (mainly dating from the Late Formative and Classic periods) from an art history perspective (see Hernández Díaz 2013 for the most recent example).

III.2.3. THE END OF THE OLD TRADITION AND THE SURGE OF THE NEW TRADITION: A WEST MEXICAN EPICLASSIC? RUPTURES *VERSUS* CONTINUITIES

Although West Mexico seems to be largely characterised by diverse regional or micro-regional developments integrated in closed interaction spheres (Valdez et al. 1996:171), at certain periods it appears to have been unified over larger areas through a series of long-standing practices and material culture traits, or traditions. Two of these periods are the Classic (100-550 CE) and the Late Classic/Epiclassic (550-1000 CE).

Perhaps West Mexico's cultural tradition par excellence is the so-called Shaft Tomb Tradition, which reached its zenith in Jalisco, Colima, Nayarit, and southern Zacatecas starting in the Classic period, around 100 CE. In addition to the characteristic shaft-and-chamber tombs that give the tradition its name (Fig. III.7), this period is known for the hollow anthropomorphic ceramic figures and, additionally in the case of Colima, anthropomorphic, zoomorphic, and phytomorphic vessels that abound in museums worldwide (Figures III.8 and III.9; Kelly 1980:1,6; see Kan et al. 1970 for a gallery of pictures). The high level of skill, expertise, and labour investment needed for the manufacture of such figures and vessels is considered enough proof of their specialised production (López Mestas Camberos 2005:235-39; Weigand 2007:106,109; Weigand and Beekman 2002:44). Moreover, in Jalisco there is evidence for the specialised production of vessels to specifically serve as mortuary offerings, which show no signs of use and evidence of a different manufacturing technology when compared to the utilitarian vessels buried alongside (Aronson 1996:164-66).

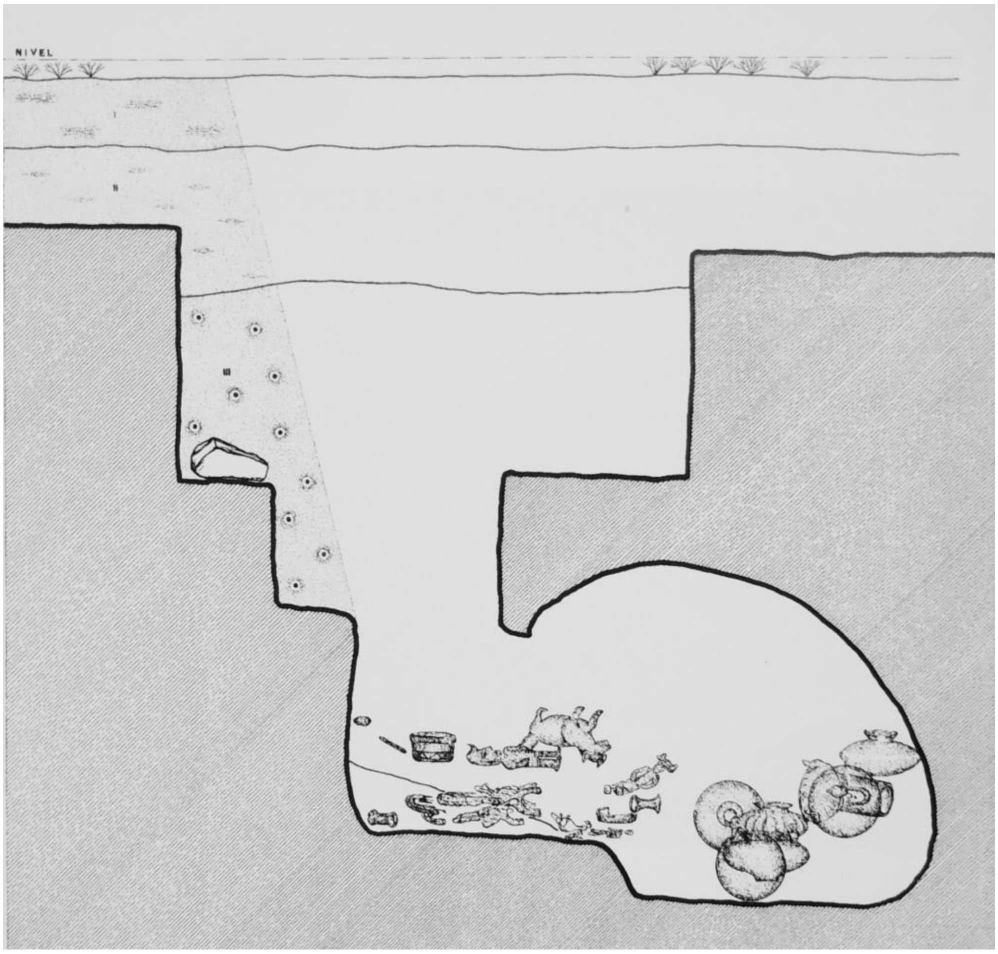

Figure III.7. Profile of one of the Loma Santa Bárbara shaft-and-chamber tombs, Colima Valley (taken from Mountjoy and Olay Barrientos 2005:32).

A widespread monumental architectural pattern known as *guachimontón*, consisting of series of structures surrounding a circular pyramid and a patio (Figure III.10), has been associated with the shaft-and-chamber tombs (Beekman 2008:416; López Mestas Camberos and Ramos de la Vega 2002; Weigand and Beekman 2002:43-50), and thus largely shares the same distribution pattern over a good part of West Mexico (Beekman 2010:61-62,Figure 4). The Teuchitlán region (Tequila Valley) in highland Jalisco is considered the core of this culture, based on the higher occurrence and larger size of the local *guachimontones* compared to those found in other regions of West Mexico (Ohnersorgen and Varien 1996). Beekman (2010:62) argues that the *guachimontón* architectural arrangement 'embodies the multileveled universe of Mesoamerican cosmology' and drew together corporate groups for ceremonies related to the calendar and the agricultural cycle, which took place on the central pyramid (see also Beekman 2008:421,429-30; Weigand and Beekman 2002:42-43,52).

Figure III.8. Hollow anthropomorphic figure and zoomorphic vessels found in the Loma Santa Bárbara shaft tombs, Colima Valley (taken from Mountjoy and Olay Barrientos 2005:32).

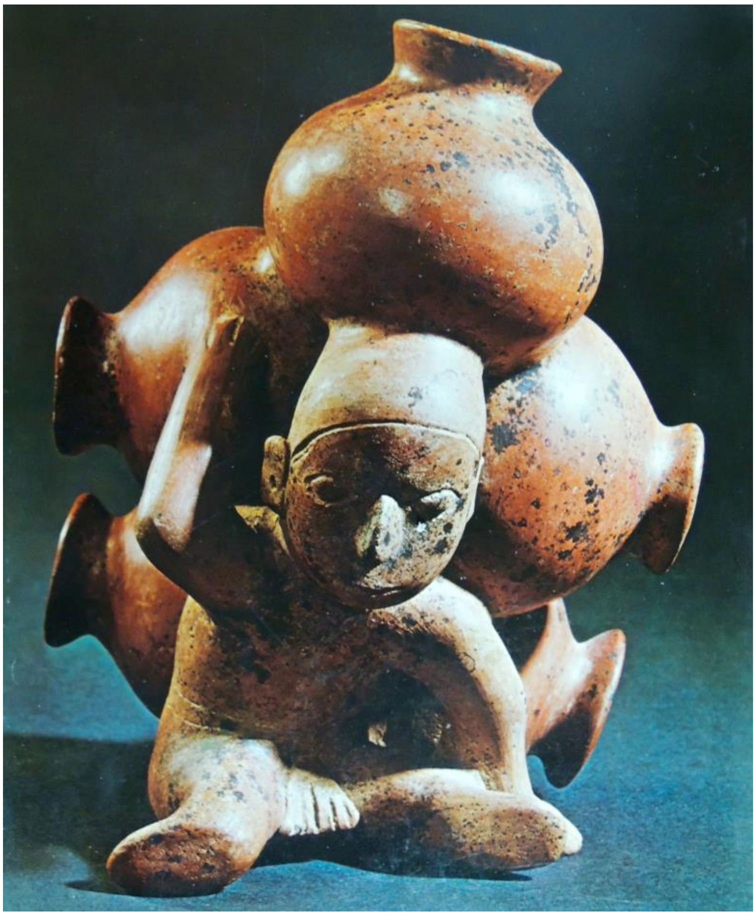

Figure III.9. Pot carrier. Comala phase, Colima (taken from Kan et al. 1970:Cover).

In the central Jalisco highlands, although the use of shaft-and-chamber tombs does not seem to be restricted to the elites, the richest tombs are those directly associated with public architecture such as the *guachimontones* (Beekman 2008:419; 2010:62; Weigand 1996:191; Weigand and Beekman 2002:43-44). This is a pattern that has not been fully tested in Colima and other regions (but see López Mestas Camberos 2007:42-43). By assessing the differential artefact assemblages found in each of the surrounding structures of the circles in Jalisco, Beekman (2008, 2010:62-63) interpreted them as belonging to different elite lineages sharing power within a corporate group, who independently built their respective structures. In turn, he believes that the larger circles, in which the surrounding structures were built using 'disparate methods', point to social alliances of a larger scale (Beekman 2010:63).

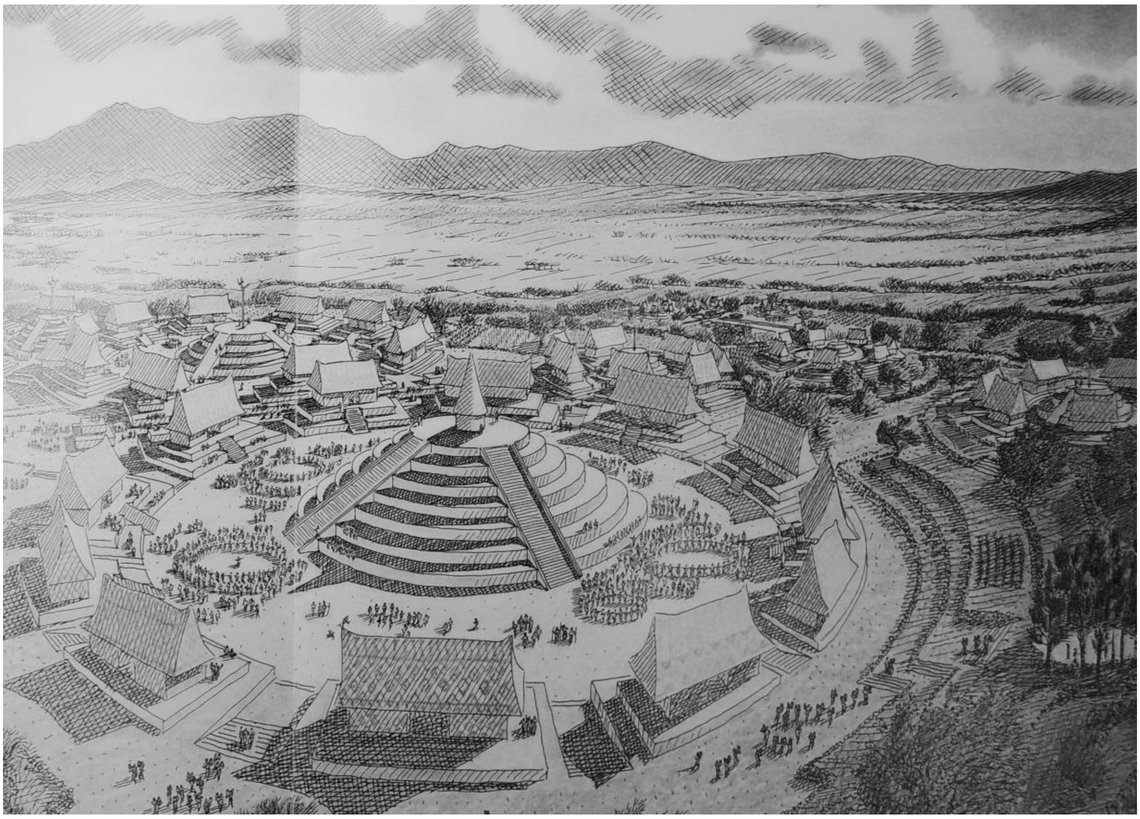
Figure III.10. Reconstructive drawing of a *guachimontón* in Teuchitlán (Tequila Valley), Jalisco (taken from Weigand and Beekman 2002:Figure 22).

Beekman (2010:63-66) argues that the unification of a large area of West Mexico, reflected in the common presence of shaft-and-chamber tombs and symbolically charged *guachimontón*-style architecture, was not centrally imposed by the Tequila Valley polity of central Jalisco; rather, it was adopted by local elites in the midst of power struggles for agricultural rituals.

The end of the Mesoamerican Early Classic period and the start of the Late Classic/Epiclassic period is marked by the abandonment and partial destruction of the city of Teotihuacan in central Mexico, arguably sparked off by internal conflicts (Matos Moctezuma 1994:69; Millon 1993:32-33). Teotihuacan was the largest city that ever existed in pre-Columbian America, with a population that reached 150,000 at its highest point during the Early Classic period (Millon 1993:29). The centre of the city was set on fire and the temples and public buildings along the Street of the Dead were systematically destroyed, in 'a process of ritual destruction and desacralization unprecedented in scope and scale in Mesoamerica' (Millon 1993:33; see Manzanilla 2003). This series of events has been dated to 550 CE (Manzanilla 2003:70-72).

Before coming to be known as the Epiclassic, the period following the fall of Teotihuacan (initially called the Local Cultures Horizon (600-900 CE)) was deemed to be a period of decadence provoked either by internal (i.e. Mesoamerican) factors or by the invasion of the ‘barbarian tribes of the North’ (Vivó 1992 [1935]:27). More recently, the Mesoamerican Epiclassic has been characterised more fairly as a time of intense political, economic, and spatial population reorganisation, population growth, and cultural innovation (Beekman 2010:68-71; Fournier et al. 2006; Liot et al. 2007:166; Manzanilla 2004; Pollard 1997:361-65,370). These events correlate with the start of an intense drought affecting the whole of Mesoamerica between 500-1000 CE, most severely in 600-800 CE (Rodríguez-Ramírez et al. 2015). This drought is considered the most important climatic event of the last 2000 years in Mexico (Rodríguez-Ramírez et al. 2015:1246).

For West Mexico in particular, the general agreement is also that there seems to be a shift in the political, economic, and social structures at this time (Carot 2013:172-73; Weigand 2004), marking a break with the Late Formative- and Early Classic-period Shaft Tomb Tradition (West Mexico’s Old Tradition), and the start of a so-called New Tradition (Hers 2013b; Olay Barrientos 2012:9-14) that lasted until the European contact (Schöndube Baumbach 1994:227-33).

The building of *guachimontón*-style architecture and shaft-and-chamber tombs ceased (Weigand and Beekman 2002:55), and a new set of cultural features emerged across West Mexico, including new models of architecture, settlement planning, burial practices, and so forth (Beekman 2010:70-71; Liot et al. 2007; Pollard 1996; Schöndube Baumbach 1994:230-31). The obsidian reaching places that lack local deposits began to come from more sources (Liot et al. 2007:174), and the sources that had already been used for some time, such as Ucareo, began to be exploited more intensively (Healan 2004:53-54). Salt production in the Sayula basin in southern Jalisco also burgeoned (Valdez et al. 1996:184).

This is the period of the so-called ‘mesoamericanization’ of West Mexico (Schöndube Baumbach 1994:232; see Beekman 1996; Olay Barrientos 2012:9-27). Major centres containing new architectural forms (*plazas*, pyramids with *talud-tablero* style architecture) and Teotihuacan-style artefacts are said to indicate contact with central Mexico and reflect the migration of elites and artisans to the west after the collapse of Teotihuacan (Hers 2013b:215-17; Pollard 1997:362-63). Gómez Chávez (2002) believes that this migration included people of western ancestry, who were returning to the land of their ancestors.

According to Pollard (1997:363), the new pattern in western Mexico is one of 'territorially discrete and competing polities', whose elites were contending over access to inter- and intraregional trade networks. Beekman (2010:71) calls this a process of political 'balcanization' across the whole of Mesoamerica. In contrast, Jiménez Betts (2007:160-61) visualises it as a period of interregional integration resulting in a multicentric world-system of trade that benefited all parties; in this way, the increasing similarity of cultural traits between diverse Mesoamerican areas in this period is explained not by migrations but by rising interregional interaction, of which the trade networks are an expression.

In Colima, Jarquín Pacheco and Martínez Vargas (2007:187-88) see this period as one of social destabilisation and reorganisation, caused by the fall of the big Mesoamerican political, economic, and religious powers; Olay Barrientos (2012:60-61,74-75,104) adds to these changes an economic boom expressed in a demographic rise. Olay Barrientos (2012:75) argues that these changes were locally driven by a secularised elite class that rejected the Old Tradition ideology, based on the absence of representations of deities during this period. The manufacturing of the hollow human effigies (Figure III.9) and anthropomorphic, zoomorphic, and phytomorphic vessels (Figure III.8) that characterised the Comala phase (100-550 CE) came to an end. Other Comala-phase ceramic products such as portrait masks (Kan et al. 1970:92-93,Figures 148 and 150) and models of houses/temples (*maquetas*) were also no longer made. Among the new (simpler and more limited) pottery repertoire appeared mortar bowls for grinding and, later, ring and pedestal bases in bowls (III.2.4). New ceramic products like so-called stools, spindle whorls, and base moulds, emerged sometime during the Epiclassic (Appendix A, A.1. Type Descriptions). The emergence of these products and the aforementioned macroscopic pottery attributes is partially or fully paralleled in other parts of western Mexico, such as south and central Jalisco and southwestern Guanajuato (Acosta et al. 1998:107; Beekman 1996; Liot et al. 2007:169; Migeon and Pereira 2007:204-07; Noyola 1994:56).

Hers (2013a:12) characterises this period as one of a violent rupture with the Old Tradition in West Mexico. However, the evidence in central Colima shows that there were also important continuities and suggests a more gradual change (Salgado Ceballos 2008); central Jalisco may have experienced a similar process (Beekman 1996:257-58; Weigand and Beekman 2002:55). At the site of La Campana (Colima Valley), buildings dating to the Shaft Tomb Tradition were modified but still used (Jarquín Pacheco and Martínez Vargas 2007:188). Moreover, at least in the Salado River basin, a smaller, modified version of the Late Formative and Early Classic-period shaft-and-chamber tomb (known as *cueva de alcatraz* or pelican's cave, see Kelly 1980:8) was constructed and used during the Colima phase. The practice of reusing previously made shaft-and-chamber tombs, evident in their heyday (Kelly 1978:3-6), also remained through the Colima phase and the beginning of the Armería phase in the Salado River basin and the Colima Valley (Deraga and Fernández 1994:29-30; Jarquín Pacheco and Martínez Vargas 2005:40; Kelly 1939-1971:130n,153a,182; Olay Barrientos 1993). This batch of evidence indicates that a complete break with Old Tradition practices may have taken several generations to complete, and that people inhabiting this region during New Tradition times had a long local history.

III.2.4. THE COLIMA AND ARMERÍA CERAMIC PHASES: CERAMIC AND NON-CERAMIC PECULIARITIES

The Colima and Armería ceramic phases were defined more than 70 years ago, as part of the culture-historical sequence proposed for central Colima (Kelly 1944). After Kelly's passing in 1982, both phases remained poorly studied for decades, and even their ceramic components were until recently rather obscure: only a handful of pottery photographs and descriptive lines were ever published (Kelly 1980:8-9). Kelly (1980:8) acknowledged the difficulty of clearly separating the Colima and Armería ceramics, arguing that both ceramic clusters had diagnostic wares but also 'a common denominator'; this scenario was further complicated by regional differences. Yet a micro-regional arrangement of ceramic styles was always recognised for this period (Kelly 1980:8-9; Olay Barrientos 2004a:297).

Studies conducted in the early 2000s by this author offered a reappraisal of the relationship between the two ceramic phases, and confirmed the pottery regionalisation hypothesis (Appendix A). Three assemblages of mostly ceramic materials were isolated on the basis of their recurrent association in burial contexts in the Colima Valley and the Salado River basin; one assemblage was assigned to the Colima phase, 550-750 CE, and the other two to Armería times, 750-1000 CE (Figures III.11 and III.12). The contemporaneity between the two Armería-phase assemblages was secured through their sharing of two pottery types: Borregas Red-on-cream and Pozo Hundido Red-on-brown. By mapping the occurrence of the ceramic types that comprised the two Armería assemblages, it was clear that one of the assemblages, i.e. the North Armería complex, was exclusive to the Colima Valley, while the other, although originally recognised in burial contexts in the Salado River basin, featured pottery types that were more widely distributed among Colima's regions, such as the Armería Cream/Orange (Armería Valley, Tecomán coastal plain, western coast, Lower Coahuayana basin), and Amela Red (Tecomán coastal plain, Lower Coahuayana basin) (Appendix A, A.2. Pottery Distribution Patterns). In addition, the distribution mapping of the Colima-phase assemblage was notoriously concentrated in two areas: the Colima Valley and the Salado River basin. Among the conclusions of this study was that the Colima ceramic phase of the central Colima sequence was in reality only valid for the Colima Valley and the Salado River basin (that is, key components of the recognised Colima-phase assemblage are seldom found elsewhere); moreover, as stated above, an Armería-phase pottery assemblage restricted to the Colima Valley was determined through spatial distribution analysis, indicating the micro-regionalisation of pottery assemblages in Colima for Armería times (Appendix A, A.2. Pottery Distribution Patterns).

The changes in the ceramics that started in this period are considered 'fundamental and marked by diminished skill' (Kelly 1980:8) when compared with the modelled hollow effigies and zoomorphic and phytomorphic vessels that dominated the previous Ortices and Comala phases (Schöndube Baumbach 2005:17-18). There is an apparent reduction of vessel form diversity resulting in a more stable ware repertoire consisting of bowls and jars of 'simple' shapes (Figure III.11), a pattern that continues through the Armería phase (Figure III.12; for a full description of pottery types, see Appendix A, A.1. Type Descriptions). The great majority of the bowls are mortar bowls for grinding (known as *molcajetes* in Mexico), which were produced for the first time in this period (Kelly 1980:8).

Figure III.11. Colima-phase pottery (from Salgado Ceballos 2008).

Figure III.12. Examples of components of the North Armería complex assemblage (from Salgado Ceballos 2008).

Among other ceramic products, spindle-whorls (*malacates*) were first made in Colima during this time period; they are associated with the production of spun fibre (Beltrán Medina and González Barajas 2007:167). The distribution of solid clay figurines (modelled and mould-made) is largely restricted to the

Lower Armería basin and the western coast; they are scarcely found in the Colima Valley and the Salado River basin (Baus Reed Czitrom 1978; Beltrán Medina 1991; Beltrán Medina and González Barajas 2007; Kelly 1980:9). So-called *tapaderas* (Figure III.13) were also manufactured; in this period, they are tetrapod covers of animal shape, believed to have been used over burning stones or incense, as indicated by their blackened interior (Kelly 1947a:69, 1980:8).

Figure III.13. *Tapadera* of the Colima and Armería phases (from Salgado Ceballos 2008).

Although direct evidence of pottery production has not yet been recovered, it is possible to assume that at the time of the Colima and Armería phases the production of pots was also done by specialists (as in the previous phases), as indicated by a limited range of well-defined pottery types in each of Colima's geographical micro-regions, and the widespread distribution of some of these types (Appendix A).

Diagnostic non-ceramic artefacts of this period include anthropomorphic and zoomorphic stone sculptures and bifacial obsidian knifes (Figure III.12; Hernández Olvera et al. 2012:36; Kelly 1980:9; Salgado Ceballos 2007:Chapter IV) although the distribution of the stone sculptures seems to be restricted to the Colima Valley and the Salado River basin. There are no obsidian sources in Colima. As mentioned in III.2.3, obsidian exploitation in West Mexico seems to have experienced a boom in this period (Healan 2004:53-54); judging by the presence of bifacial obsidian knifes as burial offerings during this period, access to obsidian artefacts seems to have increased in relation to the previous phases, for which obsidian artefacts are rare (Olay Barrientos 2012:72). However, obsidian is nowhere near as popular as it would be in the Postclassic, when the presence of prismatic cores and flaking debitage are reported (Olay Barrientos 2004b:237-41,526). Although Hosler (2009:186) argues that South American metalworking knowledge was introduced to Mesoamerica through western Mexico, and dates the presence of artefacts in the west Mexican coast as early as 650-700 CE, in Colima no metal artefacts or any evidence of metalworking have been found for this period (550-1000 CE) (cf. Olay Barrientos 2012:258).

Non-artefact related archaeological data from this period remains scarce, and most available information is scattered through volumes of unpublished reports produced by salvage and rescue archaeological excavation projects, as is the case for the rest of western Mexico (Pollard 1997:353).

Schöndube Baumbach (1994:227) argues that the settlement pattern in Colima always conformed to a pattern of villages. Since houses were predominantly built with perishable materials (i.e. adobes or wattle and daub), only the alignments of stones used as house foundations are usually found in the archaeological record (Schöndube Baumbach 1994:227). A fair number of dwelling remains dating to the Colima and Armería phases have been recently excavated in the Colima Valley. Cabrera Cabello (2007) excavated a well-preserved Armería-phase quadrangular dwelling (15 x 15m) at the Rancho Blanco site, with parts of the mortared-stone walls still intact; he excavated 15 human burials and one dog interment directly beneath the house. Some of the houses found elsewhere in the Colima Valley feature stone hearths or kilns of a yet unidentified purpose located next to the house foundations; based on ethnographic analogies, Zizumbo-Villareal et al. (2009) argue that they could have been used to cook and prepare agave for food and alcoholic beverages.

Kelly states that the first evidence in Colima for the construction of *plazas* (i.e. squares) delimited by low artificial mounds belongs to the Colima phase (Kelly 1980:8). This is a typical and long-standing Mesoamerican architectural arrangement absent in Colima and large parts of western Mexico before 550 CE. According to Kelly (1939-1971:159,165, 1980:9), the first evidence of major engineering work belongs to the Armería phase; for the Armería Valley and the

Tecomán region, she documented several sites with *plazas*, located on carved and flattened hill slopes. This indicates a considerable mobilisation of labour. The largest excavated site of this period is La Campana, in the Colima Valley. It features broad civic-ceremonial *plazas* delimited by basements or mounds built up with earth and pebble stones (Figure III.14). Similar sites in the Colima Valley that were documented by Kelly (1939-1971:76a) in the early 70s, some with mounds of up to 5m in height (e.g. Los Limones), are now destroyed.

Figure III.14. Square *plaza* and structures at La Campana site, Colima Valley (from Jarquín Pacheco and Martínez Vargas 2005:39).

Different statuses of burials and disparities in site sizes during this period are said to indicate chiefdom-like hierarchical societies, featuring political centres with organising roles over groups of villages (Olay Barrientos 2012:58-61,162-63), at least at the micro-regional level (i.e. micro-regional rulership).

Excavations conducted at the western coastal site of Playa del Tesoro documented evidence of skull trepanation, fronto-occipital artificial cranial deformation (which has a long history in West Mexico, see David et al. 2007:94,Figure 4; Oliveros Morales 2007:33,Figure 2), and dental mutilation in human remains; moreover, some of the bone remains were covered with hematite and limonite powders (Beltrán Medina and González Barajas 2007:165). Another traditional West Mexican practice, burying dogs along human interments, is also reported for this period at Playa del Tesoro (Beltrán Medina and González Barajas 2007:165; see Valadez et al. 2007:233).

Figure III.15. Alignment of stones and adobe blocks in an Armería-phase burial, Seal-Centenario site, Colima Valley (from Alcántara Salinas 2016:17).

As mentioned in III.2.3, in central Colima there is evidence for Colima- and Armería-phase interments inside Old Tradition shaft-and-chamber tombs (i.e. reused burial facilities) (Deraga and Fernández 1994:29-30; Jarquín Pacheco and Martínez Vargas 2005:40; Kelly 1939-1971:130n,149,153a,182; Olay Barrientos 1993). In the Salado River basin there is also evidence for the making, during the Colima phase, of smaller tombs known as ‘pelican’s caves’ (Kelly 1939-1971:339; 1980:8). Also characteristic of the Salado River basin are extended, flexed, and seated burials, sometimes underneath limestone slabs, found in ash deposits known as *ceniceros* (Kelly 1939-1971:169,177-78,263-82,319-30,369,391, 1980:8; see VII.3 of this thesis). In the Colima Valley, interments were usually direct, extended burials, often delimited to one side by an alignment of medium-sized stones and/or adobe blocks (Figure III.15) or completely covered by the same materials (Figure III.16). Some others are found in low stone cists (Berdeja Martínez 1999:151-71, 2000:73-74), and an extraordinary burial inside an adobe cist has recently been excavated (Figure III.17).

Figure III.16. Stones and adobe blocks covering an Armería-phase burial,
El Tropel site, Colima Valley.


Figure III.17. Adobe cist burial, Armería phase,
Real Centenario II site, Colima Valley (from Alcántara Salinas 2016:14).

There is also evidence of long-distance trade. Obsidian samples from this period have not been sourced, but the closest possible sources are some 200km north of the Colima Valley, in the Jalisco highlands. Another proof of the integration of Colima into large interregional trade networks is the presence of small turquoise ornaments deposited in a couple of Armería-phase burials excavated at Las Guásimas #1 site, in the Salado River basin (Kelly 1939-1971:263-71,277-82). It is argued that the distribution route of turquoise during this period was through the Western Sierra Madre; turquoise sources are located in the northern extreme of Mexico and particularly in the American Southwest, 1500-2000km north of Colima (Hull et al. 2008; Weigand et al. 1977).

III.2.5. SITE CHARACTERISTICS

This section contains descriptions of the archaeological sites where the pottery samples studied in this research were collected, with consideration of the types of archaeological contexts from which the pottery was recovered. In most cases, instead of well-defined archaeological sites, these samples were recovered during salvage and rescue archaeological projects executed in delimited suburban areas where construction work was about to take place.

Primavera. This site is located on the northeastern outskirts of Colima city in the Colima Valley. It was excavated by three rescue archaeological projects in 2003-2004, 2005, and 2006. The second of these archaeological interventions was forced by the discovery of several archaeological features during the construction of a commercial mall. The materials recovered in this area (ca. 25ha) range from the Early Formative to the Postclassic periods. The following data was obtained from the report of the second excavation on the site (Alcántara Salinas 2006).

In Excavation Unit 1, the foundations of two domestic units were found on top of a natural but artificially modified hill, from which potsherds and broken polished stone tools were recovered. The quadrangular domestic units (8 x 5m and 9 x 2.5m, respectively) were delimited by alignments of medium-size flat-faced andesite rocks; at least one of the units had a single-step entrance (Alcántara Salinas 2006:26-37). One of the dwellings was divided into two rooms, separated by a foundational stone alignment (Alcántara Salinas 2006:32).

In Excavation Unit 2, two funerary spaces were found. In one of them an Armería-phase burial was excavated: the extended body was deposited in an elongated pit carved into the *tepetate*, a hardened underlying volcanic deposit; the pit was covered with large-sized stones, which rested on both sides of the pit and formed a small chamber (Alcántara Salinas 2006:47-50). A 20 x 16m multiple-room domestic complex on top of a hill was found in Excavation Unit 5, and presumably dates to the Postclassic period; it features a drainage channel originating from a circular structure, stair entrances, and hearths (Alcántara Salinas 2006:96-164). Most of the ceramic material from the Colima and Armería phases was obtained from the fill in this architectural complex (Alcántara Salinas 2006:192-246).

Parcela 82, El Diezmo. This site is located on the eastern outskirts of Colima city in the Colima Valley. A salvage archaeological project was conducted in 2010, due to the construction of a housing development in an area already known to be rich in archaeological features. At the time of excavation, this area (8ha) was a sugarcane farm whose surface presented a NE-SW slope and four low hills. Around 150 test pits were excavated and two funerary areas were found in two of the hills. The burial area to the south was found to be looted of archaeological objects, and only disturbed human bones were registered; potsherds in this area belong to the Ortices and Comala phases (Ligia Sofía Sánchez Morton, personal communication, 2017). An extensive excavation (30 x 20m) of the funerary area to the north yielded 41 burials attributed to the Armería phase; a couple of them featured, along with Armería-phase pottery, pots and clay figurines of the Ortices and Comala phases used as offerings. This is therefore interpreted as an Ortices/Comala funerary area reused in Armería times (Ligia Sofía Sánchez Morton, personal communication, 2017). Armería-phase burials are extended interments deposited in shallow and elongated pits carved into the underlying *tepetate* (volcanic deposit). Pottery types from the Armería phase found as burial offerings include Borregas Red-on-cream jars, bowls of the Pozo Hundido Incised, Bugambilias Red-on-orange, Pozo Hundido Red-on-brown, Libramiento Red Rim, and Libramiento Pedestal-based types, and an Armería Cream cup.

Nuevo Milenio. This site is located on the southeastern outskirts of Colima city in the Colima Valley. The area of the site was badly altered by urban construction work (the Nuevo Milenio III housing estate) right before the archaeological excavation in 2007. The rescue archaeological work was focused on the least disturbed zone (north) of the construction site, which had shattered potsherds dating to the Armería and Chanal phases covering its surface (Leiva García 2007). Several architectural features partially destroyed by the construction of a street were excavated, including a 30m long structural stone alignment (Leiva García 2007). Up to 17 human burials were excavated in Excavation Unit 3, 14 of which correspond to either the Colima or Armería phase. A Colima-phase infant internment was found underneath a concentration of stones in an elongated pit carved into the *tepetate*; it had several specimens of Colima Incised bowls as burial furniture (Leiva García and Galicia Flores 2015). Armería-phase internments feature individuals deposited in a seated position in circular pits carved into the hardened underlying volcanic deposit layer. Burial 15 had a red obsidian knife and several types of bowls (including some of the Pozo Hundido Incised type) as offerings. Burial 9 was found with more than 200 greenstone beads, several bowls, and a jar (Leiva García and Galicia Flores 2015).

El Tívoli. This site is located on the southern outskirts of Colima city in the Colima Valley. Salvage archaeology work in an area of more than 60ha of farming land, consisting mainly of grasslands, was forced by the construction of a housing estate. More than 350 test pits were done and three excavation units were opened. The excavation works were divided into five stages and areas. During the third excavation stage, three stone alignments corresponding to a single quadrangular dwelling were discovered in Excavation Unit 1 (Galicia Flores and Olay Barrientos 2011:37-41). Broken ceramic and stone artefacts were recovered from this zone, including the five potsherds from this site that are analysed in this research. More structural stone alignments were discovered during the fourth excavation stage in Excavation Unit 2 (Galicia Flores and Olay Barrientos 2011:52-62).

Higueras del Espinal. This site is located in the western limits of the Colima-Villa de Álvarez metropolitan area in the Colima Valley. It is a relatively flat piece of land, with a gentle N-S slope and a few low hills. It was on the higher (2.5m) of these elevations that archaeological features were discovered through salvage archaeological work in 2007, among them stone-and-mortar walls, small adobe-walled rooms (ca. 25 x 70cm), patios, and a drainage channel made of stone (Galicia Flores 2014). The main architectural space measures 34 x 5m, has an E-W orientation, and a stair entrance facing south; it also shows several architectural extensions. Ceramic and stone artefacts from the Colima and Armería phases, including red-on-cream jars, were found directly associated with this architectural complex (Galicia Flores 2014).

Tabachines. This site is located in the southwestern limits of the Colima-Villa de Álvarez metropolitan area in the Colima Valley. This piece of land was flattened for agricultural purposes, such as the cultivation of orange trees, before the start of any archaeological work. Three funerary areas were excavated during the TAB-AL salvage archaeological project, which was forced by the imminent construction of a housing estate. Surface concentrations of potsherds led to the discovery of structural stone alignments and two funerary areas. Both cemeteries were used through long periods of time, and feature internments dating from the Late Formative to the Postclassic periods (Andrés Saúl Alcántara Salinas, personal communication, 2017). The majority of Colima- and Armería-phase burials are extended burials in elongated pits carved into the *tepetate*; one had an alignment of adobe blocks to one side. Concentrations of small-sized stones in circle patterns were also found associated with the burial areas (Andrés Saúl Alcántara Salinas, personal communication, 2017).

Rancho Blanco. This site is located on the southwestern limits of the Colima-Villa de Álvarez metropolitan area, next to the Tabachines site, in the Colima Valley. A 9ha field was archaeologically explored in 2007, before the construction of a housing estate. The work focused on the excavation of a 15 x 15m Armería-phase quadrangular dwelling, featuring one of the best-preserved examples of ancient adobe and stone-and-mortar architecture discovered in the Colima Valley. The dwelling had a central patio, a hearth, and a rubbish dump;

more than 14,000 potsherds were recovered during its excavation (Cabrera Cabello 2007:71-79). Up to 18 interments associated with this dwelling were excavated (including one dog burial), the majority of which were found directly beneath the house (Cabrera Cabello 2007:74). Human burials were extended, flexed, and seated; extended and flexed burials sometimes featured alignments of stones or abode blocks (Cabrera Cabello 2007:70). Nearly all of the ceramics found as burial furniture were bowls of the Pozo Hundido Red-on-brown type (Cabrera Cabello 2007:92-93).

Real Centenario. This site is located on the west side of the Colima-Villa de Álvarez metropolitan area in the Colima Valley. This piece of land was already flattened for construction by the time rescue archaeological work took place. Isolated burials and one funerary area with Postclassic seated burials were found through test pitting (Andrés Sául Alcántara Salinas, personal communication, 2017). Aligned adobe blocks, presumably dating to the Armería phase, were found without a clear association with any other archaeological features (Andrés Sául Alcántara Salinas, personal communication, 2017).

Tapatía. This site is located on the southwest side of the Colima-Villa de Álvarez metropolitan area in the Colima Valley. Test pits in the low hills of the terrain uncovered several burials from the Comala and Armería phases. The Armería-phase interments were extended or seated; some crania show intentional deformation (Andrés Sául Alcántara Salinas, personal communication, 2017). Burial 1 was an extended burial with some aligned adobe blocks to one side and a Borregas Red-on-cream jar as furniture; Burial 10 was also next to aligned adobe blocks and had red-on-cream jars as burial furniture, but was found underneath a row of stones; Burial 12 had a Libramiento Ring-based Mortar type bowl as an offering and the cranium shows deformation; Burial 17 had a low pebble wall inside the pit carved into the *tepetate*, besides the alignment of adobe blocks; Burial 26 was a seated burial with a stone alignment to one side and Bugambilias Red-on-orange bowls and a Borregas Red-on-cream jar as offerings (Andrés Sául Alcántara Salinas, personal communication, 2017).

Cajita del Agua. This site is located on the north side of the Colima-Villa de Álvarez metropolitan area in the Colima Valley. Salvage archaeological work, done before the construction of a commercial mall, discovered alignments of stones used as part of a quadrangular platform foundation (ca. 25 x 7m) and three drainage channels, one of which crosses the platform transversely; this architectural complex presumably dates to the Armería phase (Olay Barrientos 2012:186-92). In deeper layers Colima-phase burials (some seated, some with Colima Red-on-cream vessels as burial furniture) and a Comala-phase rubbish dump were found (Andrés Saúl Alcántara Salinas, personal communication, 2017).

Lagunas. This site is located on the northern limits of the Colima-Villa de Álvarez metropolitan area in the Colima Valley. A relatively large hill was flattened by construction work before rescue archaeological work started. Most of the visible archaeological features, including stone alignments, were concentrated in this zone (Andrés Saúl Alcántara Salinas, personal communication, 2017). An extensive excavation of this zone uncovered a Chanal-phase platform structure. Two small circular depressions (ca. 1m in diameter) lined with stones were also excavated; their function is unknown, but perhaps they were used as hearths or kilns (Andrés Saúl Alcántara Salinas, personal communication, 2017).

Tecnológico/La Campana. This site is located on the northern limits of the Colima-Villa de Álvarez metropolitan area in the Colima Valley. La Campana is considered a regional economic, political, and religious centre from the Late Formative up to the Late Classic/Epiclassic, inclusive; it was reoccupied during the Postclassic period (Jarquín Pacheco and Martínez Vargas 2005:38). What is considered to be the site's administrative and ceremonial centre has been excavated for several field seasons, since the 1990s. The site's centre is an architectural complex of superimposed quadrangular platforms that served as the base for quadrangular rooms built with perishable materials. The quadrangular platforms, made with earth and pebbles, were built to delimit interior *plazas* that sometimes feature central platforms for ceremonial purposes (Jarquín Pacheco and Martínez Vargas 2005:39). The five potsherds from this site that are analysed in this research were recovered through test pits done at a neighbouring institute of technology; thus, they were recovered from outside the site's administrative and ceremonial centre (Andrés Saúl Alcántara Salinas, personal communication, 2017).

Las Ánimas. This site is located 2.5km to the south of the town of Los Ortices in the Salado River basin. The site lies over a hill of ca. 30m of height overlooking a relatively flat area to the west, and a ravine leading down to the Salado River to the east (Olay Barrientos 2012:33). The gentle eastern slope of the hill shows several partially artificial terraces defined by stone alignments; it is in these terraces that over 100 looted chamber tombs are located (Olay Barrientos 2012:34). The finding and partial looting of five tombs by the locals in the late 1980s motivated salvage archaeological work in this area. One unlooted tomb with Colima-phase material, three test pits, and one terrace with a stair access were excavated (Olay Barrientos 2012:35-38). Almost all of the ceramic material from this site that is analysed in this research was found in the test pits or collected from the surface.

Zanja Prieta. This site is located in the Tecomán coastal plain, around 4km inland from the Pacific Ocean. An archaeological surface inspection of the site (6ha) recorded five structures less than 5m tall and grouped over two hills, house terraces, and concentrations of potsherds and broken stone tools (Andrés Saúl Alcántara Salinas, personal communication, 2017). Excavation work focused on a multiple burial exposed by construction work. The burial furniture is from the Armería phase. The potsherds from this site that are analysed in this research were recovered during excavation of the burial and are likely associated with it (Andrés Saúl Alcántara Salinas, personal communication, 2017).

Terminal Marítima. The site is located on the wide sandbar that separates the Cuyutlán lagoon from the Pacific Ocean on the western coast. The site was excavated in two different seasons before a liquefied natural gas terminal was built in the area (111ha). A good part of the pottery recovered was plain domestic ware, but no domestic architectural features were found; however, the existence of an ancient semi-dispersed settlement on the site was proposed by the first season excavation team (Olay Barrientos et al. 2008:43). Two funerary areas were excavated, both on slightly elevated areas higher than the flood level, at least one presumably artificial (Chávez Torres and Moguel Cos 2009:46-47), and both featuring Armería-phase burials, among others. The second funerary area seems to be associated with a large elongated platform and a mound (Chávez Torres and Moguel Cos 2009:46). Some red-on-cream vessels, incense burners known locally as *piñas*, clay figurines, spindle whorls, and obsidian knifes and projectile points were found among the burial offerings in the Armería-phase internments (Chávez Torres and Moguel Cos 2009:23-31,147-49; Olay Barrientos et al. 2008:28-29,40). It is possible that some of the bodies were originally placed in shrouds (Chávez Torres and Moguel Cos 2009:30). Some human bone remains show artificial cranial deformation and incrusted dental decoration (Chávez Torres and Moguel Cos 2009:24-26). Stone concentrations in circular patterns, featuring ceramic and lithic fragments, were found associated with some funerary contexts (Olay Barrientos et al. 2008:40-43).

El Volantín. The site is located on a low natural hill on the wide sandbar that separates the Cuyutlán lagoon from the Pacific Ocean on the western coast. This area has been severely altered by agricultural activity. During a surface reconnaissance of the site no architectural features were found, despite the large concentrations of archaeological material (Olivares Orozco and Galicia Flores 2010). The ceramic material collected from the surface dates from the Colima and Armería phases, and includes the potsherds analysed in this research. Colima Shadow-striped and red-on-cream vessels, Armería Cream cups, and monochrome ware vessels and bowls, are among the pottery types found in the collected material (Olivares Orozco and Galicia Flores 2010).

Besides its location in the middle of the Colima Valley, some 10km north of Colima City, no other information about the Chiapa site was able to be obtained.

III.3.HISTORICAL SETTING

This section serves as an introduction to the debate about the political subdivision of Colima in historical times. The debate is based on the earliest known written references to this area, dating to the time of Spanish Conquest.

Carl Sauer (1948:1) argues that the Spanish Conquest of Colima was an integral part of the design of New Spain as imagined by Hernán Cortés. Soon after the conquest of the Aztec capital (Tenochtitlan, now Mexico City) and (by extension) its subordinate territories to the south in the summer of 1521, the attention of the Spanish conqueror focussed on the western portion of today's Mexico; Colima was an important region in the search for mineral wealth, and as a base for the exploration of the unknown North and sea voyages to southeastern Asia (Sauer 1948:1).

According to Sauer (1948:5), the first historical reference to Colima is given by Cortés in the third of his two-yearly letters to Emperor Charles V, dated 15 May 1522. Cortés (2005:206) wrote (translation from Sauer 1948:5):

> 'Since I had recently had some notice of the South Sea [Pacific Ocean], I inquired also of them [Tarascan messengers sent by the head of the Tarascan state to meet Cortés] if one could go by way of their country [Michoacán]; and they answered 'yes,' but that to reach the sea it was necessary to go through the land of a great lord with whom they were at war, and that for this reason they could not at that time get to the sea.'

Later on in the same letter, Cortés (2005:209; my own translation) adds:

> '...two Spaniards returned from the province of Michoacán, through which the messengers sent by the lord from there [Michoacán] had told me the South Sea could also be reached, save for the fact that it had to be through the land of a lord who was their enemy...'

Sauer (1948:5) argues that the above statements can only refer to Colima, 'which was independent from Michoacán [Tarascan state] and the only coastal group of any military importance other than Aztecan Zacatula.'

An explicit reference to Colima, related to the episodes mentioned above, appears in the *Relación de Michoacán*, written down in 1540 by Jerónimo de Alcalá (2010). In it, it is said (de Alcalá 2010:249; my own translation):

‘There came, thus, other four Spaniards and they stayed two days at the [Michoacán] city and they asked the Cazonçi [Tarascan Emperor] for twenty chiefs and a lot of people and he agreed. And they left with the people to Colima and reached a town named Háczquaran, and remained there and sent the chiefs ahead for the Colima lords to come in peace to where the Spaniards were. And they [the chiefs] were all sacrificed there, and none came back, and the Spaniards unconvinced about their coming and of waiting for the messengers, returned to the city of Michoacán for two days and went back to Mexico [City].’

Sauer (1948:6) dates this failed expedition to the spring of 1522. Two more early mentions of Colima appear in Cortés’ fourth letter to Charles V, dated 15 October 1524, referring to an unplanned, failed first entry, and the Spanish subjugation of Colima, respectively. Cortés (2005:223) writes (translation from Sauer 1948:9):

‘And this captain [either Rodríguez de Villafuerte or Juan Álvarez Chico] and company going toward the said town of Zacatula, they had notice of a province called Colimán, which lies apart from the road they were to travel, toward the right hand, which is to the west, a matter of fifty leagues [ca. 280 km]; and with the party that was with him, together with many allies from the province of Michoacán [surrendered by then], he went thither without my permission and entered a matter of several days’ marches, where they had some brushes with the natives; and although there were forty horsemen and more than a hundred foot soldiers, archers, and shield carriers, they were beaten and driven out, three Spaniards and many allies being killed.’

Sauer (1948:11) dates this first entry to early 1523. Months later, Cortés (2005:231-32) sends another captain; he writes about this entrance in the following passage (translation from Sauer 1948:10):

‘...with the men whom he [Gonzalo de Sandoval] was leading, and with whatever additional force he could take from Zacatula, he should proceed to the province of Colimán, where, as I said in a previous passage, the natives had defeated a captain and soldiers proceeding from Michoacán toward the said town, and that he should attempt to secure this province by peace, and if not thus, that he should gain it by conquest. And so he went, and of the men whom he led and of those he levied there [in Zacatula], he assembled fifty horsemen and a hundred and fifty foot soldiers, and went on to the said province [of Colima], which lies from the town of Zacatula along the coast of the South Sea, a distance of sixty leagues [ca. 335 km]... At the place where the other captain had been defeated, he found many men-at-arms who were awaiting him, thinking they could do with him as they had done with the other, and so they opened the fight. It pleased our Lord that victory was ours, without the death of a single person, though many and also the horses were wounded. The enemy paid well for the damage they had done, and so great was the chastisement that without more fighting the whole land submitted, and not only that province, but also many others near by came to offer themselves as vassals of your august majesty. These were Alima, Colimotl, and Cihuatlán.'

As can be gathered from these accounts, written at the time of the Spanish conquest of these territories, or very shortly after, there is mention of a Province of Colima or Colimán under the rule of a single lord or several lords, and at the same time of a handful of provinces (i.e. Alima, Colimotl, Cihuatlán, and the one where the battle took place, identified as Tecomán; see Lebrón de Quiñones 1952 [1551-1554]:14) that, along a few others, came to constitute the New Spanish Province of Colima.

Information on the early 16th-century political subdivision of the New Spanish Province of Colima is found in Lebrón de Quiñones' (1952 [1551-1554]) extensive account of his visit, made 30 years after the events described above. In April 1550, the King of Spain instructed Lorenzo Lebrón de Quiñones, Oidor Alcalde Mayor of the New Kingdom of Nueva Galicia, to visit the Province of Colima. Lebrón's visit began a year and a half later, in October 1551; it took almost two and a half years to complete, ending in February 1554 (Lebrón de Quiñones 1952:7-8). By then, the Province of Colima was part of New Spain and far larger in area than either the current state of the same name or the Province of Colima encountered by the Spaniards (Sauer 1948:24-26). The reason behind this visit, interesting though it may be, is not relevant to the present study. What matters is that Lebrón de Quiñones (1952:9-10,17-22) listed 161 towns of Colima proper in geographical sequence (i.e. as he was inspecting them). Many of the *pueblos* (towns) listed by Lebrón de Quiñones were put on a map by Sauer (1948:36-37,Map 3; Figure III.18); this was done based on Lebrón's list and on the revision of the grants conceded to the first Spanish settlers in the 1520s as noted down by Lebrón (1952:30-55), which provided place determinations and the particular 'minor' provinces to which they belonged. Sauer (1948:45) states that 'there is no possibility of making, from the record, a sharp delineation among [the minor provinces]. Probably there never was a sharp distinction.'

Three of the minor provinces that constituted the early New Spanish Province of Colima are especially relevant here since they cover the research area of this study; these are the Provincia del Colimotl, the Valle de Tecomán, and the Provincia de Tepetitango (Lebrón de Quiñones 1952:10). Together they comprised almost the totality of present-day Colima state. The Provincia del Colimotl corresponds to the municipalities of Colima, Comala, Cuauhtémoc, and the eastern portions of Villa de Álvarez and Coquimatlán (Sauer 1948:45); geographically, it corresponds to the Colima Valley and the Higher and Middle Salado River basin. According to Sauer (1948:45), Colimotl was the name of the head of the most powerful native 'state' in this area. The Valle de Tecomán corresponds roughly to the municipality of Tecomán (Sauer 1948:45), and geographically to the Tecomán coastal plain. The Province of Tepetitango comprised a series of towns situated over a large area on the west side of the Armería River (Río Grande de Colima in Figure III.18), extending to the mountain border of Jalisco (Sauer 1948:52). It corresponds geographically to the western mountainous region and the eastern half of the western coast.

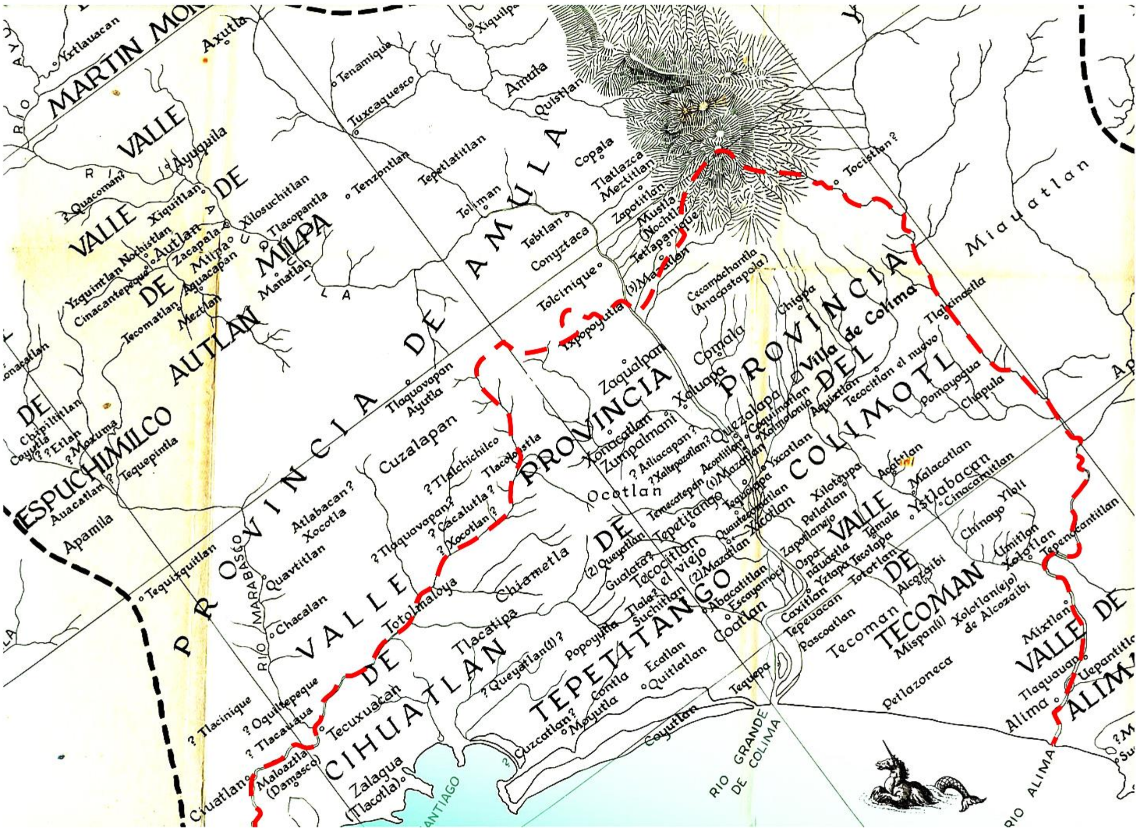

Figure III.18. Provinces and *pueblos* of 16th-century Colima as mapped by Carl Sauer.
The dotted red line marks the current limits of Colima state (modified from Sauer 1948:Map 3).

Based on the number of Spaniards that received grants of native settlements and native males of working age, Sauer (1948:59) gives a 'conservative' (in his own words) estimate of 140,000 for the population of these territories at the time of the conquest. By the time of Lebrón de Quiñones' visit, 30 years later, the native population had been reduced dramatically. For example, Lebrón de Quiñones (1952:12) states (translation from Sauer 1948:60): 'In the Valley of Ticoman [Tecomán] there were four or five thousand men [at the time of the first Spanish settlement] and now there were listed one hundred and eight.'

Based on his study of Lebrón's account, Sauer (1948:64) concludes:

'The area of Colima proper does not seem to have been unified politically in Indian [prehispanic] days. The central part was designated as the Provincia del Colimotl, named after a chieftain, and it seems to have been a political unit of some importance. That the Valle de Tecomán represented a separate unit is indicated in particular by the statement of Lebrón that it alone offered resistance to the Spaniards. The land to the west of the Colima [Armería] River was referred to as the Provincia de Tepetitango, and the two border valleys of Alima and Cihuatlán (whence originated the story of the Amazons as brought by Sandoval to Cortés) were also identified as distinct provinces,– political groupings of population.'

Sauer does not provide any information on why he believes that Colimotl was the name of a chieftain (Sevilla del Río 1973:120-21). The facts that Colima or Colimán was referred to in historical accounts as a single province, and that, at the same time, there were references to several provinces in the same territory, have sparked discussion among historians in relation to the political organisation of this area. There is general agreement with Sauer in assuming that the 'minor provinces' were not invented by the Spaniards and thus represent native political units (Brand 1960; Reyes Garza 1995:43; 2000:20-21; Sevilla del Río 1973:41-44). But then what was the Province of Colima or Colimán? Reyes Garza (1995:43-44) tried to resolve the problem by raising the possibility that Colimotl, Tepetitango, Tecomán, etc., were independent chiefdoms that could have worked together as an alliance against the Tarascan state (from whom they remained independent), arguing that this would explain the reference to a 'land of a great lord' given to Cortés (2005:206) by the Tarascans. Reyes Garza (2000:54-55) further argues that is very suspicious that all the remaining minor provinces surrendered after the defeat of Tecomán, believing that this fact may indicate that the defeated army was made up of warriors from all the chiefdoms (i.e. a Greater Colima army). Reyes Garza

(2000:55) thinks that if the divisions based on Lebrón (1952) are correct, it is not probable that the references to Colima were directed solely to the Provincia del Colimotl, since this province did not have any access to the sea (a fact early stated by Cortés in reference to Colima or Colimán). Sevilla del Río (1973:42-42), in contrast, believed that Colimán was always a reference to Tecomán.

Archaeologists have been less involved in this debate and seldom refer to these issues. Schöndube Baumbach (2005:19) seems to follow Sauer's interpretation, writing that, at the time of the arrival of the Spaniards, Colima was not unified under a single political leadership but divided into chiefdoms under different political centres and rulers. This research represents the first archaeological exploration of this matter.

CHAPTER IV. SAMPLES AND SAMPLING STRATEGY

A variety of pottery types and assemblages were in use in the research area during the Colima and Armería phases (550-1000 CE) (Appendix A). Since these pottery types have previously been defined based on their shape and decorations, there is a need to improve their categorisation by identifying pottery compositional groups. The characterisation of compositional groups and identification of sources allow true insight into the technological variability of pottery production in this period, and how this variability relates to the different geographical micro-regions and regional polities in the study area. This data will permit the discussion of how political strategies at the regional and micro-regional levels may have affected the technology, production, and circulation of pottery.

A set of 215 potsherds covering the Colima and Armería phases (550-1000 CE) was used for the present study. The pottery samples were selected from collections of excavated material that are in the possession of archaeologists working at the Colima Centre of the National Institute for Anthropology and History (INAH) of Mexico. The full list of the samples, along with a breakdown of the archaeologists in charge of each collection/project sampled, is provided in Appendix B. Fourteen samples of raw clay from 12 clay deposits in and around the research area were also selected for analysis, in hopes of identifying the clay sources that had been exploited for archaeological pottery production.

IV.1. POTTERY SAMPLES

Potsherds were chosen from 17 different sites or archaeological projects (Table IV.1), the loci of which (Figure IV.1) correspond to four different geographical micro-regions and three of the 16th-century minor provinces that have been used by historians to study the research area (Sauer 1948).

The sampling strategy was partially determined by the uneven distribution of the archaeological work that has been done in the different micro-

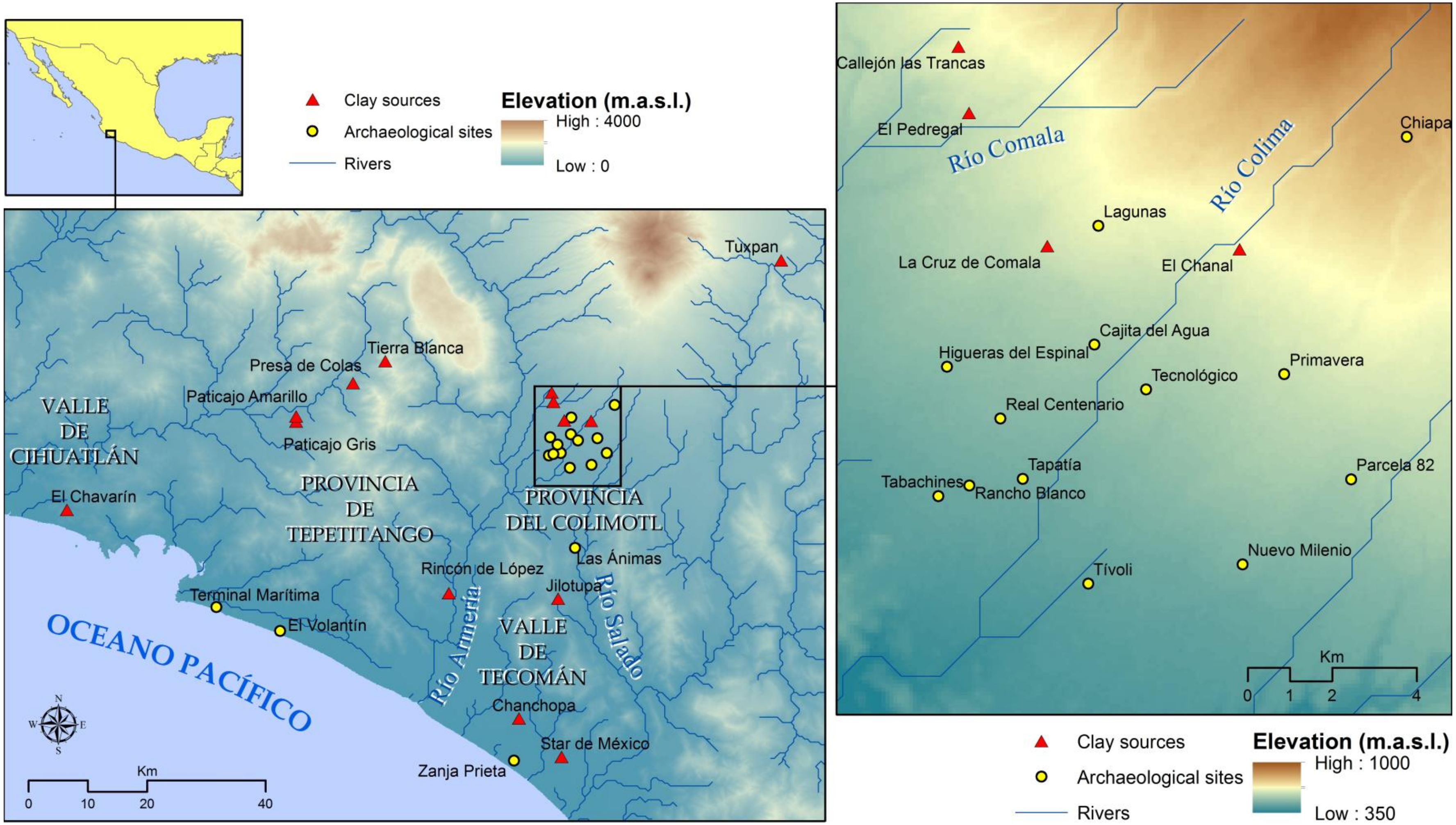

Figure IV.1. Geographical position of the sites (yellow dots) and clay deposits (red triangles) from which the samples analysed were recovered, and the general location of the provinces mentioned in 16th-century accounts, as plotted by Sauer (1948).

Table IV.1. List of the 17 sites from where the 215 samples analysed were recovered, and the micro-region and 16th-century minor province to which they correspond (see also Figure IV.1).

Site/Project	***Micro-region***	***16th-century minor province as understood by Sauer (1948)***	***Number of potsherds analysed***
Chiapa	Colima Valley	Provincia del Colimotl	10
Primavera	Colima Valley	Provincia del Colimotl	15
Parcela 82, El Diezmo	Colima Valley	Provincia del Colimotl	15
Nuevo Milenio	Colima Valley	Provincia del Colimotl	15
El Tívoli	Colima Valley	Provincia del Colimotl	5
Higueras del Espinal	Colima Valley	Provincia del Colimotl	15
Tabachines	Colima Valley	Provincia del Colimotl	15
Rancho Blanco	Colima Valley	Provincia del Colimotl	10
Real Centenario	Colima Valley	Provincia del Colimotl	15
Tapatía	Colima Valley	Provincia del Colimotl	15
Cajita del Agua	Colima Valley	Provincia del Colimotl	15
Lagunas	Colima Valley	Provincia del Colimotl	5
Tecnológico/La Campana	Colima Valley	Provincia del Colimotl	5
Las Ánimas	Salado River basin	Provincia del Colimotl	15
Zanja Prieta	Tecomán coastal plain	Valle de Tecomán	15
Terminal Marítima	Western coast	Provincia de Tepetitango	15
El Volantín	Western coast	Provincia de Tepetitango	15
TOTAL			***215***

regions in the study area, especially the large amount of work done in the Colima Valley compared with other micro-regions. This disparity arises from two interlinked issues: the location of the modern capital city of Colima state, and the predominance of salvage and rescue archaeology in the area over the past thirty years due to the expansion of urban areas. These two issues translated into plenty of material available for analysis from the Colima Valley, and just a small amount available from sites outside it.

The term *site* is used here to identify a findspot more than a proper archaeological site (III.2.5). All pottery analysed in this research comes from salvage or rescue archaeological projects. Site delimitation is typically beyond the scope of such studies, due to their restriction to the areas where modern construction or disturbance is to take place. Since the focus of this research is regional and micro-regional, delimitation of the sites from where the potsherds were recovered is not mandatory. However, it should be kept in mind that some of the sites sampled, especially those in close proximity, could be a single archaeological site.

The sampling strategy thus reflects the availability of potsherds recovered across the Colima Valley, with a total of 13 sampled sites (Table IV.1). In the site selection process, geographical distance between sites was considered over any other variable. This increased the possibility that each findspot represents a different archaeological site. A wider spread of sites across the micro-region also provided richer data for analysis in relation to production and political processes: the sharing of pottery technology between two sites separated by 10km, for example, is usually more telling than that between neighbouring sites.

Among the sites sampled in the Colima Valley, the longest distance between a pair of sites is close to 13km as the crow flies, which is the distance between the northern site of Chiapa (820m amsl) and the southern site of El Tívoli (440m amsl). The walking distance between them is much greater due to the sloping topography. The longest distance between two sites located in lands of the same 16th-century minor province is around 25km, the distance between Chiapa and Las Ánimas, both in the territory of the Provincia del Colimotl according to Sauer's map (see Chapter III). These two sites occupy different micro-regions; while Chiapa is located in the Colima Valley, Las Ánimas location lies in the Salado River basin (Figure IV.1; Table IV.1).

Four other sites or findspots complete the list of sites sampled: El Volantín and Terminal Marítima on the western coast, in the 16th-century Provincia de Tepetitango; and Zanja Prieta on the Tecomán coastal plain, in the 16th-century Valle de Tecomán (Figure IV.1; Table IV.1). El Volantín and Terminal Marítima are separated by 7km of land.

As already mentioned, the number of available findspots in the Colima Valley far exceeded those in the rest of the micro-regions in the research area. While I had considered the possibility of using more samples from these sites to compensate for this discrepancy, this idea was finally dismissed.

Due to constraints of the available laboratory time, the total number of samples was restricted to 215. Taking this into consideration and given the apparent homogeneity of the pottery assemblages, it was decided that between five and 15 potsherds would be enough to represent the pottery from the period from each findspot. The total number of samples was deemed to be appropriate for the objectives of this study, since it allowed for a meaningful multivariate statistical analysis.

A site-scale perspective of pottery production is not relevant for the objectives of this research, since it concerns pottery as a representation of production, technology circulation and consumption at the micro-regional level, more than at a particular site. The research questions were elaborated from a regional perspective and sampling more or less reflects this view, considering the limitations described above. As underlined by Arnold (2000:367-70), inferences through compositional analyses are especially strong at the regional level, including the identification of the loci of production, the organization of production, community and product specialisation, patterns of distribution, etc.

The final list of sampled sites offers the possibility to test pottery production and distribution in a profound manner in one of the 16th-century minor provinces: the Provincia del Colimotl. The 13 sites sampled from the Colima Valley are scattered over a broad area of around 130km^2, thereby providing the opportunity to see the degree of standardisation in pottery production in different and widely distributed findspots. Moreover, since Las Ánimas supposedly belongs to the same minor historical province but is located in a different micro-region, there was the chance to see if differential availability of resources within a hypothetical political entity reflects the environment of each micro-region (Arnold 2000:341-42,363-65) or hints at a more restricted control over access to resources and other political and social aspects of production.

Finally, the wide distribution of sites, regardless of the number in each historical political entity or micro-region, offers the possibility of properly discussing pottery distribution and technology and potential routes of circulation in the research area for the first time.

The selection of samples also aimed to thoroughly represent the ceramic assemblages and pottery types of the Colima and Armería phases, the latter defined in terms of shape and decoration (Appendix A, A.1. Type Descriptions; Kelly 1980:1). Nearly all of these types are represented in the overall sample of 215 potsherds (Table IV.2; Figures IV.2-IV.11), including the most common and diagnostic within the three assemblages or complexes so far defined for this period (Appendix A). Since there are earlier and latter pottery wares everywhere in the research area, the selective and correct sampling of the Colima and

Armería-phase ceramic types was the only way to ensure the analyses would allow relevant chronological discussions. Complete descriptions of the key ceramic types were written a few years ago (Appendix A, A.1. Type Descriptions), ensuring the reliable identification of the potsherds that form the sample. Shape-obvious fragments were favoured, since they offered extra macroscopic data for the standardisation assessment. None of the samples in this particular set have been subjected to any kind of analysis before. A complete breakdown per site is shown in Table IV.2.

The selection process was not random and the macroscopic stylistic typology can be considered a selection bias. Since central Colima's ceramic typology was built on material discovered in central Colima (Appendix A; Kelly 1980), it more accurately represent wares used in the Colima Valley and the Salado River basin than those local wares from the western coast and the Tecomán coastal plain (III.2.2).

The lack of a solid pottery typology for the regions outside the Central Axis means that central Colima types may be over-represented in samples selected from elsewhere. However, potsherds with diagnostic decorative and shape attributes of this period were selected for analysis from outside central Colima, since they may represent regional variants of the Central Axis types (i.e. both Tecomán cream wares, Figure IV.11). The possible effects of sampling decisions are taken into consideration when discussing pottery production and circulation in this thesis (Chapter VII).

All 215 samples were graphically documented before being subjected to analysis. A fair selection of examples of every sampled type is offered in Figures IV.2 to IV.11. The documentation consisted of obverse and reverse photographs of each potsherd, plus drawings of their profiles with the help of a profile gauge, to demonstrate the vessel's shape. Wall thickness was measured with a Vernier calliper. Mouth diameters were also calculated when large enough fragments of rims were available. Graphic documentation is important because some attributes like decoration and shape may be less perceptible once the fragment subjected to analysis is removed.

Table IV.2. Phase and type classifications of the 215 samples analysed in this research, and the sites from which they were recovered.

Phase	***Colima***			***Armería***										
Site / Pottery types	*Colima Shadow -striped*	*Colima Red-on-cream*	*Colima Incised*	*Borregas Red-on-cream*	*Pozo Hundido Incised*	*Pozo Hundido Red-on-brown*	*Bugambilias Red-on-orange*	*Libramiento Ring-based Mortar*	*Libramiento Red Rim*	*Libramiento Pedestal-based Bowl*	*Amela Red*	*Armería Cream/ Orange*	*Tecomán Fine Cream*	*Tecomán Coarse Cream*
Chiapa	2	3			1		2			2				
Primavera	2	2	2	2	1	1	2		1	2				
Parcela 82, El Diezmo	3			1	3		3		5					
Nuevo Milenio	2	2	4	1	1		5							
El Tívoli		2	1	2										
Higueras del Espinal	4	4		1			3	1	2					
Tabachines		1		3	1	3	4		1	2				
Rancho Blanco		3	3	3	1									
Real Centenario	4		2	1			5			2		1		
Tapatía	2	2	3	2	1	1	2		1	1				
Cajita del Agua	6	5	1	3										
Lagunas	1	2					2							
Tecnológico/ La Campana	1	1						3						
Las Ánimas	4	6	5											
Zanja Prieta	3	1		6							1		2	2
Terminal Marítima	4	1	1	6								3		
El Volantín	5			5								5		
Totals	43	35	22	36	9	5	28	4	10	9	1	9	2	2

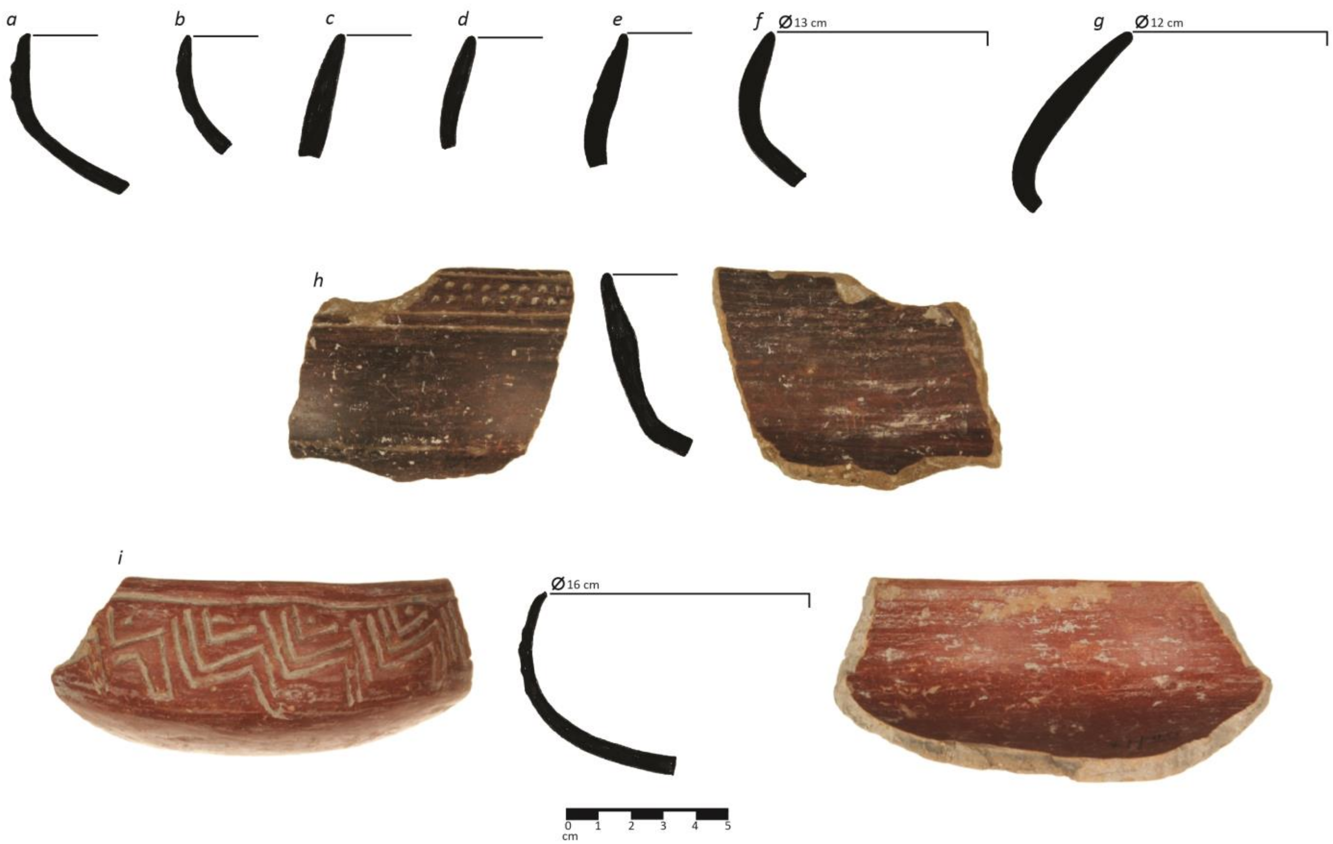

Figure IV.2. Samples of the Colima Incised type, a-i: 095, 137, 097, 200, 021, 044, 043, 096, 166.

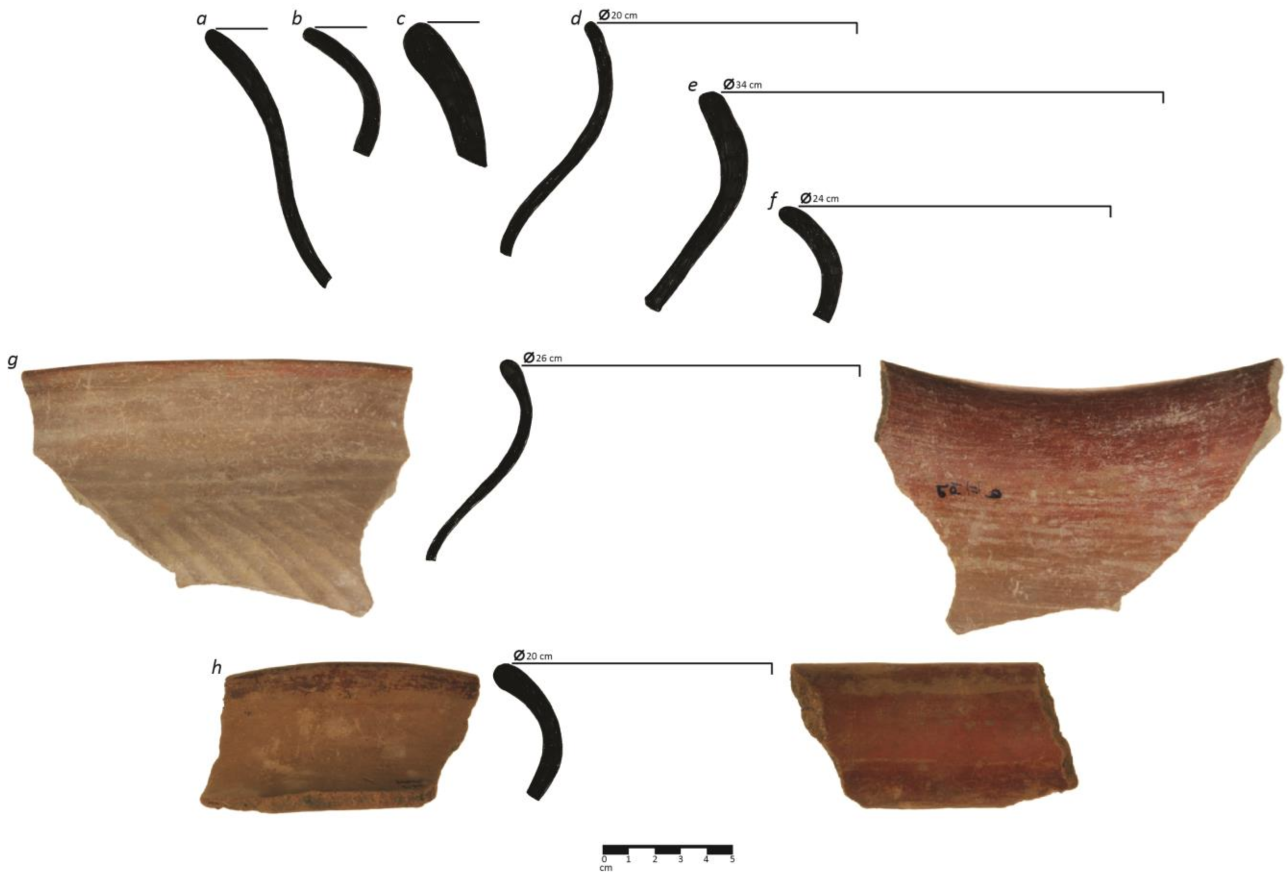

Figure IV.3. Samples of the Colima Shadow-striped type, a-h: 066, 038, 101, 163, 131, 198, 164, 201.

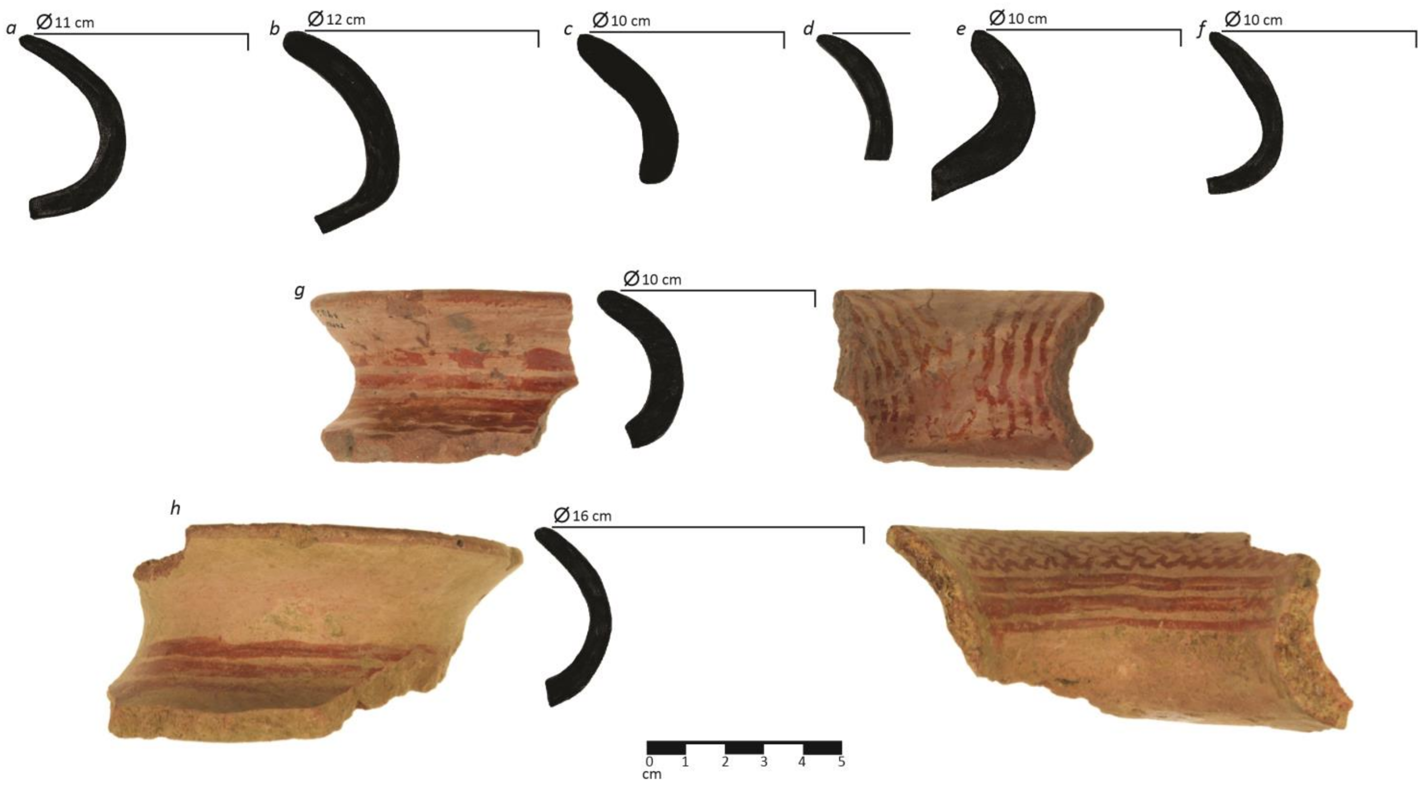

Figure IV.4. Samples of the Colima Red-on-cream type, a-h: 157, 057, 014, 008, 013, 189, 128, 090.

Figure IV.5. Samples of the Borregas Red-on-cream type, a-c: 089, 144, 143.

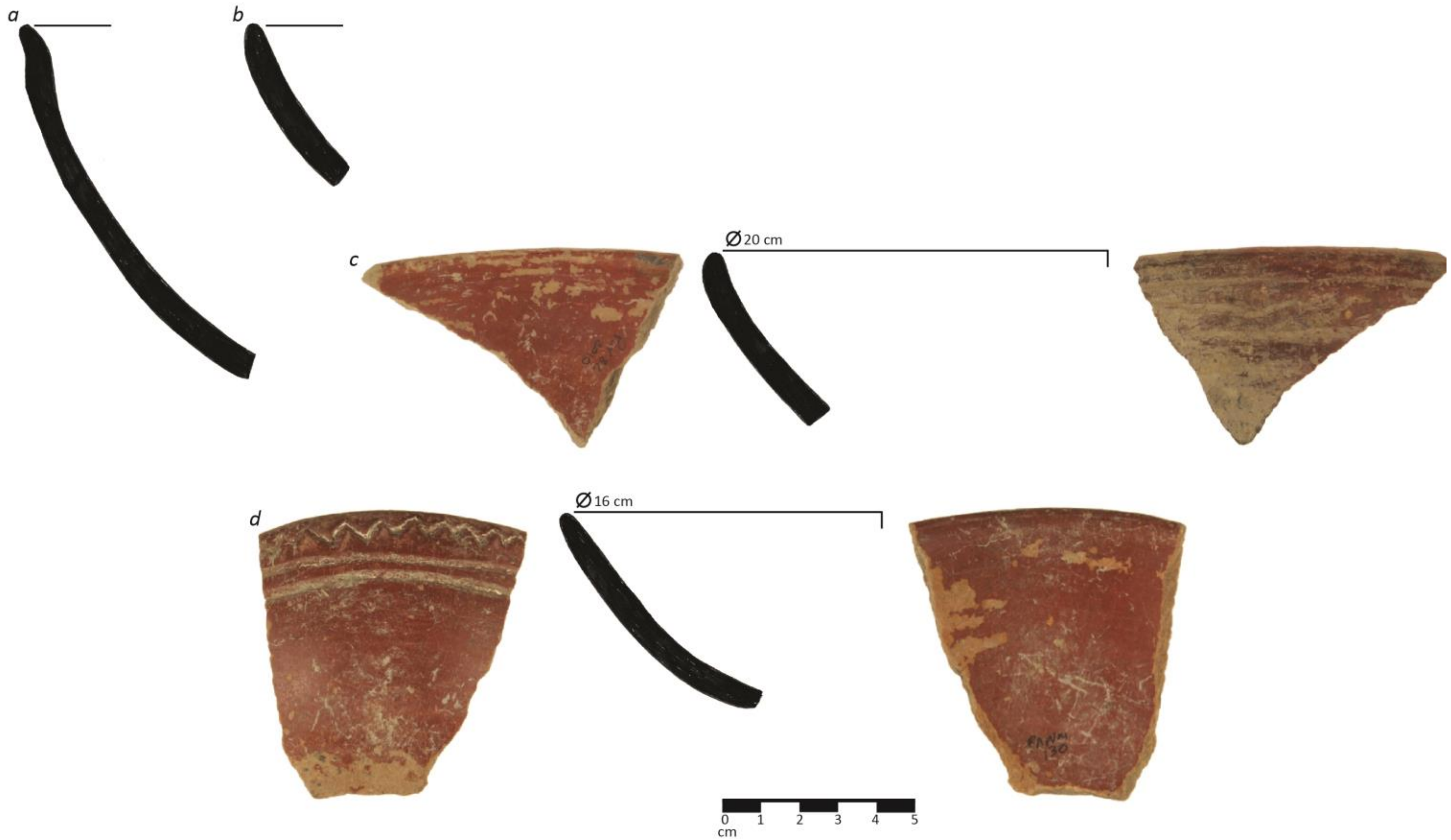

Figure IV.6. Samples of the Pozo Hundido Incised type, a-d: 028, 123, 027, 050.

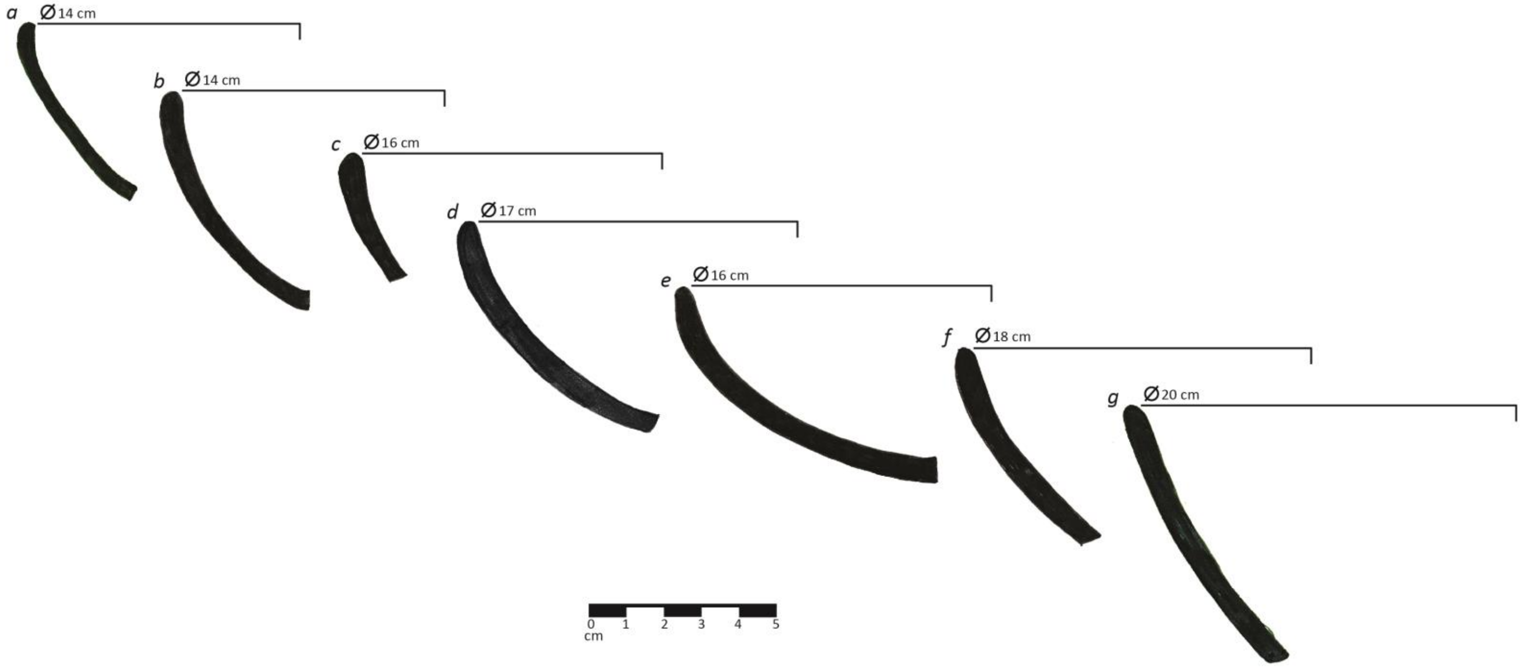

Figure IV.7. Samples of the Bugambilias Red-on-orange type, a-g: 051, 074, 147, 034, 073, 052, 036.

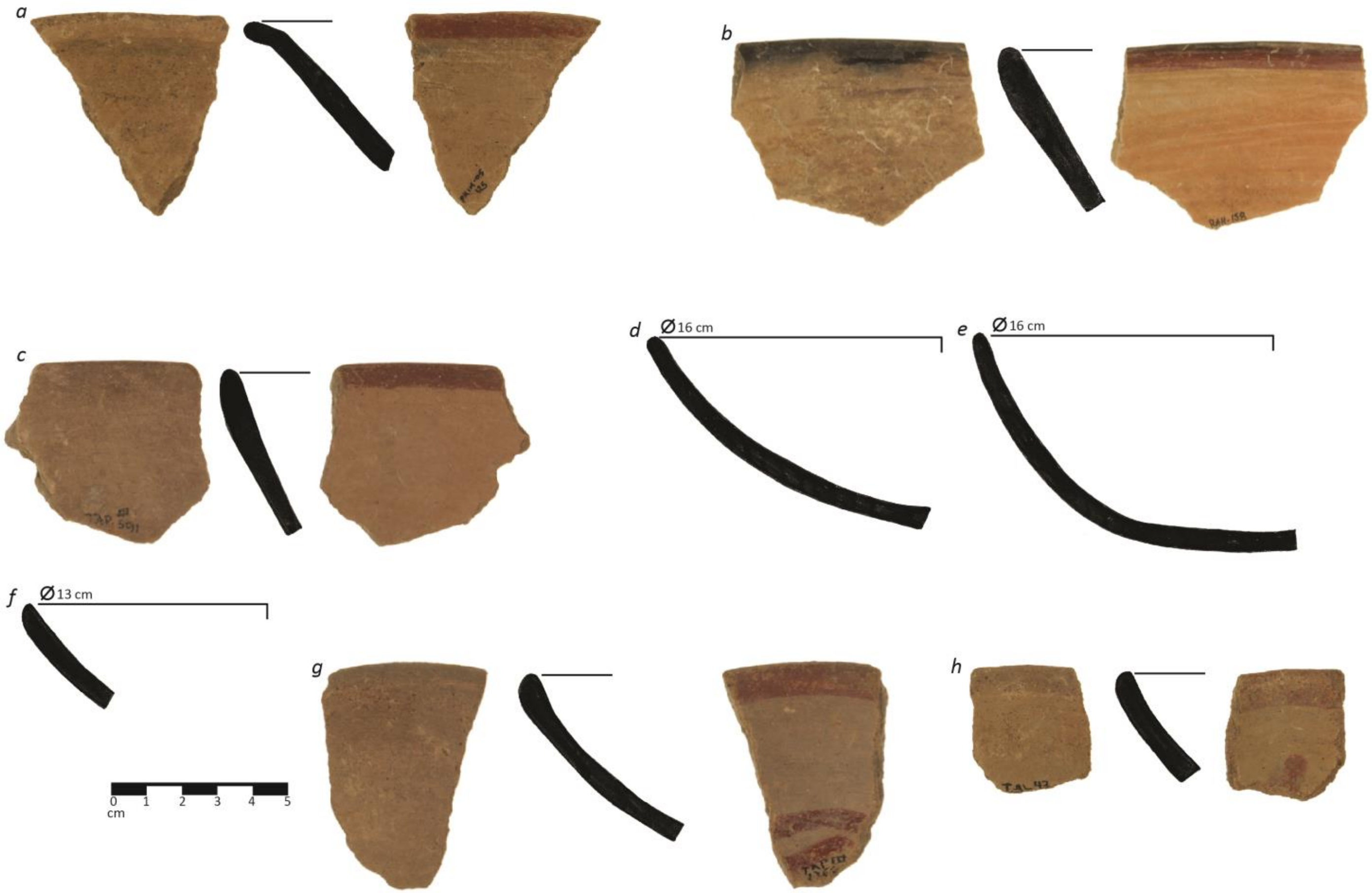

Figure IV.8. Samples of the Libramiento Red Rim type, a-e: 018, 072, 118, 031, 030; and the Pozo Hundido Red-on-brown type, f-h: 082, 119, 083.

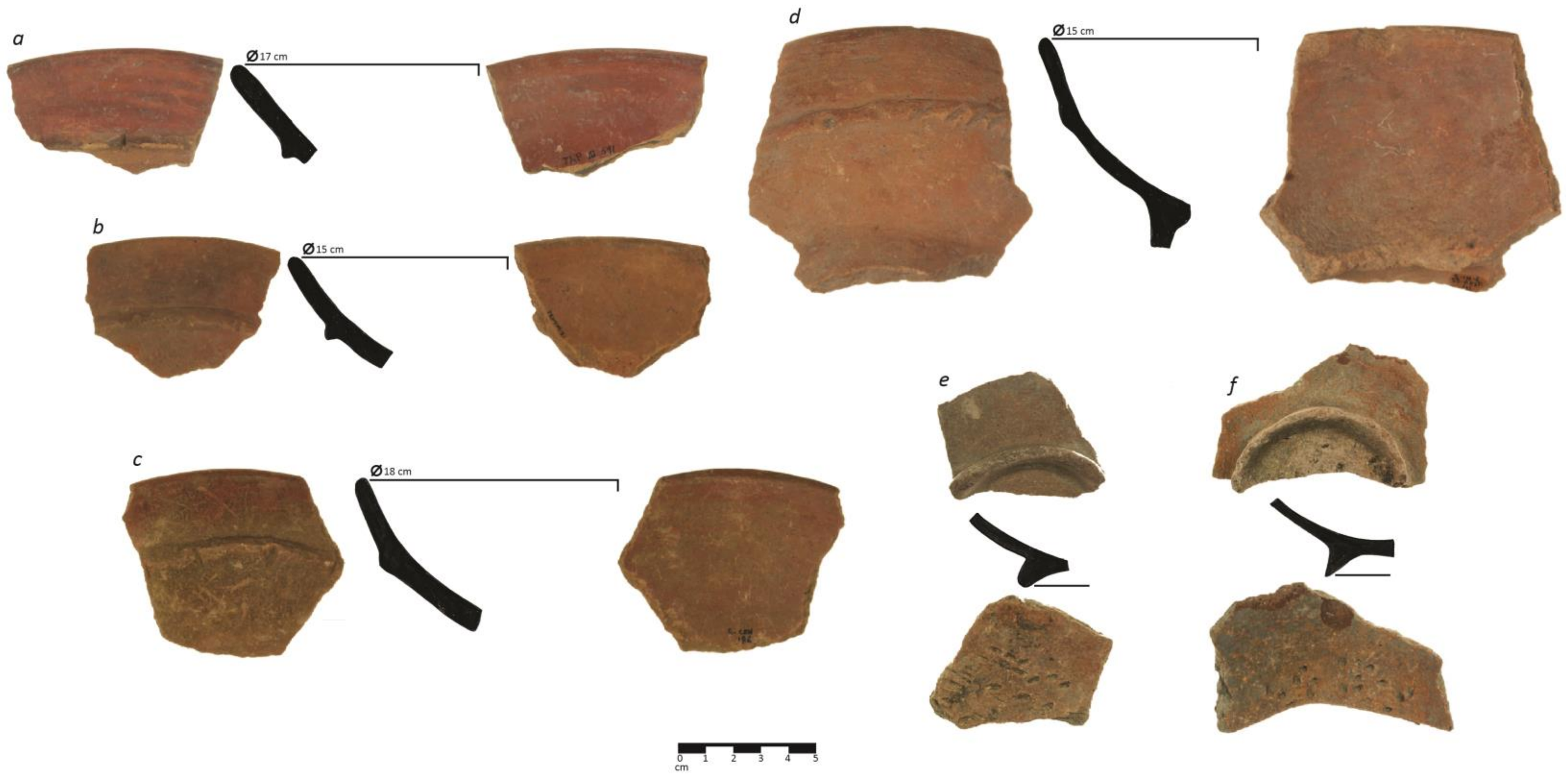

Figure IV.9. Samples of the Libramiento Pedestal-based Bowl type, a-d: 122, 024, 109, 001; and the Libramiento Ring-based Mortar type, e-f: 153, 154.

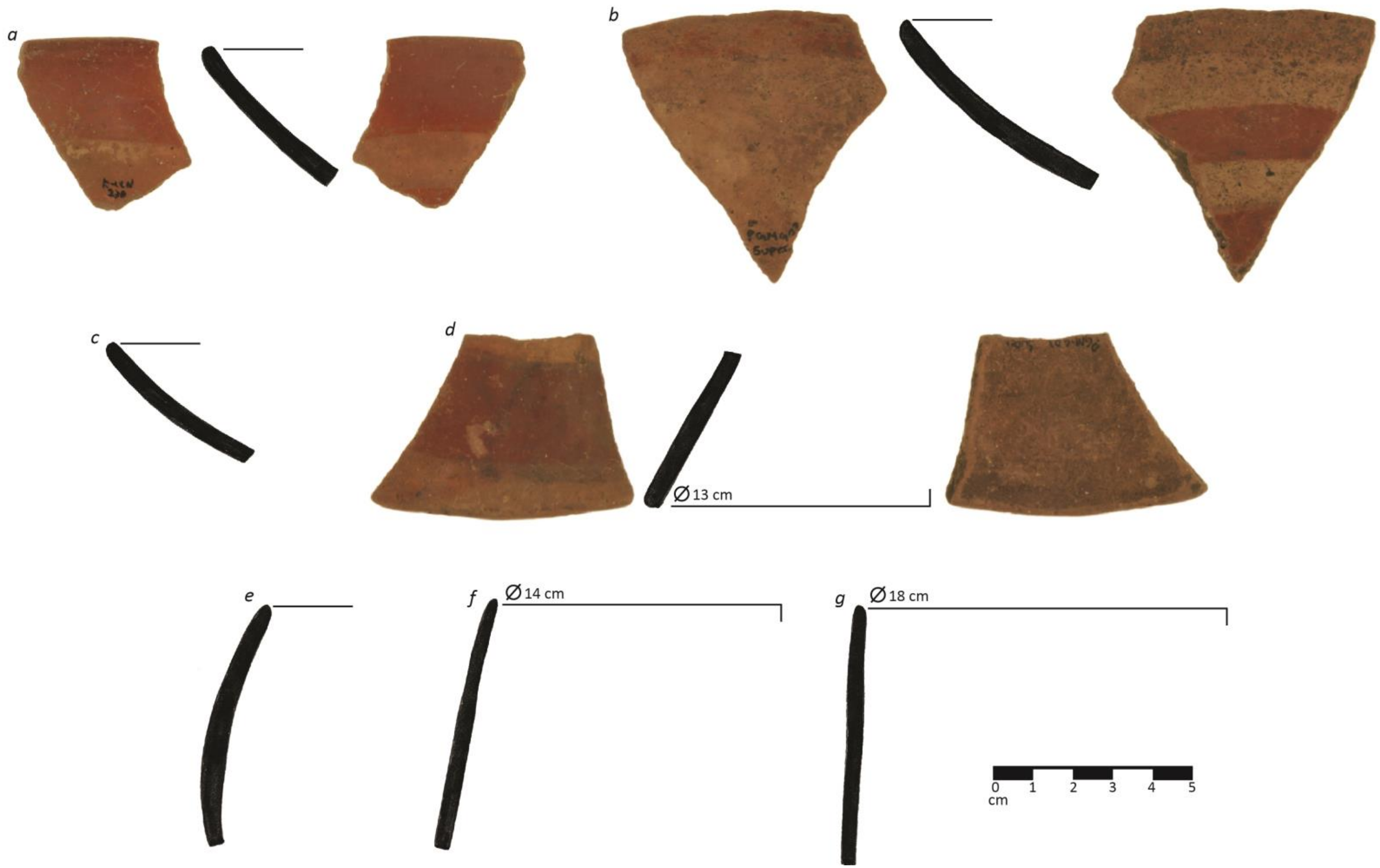

Figure IV.10. Samples of the Armería Cream/Orange type, a-g: 107, 215, 186, 213, 187, 188, 211.

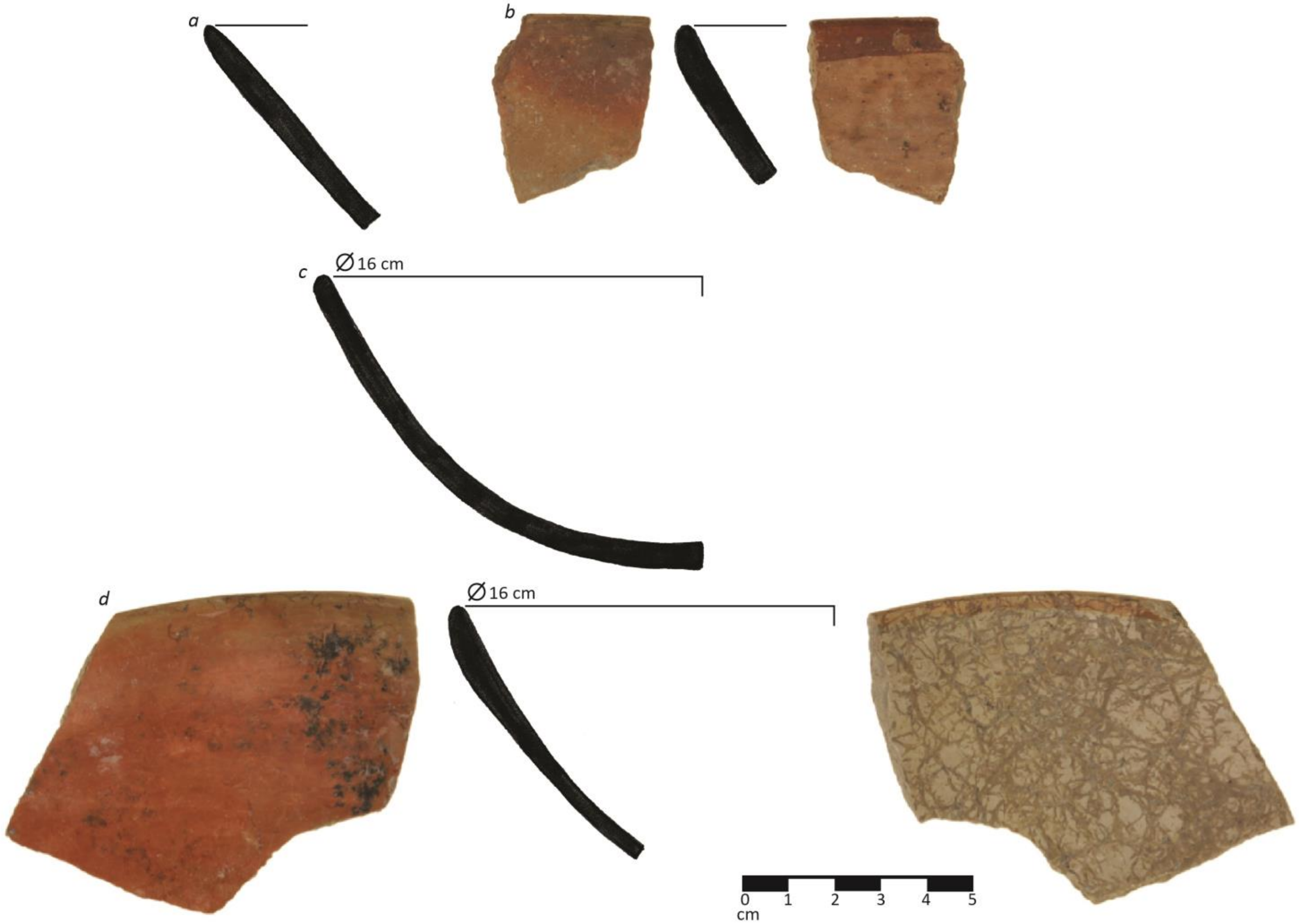

Figure IV.11. Samples of the Tecomán Coarse Cream type, a-b: 183, 185; and the Tecomán Fine Cream type, c-d: 182, 184.

IV.2. RAW CLAY SAMPLING

A craft-oriented research project recently conducted by scholars from the Universidad de Colima analysed and experimentally tested raw clay deposits located in the region (Novelo 2007a). Their aim was to study current pottery production and suggest superior, more competitive clay mixtures to the local potters. Local production has recently decreased due to market displacement by better-quality imports from neighbouring regions in Jalisco and Michoacán, both well-known pottery production centres (Novelo 2007b:14-18). Perhaps in response to this decline, some of the potters have started creating tourist-oriented reproductions of the world-famous zoomorphic and anthropomorphic vessels that characterise the archaeological Comala phase (1-550 CE) (Novelo 2007b:17).

Initially, the Universidad de Colima research team located up to 12 different clay deposits, mainly through interviews with current potters, discussions with people living near potential deposits shown on geological maps, and current exploitation of deposits by tile and brick makers; however, they admit that their search for deposits was by no means exhaustive (Elizondo 2007:20-21). Some time later, the research team found a few more clay deposits; these were sampled but not included in the report published in 2007.

The 12 clay deposits that were analysed in this research include 10 of those that were originally analysed and published by the Universidad de Colima team, plus 2 more that were sampled by them but not published, namely Paticajo Amarillo and El Chanal (Figure IV.1, Table IV.3). Their exact geographic coordinates are not known; they are shown in Figure IV.1 next to the villages of Paticajo and El Chanal, respectively, since it is known they were collected from their vicinities (Pablo Quezada, personal communication 2014). Conversely, there are two deposits that were analysed and featured in the 2007 publication (Novelo 2007a), but which I did not have access to for this investigation; these are Presa de Colas and Jilotupa (Figure IV.1).

All but two of the clays were sampled from the storage room at the old CENCADAR (National Centre for Craft Training and Design, Universidad de Colima) facilities in Nogueras, Colima. The La Cruz de Comala and Callejón Las Trancas deposits were sampled during field visits.

Table IV.3. List of the 12 clay deposits sampled and analysed in this research, including the micro-region and the 16th-century minor province to which they correspond (see also Figure 1). Current land use and approximate surface area taken from Novelo (2007a).

Clay deposit	***Approximate surface area***	***Micro-region***	***16th-century minor province as understood by Sauer (1948)***	***Current land use***	***Number of samples analysed***
B1. Paticajo Amarillo, Minatitlán	Unknown	Paticajo Valley	Provincia de Tepetitango	None	1
B2. Paticajo Gris, Minatitlán	2 ha.	Paticajo Valley	Provincia de Tepetitango	Pottery making	1
B3. Callejón Las Trancas, Comala	Unknown, but may be the same deposit as B4	Colima Valley	Provincia del Colimotl	Tile, brick and pottery making	1
B4. El Pedregal, Comala	Unknown, but may be the same deposit as B3	Colima Valley	Provincia del Colimotl	Mainly for the making of pottery, but also for the making of tile and brick	1
B5.(B6.) La Cruz de Comala	Unknown	Colima Valley	Provincia del Colimotl	Tile, brick and pottery making	2
B7. Rincón de López, Armería	Unknown	Armería Valley	Provincia de Tepetitango	Tile, brick and pottery making	1
B8. El Chavarín, Manzanillo	0.5 ha.	Western coast	Valle de Cihuatlán	Tile, brick and pottery making	1
B9. Star de México, Tecomán	10 ha.	Tecomán coastal plain	Valle de Tecomán	Low-intensity livestock	1
B10. Tierra Blanca, Minatitlán	Unknown	El Mamey Sierra	Provincia de Tepetitango	None	1
B11. Chanchopa, Tecomán	Unknown	Tecomán coastal plain	Valle de Tecomán	None	1
B12. El Chanal, Colima	Unknown	Colima Valley	Provincia del Colimotl	Unknown	1
B13.(B14.) Tuxpan, Jalisco	Unknown	Tuxpan plain	Provincia de Tuspa, Zapotlán y Tamazula	None	2

Thus, ten of the 12 sampled clay deposits had been subjected to laboratory analyses by scholars from the Universidad de Colima. The first tests, meant to evaluate the plasticity of the raw materials, included determination of their pH and electrical conductivity, percentage of organic material content, and physical characteristics (i.e. granulometry, specific weight and water content). The samples that showed more promise in these experimental tests were subjected to sintering and crystallography (X-ray diffraction) analyses. The results showed low organic content (below 1%) and low humidity values in most of the clays (Elizondo 2007:27).

X-ray diffraction (XRD) analyses revealed the presence of montmorillonite in most of the clay deposits, with Paticajo Gris having the highest proportion of kaolinite. The dominant presence of these clay minerals was deemed appropriate for either hand modelling or moulding of pottery (Zimbrón 2007:30; see Henderson 2000:115-17). XRD analyses also showed that the Tuxpan deposit is high in cristobalite, Tierra Blanca is high in quartz, and the Comala area clays (El Pedregal, Callejón Las Trancas, and La Cruz de Comala) are mainly composed of feldspars (Zimbrón 2007:Cuadro 3). The analyses classified them all as clays, with the exception of Tierra Blanca and Presa de Colas (sands), and Tuxpan (rockdust) (Zimbrón 2007:Cuadro 1).

IV.3. BULLET POINT SUMMARY

SAMPLES AND SAMPLING STRATEGY

- Pottery sampling:

  -215 archaeological pottery samples from 17 sites in the research area

  -The 17 findspots are diversely distributed throughout four geographical micro-regions and three 16th-century minor provinces

  -14 pottery types were sampled from the Colima (3) and Armería phases (11)

- Raw clay sampling:

  - 14 raw clay samples from as many as 12 deposits located in seven geographical micro-regions and five 16th-century minor provinces in or around the research area

CHAPTER V. INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS

In this research, bulk geochemical analysis of 215 samples of archaeological pottery and 14 samples of raw clay from in or around the research area (Figure IV.1) was conducted to identify pottery compositional groups, determine their probable provenances, and establish patterns of distribution and circulation between both geographical micro-regions and regional polities. Due to its high precision and accuracy, particularly with regard to trace elements, instrumental neutron activation analysis (INAA) was chosen for this geochemical characterisation. The analyses were done at Mexico's National Nuclear Research Institute (ININ) during two six-month research stays in 2012-2013 and 2014.

V.1. METHOD AND OBJECTIVES

The need for a nuclear reactor is probably INAA's biggest disadvantage, making it expensive and generally not very accessible (Neff 2000:104-06). However, the long list of benefits more than compensates this. INAA's ability to simultaneously measure several elements—delivering a 'chemical fingerprint' of a sample in one go—in combination with its high accuracy, high precision, and high sensitivity when compared to other techniques, makes it the best method for bulk chemical characterisation and a perfect fit for archaeological provenance studies.

It is important to identify multiple elements, since source compositions are often very similar; the possibility of discriminating sources increases with the number of elements that can be measured (Neff 2000:103-04). Accuracy indicates how close a measurement is to the actual value; in INAA, accuracy is usually tested against standards of known composition. Precision is the ability to replicate the same results by repeatedly taking measurements under the same conditions. Sensitivity indicates how small an amount can be detected. INAA's high sensitivity allows the measurement of chemical elements in the order of parts per million (ppm). Due to their scarcity, it is trace elements that provide the greatest distinction between different compositions. Sensitive elemental analysis increases the possibility of identifying meaningful compositional groups and diagnostic sources of raw materials for the manufacture of ceramics.

Another big advantage to INAA is its ability to analyse samples of less than 100mg. Since INAA is an invasive technique, in the sense that it requires the removal and pulverisation of material, this characteristic certainly helps to minimize damage to the artefact (Neff 2000:103). It also removes the need for a big sample, which is helpful when materials are scarce.

INAA requires the preparation of a homogeneous, powdered sample. In the case of pottery specimens, the first step is to remove a small, representative piece of the fabric. The second step is to remove the inner and outer surfaces; any remnants of paint, slip, or surface contaminants would have an undesired effect on the chemical characterisation of the fabric itself. In this project, the surfaces were physically removed with a tungsten carbide drill, after which each fragment was subjected to an ultrasonic wash in deionised water.

A day after this washing, the dry fragments were individually powdered in an agate mortar inside a FRITSCH PULVERISETTE vibratory mill machine. The resulting analytical powders were placed in a drying oven for a minimum of 17 hours at a temperature of 100°C. The loss of humidity is fundamental, since any remaining water would affect the weight of the powder and any related calculations. Once humidity was lost through evaporation, around 200mg of each sample was put in an analytical balance and weighed, with accuracy within a milligram. Raw clay samples were not washed, but were also ground into powder and dried. Approximately 200mg of analytical powder was selected from each of the raw clay samples as well.

After weighing, each powdered sample was put inside a high-density polyethylene vial. In turn, these vials were encapsulated (mostly in pairs) with two samples of reference standards inside irradiation polyethylene capsules, or rabbits.

Each rabbit usually contained four samples of analytical powder, placed vertically: two samples of unknown composition (i.e. powdered pottery or raw clay) at the top and bottom, and two reference standards in the middle. In the case of three-sample rabbits, the sample of unknown composition was placed between the two standards. Encapsulated samples and standards should be as physically close as possible to guarantee similar exposure to the neutron flux during irradiation.

All rabbits were irradiated for two hours in the Triga Mark III reactor of the ININ, at a thermal neutron flux of 1.19 x $10^{13}cm^{-2}s^{-1}$. During irradiation, the nuclei of atoms in the samples are exposed to a neutron-rich environment; isotopes are produced under these conditions as atoms acquire extra neutrons through capture. Neutrons are released inside the nuclear reactor via the fission of ^{235}U through a chain reaction. Several of the product isotopes are radioactive (i.e. radioisotopes), meaning that they have unstable nuclei that dissipate excess energy by emitting radiation in the form of alpha, beta, and gamma rays. Gamma rays are used in INAA, most commonly delayed gamma rays, which are emitted only after the sample is removed from the reactor (Neff 2000:83-84).

Crucially, the decay of radioisotopes happens at a constant rate; each isotope has a characteristic half-life, varying from seconds to years. This rate of decay is the reason that the abundance of chemical elements can be quantified. Decay by the emission of gamma rays happens at a different energy depending on the isotope. Gamma rays up to about 3300keV are counted in INAA (Neff 2000). The energy of the gamma ray photon is transferred to a photoelectron inside the detector of the gamma ray spectrometer, where detection and measurement is done (Neff 2000:91). These electric pulses produce spectral photopeaks (i.e. electric pulses produced by gamma rays of the same energy, indicated by a peak formed through the number of counts recorded in that energy channel), hence providing a gamma spectrum readout for each sample.

Due to technical limitations, only medium and long-lived radioisotopes were quantified in this research. It is recommended that longer-lived isotopes be counted only after any activity from shorter-lived isotopes is gone (Neff 2000:90). For this reason, a decay time of between one and four weeks was allowed between the end of the irradiation and the beginning of counting the gamma rays. This wait resulted in less interference, making the activity of the relevant radioisotopes stand out. Gamma ray spectra were recorded and counted for one hour by a high-purity germanium (HPGe) detector linked to a computerised multi-channel analyser. Counting took place at the Chemistry Area laboratories at the ININ.

Following the count, gamma ray peak spectra automatic analyses were performed with the HYPERMET PC software package. The simplest way to turn gamma ray spectra into elemental concentrations is to calculate the photopeaks' areas and then compare them with those from a standard of a known composition. Currently, such calculations are mostly computerised. To be comparable, it is a requisite for the standard to have gone through closely similar experimental conditions as the sample of unknown composition, including irradiation, decay, and count times. To aid in the calculation of concentrations, the standard's composition should be multi-elemental and fairly similar to the kind of material to be analysed (i.e. the more elements they have in common, the more elements can be quantified). The standards used in this analysis were Obsidian Rock SRM 278 and Flint Clay SRM 97b, both prepared by the National Institute of Standards and Technology (NIST). The use of two standards has two main benefits. First, their different compositions provide a wider set of chemical elements for quantitative analysis through comparison. Second, since both standards are of known quantified compositions and share 9 quantified elements (Co, Cs, Eu, Fe, Hf, Rb, Sb, Sc and Th), they can be used to crosscheck each other. In this way, one could be used as an unknown sample and tested against the other, providing data on the precision and accuracy of the analysis.

Finally, all radioactivity values were corrected to account for corresponding weights, half-lives, and decay times. Elemental concentration data were produced through comparisons between the gamma spectra values of the pottery samples and those of the standards. The results of INAA are presented and discussed in the next section.

The main objective of geochemical compositional characterisation was to explore the variability of the ceramics in the research area beyond stylistic typologies. Specific aims of the analysis were: a) to assess the inter-regional and intra-regional geochemical variability of the pottery by looking for groups of samples with shared compositions and discussing compositional diversity between groups; b) to aid in provenance determination for the pottery samples. This data permits the examination of intra-regional patterns of production and inter-regional circulation, and consequently the social interplay between people inhabiting different geographical regions. The characterisation of the raw clays was done in the hope of finding matches for those used in the production of the pottery samples, and thereby establish relationships between the clay deposits and pottery distribution (e.g. distance to the source, possible procurement and production areas, etc.).

V.2. COMPOSITIONAL RESULTS AND GROUPINGS

Sixteen chemical elements were quantified by INAA in the 215 pottery specimens and 14 raw clay samples, namely Ce, Co, Cr, Cs, Eu, Fe, Hf, Lu, Rb, Sb, Sc, Th, U, Yb, Zn, and Zr.

Not all of these elements were directly determined and quantified by gamma rays emitted by one of their radioisotopes. Th was indirectly determined through ^{233}Pa, and U was determined through ^{239}Np. Table V.1 lists the radioactive isotopes that were analysed, along with their characteristics and the number of samples in which they were determined, regardless of the quality of the measurement data.

Table V.1. Characteristics of the radioisotopes analysed by means of INAA, and the number (N) of samples in which they were determined.

Element	Radioisotope	Half-life (days)	Gamma energy (keV)	N
Ce	^{141}Ce	32,4	145,5	213
Co	^{60}Co	1923,6	1173,2	229
Cr	^{51}Cr	27,7	320,1	229
Cs	^{134}Cs	752,6	604,7	129
Eu	^{152}Eu	4635,5	344,3	219
Fe	^{59}Fe	45,1	1099,2	229
Hf	^{181}Hf	42,5	482,2	229
Lu	^{177}Lu	6,7	208,4	229
Rb	^{86}Rb	18,6	1076,6	206
Sb	^{122}Sb	2,7	564,1	160
Sc	^{46}Sc	83,9	889,3	229
Th	^{233}Pa	27,4	311,9	229
U	^{239}Np	56,3	228,2	106
Yb	^{175}Yb	4,2	396,3	229
Zn	^{65}Zn	243,8	1115,5	74
Zr	^{95}Zr	64,4	724,2	62

V.2.1. MULTIVARIATE STATISTICAL ANALYSES

As discussed in sub-section II.5.1 of this thesis, pottery's chemical composition depends greatly on the chemical signature of the clay bed used as the raw material source. In consequence, having the same composition highly suggests a common provenance, since the elemental pattern obtained by measuring several elements can be considered almost unique and thus diagnostic of a source spot, at least at the level of the research area (Mommsen 2001). In this sense, multivariate statistical analysis of the chemical data can help distinguish one clay source from another.

One of the criteria used to select elements for multivariate statistical analyses in this research was the analytical uncertainty of their resulting concentration value. It was determined that this uncertainty must be below 25% in all included samples (although almost all of the used values have analytical uncertainties below 10%).

A second criterion also concerned the measured data quality. As mentioned above, Flint Clay SRM 97b was treated as a check standard and its composition was obtained through comparison with Obsidian Rock SRM 278 (Table V.2). The elemental concentration in Flint Clay SRM 97b was expected to be in a range of values that would indicate both accuracy and precision of the measurement. In this way, the accuracy of the analysis was tested on a capsule basis. If an element in question was to be included in the analysis but its concentration value did not fall in the expected range in the check standard, the samples irradiated along with that standard were automatically eliminated from the statistical analysis. Out of the nine elements whose concentrations were known and experimentally checked, Sc, Fe, Hf, Th, and, to a lesser extent, Rb produced resulting values with both high accuracy and precision (Table V.2). On the contrary, experimental calculations for Sb and Cs showed a higher variation matrix; if used in the statistical analysis, they might have introduced a false variability into the data set.

The aim was to build a meaningful and trustworthy data set that involved the highest number of samples and elements as possible, with all samples providing the full set of elements to be included in the analysis (i.e. no zero values) and without the variables (elements) that may have introduced a false variability to the results.

The first statistical analysis was initially carried out with data obtained from the complete set of analysed samples (n = 229), but considering only seven of the 16 quantified elements, namely Cr, Fe, Hf, Lu, Sc, Th, and Yb.

Table V.2. Certified and experimental values of INAA measurements for Flint Clay SRM 97b, expressed as parts per million. CV is the coefficient of variation. N is the number of times elements were measured.

Element	Certified value	Experimental value	CV (%)	N
Sc	22	23 ± 1	3.2	121
Fe	8310	8338 ± 349	4.2	121
Co	3.8	3.7 ± 0.6	15.8	126
Rb	33	31 ± 3	9.7	123
Sb	2.2	1.7 ± 0.4	22.2	119
Cs	3.4	4.2 ± 0.7	17.3	125
Eu	0.84	0.96 ± 0.15	15.4	122
Hf	13	14 ± 1	4.8	121
Th	36	36 ± 1	3.6	129

The concentrations of these seven elements plus three more (Ce, Co, and Rb) were subsequently statistically analysed using a sub-set of 111 samples (107 pottery samples and 4 raw clay samples). This was done to confirm the results of the first analysis using a higher number of variables (i.e. those three extra elements that were confidently measured in 111 samples).

For both statistical analyses, and taking into consideration analytical uncertainty values, Ce, Eu, Fe, Lu, Rb, Th and Yb were quantified by comparison against Obsidian Rock SRM 278; Cr, Hf and Sc were quantified using Flint Clay SRM 97b as a reference.

Among the 10 elements used in at least one of these statistical analyses, only Iron is considered a minor element in clays, with a usual concentration in the range 1-7%. The rest are trace elements, with concentrations below 0.1%, normally expressed in parts per million (ppm). This characteristic makes it improbable that the concentrations of multiple trace elements would be the same for clays from different sources. Moreover, Hf, Th, Sc and Cr are so-called immobile elements, components that are resistant to the effects of pottery manufacturing and/or post-depositional processes, and thus refer rather confidently to the raw material source (Dias et al. 2013). A table of the elemental concentrations data used in the two statistical analyses can be found in Appendix B, Table B.1.

Statistical analyses were executed using the GAUSS Run-Time software developed by the University of Missouri Research Reactor (Glascock and Neff 2003). Prior to any calculations, a log-base 10 transformation was applied to the data in order to compensate for differences in magnitude between Iron and the trace elements (cf. Baxter and Freestone 2006).

Multivariate statistical analysis was performed with the assistance of several techniques with the intention of identifying and making explicit any group pattern structures in the data set (Shennan 1997:217-18; Tite 2008:225). For this reason, raw clay samples B8, B10 and B12 were removed from the dataset early in the analysis. As the three biggest statistical outliers, their inclusion would complicate the graphical appraisal of the data.

The hierarchical cluster plot shown in Figure V.1 is based on the logarithm of the Euclidean distance between samples. Samples that are similar to each other are placed in the same cluster, and those dissimilar are placed in different clusters. Separated at a distance of 0.05ppm or more, the resulting dendrogram distinguishes eleven branches. The five largest primary groups, Groups 1 to 5, account together for 202 (61, 97, 25, nine and 10 samples, respectively) of the 226 samples represented in the analysis. This leaves 24 samples in Figure V.1 outside the five largest clusters. One of them (raw clay sample B2) is not clustered at a 0.05 value; the remaining 23 are clustered in groups of 8 samples or less, impeding the analytical test of group membership probabilities that followed for the five largest groups.

Next, the relative likelihood that the samples belong to the groups proposed by hierarchical cluster analysis (HCA), was obtained. This was done through the calculation of the Mahalanobis distance (MD) from the group centroid, with the assumption of an *F*-distribution (i.e. a continuous probability distribution). After this group classification test (Appendix B, Table B.2), 169 out of 202 samples matched their HCA-suggested group and 33 samples were reclassified in agreement with their highest group membership probability.

According to the analysis of group membership probabilities, 127 out of the 202 samples classified into the five largest groups have a more than 40% probability of membership in their respective group; these samples represent

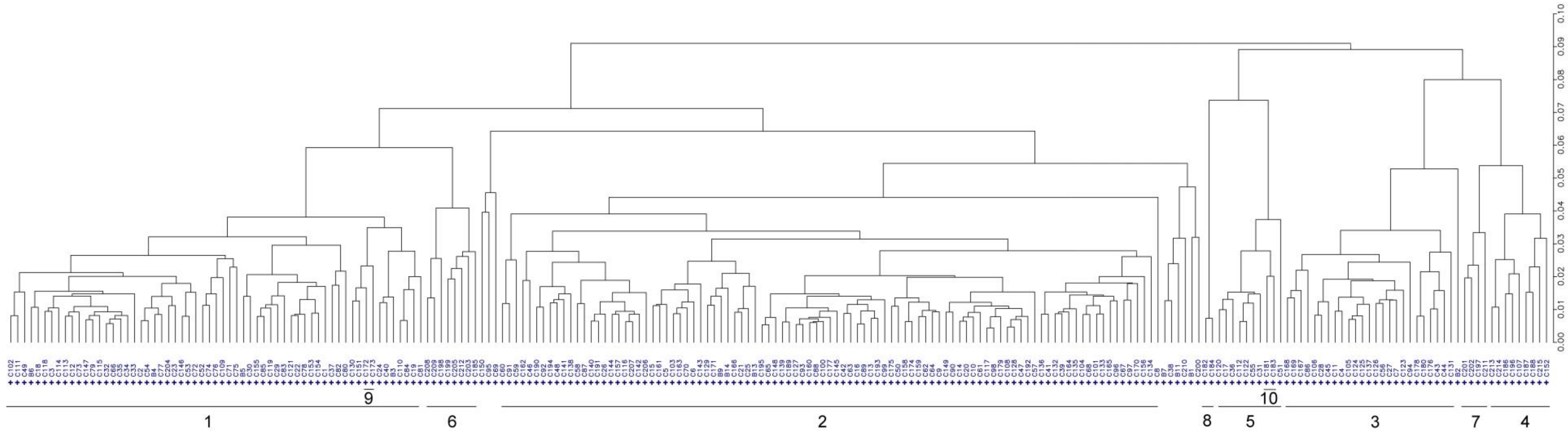

Figure V.1. Dendrogram resulting from HCA using squared Euclidean distance on the sub-composition of seven chemical elements. The large numbers (1-10) along the bottom of the chart represent the ten initial compositional groups referred to in the text.

the core groups. Given that the limited number of variables used in the analysis increases the potential for overlap in the measurement of otherwise different compositions, a high membership probability ensures the soundness of the compositional group classifications (see Mommsen 2001). Therefore, samples with less than 40% probability of group membership were excluded from further analyses and core groups were formed with the remaining samples.

The 24 samples outside the five largest groups proposed by HCA were treated as a single group of unassigned samples and analytically tested against the aforementioned groups. None of them produced a membership probability higher than 15% for any of the five largest groups (Appendix B, Table B.2, Unassigned samples). This supports both the statistical robustness of the five largest groups and the need for the high theoretical limit of 40% membership probability that was used to define the core groups.

Amongst the 24 initially unlabelled samples, it is here proposed that samples 185, 198, 199, 203, 205, 208, 209 and 212 form one group (Group 6), samples 197, 201, 202 and 211 form a second (Group 7), and samples 182 and 184 a third (Group 8). This suggestion is based on the cluster analysis (Figure V.1), the macroscopic classification of samples, and the findspot where they were recovered. Due to the number of samples in each of these groups being less than nine, membership probabilities could not be tested using MD and seven variables.

Even between the core groups, the separation between Group 1 and Group 5 is not fully supported by the analysis based on MD. Five of the 34 samples that form the core of Group 1 have > 40% membership probability of belonging to Group 5; three of those nine reclassified as Group 5 had more than 40% probability of belonging to Group 1. Furthermore, one of the 10 samples in Group 5 (according to HCA) has more than 40% probability of belonging to Group 1 (Appendix B, Table B.2). Most importantly, both Group 1 and Group 5 are related to the same ceramic stylistic types.

Finally, among the samples discarded from the five largest groups after the group analysis based on MD, it is proposed that samples 172 and 173 on the one hand, and samples 181 and 183 on the other hand, form two more compositional groups (Groups 9 and 10) based on their shared archaeological background (i.e. recovery from the same site and in the case of samples 172 and 173 belonging to the same stylistic type) and almost identical composition.

Thus, after HCA and a subsequent probabilistic group assignment based on MD calculations, and taking into consideration archaeological information, there seem to be 10 compositional groups.

Principal component analysis (PCA) is a variable reduction technique that maximizes the variance accounted for in the observed variables (in this case chemical elements) by a smaller group of variables called components. Its function is exploratory. Bivariate projections of PCA data (based on the variance-covariance matrix) allow for further evaluation of these compositional groups in a reduced dimensional space. PCA was performed on a dataset that included only the 146 samples already classified plus raw clay sample B7, which was unassigned according to HCA and MD-based group membership probabilities, but its closeness to Group F in several PC biplots prompted its inclusion.

Bivariate projections of the principal components supported the suspicion that Group 1 and Group 5 were in fact a single compositional group, and were consequently merged into a single group named Group A (Figure V.2). Further modifications based on PCA plots also included the return of samples 44 and 156 to their original groupings, as was originally indicated by HCA. Most importantly, PC biplot tests also hinted at the split of Group 6 into two (Group E and Group F in Figure V.2), in the way also indicated by its two branches in HCA.

The bivariate projection of Principal Component 1 and Principal Component 2 shows fair amounts of separation between the rearranged ten compositional groups (Figure V.2). The most problematic group is Group D, whose confidence ellipse overlaps with those of Groups G, B, and C. In general, those groups for which only core members were used produced tighter confidence ellipses, even if they included a larger number of samples. Together, PC1 and PC2 explain 82.7% of the total variance found in the set (66.2% and 16.5%, respectively). As we can see in Table V.3, the first component primarily represents variability in Cr, while the second component represents variation in Fe and the rare earth elements (i.e. Sc, Lu, and Yb).

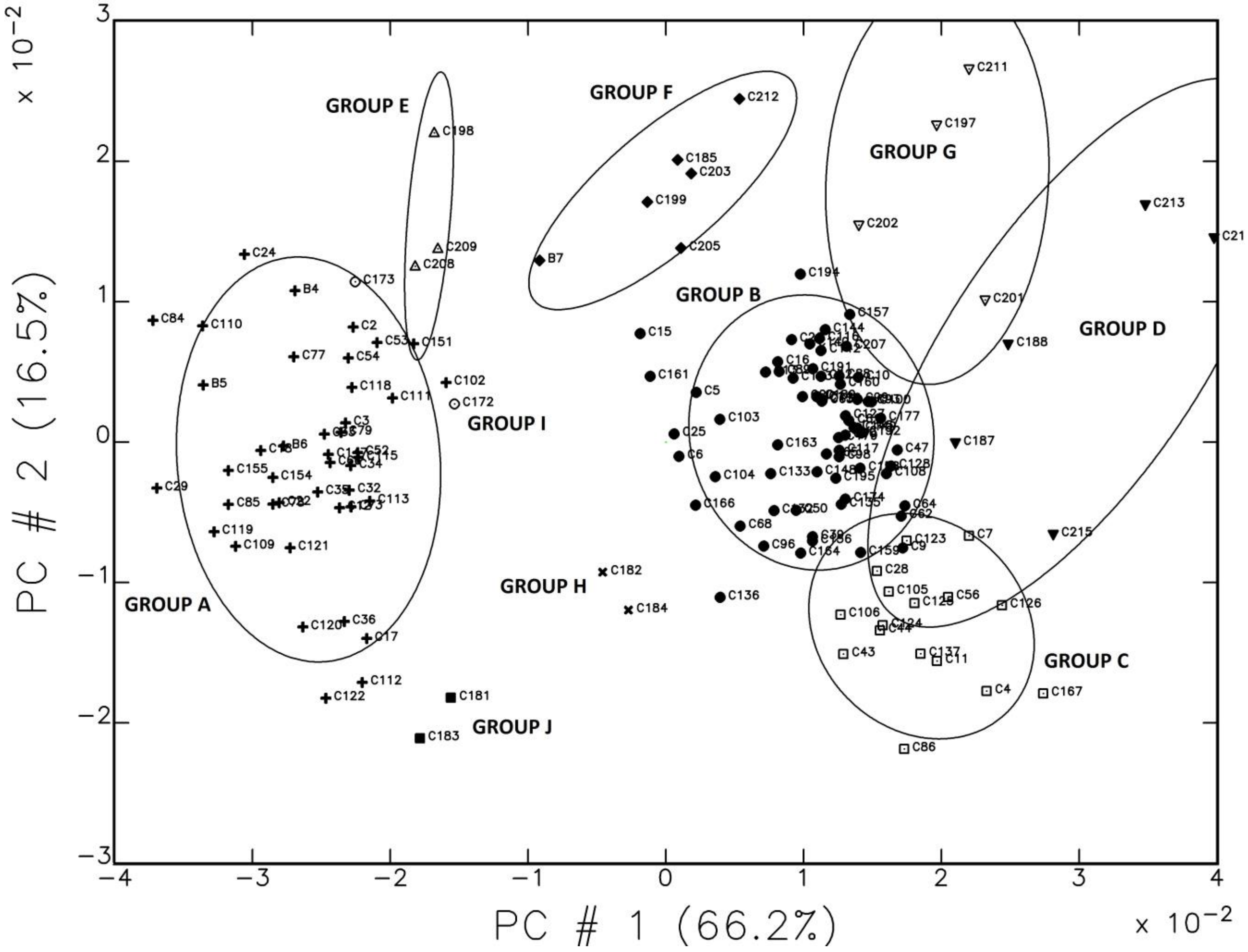

Figure V.2. Scatter plot on Principal Component 1 and Principal Component 2 of 147 samples (143 pottery samples and 4 raw clay samples), forming the 10 groups (A-J) identified by INAA. This first analysis used the compositional data of seven elements. Confidence ellipses for group membership have been drawn at the 85% probability level for groups consisting of three or more samples.

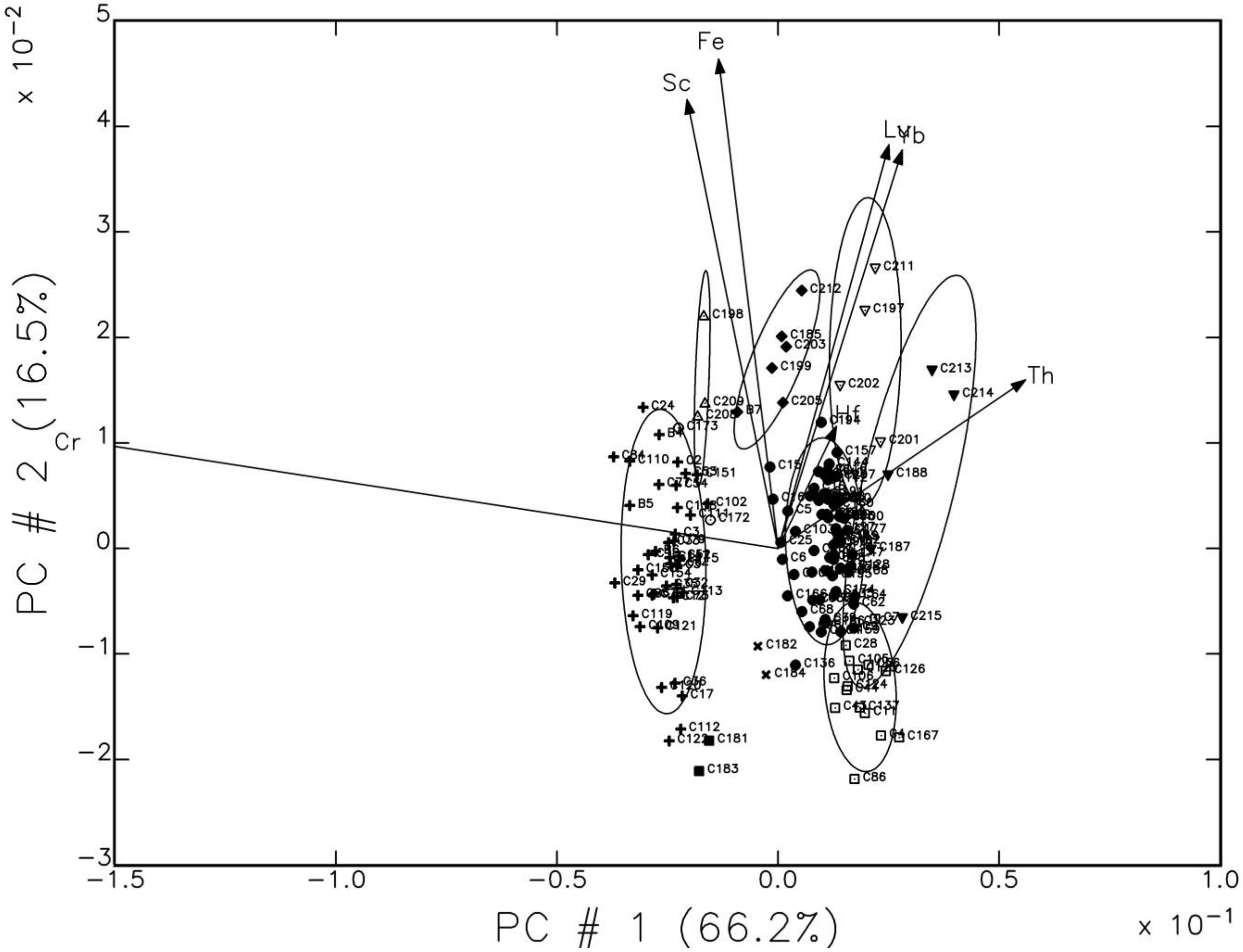

Figure V.3. Scatter plot showing both the samples and the element vectors on Principal Component 1 and Principal Component 2 for the first PCA analysis. The magnitude and direction of the vectors represent the contribution of individual elements to the principal components.

Table V.3. Component loadings derived from PCA of the INAA data, using compositional data for seven elements. The key variables for each PC are highlighted.

Variable	PC1	PC2	PC3
Sc	-0.119922687	**0.49652898**	-0.128296751
Cr	**-0.905377079**	0.117310132	0.354144087
Fe	-0.078199704	**0.54129225**	-0.236356144
Yb	0.163237239	**0.440828059**	-0.030585463
Lu	0.145720761	**0.446486401**	-0.044815204
Hf	0.07659927	0.135150948	0.140476637
Th	0.32564907	0.186426237	**0.882938347**
Eigenvalues:	0.052555027	0.013059775	0.009356759
Variance explained (%)	66.23905758	16.46021809	11.79302795

Additionally, Figure V.3 exhibits how Groups A, E, I and J are characterised by relative high levels of Cr compared to Groups B, C, D, F and G; how Groups E, F and G are richer in Fe and Sc; and how Group G is defined primarily by relative high levels of Lu and Yb.

The plotting of PC1 versus PC3 (Figure V.4), on the other hand, enables the clear distinction of Group D from Groups B and G, but the separation between Groups C and D is even less clear than in Figure V.2. There is also some overlapping between Groups E and J (clearly separated in Figure V.2), while Group I now appears at more distance from Group A than in the previous PCA biplot. Together, PC1 and PC3 explain 78% of the total variance. Both Table V.3 and Figure V.5 show that the key variables of the PC1 vs PC3 biplot are Cr and Th; PC3 basically represents variation in the latter. Figure V.5 also depicts how Group B has higher Th values compared to the rest of the groups, while Group A is the highest in Cr. Conversely, Groups E, H and J have the lowest Th concentrations, and Groups D and G are poorer in Cr.

As was mentioned above, a second round of multivariate statistical analyses was executed adding three additional chemical elements to the analysis, which in turn reduced the total of analysed samples to 110: 107 pottery samples and 3 raw clay samples. Raw clay sample B10 was left out of the analysis due to its markedly different composition, which would complicate the graphical appraisal of the data.

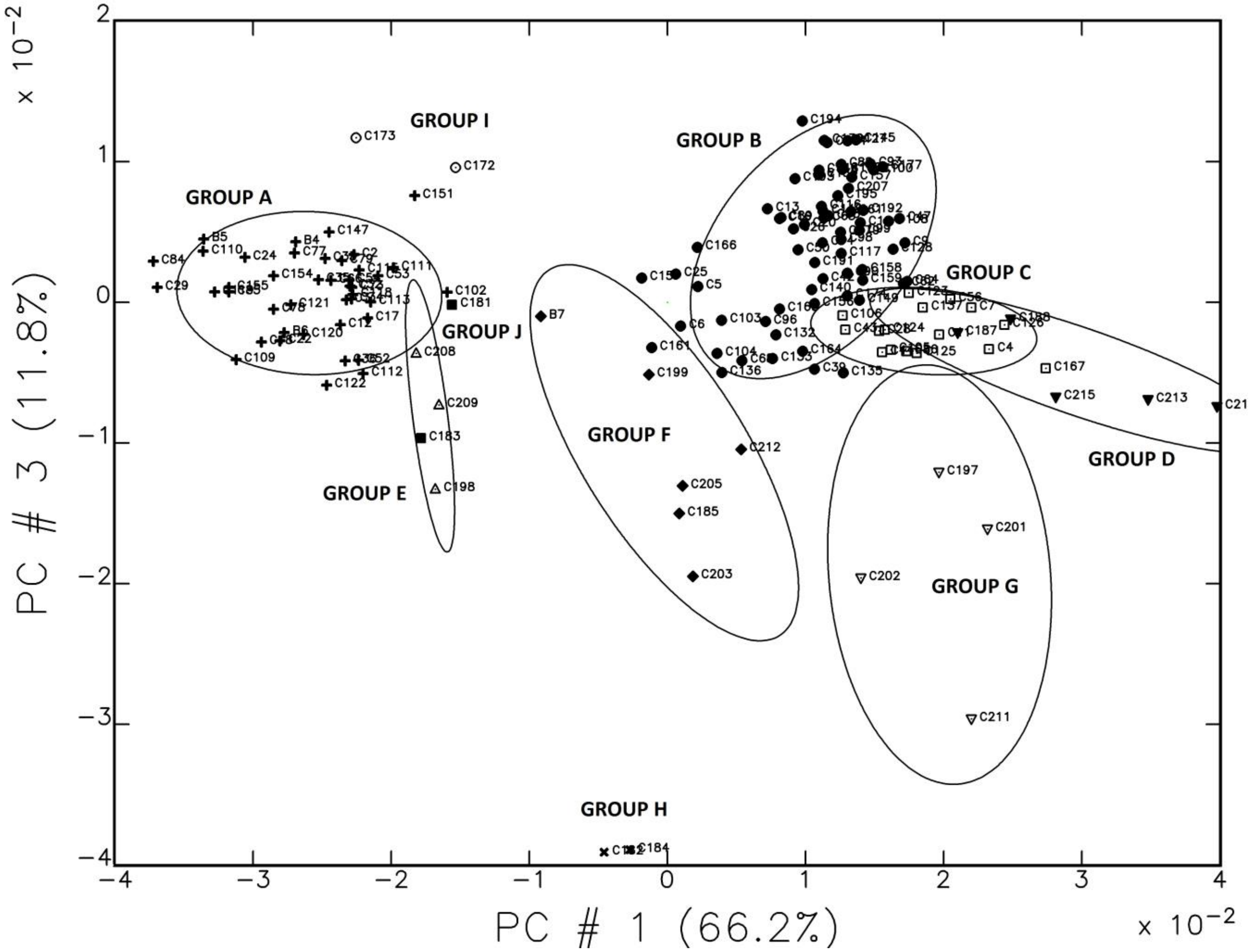

Figure V.4. Scatter plot of Principal Component 1 and Principal Component 3 of 147 samples, forming the 10 groups (A-J) identified by INAA using the compositional data of seven elements. Confidence ellipses for group membership have been drawn at the 85% probability level for groups consisting of three or more samples.

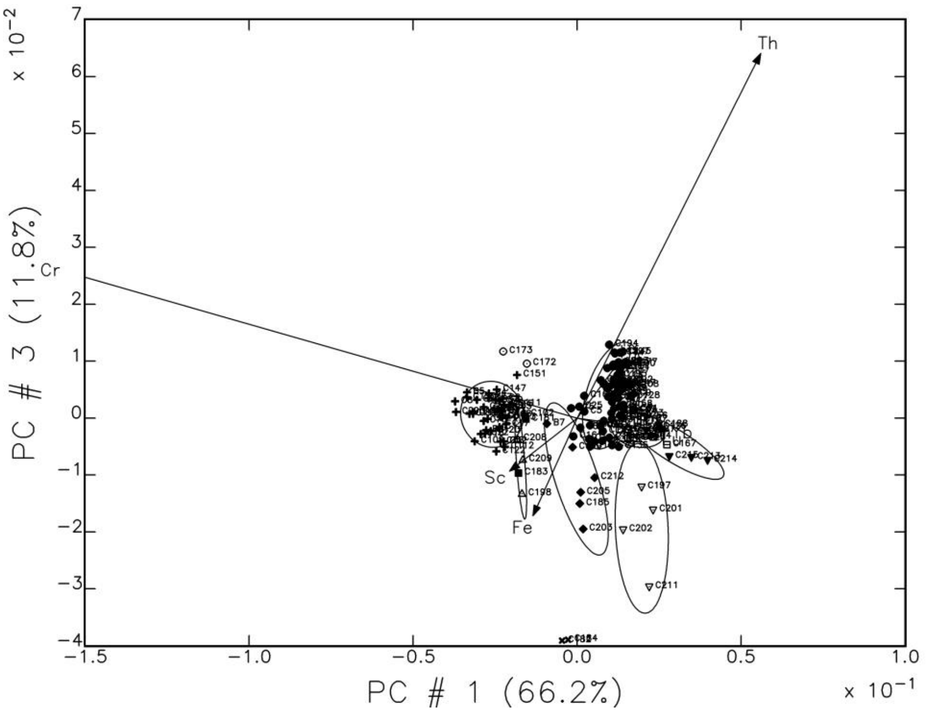

Figure V.5. Scatter plot showing both the samples and the element vectors on Principal Component 1 and Principal Component 3 for the first PCA analysis.

The resulting dendrogram of the HCA (Figure V.6) is much clearer. Most notably, Groups 1 and 5 of the first dendrogram (Figure V.1), which later merged into Group A, appear as a single branch.

There are 10 branches at a distance of 0.04ppm. Four of them are single-sample branches for samples B1, 198 (Group E), 180, and 8. There is a fifth branch for outliers 150 and 95. Four branches are for the groups previously defined as A, B, C and D. A tenth branch is for groups F and G, which are separated at a distance slightly smaller than 0.04 ppm. Finally, samples 172 and 173 (Group I) on the one hand, and sample 181 on the other (Group J), all appear as part of Group A's branch. Samples 182 and 184, which form Group H, were not included in this second round of analysis.

As with the first time around, group membership probabilities as determined by MD calculations were used to refine the groups. However, it was only possible to perform these calculations on Groups A, B and C (29, 45 and 15 samples, respectively) when using all 10 variables (i.e. chemical elements) in the analysis. After the group membership test, 83 out of the total of 89 samples fell into the groups suggested by HCA (Appendix B, Table B.3).

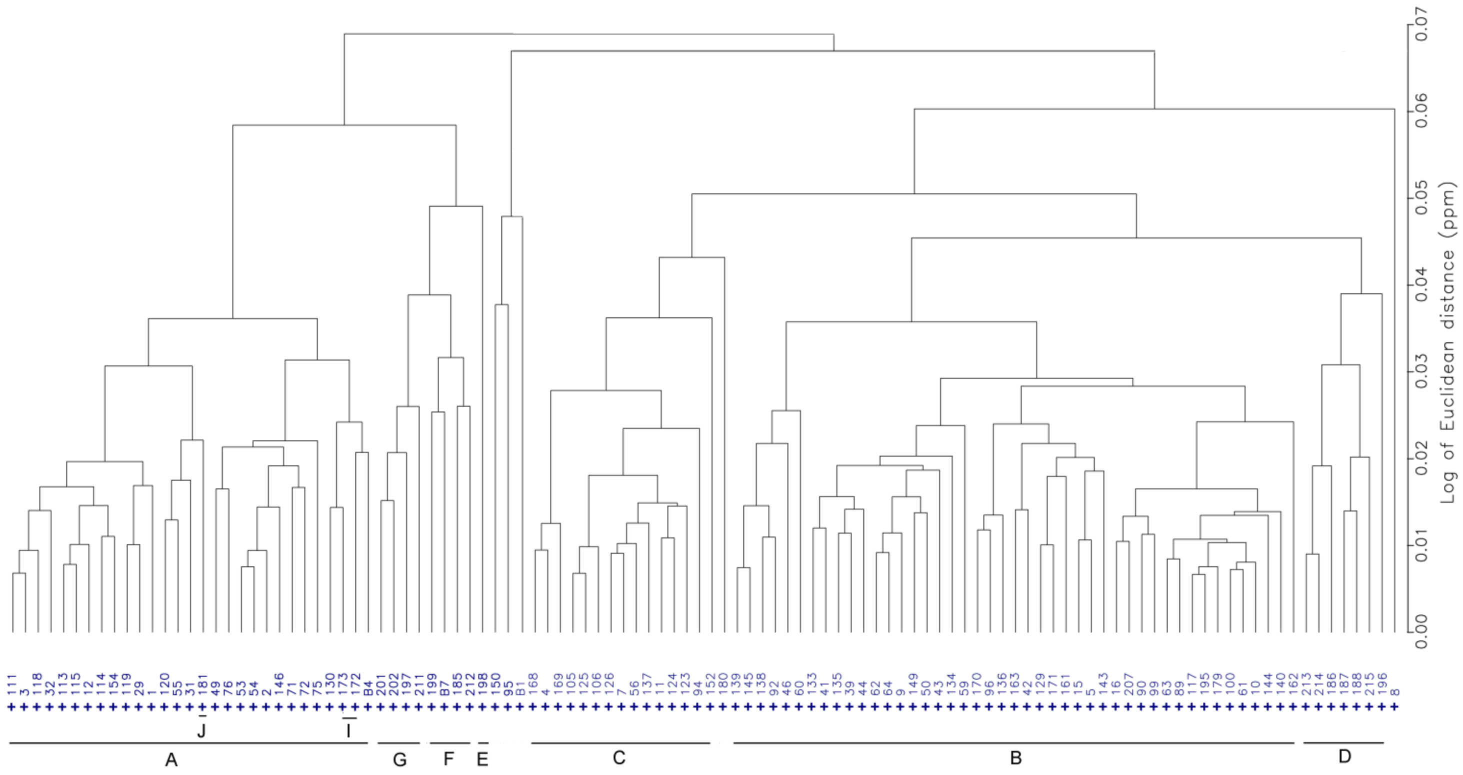

Figure V.6. Dendrogram resulting from HCA using squared Euclidean distance on the sub-composition of ten chemical elements. The letters (A-I) along the bottom of the chart represent the proposed ten compositional groups referred to in the text.

For the formation of the core groups, only those samples with a minimum of 45% of group membership probability were considered, a percentage slightly higher than in the previous analysis due to the smaller number of samples per group. The refining of the groups and the formation of core groups meant samples 172 and 173 (Group I), and sample 181 (Group J), were dropped from Group A, as expected. It also meant that samples 49, 55, 114 and 130, which were not included in the core of Group A during the first round of analysis, were now added to it. Sample 29, on the other hand, was removed from the core of Group A, due to its low group membership probability when considering 10 chemical elements. In the case of Group B, sample 138 was added to its core members and samples 42, 50, 113, 133, and 149, were removed. Finally, this second round of group membership probability calculations required the addition of samples 168 and 169 to the core members of Group C, and the removal of samples 7 and 123 from it.

A PCA of the reduced sample set was performed, using only the core members for the largest groups (as defined above). This reduced the total number of samples to 71. Together, PC1 and PC2 explain 77.9% of the total variance found in this reduced set.

PC1 primarily represents variability in Cr, while PC2 mainly represents variation in Fe and Sc, as represented by the vectors in Figure V.7. Again, the plot depicts good separation between the groups, with the exception of Group I, which falls inside the confidence ellipse of Group A. As the vectors indicate, Th and Hf do not have much weight in this plot; Figure V.5 previously showed that these are the elements constituting the basic distinction between these groups, hence their similar position in this projection.

In summary, it can be argued that the second round of multivariate analyses supported the existence of the groups defined by the first round of the same analyses, which originally included the full sample set but only seven chemical elements as variables. The only changes had to do with slight refinements of the cores of the major groups, adding and subtracting a few members based on group membership probabilities. The final groupings after the first round of analyses are listed in Table V.4, and descriptive statistics for the same groups are presented in Table V.5.

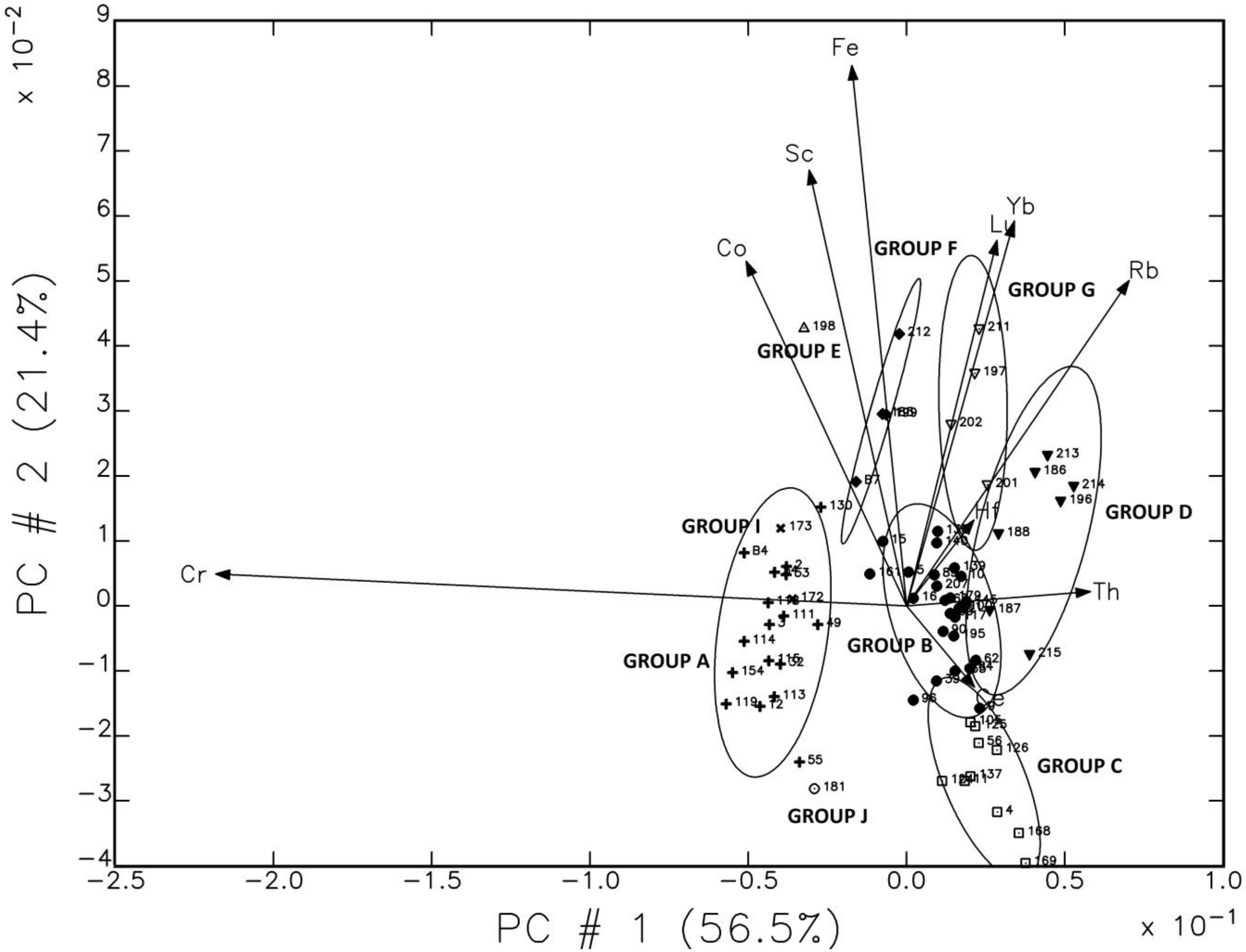

Figure V.7. Scatter plot on Principal Component 1 and Principal Component 2 of 71 samples and the element vectors, using the compositional data of 10 elements. Confidence ellipses for group membership have been drawn at the 90% probability level for groups consisting of three or more samples.

Table V.4. Compositional groups amongst the samples analysed by Instrumental Neutron Activation after two rounds of HCA, MD calculations and PCA. For the groups whose members were statistically tested by MD calculations (Groups A, B and C were tested using seven and 10 variables, Group D only using 7 variables), only the core members are included.

Compositional Group	Sample #
Group A, n = 45	B4, B5, B6, 2, 3, 12, 17, 18, 22, 24, 32, 33, 34, 35, 36, 49, 52, 53, 54, 55, 66, 73, 77, 78, 79, 84, 85, 102, 109, 110, 111, 112, 113, 114, 115, 118, 119, 120, 121, 122, 130, 147, 151, 154, 155
Group B, n = 63	5, 6, 9, 10, 13, 14, 15, 16, 20, 25, 26, 39, 47, 61, 62, 63, 64, 65, 68, 88, 89, 90, 93, 96, 98, 99, 100, 103, 104, 108, 116, 117, 127, 128, 132, 135, 136, 138, 139, 140, 142, 144, 145, 148, 156, 157, 158, 159, 160, 161, 163, 164, 166, 174, 177, 179, 189, 191, 192, 193, 194, 195, 207
Group C, n = 16	4, 11, 28, 43, 44, 56, 86, 105, 106, 124, 125, 126, 137, 167, 168, 169
Group D, n = 5	187, 188, 213, 214, 215
Group E, n = 3	198, 208, 209
Group F, n =6	B7, 185, 199, 203, 205, 212
Group G, n = 4	197, 201, 202, 211
Group H, n = 2	182, 184
Group I, n = 2	172, 173
Group J, n = 2	181, 183

Table V.5. Descriptive statistics (means and standard deviations) of the ten compositional groups characterised by INAA. Standard deviations are shown between brackets when more than one sample was quantified. Co, Rb, and Ce quantifications were obtained from the analysis of a reduced sample set, hence the absence of results for Group H. For the groups that were statistically tested by MD calculations (i.e. A, B, C and D), only the core members are included.

	Sc	Cr	Fe (wt %)	Yb	Lu	Hf	Th	*Co*	*Rb*	*Ce*
Group A (n = 45, *17*)	**16** ± 1	**95** ± 14	**4.7** ± 0.4	**1.5** ± 0.2	**0.24** ± 0.03	**3.4** ± 0.3	**1.9** ± 0.2	**22** ± 2	**23** ± 5	**31** ± 2
Group B (n = 63, *25*)	**14** ± 1	**40** ± 5	**4.4** ± 0.3	**1.8** ± 0.2	**0.28** ± 0.02	**3.5** ± 0.2	**3.0** ± 0.5	**18** ± 2	**35** ± 6	**31** ± 3
Group C (n = 16, *10*)	**11** ± 1	**29** ± 4	**3.4** ± 0.3	**1.6** ± 0.2	**0.25** ± 0.02	**3.7** ± 0.3	**2.4** ± 0.1	**16** ± 2	**26** ± 4	**39** ± 4
Group D (n = 5, *7*)	**14** ± 1	**23** ± 4	**5.1** ± 0.4	**2.2** ± 0.5	**0.32** ± 0.07	**4.8** ± 0.4	**2.7** ± 0.2	**19** ± 4	**37** ± 3	**36** ± 7
Group E (n = 3, *1*)	**20** ± 2	**74** ± 5	**6.7** ± 1.2	**1.9** ± 0.2	**0.30** ± 0.02	**3.6** ± 0.3	**1.8** ± 0.1	**30**	**37**	**17**
Group F (n = 6, *4*)	**20** ± 2	**48** ± 10	**6.4** ± 0.7	**2.1** ± 0.2	**0.35** ± 0.03	**3.4** ± 0.4	**2.0** ± 0.3	**26** ± 6	**35** ± 5	**33** ± 5
Group G (n = 4, *4*)	**20** ± 3	**26** ± 3	**6.6** ± 0.8	**2.3** ± 0.3	**0.38** ± 0.04	**3.4** ± 0.3	**2.0** ± 0.4	**23** ± 2	**33** ± 3	**30** ± 5
Group H (n = 2, *0*)	**15** ± 0	**36** ± 1	**4.7** ± 0.3	**1.5** ± 0	**0.27** ± 0.01	**2.9** ± 0	**0.8** ± 0			
Group I (n = 2, *2*)	**15** ± 1	**94** ± 16	**5.0** ± 0.2	**1.8** ± 0.1	**0.27** ± 0.03	**4.4** ± 0.9	**2.6** ± 0.1	**27** ± 4	**26** ± 5	**32** ± 1
Group J (n = 2, *1*)	**12** ± 0	**69** ± 1	**3.3** ± 0.1	**1.4** ± 0.1	**0.22** ± 0.01	**2.4** ± 0	**1.7** ± 0.4	**18**	**25**	**25**

V.3. CORRESPONDENCE BETWEEN GEOCHEMICAL GROUPS, STYLISTIC TYPOLOGY, AND MICRO-REGIONAL DISTRIBUTION

As depicted in Table V.6, half of the geochemical groups can be almost exclusively linked to one or more specific ceramic types. Group A is clearly associated with five ceramic types: Libramiento Ring-based Mortar, Libramiento Pedestal-based Bowl, Libramiento Red Rim, Bugambilias Red-on-orange and Pozo Hundido Red-on-brown. At least the first four of these have already been considered part of the same ceramic complex located around the Colima Valley (Appendix A). Group B seems to be linked with the red-on-cream jars, and Group C with the Colima Incised bowls. All five Group D specimens are of the Armería Cream/Orange type, and both Group H samples are of the Tecomán Fine Cream type, the only specimens of this type analysed.

Conversely, eight of the fourteen characterised types seem to have been separately produced using more than one raw clay source, even if most show a preferred or more popular one within the sampled material. The Colima Shadow-striped type of cooking vessels shows by far the largest compositional diversity, with at least six different clay sources used for its manufacture.

Table V.6. Correlation of geochemical groups with stylistic types. Key numbers are shown in a larger size and italics to highlight the main correlations.

CERAMIC TYPE / GROUP	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**total**
Tecomán Fine Cream								*2*			**2**
Amela Red										1	**1**
Tecomán Coarse Cream						1				1	**2**
Armería Cream/Orange				*5*		1	1				**7**
Colima Incised	1	2	*12*								**15**
Pozo Hundido Incised		2	2								**4**
Colima Red-on-cream	1	*28*									**29**
Borregas Red-on-cream		*17*			2						**19**
Colima Shadow-striped	4	14			1	3	3		2		**27**
Libramiento Ring-based Mortar	*2*										**2**
Libramiento Pedestal-based Bowl	*7*										**7**
Libramiento Red Rim	*4*										**4**
Bugambilias Red-on-orange	*21*		2								**23**
Pozo Hundido Red-on-brown	*2*										**2**
total	**42 + B4, B5, B6**	**63**	**16**	**5**	**3**	**5 + B7**	**4**	**2**	**2**	**2**	**144**

To gain insight into the probable location of the clay sources, Table V.7 exposes the relationship between compositional groups and pottery distribution. In the case of Group A, besides the fact that pottery from this group has a restricted distribution, limited to the Colima Valley, there is also a geochemical match with raw clay samples B4, B5 and B6 (Table IV.3) from the Comala area of the same valley. The link between geographical micro-region and compositional group is thus straightforward in this instance.

The same can be said about Groups D, E and G on the one hand, and H, I and J on the other. Their pottery was recovered exclusively in the western coast and the Tecomán coastal plain, respectively, although in both cases there was no compositional match with any of the analysed raw clays.

In the case of Group B things get more complicated. It is the only compositional group that appears in all four of the sampled micro-regions. However, of the Group B pottery, only red-on-cream jars were recovered from the western coast and the Tecomán coastal plain. The fact that the shadow-striped cooking vessels from this compositional group were only recovered in the Colima Valley and the Salado River basin points to either of these two micro-regions as probable locations of the clay source.

Group C pottery was only recovered in the Colima Valley and the Salado River basin, so its clay source is likely to be around either of these two areas.

Finally, there seems to be a fair match between raw clay sample B7, from Rincón de López in the Armería Valley, and Group F pottery, which was recovered in the neighbouring micro-regions of the western coast and the Tecomán coastal plain. This match is statistically less robust than the one for raw clay samples B4, B5, and B6 and Group A, since it was not supported by all of the multivariate statistical analyses as the latter. It is tempting to believe that, at least, the clay source for this pottery must be located *somewhere* around the Armería Valley; however, geographical space does not equal compositional space (Day et al. 1999:1027). Pottery samples recovered at the Armería Valley were not available for this study.

Chapter VI presents the results of the thin-section petrographic analysis. The geology of the research area in relation to the location of the clay sources, the degrees of standardisation of pottery production, and the directions of pottery circulation, are discussed in Chapter VII, which integrates the geochemical and petrographic data.

Table V.7. Correlation of the geochemical groups, the micro-regions where they were recovered, and the probable location of the clay sources. Sources in bold are backed by strong (Group A) and fair (Group F) geochemical matches between compositional groups and raw clay samples.

GEOCHEMICAL GROUP	***MICRO-REGION WHERE POTTERY WAS RECOVERED***	***SOURCING***
A	**Colima Valley** (n = 42)	**Comala** area (Colima Valley)
B	**Colima Valley**, **Salado River basin**, **Tecomán coastal plain** & **western coast** (n = 44, 9, 3, 7)	Colima Valley? Salado River basin?
C	**Colima Valley** & **Salado River basin** (n = 13, 3)	Colima Valley? Salado River basin?
D	**Western coast** (n = 5)	Western coast?
E	**Western coast** (n = 3)	Western coast?
F	**Western coast & Tecomán coastal plain** (n = 4, 1)	**Rincón de López** (Armería Valley)?
G	**Western coast** (n = 4)	Western coast?
H	**Tecomán coastal plain** (n = 2)	Tecomán coastal plain?
I	**Tecomán coastal plain** (n = 2)	Tecomán coastal plain?
J	**Tecomán coastal plain** (n = 2)	Tecomán coastal plain?

V.4. BULLET POINT SUMMARY

INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS

- Method and objectives

  -INAA of 215 pottery samples and 14 raw clay samples

  Objectives:

  -To determine pottery compositional groups

  -To help in determining pottery provenance by comparing the geochemical compositions of the pottery samples with those of the raw clay samples

- Results

  -Ten geochemical groups, each comprised of at least two pottery samples

  -Strong association between geochemical groups, ceramic stylistic types and geographical micro-regions:

  -Group A's pottery, mostly composed of five different types of mortar bowls, is exclusively found in the Colima Valley. Three raw clay samples from the Comala area of the same valley are excellent compositional matches for Group A's pottery

  -Group B's pottery, mostly composed by Red-on-cream jars (liquid containers) and Shadow-striped cooking vessels, is found in all four geographical micro-regions sampled for pottery. Notably, only the Red-on-cream jars are found outside the Colima Valley and the Salado River basin

  -Group C's pottery, mostly composed of engraved (Colima Incised) and incised (Pozo Hundido Incised) bowls, is found in the Colima Valley and the Salado River basin

  -Group D's pottery specimens are all of the Armería Cream/Orange type, and were all recovered from the western coast

  -Groups E and G are also exclusively linked to the western coast

-Group F’s pottery is found in the western coast and the Tecomán coastal plain. A raw clay sample from the Armería Valley turned out to be a fair compositional match

-Groups H, I and J, are exclusively linked to the Tecomán coastal plain

-The Colima Shadow-striped type of cooking vessels is linked to six different compositional groups (A, B, E, F, G and I), covering the four micro-regions sampled for pottery

CHAPTER VI. THIN-SECTION PETROGRAPHY

The general aims of petrographic analysis are to assess the variability of the set of ceramic samples, in terms of mineralogical composition and manufacturing technology, as well as providing useful data for determining the provenance of the samples. Thin-section petrographic analysis was chosen for the following reasons: (i) it is a cost-effective way to analyse and qualitatively characterise the mineralogical composition of pottery samples while observing any microscopic technological features; and (ii) in addition to the geochemical characterisation of the samples, petrography provides another way to assess the samples' compositional variability and gives extra data for provenance studies. Moreover, petrographic analysis can help explain the geochemical differences found within the sample set.

The number of samples to be examined by thin-section petrography was determined by the limited time available for sample preparation (2 weeks), which was the length of the stay at the Wolfson Archaeological Science Laboratories (UCL) covered by a bench fee. Standard petrographic thin-sections were prepared from 60 pottery samples chosen from the 215 samples previously subjected to INAA. These 60 samples included specimens from each of the four geographical micro-regions, and were recovered from fifteen different sites: eleven sites in the Colima Valley, one in the Salado River basin, one in the Tecomán coastal plain, and two in the western coast (Table VI.1).

Thirty-nine of these samples represent the ten geochemical compositional groups obtained through INAA: fifteen samples belong to compositional Group B, eight samples to Group A, six samples to Group C, three samples to Group G, two samples to Group D, and one sample each to the rest of the groups (Group E, Group F, Group H, Group I and Group J). Samples that fell into an unexpected geochemical group (i.e. grouped with non-related samples), such as 004, were favoured in the selection process. The remaining 21 samples were selected from those whose geochemical data was not confidently assigned to a compositional group and those that are clearly geochemical outliers, such as 008. Beyond this influence in the sampling process, the geochemical grouping of the samples was not taken into consideration during petrographic analysis. A comparison of the results from these two tests is presented in VI.5. Because of the (small) discrepancies between the two sets of results, the discussion about the relationship between petrographic fabrics, macroscopic typology, and micro-regional distribution was left for the next chapter (VII). Chapter VII also offers a discussion of the samples' provenance based on the joint results from the two analyses.

Table VI.1. List of the 60 thin-sectioned ceramic samples. Total numbers of samples are between brackets. Samples (n = 12) that were also subjected to X-ray diffraction analysis (XRD) are in bold.

Sample #	Site	Micro-region
001, 003, 004, 008	Chiapa (4)	Colima Valley (39)
015, 017, 019, 022	Primavera (4)	
028, **031**, 040	Parcela 82 (3)	
043, **051**, 052, 055	Nuevo Milenio (4)	
056, 059	El Tívoli (2)	
065, **069**, 072	Higueras del Espinal (3)	
076, 084, 088	Tabachines (3)	
091, 094, 095	Rancho Blanco (3)	
104, 107, 108, 110	Real Centenario (4)	
116, 117, 119, 123, 125	Tapatía (5)	
133, 138, 142, 143	Cajita del Agua (4)	
156, 159, 161, 162, 168	Las Ánimas (5)	Salado River basin (5)
173, 177, **178**, **181**, 182, 185	Zanja Prieta (6)	Tecomán coastal plain (6)
186, **188**, **194**, 195, 197, **200**	Terminal Marítima (6)	Western coast (10)
201, 208, **211**, 215	El Volantín (4)	

VI.1. METHOD AND OBJECTIVES

Ceramic petrographic analysis centres on the microscopic examination of pottery sections of a standard thickness under transmitted polarized light (Reedy 2008). All of the sample preparation work was done at the Wolfson Archaeological Science Laboratories at the UCL Institute of Archaeology. Preparing the thin sections required a small piece, or 'chip,' to be cut from each potsherd. Cuts were made following the vessels' vertical axes; consistent use of the same type of sectioning permits a meaningful comparison to be made between samples. Vertical or perpendicular sectioning enables both the inner and outer walls of the vessel to be observed under the microscope and, consequently, allows the orientation of inclusions and voids to be examined in relation to those margins. Certain preferential orientations are considered diagnostic of some forming techniques (Quinn 2013:97,174-81; Reedy

2008:181-82; Rice 1987:380-81; Santacreu 2014:77-79; Thér 2016; Whitbread 1996).

The small pieces removed from the potsherds had their freshly cut side polished until a flat surface was achieved. The samples were then bonded to a glass slide (76 x 26mm), with the polished face down. At this point, a majority of the pottery chip was cut off using a thin-sectioning machine; the remainder on each slide was hand-polished on a glass plate fed with abrasive carborundum grit and water. In this way, each chip was ground down to the desired thickness of 30µm (1000µm = 1mm), at which quartz exhibits a grey-white first order interference colour under the microscope. The thin sections were then covered with a thin glass cover and labelled with the corresponding sample numbers.

These samples were examined in the microscope room of the Department of Archaeology at the University of Exeter. A polarising light microscope with a rotating stage was employed, using both plane polarised light and crossed polars, and final magnifications of 25x, 50x and 100x. The microscope was equipped with a ZEISS *Axiocam 105 color* digital camera with a 1x adapter, controlled with computer software; this camera was used to obtain images of the samples as shown in this chapter and in Appendix D. The image captions state the scale of the image and whether it was taken under plane polarised light (PPL) or under crossed polars (XP).

The objectives of this examination are to visually assess, group and characterise the composition, microstructure and optical activity under the microscope of the archaeological ceramics, focusing on the ceramic's main body or fabric proper, while giving far less attention to slips and paint layers. This allows the determination of fabric classes and sub-classes, on the one hand, and the identification of raw materials and pottery recipes, the recording of evidence about clay forming techniques, and estimations of firing temperature on the other hand.

Once the petrographic variability within the sample set is established, it is possible to determine: (i) if the fabrics sampled are homogenous (in both their compositional and technological characteristics) within and between the micro-regional geographical units; (ii) what fabric groups can be linked exclusively to particular micro-regions; (iii) if there are compositional or technological peculiarities that can be connected to specific pottery types or assemblages; and (iv) the relationship of the results with those produced through INAA.

VI.2. CLASSIFICATION OF FABRICS

The term 'fabric' is defined as the arrangement, size, shape, and frequency of the different components of the ceramic body material and voids, plus the material's petrological and mineralogical composition (Quinn 2013:39; Whitbread 1986:79, 1995:368). Since there is no database of thin-sectioned pottery from the research area, there was no possibility of comparing these samples with previous petrographic studies of contemporaneous material. Therefore, the fabric classification was constructed exclusively on compositional and technological distinctions and similarities within the sample set, as judged meaningful when viewed in thin section (Quinn 2013:71-79).

The three main constituents of the fabrics, namely clay matrix, inclusions, and voids, were visually assessed. The term 'clay matrix' refers to the extremely fine-grained material (<0.01mm) that surround the inclusions (Quinn 2013:39-44; Whitbread 1995:369-71).

Samples were grouped into fabric classes by considering characteristics such as mineralogy, the abundance of non-plastic inclusions in relation to the clay matrix (based on estimation charts; Appendix D, Figure D.10), shape, roundness and degree of chemical weathering and erosion of the inclusions, and the texture of the clay matrix, amongst others. Each of the resulting fabric classes can therefore be defined as representing a specific combination of inclusions, clay matrices, and voids, one that differs from other combinations found in the sample set (Quinn 2013:73-79). The results show relatively high variability within the sample set, consisting of seven fabric classes (Table VI.2).

Table VI.2. Fabric classification of the 60 pottery samples that were petrographically analysed.

Fabric Class	Sample #
Residual Volcanic Rocks	001, 003, 004, 017, 031, 051, 052, 055, 072, 076, 084, 110, 119
Volcanic Rocks-tempered	015, 019, 022, 028, 040, 043, 056, 059, 065, 069, 088, 091, 094, 095, 104, 108, 116, 117, 123, 125, 133, 138, 142, 143, 156, 159, 161, 162, 168, 173, 194, 195, 200, 208
Volcanic Rocks-tempered with Peloids	177, 178
Volcanic Rocks-tempered with Sparry Calcite	181
Well-sorted Sand	008
Metamorphic Rocks	107, 185, 186, 188, 197, 201, 211, 215
Very Fine Feldspar and Biotite	182

VI.3. CHARACTERISATION OF FABRICS

In this thesis, ‘fabric characterisation’ refers to the qualitative description of the characteristics of the petrographic fabrics. Ideally, such characterisations go beyond the mere illustration of the differences between fabric classes; they should provide comprehensive and systematic descriptions that can aid in the classification of samples not initially considered in the analysis (Quinn 2013:79-80; Whitbread 1995:2). In other words, fabric characterisations must serve as a reference database for future analyses.

Full petrographic characterisations can be found in Appendix D. The complete descriptions include the relative abundance of the main fabric constituents within each class, detailed entries for each rock and mineral identified (e.g. maximum grain size, dominant size, etc.), notations of any evidence of forming and finishing techniques, and internal variations found within classes.

In this chapter, I present summarised petrographic characterisations of the seven fabric classes (one of them composed of 2 sub-classes). Fabric classes were numbered consecutively from 1 to 7; in this discussion they will sometimes be referred to by these numbers and not by their full name. Likewise, the names of the two sub-classes of Fabric Class 2 were shortened to Sub-classes A and B. The short descriptions presented below aim to explain and clarify the differences within the sample set (Quinn 2013:100-02). They include the main petrological and mineralogical compositions, a short interpretation of the raw materials that were identified, and comments on the manufacturing and firing technologies inferred by thin-section evidence. The relationship between classes with respect to similar ceramic composition and manufacture technology is also noted (e.g. two classes may share mineralogical compositions or textural features, or—perhaps—recipes).

1. **Residual Volcanic Rocks Fabric Class**, n = 13 (21.7% of the sample set). Pottery types: Bugambilias Red-on-orange (6), Libramiento Pedestal-based Bowl (3), Libramiento Red Rim (2), Pozo Hundido Red-on-brown (2).

This medium coarse-grained, moderately calcareous fabric is characterized by the dominant presence of very poorly sorted sub-angular to sub-rounded inclusions of volcanic origin, set in a dark brown clay matrix (Figure VI.1). Non-plastics include basic to intermediate fine-grained volcanic rock fragments, plagioclase feldspars, pyroxenes and amphiboles. The size mode of the most frequent type of inclusion = 0.5mm. The degree of angularity of the inclusions, and their poor degree of sorting, both suggest that this is primary or residual clay—or just minimally transported from the parent rock's location.

There is no evidence of significant modification of this clay for pottery manufacturing. A few samples appear to be more packed and to have more angular-shaped inclusions, suggesting that they could have been tempered. More likely, they represent the natural variability within the clay deposit. In any event, most of the inclusions found in the clay can be considered residues of the parent rock(s): fine-grained basic to intermediate volcanic rocks, such as basaltic andesite and/or andesite (for a discussion of clay sourcing and the geology of the area see Section VII.1).

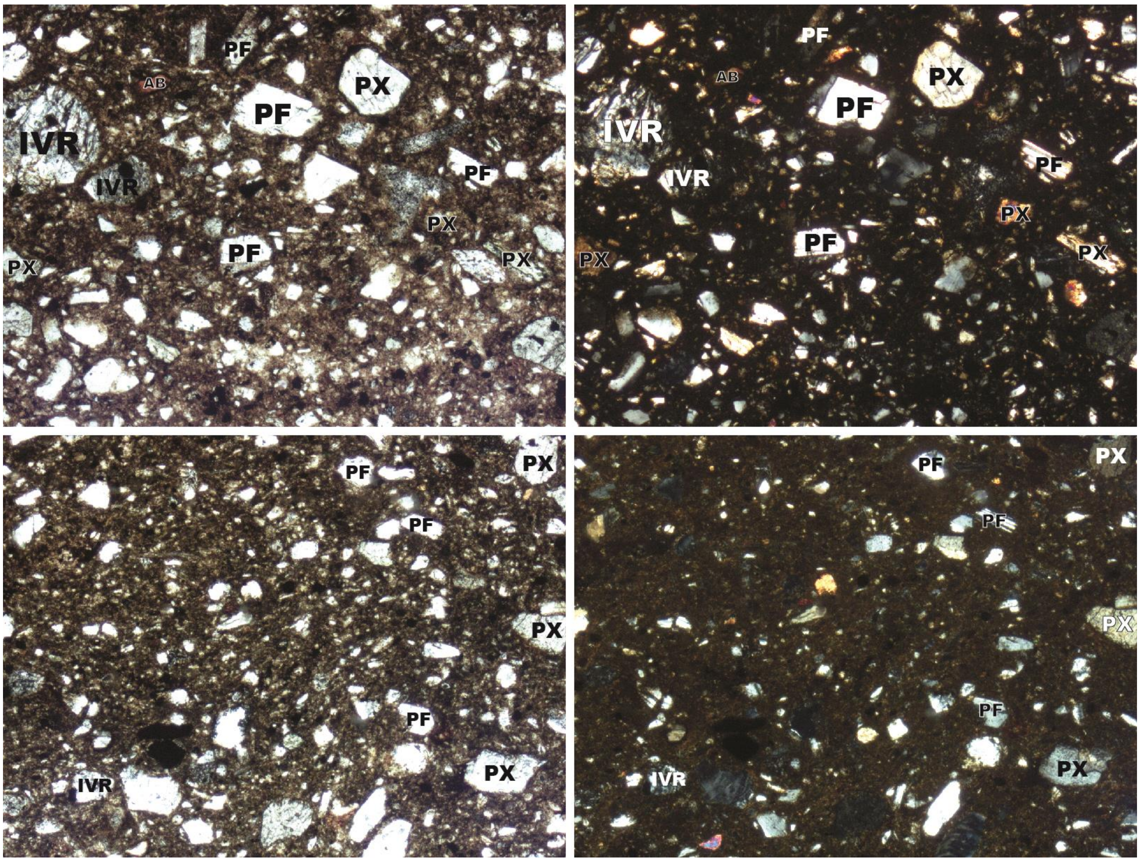

Figure VI.1. Photomicrographs of samples 001 (top) and 052 (below) of the Residual Volcanic Rocks Fabric Class. Key: IVR, intermediate volcanic rock; PF, plagioclase feldspar; PX, pyroxene. Taken in PPL (left) and with XP (right). Single image width = 2.3mm.

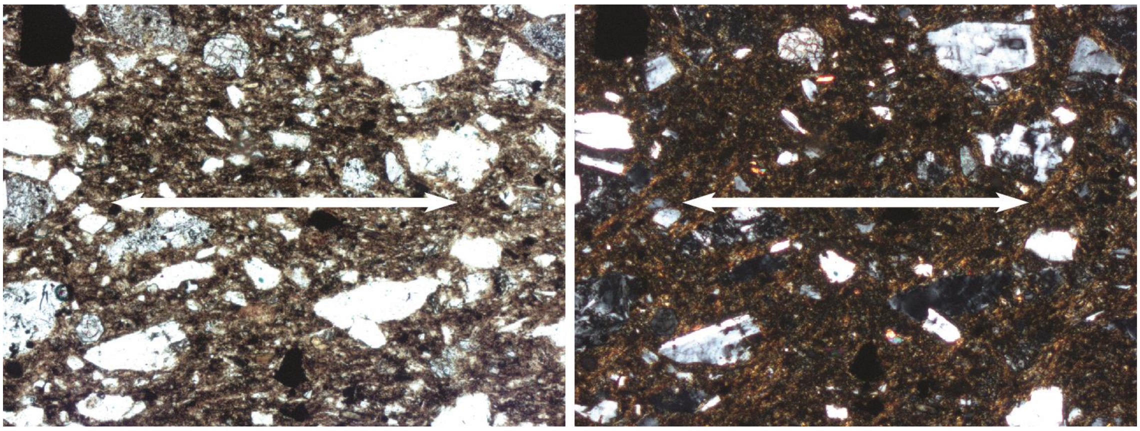

Figure VI.2. Photomicrographs of sample 003 of the Residual Volcanic Rocks Fabric Class. The white arrow highlights moderate left-right preferred orientation of inclusions and voids, aligned with vessel margins. Taken in PPL (left) and XP (right). Single image width = 1.1mm.

The preferred alignment of planar voids and elongated rock fragments or minerals (Figure VI.2) points to the application of pressure to the clay during forming and, perhaps, to the paddle-and-anvil secondary forming technique (Quinn 2013:61-68,156). This technique can be applied to hand-formed pots, including coiled and moulded ones (Orton et al. 1993:125; Rice 1987:136-37). Coiling evidence is commonly erased after paddling, but there are still some relic coils visible in thin section around the vessels' borders. It can also be that a single coil was added to form the bowls' lips and the rest of the shape was made using another primary forming technique.

Several of the samples exhibit anisotropic matrices, i.e. their crystalline structures were not eliminated during firing (Rice 1987:431). Colour variations found within the clay matrices indicate that the pottery was fired in an uncontrolled atmosphere, hinting at the use of open firing.

This fabric class is not closely related to any other in this study.

2. **Volcanic Rocks-tempered Fabric Class**, n = 34 (56.7% of the sample set). Pottery types, Sub-class A: Borregas Red-on-cream (9), Colima Red-on-cream (8), Colima Shadow-striped (6), Colima Incised (1); Sub-class B: Colima Incised (7), Pozo Hundido Incised (2), Colima Shadow-striped (1).

This medium coarse to fine-grained, calcareous fabric is characterized by well-sorted, crushed intermediate volcanic rocks (andesite?) used as tempering material; there are two defined sub-fabrics, determined by how finely crushed the rocks added as temper are (Figure VI.3). The size modes of the most frequent inclusions of the coarse fraction (temper) are 0.40 and 0.20mm, respectively. Two samples of the Medium-sorted Temper Sub-class show evidence for added grog, in addition to crushed rocks. The temper material was added to clay that already contained some rounded, non-plastic inclusions as constituents of the alluvium sediment. Amongst the most prominent inclusions—added and/or naturally occurring—are intermediate volcanic rock fragments (andesite?), sedimentary rock fragments (clastic rocks, carbonate rocks and chert), clay pellets, plagioclase feldspars, pyroxenes, amphiboles, and biotite. The base clay is sedimentary/secondary in nature: the eroded appearance and high degree of variety of the naturally occurring inclusions suggests that they were long transported by natural forces before being deposited in the alluvial deposit.

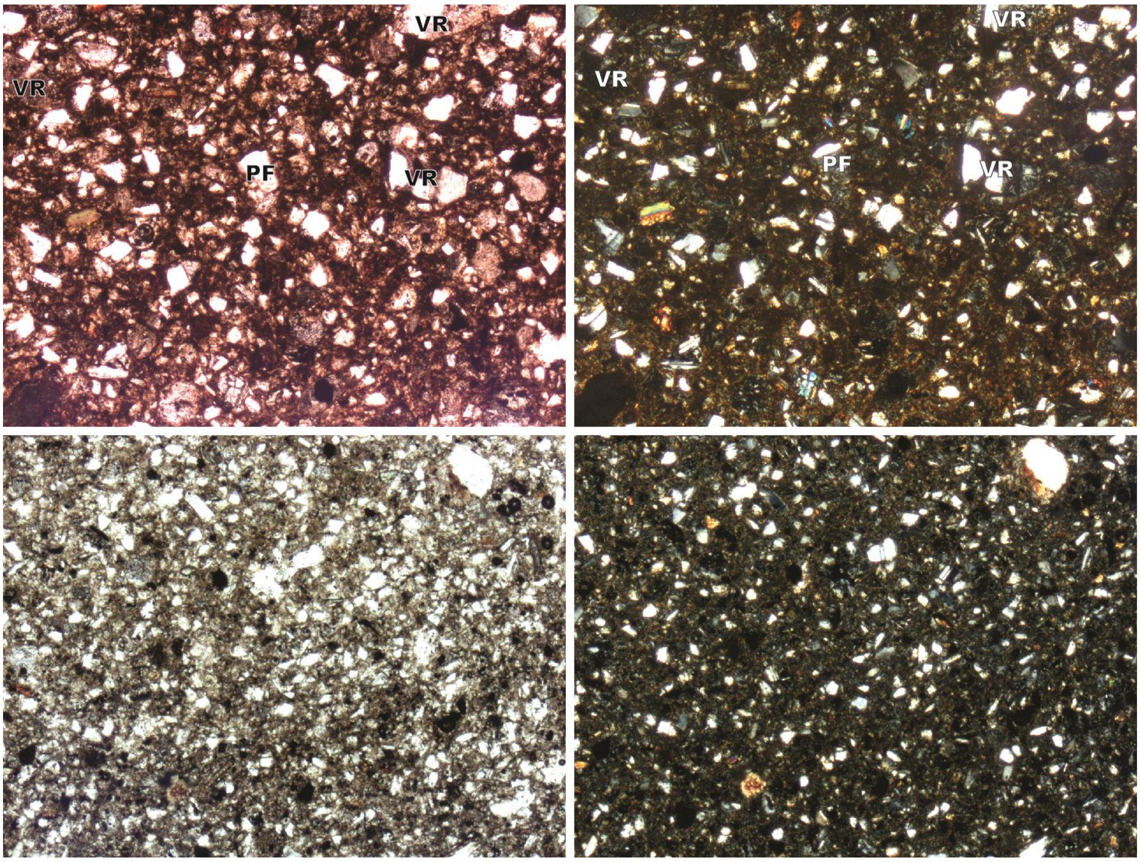

Figure VI.3. Photomicrographs of two samples of the Volcanic Rocks-tempered Fabric Class, taken with PPL (left) and XP (right). Sample on top (133) belongs to the Medium-sorted Temper Sub-class, while sample on bottom (022) belongs to the Fine-sorted Temper Sub-class. Key: PF, plagioclase feldspar; VR, volcanic rock. Single image width = 2.3mm.

The fact that some inclusions appear eroded and rounded while others appear sharp and fresh (Figure VI.4, top right) hints that the latter did not occur naturally in the clay, but were added as temper (Maggetti 1982:131). It is not clear if the base clay of the Fine-sorted Temper Sub-class was originally poor in inclusions larger than 0.20mm or if it was levigated previous to tempering. The dominant and largest naturally occurring inclusions present in the fabric are clay pellets, which dissolve in water. Thus, if the base clay was levigated at some stage, most likely this was done before tempering. In this scenario, the temper was sieved/sorted in a dry state and then added to the clay, as opposed to the artificial levigation of the mixture. Another possibility is that clay pellets alone could have been unconsciously introduced to the levigated mixture at a later stage (Whitbread 1986:83-84; see also Braekmans and Degryse 2017:254-55). However, fully assessing the possibility of levigation would require the petrographic analysis of the raw clay in question.

Most planar voids exhibit preferred alignment (Figure VI.4, bottom left), either parallel or slightly perpendicular to the vessel walls; preferentially orientated elongate voids can result from drying after the application of pressure to the walls during forming.

Many of the samples seem to have been fired at a temperature that did not cause the elimination of the crystalline structures of the clay matrix (Rice 1987:431), as indicated by their birefringence optical property (Figure VI.5). In a few samples this property is no longer visible, although in some cases that may have to do with the thin sections being too thick (>30µm) or the fabrics too dark (Quinn 2013:94).

This fabric class is closely related to the Volcanic Rocks-tempered with Peloids, and the Volcanic Rocks-tempered with Sparry Calcite, fabric classes; all three are volcanic rocks-tempered fabrics made from secondary clays. This fabric class can be distinguished from them based on the occurrence of argillaceous rock fragments, and the relatively few naturally occurring peloids and complete lack of sparry calcite grains, respectively.

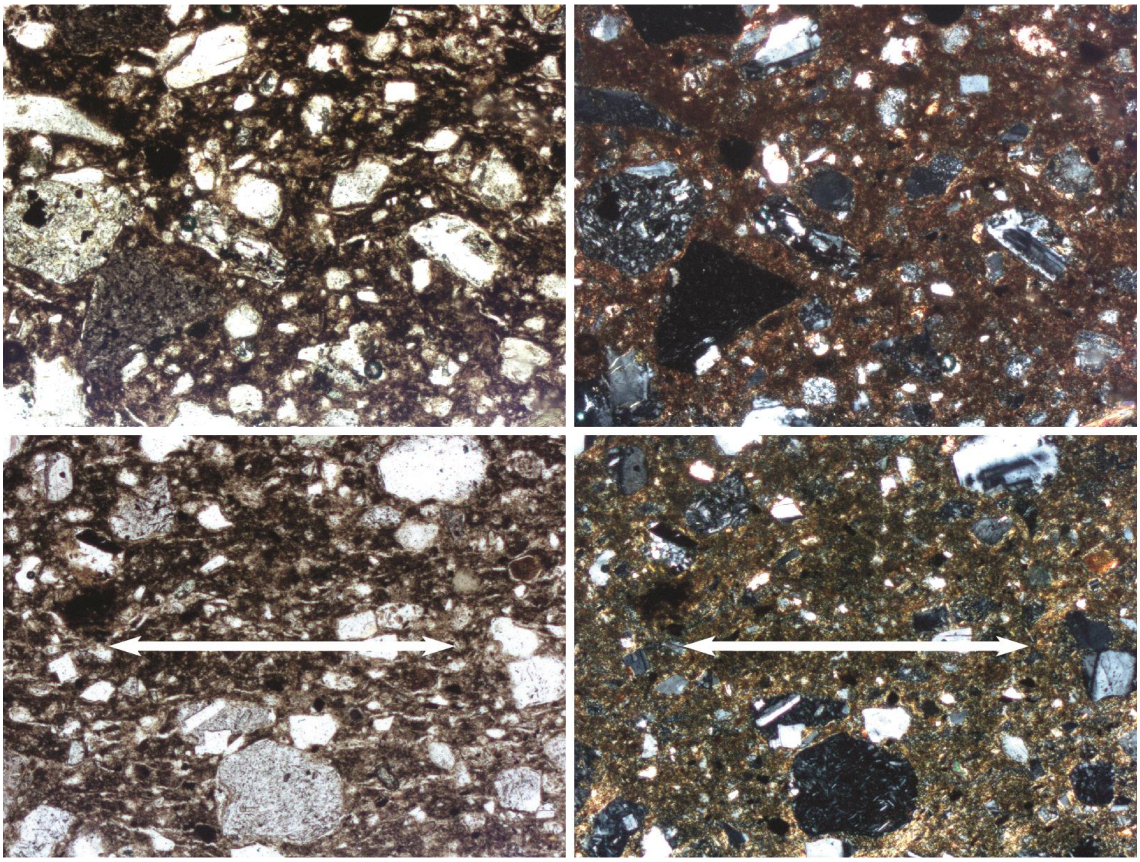

Figure VI.4. Photomicrographs of two samples of the Volcanic Rocks-tempered Fabric Class, taken with PPL (left) and XP (right). Images on top (116) show crushed, angular inclusions added as temper, next to rounded, eroded inclusions that occur naturally in the clay. Images on bottom (095) depict moderate left-right preferred orientation of inclusions and voids (highlighted by the white arrow), aligned with vessel margins. Single image width = 1.1mm.

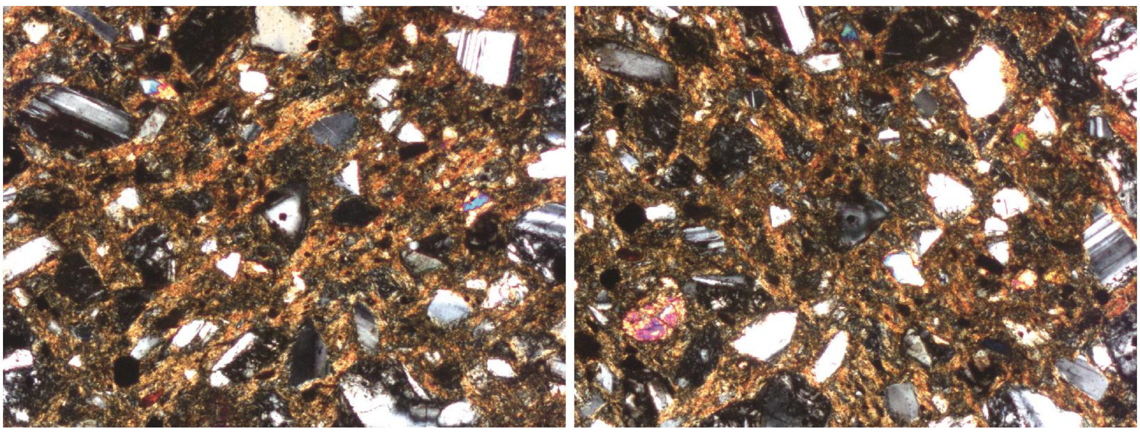

Figure VI.5. Photomicrographs of sample 156 of the Volcanic Rocks-tempered Fabric Class, Medium-sorted Temper Sub-class, taken with XP. Stage was rotated 45 degrees (right) to highlight the high optical activity of the non-vitrified clay matrix. Single image width = 1.1mm.

3. **Volcanic Rocks-tempered with Peloids Fabric Class**, n = 2 (3.3% of the sample set). Pottery type: Borregas Red-on-cream (2).

This medium coarse-grained, highly calcareous fabric is characterized by being relatively rich in peloids; it also features crushed fine-grained volcanic rocks as temper (Figure VI.6). The size mode of the most frequent type of inclusion of the coarse fraction = 0.5mm. Clay is sedimentary/secondary in nature, but the low variety of the naturally occurring inclusions indicates that the material was only transported a short distance before forming a new sedimentary deposit.

The fact that most of the volcanic rocks (andesite?) and related mineral inclusions are angular-shaped and appear fresh suggests they do not occur naturally in the clay and were added as temper after crushing and moderate sorting (Maggetti 1982:131).

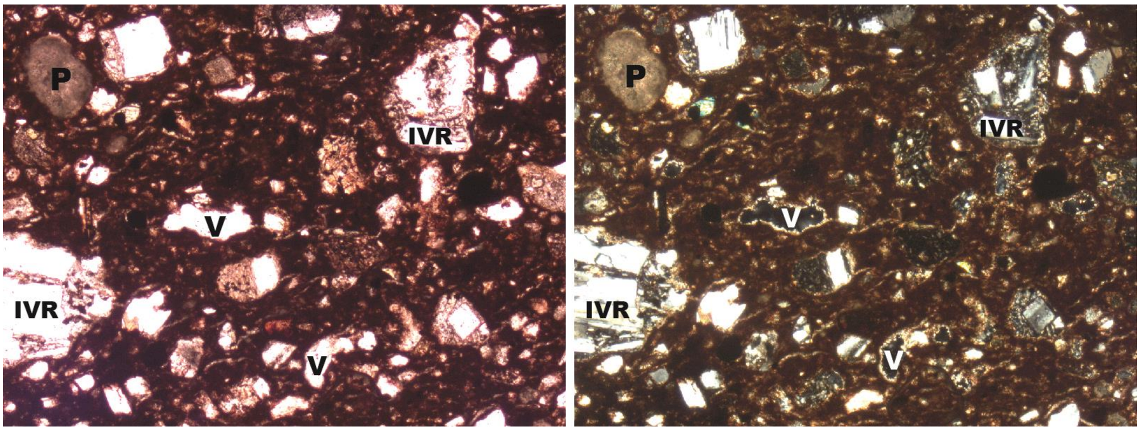

Figure VI.6. Photomicrographs of sample 177 of the Volcanic Rocks-tempered with Peloids Fabric Class, taken with PPL (left) and XP (right). Key: IVR, intermediate volcanic rock; P, peloid; V, void. Single image width = 2.3mm.

There is no evidence of primary or secondary vessel-forming techniques.

Due to the fabrics being too dark or the thin sections too thick, it was not possible to assess how optically active they are (Quinn 2013:94).

This fabric is related to the Volcanic Rocks-tempered and the Volcanic Rocks-tempered with Sparry Calcite, fabric classes: all three are volcanic rocks-tempered fabrics made from secondary base clays. This fabric class can be distinguished from them on the basis of its relative richness in peloids, while lacking sparry calcite grains.

4. **Volcanic Rocks-tempered with Sparry Calcite Fabric Class**, n = 1 (1.7% of the sample set). Pottery type: Amela Red (1).

This medium coarse-grained, highly calcareous fabric is characterized by the dominant presence of naturally occurring sparry calcite grains and finely crushed volcanic rock fragments added as temper (Figure VI.7). Other inclusions include siltstones, plagioclase feldspars, clinopyroxenes, quartz, and biotite. The size mode of the most frequent type of inclusion of the coarse fraction = 0.7mm. Clay is perhaps sedimentary/secondary in nature, but the low degree of variety of the naturally occurring inclusions indicates that the material was only transported a short distance before forming a new sedimentary deposit.

The fact that only some volcanic rock fragments and related loose mineral inclusions are angular-shaped and appear fresh suggests they may have been added as temper after crushing and fine sorting; calcite fragments, on the contrary, have rounded edges because of transport during clay deposition (Maggetti 1982:130-31). Moreover, the fabric is heterogeneous, revealing some portions rich in inclusions and some rich in base clay, revealing that the mixing of temper with base clay was incomplete (Figure VI.8).

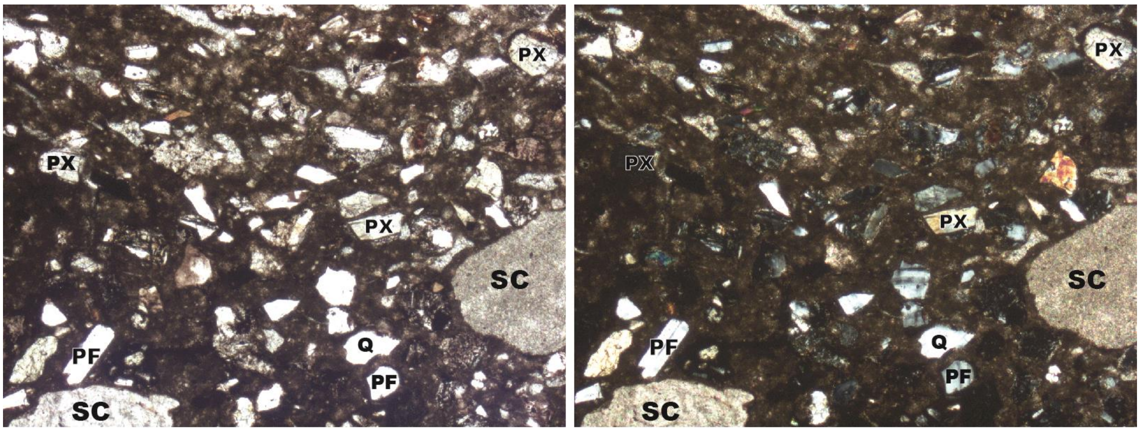

Figure VI.7. Photomicrographs of sample 181 of the Volcanic Rocks-tempered with Sparry Calcite Fabric Class, taken with PPL (left) and XP (right). Key: PF, plagioclase feldspar; PX, pyroxene; Q, quartz; SC, sparry calcite. Single image width = 2.3mm.

The sole sample of this fabric class shows planar voids oriented parallel to the vessel walls; they may have been formed by the shrinkage of the clay as it dried, and their alignment with the vessel margins might indicate the application of pressure to the clay during forming (Quinn 2013:61-68). Again, this could suggest the use of the paddle-and-anvil secondary forming technique.

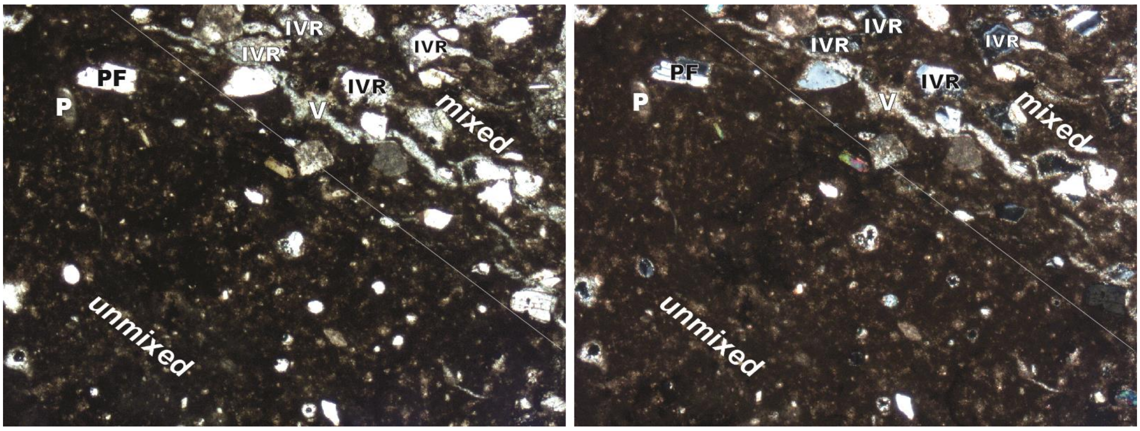

Figure VI.8. Incomplete mixing of temper and base clay, as visible in sample 181 of the Volcanic Rocks-tempered with Sparry Calcite Fabric Class. Photomicrographs taken with PPL (left) and XP (right). Key: IVR, intermediate volcanic rock; P, peloid; PF, plagioclase feldspar. Single image width = 2.3mm.

The clay matrix is optically inactive under the microscope, but the fabric may be too dark or the thin section too thick to properly appreciate this property properly (Quinn 2013:94).

This fabric class, as a volcanic rocks-tempered fabric, is closely related to the Volcanic Rocks-tempered and the Volcanic Rocks-tempered, with Peloids, fabric classes. It can be distinguished from them based on the presence of sparry calcite fragments.

5. **Well-sorted Sand Fabric Class**, n = 1 (1.7% of the sample set). Pottery type: Colima Red-on-cream (1).

This medium coarse-grained, calcareous fabric is characterized by naturally occurring and well-sorted sand-size inclusions. The main inclusions are: plagioclase feldspars, quartz, sandstones and siltstones, and volcanic and metamorphic rock fragments; it is apparent that all of these inclusions belonged to the same heavily eroded detrital sediment (Figure VI.9). The size mode of the most frequent type of inclusion of the coarse fraction = 0.3mm. The clay is sedimentary/secondary in nature: an eroded appearance, high roundness, and high degree of variety in the naturally occurring inclusions all indicate that the material was transported a long way by natural forces from the location of the parent rocks.

The sole sample of this class belongs to a neck and rim fragment and displays evidence of coiling in thin section; however, it may be that only this part of the vessel was coiled (Rice 1987:129). It has an optically active, anisotropic clay matrix, indicating that the matrix is non-vitrified (Quinn 2013:94; Rice 1987:431).

This fabric class is not related to any other in this study.

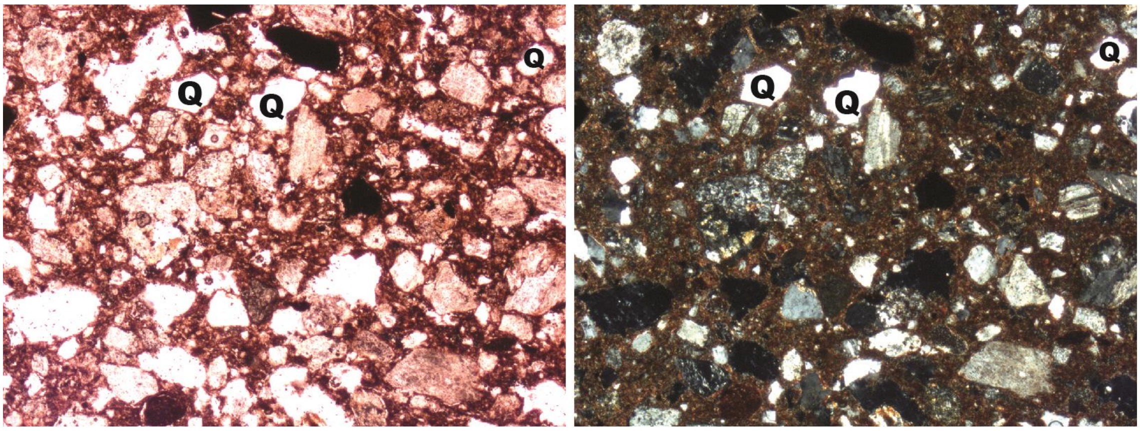

Figure VI.9. Photomicrographs of sample 008 of the Well-sorted Sand Fabric Class, taken with PPL (left) and XP (right). Key: Q, quartz. Single image width = 2.3mm.

6. **Metamorphic Rocks Fabric Class**, n = 8 (13.3% of the sample set). Pottery types: Armería Cream / Orange (5), Colima Shadow-striped (2), Tecomán Coarse Cream (1).

This fine-grained, moderately calcareous fabric is characterized by the common presence of a range of naturally occurring metamorphic rock fragments. Other significant inclusions are plutonic granite, plagioclase feldspars and polycrystalline quartz (Figure VI.10). The size mode of the most frequent type of inclusion = 0.15mm. Most inclusions have an altered appearance, but roundness is not high and most have a sub-angular to sub-rounded shape. This indicates that they clay may have been formed by the chemical decomposition of granite and that chemical weathering happened *in situ*. However, compositional heterogeneity suggests that some parent materials were minimally transported.

It is not clear why granite fragments are commonly present in only three of the eight samples analysed. Crushed granite may have been used as temper in those specimens, or they may have a slightly different geographical origin. These and other differences among the samples of this fabric have been treated as internal variations within the fabric class (Appendix D, 6. Metamorphic Rocks Fabric Class, Internal Variation).

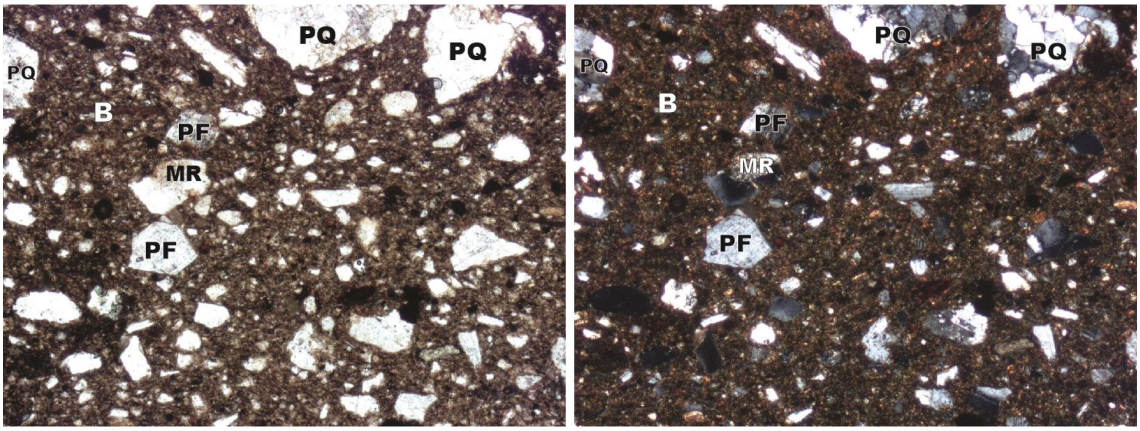

Figure VI.10. Photomicrographs of sample 215 of the Metamorphic Rocks Fabric Class, taken with PPL (left) and XP (right). Key: B, biotite; MR, metamorphic rock; PF, plagioclase feldspar; PQ, polycrystalline quartz. Single image width = 2.3mm.

Voids show preferential orientation, i.e. parallel to the vessel margins, indirectly suggesting the use of the paddle-and-anvil secondary forming technique.

Clay matrices are optically active (anisotropic), indicating that they are non-vitrified and retain their birefringence property.

This fabric class is not related to any other in this study.

7. **Very Fine Feldspar and Biotite Fabric Class**, n = 1 (1.7% of the sample set). Pottery type: Tecomán Fine Cream (1).

This very fine-grained, calcareous fabric is characterized by the common presence of very fine (< 0.1 mm) mineral grains of feldspar and biotite, which constitute almost half of the non-plastics section (Figure VI.11). The size mode of the most frequent type of inclusion = 0.25mm. Inclusions have a chemically weathered and altered appearance (e.g. PF in Figure VI.11). The roundness of the inclusions is not high, and sub-angular shapes predominate; these attributes suggest chemical weathering happened *in situ*. The parent material is probably residual or just minimally transported from the location of the parent rocks.

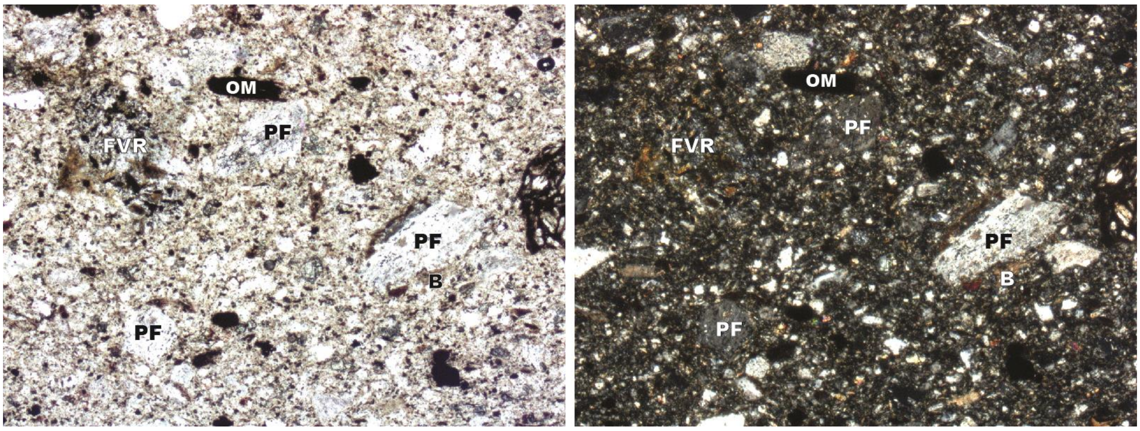

Figure VI.11. Photomicrographs of sample 182 of the Very Fine Feldspar and Biotite Fabric Class, taken with PPL (left) and XP (right). Key: B, biotite; FVR, fine-grained volcanic rock; OM, opaque mineral; PF, plagioclase feldspar. Single image width = 2.3mm.

There is no conclusive evidence of significant modification of this clay for pottery manufacture.

Voids display alignment to the vessel margins, indicating the application of pressure to the clay during forming and thus suggesting the use of the paddle-and-anvil secondary forming technique.

The clay matrix of the sole sample of this class is still optically active (i.e. it retains its birefringence property).

This fabric class is not closely related to any other in this study.

VI.4. DISCUSSION OF THE EVIDENCE FOR POTTERY TECHNOLOGIES

Establishing the relationship between ceramic types, fabric classes, and manufacturing technology is important, since the types analysed in this research were originally defined based solely on shape and decorative features. The technological features assessed in this research by means of petrography and some macroscopic observations include: forming method and techniques, preparation of the clay pastes, surface finish treatments, and firing strategies. The discussion of firing temperatures is supported by the results of X-ray diffraction (XRD) analysis.

VI.4.1. FORMING METHOD

All pottery was handmade, and for the most part there is no evidence of major variability in forming techniques between the seven different fabric classes. As mentioned above in the fabric descriptions, thin-section petrographic analysis has provided some evidence of secondary forming techniques: preferential orientation of inclusions and voids, caused by the application of physical force during the forming sequence. In the great majority of cases, such orientation runs parallel to the exterior and interior of the vessel's surfaces in a vertical, or perpendicular, thin section (i.e. parallel to the vessel height). Large elongate inclusions are scarce in all fabric classes; preferential orientation was more commonly detected in planar voids. As for primary forming techniques, there is evidence of coiling (i.e. relic coils) in the necks and borders of jars and the lips of bowls. This suggests that all fabric classes were formed through a composite method (Rice 1987:124; Thér 2016:225), involving coiling and/or moulding as a primary forming technique, and beating/paddling with an opposite pressure (i.e. an anvil or a mould), and scraping, as secondary forming techniques. If originally present, primary coiling features were obliterated by the secondary beating, with the exception of those located near or at the vessel's border. Base-moulds to form the lower part of the vessels, also used as potters' turntables, are known for this period (Salgado Ceballos 2007:Chapter IV, Productos Cerámicos Especiales; see Lyons and Lindsay 2006 for similar artefacts in the American Southwest), although large potsherds and even complete vessels, face down, can be used with the same purpose.

VI.4.2. PASTE PREPARATION

Methods of paste preparation such as medium-sorted and fine-sorted tempering were detected through thin-section analysis (Table VI.3). This variability helped in the determination of fabric classes, including splitting Fabric Class 2 into two sub-classes (2A and 2B in Table VI.3).

In contrast, some fabrics (1, 5, 6, and 7) were apparently formed from largely unprocessed clays. As Table VI.3 shows, some unprocessed clays seem to have been used for the manufacture of a range of ceramic types. In the cases of Fabric Classes 1 and 6, the same base clay was used to produce a range of vessel shapes with different decoration styles.

Table VI.3. Summary of the fabric classes, geological origins of the base clays, recipes, and final product characteristics.

Fabric classes	*Parent material(s)*	*Transportation distance from the parent rock(s)*	*Pottery recipe*	*Preferred vessel shape and decoration*
1	Basic to Intermediate volcanic rocks	Minimal	Largely unprocessed clay	Painted bowls, ring-based bowls and pedestal based-bowls
2A	Mixed: Intermediate volcanic and sedimentary rocks	Long	Clay tempered with medium-sorted andesite	Painted jar vessels, open-mouthed cooking vessels
2B			Clay tempered with fine-sorted andesite	Engraved and incised bowls
3	Limestone	Short	Clay tempered with sorted andesite	Painted jar vessels
4				Resist painted bowl
5	Mixed: Intermediate volcanic and sedimentary rocks	Long	Largely unprocessed clay	Painted jar vessel
6	Mixed: Intermediate volcanic, granitic and metamorphic rocks	Minimal/Short	Largely unprocessed clay	Painted pedestal-based bowls, bowls, and open-mouthed cooking vessels
7	Mixed: sedimentary, intermediate volcanic and granitic rocks?	Minimal	Largely unprocessed clay	Bowl

With regard to processed clays, paste recipes do not seem to be primarily related to vessel morphology or a singular ceramic type, save for one exception. The Fine-sorted Temper Sub-class of the Volcanic Rocks-tempered Fabric Class is almost exclusively linked to ‘incised’ bowls of both the earlier (Colima Incised) and later (Pozo Hundido Incised) types (2B in Table VI.3). In thin section this fabric seemed to be a finer version of Sub-class 2A (but see VI.5, below), which was used primarily for the manufacture of larger jars and cooking vessels (Table VI.3). It is possible their at times complex engraved/incised decoration would benefit from a finer paste (see VII.1.1, Colima Valley Group, for a single case in which the raw clay was levigated and then tempered to manufacture an incised bowl, imitating this fabric). Also of note is the permanence of the procured clay and the paste recipe while the external decoration techniques and motifs changed through time, i.e. engraved decoration (done when the clay was leather-hard) was replaced by incised decoration (done when the clay was damp), and the designs became more simple and standardised.

With regard to jar vessels, the Colima Red-on-cream and Borregas Red-on-cream types are not restricted to a single fabric. Besides Fabric Sub-class 2A, Fabric Classes 3 and 5 were also used for the manufacture of such jars. With the exception of Fabric Class 5, these are tempered fabrics. The manufacture of Fabric Class 3 followed the same crushed-volcanic rocks tempering recipe as Sub-class 2A, but using a different base clay.

Whether the paste recipe is solely a culturally rooted practice or is related to technical issues such as the nature of the raw clays involved, the desired forming and firing performance of the clay paste, and the vessel's desired utilitarian performance, needs to be assessed in light of the available information (Skibo and Schiffer 2008:12-15). In general, there is an apparent strong correlation among the sample set between tempering and what are supposed to be plastic clays (i.e. those formed by the solution of limestone), suggesting that the technological choice of tempering the clay is likely related to the natural condition of the raw clays and their performance during manufacture. There are two main lines of indirect evidence for this: the open-mouthed cooking vessels made with the base clay of Fabric Sub-class 2A were tempered, whereas those belonging to Fabric Class 6, made from residual clay, were not. Likewise, the sandy Fabric Class 3 jar vessel was not tempered, as opposed to those jars of Fabric Class 5 and Sub-class 2A. It is known that the addition of temper to raw clays that were originally poor in inclusions would increase their porosity, preventing excessive shrinking and cracking during firing through an easy water release (Krishnan and Rao 1994).

VI.4.3. SURFACE FINISHING TREATMENTS

A range of surface finishing treatments were identified in thin section, including burnished and slipped surfaces. Fabric-diagnostic surface features are as follows:

- Fabric Class 1 is the only one in which both iron-rich and iron-poor slips are present, although the former are far more common.
- Fabric Sub-class 2A includes some diagnostically thick calcareous slips.
- Fabric Sub-class 2B has diagnostic engraved and incised decoration carried out when the clay was leather-hard (Colima Incised) or damp (Pozo Hundido Incised), and before (Pozo Hundido Incised) or after (Colima Incised) the application of an iron-rich slip.
- Fabric Class 4, consisting of one sample, has an iron-poor slip partially applied on top of an iron-rich slip in order to create a decorative pattern with the help of something (possibly wax?) as resist. Decoration with resist is also present in Fabric Class 6.
- Fabric Classes 6 and 7 feature the application of thinner, iron-poor and probably calcareous slips to produce pale backgrounds for decoration.

VI.4.4. FIRING

The type of firing, the way the vessels are arranged within the firing structure (including perishable ones, such as a bonfire), and the intended atmosphere(s) during firing, constitute the 'firing strategy' (Santacreu 2014:87). This section summarizes the evidence of firing strategies for the pottery under study, based on both microscopic and macroscopic observations.

Evidence of certain firing procedures can be gleaned from several methods, including thin-section petrography; for example, colour transitions, which are influenced by the firing atmosphere, and 'firing clouds' on the surface of the vessel are best observed macroscopically (Santacreu 2014:102; Figure VI.14 of this thesis). This discussion of maximum firing temperatures is also supported by the results of X-ray diffraction analysis (see XRD diagrams in Appendix E).

VI.4.4.1 Firing temperature

The discussion presented here covers all seven of the identified fabric classes, since all show evidence of firing at a similar temperature range. Thus all of this information is presented in a single section that applies to the whole sample set.

As seen under the microscope, the crystalline structures of several clay matrices within the sample set have not been eliminated during firing. The temperature at which the complete destruction of the clay minerals is achieved depends on several factors, but usually does not occur below 900°C (Rice 1987:90-93,103-04; Santacreu 2014:91; Thér and Gregor 2011:135).

Low firing temperature (i.e. firing a clay below vitrification) is commonly associated with the use of open firing, although in certain conditions kiln-firing temperatures can fall within the same range (Arnold 1991:55). The temperature normally achieved in open firing ranges between 600 and 850°C, but can reach as high as 850–1000°C under exceptional conditions (Arnold 1991:52-53; Rice 1987:156-57; Santacreu 2014:104).

X-ray diffraction (XRD) analysis was performed to 33 samples, 12 of which were also petrographically analysed (Table VI.4). The diffractograms (Appendix E, Figures E.1-E.33) do not show any of the mineral phases that form in temperatures above 900°C, such as gehlenite, wollastonite and akermanite (Rasmussen et al. 2012:1708-09; Rice 1987:90; Santacreu 2011).

Among the samples that were also petrographically analysed, clay minerals were only detected in sample 051 of Fabric Class 1, and in sample 181 of Fabric Class 4 (Table VI.4). Samples 178 (Fabric Class 3) and 181 both revealed calcite crystalline phases (Table VI.4). Peloids composed of micritic calcite were noted in the petrographic description of Fabric Class 3 (Figure VI.6), as were coarse grains of calcite in sample 181 (Figure VI.7). Calcite structures decompose around 800–850°C (Grim and Kulbicki 1961; Maggetti 1982:127-28; Rasmussen et al. 2012:1708-09; Rice 1987:92,98). Moreover, the detection of muscovite peaks in samples of most fabric classes (Table VI.4) further indicates that the firing temperature did not reach 900°C (Rasmussen et al. 2012:1708-09).

All evidence considered, a fair estimate would be a maximum temperature not in excess of 850°C during the firing of all fabric classes, at least not for a long period. A temperature range of 500–700°C is considered enough to avoid the rehydration of clay; the permanent bonding of the particles means that the material becomes waterproof and mechanically useful as a container (Santacreu 2014:91,103).

Table VI.4. Qualitative mineralogy by XRD and petrograpic groups. Key: ++, major; +, moderate, minor, or trace.

								Clay minerals		
Petrographic group: Sample	Plagioclase	Quartz	Calcite	Iron Oxide	Mica	Zeolite	Amphibole	Smectite	Palygorskite	Pyrophyllite/ Talc
Residual Volcanic Rocks										
031	++	+				+				
051	++	+								+
Volcanic Rocks-tempered										
015	+	+			+					
056	++	+								
069	++	++		+						
168	++	++	+	+	+					
194	++	++		+	+					
200	++	++		+						
Volcanic Rocks-tempered with Peloids										
178	++	++	++	+	+					
Volcanic Rocks-tempered with Sparry Calcite										
181	++	++	++	+	+		+	+	+	
Metamorphic Rocks										
188	+	++		+	+					
211	++	++					+			

VI.4.4.2 Firing strategy

Comments about the intended firing atmosphere and other strategies are presented on a fabric-by-fabric basis, since a few firing strategies discussed in this section seem to be particular to fabric classes or sub-classes. However, there is enough evidence to indicate the widespread use of open firing. No kilns have been found for this period.

1. Residual Volcanic Rocks Fabric Class

Pottery of this fabric, consisting of bowls of different types, display a range of colour transitions within specimens that fits well with the uncontrolled firing atmosphere characteristic of a non-kiln, open fire. Macroscopically, most fragments show either fully oxidised fabrics or fabrics with a non-oxidised, black core in cross section (Figure VI.12). Black cores can indicate a firing time that is insufficient to achieve complete fabric oxidation, an internal reductive atmosphere created by the presence of organic matter in the paste, and/or a relatively low maximum temperature (Rice 1987:88,103,109; Santacreu 2014:88). There is a tendency toward non-oxidised lips, which were perhaps the part of the vessels in direct contact with the fuel during firing, and/or in contact with the floor while cooling. Also telling is one specimen that shows an irregularly fired cross section (Figure VI.12, bottom), with a non-oxidised area stretching from the fabric's core to the whole lip of the bowl: this is proof that there was no uniform air circulation due to the vessel's position within the bonfire. Another specimen shows an oxidised inner half (where the painted surface decoration is located) and a non-oxidised outer half, whereas yet another example exhibits an almost completely non-oxidised fabric, with only the painted inner surface oxidised (Figure VI.13). These last two, especially the last specimen, must have been fired with something tightly covering everything but the vessel's inner surface (a pot?), or maybe was fired or cooled while partially buried in a pit. Anyhow, the outcome seems to be intentional and demonstrates a certain degree of sophistication in the firing procedures.

Black patches on the surface—known as 'fire clouds'—are recorded among pottery types in this fabric class (Figure VI.14, c). Fire clouds are proof that fuel was in contact with the vessels within the firing structure (Rice 1987:109), in this case a bonfire.

The recording of more than one firing atmosphere for a single specimen would be far more common if complete vessels were available for analysis, as opposed to relatively small fragments (Rice 1987:109).

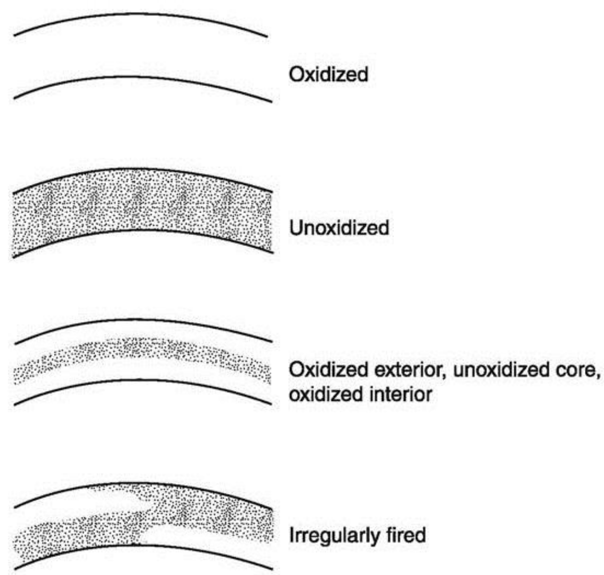

Figure VI.12. General firing conditions as seen in cross section (Prehistoric Ceramics Research Group 2010:Appendix 8).

Figure VI.13. Sample 055 (Residual Volcanic Rocks Fabric Class), exhibiting a non-oxidised section and an oxidised inner surface.

Microscopically, voids left by burned organic matter were recorded during petrographic analysis of this fabric class; such voids show darkened borders (i.e. reduced iron oxides), which, along with the absence of charred remains, indicates oxidising firing conditions (Thér and Gregor 2011:136-37).

2. Volcanic Rocks-tempered Fabric Class

Sub-class 2A. The fragments of this fabric sub-class, consisting almost exclusively of jars and cooking vessels, show proof of exposure to a variety of firing atmospheres. Most common are the fully oxidised fragments, followed by those with a non-oxidised core; there is only one fully non-oxidised fragment.

Perhaps logically, all of the jar examples with non-oxidised cores are neck fragments, the thickest part of the vessel. Likewise, most of the fragments from open-mouthed cooking vessels (Colima Shadow-striped) show a reduction core. This might also be related to their body thickness, which is on average twice as thick as the jars. Thickness, in combination with organic matter, might have created an internal reductive atmosphere that contrasted with the oxidising atmosphere to which the surfaces were exposed (Santacreu 2014:107). Voids left by burned organic matter were also recorded in fabrics of this class and type (Appendix D, Figure D.6, top).

On the other hand, a few specimens exhibit non-oxidised outer walls with oxidised inner walls, and some other fragments the other way around (i.e. oxidised outer walls and non-oxidised inner walls). The first may have involved covering the vessel with fuel while leaving the mouth exposed to the air; the second was probably achieved by putting pairs of vessels mouth to mouth, either horizontally or vertically, during firing; or by the placement of vessels face down during cooling. Complete specimens of the pottery types in this fabric class commonly show 'fire clouds' on their surfaces (Salgado Ceballos 2007); some of the fragments analysed in this research show them too (see Figure VI.14, d). Interestingly, many specimens show red decorations painted over the 'fire clouds' (Figure VI.14, d), indicating that the painting was done after firing. Again, this batch of evidence suggests the use of open firing (Santacreu 2014:103,105).

Sub-class 2B. Most of the engraved/incised bowls fragments are either fully oxidised, have a non-oxidised core, or show an oxidised inner wall and a non-oxidised outer wall. As mentioned in VI.4.3, they were all covered with an iron-rich slip (Appendix D, Figure D.9); some darker exterior surfaces seem to have been purposely achieved by firing in a non-oxidising atmosphere. One exceptional example displays a reduced core and non-oxidised surfaces in cross-section, but also has thin oxidised sections between the core and both surfaces. This implies that the dark surfaces were achieved at a different stage of the firing, probably by smudging through the late addition of carbon-rich green fuel or dung (Evans and Webster 2001:608; Rice 1987:109). 'Fire clouds' are also recorded for the pottery types conforming to this sub-class (Figure VI.14, b).

Figure VI.14. Fire clouds on the exterior and interior of Colima- and Armería-phase potsherds. a-e: 040, 044, 115 (exterior and interior), 139, 172.

3. Volcanic Rocks-tempered, with Peloids Fabric Class

This fabric class is represented by two jar fragments: one is fully oxidised, and the other has a non-oxidised inner surface.

4. Volcanic Rocks-tempered, with Sparry Calcite Fabric Class

The fragment of the sole sample of this fabric class shows an oxidised inner half and a non-oxidised outer half. It is an Amela Red bowl with internal decoration (resist painting).

5. Well-sorted Sand Fabric Class

The fragment of the sole sample (Colima Red-on-cream jar) of this fabric class is oxidised.

6. Metamorphic Rocks Fabric Class

Evidence of exposure to a variety of firing atmospheres appears in this fabric class, but oxidised fragments are most common. However, three Armería Cream fragments show fabrics with thick non-oxidised cores and thin oxidised walls. Although voids left by burned organics in this fabric class were also recorded under the microscope, the non-oxidised cores are not black but light grey in colour, perhaps suggesting the use of clay with little organic matter. The exterior painting of one of these fragments appears to be non-oxidised; for this reason, I believe the firing procedure may have involved sealing the painted parts after a non-oxidising firing, before the final oxidation of the vessel. Light grey cores may be relics of this initial non-oxidation firing rather than evidence of incomplete firing.

The technology of using multiple firing stages to create a reduced painted decoration over an oxidised surface is perhaps exclusive to this fabric class. Multiple-step firing under different atmospheres usually involves the use of a kiln, although as mentioned before no kilns have been found in the research area for this period.

7. Very Fine Feldspar and Biotite Fabric Class. The fragment of the sole sample (Tecomán Fine Cream bowl) of this fabric class is oxidised.

VI.5. COMPARISON OF PETROGRAPHIC AND CHEMICAL ANALYSES

For the most part, petrographic analysis supports the compositional groups obtained through chemical analysis, but there are some important discrepancies.

Five geochemical groups clearly correlate to the same number of fabric classes or sub-classes. The major correlations are as follows:

- Seven of the eight samples of Group A pottery selected for petrographic analysis fell into Fabric Class 1.
- Fourteen of the 15 samples of Group B pottery were petrographically classified into Fabric Class 2, all of them into Sub-class 2A.
- All but one of the six thin-sectioned samples of Group C pottery were classified into Fabric Class 2, specifically into Sub-class 2B.
- The sole thin-sectioned sample of Group H is the only sample of Fabric Class 7.
- Likewise, the sole thin-sectioned sample of Group J constitutes a fabric class of its own: Fabric Class 4.

The major discrepancies between the analyses are the following:

- All six samples coming from geochemical Groups D, F, and G, were classified into petrographic Fabric Class 6. However, this does not mean that the three geochemical groups are completely undistinguishable in thin section; in fact, samples from these three groups neatly represent the identified internal variation within Fabric Class 6 (Appendix D, 6. Metamorphic Rocks Fabric Class, Internal Variation). The petrographic analysis of a larger set of samples will surely allow the complete characterisation of the internal variation within this class as distinct fabric classes. For now, it is possible to mention that samples 188 and 215 of Group D have a higher proportion of granitic rock fragments; sample 185 of Group F contains pyroxenes; and samples 197, 201 and 211 of Group G have the largest fraction of eroded rocks/minerals.
- Geochemical groups B and C were classified as a single petrographic class (Fabric Class 2), but its two sub-classes (2A and 2B) largely correspond to the two compositional groups. The temper material looks very similar between both sub-classes under the microscope, differing only in size, which is smaller/finer in Sub-class 2B. Because the size of the temper would

not cause changes in geochemical composition, the reason behind the geochemical differences must be found in the base clay.

- Samples 173 (Group I) and 208 (Group E) were petrographically classified into Fabric Class 2, Sub-class 2A. This case illustrates how the tempering with intermediate volcanic rocks of inclusion-poor base clays makes them very difficult to distinguish in thin section. Fabric Classes 3 and 4, also tempered with crushed volcanic rocks of intermediate composition, were distinguished from Fabric Class 2 and from one another on the basis of natural-occurring peloids and sparry calcite grains, respectively. If the pastes lack diagnostic natural inclusions such as these, it is better to rely on geochemical characterisations to distinguish between samples made from different base clays and tempered with the same material of the same sorted size.
- Similarly, due to sharing the same recipe, several clearly geochemically unrelated specimens were classified into fabric classes that otherwise largely correspond to specific geochemical groups. This is the case of sample 200, classified into Sub-class 2B, and sample 069, classified into Sub-class 2A. Notable examples of samples sharing the same recipe (or lack thereof) but of different geochemical composition are those of samples 004 and 022. The first belongs to Group C, which largely correlates with Sub-class 2B. It was classified into Fabric Class 1 due to not sharing the crushed rocks tempering recipe of Sub-class 2B and having a similar petrographic composition than Fabric Class 1. Conversely, sample 022 of Group A was classified into Sub-class 2B, since it features the same kind of fine-sorted crushed rocks tempering recipe; geochemically, it belongs with the pottery of Fabric Class 1.
- In contrast, petrographic criteria made it possible to distinguish samples 177 and 178 as Fabric Class 3 and thereby compositionally different from the rest of the sample set. Statistical analysis of the geochemical data failed to distinguish these two samples as a different group: Sample 177 was geochemically classified into Group B, while Sample 178 was tentatively considered to be a geochemical outlier, compositionally closer to Group B

VI.6. BULLET POINT SUMMARY

THIN-SECTION PETROGRAPHY

- Method and objectives

  -60 pottery samples were petrographically analysed

  Objectives:

  -To determine and characterise petrographic fabrics

  -To help in determining pottery provenance by comparing the mineralogical compositions of pottery samples with the geology of the area and the geochemical composition results

- Results

  -Seven petrographic pottery fabrics. Most of them correspond to more than one type and/or shape; most exceptions are one-sample fabric classes

  -All pottery was hand-built through a composite method. At least necks and borders were built up from coils. There is evidence for beating/paddling in body fragments, which may have obliterated the body coils that were originally present.

  -Save for one exception, fine-sorted crushed rocks tempering is exclusively related to the manufacture of engraved/incised bowls

  -All fabrics seem to have been fired at a temperature below their vitrification point. There is indication of the widespread use of open firing

  -Fabric Class 1 features four different types of mortar bowls. It correlates with geochemical Group A. It was made from largely unprocessed clay and was open-fired

  -Fabric Sub-class 2A is composed largely of the two types of Red-on-cream jar vessels (liquid containers) and cooking vessels. The clay was tempered with crushed rocks (and in two cases with additional grog). It correlates with geochemical Group B. It was open-fired

-Fabric Sub-class 2B is mostly composed of engraved/incised bowls. It correlates with geochemical Group C. The clay was tempered with crushed rocks. It was open-fired, and there is evidence of smudging

-Fabric Class 3 is only conformed by two red-on-cream jar vessels. The clay was tempered with crushed rocks. This group was not previously isolated through geochemical composition analysis

-Fabric Class 4 is represented by a single specimen of an Amela Red bowl with resist painting. It belongs to geochemical Group J. It was probably open-fired. The clay was tempered with crushed rocks

-Fabric Class 5 is represented by one red-on-cream jar vessel fragment. It is a geochemical outlier. It was made from largely unprocessed clay and was open-fired

-Fabric Class 6 features mostly Armería Cream/Orange pottery and cooking vessels. Internal variations correlate with geochemical Groups D, F, and G. One specimen of the internal variation that correlates with geochemical Group D, formed exclusively by Armería Cream/Orange pottery, shows evidence of multiple-step firing. This type of pottery also features resist painting

-Fabric Class 7 is represented by one Tecomán Fine Cream bowl. It belongs to geochemical Group H. It was made from largely unprocessed clay

CHAPTER VII. DISCUSSION AND INTERPRETATIONS

This chapter discusses the results of archaeometric analyses on pottery in terms of provenance and technology, followed by an analysis of the political strategies that can be determined from its production, technology, and circulation. The first section (VII.1) assesses the compositional data for pottery and raw clay samples, the geology of the research area, and the distribution patterns of the different pottery types to propose the location of provenance areas for each of the characterised pottery groups. The second section (VII.2) proposes models for the technological styles, and discusses the micro-regional production organisation of the research period; this is followed by a discussion of the geographical distribution of these technological styles and how they relate to the territories occupied by the different political units. The third section (VII.3) offers an interpretation of the peculiar distribution and circulation patterns of the red-on-cream jars made in the Salado River basin.

VII.1. PROVENANCE

As described in earlier chapters of this thesis, compositional groups were determined using the results of both geochemical and petrographic analyses of Colima- and Armería-phase pottery. The provenance of seven of these groups could be established by either matching the pottery compositions with those of the raw clay samples and/or comparing the pottery's composition with the available geological information from the research area; further support was obtained through the examination of pottery distribution patterns. In this section, I detail the data and probable provenances for these seven compositional groups. The provenance of four compositional groups remains uncertain.

1) Colima Valley Group (Geochemical Group A; Residual Volcanic Rocks Fabric Class). This group is constituted by relatively high-Cr (ca. 100ppm) pottery. As seen on thin-section petrographic analysis, this pottery was made from largely unprocessed clay (with the exception of one sample, see VII.2.1) formed by the *in* *situ* physical and chemical breakdown of volcanic rocks of mostly intermediate composition. While this group is geochemically distinct from the rest of the pottery analysed in this research, it can be petrographically similar to the untempered-clay version of the Salado River Basin Group 2. The low- to very low-mobility of Cr in all weathering conditions (Naamoun 2002:234) suggests that its relative abundance in clay derives from the clay's parent rock(s). Cr is not found free in nature: its principal ores consist of the mineral chromite, and it also occurs as an accessory element in micas, pyroxenes and amphiboles (Salminen et al. 2005:127). The last two are found in the fabric of this pottery. Cr's abundance in basic rocks ranges from 170 to 3400ppm in ultrabasic rocks, while its content in acidic rocks is 50ppm or less (Kabata-Pendias 2011:181-82). The average Cr content of this pottery group is thus indicative of its predominantly andesitic origin.

As discussed in Chapter V, two geochemically-characterised raw clay deposits were excellent compositional matches for this group; these are El Pedregal and La Cruz de Comala, both located in the western part of the Colima Valley, to the northwest of Colima's capital city. El Pedregal is located in the southern outskirts of Comala city (Figure VII.1).

These two deposits lie in the Suchitlán/Comala River drainage basin, around 4km from each other (Figure VII.1; see also Figure IV.1). With the data currently available, it is not possible to know if they in fact constitute the same clay deposit or just share the partial geochemical signature obtained in this research. The Callejón Las Trancas clay deposit, located less than 2km to the north of El Pedregal—considered tentatively by the Universidad de Colima scholars as the same deposit as El Pedregal (Table IV.3)—has a similar yet distinct geochemical composition when compared to El Pedregal and La Cruz de Comala. For this reason, the geochemically analysed Callejón Las Trancas clay sample fell outside the core membership of this compositional group (Appendix C, Tables C.1 and C.2, sample B3). Additionally, the El Chanal clay deposit, located in the same valley some 4km to the east of La Cruz de Comala, in the Colima River drainage basin, has a radically different geochemical composition, with three times more Cr than the Comala area clays (Appendix C, Table C.1, sample B12). It is therefore possible to provisionally restrict the extension of the clay source(s) of this compositional group to a ca. 5km-long strip between Comala city and the northwestern perimeter of Colima city, along the limit between two geological formations (Figure VII.1). The two La Cruz de Comala samples, gathered 200m from each other, produced very similar compositional results (Appendix C, Table C.1, samples B5 and B6), suggesting that it is a relatively homogenous deposit in geochemical terms.

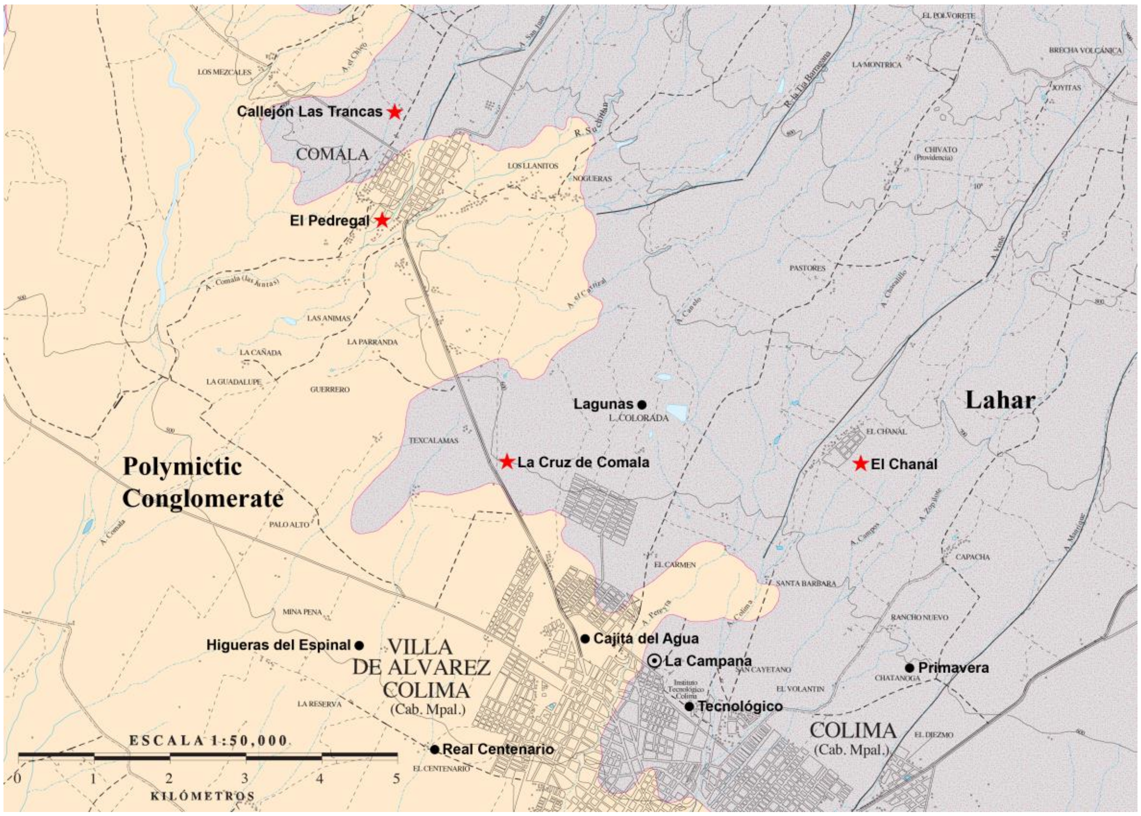

Figure VII.1. Geological map of the western half of the Colima Valley (modified from Barrios and García Ruiz 2000). The locations of archaeological sites are indicated by black dots, and the clay sources by red stars.

Geologically, both El Pedregal and La Cruz de Comala are located near the limit between the Pleistocene lahar (or volcanic breccia) that fills the Colima Valley and the polymictic conglomerate on top of the lahar's western flank (Figure VII.1). The lahar is made of epiclastic deposits of andesitic to basaltic composition that slid down from the Colima Volcanic Complex (Barrios and García Ruiz 2000). This volcanic breccia consists of angular, sub-angular, and rounded rock fragments in a sandy matrix. The largest clasts are greater than one meter in size (Barrios and

García Ruiz 2000). The polymictic conglomerate is located in the western part of the valley, on top of the lahar; it is a product of the erosion of the volcanic breccia and thus shares its composition and origin. The conglomerate is well compacted but poorly cemented; its fragments vary from sub-rounded to rounded in shape (Barrios and García Ruiz 2000; Secretaría de Programación y Presupuesto 1982).

The clay deposits of both El Pedregal and La Cruz de Comala are currently used to make pottery, tiles, and bricks (Table IV.3). The El Pedregal deposit is currently favoured for pottery production, given that it is less sandy and more plastic in behaviour; for these reasons, it is considered to be better quality than La Cruz de Comala, although these same characteristics change within the deposit, depending on the particular clay seam that is being mined (Elizondo 2007:21; Elizondo Mata 2007:79; Novelo 2007a:36; Quesada 2007:37). XRD analyses conducted by Universidad de Colima scholars determined that the two deposits were very similar in mineralogical composition, consisting mostly of plagioclase feldspars (Zimbrón 2007:Table 3,36), which is in agreement with a predominantly andesitic origin. In this research, two samples confidently assigned to this compositional group were subjected to XRD analyses, which revealed the same dominant plagioclase feldspar composition (Appendix E, Table E.1). This was also seen in thin section (Chapter VI, Section VI.3, 1. Residual Volcanic Rocks Fabric Class). Moreover, the Universidad de Colima scholars (Novelo 2007a:152) studied the firing behaviour of El Pedregal and La Cruz de Comala clays at both 900 and 1280°C, using an electric kiln; they behaved similarly, both firing a deep red and showing no macroscopic signs of vitrification at 900°C. Experimentally, both clay deposits were deemed good for the manufacture of earthenware (Novelo 2007a:152). Archaeological pottery from this group fired a light to deep red (2.5YR 6/8 to 5/6 to 10R 6/8 to 4/6) under oxidising conditions.

2) Salado River Basin Group 1 (Geochemical Group B; Volcanic Rocks-tempered Fabric Class, Medium-sorted Temper Sub-class). This group of pottery is made from calcareous secondary clay heavily tempered with crushed and sieved volcanic rocks of intermediate composition. It is geochemically distinct from the rest of the pottery analysed in this research. Petrographically, it can be similar to vessels manufactured elsewhere that used the same kind of temper material—if the latter do not have any diagnostic naturally occurring inclusions.

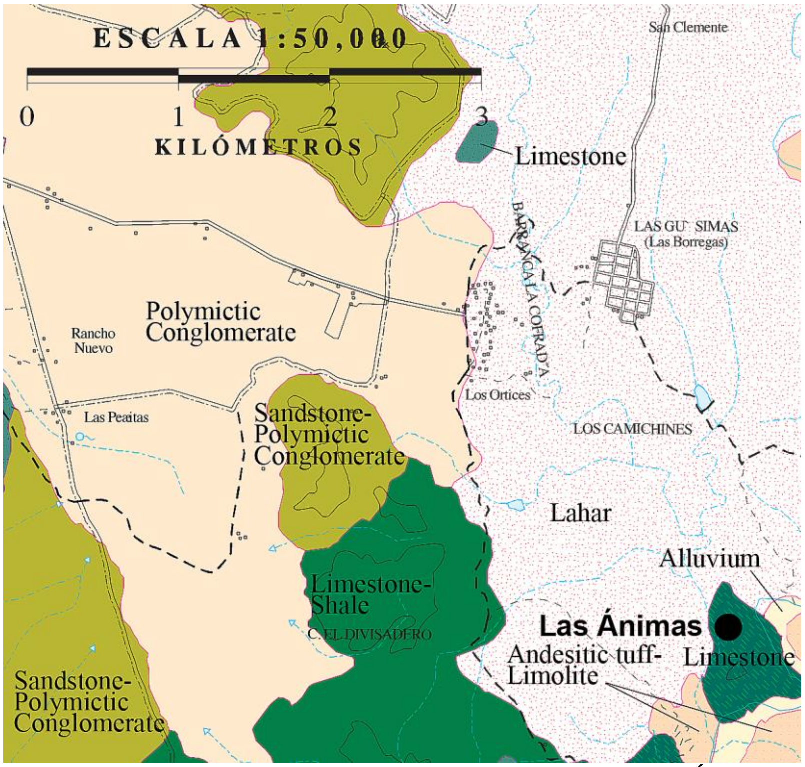

Figure VII.2. Geological map of the middle Salado River basin, where Las Ánimas site (black dot) is located (modified from Rosales Franco and Rodríguez Lara 2010).

Although the exact location of the clay source for this compositional group remains unknown, it is highly suggestive that the distribution of its shadow-striped cooking vessels is restricted to the Colima Valley and the Salado River basin. The calcareous nature of the clay, as seen in thin section, points toward an origin in the Salado River basin, which as opposed to the Colima Valley is dominated by calcareous formations (Figure VII.2). XRD patterns of samples from this compositional group (Appendix E, Figures E.14 and E.26) show significant quantities of calcium silicates. Under oxidising conditions, this pottery fired red to reddish brown to dark yellowish brown (10R 5/8 to 5YR 4/4 to 10YR 4/4).

The Las Ánimas site, the only sampled site in this micro-region, lies on a Lower Cretaceous limestone formation, to the east of the southernmost part of the Pleistocene andesitic basaltic lahar originating in the Colima Volcanic Complex;

this lahar covers some of the lowest parts of this micro-region (Rosales Franco and Rodríguez Lara 2010). The Las Ánimas area limits to the southwest with an Upper Cretaceous unit of andesitic tuff interspersed with limolite strata (Figure VII.2). The Holocene alluvial sediment deposited as terraces along the Salado River, less than 1km to the south and east of Las Ánimas, is a strong candidate for the location of the clay source (Figure VII.2); the neighbouring limestone and andesitic tuff/limolite formations are possible contributors of material to the alluvium. Andesite blocks were readily available in this area to be mined for temper material.

No raw clay sources from this micro-region were analysed in this research. The Universidad de Colima team (Novelo 2007a) did analyse one clay deposit, not available to this study, which was located around 10km to the south of Las Ánimas but outside the aforementioned alluvium (Jilotupa in Figure IV.1).

3) Salado River Basin Group 2 (Geochemical Group C; Volcanic Rocks-tempered Fabric Class, Fine-sorted Temper Sub-class). This group is constituted by relatively low-Sc (ca. 10ppm), Fe-poor (ca. 3.5wt%) pottery made from calcareous secondary clay; with few exceptions (VII.2.1), the base clay was heavily tempered with powder made from crushed and finely sieved (0.2mm) volcanic rocks of intermediate composition. For the most part, it is geochemically and petrographically distinct from the rest of the pottery analysed in this research; the same recipe is used with different base clay in the manufacture of engraved/incised bowls in the same micro-region (Salado River Basin Group 1) and elsewhere (i.e. one sample from the Colima Valley Group and ungrouped sample 200). The untempered-clay version of this group can be petrographically similar to the Colima Valley Group. The pottery from this group fired red (10R 5/6) to light red (10R 6/8) under oxidising conditions.

Although the exact location of the clay source of this group is not known, pottery distribution is restricted to the Colima Valley and the Salado River basin. Like the Salado River Basin Group 1, its calcareous nature points to a source in the Salado River basin (Figure VII.2). However, its compositional distinctiveness from the other Salado River basin group implies the use of two different clay sources. For the geological information related to this group, refer to Salado River Basin Group 1, above (Figure VII.2).

4) Tecomán Coastal Plain Group 1 <u>(Volcanic Rocks-tempered, with Peloids Fabric Class)</u>. This group is constituted by pottery made with a highly calcareous paste tempered with crushed and sieved andesite rocks. It is petrographically distinct from the rest of the pottery analysed in this research due to the fair amount of peloids present in the fabric. Its partial geochemical signature (i.e. the concentration of the seven elements confidently measured in this research) can be very similar to that of the Salado River Basin Group 1. The pottery from this group fired light red (2.5YR 6/6) under oxidising conditions.

Zanja Prieta, the only site sampled from the Tecomán coastal plain, lies in the coastal alluvial plain, around 4km inland from the Pacific Ocean. Between the site and the coastline there is a Quaternary lacustrine plain (Figure VII.3) consisting of alternating thin strata of fine sands, clays, and silt, with some carbonate horizons (Instituto Nacional de Estadística, Geografía e Informática 1994). It is thus possible that the clay procured for making this pottery is located within this unit. In addition to the proximity between the site and this deposit, this suggestion is supported by the fragments of carbonate rocks in this pottery fabrics, as well as the significant calcite content shown in the XRD pattern of one of the samples (Appendix E, Table E.1). Moreover, there are andesite formations next to the site (Figure VII.3), which offered easy access to the raw material that was used as temper.

Universidad de Colima scholars analysed two clay deposits located in the Tecomán coastal plain: Chanchopa and Star de México (Novelo 2007a). After experimental analysis, Chanchopa's clay was considered useful if mixed with other material but not a good choice for base clay (Novelo 2007a:Table 4). This deposit is located around 8km to the north of Zanja Prieta (outside Figure VII.3). Star de México is located almost 6km to the east of Zanja Prieta (Figure VII.3); its clay was also deemed too plastic and sticky for pottery manufacturing if used unmixed (Quesada 2007:38-40). Samples from these two deposits were geochemically analysed in this research (Table IV.3, B9 and B11). Both turned out to be compositionally different from any of the pottery groups identified in this research. However, Star de México is a good match with sample 171, a shadow-striped fragment recovered in Zanja Prieta, which was treated as an ungrouped sample after geochemical analysis. Thus, it seems that the Star de México clay deposit was used to make pottery during the research period, but it is not related to this compositional group.

Figure VII.3. Geological map of the Tecomán coastal plain, where Zanja Prieta site (black dot) is located (modified from Secretaría de Programación y Presupuesto 1984). The location of one clay source is indicated by a red star.

5) Tecomán Coastal Plain Group 2 (Geochemical Group J; Volcanic Rocks-tempered with Sparry Calcite Fabric Class). This group is constituted by pottery made with highly calcareous clay that features diagnostic sparry calcite fragments; the paste was tempered with crushed and sieved andesite rocks. Geochemically, this group is characterised by low concentrations of rare earth elements. The pottery from this group fired brown (10YR 5/3) under oxidising conditions.

The exact location of the clay source for this pottery group is not known, though it is almost surely local at the micro-regional level. The only two samples that constitute this group were recovered at Zanja Prieta, in the Tecomán coastal plain, and one of the samples is of a type (Amela Red) most frequently found around the same micro-region (Appendix A, A.2. Pottery Distribution Patterns). The XRD patterns of these samples showed calcite as the major crystalline phase in their fabrics (Appendix E, Table E.1). Considering the micro-regional geology, petrographic compositional data is also in agreement with the local origin hypothesis. The coastal plain is bounded to the north by Lower Cretaceous limestone formations (Figure VII.3), which could include the parent rocks of the clay sediment used for the manufacture of this pottery. The non-added material present in this pottery fabric seems to have been transported only a short distance before deposited as new sediment; the clay deposit is therefore most probably located at or near the foot of the aforementioned limestone outcrops. Andesite used as clay temper is readily available in this micro-region. For the raw clay samples analysed from this area—which were not related to this compositional group—refer to Tecomán Coastal Plain Group 1.

6) Western Coast Group 1 (Geochemical Group D). This is relatively low-Cr, high-Hf pottery whose fabric contains granitic rock fragments and metamorphic minerals and rocks. Its low Cr (ca. 20ppm) and high Hf (ca. 5ppm) concentrations, both low-mobility elements, tend to confirm a largely granitic origin (Salminen et al. 2005:127,187). The pottery from this group fired red (10R 5/8) under oxidising conditions.

All pottery from this group was recovered from either of the two sampled western coast sites: Terminal Marítima and El Volantín. No raw clay samples from this micro-region were analysed, either in this research or by the Universidad de Colima team. However, unlike the other micro-regions studied in this research, the western coast is geologically dominated by granite (Figure VII.4); this indicates that the clay's origin must be local at the micro-regional level.

Probable locations for the clay source are the spots that are currently mined for clay. One such modern clay mine is called La Ladrillera ('brickworks' in Spanish), located around 8-9km to the northeast of Terminal Marítima and some

10km to the northwest of El Volantín (Figure VII.4). The other known active clay mine is Costa Rica, located 6km to northeast of Terminal Marítima and some 5km to the northwest of El Volantín. The La Ladrillera deposit lies in a Pleistocene polymictic conglomerate at the base of an Upper Cretaceous granite intrusion, near the confluence of the currently intermittent streams of El Águila and El Zacate (Figure VII.4). The polymictic conglomerate is composed of semi-consolidated and poorly sorted sub-rounded fragments of calcareous, metamorphic, volcanic and intrusive rocks (Munguía Rojas et al. 1996). Thus, the La Ladrillera clay deposit may well feature weathered material from a heterogeneous assemblage. The conglomerate's heterogeneity matches the surrounding geology and the petrographic fabric composition of this pottery group. The El Zacate stream originates on an Upper Cretaceous granite intrusion to the east, flowing through a mixed muscovite schist/gneiss Late Devonian formation, before descending into the alluvial plain, which is surrounded by limestone and intermediate and acidic volcanic breccia. The El Águila stream is formed to the north of the clay deposit by minor tributaries coming from Upper Cretaceous granite and Lower Cretaceous mixed limestone/intermediate volcanic breccia formations, flowing next to a skarn deposit before descending through a limestone formation into first the polymictic conglomerate, and then the alluvial plain (Figure VII.4). Meanwhile, the Costa Rica clay mine lies in the alluvial plain at the foot of intermediate to acidic volcanic breccia formations (Munguía Rojas et al. 1996; see Álvarez Pineda et al. 2009), and does not seem to have any input of metamorphic material. The XRD patterns of pottery samples from this group (Appendix E, Figures E.24, E.25, and E.33, Table E.1) show metamorphic minerals such as muscovite, talc and pargasite, and granite-related minerals such as albite and riebeckite (Anthony et al. 2001).

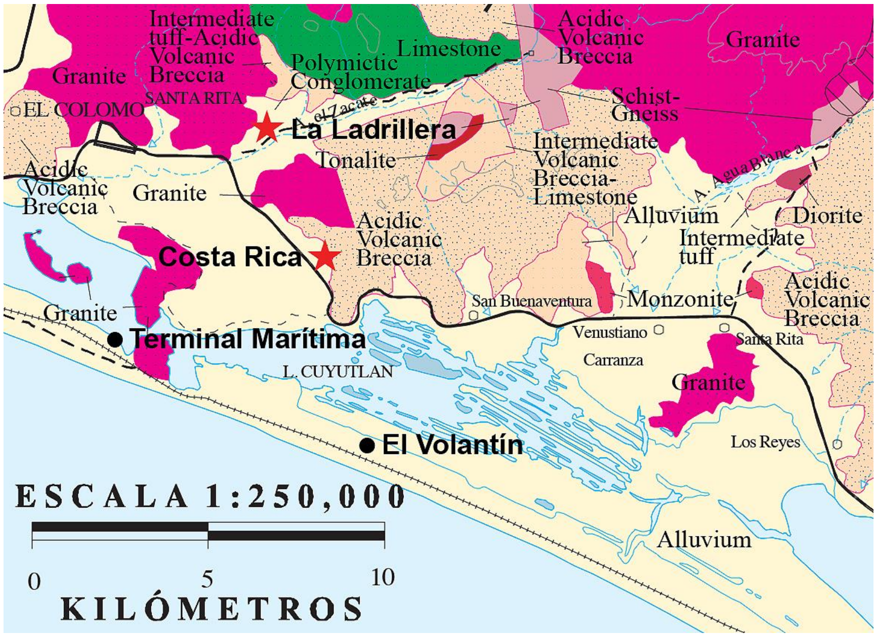

Figure VII.4. Geological map of the eastern half of the western coast, where the Terminal Marítima and El Volantín sites (black dots) are located (modified from Alvarado Méndez et al. 2000). The locations of active clay mines are indicated by red stars.

7) Western Coast Group 2 (Geochemical Group G). This is a geochemically distinct, high-Sc (ca.20 ppm), low-Cr (ca. 25ppm), Fe-rich (ca. 6.5wt%) pottery made with clay of granitic origin. The pottery from this group fired yellowish red (5YR 4/6) under oxidising conditions.

All members of this group were recovered from either of the two sampled western coast sites: Terminal Marítima and El Volantín. As mentioned for Western Coast Group 1, among the sampled micro-regions only the geology of the western coast is dominated by granite (Figure VII.4). The granitic origin of the base clay is supported by the XRD pattern of one sample (Appendix E, Figure E.31, Table E.1), which shows albite calcian low and riebeckite among its crystal phases.

The specific location of the clay source is unknown, but it must be located at some distance from the parent rocks; petrographically, this pottery shows heavily eroded minerals and rocks, and has no granitic rock fragments.

Besides the seven compositional groups described above, there are four non-sourced compositional groups, corresponding to geochemical Groups E, F, H, and I. In this research, Groups H and I were only found in the Tecomán coastal plain and correspond, respectively, to the only two Tecomán Fine Cream samples that were analysed, and two shadow-striped cooking vessels. Tecomán Fine Cream is a type not mentioned in the literature and whose distribution is not known. Besides its distinct geochemical composition, it is also petrographically different from the rest of the pottery analysed, corresponding to the Very Fine Feldspar and Biotite Fabric Class, a composition not readily diagnostic of any of the micro-regions studied in this research. Meanwhile, the Group I shadow-striped cooking vessels were tempered with crushed and sieved andesite rocks. In contrast to the rest of the Tecomán coastal plain samples, their geochemical composition is relatively high in Cr (ca. 90ppm); it is distinguished from the also Cr-rich Colima Valley Group by its higher Hf and Th concentrations. If locally produced, a possible location of the clay source is the predominantly andesitic lahar situated around 7km to the northeast of Zanja Prieta (just outside Figure VII.3), which would explain its higher Cr content.

Group E corresponds to pottery sampled from the two western coast sites. Members of Group E are two Borregas Red-on-cream jars and one shadow-striped cooking vessel. At least the cooking vessel was tempered with crushed and sieved rocks of intermediate composition, but it is not micro-regionally diagnostic in petrographic composition. Group F pottery was found in Zanja Prieta (Tecomán coastal plain) and the western coast sites. This group is composed of a range of types: Tecomán Coarse Cream, Armería Cream/Orange, and shadow-striped cooking vessels. The only sample petrographically analysed from this group contains pyroxenes as well as some metamorphic rocks. A raw clay sample collected from the Armería Valley (B7 in Table IV.3) is geochemically similar to this group, but the location of the clay source remains tentative at best.

Finally, there are a few geochemical and/or petrographic 'outliers', with radically different compositions than any of the defined groups and whose provenance could not be determined. Leaving aside the aforementioned case of sample 171 (see Tecomán Coastal Plain Group 1), they correspond typologically to the Colima Red-on-cream (sample 008 of the Well-sorted Sand Fabric Class), Borregas Red-on-cream (069, 210), Colima Incised (095 and 200), and Colima Shadow-striped (038, 150) types.

VII.2. POTTERY TECHNOLOGY AND PRODUCTION IN COLIMA DURING THE LATE CLASSIC/EPICLASSIC

After the pottery production locations for the research area were determined at the micro-regional level, it became possible to assess and compare technological choices/styles and related production concerns from a micro-regional perspective. In this section the following topics will be discussed: the different *chaînes opératoires* employed in the production of pottery; how some steps of the production sequence are exclusive to some wares/types (i.e. product standardisation); how the sharing of complete production sequences is restricted to the micro-regional sphere (i.e. micro-regional standardisation); and how specific resources were used in every micro-region (i.e. resource specialisation), sometimes to produce specific types (i.e. product specialisation). Finally, the territories of the established technological styles will be compared with the known 16th-century political entities from the same area.

VII.2.1 MICRO-REGIONAL *CHAÎNES OPÉRATOIRES* AND TECHNOLOGICAL STYLES

Colima Valley. Current data indicates that a single large clay deposit, or a series of contiguous clay deposits of very similar composition, was/were the only raw clay source(s) used in the Colima Valley for pottery production during the research period.

In this research, pottery production in the Colima Valley is typologically characterised largely by five different types of relatively small-sized mortar bowls (Figure VII.5; see also Figures IV.7-IV.9): Libramiento Ring-based Mortar, Libramiento Pedestal-based Bowl, Libramiento Red Rim, Bugambilias Red-on-orange, and Pozo Hundido Red-on-brown. At least four of these types were already considered diagnostic of the North Armería complex, as defined by their recurrent co-occurrence in burial contexts limited to the Colima Valley during the Armería phase (Appendix A). According to this research results, only the Bugambilias Red-on-orange type was also produced with a second, different clay source, located in the Salado River basin. The remaining four types of mortar bowls are exclusive to pottery production in the Colima Valley *and* have a distribution limited to this micro-region.

Figure VII.5. Types of bowls manufactured in the Colima Valley.

Also found to be produced in the Colima Valley are cooking vessels of the Colima Shadow-striped type, a Colima Incised bowl, and a Colima Red-on-cream jar. In contrast to the largely unprocessed clay used in the production of the five types of mortar bowls, the clay was heavily processed in the manufacture of the Colima Incised specimen. Its manufacture involved the levigation of the clay and the subsequent addition of finely sieved crushed rocks as temper, in the manner of those bowls manufactured in the Salado River basin. The reason(s) behind these technological choices is perhaps the need to create a finer paste that was required for the incised (and sometimes complex) decoration lacking in the other types, and/or to conform to a technological style. The Colima Red-on-cream jar and Colima Shadow-striped vessels of this group were not petrographically analysed; thus, I can only speculate about whether their manufacture involved any sort of clay treatment or they were manufactured with largely unprocessed clay, as the mortar bowls were. In sum, there are two defined technological styles in this area, related to the same clay source(s): one represented by a single sample of a Colima Incised bowl, and the other by five different types of mortar bowls (Figure VII.6).

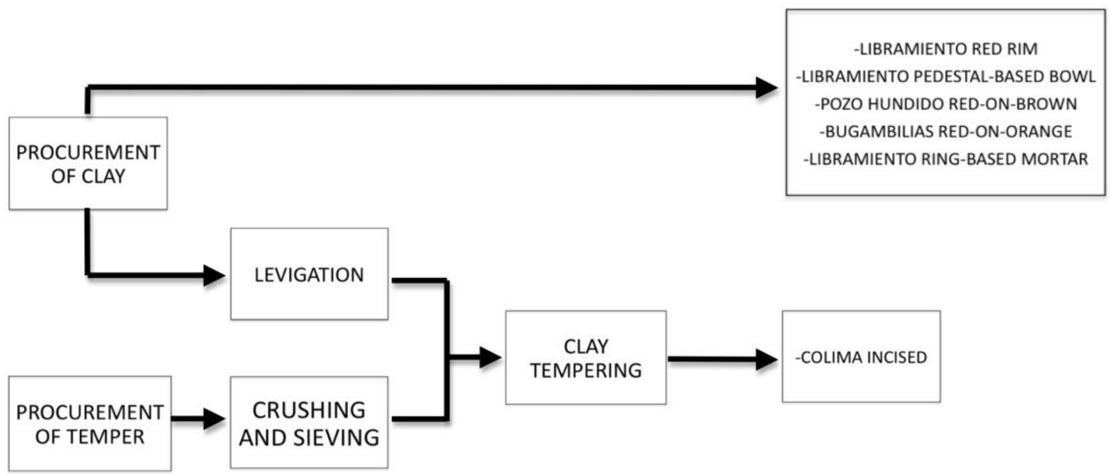

Figure VII.6. Raw material procurement and paste preparation stages of the *chaîne opératoire* for pottery production in the Colima Valley.

Salado River basin. Two clay sources (1 and 2) were used for pottery production in the Salado River basin during the research period, each used to produce a different range of products.

Five different pottery types were manufactured with clay source 1, including the production of the two types of red-painted jars from this period: Colima Red-on-cream and Borregas Red-on-cream (Figure VII.7; see also Figures IV.4 and IV.5). These were believed to be stylistically related types, with Borregas Red-on-cream representing the later, Armería-phase variants of the earlier, Colima-phase Colima Red-on-cream specimens (Appendix A, A.1. Type Descriptions; Kelly 1980:8-9). This research provides evidence of their manufacture with the same clay source and following the same recipe in the Salado River basin. There is compositional evidence that both types were produced outside this micro-region as well.

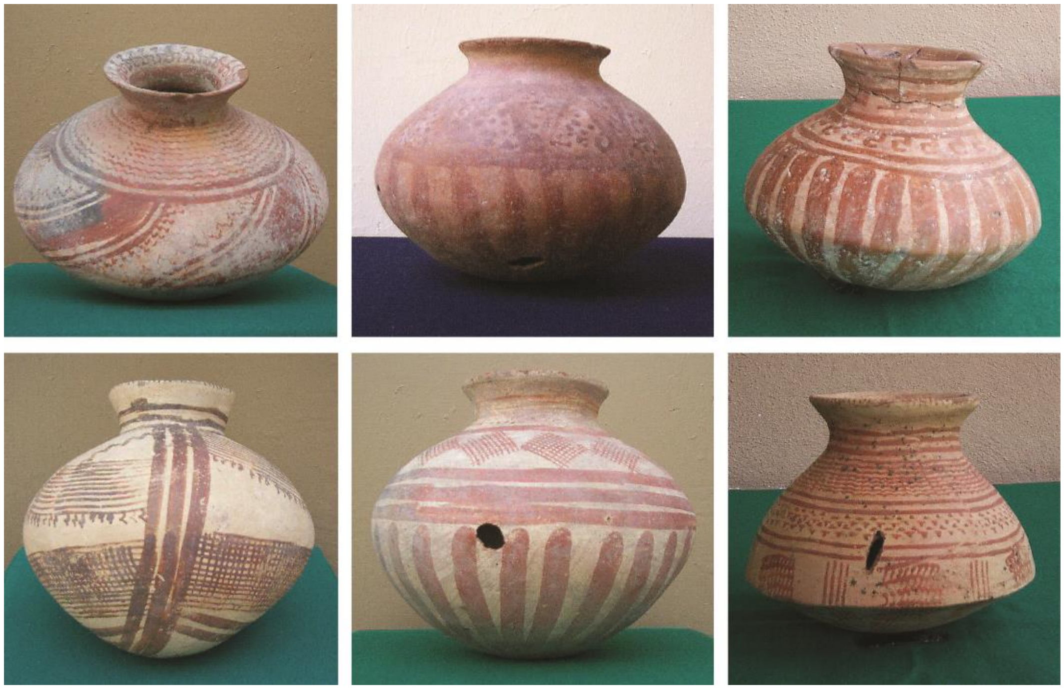

Figure VII.7. Colima Red-on-cream (top row) and Borregas Red-on-cream (bottom row) jars. Both types were manufactured using a single clay source in the Salado River basin.

Even if the raw materials and paste recipe for the Red-on-cream types remained unchanged throughout the Colima and Armería phases, some changes in technological choices/style are evident in the vessel morphology and the finishing stage of the production sequence. Earlier Colima-phase specimens are sometimes burnished, and unpolished examples tend to lack the diagnostic cream slip. Meanwhile, Armería-phase jars are always slipped but polishing seems to disappear completely (Appendix A, A.1. Type Descriptions). The sporadic use of a white slip is another characteristic of Armería-phase production. Metric variability in the maximum rim diameter reveals increasing standardisation and simplification through this period (Appendix A, A.1. Type Descriptions), perhaps in turn reflecting an increase in the scale and intensity of production due to the need to produce more in less time (but see II.3.2, for the complexities surrounding the standardisation of ceramic output). In this way, compositional homogeneity remains despite variations in metric and ornamental characteristics.

Other pottery types manufactured with clay source 1 from the Salado River basin are shadow-striped cooking vessels and the two types of engraved/incised bowls from this period: Colima-phase Colima Incised and Armería-phase Pozo

Hundido Incised. As with the red-on-cream jars, the so-called Incised types represent the persistence of pottery fabrics for half a millennia through changes in vessel shape, decoration techniques (engraved *versus* incised) and decorative motifs. Both of these Incised types were also manufactured with a second, different clay source also located in the Salado River basin (clay source 2, see below), as well as, minimally, outside the Salado River basin (i.e. one sample of the Colima Valley group), always following the same recipe.

As it can be appreciated in Figure VII.8, the main difference within the early stages of the *chaînes opératoires* for pottery produced with clay source 1 is the use of finer sieved crushed rocks in the production of the engraved/incised bowls. As mentioned earlier, this technological choice may have had something to do with the bowls' decoration, as the potters sought to create a finer paste on which to engrave/incise the ornamental motifs.

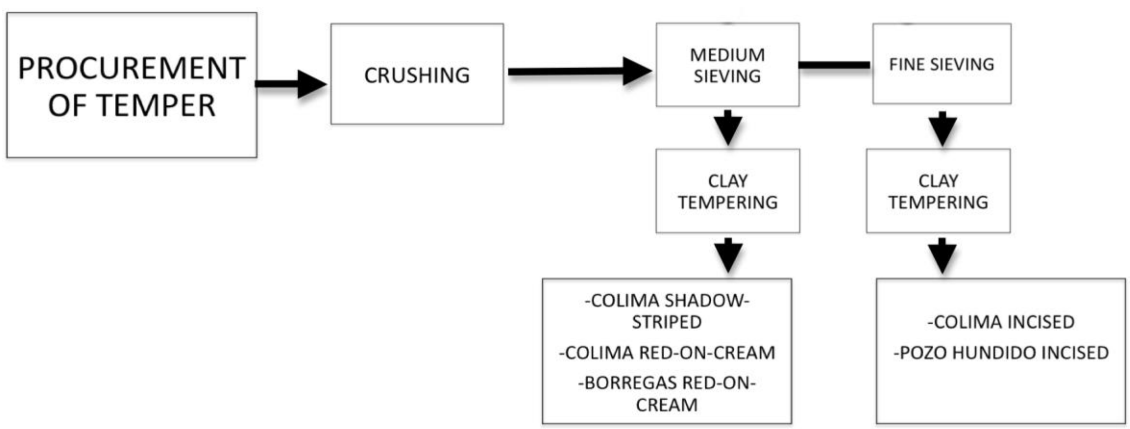

Figure VII.8. Temper procurement and paste preparation stages of the *chaînes opératoires* for pottery production in the Salado River basin (clay source 1).

In contrast, the exploitation of clay source 2 in the Salado River basin seems to have been almost completely devoted to the manufacture of engraved/incised bowls of the Colima Incised and the Pozo Hundido types (Figure VII.9). However, Bugambilias Red-on-orange bowls were also produced with clay source 2 (this type was also manufactured in the Colima Valley, see Colima Valley Group in this section). The Bugambilias Red-on-orange bowls were made with an untempered paste: they did not follow the same recipe employed for the engraved/incised bowls (Figure VII.10). This indicates that, in this case, the technological choice of tempering was not demanded by the clay's performance in the forming and firing stages of the production sequence, or by the product's functional use (all types are mortar bowls).

Figure VII.9. Colima Incised (left) and Pozo Hundido Incised (right) bowls. Both types were predominantly manufactured in the Salado River basin, using two sources of clay (separately).

As with the two types of Red-on-cream jars, even though both types of engraved/incised bowls share the same raw material sources and are compositionally homogenous, their manufactures differ significantly in the finishing stage of the production sequence (Figure VII.11). The Colima Incised decoration was done after the application of the slip, when the clay was leather-hard (i.e. engraving). In contrast, the simpler decoration of the Pozo Hundido bowls tended to be done before the drying and slipping stages, when the clay was still wet (i.e. incising). Pottery smudging, relatively common in the Colima Incised type, disappears by Armería times. These examples are strong evidence for production simplification, which would allow faster finishing of the bowls. This simplification strategy for the manufacture of engraved/incised bowls is further reflected in the reduced variation in shapes and decorative motifs. As opposed to the more complex designs found in Colima Incised bowls, Pozo Hundido specimens recurrently feature a single motif: one wavy line and two straight ones (Appendix A, A.1. Type Descriptions).

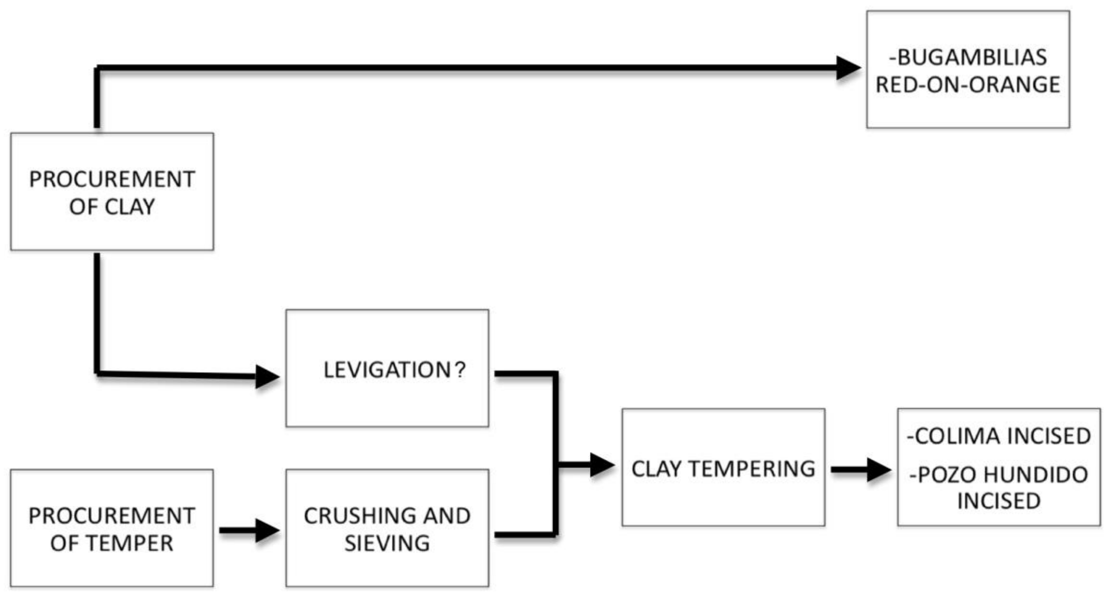

Figure VII.10. Raw material procurement and paste preparation stages of the *chaîne opératoire* for pottery production in the Salado River basin (clay source 2).

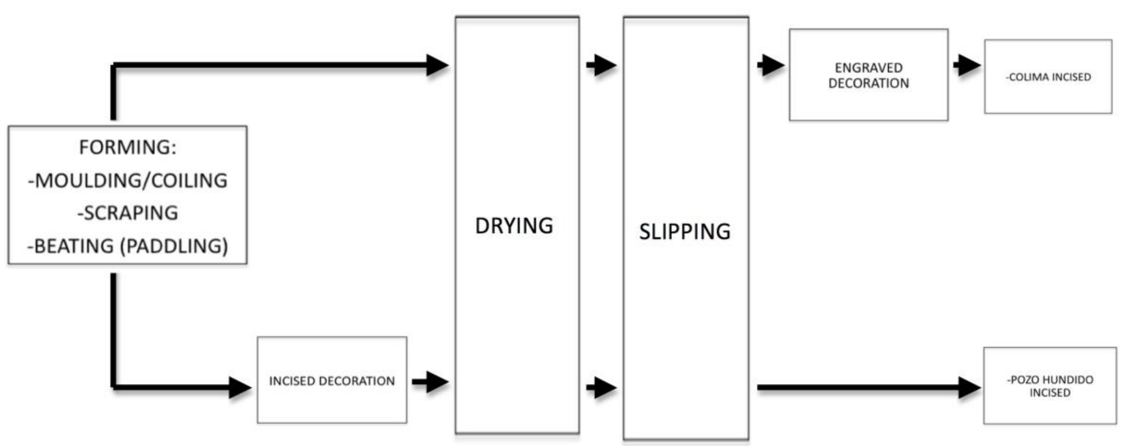

Figure VII.11. Forming and finishing stages of the *chaîne opératoire* for engraved/incised bowl production in the Salado River basin (clay sources 1 and 2).

In sum, in the Salado River basin, one clay deposit was mined preferentially for the production of red-on-cream jars and shadow-striped cooking vessels (clay source 1), while a second clay source was used mainly for the manufacture of so-called Incised types (clay source 2). The production of both red-on-cream jars and engraved/incised bowls went through an increase in standardisation during the research period. These documented shifts in technological choices, which do not involve changes in the procurement of resources, parallel and help define the transition between the Colima and Armería phases in the Salado River basin.

Tecomán coastal plain. At least three clay sources (1, 2, and 3) were used for pottery production in the Tecomán coastal plain. The pottery analysed in this research indicates that these clay deposits may have been utilised in a product-specific manner: clay source 1 for red-on-cream jar production; clay source 2 to produce the local bowl-types Amela Red (Figure VII.12) and Tecomán Coarse Cream; and clay source 3 for the manufacture of shadow-striped cooking vessels (Figure VII.13). There is also a potential fourth local clay source (geochemical Group I), which may have been used to produce shadow-striped cooking vessels. At least clay from sources 1 and 2 (and from the potential fourth local source) were tempered with crushed and sieved rocks of intermediate composition; the sole sample of pottery linked to clay source 3 was not petrographically analysed (Figure VII.13).

Figure VII.12. Amela Red bowl. This pottery type was produced in the Tecomán coastal plain.

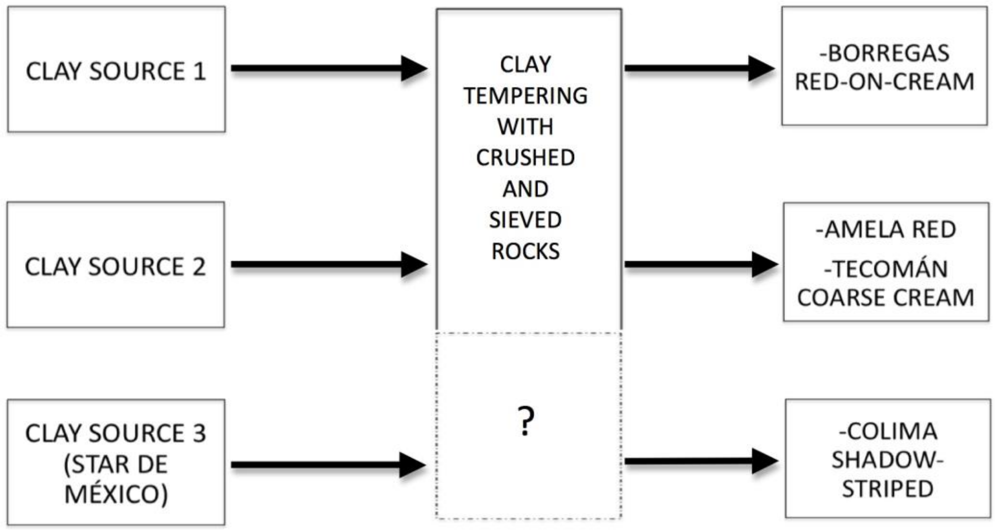

Figure VII.13. Relationship between clay sources, paste processing, and pottery types in the Tecomán coastal plain.

Western coast. At least two clay sources (1 and 2) were used for the production of pottery in the western coast. Clay source 1 was utilised exclusively for the production of the Armería Cream/Orange type (Figure VII.14), which consists of flat-bottomed bowls and so-called 'cups' (bowls with a tall pedestal base). For its part, clay source 2 is linked to the production of both the Armería Cream/Orange and shadow-striped cooking vessels (Figure VII.15).

Figure VII.14. Armería Cream/Orange 'cup' (left) and flat-bottomed bowl (right). This type was produced using two different clay sources (separately) in the western coast.

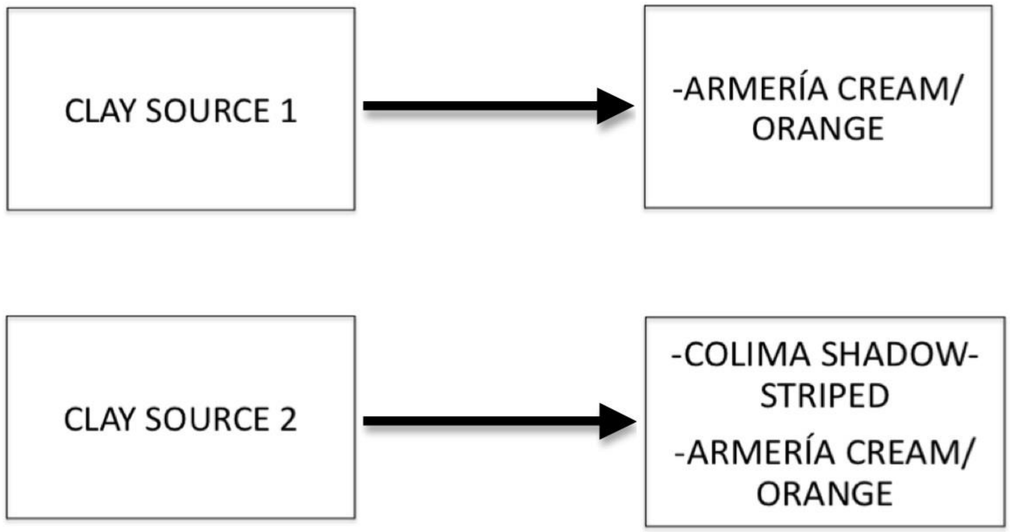

Figure VII.15. Relationship between clay sources and pottery types in the western coast.

VII.2.2. THE ORGANISATION OF PRODUCTION: REGIONAL AND MICRO-REGIONAL CONSIDERATIONS

The research area is still in need of a deep understanding of the social backgrounds in which pottery production took place: a prerequisite to fully reconstruct and understand the mode and context of ceramic production (Costin 1991). Nevertheless, this research has obtained valuable sourcing and technological information that allows, for the first time, some insight into production issues.

According to the results of this research, the organisation of pottery production in Colima during the period of study is specialised, if 'specialisation' is understood as the repeated provision of commodities for others' consumption (Arnold 2000:334; Clark 1995:279; Costin 1986:328, 1991:4). It is not clear if demand was steady enough to sustain the existence of full-time specialists, and perhaps this label can only be given to the potters of the Salado River basin (see discussions in VII.2.3 and VII.3). A large part of the results could represent part-time, independent specialists producing fairly distinctive ware for local consumption, either at the micro-regional or the community level. In the micro-regions where more than one site was sampled (Colima Valley and the western coast), production had a micro-regional reach and was probably aimed at the local market (see Williams and Weigand 2004:19-21 for a few references on West Mexican Late Postclassic markets), from which it was circulated within the micro-region through some kind of exchange (e.g. Brumfiel 1998:147). Some of the pottery produced in the Salado River basin reached further; its peculiarities will be discussed below and in the following section (VII.3). All evidence considered, there is no support for the existence of a pan-regional market system either for pottery or including pottery in some way.

A major source of proof for specialised pottery production is the persistence of fabrics over a long period of time (Arnold 1991:57); for Colima's Late Classic/Epiclassic, this is the case for almost 500 years. Examples of compositional homogeneity and technological standardisation were found in every micro-region through the exploitation of the same resources and continued use of either paste recipes or largely unprocessed clay. Furthermore, there is evidence of resource and product specialisation at the micro-regional level, the former indicated by the apparently restricted access to and use of specific resources by potters of every micro-region (Rice 1991).

The only micro-region in which only a single clay deposit could have been mined is the Colima Valley. Even though it is the micro-region with the least geological variability, geochemical composition studies of both pottery (by far the largest sample in this research) and raw clays permitted the provisional restriction of the source zone to a ca. 5km-long strip of clay(s) to the west of the valley. Pottery made from this source(s) is found within the valley as far as 10km in two directions, and in an area of around 130km^2. The high degree of paste homogeneity at the micro-regional level is not itself a sufficient basis for claims of production centralisation, especially when dealing with a relatively large, compositionally homogenous source zone. In fact, together with previously acquired data on metric and decoration variability of the five pottery types of mortar bowls repeatedly produced with this clay (Appendix A, A.1. Type Descriptions), a more likely scenario is the existence of several workshops in the area, exploiting the same large clay deposit or contiguous deposits of similar composition. The potters mining this deposit or deposits, even if part-time specialists, could have been permanent local residents. One of the largest (if not the largest) sites of this period, La Campana, is located just 4km southeast from the La Cruz de Comala deposit (Figure VII.1); it is thus fair to say it could have been a relatively densely populated area. Pottery could have been distributed within the micro-region through a variety of mechanisms, such as the local market, itinerant merchants, or even itinerant potters carrying clay to places with no available sources (Donnan 1971). Any of these mechanisms (or a combination of them) could have resulted in the observed pattern; at any rate, it is safe to say that pottery was produced in the Colima Valley for consumption within the micro-region.

In addition to resource specialisation, the other three sampled micro-regions show strong evidence for product specialisation (Rice 1991), with particular clay sources preferentially used for the production of single types of pottery. At the scale of this research (i.e. micro-regional), in most cases it is difficult or impossible to assign product specialisation to workshop- or community-based specialisation; this is especially relevant for the micro-regions where only a single site was sampled (Salado River basin, Tecomán coastal plain), for which it is not possible to know whether the patterns of product specialisation are linked to micro-regional or community resource specialisation. However, in the Salado River basin, where one source was used mostly for the manufacture of engraved/incised bowls and a second source for the manufacture of red-on-cream jars, cooking vessels, *and* engraved/incised bowls, it is possible to suggest workshop-based or at least community-based specialisation.

A similar pattern to the one described for the Salado River basin was obtained for the western coast, where one clay source seems to have been exclusively utilised for the production of Armería Cream/Orange ware, while a second was used for the manufacture of cooking vessels and also Armería Cream/Orange ware.

Yet another example of product specialisation is found in the Tecomán coastal plain: three different sources were distinctly used for the manufacture of bowls, jars, and cooking vessels, respectively.

As far as pottery types are concerned, the shadow-striped type of cooking vessels is one of just two interregional types (i.e. locally made in all four micro-regions), the other being—if considered a single type—the red-on-cream jars. This corroborates previous suggestions of local manufacture based on macroscopic fabric observations of shadow-striped vessel specimens from the western coast and other micro-regions neighbouring the ones studied here. Since the shadow-striped vessels had the same fabric as the known local types, they were deemed to be local products in all cases (Beltrán 1991; Kelly 1949:45; Meighan 1972:45-46). In this research, the pattern of consumption of this type is also local (at the micro-regional level), with the exception of the one-way circulation between the Salado River basin (the producing micro-region) and the Colima Valley: 75% of the specimens sampled in the Colima Valley were sourced to the Salado River basin. In the rest of the cases, they were consumed within their producing micro-region (Table VII.1).

Table VII.1. Relationship between provenance (columns) and distribution (rows) of the Colima Shadow-striped type. N = sample size.

PROVENANCE/ DISTRIBUTION	COLIMA VALLEY	SALADO RIVER BASIN	TECOMÁN COASTAL PLAIN	WESTERN COAST	N
COLIMA VALLEY	**X** (25 %)	**X** (75 %)			16
SALADO RIVER BASIN		**X**			2
TECOMÁN COASTAL PLAIN			**X**		1
WESTERN COAST				**X**	3

Besides the special relationship between the Colima Valley and the Salado River basin (further tackled in VII.2.3), the two major exceptions from the overwhelming micro-regional pattern of pottery production and consumption concern the interregional transmission of technological knowledge, and the pan-regional distribution of red-on-cream jars produced in the Salado River basin.

Aesthetic choices, which for the most part are used to define pottery types in the archaeological literature of the research area (Kelly 1980:1), were widely shared between producing micro-regions. Cooking vessels were decorated with ‘shadow stripes’ and jars were red-painted with similar designs. This speaks highly about interregional interaction, but shared artefact attributes that are visible and thus easy to copy do not imply apprenticeship or the transmission of technological knowledge (Hegmon et al. 2000:219; Zedeño 1995:120). The existence of an interregional technological tradition in Colima may have its best expression in the Colima Incised type. The sharing of its paste recipe (i.e. the tempering of base clay with finely sieved crushed rocks) happened on a regional scale (Colima Valley, Salado River basin, and an unsourced sample found in the western coast) and involved the use of raw material sources with potentially different physical properties. This reveals a regionally established technological style for the production of this type, the existence of 'communities of practice', and the interregional transmission of knowledge between them (Esposito and Zurbach 2014:43).

The pan-regional distribution of pottery is restricted to the red-on-cream jar vessels produced in the Salado River basin. As seen in Table VII.2, red-on-cream jars were made in at least three of the four micro-regions sampled: the Salado River basin, the Colima Valley, and the Tecomán coastal plain. Non-sourced samples were found in the western coast, so they were most probably also produced there. However, the Salado River basin specimens of these jars are notoriously present in all sampled micro-regions, and so far the circulation of these vessels seems to be one-way, as no foreign specimens were found in Las Ánimas (Table VII.2). This pattern applies to both the Colima and Armería phases, represented by the Colima Red-on-cream and Borregas Red-on-cream types, respectively. In short, only those jars produced in the Salado River basin circulated outside of their producing micro-region. What exchange and/or consumption behaviours produced this pan-regional distribution pattern that differs from the dominant pattern of micro-regional consumption? The answer could lie in their use, and this possibility is explored in VII.3.

Table VII.2. Relationship between provenance (columns) and distribution (rows) of the red-on-cream jars. N = sample size.

PROVENANCE/ DISTRIBUTION	COLIMA VALLEY	SALADO RIVER BASIN	TECOMÁN COASTAL PLAIN	WESTERN COAST	N
COLIMA VALLEY	**X** (3 %)	**X** (97 %)			30
SALADO RIVER BASIN		**X**			6
TECOMÁN COASTAL PLAIN		**X** (50 %)	**X** (50 %)		4
WESTERN COAST		**X**			6

VII.2.3. CORRELATION BETWEEN TECHNOLOGICAL, PRODUCTION, AND DISTRIBUTION PATTERNS WITH THE 16TH-CENTURY POLITICAL UNITS

As introduced in Chapter I of this thesis, one of the main aims of this research is to identify any correlations between the territorial distribution of technological styles (i.e. sets of technological choices in the *chaîne opératoire*) during the research period and the territories of the regional polities documented in the research area for the 16th century. Therefore, the sampling strategy (Chapter IV) was designed to analyse pottery produced in the territories occupied by three 16th-century political entities, covering four geographical micro-regions. These geographical micro-regions were used in this research as analytical units since they would correspond to different 'source zones' (Arnold et al. 1999:68), offering distinctive raw materials for pottery production. In two cases (Tecomán coastal plain/Valle de Tecomán, and western coast/Provincia de Tepetitango) there is a one-to-one correspondence between a geographical micro-region and a 16th-century political unit, while the territory of the Provincia del Colimotl occupies two micro-regions: the Colima Valley and the Salado River basin (Figure VII.16).

The results produced by this research show that the most marked differences between pottery production sequences in the research area have to do with the exploitation of distinctive sources of raw materials. The four sampled geographical micro-regions used different clay sources to produce both distinctive wares and some shared types.

Differences in the exploitation of resources were not restricted to different micro-regions, however. At least a couple of clay sources were simultaneously exploited in each micro-region, with the probable exception of the Colima Valley. In VII.2.2, it was highlighted that this contemporaneous use of different sources within a micro-region often reflects product specialisation, while in a couple of cases some pottery types were produced using different micro-regional sources. Product specialisation is also evident in the clay processing stage of the *chaîne opératoire.* For example, in the Salado River basin and the Colima Valley, the manufacture of engraved/incised bowls involved in both instances a specific paste recipe not used for other pottery types produced with clay from the same source.

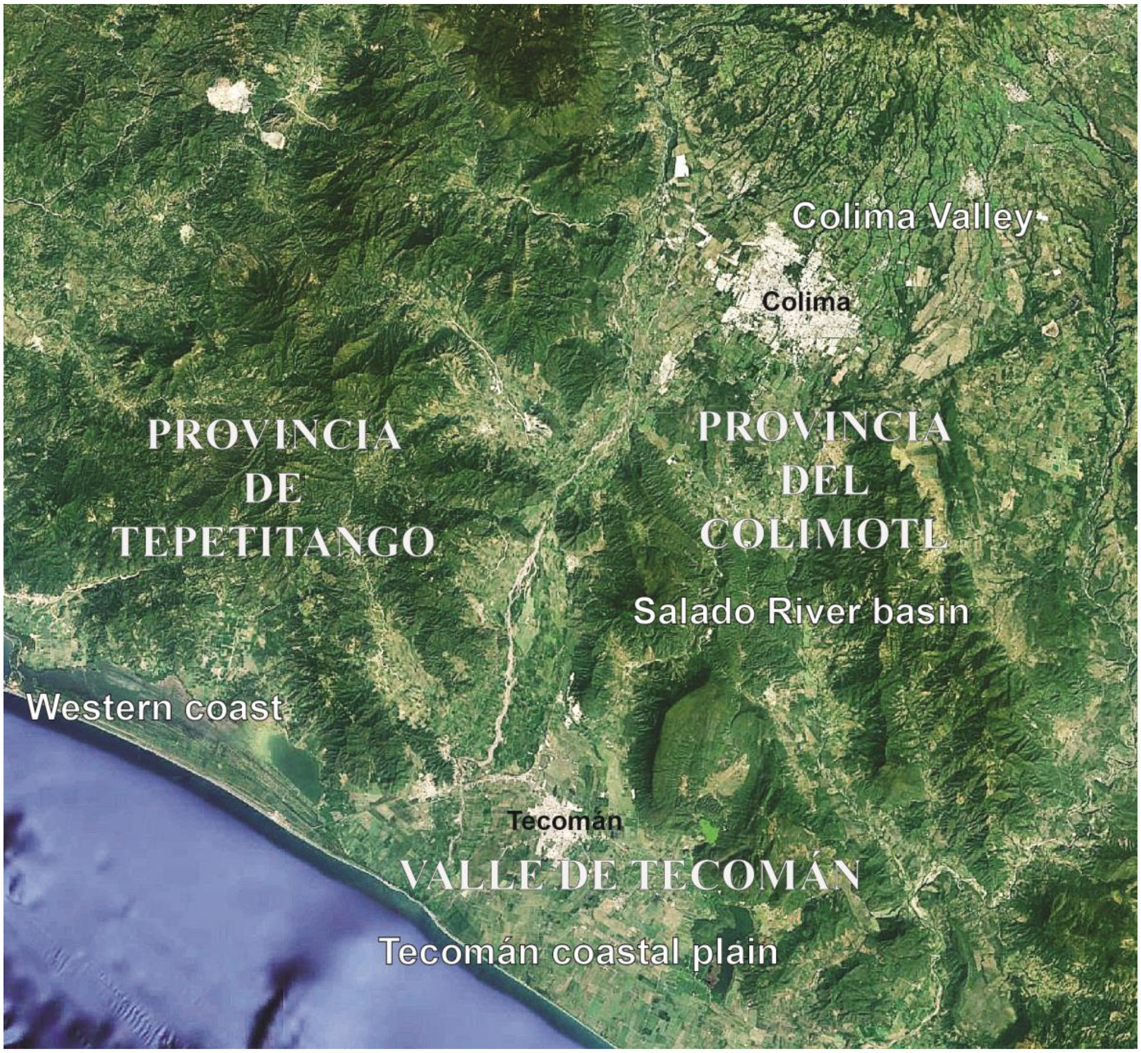

Figure VII.16. Map of the four micro-regions sampled for pottery (in black) and the 16th-century political units (in blue). Modified from Google Maps.

Despite the widespread use of a similar firing technology, a couple of peculiarities in the firing and post-firing steps of the *chaîne opératoire* were documented: the practice of multiple-step firing in the western coast, and the 'smudging' of Colima Incised bowls in the Salado River basin.

Finally, it was also revealed that the exploitation of some clay sources continued throughout the Colima and Armería phases, surviving the changes in other steps of the *chaîne opératoire* connected to temporal differences.

Given that two of the micro-regions studied here (the Colima Valley and the Salado River basin) belong to the territory of the 16th-century Provincia del Colimotl, one aim of this research was to see if comparisons between the pottery found in these areas showed a greater degree of technological standardisation than comparisons with pottery assemblages found in other micro-regions/polities. Technological standardisation is the result of the repeated use of the same technological choices in the production process (raw materials, intended vessel shapes, and forming, finishing, and firing techniques). As reviewed in Chapter II, production standardisation may occur among craft communities for a variety of reasons, including the normative behaviour of technological practices as a result of 'communities of practice' (Livingstone Smith and Viseyrias 2010; Roux and Courty 2005; Sassaman and Rudolphi 2001). However, pottery standardisation has also been considered to be a passive reflection of political control over production (Postgate 2007), as well as an active political tool for cultural homogenisation (Glatz et al. 2011; Morgan and Whitelaw 1991). Based on these last two interpretations of standardised ceramic outputs, if the 16th-century Provincia del Colimotl could be traced back to the research period, and pottery was centrally produced, a certain degree of pottery technological standardisation could be expected across the Colima Valley and the Salado River basin. Extending this argument to the whole research area, the manufacture of pottery in both micro-regions would involve a distinctive set of technological choices when compared to those of the other two micro-regions/polities and the latter would each demonstrate a different technological style resulting from distinct political chains of command.

The *chaînes opératoires* reconstructed in this research show that the production sequences of pottery do indeed vary between geographical micro-regions, even if some technological and aesthetic choices were regionally shared. That is, the degree of micro-regional standardisation is relatively high when compared with other micro-regions: micro-regional pottery production technology is in every case characterised by the production of some distinctive and relatively standardised ware, the continuous exploitation of specific resources, and sometimes also by unique technological choices related to specific products.

Yet the overall picture demonstrates no clear-cut correlation between a single technological style and any of the micro-regions. The detailed analysis implemented in this study unveiled that within the same micro-region different *chaînes opératoires* can be found, and are associated with different raw material sources (e.g. the use of two sources in the Salado River basin for the production of engraved/incised bowls), different intended products (e.g. the use of different sources for different products in the Tecomán coastal plain), and different periods in time (e.g. changes in the production steps for the manufacture of engraved/incised bowls in the Salado River basin).

In summary, there is production standardisation at the micro-regional level when micro-regional pottery outputs are compared with each other, as indicated by established micro-regional wares and the use of particular resources restricted to micro-regional production; and there is technological variation within every micro-region (with the exception of the Colima Valley), as reflected in product specialisation and the exploitation of different clay sources. That is, the micro-regional scenarios of pottery production are more likely the result of competing micro-regional workshops and different 'communities of practice', rather than centralised control over micro-regional production.

In any case, micro-regional technological characteristics could support the hypothesis that the sampled micro-regions were distinct political units (i.e. based on a relatively standardised ceramic output when compared to other micro-regions), but they fail to highlight the Colima Valley and the Salado River basin as a single political entity, if that was indeed the case. In other words, differences in pottery technology depict a connection between the Colima Valley and the Salado River basin no different than their connection with the other two sampled micro-regions (i.e. the exploitation of different resources and production of partially different ware).

Thanks to provenance studies, a different story is told by the patterns observed in pottery distribution. The pattern of manufacturing locations and associated micro-regional-restricted distribution areas does not fully apply to the Colima Valley and the Salado River basin when considered as separate units. As shown in Tables VII.1 and VII.2, the Colima Valley not only engaged in pottery exchange with the Salado River basin but, judging by the numbers, it *relied* on pottery produced there. Even though the red-on-cream jars made in the Salado River basin are pan-regionally distributed, they account for 97% of the specimens of this type sampled from the Colima Valley (Table VII.2). Furthermore, the Colima Valley was also consuming the Colima- and Armería-phase engraved/incised bowls made in the Salado River basin; only one out of 14 specimens confidently sourced was made locally. Perhaps more striking is the fact that 75% of the shadow-striped cooking vessels sampled from the Colima Valley were also produced in the Salado River basin (Table VII.1). As discussed in the previous sub-section (VII.2.2), this pottery type is typically not traded, but produced and consumed locally in all micro-regions/polities (Beltrán 1991; Kelly 1949:45; Meighan 1972:45-46). The Armería-phase equivalent of the Colima Shadow-striped type (i.e. an open-mouthed *olla* for boiling) was not sampled for this study, so it can only be speculated if this pattern applies to both phases in relation to cooking vessels as it does in relation to engraved/incised bowls and red-on-cream jars. Finally, it needs to be remarked that the red-on-cream jars, the engraved/incised bowls, and the shadow-striped cooking vessels were mundane commodities, apparently used mainly for utilitarian purposes and among the commonest types of this period (Appendix A).

Considering the above data, I argue that the relationship between the Colima Valley and the Salado River basin is better explained as one of different areas of the same political unit. It seems that the two micro-regions were deeply integrated into the same economic system and thus were part of the same network of authoritative relationships that delimited the production and distribution of pottery products. The fact that the circulation of pottery appears to have been one-way suggests that potters in the Salado River basin may have been more dependent on the returns generated by the exchange of their products. Consequently, communities in the Colima Valley, perhaps preferentially serving other sectors of the polity's consumer market, relied in a complementary way on pottery produced in the Salado River basin (see Stark and Heidke 1998:510-12 for an example of complementary craft production).

The reconstruction of pottery's *chaîne opératoire* in both areas revealed that Salado River basin-like pottery (i.e. engraved/incised bowls, shadow-striped cooking vessels, and red-on-cream jars), conforming to established aesthetic and technological standards, could have been manufactured in the Colima Valley if so desired. However, this was apparently done on a small scale, and Colima Valley potters seem to have specialised in mortar bowls for micro-regional use. Therefore, the strong differentiation of ceramic outputs between the Colima Valley and the Salado River basin must not be understood as solely the passive, materialistic reflection and unconscious result of the exploitation of different resources, but rather as embedded in dynamic political strategies and continually-negotiated political relationships within the regional polity, constituted by both micro-regions. In other words, technological and production strategies enabled and sustained complementary practices that facilitated political integration.

Under the model proposed here, pottery producers in the Colima Valley may have been part-time specialists mainly devoted to agriculture or other subsistence means, while the larger scale of pottery production demanded from the Salado River basin (supported by evidence of simplification in pottery production through time, see VII.2.1, Salado River basin) required full-time specialists. On the one hand, since there is no evidence for centralised pottery production, independent pottery specialists, as ‘communities of practice’ and social and political actors, could have been able to exercise authority in horizontal communal relationships (that is, with micro-regional competitors for communal ‘resources rights’, and with ‘local’ and Colima Valley consumers for the agreement of the terms of exchange) through their own political strategies even while embedded in a hierarchical political landscape. On the other hand, it also needs to be considered that the control of resources and centralised decision-making does not always result in centralised production (Arnold 2000:358); in this way, the elite’s intervention in the elaboration of political strategies related to pottery production remains a possibility even in a production context of independent specialists.

With regard to the question about whether Colima as a whole was politically unified in prehispanic times, the analysis of pottery technology completed in this research provides little evidence for such integration during the Late Classic/Epiclassic. There is evidence of shared technological knowledge, but also of technologies that are particular to some micro-regions. Moreover, with the exception of the red-on-cream jars produced in the Salado River basin, pottery was barely traded between micro-regions during this period; pottery production seems to be organised in a micro-regional way (with the exception of the Colima Valley and Salado River basin, as noted above). As far as pottery is concerned, the western coast and the Tecomán coastal plain seem to be economically autonomous, both from each other and from the Colima Valley and the Salado River basin. Pottery analysis provides no evidence for a centralised economic system involving all micro-regions, or for economic interdependence outside of a centralised economic system that would indicate the constitution of a pan-regional polity. However, the patterning of pottery offers only a limited view of the regional craft economy (Bayman 1999:252-55). As evidenced, for example, by the Postclassic Tarascan state of West Mexico (Pollard 1994:86-87), interregional technological variation of pottery, restricted micro-regional distribution, and the absence of direct intervention by the elites into pottery production, are not enough proof for the lack of a centralised regional power, which may have physical expressions or material evidence outside of pottery production technology and pottery distribution patterns. In any case, a few shared pottery types, the evidence for some shared technological knowledge, and indications of events in the Salado River basin that were attended by people coming from all of the studied micro-regions (VII.3), depict close interregional interactions and a shared set of ideological and social beliefs and practices within the whole Colima region. In summary, the analysis of pottery production, technology, and distribution offers proof for the political integration of the Colima Valley with the Salado River basin, while the overall political unity of the four micro-regions studied in this research remains inconclusive.

VII.3. INTERPRETATION OF THE CIRCULATION PATTERN OF THE RED-ON-CREAM JARS MADE IN THE SALADO RIVER BASIN

The wide distribution of the red-on-cream jars produced in the Salado River basin represents an anomaly in a region otherwise characterised by micro-regional and mutually exclusive pottery assemblages (with the exception of the rest of the pottery consumed in the Colima Valley and made in the Salado River basin, as noted above). What mechanism produced this distribution pattern of the red-on-cream jars produced in the Salado River basin, and what does it mean in social terms? The determination of vessel function is extremely significant for assessing the social (and political) meanings of production, exchange, and consumption patterns (Abbott 2000:109). I argue that inter-communal feasting was the mechanism governing the circulation of the red-on-cream jars produced in the Salado River basin.

Both red-on-cream jar types, including the whole range of variants in size and shape, have a short neck and a restricted mouth with a rim diameter mode of 10cm (Appendix A, A.1. Type Descriptions; see also Figures IV.4 and IV.5 of this thesis). Their physical characteristics thus correspond to that of liquid containers (Kelly 1980:1). The painted depiction of agave plants on their body, together with some specific use-alteration traces found in specimens of these types, indicate that they could have been used for the production and/or consumption of a fermented beverage made out of agave sap (i.e. *pulque*).

Although more commonly found in specimens of the earlier Colima Red-on-cream than of the later Borregas Red-on-cream type (Appendix A, A.1. Type Descriptions), a recurrent painted motif featured in both types has been interpreted as a depiction of the agave plant (González Zozaya et al. 2007:13; Zizumbo-Villareal et al. 2009), commonly known in Mexico as *maguey* (Figure VII.17). Multiple representations of this motif are usually located on the lower half and/or base of the vessels (Figure VII.18).

Figure VII.17. Adult agave plant surviving in the wild in the Lower Salado River basin (from González Zozaya et al. 2007:3). The photograph was probably taken during the rainy season.

Figure VII.18. Painted agave plants on the base and lower half of four Colima Red-on-cream vessels (modified from Almendros López et al. 2012:30,32,33).

The agave plant was used in prehispanic times as a source of food and fibre and to produce *pulque* (Bruman 2000; Correa-Ascencio et al. 2014; Schöndube Baumbach 1994:239-40). *Pulque* is made by the fermentation of the *maguey* juice, a process that involved the use of ceramic vessels in prehispanic times. An abrasive trace known as ‘pitting’ or ‘spalling’ is found in the interior of vessels used in the fermentation of beverages (Arthur 2003); it is caused when the fermenting liquid penetrates the interior wall and spalls the surface as expanding gases rise (Skibo 2015:194).

Evidence of ‘pitting’ found in red-on-cream jars suggests they were used for fermentation purposes (Figure VII.19). However, not all potsherds from this type show this type of abrasive marks. This could be explained in several ways. Ethnoarchaeological research on earthenware pottery currently used for the fermentation of beverages has found that inner ‘spalling’ is formed only after years of continued use (Juan Jorge Morales, personal communication, 2017). Moreover, some of the vessels of these types were grave goods (Appendix A), and this use may not have always been an actual secondary function; that is, some vessels that appear without use wear could have been acquired to serve especially as burial furniture, even if they were manufactured to serve their primary ‘technofunction’ (Skibo 2013:4-5). Finally, the range of variation in shape and size of these types of jars could be associated with different but related functions (i.e. serving, drinking, transportation, etc.), and not exclusively to beverage fermentation.

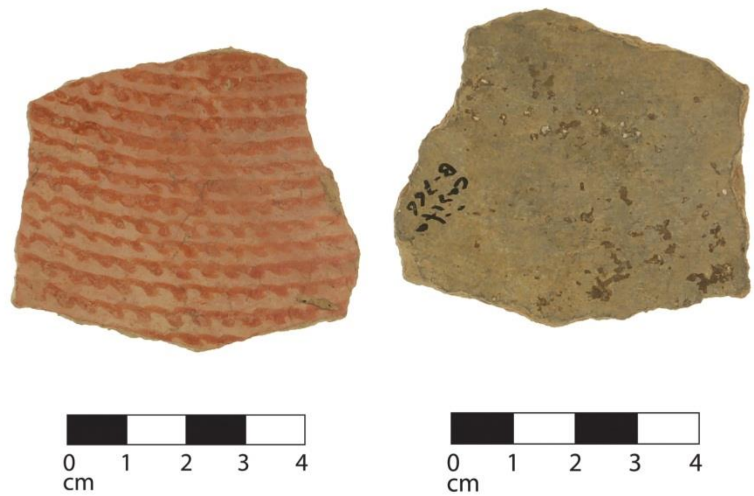

Figure VII.19. ‘Pitting’ marks on the interior of a Colima Red-on-cream vessel (sample 142).

Since boiling was part of the prehispanic process of making *pulque* (Bruman 2000:76), another use-alteration trace that would link these vessels to this function is the deposition of soot on their bases. Permanent exterior ‘sooting’ is a use-related carbon deposit resulting from cooking directly over an open fire. For ‘sooting’ to be formed, the temperature of the ceramic surface must not approach 400°C during cooking (Skibo 2015:191). Since one of the factors that limit the increase of temperature of low-fired, permeable pots is the presence of water (Skibo 2015:191), soot is only formed on vessels that were used for boiling, as opposed to dry types of cooking such as frying or roasting. ‘Sooting’ is notoriously present in some red-on-cream vessels (Figure VII.20), yet this is another mark that does not appear in all specimens.


Figure VII.20. Soot traces on the bases of Colima Red-on-cream jars (from González Zozaya et al. 2007:13). Note the painted agave plants.

Based on the results of this research, it is now known that the red-on-cream vessels that circulated were made in the Salado River basin. If they were indeed utilised in the production of *pulque*, then the agave plant must have been grown locally. The Salado River basin is one of the most arid areas in the Colima region, but crucially the *maguey* is a water-efficient plant capable of surviving in these conditions (Correa-Ascencio et al. 2014:14223; Davis et al. 2017). Agave cultivation in the Middle and Lower Salado River basin is mentioned in a 18th-century document, where it is said that 'a lot of *vino* is extracted' from it; it is also stated that its shoots are renewed all year round (Morales 1978 [1778]:33; my own translation). A micro-regional intersection between an agricultural subsistence economy and pottery product specialisation seems a possibility (Bayman 1999:271).

Was the wide circulation of Salado red-on-cream vessels related to their content? Were these red-on-cream vessels distributed outside the Salado River basin through exchanges with itinerant pottery merchants or *pulque* makers? If the Salado red-on-cream jars were distributed by itinerant merchants as 'pots', it is noteworthy that the rest of the products (engraved/incised bowls, shadow-striped cooking vessels) manufactured in the same area (and sometimes arguably by the same potters) were not traded with the Tecomán coastal plain and the western coast at all. Given their fragility (the Salado red-on-cream jars can be considerably thin-walled, as much as 0.30cm), maximum size, and potential maximum weight, their interregional distribution (covering distances of tens of kilometres) by foot when full seems a very remote possibility (see Williams and Weigand 2004:21-25 for the practicalities of the long-distance movement of commodities in Mesoamerica).

For these reasons I believe that they were obtained in the Salado River basin at inter-communal events involving the consumption of *pulque* (i.e. feasts) and then taken back home when empty. Feasts 'often provide the context for exchange events' (Dietler and Hayden 2001:9). Since there is now compositional proof that similar red-on-cream jars were in each case produced locally across the Colima micro-regions for local consumption (i.e. they were not circulated), I argue that the Salado red-on-cream jars were taken back home mainly as mementoes of the experience, and tokens of communal entitlement (Section II.2.1). After the inter-communal events, Salado red-on-cream jars were perhaps used in domestic feasting contexts all over the Colima region along with locally made specimens. In the Colima Valley, circular stone structures often found next to dwellings of the Colima and Armería phases have been interpreted as ovens for agave cooking (Zizumbo-Villareal et al. 2009).

The Salado River basin, as perhaps the largest regional producer of *maguey* and *pulque*, could have been the recurrent hosting land for communal feastings that attracted people from the neighbouring micro-regions. In fact, alcohol is one of the diagnostic signs of feasts, whose consumption is often restricted to this context (Butterwick 2002:93; Dietler and Hayden 2001:10). Notably, *pulque* consumption in feasts has a long history in Mesoamerica (Butterwick 2002). Butterwick (2002:103-08) has interpreted several hollow figures and ceramic models from West Mexico's Shaft Tomb Tradition as representations of funerary feastings involving the consumption of *pulque*. Butterwick (2002:94) argues that feasts to celebrate and honour ancestors—sponsored by extended kin groups—were used as opportunities to consolidate social relationships, whereas elite-sponsored feasts could have been used as instruments to compete for power and build political alliances.

Since agave can be harvested all year round, production of *pulque* could have been constant; this possibility and the hosting of communal events in the Salado River region would have required the existence of full-time pottery specialists, at the very least occasionally for the preparation of larger events. While fully assessing the existence of feasting practices and the reason behind them would require extensive consideration of multiple lines of evidence not yet available in the study area, there are indicators that support it as working hypothesis for future work.

Kelly (1980:8) identified so-called *ceniceros* (large ash pits) in Los Ortices area of the Salado River basin (where Las Ánimas is located), which she described as 'considerable deposits, presumably artificial, of white volcanic ash, which contain a heavy concentration of sherds, almost as if cyclic destruction were involved.' Although Kelly never made the link, her description of ash pits rich in broken vessels is highly suggestive of the result of post-feasting vessel destruction (Dabney et al. 2004:92-93; Hamilakis 1998:122-23). According to Kelly's (1939-1971:319-30,369,391) unpublished field notes, *ceniceros* are sometimes located on top of a hill, such as the one in the Rincón del Diablo #2 site, and sometimes next to architectural features (e.g. artificial mounds, *plazas*), just as the ones at the Mesa de Acatitán and Potrero de los Quajiotes #2 sites. So far, no *ceniceros* have been reported elsewhere and their presence seems to be restricted to the Salado River basin. Notably, Kelly (1939-1971:169,177-78,263-82,369, 1980:8) found that primary Colima-phase and Armería-phase interments, along with burial furniture, sometimes occur in *ceniceros*. This fact attests to the ritual nature of these archaeological features and eliminates them as possible settlement discard deposits. It would also explain some of the large concentrations of potsherds as the remains of funerary meals or ancestor worship celebrations, and the subsequent 'killing' of pots (Dabney et al. 2004:82; Hamilakis 1998:122-23).

CHAPTER VIII. CONCLUSIONS AND FUTURE WORK

The determination of technological patterns, the physical and social constraints of production, manufacture-distribution systems, and the context of consumption of a widely distributed type, provided insight into the degree of political integration in the research area during the Late Classic/Epiclassic period (550-1000 CE). The results ascertain the historical depth of three of the regional polities known for the 16th century in the Colima region.

The reconstruction of the pottery production sequence, sourcing, and the analysis of circulation patterning, permitted to distinguish distribution patterns resulting from economic interdependence through exchange from those derived from the feasting-related circulation of pottery, and to differentiate polities from 'source zones' and related spheres of compositional homogenisation.

For the most part, pottery manufacture was done by part-time specialists who made use of distribution networks restricted to the limits of the polity, which is understood as a web of authoritative relationships in a dynamic physical environment (Joyce and Barber 2015:820; Smith 2011b:416). In this way, it is argued that even though the Colima Valley and the Salado River basin were producers of fairly distinctive wares, they were economically co-dependent and thus belonged to the same network of authoritative relationships—in this case assembled by interregional obligations. Importantly, technological knowledge was shared between both micro-regions, suggesting that potters could have produced a more standardised ceramic output if they wished. Given the long-standing technological traditions identified in both micro-regions, the absence of such technological standardisation could be interpreted as the result of a deliberate strategy of economic differentiation. This is a network of strategies related to pottery production in which the other two polities studied did not participate.

Pottery production and technology in the Salado River basin and elsewhere needs to be understood within its historical/archaeological and environmental contexts (Arnold 2000:363-64; Gosselain 1998:85-87; Sillar and Tite 2000:4-5). The drought recorded in Mesoamerica, including western Mexico, for the Late Classic/Epiclassic period is considered 'the most important climatic signal in the

Mesoamerican region during the last 2000 years' (Rodríguez-Ramírez et al. 2015:1239). Low rainfall and declining groundwater resources possibly turned the Salado River basin into an area unfit for the production of maize and similar more water-dependant crops. In this scenario, the more fertile Colima Valley could have served as the more diverse agricultural land of the regional polity, while the full-time specialised production of *maguey* and derived products (agave can be harvested all year round) could have provided the population of the Salado River basin with a mean of subsistence. The local craft economy and local pottery technological style certainly played an important role in articulating this subsistence strategy. In turn, the interpersonal and intercommunity obligations created by pottery exchange and economic interdependence helped in the constitution and constant reproduction of the regional polity constituted by the Colima Valley and the Salado River basin.

At the pan-regional level, inter-communal events involving large-scale feasting could have been common practice in the Salado River basin, as demonstrated by, among other pieces of evidence, the uniquely wide distribution and unrestricted circulation of vessels manufactured there and associated with the production and consumption of *pulque*. People from the four studied micro-regions attended these feasts, which are considered to be facilitators of social communication and a way to honour ancestors, promote ideological beliefs, and instigate political action, such as the making of alliances (Bayman 1999:269; Borgna 2004:247; Butterwick 2002:93-94; Dietler 2001:66-69; Hayden 2001:29-30), in this case at the pan-regional level. The existence of this inter-communal context, opened to people from all of the micro-regional polities studied, is currently the only suggestion that the Colima region could have functioned as a single political entity, or that micro-regional polities could have implemented some regional political strategies together or might have been willing to do so. As noted in the previous chapter, the fact that the regional polities were economically independent in terms of pottery, and bearers of distinct pottery technological styles, is only part of the picture.

Although the exploitation of different clay sources to manufacture the same ware suggests that there was no centralised control over pottery production (not even at the micro-regional level), the elite's degree of involvement in the context of pottery production is still poorly understood. The uncovered strategies related to pottery production seem to be defined by horizontal communal relationships—corporate strategies—rather than hierarchical ones—network strategies—(Blanton et al. 1996; Feinman 2000; Joyce and Barber 2015; Joyce et al. 2016; Smith 2011b:417), with solid examples in the presence of competing communities of specialised potters, and the corporate context in which the Salado River basin jars were consumed (i.e. non-elite feasting events). Yet whether large-scale feastings and the production of large quantities of red-on-cream jars were sponsored by the elites (i.e. 'patron role feasts', see Dietler 2001:82) and/or by entire communities or kin groups, remains unknown; also to be disclosed is the elite's part in the negotiation of the use of material resources.

Overall, these results serve as an example that rather than looking for technological standardisation and centralised control over production as evidence for political integration, better insight into the constitution of ancient political formations and their territories can be obtained through detailed reconstruction of the networks of political relationships established and continuously built through craft practices (Smith and Janusek 2014:684; VanValkenburgh and Osborne 2012). The results of this research serve as further evidence that craft specialisation and economic interdependence are not exclusive to state-like political formations (cf. Clark and Parry 1990:320) and are not necessarily related to centralised control over production.

While the overall micro-regional arrangement of production is sufficiently clear, further in-depth sampling and analysis of pottery from sites outside the Colima Valley is needed to confidently address the organisation of production in the Salado River basin, the Tecomán coastal plain, and the western coast. Future studies might also include two coastal regional polities and micro-regions not studied here that arguably also constituted the Greater Colima in the 16th century: the Cihuatlán and the Alima valleys. Incidentally, red-on-cream jars have also been recovered in these two regions (Meighan 1972:49-50; Novella et al. 2002:Figures 69 and 72); it would be interesting to know whether these can also be identified as produced in the Salado River basin.

The existence of feasting events in the Salado River basin needs to be further assessed through the excavation of presumed feasting deposits, such as the *ceniceros* reported by Isabel Kelly (VII.3). The analysis of associated ceramic and human and faunal remains would confirm or reveal the nature of such deposits. Moreover, organic residue analysis on red-on-cream jars aiming to detect bacterium involved in *pulque* fermentation (Correa-Ascencio et al. 2014) would provide hard evidence for their use as *pulque* containers.

Finally, the technological analysis of pottery production during the earlier Comala phase (100-550 CE) would highlight any chronological changes in pottery production and distribution strategies (i.e. raw clay procurement, manufacture technologies, exchange patterns). In this way, it could be tested if the political reorganisation at the start of the Late Classic/Epiclassic period (III.2.3) involved changes in Colima's pottery economies and political strategies embedded in pottery production.

APPENDIX A. THE CERAMIC WARE OF THE COLIMA AND ARMERÍA PHASES

The need for more study of pottery from the Colima and Armería phases of central Colima was initially recognised by Kelly (1980:8-9). Kelly (1980:9) asserted that there were stylistic, regional, and chronological differences among the pottery from these two phases that had not yet been adequately documented, emphasising that the red-on-cream pottery, in particular, required additional study.

Motivated by these concerns, I conducted a study in the early 2000s that focused on the associations of the ceramic types found in excavated burial contexts from these phases in central Colima (Salgado Ceballos 2007). In that study, it was possible to isolate and describe three ceramic complexes: Colima, South Armería, and a newly established North Armería complex.

Although this study completed in 2007 focused on ware found as burial offerings, the ceramics in question have a decidedly domestic flavour. Evidence for the domestic use of these types can be found in use-traces and from their presence in all kinds of archaeological contexts (e.g. Beltrán 1991; Berdeja Martínez 1999, 2000; Kelly 1949; Meighan 1972; Novella et al. 2002; see III.2.5 of this thesis). Most of the specimens analysed show use-traces and thus, it can be argued, were not manufactured to serve exclusively as burial offerings. For this reason, these types can be considered largely representative of their time periods. Besides providing secure associations, working with pottery from burial contexts was also beneficial for shape and decoration analyses, since most of the vessels were found complete or semi-complete.

In this appendix, two sections of the aforementioned study (Salgado Ceballos 2007) are included in a slightly modified and shortened form. In A.1, the known ceramic types for the two central Colima phases are described in detail. In A.2, their spatial distribution is discussed based on the data available in 2007, including Kelly's (1939-1971) unpublished fieldnotes.

A.1. TYPE DESCRIPTIONS

There were not enough available vessels from burial contexts to construct comprehensive type descriptions. Because of this, I also used similar, complete or semi-complete vessels from museums in the region as further support for the type descriptions. In the end, it was possible to gather data from a total of 188 pots, 148 of which were classified into the pottery types described below.

Three ceramic types were classified as part of the Colima complex, including four stylistic variants within the Colima Red-on-cream type. Five types were assigned to the South Armería complex, including two types that are shared with the North Armería complex. The North Armería complex includes these two shared types and six unique ones. Prior to my work in 2007, the large majority of these types had not been described or illustrated. It should be noted that these pottery types might not represent the complete ceramic repertoire used during the Colima and Armería phases.

Colima Red-on-cream

There are at least four stylistic variants of the Colima Red-on-cream pottery type, according to their shape and decoration. This description is based on 39 vessels, 35 of which are complete specimens. Twelve of the vessels come from a known archaeological context.

Colour. Red (2.5YR 4/6) to reddish brown (2.5YR 4/4) on light reddish brown (2.5YR 7/4) to yellowish red (5YR 5/6) to pale brown (10YR 6/3).

Surface. The outer surface can be slipped with a matte cream–light brown slip. If unslipped, the red-painted decoration is applied on the clay body directly or over a false slip (i.e. a watery film of the vessel's clay). The outer surface finish ranges from rough to burnished, but the large majority of the specimens are smoothed. The interior neck always has the same finish as the outer surface. 'Fire clouds' on the outer surface are common. There can be carbon or soot deposited on the exterior base (i.e. 'sooting'), suggesting that the vessels were sometimes used for boiling (Skibo 2015:191; see Figure VII.20 of this thesis). At least five specimens were 'killed'—that is, perforated to finish their function as containers.

Shape. Globular, ellipsoid, or carinated jars with a short neck, outflaring rim, rounded lip, and circular mouth. Given these characteristics, it is probable they were used as liquid containers or *cántaros* (pitchers) used for serving.

Decoration. Red painted. The most common painted motifs are the agave plant and wavy lines. Almost all specimens have fine lines painted around the exterior neck. The interior neck is either covered entirely in red paint or red-painted with other motifs.

Comments. Diagnostic pottery of the Colima complex; also known as Colima Red-on-orange. There are some clearly transitional examples between this type and Borregas Red-on-cream that are impossible to classify as one or the other (e.g. Eisleb 1971:Figures 231a and 231b).

Variant 1. This description is based on five complete vessels, three of which have a known archaeological context.

Shape. Carinated jar with a short neck, rounded base, and outflaring rim.

Decoration. Parallel and slightly curved red-painted bands on the lower three-quarters of the vessel, and wavy lines below the neck. All specimens have painted fine lines around the exterior neck. The interior neck shows the same fine lines, is completely covered in red paint, or is red-painted with other motifs.

Size. Height: 11.5-19.7cm; width: 16-26.2cm; mouth diameter: 8-10.8cm.

Variant 2. This description is based on six complete and two incomplete vessels; two have a known archaeological context.

Shape. Ellipsoid jar with a short neck, rounded base, and outflaring rim.

Decoration. The red-painted motifs are extremely varied, but the agave plant, horizontal and vertical bands, and wavy lines (sometimes forming triangles), are the most common. Most specimens have painted fine lines around the exterior neck. The interior neck shows the same fine lines (sometimes vertically oriented), is completely covered in red paint, or is red-painted with other motifs.

Size. Height: 18-24cm; width: 21-35cm; mouth diameter: 9.8-11.7cm.

Figure A.1. Colima Red-on-cream jar, Variant 2 (from Alcántara Salinas 2007).

Variant 3. This description is based on nine complete and one incomplete vessel; five have a known archaeological context.

Shape. Carinated or globular jars with a short neck, rounded base, and outflaring rim. One specimen has a stacked double neck.

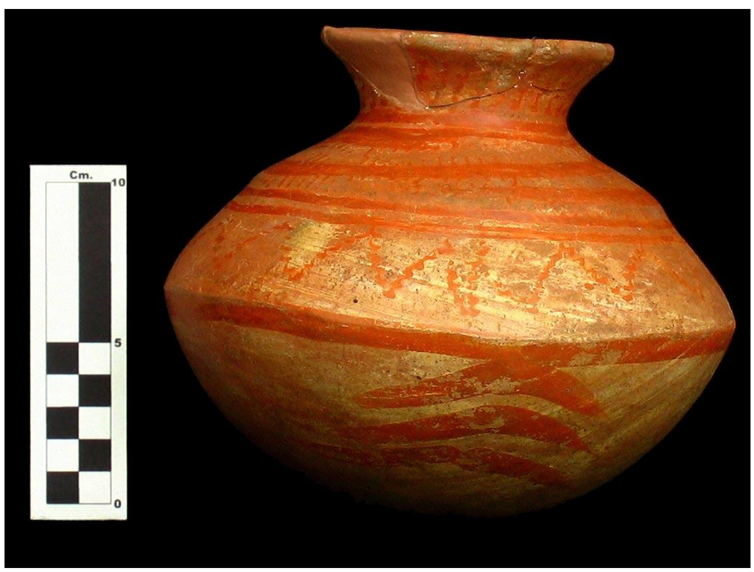

Figure A.2. Colima Red-on-cream jar, Variant 3 (from Alcántara Salinas 2007).

Decoration. Among the red-painted motifs are wavy lines, zigzagging wavy lines that sometimes form triangles (Figure A.2), short lines, a broad band near the point of carination (Figure A.2), and agave plants on the lower body (Figure A.2). The exterior neck shows painted fine lines, wavy lines vertically oriented (Figure A.2), or triangles formed by wavy lines. The interior neck shows fine lines (sometimes vertically oriented) or is completely covered in red paint.

Size. Height: 11.5-21.5cm; width: 13.2-22cm; mouth diameter: 8.6-11.9cm.

Comments. I believe this is the latest variant of the Colima Red-on-cream type; it is the only one found directly associated with the Armería-phase Borregas Red-on-cream type. It may mark the transition between these two phases in the Colima Valley and the Salado River basin.

Guásimas Variant. This description is based on 12 complete and one incomplete vessel; two have a known archaeological context.

Shape. Globular or carinated jars with a short neck, rounded base, and slightly outflaring (almost straight) rim.

Decoration. The red-painted motifs include vertically oriented broad lines (sometimes forming triangles), dots, and agave plants on the lower body. The exterior neck never has the painted fine lines that are typical of the other variants; instead, it features one or two broader lines or a continuation of the main body decoration. The interior neck is always covered in red paint. In addition to painting, one specimen also shows vertical grooving.

Size. Height: 7.7-28cm; width: 10.8-28cm; mouth diameter: 6.8-11.1cm.

Colima Shadow-striped

This description is based on four complete and three incomplete specimens. Six of the vessels have a known archaeological context.

Colour. Red (10R 4/6) and very pale brown (10YR 7/3) on reddish brown (2.5YR 5/4).

Surface. The outer surface features a pale brown slip that is removed in alternating stripes. The finish of the outer surface ranges from rough to smooth. The inner surface is rough in the *ollas* and smooth in the bowl. The inner rim is the only part that is burnished in both the *ollas* and the bowl. There is always carbon or soot deposited on the exterior base (Figure A.3), strongly suggesting their use as boiling vessels (Skibo 2015:191).

Figure A.3. Colima Shadow-striped *olla* (from Alcántara Salinas 2007).

Shape. Almost exclusively open-mouthed vessels or *ollas*, but there is also one bowl. *Ollas* have a rounded shape, a short neck, and an outflaring rim. The bowl has a rounded shape and an outflaring rim.

Decoration. The outer surface features a pale brown slip that is removed in stripes (most are almost vertical; see Figure A.3), perhaps with a plant fibre (Novella et al. 2002:115). The inner rim is always red-painted.

Size. *Ollas*: height: 14-21.5cm; width: 21-36.5cm; mouth diameter: 16.5-36.5cm. Bowl: height: 16cm; width: 26cm; mouth diameter: 15cm.

Comments. Diagnostic pottery of the Colima complex.

Colima Incised

This description is based on 17 complete specimens; eight have a known archaeological context.

Colour. Greenish black (5G 2.5/1) to dark red (10R 3/6) to red (2.5YR 4/6).

Surface. In bowls, except for the bottom (roughened) the whole surface is slipped. In the *tecomate* (bowl with a restricted mouth) only the outer surface is slipped, while in the small *olla* (a globular vessel with a short neck and outflaring rim) both the outer surface and the inner rim are slipped. Regardless of the shape, the surface finish ranges from smoothed to burnished, and the outer surfaces have better finishes.

Shape. Almost exclusively open-mouthed bowls, but there is also a small *olla* and a *tecomate*. More than half of the bowls are carinated (Figure A.4). The bases can be rounded or slightly flattened.

Figure A.4. Colima Incised bowls (from Alcántara Salinas 2007).

Decoration. Leather-hard incisions or engraving. The motifs are always located below the exterior rim and rarely reach the lower half of the vessel. The motifs include straight or wavy lines, dots, *xicalcoliuhquis*, zigzags, horizontal S-shaped scrolls, and concentric circles. Besides the *tecomate* and small *olla*, all of the other specimens have a roughened bottom surface to assist in the crushing and grinding action of the pestle (i.e. they are *molcajetes*). The darker surface colour (Figure VII.9, left) was achieved through smudging.

Size. Bowls: height: 3.8-8.5cm; mouth diameter: 10.3-17cm. *Tecomate*: height: 6cm; mouth diameter: 6.9cm. *Olla*: height: 10.3cm; width: 10.3cm; mouth diameter: 7.2cm.

Comments. Diagnostic pottery of the Colima complex. Although the leather-hard decoration is better described as engraved, I have kept the commonly used name Colima Incised in this work. This type is stylistically related to the Cofradia Incised (Kelly 1945) and Atoyac Incised (Noyola 1994) types from southern Jalisco.

Pozo Hundido Incised

This description is based on three complete and two incomplete specimens; three are from known archaeological contexts.

Colour. Red (10R 4/6).

Surface. The whole surface is slipped, sometimes excluding the base. The surface finish is either smoothed or burnished.

Shape. Sub-hemispherical bowls. The base is either rounded or slightly flattened, and there is one specimen with a pedestal base. All rims are rounded, with the exception of one specimen that has a beveled lip.

Decoration. Incisions done in the outer surface when still wet. All specimens show the same design: one wavy line on top of two straight ones, just below the rim (Figure VII.9, right). All specimens have a roughened bottom in the shape of a circle, to be used for grinding (i.e. *molcajetes*).

Size. Height: 7-8.6cm; mouth diameter: 10.9-19cm.

Comments. Diagnostic pottery of the South Armería complex. It can be considered a simplified version of the Colima Incised type.

Amela Red

This description is based on one complete specimen from a known archaeological context.

Colour. Red (10R 4/6) on red (10R 5/8).

Surface. The inner surface is slipped, except for the roughened bottom. The surface finish is rough on the outer surface and burnished on the inner surface, except for the roughened bottom that was used for grinding (Figure VII.12).

Shape. Sub-hemispherical bowl with a flat base and rounded rim.

Decoration. Resist painting. After the design was made with wax on the first layer of slip, a second slip was applied. After firing, the design is revealed in the areas that were covered in wax and therefore were untouched by the second slip. Decorative motifs are straight lines and spirals. The bottom was neatly punctated to assist in the grinding action of the pestle.

Size. Height: 4.7cm; mouth diameter: 20.5cm.

Comments. Diagnostic pottery of the South Armería complex.

Armería Cream

This description is based on nine complete and four incomplete specimens; seven are from known archaeological contexts.

Colour. Reddish yellow (5YR 6/6) to very pale brown (10YR 7/3) and red (2.5YR 4/8) and/or reddish brown (2.5YR 4/3) on red (2.5YR 4/6) to yellowish red (5YR 4/6).

Surface. All specimens are partially or fully slipped with an orange to very pale brown slip, sometimes applied over a false red slip. In the cups (bowls with a tall pedestal base), the slip is only applied to the bowl (except for the roughened bottom) and not to the pedestal base; the finish of the cup bowls range from smoothed to burnished, again except for the roughened bottom (Figure VII.14, left). The outer surface of the flat-bottomed bowls, whether smoothed or polished, always have a better finish than the inner surface (Figure VII.14, right).

Shape. More than half of the specimens are cups, formed by a sub-hemispherical bowl and a tall pedestal base (Figure VII.14, left). There are also flat-bottomed bowls, with either almost-straight or curved walls (Figure VII.14, right).

Decoration. In cups, the painted decoration is concentrated on the inner surface of the sub-hemispherical bowls. Resist-painted decoration is common. Among the decorative motifs are scrolls, spirals, vertical and horizontal straight lines, and also zoomorphic (e.g. Figure VII.14, left) and plantlike motifs. The rim is always decorated, including the exterior. The pedestal bases are completely painted in red, have red stripes, or feature other motifs. With one exception, all the cups are formally *molcajetes*: that is, they have a roughened bottom for grinding (Figure VII.14, left). On the flat-bottomed bowls, the resist-painted decorations are located on the outer surface (Figure VII.14, right). Sometimes flat-bottomed bowls have a red rim (Figure VII.14, right).

Size. Cups: height: 13.6-23.5cm; width: 15.7-25.9cm; pedestal base diameter: 10-16.5cm. Flat-bottomed bowls: height: 9.5-10.1cm; mouth diameter: 14.5-18.5cm.

Comments. Diagnostic pottery of the South Armería complex.

Pozo Hundido Red-on-brown

This description is based on nine complete and two incomplete specimens; nine are from known archaeological contexts.

Colour. Red (10R 5/8) on reddish yellow (5YR 6/6).

Surface. Unslipped or has a false slip. The surface finish is usually rough, although sometimes the inner surface is slightly polished and shows horizontal polishing marks (striations). Only one specimen has a roughened bottom for grinding.
Shape. Sub-hemispherical bowls. The base is slightly flattened. The coil forming the bowl's border can be fairly visible (Figure A.5, left).

Figure A.5. Pozo Hundido Red-on-brown bowl (from Alcántara Salinas 2007).

Decoration. The red-painted decoration is confined to the inner surface. The standard decorative pattern includes a red inner rim and two or three pairs of curved lines (sometimes accompanied by dots) on the bottom (Figure A.5, right).
Size. Height: 4.6-6.8cm; mouth diameter: 11.9-18.4cm.
Comments. Diagnostic pottery of the South Armería and North Armería complexes.

Borregas Red-on-cream

This description is based on 21 complete and seven incomplete vessels, 13 of which are from known archaeological contexts.
Colour. Red (10R 5/8) to dark reddish grey (2.5YR 3/1) to very dark grey (10YR 3/1) on pinkish white (5YR 8/2) to pale yellow (2.5Y 8/3) to light red (2.5YR 6/6).
Surface. The outer surface is usually slipped with a thick, pale yellow slip (Figure A.6, left), but there are some specimens with a pinkish-white slip, and several

examples that have a false or no slip (Figure A.6, right). The finish of the outer surface ranges from rough to slightly polished, but the large majority of specimens are smoothed. The interior neck always has the same finish as the outer surface. ‘Fire clouds’ on the outer surface are common. At least seven specimens were ‘killed’—that is, perforated to finish their function as containers (Figure A.6, left).

Figure A.6. Borregas Red-on-cream jars (from Alcántara Salinas 2007).

Shape. Globular, carinated, or barrel-shaped jars with a short neck, slightly flaring rim, rounded lip, circular mouth, and a rounded, conical, or flat base. These characteristics suggest a use as liquid containers and *cántaros* (pitchers) for serving or transportation.

Decoration. Decoration is painted in red or dark grey. Besides the broad and fine lines coming down from the neck, the decoration usually involves hatched diamond shapes and other meshwork-like designs. Almost all specimens have fine lines painted around the neck on both the outer and inner surfaces. Tiny vertical lines painted on the border lip are diagnostic of this type. It is not clear whether the grey paint is the intentional result of a non-oxidising firing or cooling atmosphere (Kelly 1980:9).

Size. Height: 8.8-25cm; width: 12.1-27.5cm; mouth diameter: 7.8-10.9cm.

Comments. Diagnostic pottery of the South Armería and North Armería complexes.

Libramiento Red Rim

This description is based on 10 complete vessels, seven of which come from known archaeological contexts.

Colour. Reddish brown (2.5YR 4/4) on pale red (10R 7/3).

Surface. Unslipped or with a false slip. The finish of the outer surface tends to be rough, but sometimes it features polishing marks (striations), except for on the base. The inner surface is always polished (sometimes excluding the bottom), and the horizontal striae produced by the polishing stone are evident (Figure VII.5, top right). Two specimens have a roughened bottom for use in grinding.

Shape. Outward-curving sub-hemispherical bowls or outward-flaring straight bowls. The outward inclination of the wall varies significantly between specimens. The base can be rounded or flattened. Two specimens have beveled lips; the rest have rounded lips.

Decoration. The inner surface of the rim is red painted.

Size. Height: 5.1-10cm; mouth diameter: 13-23cm.

Comments. Diagnostic pottery of the North Armería complex.

Striated Red Rim Mortar

This description is based on five complete vessels, all from known archaeological contexts.

Colour. Red (10R 4/6).

Surface. Unslipped or with a false slip. The finish of the outer surface is either rough or slightly smoothed, with the exception of the rim, which is always polished. The inner surface is also polished except for the bottom. The rim is the best-polished area of the vessel. The bottom is always roughened for grinding.

Shape. Hemispherical bowls. Flattened base.

Decoration. None besides the surface characteristics already described.

Size. Height: 8.2-9.3cm; mouth diameter: 15.8-19.6cm.

Comments. Diagnostic pottery of the North Armería complex.

Libramiento Pedestal-based Bowl

This description is based on five complete vessels; three are from known archaeological contexts.

Colour. Red (10R 6/4) on light red (2.5YR 6/6).

Surface. The outer surface is unslipped, while the inner surface has a red slip. In one specimen, the slip on the inner surface is cream coloured. The finish of the outer surface is either rough or slightly smoothed, while the finish of the inner surface ranges from well smoothed to slightly polished. The bottom is always roughened for grinding.

Shape. Sub-hemispherical or hemispherical bowls. The pedestal base is either conical or hyperboloidal in shape.

Decoration. An applied ceramic band with notches circles the lower half of the bowl. In one specimen, the applied ceramic band has no notches and was thumb-pressed to simulate the texture of a rope. The red-painted decoration varies: one specimen has random red dots on the outer surface; another has a red-painted base; and a third has resist painting on the inner surface, featuring zigzags and horizontal lines.

Size. Height: 5.7-11.4cm; width: 12.5-17.2cm; pedestal base diameter: 7.7-11.9cm.

Comments. Diagnostic pottery of the North Armería complex.

Libramiento Ring-based Mortar

This description is based on two complete vessels from known archaeological contexts.

Colour. Red (2.5YR 4/6) on brown (7.5YR 5/4).

Surface. Unslipped or with a false slip. The outer surface finish varies from rough to slightly polished, while the interior is slightly or well polished. Roughened bottom.

Shape. Hemispherical bowls with rounded bottoms and ring bases (Figure A.7).

Decoration. Usually, the whole inner surface is red-painted, with the exception of the roughened bottom.

Size. Height: 4.6–7cm; width: 10.3–14.1cm; mouth diameter: 9.5–13.2cm.

Comments. Diagnostic pottery of the North Armería complex.

Figure A.7. Libramiento Ring-based Mortar vessel (from Alcántara Salinas 2007).

Libramiento Olla

This description is based on three complete vessels from known archaeological contexts.

Colour. Either brown (7.5YR 5/4) or red (10R 4/6) on brown (7.5YR 4/4).

Surface. Unslipped. The surface finish ranges from rough to slightly polished. However, even rough-surfaced specimens have a slightly polished upper part; the polishing marks are striated. The lower half of the vessels show large depositions of soot (Figure A.8).

Shape. Irregular globular shape. The short neck/rim is straight and outward flaring.

Decoration. The inner rim can be painted red.

Size. Height: 15–17.5cm; width: 18.5–22cm; mouth diameter: 12.9–16.1cm.

Comments. Diagnostic pottery of the North Armería complex.

Figure A.8. Libramiento Olla type.

Bugambilias Red-on-orange. This description is based on one complete and one incomplete vessel, both from known archaeological contexts.

Figure A.9. Bugambilias Red-on-orange bowl (from Alcántara Salinas 2007).

<u>Colour</u>. Red (10R 6/4) on light red (2.5YR 6/6).

Surface. Unslipped or with a false slip. The surface finish can be rough, or polished only on the inner surface and the outer rim (Figure A.9). One specimen has a roughened bottom for grinding.

Shape. Sub-hemispherical bowls with rounded direct rims.

Decoration. Red-painted decoration on the rim and inner surface. Motifs include dots, curved and straight lines, spirals, and floral designs.

Size. Height: 3.8–11cm; mouth diameter: 9–28cm.

Comments. Diagnostic pottery of the North Armería complex. I believe that Bugambilias Red-on-orange corresponds to the type designated by Kelly in her diaries as Cruz de Gómez Red on Brown, which she relates with Pozo Hundido Red-on-brown: 'Small, unslipped bowls, cream-gray-brown; with slight convex sides. Red rim and the interior painted poorly, curved-shaped decoration (dots, spirals, etcetera) of a low quality. Somewhat larger than similar recipients of Pozo Hundido (tentatively Pozo Hundido Red on Cream)' (Kelly 1939-1971:303).

A.2. POTTERY DISTRIBUTION PATTERNS

After revising Kelly's (1939-1971) unpublished field notes, a total of 175 sites with Colima and/or Armería pottery were plotted on a map. There are four additional sites in southern Jalisco where she reported material from these phases (Kelly 1949). More recent salvage and rescue archaeological projects conducted by INAH archaeologists have uncovered a vast amount of material related to these phases. Most of these recent excavations have been in the Colima Valley, an area of high demographic growth. After revising the technical reports and interviewing the archaeologists-in-charge of these projects, another 15 sites with Colima and/or Armería pottery were added to the map, for a grand total of 194 sites. These sites range from those reduced to a surface concentration of materials to ones with major architectural remains. Up to 133 sites featured ceramics assigned to the Colima phase and 116 sites featured pottery assigned to the Armería phase; 56 of these sites featured ceramics from both phases.

As the italicized figures in the second column of Table A.1 show, there is a much higher frequency of sites with Colima-phase pottery in the Salado River basin and the Colima Valley than in the rest of the micro-regions. While Colima-phase pots are found in the rest of the geographical micro-regions, they are found in relatively few sites.

Table A.1. Percentage by geographical micro-region of the total number of sites with Colima-phase pottery. Values above 10% are in italics.

Micro-region	Percentage
Tuxcacueso-Zapotitlán, southern Jalisco	3
Colima Valley	*23.3*
Colima East	9
Salado River basin	*44.4*
Armería Valley	5.3
Western coast	3.7
Tecomán coastal plain	8.3
Northern coast of Michoacán	3
Total	**100**

The frequency of sites with pottery assigned to the Armería phase per micro-region is shown in Table A.2. In contrast to the Colima-phase ceramics, Armería-phase pottery appears to be more widely and fairly distributed, or less concentrated. This is partly an illusion because of the initial inclusion of two different ceramic complexes, each with a specific distribution pattern.

Table A.2. Percentage by geographical micro-region of the total number of sites with Armería-phase pottery. Values above 10% are in italics.

Micro-region	Percentage
Tuxcacueso-Zapotitlán, southern Jalisco	2.6
Colima Valley	*19.8*
Colima East	4.4
Salado River basin	*20.7*
Armería Valley	*19.8*
Western coast	9.5
Tecomán coastal plain	*11.2*
Northern coast of Michoacán	*12*
Total	**100**

It is worth looking at the distribution of the diagnostic types of the two Armería ceramic complexes. At first glance, it seems that the highest number of sites with types assigned to the South Armería complex are in the Salado River basin, the Tecomán coastal plain, the Armería Valley, and the Colima Valley (Table A.3). However, the presence of the South Armería complex in the Colima Valley could in fact be minimal: the two types that have been frequently reported in the area (Pozo Hundido Red-on-brown and Borregas Red-on-cream) are shared with the North Armería complex, the nucleus or centre of which is located in this valley (Table A.4). Notably, the Tecomán coastal plain has the largest number of sites with Amela Red, while the western coast and the Armería Valley show Armería Cream pots and little else. These pottery types proved to be micro-regional wares in this research (VII). In contrast, the distribution pattern of the North Armería complex shows that it is restricted to the Colima Valley (Table A.4).

In conclusion, it could be argued that there are significantly more sites with ceramics pertaining to the Colima phase in the Colima Valley and the Salado River basin than in the rest of the micro-regions. Leaving aside the types that also form part of the North Armería complex, the South Armería complex is concentrated in the Armería Valley, the Tecomán coastal plain, and the Salado River basin. In contrast, the North Armería complex pertains exclusively to the Colima Valley. This data served as an initial basis for the work presented in this thesis.

Table A.3. Distribution of the main pottery types of the South Armería complex.
Number of sites in which their presence has been reported, by geographical micro-region.

Micro-regions	Pozo Hundido Incised	Amela Red	Armería Cream	Pozo Hundido Red-on-brown	Borregas Red-on-cream
Tuxcacueso-Zapotitlán, southern Jalisco			2		1
Colima Valley	1		2	3	10
Colima East			1		1
Salado River basin	5	4	7	2	8
Armería Valley			8		1
Western coast			5		1
Tecomán coastal plain		6	5		1
Northern coast of Michoacán		1	3		
Total	**6**	**11**	**33**	**5**	**23**

Table A.4. Distribution of the main pottery types of the North Armería complex.
Number of sites in which their presence has been reported, by geographical micro-region.

Micro-regions	Libramiento Pedestal-based bowl	Libramiento Olla	Libramiento Ring-based Mortar	Striated Red Rim Mortar	Libramiento Red Rim	Bugambilias Red-on-orange	Pozo Hundido Red-on-brown	Borregas Red-on-cream
Tuxcacueso-Zapotitlán, southern Jalisco								1
Colima Valley	5	2	3	3	3	6	3	10
Colima East								1
Salado River basin							2	8
Armería Valley								1
Western coast								1
Tecomán coastal plain								1
Northern coast of Michoacán								
Total	**5**	**2**	**3**	**3**	**3**	**6**	**5**	**23**

APPENDIX B. LIST OF POTTERY SAMPLES

Table B.1. Full list of pottery samples included in the analysis.

SAMPLE NUMBER	INVENTORY/SERIAL NUMBER	SITE, MICRO-REGION	PROJECT NAME	PROJECT LEADER
001	S-CH-L S3-P-EST-111	CHIAPA, COLIMA VALLEY	CHIAPA-LA ANGOSTURA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
002	S-CH-L S4 P-100I	CHIAPA, COLIMA VALLEY	CHIAPA-LA ANGOSTURA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
003	S-CH-L S2-010	CHIAPA, COLIMA VALLEY	CHIAPA-LA ANGOSTURA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
004	S-CH-L S2-CdT-3 P15	CHIAPA, COLIMA VALLEY	CHIAPA-LA ANGOSTURA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
005	S-CH-L S2-CdT-3 P20	CHIAPA, COLIMA VALLEY	CHIAPA-LA ANGOSTURA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
006	S-CH-L S2-U10	CHIAPA, COLIMA VALLEY	CHIAPA-LA ANGOSTURA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
007	S-CH-L S2-U7 Ca 2-I	CHIAPA, COLIMA VALLEY	CHIAPA-LA ANGOSTURA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
008	S-CH-L S2-U10	CHIAPA, COLIMA VALLEY	CHIAPA-LA ANGOSTURA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
009		CHIAPA, COLIMA VALLEY	CHIAPA-LA ANGOSTURA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
010	S-CH-L S2 U10	CHIAPA, COLIMA VALLEY	CHIAPA-LA ANGOSTURA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
011		PRIMAVERA, COLIMA VALLEY	LA PRIMAVERA 2005	ANDRÉS SAÚL ALCÁNTARA SALINAS
012	PRIM-05 81	PRIMAVERA, COLIMA VALLEY	LA PRIMAVERA 2005	ANDRÉS SAÚL ALCÁNTARA SALINAS
013		PRIMAVERA, COLIMA VALLEY	LA PRIMAVERA 2005	ANDRÉS SAÚL ALCÁNTARA SALINAS
014	PRIM-05 154	PRIMAVERA, COLIMA VALLEY	LA PRIMAVERA 2005	ANDRÉS SAÚL ALCÁNTARA SALINAS
015	PRIM-05 70	PRIMAVERA, COLIMA VALLEY	LA PRIMAVERA 2005	ANDRÉS SAÚL ALCÁNTARA SALINAS
016	PRIM-05 73	PRIMAVERA, COLIMA VALLEY	LA PRIMAVERA 2005	ANDRÉS SAÚL ALCÁNTARA SALINAS
017	PRIM-05 13	PRIMAVERA, COLIMA VALLEY	LA PRIMAVERA 2005	ANDRÉS SAÚL ALCÁNTARA SALINAS
018	PRIM-05 125	PRIMAVERA, COLIMA VALLEY	LA PRIMAVERA 2005	ANDRÉS SAÚL ALCÁNTARA SALINAS
019		PRIMAVERA, COLIMA VALLEY	LA PRIMAVERA 2005	ANDRÉS SAÚL ALCÁNTARA SALINAS
020		PRIMAVERA, COLIMA VALLEY	LA PRIMAVERA 2005	ANDRÉS SAÚL ALCÁNTARA SALINAS
021		PRIMAVERA, COLIMA VALLEY	LA PRIMAVERA 2005	ANDRÉS SAÚL ALCÁNTARA SALINAS
022	PRIM-05 98	PRIMAVERA, COLIMA VALLEY	LA PRIMAVERA 2005	ANDRÉS SAÚL ALCÁNTARA SALINAS
023		PRIMAVERA, COLIMA VALLEY	LA PRIMAVERA 2005	ANDRÉS SAÚL ALCÁNTARA SALINAS
024	PRIM-05 21	PRIMAVERA, COLIMA VALLEY	LA PRIMAVERA 2005	ANDRÉS SAÚL ALCÁNTARA SALINAS
025	PRIM-05 108	PRIMAVERA, COLIMA VALLEY	LA PRIMAVERA 2005	ANDRÉS SAÚL ALCÁNTARA SALINAS
026	PAR 82 2010	PARCELA 82, COLIMA VALLEY	PARCELA 82	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
027	PAR 82 2010	PARCELA 82, COLIMA VALLEY	PARCELA 82	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
028	PAR 82 2010	PARCELA 82, COLIMA VALLEY	PARCELA 82	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
029	PAR 82 2010	PARCELA 82, COLIMA VALLEY	PARCELA 82	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
030	PAR 82 2010	PARCELA 82, COLIMA VALLEY	PARCELA 82	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
031	PAR 82 2010	PARCELA 82, COLIMA VALLEY	PARCELA 82	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS

032	PAR 82 2010	PARCELA 82, COLIMA VALLEY	PARCELA 82	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
033	PAR 82 010	PARCELA 82, COLIMA VALLEY	PARCELA 82	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
034		PARCELA 82, COLIMA VALLEY	PARCELA 82	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
035	PAR 82 2010	PARCELA 82, COLIMA VALLEY	PARCELA 82	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
036	PAR 82 2010	PARCELA 82, COLIMA VALLEY	PARCELA 82	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
037	PAR 82 2010	PARCELA 82, COLIMA VALLEY	PARCELA 82	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
038	PAR 82 2010	PARCELA 82, COLIMA VALLEY	PARCELA 82	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
039	PAR 82 2010	PARCELA 82, COLIMA VALLEY	PARCELA 82	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
040	PAR 82 2010	PARCELA 82, COLIMA VALLEY	PARCELA 82	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
041	RANM 166	NUEVO MILENIO, COLIMA VALLEY	NUEVO MILENIO	PAVEL CARLOS LEIVA GARCÍA
042	RANM 130	NUEVO MILENIO, COLIMA VALLEY	NUEVO MILENIO	PAVEL CARLOS LEIVA GARCÍA
043	RANM 210	NUEVO MILENIO, COLIMA VALLEY	NUEVO MILENIO	PAVEL CARLOS LEIVA GARCÍA
044	RANM 216	NUEVO MILENIO, COLIMA VALLEY	NUEVO MILENIO	PAVEL CARLOS LEIVA GARCÍA
045		NUEVO MILENIO, COLIMA VALLEY	NUEVO MILENIO	PAVEL CARLOS LEIVA GARCÍA
046	RANM 210	NUEVO MILENIO, COLIMA VALLEY	NUEVO MILENIO	PAVEL CARLOS LEIVA GARCÍA
047	RANM 48	NUEVO MILENIO, COLIMA VALLEY	NUEVO MILENIO	PAVEL CARLOS LEIVA GARCÍA
048	RANM 130	NUEVO MILENIO, COLIMA VALLEY	NUEVO MILENIO	PAVEL CARLOS LEIVA GARCÍA
049	RANM 61	NUEVO MILENIO, COLIMA VALLEY	NUEVO MILENIO	PAVEL CARLOS LEIVA GARCÍA
050	RANM 130	NUEVO MILENIO, COLIMA VALLEY	NUEVO MILENIO	PAVEL CARLOS LEIVA GARCÍA
051	RANM 15	NUEVO MILENIO, COLIMA VALLEY	NUEVO MILENIO	PAVEL CARLOS LEIVA GARCÍA
052	RANM 32	NUEVO MILENIO, COLIMA VALLEY	NUEVO MILENIO	PAVEL CARLOS LEIVA GARCÍA
053	RANM 18…	NUEVO MILENIO, COLIMA VALLEY	NUEVO MILENIO	PAVEL CARLOS LEIVA GARCÍA
054	RANM 162	NUEVO MILENIO, COLIMA VALLEY	NUEVO MILENIO	PAVEL CARLOS LEIVA GARCÍA
055	RANM 15	NUEVO MILENIO, COLIMA VALLEY	NUEVO MILENIO	PAVEL CARLOS LEIVA GARCÍA
056	SAT-5 E-3	EL TIVOLI, COLIMA VALLEY	QUINTA EL TIVOLI	MARÍA JUDITH GALICIA FLORES
057	SAT-10 E-3	EL TIVOLI, COLIMA VALLEY	QUINTA EL TIVOLI	MARÍA JUDITH GALICIA FLORES
058	SAT-6 E-3	EL TIVOLI, COLIMA VALLEY	QUINTA EL TIVOLI	MARÍA JUDITH GALICIA FLORES
059	SAT-9 E-3	EL TIVOLI, COLIMA VALLEY	QUINTA EL TIVOLI	MARÍA JUDITH GALICIA FLORES
060	SAT-13 E-3	EL TIVOLI, COLIMA VALLEY	QUINTA EL TIVOLI	MARÍA JUDITH GALICIA FLORES
061	RAH-173	HIGUERAS DEL ESPINAL, COLIMA VALLEY	HIGUERAS DEL ESPINAL	MARÍA JUDITH GALICIA FLORES
062	RAH-80	HIGUERAS DEL ESPINAL, COLIMA VALLEY	HIGUERAS DEL ESPINAL	MARÍA JUDITH GALICIA FLORES
063		HIGUERAS DEL ESPINAL, COLIMA VALLEY	HIGUERAS DEL ESPINAL	MARÍA JUDITH GALICIA FLORES
064	RAH-169	HIGUERAS DEL ESPINAL, COLIMA VALLEY	HIGUERAS DEL ESPINAL	MARÍA JUDITH GALICIA FLORES
065	RAH-158	HIGUERAS DEL ESPINAL, COLIMA VALLEY	HIGUERAS DEL ESPINAL	MARÍA JUDITH GALICIA FLORES
066	167	HIGUERAS DEL ESPINAL, COLIMA VALLEY	HIGUERAS DEL ESPINAL	MARÍA JUDITH GALICIA FLORES
067	RAH-158	HIGUERAS DEL ESPINAL, COLIMA VALLEY	HIGUERAS DEL ESPINAL	MARÍA JUDITH GALICIA FLORES
068	8-85 RAH	HIGUERAS DEL ESPINAL, COLIMA VALLEY	HIGUERAS DEL ESPINAL	MARÍA JUDITH GALICIA FLORES

069	RAH-122	HIGUERAS DEL ESPINAL, COLIMA VALLEY	HIGUERAS DEL ESPINAL	MARÍA JUDITH GALICIA FLORES
070	RAH-155	HIGUERAS DEL ESPINAL, COLIMA VALLEY	HIGUERAS DEL ESPINAL	MARÍA JUDITH GALICIA FLORES
071	RAH-50	HIGUERAS DEL ESPINAL, COLIMA VALLEY	HIGUERAS DEL ESPINAL	MARÍA JUDITH GALICIA FLORES
072	RAH-158	HIGUERAS DEL ESPINAL, COLIMA VALLEY	HIGUERAS DEL ESPINAL	MARÍA JUDITH GALICIA FLORES
073	RAH-169	HIGUERAS DEL ESPINAL, COLIMA VALLEY	HIGUERAS DEL ESPINAL	MARÍA JUDITH GALICIA FLORES
074	RAH-114	HIGUERAS DEL ESPINAL, COLIMA VALLEY	HIGUERAS DEL ESPINAL	MARÍA JUDITH GALICIA FLORES
075	RAH B-78?	HIGUERAS DEL ESPINAL, COLIMA VALLEY	HIGUERAS DEL ESPINAL	MARÍA JUDITH GALICIA FLORES
076	RAT C3/C4 CI	TABACHINES, COLIMA VALLEY	TABACHINES	MARCO ANTONIO CABRERA CABELLO
077	RAT AREA 2 3-C11	TABACHINES, COLIMA VALLEY	TABACHINES	MARCO ANTONIO CABRERA CABELLO
078	RAT C3/C4 CI	TABACHINES, COLIMA VALLEY	TABACHINES	MARCO ANTONIO CABRERA CABELLO
079		TABACHINES, COLIMA VALLEY	TABACHINES	MARCO ANTONIO CABRERA CABELLO
080		TABACHINES, COLIMA VALLEY	TABACHINES	MARCO ANTONIO CABRERA CABELLO
081	TAB-AL 337	TABACHINES, COLIMA VALLEY	TAB-AL	ANDRÉS SAÚL ALCÁNTARA SALINAS
082	TAB-AL 252	TABACHINES, COLIMA VALLEY	TAB-AL	ANDRÉS SAÚL ALCÁNTARA SALINAS
083	TAL	TABACHINES, COLIMA VALLEY	TAB-AL	ANDRÉS SAÚL ALCÁNTARA SALINAS
084	TAB-AL 277	TABACHINES, COLIMA VALLEY	TAB-AL	ANDRÉS SAÚL ALCÁNTARA SALINAS
085	TAB-AL 41?	TABACHINES, COLIMA VALLEY	TAB-AL	ANDRÉS SAÚL ALCÁNTARA SALINAS
086	TAB-AL 34	TABACHINES, COLIMA VALLEY	TAB-AL	ANDRÉS SAÚL ALCÁNTARA SALINAS
087	TAB-AL 252	TABACHINES, COLIMA VALLEY	TAB-AL	ANDRÉS SAÚL ALCÁNTARA SALINAS
088	TAB-AL 27	TABACHINES, COLIMA VALLEY	TAB-AL	ANDRÉS SAÚL ALCÁNTARA SALINAS
089	RAT AREA 2 C111	TABACHINES, COLIMA VALLEY	TAB-AL	ANDRÉS SAÚL ALCÁNTARA SALINAS
090	RAT AREA 2 C4-C11	TABACHINES, COLIMA VALLEY	TAB-AL	ANDRÉS SAÚL ALCÁNTARA SALINAS
091	SAURB C1 CP	RANCHO BLANCO, COLIMA VALLEY	RANCHO BLANCO	MARCO ANTONIO CABRERA CABELLO
092	B 1	RANCHO BLANCO, COLIMA VALLEY	RANCHO BLANCO	MARCO ANTONIO CABRERA CABELLO
093	SAURB	RANCHO BLANCO, COLIMA VALLEY	RANCHO BLANCO	MARCO ANTONIO CABRERA CABELLO
094	SAURB C1	RANCHO BLANCO, COLIMA VALLEY	RANCHO BLANCO	MARCO ANTONIO CABRERA CABELLO
095		RANCHO BLANCO, COLIMA VALLEY	RANCHO BLANCO	MARCO ANTONIO CABRERA CABELLO
096	SAURB CP C1	RANCHO BLANCO, COLIMA VALLEY	RANCHO BLANCO	MARCO ANTONIO CABRERA CABELLO
097	SAURB CP C1	RANCHO BLANCO, COLIMA VALLEY	RANCHO BLANCO	MARCO ANTONIO CABRERA CABELLO
098	SAURB CP C1	RANCHO BLANCO, COLIMA VALLEY	RANCHO BLANCO	MARCO ANTONIO CABRERA CABELLO
099	SAURB C1	RANCHO BLANCO, COLIMA VALLEY	RANCHO BLANCO	MARCO ANTONIO CABRERA CABELLO
100	SAURB	RANCHO BLANCO, COLIMA VALLEY	RANCHO BLANCO	MARCO ANTONIO CABRERA CABELLO
101	R-CEN 230	REAL CENTENARIO, COLIMA VALLEY	REAL CENTENARIO	ANDRÉS SAÚL ALCÁNTARA SALINAS
102	R-CEN 226	REAL CENTENARIO, COLIMA VALLEY	REAL CENTENARIO	ANDRÉS SAÚL ALCÁNTARA SALINAS
103	R-CEN 226	REAL CENTENARIO, COLIMA VALLEY	REAL CENTENARIO	ANDRÉS SAÚL ALCÁNTARA SALINAS
104	R-CEN 222	REAL CENTENARIO, COLIMA VALLEY	REAL CENTENARIO	ANDRÉS SAÚL ALCÁNTARA SALINAS

105	R-CEN 212	REAL CENTENARIO, COLIMA VALLEY	REAL CENTENARIO	ANDRÉS SAÚL ALCÁNTARA SALINAS
106	R-CEN 223	REAL CENTENARIO, COLIMA VALLEY	REAL CENTENARIO	ANDRÉS SAÚL ALCÁNTARA SALINAS
107	R-CEN 238? 278?	REAL CENTENARIO, COLIMA VALLEY	REAL CENTENARIO	ANDRÉS SAÚL ALCÁNTARA SALINAS
108	R-CEN 284	REAL CENTENARIO, COLIMA VALLEY	REAL CENTENARIO	ANDRÉS SAÚL ALCÁNTARA SALINAS
109	R-CEN 186	REAL CENTENARIO, COLIMA VALLEY	REAL CENTENARIO	ANDRÉS SAÚL ALCÁNTARA SALINAS
110	R-CEN 233	REAL CENTENARIO, COLIMA VALLEY	REAL CENTENARIO	ANDRÉS SAÚL ALCÁNTARA SALINAS
111	R-CEN 182	REAL CENTENARIO, COLIMA VALLEY	REAL CENTENARIO	ANDRÉS SAÚL ALCÁNTARA SALINAS
112	R-CEN 222	REAL CENTENARIO, COLIMA VALLEY	REAL CENTENARIO	ANDRÉS SAÚL ALCÁNTARA SALINAS
113	R-CEN 233	REAL CENTENARIO, COLIMA VALLEY	REAL CENTENARIO	ANDRÉS SAÚL ALCÁNTARA SALINAS
114	R-CEN 212	REAL CENTENARIO, COLIMA VALLEY	REAL CENTENARIO	ANDRÉS SAÚL ALCÁNTARA SALINAS
115	R-CEN 211	REAL CENTENARIO, COLIMA VALLEY	REAL CENTENARIO	ANDRÉS SAÚL ALCÁNTARA SALINAS
116	TAP III 1024	TAPATÍA, COLIMA VALLEY	TAPATÍA III	ANDRÉS SAÚL ALCÁNTARA SALINAS
117	TAP III 1028?	TAPATÍA, COLIMA VALLEY	TAPATÍA III	ANDRÉS SAÚL ALCÁNTARA SALINAS
118	TAP III 591	TAPATÍA, COLIMA VALLEY	TAPATÍA III	ANDRÉS SAÚL ALCÁNTARA SALINAS
119	TAP III 1366?	TAPATÍA, COLIMA VALLEY	TAPATÍA III	ANDRÉS SAÚL ALCÁNTARA SALINAS
120	TAP III 1033	TAPATÍA, COLIMA VALLEY	TAPATÍA III	ANDRÉS SAÚL ALCÁNTARA SALINAS
121	TAP III 591	TAPATÍA, COLIMA VALLEY	TAPATÍA III	ANDRÉS SAÚL ALCÁNTARA SALINAS
122	TAP III 591	TAPATÍA, COLIMA VALLEY	TAPATÍA III	ANDRÉS SAÚL ALCÁNTARA SALINAS
123	TAP III 834	TAPATÍA, COLIMA VALLEY	TAPATÍA III	ANDRÉS SAÚL ALCÁNTARA SALINAS
124	TAP III 1285?	TAPATÍA, COLIMA VALLEY	TAPATÍA III	ANDRÉS SAÚL ALCÁNTARA SALINAS
125	TAP III 762	TAPATÍA, COLIMA VALLEY	TAPATÍA III	ANDRÉS SAÚL ALCÁNTARA SALINAS
126	TAP III 251?	TAPATÍA, COLIMA VALLEY	TAPATÍA III	ANDRÉS SAÚL ALCÁNTARA SALINAS
127	TAP III 1497	TAPATÍA, COLIMA VALLEY	TAPATÍA III	ANDRÉS SAÚL ALCÁNTARA SALINAS
128	TAP III 1405?	TAPATÍA, COLIMA VALLEY	TAPATÍA III	ANDRÉS SAÚL ALCÁNTARA SALINAS
129	TAP III 531	TAPATÍA, COLIMA VALLEY	TAPATÍA III	ANDRÉS SAÚL ALCÁNTARA SALINAS
130	TAP III 327	TAPATÍA, COLIMA VALLEY	TAPATÍA III	ANDRÉS SAÚL ALCÁNTARA SALINAS
131	CAJITA 791	CAJITA DEL AGUA, COLIMA VALLEY	CAJITA DEL AGUA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
132	CAJITA 835	CAJITA DEL AGUA, COLIMA VALLEY	CAJITA DEL AGUA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
133	CAJITA B-815	CAJITA DEL AGUA, COLIMA VALLEY	CAJITA DEL AGUA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
134		CAJITA DEL AGUA, COLIMA VALLEY	CAJITA DEL AGUA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
135	CAJITA 791	CAJITA DEL AGUA, COLIMA VALLEY	CAJITA DEL AGUA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
136		CAJITA DEL AGUA, COLIMA VALLEY	CAJITA DEL AGUA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
137	CAJITA B-815	CAJITA DEL AGUA, COLIMA VALLEY	CAJITA DEL AGUA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
138	CAJITA 835	CAJITA DEL AGUA, COLIMA VALLEY	CAJITA DEL AGUA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
139	CAJITA 1984	CAJITA DEL AGUA, COLIMA VALLEY	CAJITA DEL AGUA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
140	CAJITA 835	CAJITA DEL AGUA, COLIMA VALLEY	CAJITA DEL AGUA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
141	CAJITA B-815	CAJITA DEL AGUA, COLIMA VALLEY	CAJITA DEL AGUA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS

142	CAJITA 66	CAJITA DEL AGUA, COLIMA VALLEY	CAJITA DEL AGUA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
143	CAJITA B-1987	CAJITA DEL AGUA, COLIMA VALLEY	CAJITA DEL AGUA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
144	CAJITA B-1775	CAJITA DEL AGUA, COLIMA VALLEY	CAJITA DEL AGUA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
145	CAJITA 1984	CAJITA DEL AGUA, COLIMA VALLEY	CAJITA DEL AGUA	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
146	C 122	LAGUNAS, COLIMA VALLEY	LAGUNAS	ANDRÉS SAÚL ALCÁNTARA SALINAS
147	C 122	LAGUNAS, COLIMA VALLEY	LAGUNAS	ANDRÉS SAÚL ALCÁNTARA SALINAS
148	C 122	LAGUNAS, COLIMA VALLEY	LAGUNAS	ANDRÉS SAÚL ALCÁNTARA SALINAS
149	C 122	LAGUNAS, COLIMA VALLEY	LAGUNAS	ANDRÉS SAÚL ALCÁNTARA SALINAS
150	C 122	LAGUNAS, COLIMA VALLEY	LAGUNAS	ANDRÉS SAÚL ALCÁNTARA SALINAS
151	TEC	TECNONLÓGICO/LA CAMPANA, COLIMA VALLEY	TECNOLÓGICO	ANDRÉS SAÚL ALCÁNTARA SALINAS
152	TEC	TECNONLÓGICO/LA CAMPANA, COLIMA VALLEY	TECNOLÓGICO	ANDRÉS SAÚL ALCÁNTARA SALINAS
153	TEC	TECNONLÓGICO/LA CAMPANA, COLIMA VALLEY	TECNOLÓGICO	ANDRÉS SAÚL ALCÁNTARA SALINAS
154	TEC	TECNONLÓGICO/LA CAMPANA, COLIMA VALLEY	TECNOLÓGICO	ANDRÉS SAÚL ALCÁNTARA SALINAS
155	TEC	TECNONLÓGICO/LA CAMPANA, COLIMA VALLEY	TECNOLÓGICO	ANDRÉS SAÚL ALCÁNTARA SALINAS
156	02 E1 PW C4	LAS ÁNIMAS, SALADO RIVER BASIN	LAS ÁNIMAS	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
157	02 E1 PW C1	LAS ÁNIMAS, SALADO RIVER BASIN	LAS ÁNIMAS	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
158	01 P1 II b	LAS ÁNIMAS, SALADO RIVER BASIN	LAS ÁNIMAS	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
159	01 T1 III	LAS ÁNIMAS, SALADO RIVER BASIN	LAS ÁNIMAS	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
160	01 P2 III	LAS ÁNIMAS, SALADO RIVER BASIN	LAS ÁNIMAS	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
161		LAS ÁNIMAS, SALADO RIVER BASIN	LAS ÁNIMAS	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
162	01 P1 III II b	LAS ÁNIMAS, SALADO RIVER BASIN	LAS ÁNIMAS	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
163	01 P1 II b	LAS ÁNIMAS, SALADO RIVER BASIN	LAS ÁNIMAS	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
164	01 P1 II b	LAS ÁNIMAS, SALADO RIVER BASIN	LAS ÁNIMAS	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
165	01 P1 II b	LAS ÁNIMAS, SALADO RIVER BASIN	LAS ÁNIMAS	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
166	01 P1 II A	LAS ÁNIMAS, SALADO RIVER BASIN	LAS ÁNIMAS	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
167	01 P1 II	LAS ÁNIMAS, SALADO RIVER BASIN	LAS ÁNIMAS	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
168	01 P1 II b	LAS ÁNIMAS, SALADO RIVER BASIN	LAS ÁNIMAS	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
169	01 S	LAS ÁNIMAS, SALADO RIVER BASIN	LAS ÁNIMAS	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
170	01 S	LAS ÁNIMAS, SALADO RIVER BASIN	LAS ÁNIMAS	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
171		ZANJA PRIETA, TECOMÁN COASTAL PLAIN	ZANJA PRIETA	ANDRÉS SAÚL ALCÁNTARA SALINAS
172		ZANJA PRIETA, TECOMÁN COASTAL PLAIN	ZANJA PRIETA	ANDRÉS SAÚL ALCÁNTARA SALINAS
173		ZANJA PRIETA, TECOMÁN COASTAL PLAIN	ZANJA PRIETA	ANDRÉS SAÚL ALCÁNTARA SALINAS
174		ZANJA PRIETA, TECOMÁN COASTAL PLAIN	ZANJA PRIETA	ANDRÉS SAÚL ALCÁNTARA SALINAS
175		ZANJA PRIETA, TECOMÁN COASTAL PLAIN	ZANJA PRIETA	ANDRÉS SAÚL ALCÁNTARA SALINAS

176		ZANJA PRIETA, TECOMÁN COASTAL PLAIN	ZANJA PRIETA	ANDRÉS SAÚL ALCÁNTARA SALINAS
177		ZANJA PRIETA, TECOMÁN COASTAL PLAIN	ZANJA PRIETA	ANDRÉS SAÚL ALCÁNTARA SALINAS
178		ZANJA PRIETA, TECOMÁN COASTAL PLAIN	ZANJA PRIETA	ANDRÉS SAÚL ALCÁNTARA SALINAS
179		ZANJA PRIETA, TECOMÁN COASTAL PLAIN	ZANJA PRIETA	ANDRÉS SAÚL ALCÁNTARA SALINAS
180		ZANJA PRIETA, TECOMÁN COASTAL PLAIN	ZANJA PRIETA	ANDRÉS SAÚL ALCÁNTARA SALINAS
181		ZANJA PRIETA, TECOMÁN COASTAL PLAIN	ZANJA PRIETA	ANDRÉS SAÚL ALCÁNTARA SALINAS
182		ZANJA PRIETA, TECOMÁN COASTAL PLAIN	ZANJA PRIETA	ANDRÉS SAÚL ALCÁNTARA SALINAS
183		ZANJA PRIETA, TECOMÁN COASTAL PLAIN	ZANJA PRIETA	ANDRÉS SAÚL ALCÁNTARA SALINAS
184		ZANJA PRIETA, TECOMÁN COASTAL PLAIN	ZANJA PRIETA	ANDRÉS SAÚL ALCÁNTARA SALINAS
185		ZANJA PRIETA, TECOMÁN COASTAL PLAIN	ZANJA PRIETA	ANDRÉS SAÚL ALCÁNTARA SALINAS
186	TMGM 2007	TERMINAL MARÍTIMA, WESTERN COAST	TERMINAL MARÍTIMA DE GAS DE MANZANILLO	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
187	TMGM 2007	TERMINAL MARÍTIMA, WESTERN COAST	TERMINAL MARÍTIMA DE GAS DE MANZANILLO	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
188	TMGM 2007	TERMINAL MARÍTIMA, WESTERN COAST	TERMINAL MARÍTIMA DE GAS DE MANZANILLO	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
189	TMGM 2007	TERMINAL MARÍTIMA, WESTERN COAST	TERMINAL MARÍTIMA DE GAS DE MANZANILLO	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
190	TMGM 2007	TERMINAL MARÍTIMA, WESTERN COAST	TERMINAL MARÍTIMA DE GAS DE MANZANILLO	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
191	TMGM 2007	TERMINAL MARÍTIMA, WESTERN COAST	TERMINAL MARÍTIMA DE GAS DE MANZANILLO	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
192	TMGM 2007	TERMINAL MARÍTIMA, WESTERN COAST	TERMINAL MARÍTIMA DE GAS DE MANZANILLO	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
193	TMGM 2007	TERMINAL MARÍTIMA, WESTERN COAST	TERMINAL MARÍTIMA DE GAS DE MANZANILLO	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
194	TMGM 2007	TERMINAL MARÍTIMA, WESTERN COAST	TERMINAL MARÍTIMA DE GAS DE MANZANILLO	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
195	TMGM 2007	TERMINAL MARÍTIMA, WESTERN COAST	TERMINAL MARÍTIMA DE GAS DE MANZANILLO	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
196	TMGM 2007	TERMINAL MARÍTIMA, WESTERN COAST	TERMINAL MARÍTIMA DE GAS DE MANZANILLO	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
197	TMGM 2007	TERMINAL MARÍTIMA, WESTERN COAST	TERMINAL MARÍTIMA DE GAS DE MANZANILLO	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
198	TMGM 2007	TERMINAL MARÍTIMA, WESTERN COAST	TERMINAL MARÍTIMA DE GAS DE MANZANILLO	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS

199	TMGM 2007	TERMINAL MARÍTIMA, WESTERN COAST	TERMINAL MARÍTIMA DE GAS DE MANZANILLO	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
200	TMGM 2007	TERMINAL MARÍTIMA, WESTERN COAST	TERMINAL MARÍTIMA DE GAS DE MANZANILLO	MARÍA DE LOS ÁNGELES OLAY BARRIENTOS
201	PGMG 02 SUPER.	EL VOLANTÍN, WESTERN COAST	TERMINAL DE GAS NATURAL, LICUADO DE MANZANILLO	MARÍA ANTONIETA MOGUEL CÓS
202	PGMG-02 SUPER.	EL VOLANTÍN, WESTERN COAST	TERMINAL DE GAS NATURAL, LICUADO DE MANZANILLO	MARÍA ANTONIETA MOGUEL CÓS
203	PGMG02 SUPER	EL VOLANTÍN, WESTERN COAST	TERMINAL DE GAS NATURAL, LICUADO DE MANZANILLO	MARÍA ANTONIETA MOGUEL CÓS
204	PGMG02 SUPER	EL VOLANTÍN, WESTERN COAST	TERMINAL DE GAS NATURAL, LICUADO DE MANZANILLO	MARÍA ANTONIETA MOGUEL CÓS
205	PGMG-02 SUPER	EL VOLANTÍN, WESTERN COAST	TERMINAL DE GAS NATURAL, LICUADO DE MANZANILLO	MARÍA ANTONIETA MOGUEL CÓS
206	PGMG-02 SUPER	EL VOLANTÍN, WESTERN COAST	TERMINAL DE GAS NATURAL, LICUADO DE MANZANILLO	MARÍA ANTONIETA MOGUEL CÓS
207	PGMG-02 SUPER	EL VOLANTÍN, WESTERN COAST	TERMINAL DE GAS NATURAL, LICUADO DE MANZANILLO	MARÍA ANTONIETA MOGUEL CÓS
208	PGMG02 SUPER	EL VOLANTÍN, WESTERN COAST	TERMINAL DE GAS NATURAL, LICUADO DE MANZANILLO	MARÍA ANTONIETA MOGUEL CÓS
209	PGMG-02 SUPER	EL VOLANTÍN, WESTERN COAST	TERMINAL DE GAS NATURAL, LICUADO DE MANZANILLO	MARÍA ANTONIETA MOGUEL CÓS
210	PGMG-02 SUPER	EL VOLANTÍN, WESTERN COAST	TERMINAL DE GAS NATURAL, LICUADO DE MANZANILLO	MARÍA ANTONIETA MOGUEL CÓS
211	PGMG 02 SUPER	EL VOLANTÍN, WESTERN COAST	TERMINAL DE GAS NATURAL, LICUADO DE MANZANILLO	MARÍA ANTONIETA MOGUEL CÓS
212	PGMG 02 SUPER	EL VOLANTÍN, WESTERN COAST	TERMINAL DE GAS NATURAL, LICUADO DE MANZANILLO	MARÍA ANTONIETA MOGUEL CÓS
213	PGMG02 SUPER	EL VOLANTÍN, WESTERN COAST	TERMINAL DE GAS NATURAL, LICUADO DE MANZANILLO	MARÍA ANTONIETA MOGUEL CÓS
214	PGMG 02 SUPER	EL VOLANTÍN, WESTERN COAST	TERMINAL DE GAS NATURAL, LICUADO DE MANZANILLO	MARÍA ANTONIETA MOGUEL CÓS
215	PGM-G 02 SUPER	EL VOLANTÍN, WESTERN COAST	TERMINAL DE GAS NATURAL, LICUADO DE MANZANILLO	MARÍA ANTONIETA MOGUEL CÓS

APPENDIX C. INAA ELEMENTAL CONCENTRATIONS DATA AND GROUP MEMBERSHIP PROBABILITIES FOR THE INDIVIDUAL POTTERY AND RAW CLAY SAMPLES

Table C.1. Raw elemental concentrations for up to 10 chemical elements in 215 pottery samples and 14 raw clay samples. The concentration values are expressed in ppm.

Sample/Element	Lu	Yb	Ce	Co	Cr	Fe	Hf	Rb	Sc	Th
001	0.22	1.4	32	20	118	56708	3.2	17	16	1.8
002	0.29	1.7	34	20	95	50441	3.7	28	17	2.1
003	0.24	1.6	28	22	90	48875	3.5	22	16	1.9
004	0.24	1.5	35	14	25	32683	3.6	26	11	2.4
005	0.3	1.7	39	20	48	47559	3.6	37	15	2.5
006	0.25	1.5			46	49541	3.8		15	2.3
007	0.27	1.8	43	16	28	37762	4.4	25	12	2.6
008	0.27	1.5	29	12	52	35184	4.3	70	12	4.4
009	0.27	1.5	33	14	32	38392	3.4	35	13	3
010	0.29	1.9	31	17	37	46216	3.5	39	15	3.2
011	0.23	1.6	38	19	28	34783	3.7	22	11	2.4
012	0.23	1.4	31	21	87	46323	3.1	17	15	1.8
013	0.3	1.7			44	46044	3.5		16	3.1
014	0.28	1.9			39	45172	3.3		15	3
015	0.29	1.8	41	22	54	52568	3.8	33	16	2.5
016	0.29	1.8	29	19	43	46146	4	26	16	3
017	0.19	1.3			80	41990	2.9		13	1.8
018	0.23	1.5			101	50739	3		16	1.7
019	0.26	1.7			139	55272	3.8		19	2.2
020	0.28	1.9			41	43976	3.6		15	3
021	0.29	1.7			46	40521	4		13	2.5
022	0.21	1.4			95	47974	3.1		16	1.7
023	0.26	1.7			109	49913	3.6		17	1.7
024	0.28	1.9			118	54702	3.6		19	2
025	0.29	1.8			51	42450	3.7		14	2.4
026	0.32	1.8			42	48154	3.3		16	3.1
027	0.3	1.8			29	36495	3.9		12	2.3
028	0.28	1.7			33	37430	4.1		11	2.3
029	0.22	1.3	25	23	125	47997	3.3	20	16	1.7
030	0.2	1.6			123	46743	3.3		16	2
031	0.19	1.1	27	18	74	39067	3.2	17	14	1.8
032	0.25	1.4	29	20	89	44023	3.4	25	15	1.9
033	0.26	1.6			98	45922	3.2		15	2
034	0.25	1.4			88	48294	3.4		15	1.9
035	0.24	1.3			93	44530	3.5		16	1.9
036	0.19	1.3			81	41683	3.4		14	1.6
037	0.25	1.3			159	47867	2.8		17	1.5
038	0.36	2			62	48723	2.9		16	2.1
039	0.25	1.4	33	18	34	45247	3.5	28	14	2.3
040	0.31	2			103	56881	3.6		18	2.1
041	0.24	1.4	32	17	38	45956	3.1	38	13	2.2

Sample/Element	Lu	Yb	Ce	Co	Cr	Fe	Hf	Rb	Sc	Th
042	0.29	1.8	42	22	38	49431	3.8	30	15	2.8
043	0.23	1.5	27	14	33	35593	2.9	34	12	2.4
044	0.23	1.4	32	17	30	40637	3.3	34	12	2.4
045	0.28	1.5			36	35687	3.6		10	2.2
046	0.35	1.8	42	20	46	46667	4.3	48	14	2.7
047	0.28	1.8			34	41281	3.5		14	3.2
048	0.32	2.2			45	49777	3.5		17	3.7
049	0.25	1.4	33	19	75	47547	3.9	31	16	1.9
050	0.27	1.7	31	15	40	40095	3	39	13	2.8
051	0.17	0.8			67	37348	2.5		11	1.5
052	0.27	1.5			85	47817	3.2		15	1.7
053	0.3	1.8	34	22	91	48017	3.7	25	16	2
054	0.27	1.7	34	24	93	49435	3.5	25	17	2
055	0.21	1.2	29	20	70	40661	2.9	22	13	1.7
056	0.28	1.6	46	18	29	35916	3.8	26	11	2.6
057	0.28	2.3			35	43164	3.4		14	2.9
058	0.33	2.6			39	48045	3.6		17	3.2
059	0.31	1.2	33	15	34	41512	3.3	31	14	3
060	0.4	1.3	38	15	40	40627	3.6	48	14	3.4
061	0.28	1.9	34	17	38	42551	3.8	38	14	3.1
062	0.28	1.7	29	16	32	39355	3.2	37	13	2.8
063	0.28	1.7	29	17	39	46421	3.9	35	15	3.1
064	0.26	1.6	28	16	31	42101	3.3	32	14	2.9
065	0.27	1.6			38	42426	3.6		15	3.1
066	0.26	1.4			93	43747	3.5		16	1.9
067	0.23	1.5			36	40336	3.6		12	2.5
068	0.24	1.6			40	43444	3.3		14	2.2
069	0.55	2.4			69	55058	6.7		17	2.7
070	0.28	1.6			42	48368	3.9		14	2.2
071	0.28	1.4	33	17	113	43056	4	30	17	1.9
072	0.28	1.7	32	17	97	40959	3.9	38	15	2.1
073	0.22	1.4			87	45553	3.6		15	1.9
074	0.26	1.6			82	41214	3		15	1.7
075	0.34	1.2	38	22	93	44156	3.5	32	15	1.8
076	0.27	1.3	28	18	79	40811	3.3	35	15	1.6
077	0.26	1.7			105	49219	3.7		17	2
078	0.19	1.4			97	49767	3.3		16	1.8
079	0.25	1.5			93	46257	3.7		16	2
080	0.32	1.4			129	47146	3.2		16	1.5
081	0.27	1.5			177	50833	3.5		18	2.1
082	0.26	1.2			137	43987	3		16	1.8
083	0.19	1.3			126	42072	3.1		15	1.8
084	0.29	1.6			138	50474	3.6		18	1.8
085	0.22	1.3			108	46839	3		16	1.8
086	0.25	1.3			29	31460	3.5		10	2.2
087	0.32	2.5			42	43767	3.8		15	3.3
088	0.31	2			41	42739	3.6		14	3.4

Sample/Element	Lu	Yb	Ce	Co	Cr	Fe	Hf	Rb	Sc	Th
089	0.28	1.9	28	17	43	44410	3.8	38	16	3
090	0.26	1.9	26	17	36	42730	3.6	29	15	2.8
091	0.43	1.3			41	44809	3.6		16	3.6
092	0.3	1.9	34	17	48	43764	4.6	44	15	3.7
093	0.29	1.9			38	43141	3.6		14	3.5
094	0.2	1.8	36	17	32	32487	3.6	19	10	2.1
095	0.57	1.7	62	23	35	47340	5.7	18	15	2.7
096	0.26	1.6	33	19	40	39209	3.5	25	13	2.3
097	0.22	1.7			40	37208	3.7		12	2.3
098	0.29	1.6			37	43553	3.4		14	3
099	0.31	1.8	29	17	37	41664	4	31	15	3
100	0.31	1.9	32	17	38	40907	3.7	36	14	3.4
101	0.22	1.6			39	47168	3.5		15	2.5
102	0.26	1.7			76	50629	3.5		16	2.1
103	0.27	1.7			44	48566	3.6		15	2.4
104	0.25	1.7			43	46500	3.5		14	2.2
105	0.25	1.7	37	16	31	36562	3.7	31	12	2.3
106	0.26	1.6	36	17	35	35599	3.9	33	11	2.3
107	0.31	2			21	49567	4		15	3
108	0.29	1.8			35	39811	3.4		13	3.1
109	0.25	1.3			104	40807	3.1		15	1.5
110	0.29	1.6			126	49499	3.6		18	1.9
111	0.26	1.6	30	22	85	49048	3.5	22	16	2.1
112	0.2	1.2			77	39073	2.7		13	1.6
113	0.23	1.4	28	20	83	43680	3.3	19	16	1.9
114	0.24	1.5	31	23	97	48231	3.7	17	18	1.9
115	0.25	1.5	29	22	89	43787	3.3	20	16	2
116	0.33	1.9			41	44202	3.5		16	3.2
117	0.29	1.7	30	17	37	42903	3.4	38	14	2.9
118	0.24	1.5	32	24	88	54388	3.6	21	17	2
119	0.22	1.4	27	21	113	42377	3.1	20	15	1.7
120	0.19	1.2	27	21	88	43645	2.9	24	14	1.7
121	0.2	1.3			94	46465	3.2		15	1.8
122	0.2	1.2			82	37188	2.7		13	1.5
123	0.29	2	42	18	33	35039	3.9	22	11	2.5
124	0.25	1.7	42	19	32	34508	3.8	19	11	2.3
125	0.26	1.8	39	17	30	35827	3.5	30	11	2.3
126	0.27	1.8	43	17	26	33411	4	26	11	2.5
127	0.29	1.8			40	42167	3.5		14	3.6
128	0.29	1.8			34	41989	3.3		13	3
129	0.26	1.5	33	20	60	50005	3.8	27	15	2.4
130	0.28	1.9	33	24	80	52965	4.4	32	17	2.5
131	0.2	1.3			38	38569	2.8		11	1.8
132	0.25	1.5			38	45636	3.4		14	2.4
133	0.24	1.7	33	17	38	46214	3.5	37	15	2.3
134	0.29	1.8	28	13	34	41667	3.2	30	14	2.1
135	0.26	1.6	31	15	33	44262	3.6	31	14	2.3

Sample/Element	Lu	Yb	Ce	Co	Cr	Fe	Hf	Rb	Sc	Th
136	0.22	1.4	31	22	40	43508	3.3	24	13	2.1
137	0.24	1.7	38	17	30	31702	4	26	11	2.4
138	0.33	2	31	18	51	43923	4.1	45	15	4.3
139	0.29	1.8	33	19	42	43496	3.9	47	14	3.5
140	0.31	1.9	31	20	39	48989	3.3	35	16	2.8
141	0.31	2			53	46274	3.6		16	3.8
142	0.32	2			41	45134	3.2		15	3.2
143	0.27	1.4	31	19	46	50602	3.3	32	15	2.7
144	0.31	1.9	33	18	42	45829	3.4	37	16	3.7
145	0.29	1.9	33	17	40	40912	3.8	45	13	3.5
146	0.3	1.9	35	19	87	46052	3.4	33	16	1.9
147	0.25	1.4			96	44666	3.5		16	2.1
148	0.28	1.5			40	41617	3.7		14	3.3
149	0.29	1.9	27	16	35	41733	3.3	43	15	2.7
150	0.5	3.1	44	18	39	50753	6	27	15	3
151	0.28	1.7			88	49139	4		16	2.4
152	0.28	1.8	34	23	24	48459	3.1	18	12	2.4
153	0.2	1.2			108	50833	3.5		16	1.8
154	0.21	1.3	30	25	100	50919	3.7	17	16	1.9
155	0.22	1.4			110	48577	3.3		16	1.8
156	0.22	1.4			35	46199	3.8		14	2.6
157	0.33	2			40	47916	3.5		15	3.5
158	0.29	1.7			35	41948	3		14	2.9
159	0.26	1.6			34	38096	3.3		13	2.7
160	0.3	1.9			40	41910	3.6		15	3.4
161	0.28	1.8	35	24	50	50131	3.5	25	16	2.2
162	0.32	2.1	29	15	39	48659	4.3	23	16	2.4
163	0.28	1.7	40	22	40	46008	3.6	23	14	2.5
164	0.26	1.5			36	41835	3.3		13	2.3
165	0.26	1.5			42	45949	3.2		13	2.4
166	0.27	1.7			49	38855	3.6		13	2.5
167	0.26	1.7			23	30466	3.8		10	2.3
168	0.24	1.5	34	13	21	31642	3.5	25	11	2.2
169	0.24	1.3	34	12	22	30292	3.8	29	10	2.4
170	0.24	1.5	35	19	40	39035	3.8	22	13	1.9
171	0.25	1.6	29	21	67	45821	3.6	28	14	2.4
172	0.25	1.7	31	29	82	49239	3.7	22	14	2.6
173	0.29	1.8	33	24	105	51472	5	29	16	2.5
174	0.29	1.6			35	40297	3		14	2.7
175	0.27	1.8			36	35318	3.1		13	2.8
176	0.24	1.4			36	35424	2.9		13	2.6
177	0.31	1.8			37	40922	3.4		14	3.5
178	0.24	1.3			28	35390	2.5		12	2.2
179	0.27	1.7	29	19	37	44083	3.3	38	15	3.1
180	0.24	1.2	20	20	30	33942	2.4	32	12	2.3
181	0.22	1.3	25	18	70	34093	2.4	25	12	1.9
182	0.27	1.5			37	48939	2.9		15	0.8

Sample/Element	Lu	Yb	Ce	Co	Cr	Fe	Hf	Rb	Sc	Th
183	0.21	1.4			68	32123	2.4		12	1.4
184	0.26	1.5			35	44435	2.9		15	0.8
185	0.41	2.5	33	25	47	60991	3.7	28	18	1.7
186	0.34	2.2	40	25	21	60176	4.7	35	14	3.1
187	0.27	1.7	34	18	28	49701	5.2	34	13	2.6
188	0.29	1.9	36	22	26	53103	5.1	34	15	2.9
189	0.28	1.8			41	43616	3.9		15	3.3
190	0.3	2.1			44	41754	4.3		14	3.6
191	0.3	1.8			39	46734	3.5		16	2.9
192	0.28	1.9			37	41905	3.3		14	3.2
193	0.29	1.8			43	45813	3.6		15	3.3
194	0.34	2			46	47035	4		16	3.7
195	0.27	1.6	29	17	38	41179	3.5	39	14	3.2
196	0.34	2.2	23	12	22	57905	5	44	16	3.7
197	0.37	2.3	34	24	28	69210	3.8	36	21	2.4
198	0.31	2	17	30	70	80506	3.2	37	22	1.7
199	0.33	1.8	25	23	50	65911	3.7	40	20	2.3
200	0.28	1.8			68	50964	4.5		16	4.2
201	0.34	2.1	28	22	24	57103	3.3	32	17	2.1
202	0.36	2.2	25	22	30	62709	3.3	35	19	1.8
203	0.37	2.1			41	66852	2.8		22	1.7
204	0.27	1.8			100	50418	3.2		18	1.8
205	0.32	2			44	65618	3.2		18	1.9
206	0.36	2.1			40	49691	3.7		17	3.2
207	0.31	1.9	30	19	39	44748	3.5	28	16	3.4
208	0.28	1.9			79	57394	3.8		19	1.9
209	0.32	1.7			73	62601	3.7		19	1.8
210	0.34	2.6			84	52872	3.5		20	3.2
211	0.43	2.7	34	25	23	75473	3.3	30	23	1.6
212	0.35	2.2	38	34	41	71768	3.9	33	23	2.2
213	0.4	2.8	42	20	21	54590	4.4	36	15	2.8
214	0.38	2.7	44	18	18	53077	4.4	36	15	2.9
215	0.26	1.7	31	16	22	43747	4.7	38	12	2.4
B1	0.33	2.1	32	13	52	58646	5.9	21	20	4.1
B2	0.26	1.7			21	20568	2.3		9	2
B3	0.31	2			119	58954	4.1		20	2.2
B4	0.27	1.8	34	26	107	53632	3.8	20	18	2.1
B5	0.24	1.7			125	46766	3.6		17	1.9
B6	0.23	1.6			98	45496	3.3		17	1.7
B7	0.33	2.2	34	21	67	51756	3.2	38	17	2.2
B8	0.29	1.6			9	18062	6.3		3	7.3
B9	0.28	1.7			60	43784	3.7		14	2.7
B10	0.35	2.3	68	1	5	4934	4.8	19	2	4.3
B11	0.36	2.1			75	44243	3.5		15	2.8
B12	0.2	1.2			397	48743	3.3		18	2
B13	0.28	1.8			53	40844	3.2		12	2.1
B14	0.28	1.7			64	43009	3.4		15	2.1

Table C.2. Group classification using Mahalanobis Distance (MD) and 7 elements.

Results are based on the following variables:
Sc Cr Fe Yb Lu Hf Th

Membership probabilities(%) for samples in group: Group 1
Probabilities calculated after removing each sample from group.

SAMPLE	Group 1	Group 2	Group 3	Group 4	Group 5	Best Group
---------	---------	---------	---------	---------	---------	---------
C79	99,3284852	0,00023248	5,76078E-05	9,92494331	16,3832714	Group 1
C77	99,1907474	1,8872E-05	2,77655E-05	7,70374834	13,8209865	Group 1
C3	98,4819429	0,00122472	0,000235277	9,06108541	38,9333556	Group 1
C155	98,1205766	2,0922E-07	2,44658E-05	7,98361962	29,8140133	Group 1
C32	97,7958354	0,00027293	0,000144621	8,61428591	15,4336723	Group 1
C54	97,0691445	0,00032871	0,000108714	9,39334328	18,449315	Group 1
C2	96,3109141	0,00137622	0,000108111	8,30607678	8,40045469	Group 1
C111	93,4907623	0,01796687	0,001243825	11,1712164	23,4621887	Group 1
B4	92,1880739	3,7933E-05	3,34332E-05	7,22338376	13,10432	Group 1
C12	90,9301396	0,00016724	0,000579057	11,3450798	51,5026458	Group 1
C66	90,8000872	5,0646E-06	1,44102E-05	6,31228528	11,714862	Group 1
C34	87,1860799	0,0047852	0,000602793	9,53748988	16,1221187	Group 1
C110	85,0591653	6,9783E-09	1,16146E-06	5,03441957	3,69350472	Group 1
C22	84,3006224	7,4925E-07	5,32735E-05	7,86124962	48,8161571	Group 1
C73	83,9945511	0,00077822	0,000175878	11,0487135	45,0407196	Group 1
C121	82,1836284	2,8587E-06	0,000152045	8,72519755	87,6447681	Group 5
C53	79,2198888	0,00455834	0,000196347	8,3043777	5,85945742	Group 1
C29	79,1168188	1,7541E-09	3,02915E-06	7,49084245	10,5526327	Group 1
C35	77,4051524	2,6648E-06	1,36936E-05	7,3935297	19,887798	Group 1
C85	71,9429577	6,3148E-09	2,83632E-05	8,57595797	31,9294095	Group 1
C102	70,7523851	0,36759883	0,00617919	11,9021857	21,6652895	Group 1
C151	68,647301	0,08228695	0,001097293	9,15839746	7,5043795	Group 1
C18	67,772717	1,6029E-06	0,00012823	8,01273428	30,334653	Group 1
C84	65,8068858	7,7214E-10	4,87556E-07	4,6561988	2,63355368	Group 1
C119	63,0893875	1,9229E-09	1,0139E-05	7,352682	15,9182404	Group 1
C115	62,4413182	1,3618E-05	0,000114044	9,6200322	33,3866319	Group 1
C147	61,2868278	8,6728E-06	5,26293E-05	8,18989838	15,0206206	Group 1
C33	60,2429956	7,9773E-05	0,000880312	8,19477452	13,0843092	Group 1
C118	56,5779512	0,00208399	0,000203205	10,5498335	24,403971	Group 1
C24	56,5187574	2,5762E-07	7,72524E-06	6,17383144	10,4210421	Group 1
C113	53,7455786	9,174E-06	7,26004E-05	11,406168	55,4518662	Group 5
C78	53,4883855	5,3449E-07	7,25679E-05	4,40870269	54,6795577	Group 5
B5	49,6169596	3,8243E-09	3,37399E-06	4,74253103	10,5168749	Group 1
C52	48,5244132	0,00229026	0,000277714	7,20527043	11,7679529	Group 1
B6	47,4489025	3,289E-08	4,97667E-06	7,03871897	45,6553009	Group 1
C109	42,7196015	1,4061E-09	1,04643E-06	4,35348288	7,08215416	Group 1
C154	42,0406483	1,0519E-05	2,58077E-05	9,78330284	40,92266	Group 1
C204	39,971682	6,0485E-07	1,52428E-05	7,59370868	15,1670232	Group 1
C130	38,1976794	0,32098396	0,001231737	8,63494652	11,0200461	Group 1
C146	36,8829364	0,00061463	0,000173577	8,75951784	10,1278436	Group 1
C19	36,5803136	3,5955E-09	3,33033E-06	5,43500967	6,84750357	Group 1
C114	36,0718297	2,1631E-07	3,09833E-06	8,94023807	29,2923971	Group 1
C23	33,915817	2,128E-06	4,41464E-06	7,62996722	11,4088275	Group 1
C40	32,0536075	0,00019599	0,00014372	7,87105964	6,60697644	Group 1
C49	30,3786321	0,02447806	6,07341E-05	9,13312072	19,9899	Group 1
C76	28,9158152	5,2437E-06	5,40744E-06	3,03250518	9,7594061	Group 1
C74	25,2622283	7,4247E-06	9,74906E-05	9,66936448	33,2325205	Group 5
C153	24,3953137	1,0848E-07	9,13198E-06	9,00270848	39,221734	Group 5
C30	19,4421042	7,3512E-10	3,33185E-05	2,36577478	28,7427804	Group 5
B3	18,9882452	2,0843E-06	5,11702E-06	6,73635388	5,07141748	Group 1

C83	15,0279468	3,576E-12	5,16382E-06	4,57845315	13,8170463	Group 1
C37	14,031538	4,6985E-15	1,73105E-07	3,72258509	3,14662766	Group 1
C71	13,1637281	1,2024E-09	2,40697E-07	3,61079816	2,43948677	Group 1
C72	8,90986782	3,6691E-05	4,14096E-05	6,34845465	2,98621921	Group 1
C1	7,58209338	1,0398E-07	0,000104897	7,06051121	19,4129448	Group 5
C82	6,56961237	1,3337E-12	9,82726E-07	2,94024938	2,5903259	Group 1
C81	3,12140041	4,0938E-13	4,74425E-07	4,45322741	1,55399804	Group 4
C80	2,04819666	2,1593E-10	2,88097E-07	1,72465808	1,22851954	Group 1
C172	0,29363397	0,07602625	0,051900794	4,93880283	10,2955946	Group 5
C75	0,26202502	1,8834E-06	3,8739E-06	0,95560552	1,14706523	Group 5
C173	0,0758698	0,00095924	6,63736E-05	6,73192833	1,42873186	Group 4

Membership probabilities(%) for samples in group: Group 2
Probabilities calculated after removing each sample from group.

SAMPLE	Group 1	Group 2	Group 3	Group 4	Group 5	Best Group
C117	1,8262E-05	99,7546335	13,97052351	17,8568975	3,06706598	Group 2
C20	0,00011712	99,1245234	3,946271446	11,0694238	3,30597219	Group 2
C98	2,6578E-06	97,9575214	7,007600492	13,9452125	3,07515306	Group 2
C193	4,2904E-06	97,942444	0,734098186	12,3857376	3,92612247	Group 2
C47	5,8834E-07	95,5182574	3,822617349	12,4462761	2,296783	Group 2
C61	0,00023857	95,4837795	5,190349447	9,12226833	3,63317433	Group 2
C14	3,6347E-06	94,5234239	3,022055602	12,2835027	2,04229502	Group 2
C10	1,4654E-06	94,3508528	1,118714303	14,9061975	1,95727649	Group 2
C100	1,0427E-06	94,1949595	1,375125735	8,17002498	3,93100069	Group 2
C160	2,0339E-07	93,7213876	0,953310806	9,12860531	3,55676895	Group 2
C191	5,3882E-06	93,4973665	1,936493861	25,1467229	1,92149255	Group 2
C163	0,04416935	93,4642983	13,38030057	32,5661504	3,68873524	Group 2
C195	7,5714E-07	93,2720917	2,789539168	13,631183	3,71997258	Group 2
C103	0,18721454	93,0140803	2,001786206	35,0215525	3,51658203	Group 2
C177	7,4716E-09	92,0164873	0,530941223	8,20988064	3,35712829	Group 2
C192	4,0052E-07	91,466742	1,64506323	7,8901981	2,58723967	Group 2
C132	0,00699583	90,2428707	10,81914188	45,2748587	2,57593103	Group 2
C189	2,0793E-05	89,6442284	0,898537038	11,1474661	4,04178111	Group 2
C5	0,14088625	89,2477164	1,677375236	14,5362162	5,31967629	Group 2
C127	3,8311E-08	89,2258617	0,167643954	7,20013918	4,11743211	Group 2
C93	4,5729E-07	87,8250998	0,288066255	7,27622316	3,29016721	Group 2
C88	2,5426E-06	87,4991905	0,5703516	6,87997075	4,37985911	Group 2
C63	0,00010897	87,2172777	1,369194528	24,4997988	3,07260093	Group 2
C207	1,2601E-08	87,0898367	0,596530577	13,9997317	2,12921084	Group 2
C164	0,00784646	86,3476313	49,94225771	25,5766121	3,40310303	Group 2
C179	1,3506E-07	86,0475105	2,940914546	19,8484302	1,78348242	Group 2
C104	0,67175613	86,0249685	5,422140113	23,606535	3,91758193	Group 2
C139	1,1944E-05	84,7354522	0,306948497	7,97130999	4,99153747	Group 2
C13	9,5692E-07	83,035734	0,921383346	14,6122771	3,2461651	Group 2
C68	0,08067078	82,8988808	8,94621257	29,6681297	2,82631296	Group 2
C148	8,0753E-07	81,9249337	0,87276666	9,73525835	5,12770339	Group 2
C108	2,3317E-06	81,2641173	5,149059382	10,1002709	3,47484955	Group 2
C26	1,0563E-07	77,8038062	0,929209054	14,0517165	2,17691274	Group 2
C116	1,3028E-07	77,7496556	0,951912829	11,2163972	2,76422349	Group 2
C159	3,0195E-05	76,3812822	62,41168457	18,899403	3,13774415	Group 2
C140	4,3917E-06	75,7253236	1,355988301	28,9480436	1,50722563	Group 2
C64	3,6276E-07	74,8485159	11,32136025	34,8598325	1,33945926	Group 2
C96	0,09192896	74,6340137	27,08654122	24,0911765	6,61585033	Group 2
C194	6,4094E-07	74,214015	0,086240391	8,40879126	3,95782686	Group 2
C62	2,4098E-06	72,4034403	29,33613525	17,9519405	2,33046673	Group 2
C16	0,00054052	70,4511722	0,568892216	21,4000463	3,75184838	Group 2

C65	9,8745E-07	69,0434076	2,429232334	20,0721798	2,79923255	Group 2
C158	5,7656E-08	68,6350169	8,833185324	17,7851524	1,94782235	Group 2
C144	4,6811E-10	68,2966812	0,092010775	9,88225471	2,44770012	Group 2
C90	0,00011088	67,0538773	6,653815909	9,56506907	1,78772113	Group 2
C142	9,3297E-08	66,9840005	0,716398589	11,5513602	2,67834005	Group 2
C9	4,0138E-07	65,9681514	17,12974325	12,8046278	2,84785297	Group 2
C133	0,01864787	65,8099723	1,890943154	17,6467987	1,6023888	Group 2
C135	0,00566377	63,6639511	6,975757359	49,4622925	1,81807649	Group 2
C149	6,4899E-06	60,5206279	8,319013655	24,2353089	1,69971277	Group 2
C25	1,81353047	59,235977	2,080003842	14,4153757	9,49083996	Group 2
C42	0,00189204	58,9898575	2,053587891	40,1290155	2,26499797	Group 2
C89	0,00014201	56,037364	0,871466194	12,4119161	3,37241766	Group 2
C39	0,0014698	55,1541401	3,67007984	18,6380513	1,89321446	Group 2
C136	0,15713309	52,4163843	10,22810606	41,7640506	3,71597048	Group 2
C174	2,3636E-07	50,9781141	27,55356117	12,2473604	2,20310699	Group 2
C145	5,9557E-06	50,6192678	0,247102021	5,1278597	4,66002051	Group 2
C6	0,4868501	50,5597016	0,239735751	30,6991717	4,57846506	Group 2
C128	3,307E-06	49,5917774	3,296395057	13,9676375	2,67953069	Group 2
C166	0,1701054	47,5209145	7,811253025	10,4218831	11,4109743	Group 2
C161	0,88778804	45,3533758	0,124937068	23,5815836	3,65768619	Group 2
C50	5,4217E-06	44,9532765	12,54169699	11,351498	4,60240895	Group 2
C157	9,186E-08	42,2466995	0,118610223	11,3905436	2,57524532	Group 2
C15	1,26525758	40,7053934	0,210970612	22,7540974	5,49867281	Group 2
C99	6,9632E-05	40,6318959	2,905685231	13,263192	3,34312439	Group 2
C21	0,35473535	39,8689232	7,739519817	11,7553531	5,65555686	Group 2
C206	4,3187E-07	39,5253903	0,207867403	13,8676995	1,74094193	Group 2
C67	0,01030606	36,7831586	38,44605942	18,164575	4,37625439	Group 3
B9	0,65281783	34,5812476	0,791240728	9,47643482	11,3955958	Group 2
C48	4,3737E-09	33,4695558	0,033113707	7,00513179	2,07427001	Group 2
C190	8,8668E-05	30,9604834	0,215176624	3,98948645	4,63754084	Group 2
C141	2,7234E-08	29,387799	0,02436798	5,36778607	6,12763108	Group 2
C87	2,5013E-05	28,1396849	0,378756152	3,65154592	3,60253415	Group 2
C138	1,2209E-08	28,0262434	0,003478317	3,93885304	4,64915333	Group 2
C57	2,5207E-05	27,1243744	1,340233113	3,71913953	1,75289336	Group 2
C165	0,00855851	25,8920566	19,3456522	28,7330962	4,76317001	Group 4
C70	0,34024557	25,6347999	0,953257535	17,6262188	4,04237724	Group 2
C41	0,00511156	21,8814088	15,15369651	38,8111157	2,64579075	Group 4
C101	0,00373223	21,3401339	1,477406017	9,47971886	1,44669855	Group 2
C134	0,00213131	17,7162959	1,828784002	27,4048758	1,8676546	Group 4
C129	6,57552719	15,6833998	0,094929039	19,1962541	13,1231929	Group 4
C143	3,1713E-05	15,5480835	0,955425349	12,0906586	3,46709126	Group 2
C97	0,014625	15,2263117	36,93896086	4,89918839	5,95447982	Group 3
C92	0,0001118	14,3145631	0,044040206	6,15220326	5,03396112	Group 2
C58	5,8098E-07	10,9430671	0,094116434	5,52931809	1,36482921	Group 2
C175	7,1252E-07	8,99037867	16,47742678	8,05453696	3,84591306	Group 3
C156	0,00115293	6,4628957	0,842188108	42,5143046	1,91080715	Group 4
C170	0,09999403	5,14519188	0,148838771	35,8214005	6,79084253	Group 4
C59	3,2097E-10	4,421352	1,413366163	1,76285225	2,59005282	Group 2
C171	15,2286664	3,38689576	0,286876491	10,5358763	21,6971634	Group 5
C162	0,04636197	1,03183217	0,086427924	34,9965679	2,31209738	Group 4
C46	0,119143	0,9570129	1,411903208	5,58627766	2,55284175	Group 4
B13	0,0340196	0,25382447	8,679340136	11,3686737	8,97943764	Group 4
B14	20,8249409	0,13677106	0,014224613	12,7365183	19,1350023	Group 1
C60	5,0768E-11	0,04455766	0,057687741	0,87034482	1,90966028	Group 5
C8	8,1447E-10	0,00422409	0,000123232	2,45967858	1,82987404	Group 4
C91	1,1223E-13	0,00198128	0,00860611	0,707984	1,50754655	Group 5

Membership probabilities(%) for samples in group: Group 3
Probabilities calculated after removing each sample from group.

SAMPLE	Group 1	Group 2	Group 3	Group 4	Group 5	Best Group
---------	---------	---------	---------	---------	---------	---------
C124	0,00024767	1,38511272	99,37829998	11,7646742	3,64938415	Group 3
C4	1,2111E-05	0,29681357	97,90678898	20,5173903	2,10683377	Group 3
C126	1,1002E-05	0,0203473	96,1637897	11,7683736	2,1691246	Group 3
C11	0,00010485	1,54224266	92,6176411	11,6441744	2,45362527	Group 3
C105	0,00162915	10,3216174	86,5279445	20,4592117	3,06794292	Group 3
C106	0,00107122	1,99896845	85,37082798	14,3238001	3,89808363	Group 3
C28	0,00027796	0,08633188	83,86151117	15,2258222	2,67248534	Group 3
C43	1,7661E-05	12,5318687	81,71673189	17,0555266	2,56807711	Group 3
C125	0,00011153	1,15748342	77,07960056	12,3618203	2,96480733	Group 3
C56	8,6979E-05	0,53211807	64,1227955	10,5895864	2,79562393	Group 3
C167	3,4365E-07	0,00028857	56,61019019	11,6615405	1,8368915	Group 3
C137	1,9854E-05	0,07341245	49,45601818	7,75625927	3,09943992	Group 3
C7	0,000231	0,07170788	47,50387971	18,5027193	2,18738741	Group 3
C123	3,4382E-05	0,08809489	42,15008111	7,00727903	2,8364341	Group 3
C86	2,8113E-05	0,08990593	40,72345575	6,71492159	3,69616285	Group 3
C178	3,206E-08	0,40162548	37,91260093	13,3542142	1,19349253	Group 3
C180	1,1081E-09	0,02382886	29,01064578	7,14127439	1,56781014	Group 3
C168	1,0078E-06	0,00591579	27,13300461	29,4862806	1,2324994	Group 4
C169	5,4237E-07	0,00077735	18,21647561	8,66985816	1,94603408	Group 3
C45	5,0673E-05	0,02543315	17,61522347	7,05143938	2,64321978	Group 3
C27	0,00042139	0,18878104	15,37593228	14,7268716	2,56075234	Group 3
C44	0,00029679	22,0240851	6,986743521	62,3187879	1,97605881	Group 4
C176	3,1265E-07	2,21163735	6,616270126	16,9930797	3,09722415	Group 4
C94	4,3487E-07	0,0432251	3,195963594	2,16353283	2,5606275	Group 3
C131	0,00485915	1,65990826	1,408629865	33,4482554	4,23315395	Group 4

Membership probabilities(%) for samples in group: Group 4
Probabilities calculated after removing each sample from group.

SAMPLE	Group 1	Group 2	Group 3	Group 4	Group 5	Best Group
---------	---------	---------	---------	---------	---------	---------
C214	1,1678E-08	7,2984E-11	0,000332051	92,1575043	0,32720193	Group 4
C187	2,8032E-05	1,4075E-06	0,107589204	88,9034822	1,43258171	Group 4
C213	1,0692E-07	1,2561E-10	0,000506253	76,0748287	0,43052316	Group 4
C215	3,501E-06	1,8079E-06	0,641264567	69,1484171	0,99036398	Group 4
C188	1,8994E-05	5,8443E-06	0,021379965	50,0602925	0,88784008	Group 4
C186	6,6251E-08	5,3281E-13	0,000107222	25,5285117	0,46721399	Group 4
C152	4,7799E-07	3,1707E-05	0,008791646	9,8042698	0,68519934	Group 4
C196	1,3048E-08	4,9484E-09	0,000364208	7,32611573	0,47893125	Group 4
C107	3,5371E-08	0,00090374	0,022683293	2,74648375	0,43760534	Group 4

Membership probabilities(%) for samples in group: Group 5
Probabilities calculated after removing each sample from group.

SAMPLE	Group 1	Group 2	Group 3	Group 4	Group 5	Best Group
---------	---------	---------	---------	---------	---------	---------
C112	13,9326278	1,5021E-06	0,00096521	13,5718938	99,8045499	Group 5
C120	46,4597077	5,8813E-07	0,000408337	10,3785179	73,2674952	Group 5
C17	12,6238922	3,5319E-05	0,009718984	7,01523214	68,6920869	Group 5
C122	9,65065931	2,2874E-08	8,63261E-05	11,7790665	64,1941108	Group 5
C36	5,62269618	2,5736E-05	4,70703E-05	9,06544516	61,3653577	Group 5
C181	0,00295189	7,7279E-08	0,026028839	8,6834109	31,9869165	Group 5
C55	19,4679379	0,00098321	0,004985302	14,4958515	28,0779024	Group 5
C31	11,1857125	8,5565E-07	9,18553E-05	14,9456048	18,287123	Group 5
C183	0,0077505	7,4452E-10	0,00012778	10,8614653	11,9261774	Group 5

C51	0,01704582	3,4829E-08	0,001163786	6,39716071	5,48228985	Group 4

Membership probabilities(%) for samples in group: Unassigned samples
Probabilities calculated after removing each sample from group.

SAMPLE	Group 1	Group 2	Group 3	Group 4	Group 5	Best Group
---------	---------	---------	---------	---------	---------	---------
B1	1,4493E-06	0,00015703	0,000133129	14,0201225	2,94249791	Group 4
B11	0,01030534	0,11057934	0,025272035	4,76259921	3,68061947	Group 4
B2	1,1945E-13	1,1427E-12	0,001294955	4,73568322	1,98259062	Group 4
B7	0,32088303	0,11538762	0,008558599	11,8988832	5,24733533	Group 4
C150	5,9396E-06	1,1229E-11	0,015695991	6,72193319	0,62584585	Group 4
C182	8,1357E-13	6,2124E-08	5,82554E-09	1,25057631	0,60122235	Group 4
C184	1,5291E-12	6,3867E-09	4,12412E-09	1,41446144	0,60529003	Group 4
C185	1,4317E-05	9,4763E-06	1,05871E-05	4,67209639	0,9232055	Group 4
C197	9,5121E-11	4,7156E-06	2,31214E-05	5,20345716	0,21460167	Group 4
C198	5,2464E-07	4,8395E-07	3,02702E-06	3,36019431	0,57572249	Group 4
C199	7,8925E-06	0,08763075	0,000338862	4,76357944	0,90290447	Group 4
C200	3,4572E-06	0,15002299	0,000310514	3,89401364	6,70716119	Group 5
C201	6,0944E-09	0,00032626	0,000288448	6,83691309	0,26122681	Group 4
C202	5,1604E-09	4,9793E-05	1,10135E-05	3,59048218	0,26525498	Group 4
C203	8,1519E-11	2,3617E-06	1,5425E-06	2,18503167	0,22679386	Group 4
C205	1,3902E-05	0,00653346	0,000344679	6,72197363	0,61345521	Group 4
C208	6,17000776	0,00594974	2,96468E-05	8,74630519	6,56868237	Group 4
C209	0,07657065	0,00736544	1,58208E-05	3,46323301	2,64092472	Group 4
C210	4,1564E-06	0,00028295	0,00073856	3,34086386	6,80329286	Group 5
C211	3,8999E-15	5,6571E-13	1,90364E-08	1,57720466	0,09245298	Group 4
C212	4,4814E-09	8,1396E-05	7,55184E-06	4,44612685	0,333515	Group 4
C38	0,00971477	0,01232263	0,009056945	6,28195859	3,92968718	Group 4
C69	1,1987E-05	1,8084E-11	2,12357E-05	1,4360726	0,27392173	Group 4
C95	2,2585E-07	2,8944E-12	0,000212097	0,49064937	0,36709488	Group 4

Table C.3. Group classification using Mahalanobis Distance (MD) and 10 elements.

Results are based on the following variables:
Sc Cr Fe Co Rb Ce Yb Lu Hf Th

Membership probabilities(%) for samples in group: GROUP A
Probabilities calculated after removing each sample from group.

SAMPLE	GROUP A	GROUP B	GROUP C	Best Group
---------	---------	---------	---------	---------
C32	99,9680385	0,03734838	0,47237107	GROUP A
C115	93,9631606	0,00884916	0,29494096	GROUP A
C111	93,8065877	0,88710877	0,5270133	GROUP A
C113	92,6386358	0,00586334	0,2871673	GROUP A
C118	91,9019459	0,53674132	0,44205514	GROUP A
C3	90,5450325	0,20357606	0,51148444	GROUP A
C2	88,9393943	0,06310869	0,43234329	GROUP A
C12	87,3167082	0,01771616	0,32402145	GROUP A
B4	84,344501	0,03682397	0,30705896	GROUP A
C154	83,2565374	0,01653348	0,26978769	GROUP A
C54	77,0791131	0,05973215	0,51218357	GROUP A
C53	68,0329721	0,22444078	0,68257119	GROUP A
C114	65,7324885	0,00066955	0,18415082	GROUP A
C119	61,5389715	6,5962E-05	0,20027406	GROUP A
C49	57,3255623	0,11820676	0,83100456	GROUP A
C55	56,5814173	0,16775811	0,84291846	GROUP A
C130	49,4110772	8,98997842	1,32123324	GROUP A
C146	37,5478551	0,00984984	0,79293374	GROUP A
C72	32,3087388	0,00092301	0,74352022	GROUP A
C71	23,1669244	2,425E-06	0,17575549	GROUP A
C31	22,1687465	0,0007106	0,31946222	GROUP A
C120	18,5262104	0,00398479	0,45008676	GROUP A
C76	15,4566622	0,00023883	0,40278857	GROUP A
C172	13,5286673	0,3053746	0,97989881	GROUP A
C29	12,7571705	0,00010413	0,14169038	GROUP A
C173	11,5537496	0,24300568	0,70079086	GROUP A
C181	3,19346013	0,00066328	0,42741093	GROUP A
C1	0,19887857	5,1724E-05	0,12650186	GROUP A
C75	0,00460513	0,00067756	0,22872995	GROUP C

Membership probabilities(%) for samples in group: GROUP B
Probabilities calculated after removing each sample from group.

SAMPLE	GROUP A	GROUP B	GROUP C	Best Group
---------	---------	---------	---------	---------
C117	0,02889271	99,7188173	2,26022931	GROUP B
C195	0,00697217	98,2709175	0,70145522	GROUP B
C10	0,00509068	96,7488527	0,82816756	GROUP B
C61	0,17401069	95,9354188	2,03978164	GROUP B
C64	0,00362871	95,9050345	1,74173134	GROUP B
C100	0,0171184	95,6544363	0,66795986	GROUP B
C90	0,02209597	91,0422986	1,25897633	GROUP B
C63	0,00745488	88,2500917	1,26872511	GROUP B
C62	0,02708065	87,3461223	3,0424899	GROUP B
C39	0,22566238	84,7554722	18,0945431	GROUP B
C139	0,02578179	84,085472	0,6992927	GROUP B
C179	0,00484931	84,0275974	0,73550909	GROUP B
C135	0,03544078	83,8307468	21,9341178	GROUP B
C16	0,03577307	82,5709763	0,94259018	GROUP B
C5	4,280688	81,5351546	8,53720076	GROUP B
C99	0,01305488	75,9483085	1,61426694	GROUP B

C96	1,52747491	67,1005695	19,6408248	GROUP B
C89	0,02549671	64,6013637	0,73790794	GROUP B
C207	0,00160876	61,1618832	0,32329575	GROUP B
C145	0,0430612	58,2788093	0,61409838	GROUP B
C9	0,00604191	55,0516187	1,97880611	GROUP B
C140	0,01853843	51,7998803	2,17845909	GROUP B
C161	10,8726764	46,9429872	5,11237012	GROUP B
C138	0,00029182	46,8045088	0,09198219	GROUP B
C15	6,36700753	45,5532877	5,3710002	GROUP B
C144	0,00024393	44,4104508	0,17872537	GROUP B
C44	0,1605261	43,9430622	41,8526879	GROUP B
C41	0,35895339	42,9272766	15,0926665	GROUP B
C136	3,06228055	40,3222696	17,426822	GROUP B
C143	0,01184663	36,8647774	1,60108118	GROUP B
C43	0,13944179	36,0538857	4,1075988	GROUP B
C42	0,38955785	32,1896882	14,0301163	GROUP B
C129	16,4831001	32,1240853	2,17469192	GROUP B
C50	0,05427552	30,1369784	1,05955359	GROUP B
C149	0,01116958	27,683312	1,82821808	GROUP B
C163	0,82530701	26,9660446	20,0587009	GROUP B
C92	0,02315059	18,8988302	0,44880292	GROUP B
C133	0,50538788	15,4311324	11,0457101	GROUP B
C134	0,00248343	8,37232114	7,16582392	GROUP B
C59	0,00011853	7,75712188	1,23987375	GROUP B
C170	0,02505842	5,22638486	7,27874461	GROUP C
C171	57,2667545	1,91378249	1,7481228	GROUP A
C46	2,76456519	1,19400005	29,3669605	GROUP C
C162	0,00023888	0,10811495	2,64180679	GROUP C
C60	4,355E-05	0,06765926	0,94278266	GROUP C

Membership probabilities(%) for samples in group: GROUP C
Probabilities calculated after removing each sample from group.

SAMPLE	GROUP A	GROUP B	GROUP C	Best Group
---------	---------	---------	---------	---------
C11	0,00118573	1,26155911	90,0786284	GROUP C
C137	0,00050887	0,45310524	87,8337882	GROUP C
C4	0,00166901	3,98891741	84,0960592	GROUP C
C125	0,00352105	3,80458101	82,1661081	GROUP C
C105	0,02021138	26,3626684	81,5356032	GROUP C
C126	0,00015317	0,20554795	76,2615999	GROUP C
C56	0,00122195	0,6226459	53,4215092	GROUP C
C169	0,00018074	0,37750133	46,0954936	GROUP C
C124	0,00014157	0,17913921	46,0928494	GROUP C
C168	0,00020015	1,31504906	45,7935112	GROUP C
C106	0,01787558	11,1985749	31,4614355	GROUP C
C123	0,00017698	0,04634107	20,5523498	GROUP C
C7	0,00037228	0,53076058	9,4289688	GROUP C
C94	1,6758E-05	0,02103749	8,68522809	GROUP C
C152	0,00029628	1,9617E-05	1,89417286	GROUP C

APPENDIX D. FULL PETROGRAPHIC CHARACTERISATIONS OF CERAMIC FABRICS

The full petrographic characterisations of the seven fabric classes identified were assembled following the guideline published by Quinn (2013) based on Whitbread (1995). The descriptions include internal variations within classes, and in one case two formal sub-classes. The type of manufacturing and the firing technology inferred by thin-section evidence are both noted in the Comments on Pottery Technology section at the end of each class characterisation. Roundness, sphericity, sorting, abundance, and porosity image references and abbreviations can be found in Section D.1 of this Appendix. Summarised descriptions, technology discussions and more photomicrographs can be found in Chapter VI.

1. Residual Volcanic Rocks Fabric Class (Figures D.1-D.4). Samples 001, 003, 004, 017, 031, 051, 052, 055, 072, 076, 084, 110, 119; n = 13.

<u>Inclusions</u>

10-30% (Figure D.10). equant (eq) & elongate (el) (Table D.1). va-wr (Table D.1; Figure D.11). < 3.04mm. Open to less than single-spaced (Table D.1). Sometimes weakly aligned with vessel margins. There is no dominant mode or grain size distribution. Poorly-sorted (Figure D.12).

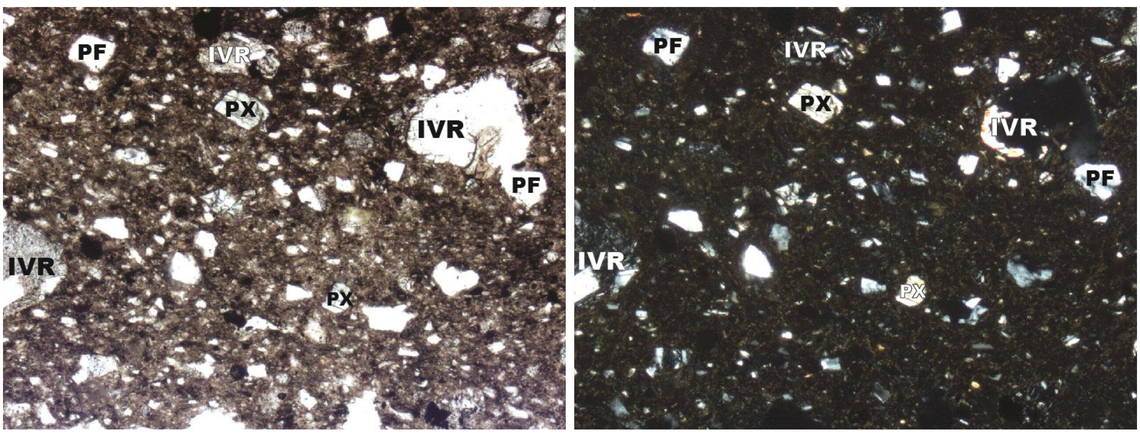

Figure D.1. Photomicrographs of sample 076 of the Residual Volcanic Rocks Fabric Class, taken in plane-polarized light (PPL; left) and with crossed-polars (XP; right). Key: IVR, intermediate volcanic rock; PF, plagioclase feldspar; PX, pyroxene.
Single image width = 2.3mm.

Frequent (Table D.1): *Fine-grained volcanic rock fragments*; el & eq. a-r. < 3.04mm, mode = 0.5mm. A range of fine-grained porphyritic volcanic rocks dominated by micro-phenocrysts of plagioclase feldspars, pyroxenes, amphiboles, opaque minerals and/or olivine. Commonly the groundmass is composed of feldspar laths in trachytic texture. Some are glassy. Some have carbonate mud filling voids. Some are chemically altered. Intermediate to basic composition (andesite, basaltic andesite, basalt).

Common: *Plagioclase feldspars*; el & eq. va-sr. < 0.72mm, mode = 0.07mm. Anhedral to euhedral. Often tubular. Most are polysynthetically twinned. Can be oscillatory-zoned. Volcanic origin.

Few: *Clinopyroxenes*; eq & el. a-sr. < 1mm, mode = 0.2mm. Augite. Anhedral to euhedral. Can be twinned.

Orthopyroxenes; eq & el. a-r. < 0.76mm, mode = 0.15mm. Anhedral to euhedral.

Quartz; eq & el. a-sr. < 1.1mm, mode = 0.06mm. Can have either straight or undulose extinction.

Few-Absent: *Argillaceous rock fragments*; el. r. < 1.06mm, mode = 0.5mm. Deep brown.

Clay pellets; eq & el. sr-wr. < 1.32mm, mode = 0.7mm. Light to deep brown. High to low optical density. Sharp to merging boundaries. Can be either concordant or discordant. Composed of fine brown clay with few opaques, quartz, plagioclase feldspars and smaller unidentified minerals.

Very Few: *Opaque minerals*; eq & el. sa-r. < 0.7mm, mode = 0.05mm.

Very Few-Rare: *Amphiboles*; el & eq. a-sr. < 0.78mm, mode = 0.07mm. Sometimes altered to biotite.

Rare-Very Rare: *Olivine*; el & eq. sa-sr. < 0.55mm, mode = 0.12mm. Can be partially altered.

Biotite; el. a-sr. < 0.47mm, mode = 0.08mm. Sometimes as alteration of amphiboles.

Rare-Absent: *Epidote*; el & eq. sa-sr. < 0.44mm, mode = 0.2mm.

Very Rare-Absent: *Peloids*; eq & el. sr-wr. < 0.65mm, mode = 0.35mm. Most are pellets composed of micritic calcite or carbonate mud.

Ultrabasic igneous rock fragments; el & eq. sa-sr. < 0.8mm, mode = 0.6mm. Found only in samples 072 and 110.

<u>Matrix</u>

68-85%. Moderately calcareous, based on the amount of carbonate matter in the matrix. Greenish brown to deep brown in PPL (Figure D.1, left), yellowish brown to blackish brown in XP (Figure D.1, right); x50. Moderately heterogeneous in terms of colour due to firing colour differentiation either between core and margins or inner and outer halves. Can be optically inactive, moderately active (e.g. 051, 076), or fully active (e.g. 003, 017) (Figure D.2).

<u>Voids</u>

2-5%. Include Macro- and Meso-vughs and Macro- and Meso-planar voids; also a few Meso-vesicles voids (Table D.2; Figure D.13). Planar and channel voids show either clear or moderate alignment to margins of samples (Figure D.3): these may have been formed by the shrinkage of the clay as it dried out, and their alignment to the margins might indicate the application of pressure to the clay during forming (Quinn 2013:61-68). Some Meso-vughs have blackened margins, left out by burned plant matter after firing. Note: voids on sample 017 are large and represent around 25% of the total area; some of them may have resulted from a poor thin-section preparation, however hand specimen showed both a high degree of porosity and fragility related to a low firing temperature (see Internal Variation); they could also represent the addition of organic material as temper (Maggetti 1982:130).

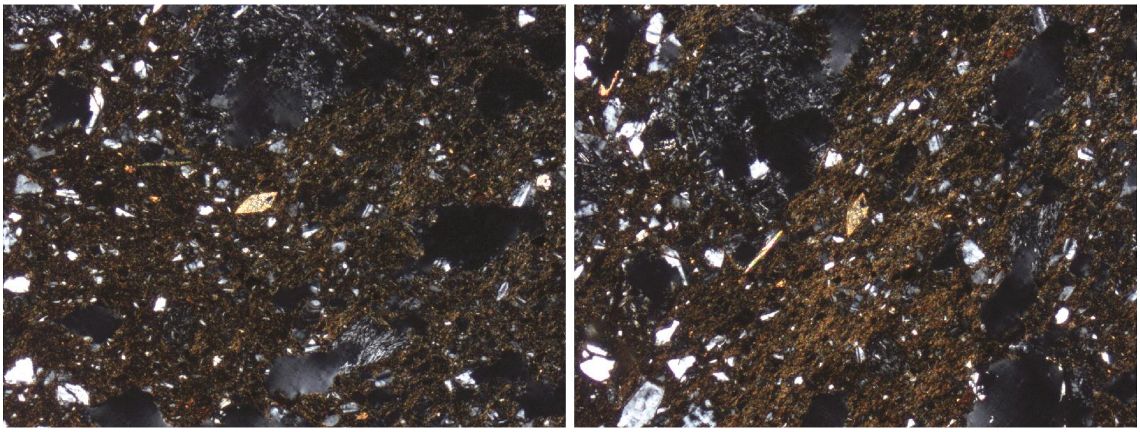
Figure D.2. Photomicrographs of sample 003 taken with XP, depicting an optically active matrix when rotated 45 degrees under the microscope. Single image width = 2.3mm.

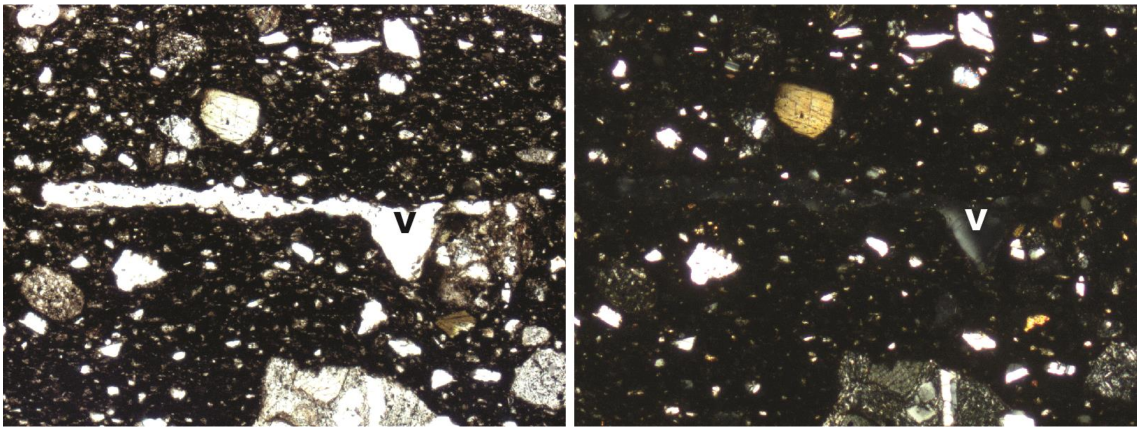

Figure D.3. Photomicrographs of sample 055 taken with PPL (left) and XP (right). Image depicts the left-right preferred orientation of a large void, aligned with vessel margins. Key: V, void. Single image width = 2.3mm.

<u>Internal Variation</u>

There are some compositional and textural variations within the fabric class. They may just indicate variations in the clay deposit, but the analysis of a larger sample-set may lead to a subdivision of the class into sub-classes based on these. The most notable variations are:

Sample 017 – Extremely porous: up to 25% of total area are voids (see Voids), although this may only indicate a lower fire temperature or the addition of organic material as temper (Maggetti 1982:130). At the same time also has a more packed texture than the average sample, and its inclusions are more angular.

Samples 031, 055 – Have more space between inclusions than the rest, i.e. they are less packed. Non-plastics are dominated in frequency by very fine inclusions; in this way, those inclusions larger than 0.2mm are scarcer when compared to other samples (Figure D.4, top).

Sample 051 – Has open spacing likes samples 031 and 055, but features some of the coarsest mineral grains.

Samples 084, 110 – Contain epidote; also have closer spacing due to higher proportion of non-plastic inclusions in relation to matrix and voids than the average sample (Figure D.4, bottom).

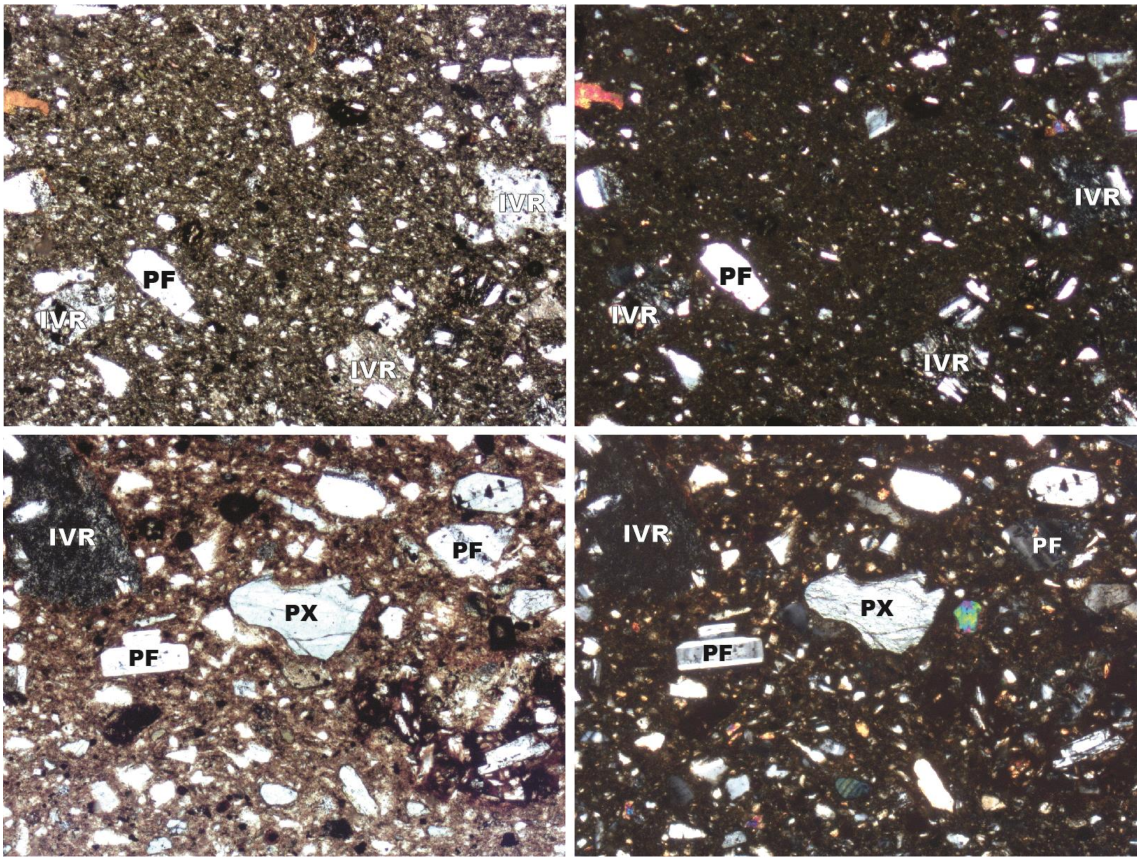

Figure D.4. Photomicrographs of two samples of the Residual Volcanic Rocks Fabric Class, depicting internal variation within the fabric class. Taken with PPL (left) and XP (right). Sample 031 (top) shows a more open spacing, while sample 110 (bottom) has a more packed texture and a slightly different composition. Key: IVR, intermediate volcanic rock; PF, plagioclase feldspar; PX, pyroxene. Single image width = 2.3mm.

Other comments on pottery technology

There is no conclusive evidence of significant alteration of the clay for pottery production (but see Internal Variation). Evidence of forming techniques seen in thin section includes the preferred alignment of planar voids and minerals, sometimes parallel to the vessel margins (Figure D.3), which indicates the application of pressure to the clay during forming, in conjunction with an uneven drying in the case of voids (Quinn 2013:61-68,156). A microscopic evidence of primary forming techniques is that of relic coils related to coil building (Quinn 2013:177-179), all of them located on the borders/lips of bowls. Surface finishing treatments seen in thin section include burnished surfaces (003, 004, 052), the application of iron-rich painted decoration (004, 052), and iron-rich (084, 110) and iron-poor slips (051). Concerning firing, not all the samples show evidence of firing in the same type of atmosphere. Fabrics deep brown in colour or with a non-oxidised core might be carbonaceous (rich in organic matter), and the former may also reflect their exposure to a partially non-oxidising atmosphere within the firing structure, which is common in open firings (Rice 1987:431; Tite 2008:220). Furthermore, several samples were fired at a temperature that did not vitrify the clay, with the clay matrix fully or partially retaining its birefringence property (Rice 1987:431).

2. Volcanic Rocks-tempered Fabric Class (Figures C.5-C.9). Samples 015, 019, 022, 028, 040, 043, 056, 059, 065, 069, 088, 091, 094, 095, 104, 108, 116, 117, 123, 125, 133, 138, 142, 143, 156, 159, 161, 162, 168, 173, 194, 195, 200, 208; n = 34.

2A. Medium-sorted Temper Fabric Sub-Class (Figures C.5 and C.6). Samples 015, 019, 040, 059, 065, 069, 088, 091, 095, 104, 108, 116, 117, 133, 138, 142, 143, 156, 159, 161, 173, 194, 195, 208; n = 24.

Inclusions

30-40% (Figure D.10). eq & el (Table D.1). va-wr (Table D.1; Figure D.11). < 2.28mm. Double to less than single-spaced (Table D.10). Sometimes aligned with vessel margins. Moderately bimodal grain size distribution; coarse fraction dominated by temper. Moderately-sorted (Figure D.12).

Coarse fraction

15-60%. 2.28-0.28mm

Predominant-Dominant

(Table D.1): *Fine-grained volcanic rock fragments*; eq & el. sa-r. < 2.28mm, mode = 0.4mm. Included here are rock fragments added as temper and those naturally occurring as part of the sediment. Basic to intermediate composition, commonly with feldspar laths in trachytic texture as groundmass, and micro-phenocrysts of plagioclase, pyroxene, olivine, amphiboles and/or biotite. Some are glassy. Some samples have voids filled with precipitated sparry calcite (e.g. 159). Several chemically altered. Andesite?

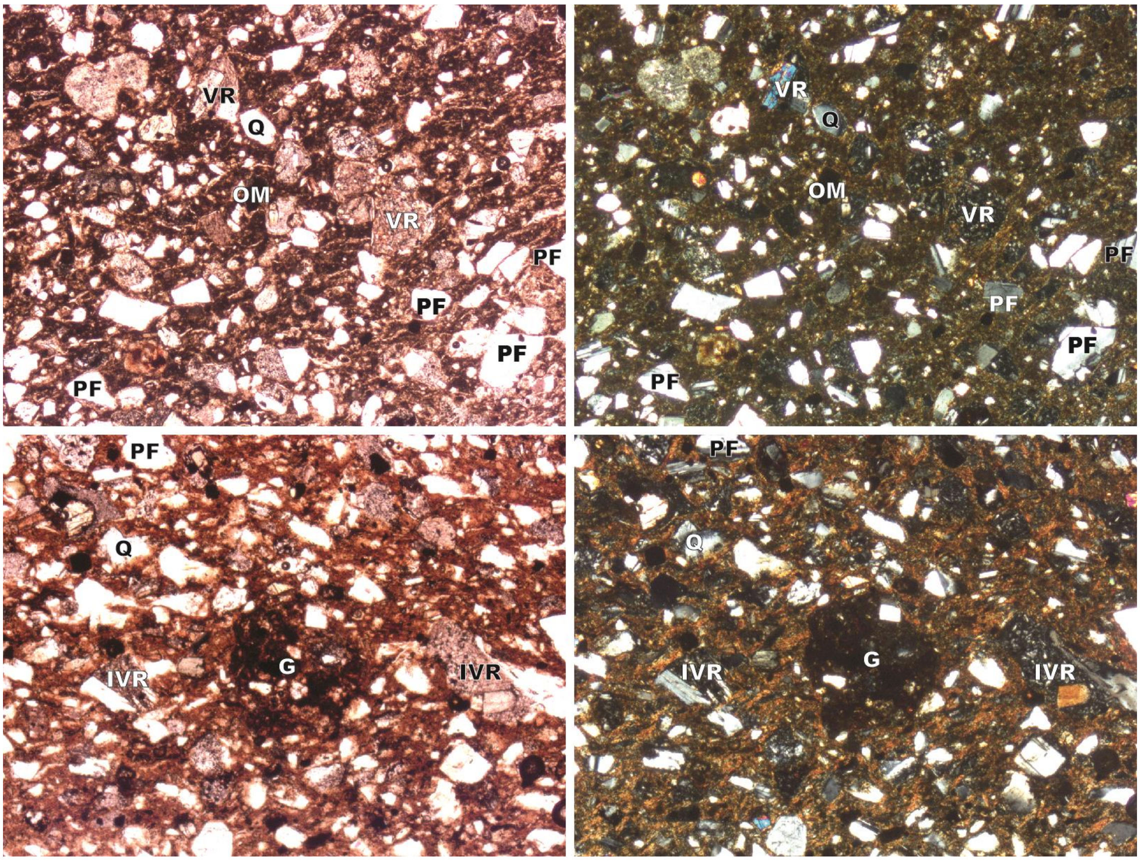

Figure D.5. Photomicrographs of samples 095 (top) and 156 (bottom) of the Volcanic Rocks-tempered Fabric Class, Medium-sorted Temper Sub-class, taken with PPL (left) and XP (right). Both samples show preferred orientation of voids and inclusions. Key: G, grog; IVR, intermediate volcanic rock; OM, opaque mineral; PF, plagioclase feldspar; Q, quartz; VR, volcanic rock. Single image width = 2.3mm.

Common-Absent: *Grog*; el & eq. sa. < 2.2mm, mode = 0.6mm. Two types:
1. Brown. Containing quartz, plagioclase feldspar, pyroxenes, opaques, amphiboles and volcanic rocks fragments. Optically very active, with a striated fabric that highlights internal microstructure. Exhibits relic vessel surface. As is the case with the fabric proper, some minerals appear badly eroded, rounded and altered, and some do not. Found only in sample 138.
2. Yellow-brown. Containing quartz, textural features (TFs), rock fragments and opaques. Optically active. Found only in sample 156.

Few: *Plagioclase feldspars*; eq & el. va-sr. < 0.88mm, mode = 0.35mm. Often heavily altered. Can be heavily eroded. Some part of the secondary sediment, some added as temper.

Argillaceous rock fragments; el. r. < 1.22mm, mode = 1mm. Deep brown. Display internal orientation. Optically inactive. Weathered shale?

Very Few-Rare: *Quartz*; eq & el. va-sa. < 0.62mm, mode = 0.3mm.

Clay pellets; eq & el. wr. < 0.9mm, mode = 0.5mm. Discordant. Neutral to Low optical density. Clear to Merging boundaries (Figure D.14).

Clinopyroxenes; el. a-sr. < 0.56mm, mode = 0.35mm.

Very Few-Absent: *Coarse-grained igneous rock fragments*; eq. sa. < 1.1mm, mode = 1.1mm. Intermediate to acidic composition. Found only in sample 088.

Sandstones; eq & el. sa-sr. < 1.08mm, mode = 0.3mm. Some have a low percentage of clay matrix, while others have a high percentage (above 30%) of carbonate mud between quartz (undulose extinction) and feldspar grains. A few are micaceous, and a few more display sedimentary bedding structure. They are likely to come from the same secondary sediment as the rest of the sedimentary rock fragments and the metamorphic rock fragments.

Rare:

Opaque minerals; eq & el. sa-r. < 0.9mm, mode = 0.3mm.

Orthopyroxenes; eq & el. va-sr. < 0.46mm, mode = 0.3mm.

Biotite; el. a. < 0.51mm, mode = 0.35mm.

Rare-Absent:

Amphiboles; eq & el. sa-sr. < 0.42mm, mode = 0.3mm.

Siltstones; eq & el. sr. < 0.87mm, mode = 0.5mm. They are likely to come from the same secondary sediment as the rest of the sedimentary rock fragments and the metamorphic rock fragments.

Peloids; el & eq. wr. < 0.3mm, mode = 0.3mm. Pellets composed of micritic calcite or carbonate mud. They are likely to come from the same secondary sediment as the rest of the sedimentary rock fragments and the metamorphic rock fragments.

Ultrabasic igneous rock fragments; el & eq. sa-sr. < 1.34mm, mode = 0.4mm. Ultra-basic composition (peridotite?), inter-granular or ophitic texture. Found only in sample 091.

Granitic rock fragments; el & eq. sa-sr. < 1.72mm, mode = 0.8mm. Found only in sample 173.

Very Rare-Absent:

Chert; eq. wr. < 0.3mm, mode = 0.3mm.

Polycrystalline quartz; el. a. < 0.5mm, mode = 0.3mm.

Metamorphic rock fragments; eq & el. r. < 0.72mm, mode = 0.5mm. Derives of schist or gneiss. Low to medium grade.

White mica; el. a. < 0.5mm, mode = 0.5mm.

Fine fraction
40-85%. 0.28-0.01mm

Frequent:	*Fine-grained volcanic rock fragments*
Common:	*Plagioclase feldspars*
Few:	*Siltstones*
	Quartz
	Alkali feldspars
	Opaque minerals
	Amphiboles
Few-Very Few:	*Biotite*
Very Few:	*Clinopyroxenes*
	Sandstones
Very Few-Absent:	*Peloids*
Rare:	*Orthopyroxenes*
Rare-Absent:	*White mica*
	Polycrystalline quartz
	Metamorphic rock fragments
	Chert

<u>Matrix</u>
50-67%. Calcareous to highly calcareous. Reddish brown to deep brown in PPL, yellowish brown to greyish brown in XP (x50). Homogenous to highly heterogenous in terms of composition, colour and texture; heterogeneity related to core/margin or inner/outer halves firing colour differentiation (e.g. samples 040, 065, 104, 108, 133, 159). Optically inactive (e.g. samples 091, 117, 177),

to moderately active (e.g. samples 015, 116, 159, 161, 194), to very active (e.g. sample 156). A striated b-fabric can be seen in some samples.

Voids

3-10%. Include Meso-, Macro- and Mega-vughs, and Meso-planar voids (Table D.2; Figure D.13); also a few Macro-channels with blackened margins (040), left by the destruction of plant matter during firing (Quinn 2013:97). Most planar voids exhibit preferred alignment, indicating the application of physical force during forming. Others can be defined as ring voids: these were formed around the inclusions due to the shrinkage of the clay matrix during firing (Quinn 2013:61). There are also cracks formed probably during the firing of the clay (095). Voids were also left by carbonate inclusions destroyed either during firing, use, burial or cleaning of the vessel/sherd; one Mega-vugh (> 2mm) in sample 091 is one of such cases. Secondary calcite was precipitated into some voids: samples 095 and 159 are notable examples of this. Voids resulting from a poor thin-section preparation were not taken into account (069).

Internal Variation

The percentage of weathered inclusions is highly variable within the sub-class; therefore, besides the outstanding case of sample 208, this type of variation will not be disclosed below. The analysis of a larger sample-set may lead to further division into sub-classes based on the following variations:

Sample 088 – Contains coarse-grained igneous rock fragments and the highest amount of argillaceous rock fragments.

Sample 091 – Contains ultrabasic rock (peridotite?) fragments and precipitated carbonate mud inside rocks' fracture voids.

Sample 159 – Has abundant secondary calcite.

Sample 173 – Has a higher proportion of clinopyroxenes and contains granitc rocks.

Sample 208 – Contains the largest section of weathered minerals and rocks, which are also the most weathered and altered of the whole set.

Other comments on pottery technology

There is evidence for the use of tempering materials. Crushed volcanic rocks appear in every sample and as such it is the one tempering material that defines the fabric class; nevertheless, there is also evidence in samples 138 and 156 for added grog. Rock temper was added after sieving; tempering was probably required by the use of very plastic secondary clay. Low firing temperatures (i.e. below the vitrification point of the clay) are suggested by the optical activity of the clay matrixes. Surface finishing treatments seen in thin section include the application of iron-rich painted decoration (040), iron-rich slips (088, 142), a calcareous slip to provide a pale background for decoration (Figure D.6, bottom), and burnished surfaces (095, 161).

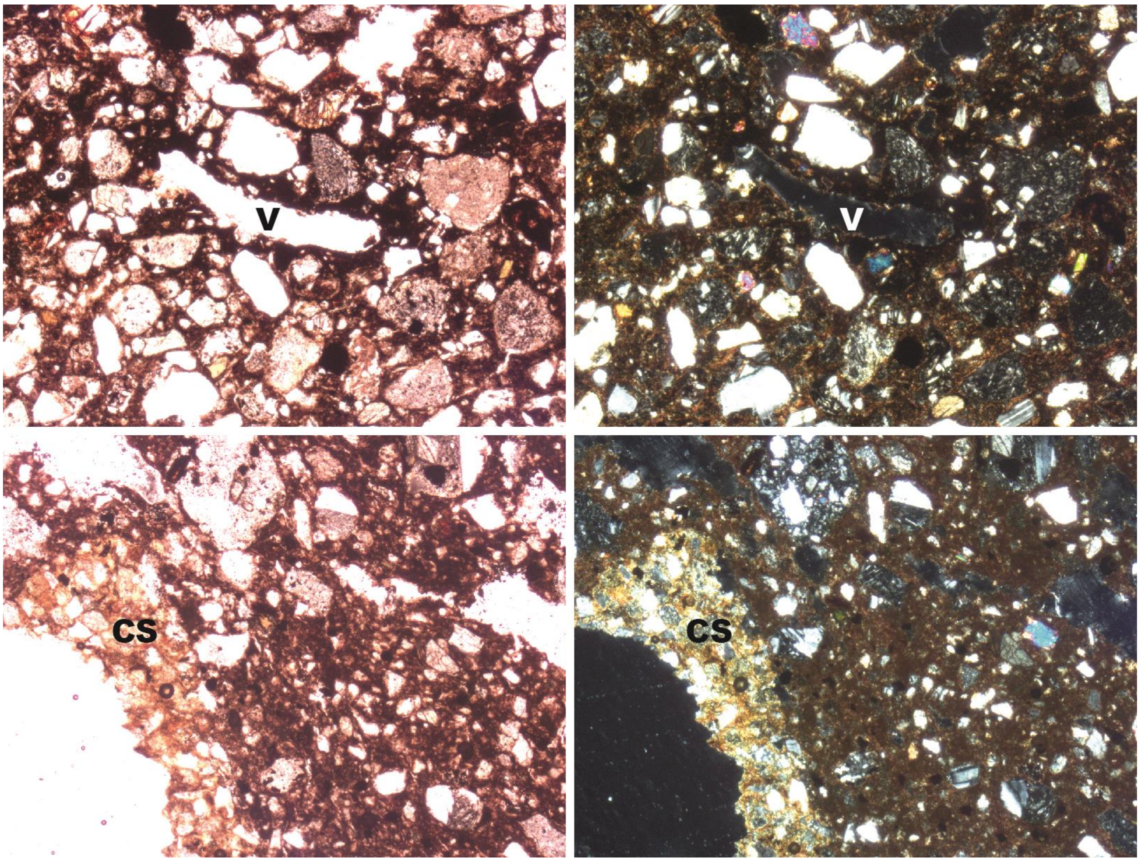

Figure D.6. Compositional and technological features seen on two samples of the Volcanic Rocks-tempered Fabric Class, Medium-sorted Temper Sub-Class. Photomicrographs were taken in PPL (left) and XP (right). Images on top (040) show a void with black margins, left out by burned plant matter. Bottom images show a calcareous slip on the outside wall of sample 116. Key: CS, calcareous slip; V, void. Single image width = 2.3mm.

2B. Fine-sorted Temper Fabric Sub-Class (Figures D.7-D.9). Samples 022, 028, 043, 056, 094, 123, 125, 162, 168, 200; n = 10.

<u>Inclusions</u>

20-35% (Figure D.10). eq & el (Table D.1). va-wr (Table D.1; Figure D.11). < 2.12mm. Double to less than single-spaced (Table D.1). Sometimes aligned with vessel margins. Moderately bimodal grain size distribution; coarse fraction dominated by naturally occurring inclusions. Moderately-sorted (Figure D.12).

Coarse fraction

10-20%. 2.12-0.2mm

Dominant-Few (Table D.1):	*Clay pellets*; eq & el. sr-r. < 2.12mm, mode = 0.4mm. Discordant; high optical density (Figure D.14). Can be optically active.
Frequent-Absent:	*Argillaceous rock fragments*; eq & el. sa-sr. < 1.52mm, mode = 0.3mm. Sharp boundaries; conchoidal fractures; discordant; High or Neutral optical density (Figure D.14). Containing opaques and quartz. Can show preferred orientation. Shale?
Common-Very Few:	*Plagioclase feldspars*; el. sa-sr. < 0.42mm, mode = 0.2mm. Can look either fresh or eroded.
Common-Rare:	*Fine-grained volcanic rock fragments*; eq & el. sa-r. < 1.32mm, mode = 0.4mm. Included here are rocks added as temper and those naturally occurring as part of the sediment. Basic to intermediate composition, most seem to be andesite.
Few-Rare:	*Sandstones*; eq & el. sa-sr. < 1.7mm, mode = 0.5mm. They are likely to come from the same mixed secondary sediment as the siltstones, carbonate rocks and metamorphic rock fragments.

Quartz; eq. sa. < 0.4mm, mode = 0.2mm. Straight or undulose extinction.

Opaque minerals; eq & el. sa-r. < 0.78mm, mode = 0.3mm.

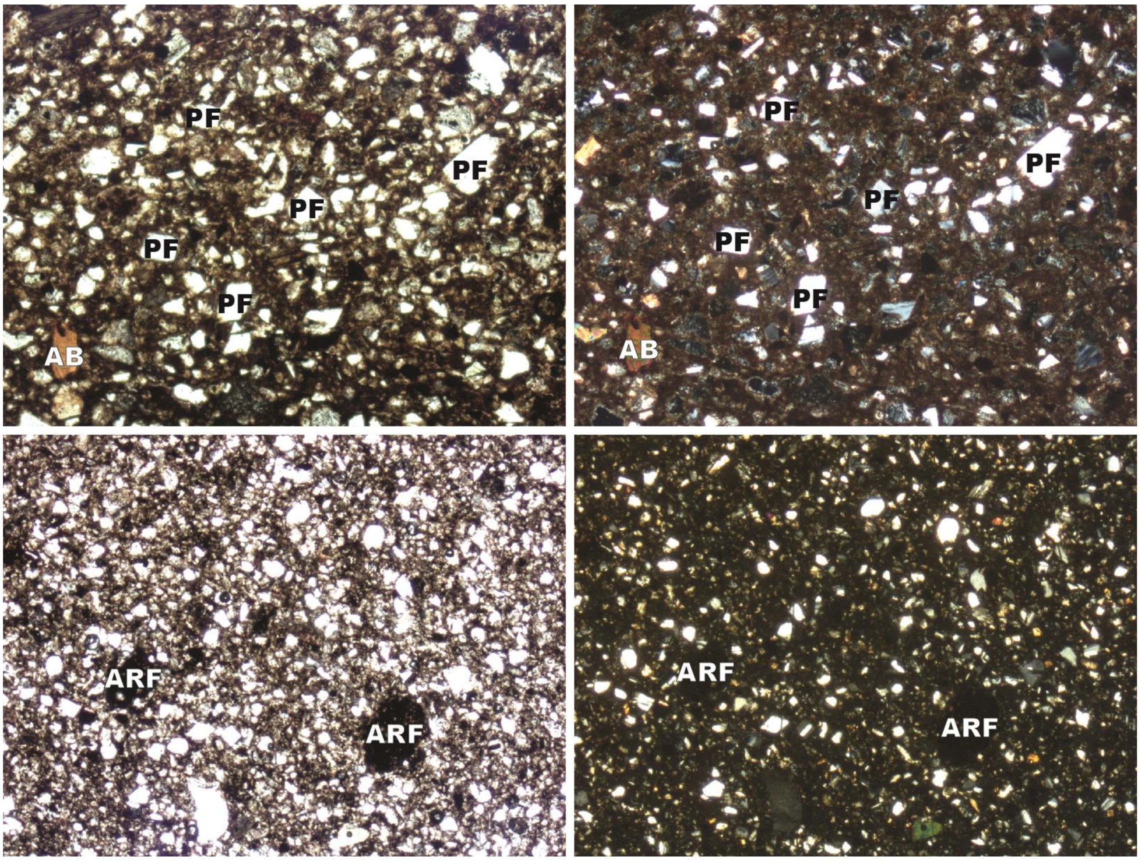

Figure D.7. Photomicrographs of samples 043 (top) and 123 (bottom) of the Volcanic Rocks-tempered Fabric Class, Fine-sorted Temper Sub-Class, taken with PPL (left) and XP (right). Sorting apparent in sample 043 is borderline in relation to the Medium-sorted Temper Sub-Class; compare with Figure D.5. Key: ARF, argillaceous rock fragments; PF, plagioclase feldspar. Single image width = 2.3mm.

Few-Absent: *Chert*; eq. sr. < 0.64mm, mode = 0.45mm. Some with chalcedonic quartz. They are likely to come from the same mixed secondary sediment as the carbonate rocks and the rest of the sedimentary rocks.

Peloids; el & eq. sr-r. < 1.3mm, mode = 0.3mm. Most are pellets composed of micritic calcite or carbonate mud, retaining their form. They are likely to come from the same mixed secondary sediment as the rest of the sedimentary rocks and the metamorphic rock fragments.

Very Few-Absent: *Siltstones*; el. sa. < 0.42mm, mode = 0.4mm. They are likely to come from the same mixed secondary sediment as the rest of the sedimentary rocks and the metamorphic rock fragments.

Clinopyroxenes; el. sa. < 0.55mm, mode = 0.55mm.

Rare-Absent: *Metamorphic rock fragments*; el. sr. < 0.92mm, mode = 0.45mm. Low to medium grade. Schistose. They are likely to come from the same mixed secondary sediment as the sedimentary rocks.

Amphiboles; el. sa. < 0.21mm, mode = 0.21mm.

Very Rare-Absent: *Coarse-grained volcanic rock fragments*; eq. sr. < 0.5mm, mode = 0.5mm. Eroded and altered, probably part of the secondary sediment (i.e. not added as temper).

Fine fraction
80-90%. 0.2-0.01mm

Frequent:	*Plagioclase feldspars*
Common:	*Quartz*
Few:	*Fine-grained volcanic rock fragments*
Very Few:	*Siltstone*
	Sandstone
	Opaque minerals
Rare:	*Clinopyroxenes*
Very Rare:	*Orthopyroxenes*
	Amphiboles
	Peloids
	Biotite

Matrix

60-70%. Calcareous to highly calcareous (e.g. 043). Greenish brown to reddish brown in PPL, yellowish/reddish brown to deep brown in XP (x50). Homogenous. Moderately active.

Voids

5-10%. Consisting mainly of Meso- and Macro-vughs (Table D.2; Figure D.13). In samples 043 and 200 planar voids exhibit preferred alignment parallel to the vessel walls (Figure D.8); elongated parallel voids can result from the application of pressure to the walls during forming. Also present are a few Macro-channels with blackened margins (Figure D.9, top), left by the burning of plant matter, and ring voids formed around the inclusions due to the shrinkage of the clay matrix during firing (Quinn 2013:61,97). Secondary calcite was precipitated into some voids (e.g. 043). Voids resulting from a poor thin-section preparation were not taken into account.

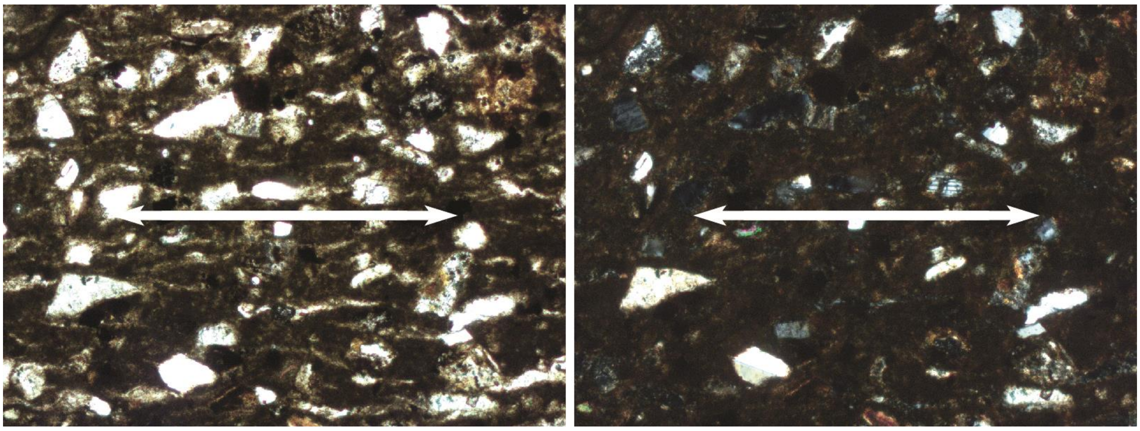

Figure D.8. Preferred alignment of voids as seen on sample 200, Volcanic Rocks-tempered Fabric Class, Fine-sorted Temper Sub-class. The white arrow highlights moderate left-right preferred orientation of inclusions and voids. Photomicrographs taken in PPL (left) and XP (right). Single image width = 1.1mm.

Other comments on pottery technology

There is evidence for the addition of well-sorted finely crushed volcanic rocks to the paste, in order to produce a tempered fabric suitable for complex engraved and incised decoration. All the clay matrices partially or fully retain their birefringence property, indicating lack of vitrification (Rice 1987:431). Surface finishing treatments identified in thin section include incised and engraved decoration and the application of iron-rich slips on top of the incised surfaces (Figure D.9, bottom; see Rice 1987:146).

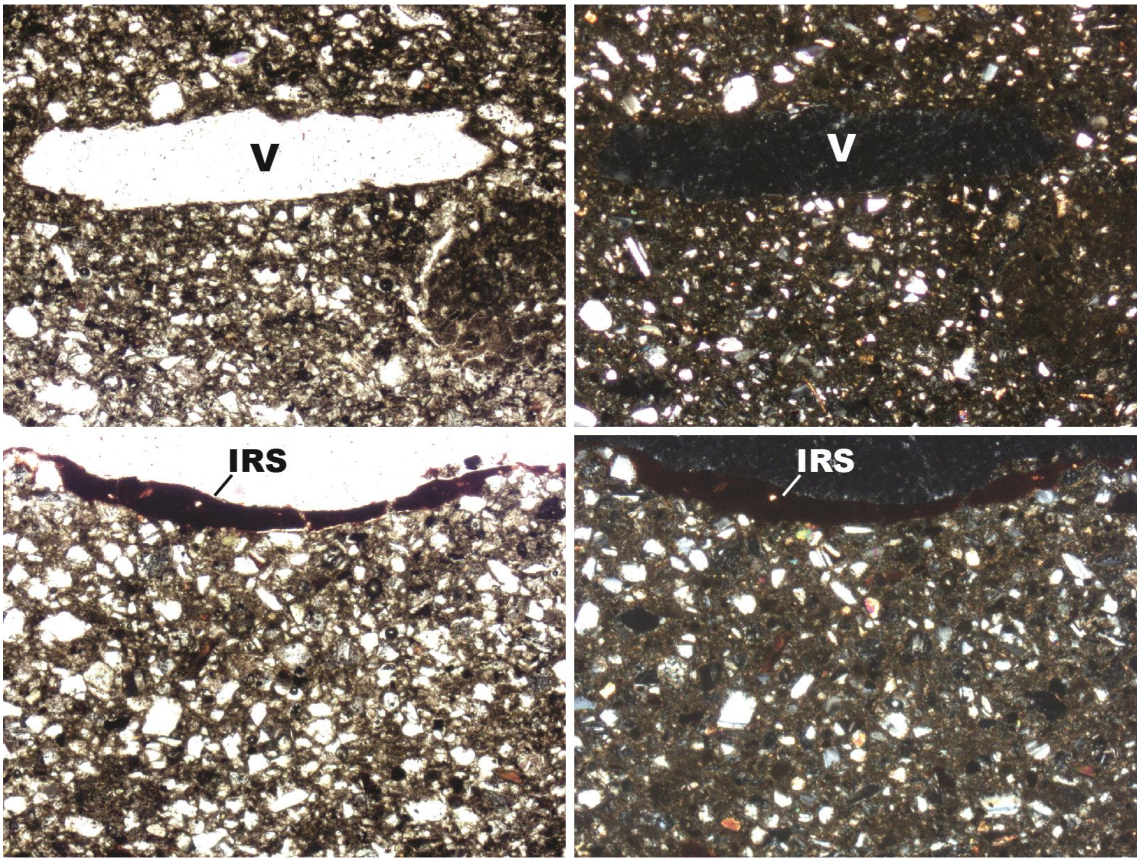

Figure D.9. Photomicrographs of two samples of the Volcanic Rocks-tempered Fabric Class, Fine-sorted Temper Sub-class, taken in PPL (left) and XP (right). Images on top (028) show a void with black margins, left out by burned plant matter; bottom images show an iron-rich slip applied on the incised outer wall of sample 094. . Key: IRS, iron-rich slip; V, void. Single image width = 2.3mm.

3. Volcanic Rocks-tempered with Peloids Fabric Class. Samples 177, 178; n = 2.

<u>Inclusions</u>

25% (Figure D.10). el & eq (Table D.1). va-r (Table D.1; Figure D.11). < 1.22mm. Open to single-spaced (Table D.1). Moderately aligned with vessel margins. Moderately bimodal grain size distribution. Moderately-sorted (Figure D.12).

Coarse fraction

75%. 1.22-0.3mm

Dominant/Frequent

(Table D.1): *Fine-grained volcanic rock fragments*; el. a-sr. < 1.18mm, mode = 0.5mm. Basic to intermediate composition (andesite?), commonly with feldspar laths in trachytic texture as groundmass, and micro-phenocrysts of plagioclase, biotite, olivine, amphiboles and/or clinopyroxene.

Common: *Plagioclase feldspars*; el & eq. a-sr. < 0.46mm, mode = 0.3mm.

Few: *Peloids*; el. r. < 1.22mm, mode = 0.6mm. Most are pellets composed of micritic calcite or carbonate mud. Bioclasts shapes are still discernable in some non-pellet grains.

Few-Very Few: *Clay pellets*; eq & el. sr-r. < 2.12mm, mode = 0.4mm. Discordant; High optical density (Figure D.14). Can be optically active.

Very Few: *Quartz*; eq & el. sa. < 0.35mm, mode = 0.3mm.

Clinopyroxenes; el. sa-sr. < 0.41mm, mode = 0.3mm.

Biotite; el. a. < 0.52mm, mode = 0.5mm.

Rare-Absent: *Epidote*; el. sa. < 0.32mm, mode = 0.32mm.

Amphiboles; el. sa. < 0.39mm, mode = 0.39mm.

Fine fraction

25%. 0.3-0.01mm

Frequent-Common: *Plagioclase feldspars*

Common: *Peloids*

Common-Few: *Fine-grained volcanic rocks*

	Quartz
Very Few:	*Opaque minerals*
	Clinopyroxenes
Rare:	*Orthopyroxenes*
	Biotite
	Amphiboles
Rare-Absent:	*Epidote*

<u>Matrix</u>

67%. Highly calcareous. Brown in PPL, deep brown in XP, x50. Optically inactive.

<u>Voids</u>

8%. Meso-vughs (Table D.2; Figure D.13). Sparry calcite can be seen in every single void as a fringe or completely filling it.

<u>Other comments on pottery technology</u>

There is evidence of crushed volcanic rocks intentionally added after sieving.

4. Volcanic Rocks-tempered with Sparry Calcite Fabric Class. Sample 181; n = 1.

<u>Inclusions</u>

20% (Figure D.10). eq & el (see Table D.1). va-r (Table D.1; Figure D.11). < 1.8mm. Open to less than single-spaced (Table D.1). Moderately aligned with vessel margins. Moderately bimodal grain size distribution; coarse fraction dominated by natural-occurring inclusions. Poorly-sorted overall, but added inclusions are Well sorted (Figure D.12).

Coarse fraction

65%. 1.8-0.45mm

Predominant

(Table D.1): *Sparry calcite*; eq & el. sa-sr. < 1.8mm, mode = 0.7mm.

Fine fraction

35%. 0.45-0.01mm

Frequent:	*Fine-grained volcanic rocks*
Common:	*Plagioclase feldspars*
Few:	*Clinopyroxenes*
	Sparry calcite
	Peloids
	Orthopyroxene
	Quartz
Rare:	*Biotite*
	Amphiboles
	Siltstones

<u>Matrix</u>

70%. Highly calcareous. Brown in PPL, light brown in XP (x50). Moderately heterogeneous in terms of composition and texture due to incomplete mixing of temper and base clay. The sample is too dark or the thin section too thick to truly appreciate how optically active is.

<u>Voids</u>

10%. Mainly Micro-, Meso-, and Macro-vughs (Table D.2; Figure D.13), but also ring voids around the unmixed portions of base clay, and Meso-planar voids orientated parallel to the vessel walls. All voids are partially or completely filled with calcite.

<u>Other comments on pottery technology</u>

There is evidence for the addition of well-sorted crushed volcanic rocks to base clay poor in inclusions. A light-coloured slip (iron-poor) seems to have been applied on top of a dark-coloured one (iron-rich).

5. Well-sorted Sand Fabric Class. Sample 008; n = 1.

<u>Inclusions</u>

30% (Figure D.10). eq & el (Table D.1). va-r (Table D.1; Figure D.11). < 0.8mm. Open to less than single-spaced (Table D.1). Not aligned with vessel margins. Moderately bimodal grain size distribution.

Coarse fraction

50%. 0.8-0.2mm

Frequent (Table D.1): *Plagioclase feldspars*; el & eq. sr. < 0.45mm, mode = 0.3mm. Anhedral. The big majority looks altered and eroded.

Sandstones; eq & el. sr. < 0.8mm, mode = 0.3mm. They are likely to come from the same mixed sediment as the siltstones and the metamorphic rock fragments.

Common: *Quartz*; eq & el. va-sa. < 0.43mm, mode = 0.2mm.

Very Few: *Argillaceous rock fragments*; el. wr. < 0.54mm, mode = 0.4mm. Abraded. Discordant; High to Neutral optical density; Sharp to Merging boundaries (Figure D.14). Shale?

Rare: *Siltstones*; eq & el. sr. < 0.3mm, mode = 0.25mm. They are likely to come from the same mixed sediment as the sandstones and the metamorphic rock fragments.

Metamorphic rock fragments; el. sr. < 0.38mm, mode = 0.23mm. Low grade. They are likely to come from the same mixed sediment as the sedimentary rocks.

Fine-grained volcanic rock fragments; el. sr. < 0.37mm, mode = 0.2mm. Basic to intermediate composition, commonly with feldspar laths in trachytic texture as groundmass, and micro-phenocrysts of plagioclase.

	Opaque minerals; eq & el. sr. < 0.36mm, mode = 0.3mm.
Very Rare:	*Biotite*; el. va. < 0.3mm, mode = 0.3mm.

Fine fraction

50%. 0.2-0.01mm

Frequent:	*Plagioclase feldspars*
Common:	*Quartz*
Few:	*Sandstones*
	Opaque minerals
Very few:	*Metamorphic rocks*
	Polycrystalline quartz
	Siltstones
	Amphiboles

<u>Matrix</u>

60%. Calcareous. Brown in PPL, yellowish brown in XP (x50). Optically moderately active.

<u>Voids</u>

10%. Meso-vughs (Table D.2; Figure D.13). Micritic calcite can be seen around voids.

<u>Other comments on pottery technology</u>

The only sample of this class shows a clay matrix partially retaining its birefringence property, suggesting a relatively low maximum firing temperature (Rice 1987:431).

6. Metamorphic Rocks Fabric Class. Samples 107, 185, 186, 188, 197, 201, 211, 215; n = 8.

<u>Inclusions</u>

15-35% (Figure D.10). el & eq (Table D.1). va-r (Table D.1; Figure D.11). < 2.28mm. Double to less than single-spaced (Table D.1). Not aligned, or moderately aligned with vessel margins. There is no dominant grain mode or size distribution. Poorly-sorted to Moderately-sorted (Figure D.12).

Common-Few (Table D.1): *Quartz*; el & eq. va-a. < 1.08mm, mode = 0.06mm. Straight or undulose extinction.

Plagioclase feldspar; el & eq. a-r. < 0.76mm, mode = 0.15mm. Several specimens are altered (sericite?).

Common-Very Few: *Metamorphic rock fragments*; el & eq. sa-sr. < 2.28mm, mode = 0.2mm. Low to medium grade. Can be foliated. Either derived from schist or gneiss.

Common-Absent: *Granitic rock fragments*; el & eq. va-sa. < 2.28mm, mode = 0.45mm. Coarse-grained rock fragments containing mainly quartz, plagioclase and alkali feldspars. Holocrystalline. Consertal texture. Feldspars crystals show alteration. Related to the presence of biotite, quartz and feldspars.

Very Few-Rare: *Opaque minerals*; el. sa. < 0.56mm, mode = 0.06mm.

Very Few-Absent: *Biotite*; el. a. < 0.72mm, mode = 0.02mm.

Polycrystalline quartz; el. sa-sr. < 0.28mm, mode = 0.2mm.

Alkali feldspar; el. va-sa. < 0.32mm, mode = 0.1mm.

Rare-Absent: *Orthopyroxene*; eq & el. a-sr. < 0.5mm, mode = 0.3mm. Partially altered.

Clinopyroxene; el. sa-sr. < 0.53mm, mode = 0.25mm. Partially altered.

Very Rare-Absent: *Amphiboles*; el. sa. < 0.24mm, mode = 0.24mm.

Epidote; el. sr. < 0.23mm, mode = 0.2mm.

Muscovite; el. a. < 0.45mm, mode = 0.45mm.

Matrix

53-82%. Moderately calcareous to non-calcareous. Blackish brown to reddish brown in PPL, blackish brown to yellowish brown in XP (x50). Moderately heterogeneous in terms of colour due to firing colour differentiation, either between core and margins or inner and outer halves. Optically moderately active, to active.

Voids

3-12%. Mainly Micro-, Meso-, and Macro-vughs (Table D.2; Figure D.13), but also Meso- and Mega-planar voids orientated parallel to the vessel walls (e.g. 186, 188, 211); they may have been formed by the shrinkage of the clay as it dried out, and its alignment to the margin might indicate the application of pressure to the clay during forming (Quinn 2013:61-68). Some Meso-vughs have blackened margins, and so were probably left out by burned plant matter.

Other comments on pottery technology

There is a hint of the use of granitic rock fragments as temper in three of the samples, but they may well occur naturally in the clay. Moreover, internal variation in texture and composition could be eventually linked to different recipes (see Internal Variation). Concerning firing temperature, the clay matrices partially retain their birefringence property, while two samples (107 and 197) are very optically active (Rice 1987:431). Surface finishing treatments seen in thin section include the application of iron-poor and/or calcareous clay(s) to produce light coloured slips and pale backgrounds for decoration (e.g. 186, 188).

Internal Variation

The analysis of a larger sample-set may lead to a subdivision of the class into sub-classes based on this internal variation:

Samples 107, 188, and 215 – Have higher proportion of possibly added crushed granitic rocks. Sample 188 also has a darker clay matrix, though it may be just the result of non-oxidising firing conditions.

Sample 185 – Contains pyroxenes.

Sample 186 and 211 – Have no granitic grains and along with samples 197 and 201 have the largest fraction of eroded minerals and rocks, constituting almost the total of the inclusions.

Samples 197 and 201 – Along samples 186 and 211, they have the largest fraction of eroded minerals and rocks, constituting almost the total of the inclusions. Main difference resides in the mode size of the inclusions: in samples 197 and 201 they are slightly coarser, and better sorted, than those on the rest of the samples; inclusions bigger than 0.20 mm dominate. Another difference is that the base clay seems to lack the very fine biotite grains featured in the rest of the samples.

7. Very Fine Feldspar and Biotite Fabric Class. Sample 182; n = 1.

<u>Inclusions</u>

30% (Figure D.10). eq & el (Table D.1). a-sr (Table D.1; Figure D.11). < 2.76mm. Single to less than single-spaced (Table D.1). Not aligned with vessel margins. Bimodal grain size distribution. Poorly-sorted (Figure D.12).

Coarse fraction

55%. 2.76-0.14mm

Common

(Table D.1): *Plagioclase feldspars*; eq & el. a-sr. < 0.7mm, mode = 0.25mm. Most look weathered and altered, a few look fresh.

Few: *Opaque minerals*; eq & el. sa-sr. < 1.1mm, mode = 0.2mm.

Clay pellets; eq & el. r. < 2.76mm, mode = 1.1mm. Discordant; High optical density (Figure D.14). Optically inactive.

Clinopyroxenes; eq & el. sa-sr. < 0.73mm, mode = 0.5mm.

Microgranite; el. el & eq. sa-sr. < 0.92mm, mode = 0.3mm.

	Quartz; eq. va-sa. < 0.6mm, mode = 0.4mm.
Very Few:	*Fine-grained volcanic rocks*; el. sr. < 0.55mm, mode = 0.55mm.
Rare:	*Amphiboles*; el. sa. < 0.4mm, mode = 0.4mm.
	Siltstones; eq. r. < 0.2mm, mode = 0.15mm.
	Orthopyroxenes; el. sr. < 0.2mm, mode = 0.2mm.
	Epidote; el. sa. < 0.22mm, mode = 0.22mm.
	Olivine; el. sa. < 0.3mm, mode = 0.3mm.
	Peloids; el. sr. < 0.33mm, mode = 0.3mm.

Fine fraction
45%. 0.14-0.01mm

Common:	*Plagioclase feldspars*
	Biotite
Few:	*Quartz*
	Opaque minerals
Very Few:	*Clinopyroxenes*

Matrix
65%. Calcareous. Light to deep brown in PPL, deep brown in XP (x50). There are streaks of darker-coloured clay: their origin seems to be natural and not anthropogenic, since there is no heterogeneity in terms of non-plastics composition or texture. Optically slightly active.

Voids
5%. Mainly Meso-, Macro-, and Mega-vughs, but also Meso-vesicles (Table D.2; Figure D.13). Most elongated voids display alignment to the margins, indicating the application of pressure to the clay during forming (Quinn 2013:61-68). Some Meso-vughs have blackened margins, left out by burned plant matter after firing.

Other comments on pottery technology

The sample seems to have been low-fired (below vitrification), with the clay matrix partially retaining its birefringence property (Rice 1987:431). A thin (< 0.07mm) light coloured slip (iron-poor) appears to have been applied on the vessel's surface.

D.1. TEXT AND IMAGE REFERENCES FOR THE FULL PETROGRAPHIC CHARACTERISATIONS

Table D.1. Categories and abbreviations for grain shape and roundness (top), descriptions of spacing between inclusions (bottom left), and frequency labels (bottom right).

Abbreviations for shape	**Abbreviations for roundness**
eq: equant el: elongate	va: very angular a: angular sa: sub-angular sr: sub-rounded r: rounded
Description of spacing	**Semi-quantitative frequency labels based on density charts**
Close-spaced: inclusions in contact Single-spaced: spacing = mean diameter Double-spaced: spacing = 2 x diameter Open-spaced: spacing > 2 x diameter	Predominant: > 70 % Dominant: 50-70 % Frequent: 30-50 % Common: 15-30 % Few: 5-15 % Very Few: 2-5 % Rare: 0.5-2 % Very Rare: < 0.5 %

Table D.2. Prefixes to indicate the size of voids (based on Quinn 2013:97).

Prefixes of voids size
Micro = < 0.05 mm Meso = 0.05-0.50 mm Macro = 0.50-2 mm Mega = > 2mm

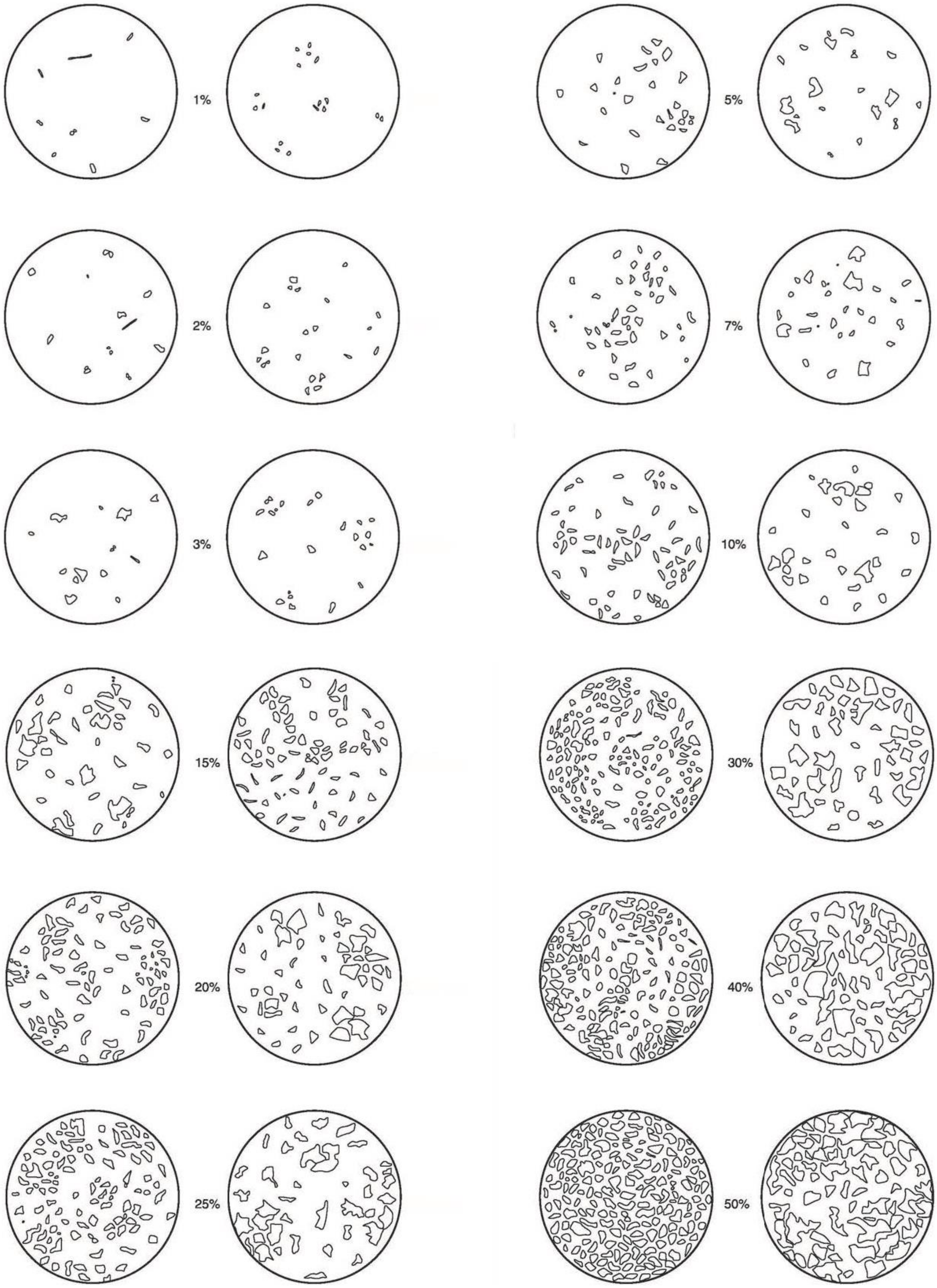

Figure D.10. Density chart to visually estimate the abundance of inclusions and voids (modified from the Prehistoric Ceramics Research Group 2010:Appendix 3).

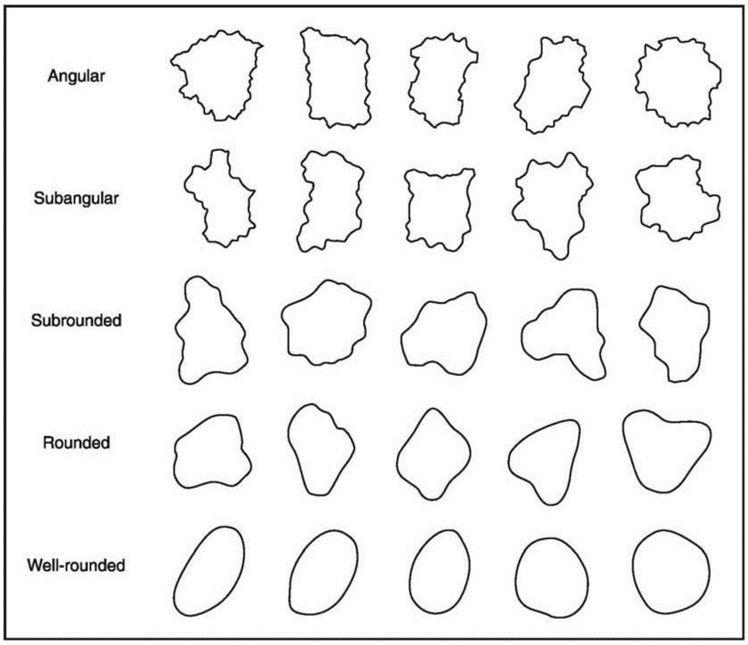

Figure D.11. Categories of roundness for inclusions (modified from the Prehistoric Ceramics Research Group 2010:Appendix 5).

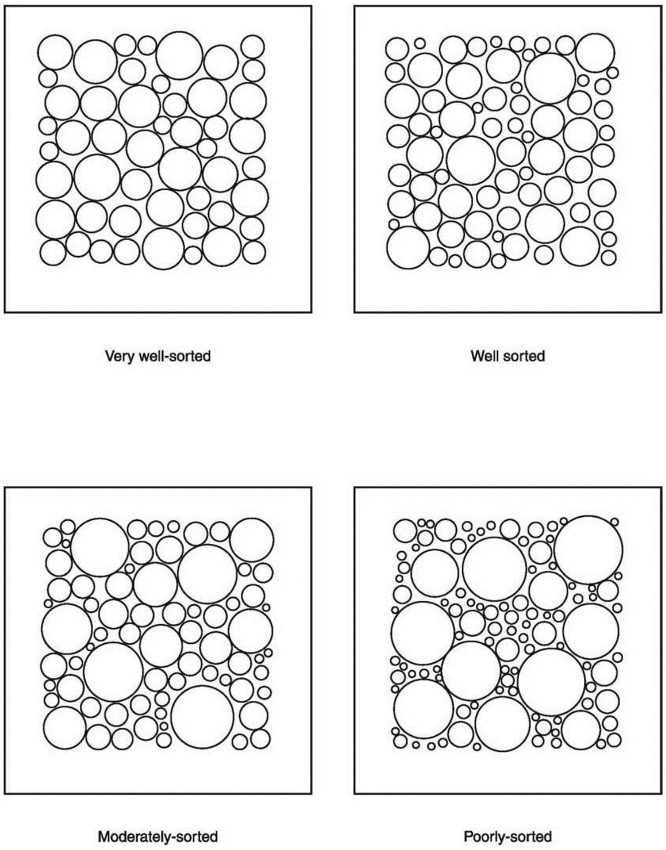

Figure D.12. Chart for estimating the degree of sorting of the inclusions (modified from the Prehistoric Ceramics Research Group 2010:Appendix 4).

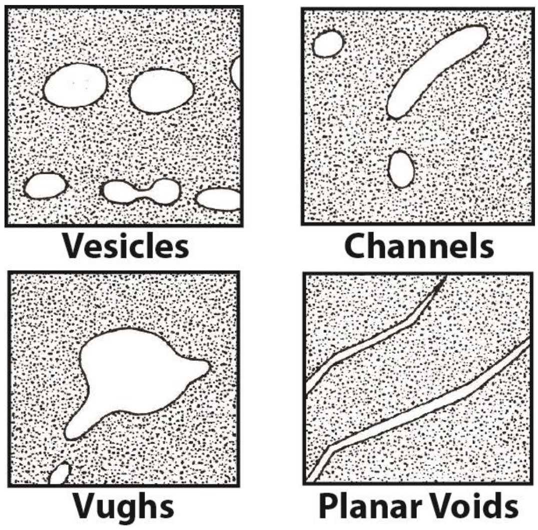

Figure D.13. Terminology for the description of void shape in thin section (modified by Quinn 2013:Fig. 4.25 from Stoops 2003:Fig. 5.6).

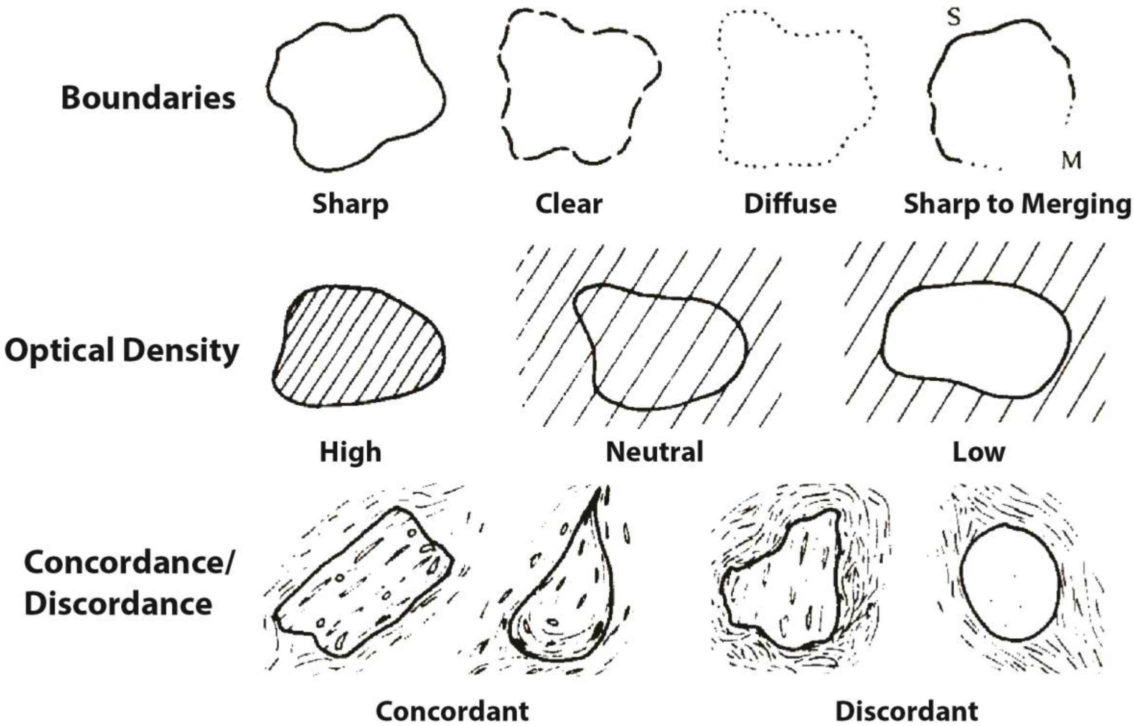

Figure D.14. Terminology for the description and characterisation of argillaceous inclusions (modified from Whitbread 1986:Table 1).

APPENDIX E. X-RAY DIFFRACTION PATTERNS

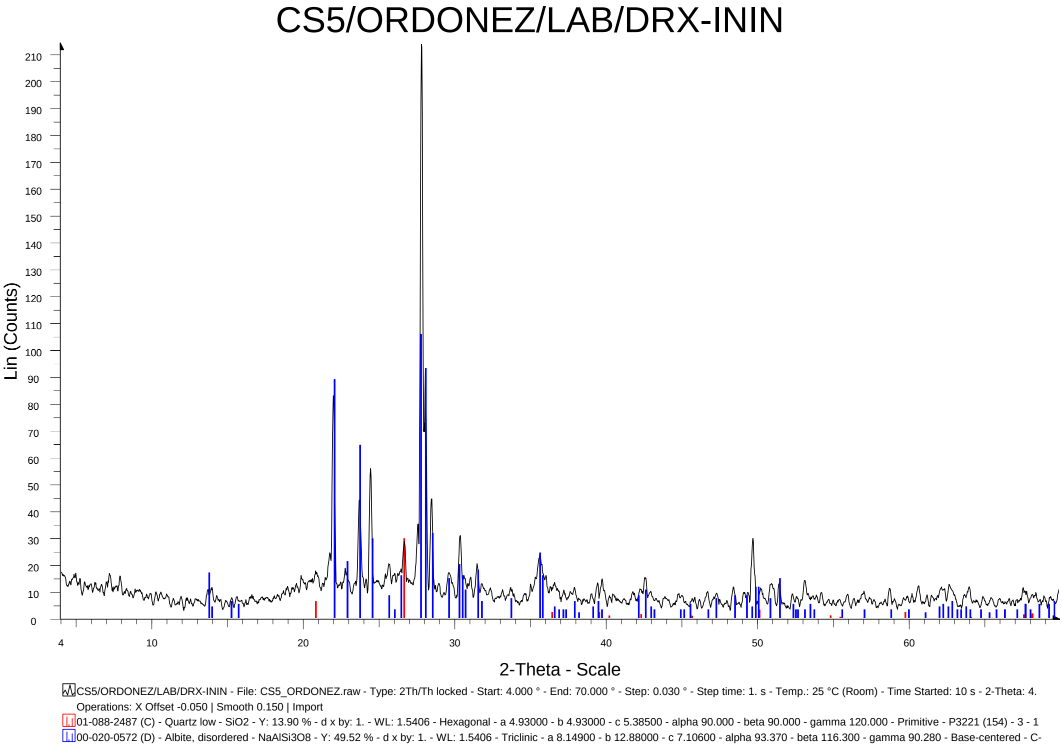

Figure E.1. X-ray diffraction pattern of pottery sample 005.

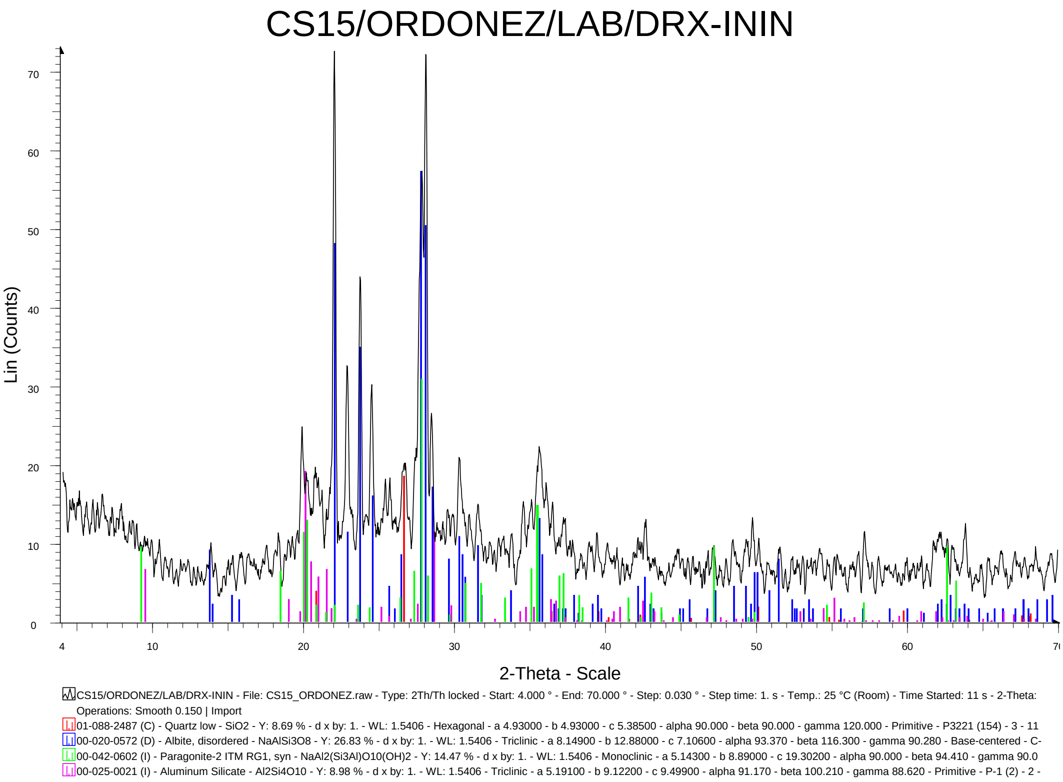

Figure E.2. X-ray diffraction pattern of pottery sample 015.

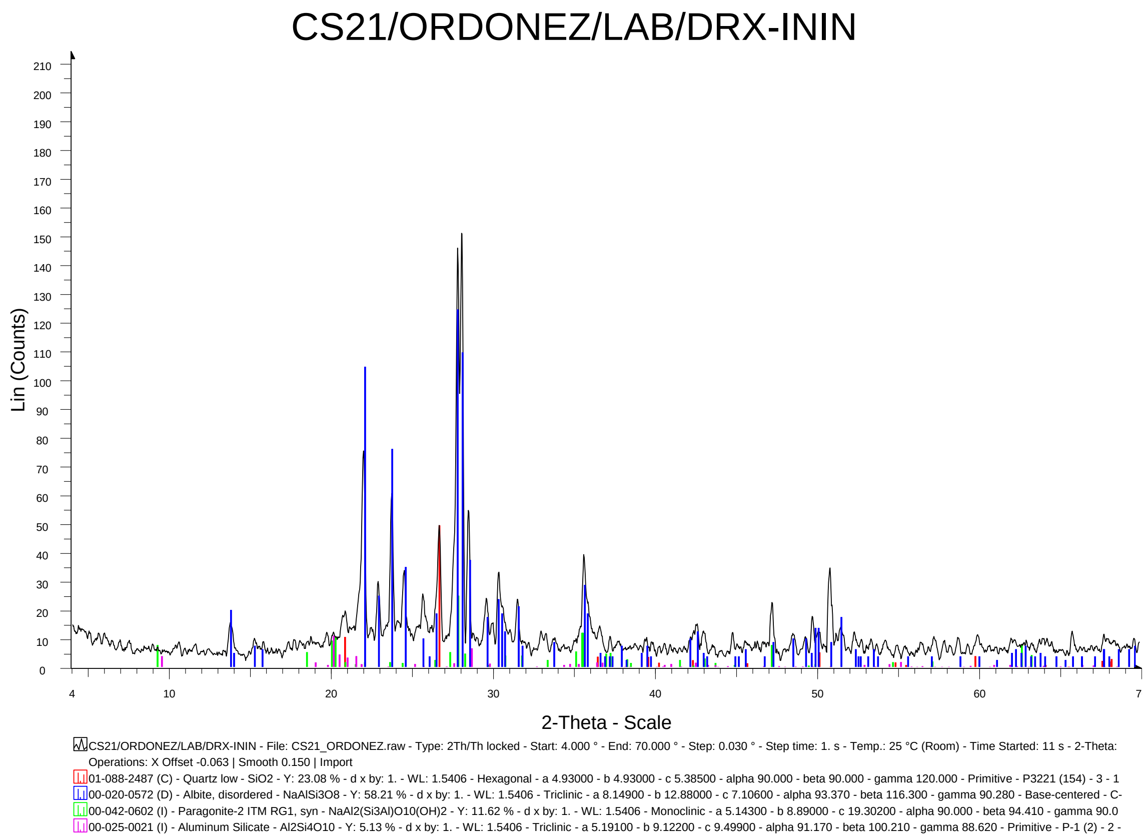

Figure E.3. X-ray diffraction pattern of pottery sample 021.

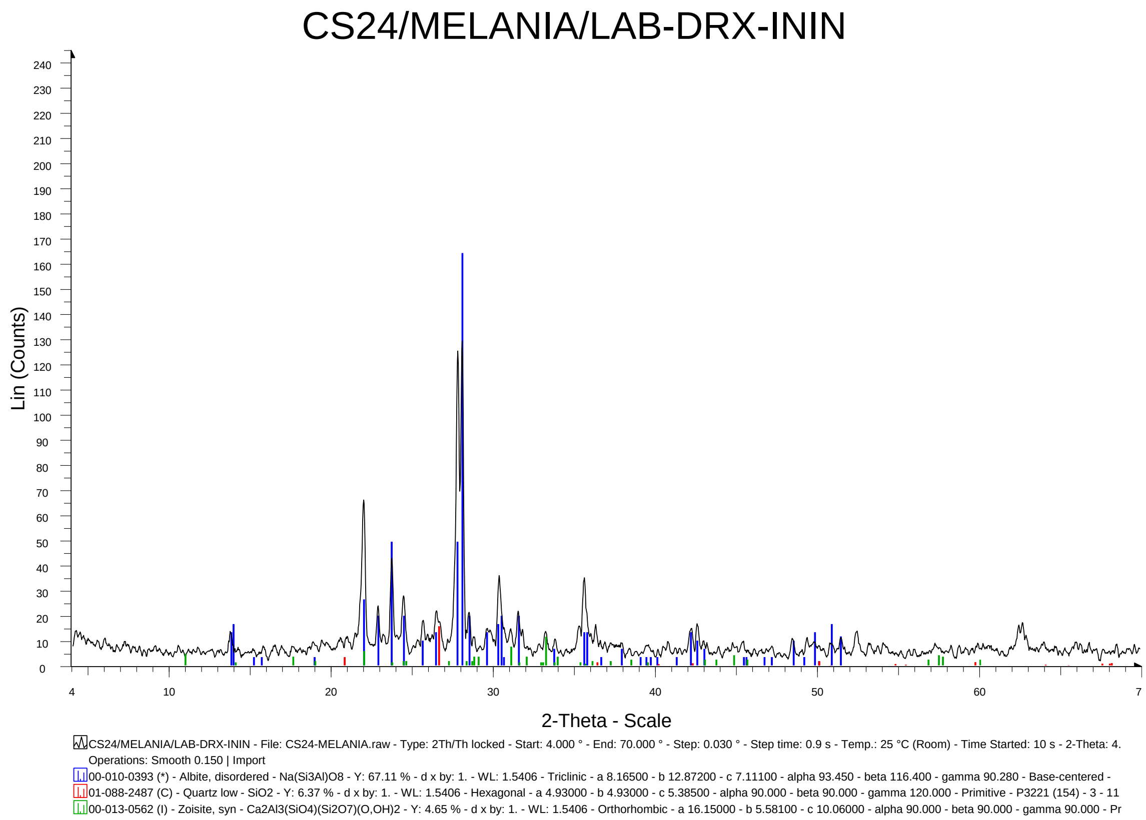

Figure E.4. X-ray diffraction pattern of pottery sample 024.

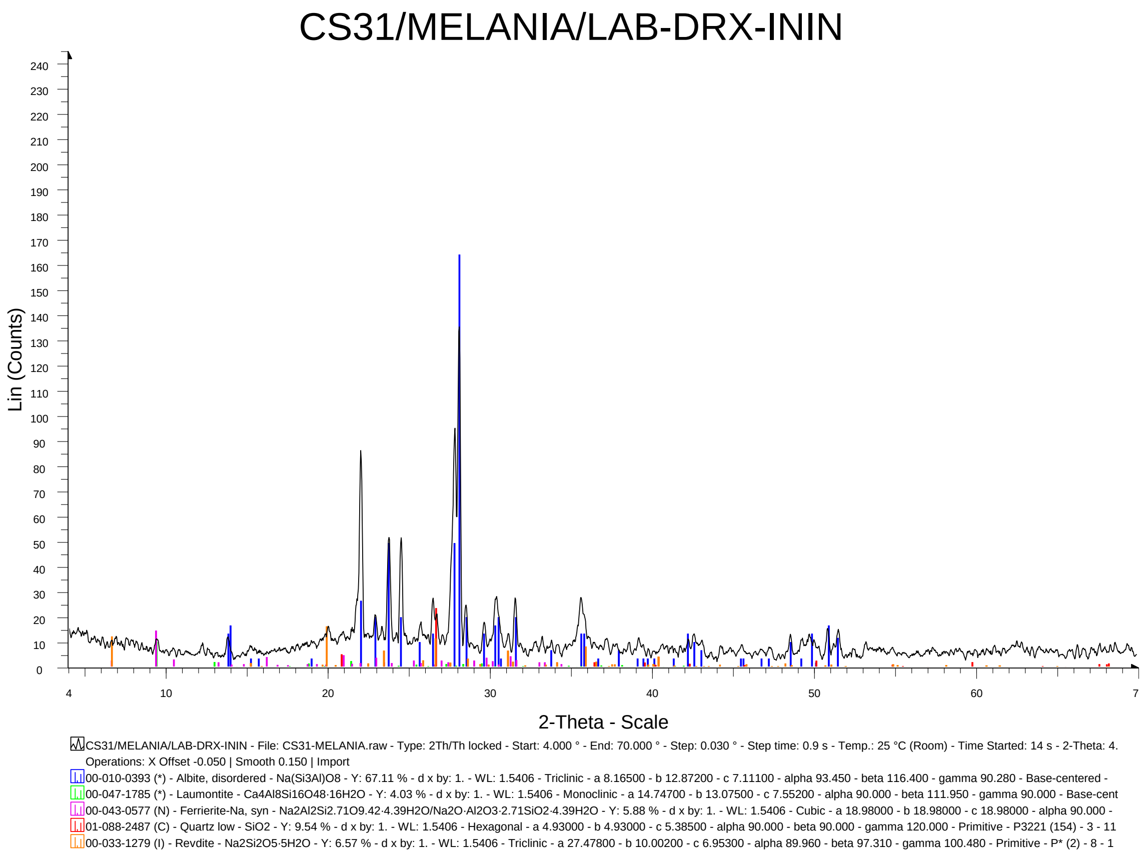

Figure E.5. X-ray diffraction pattern of pottery sample 031.

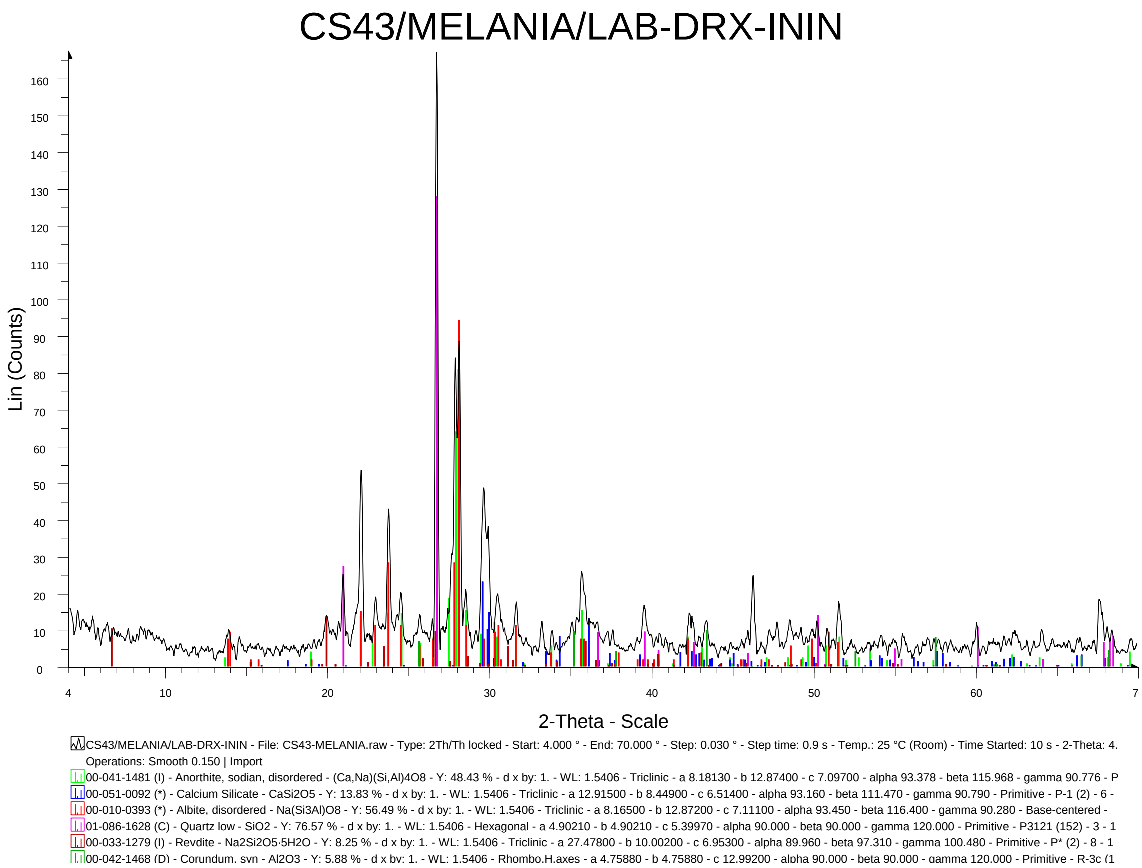

Figure E.6. X-ray diffraction pattern of pottery sample 043.

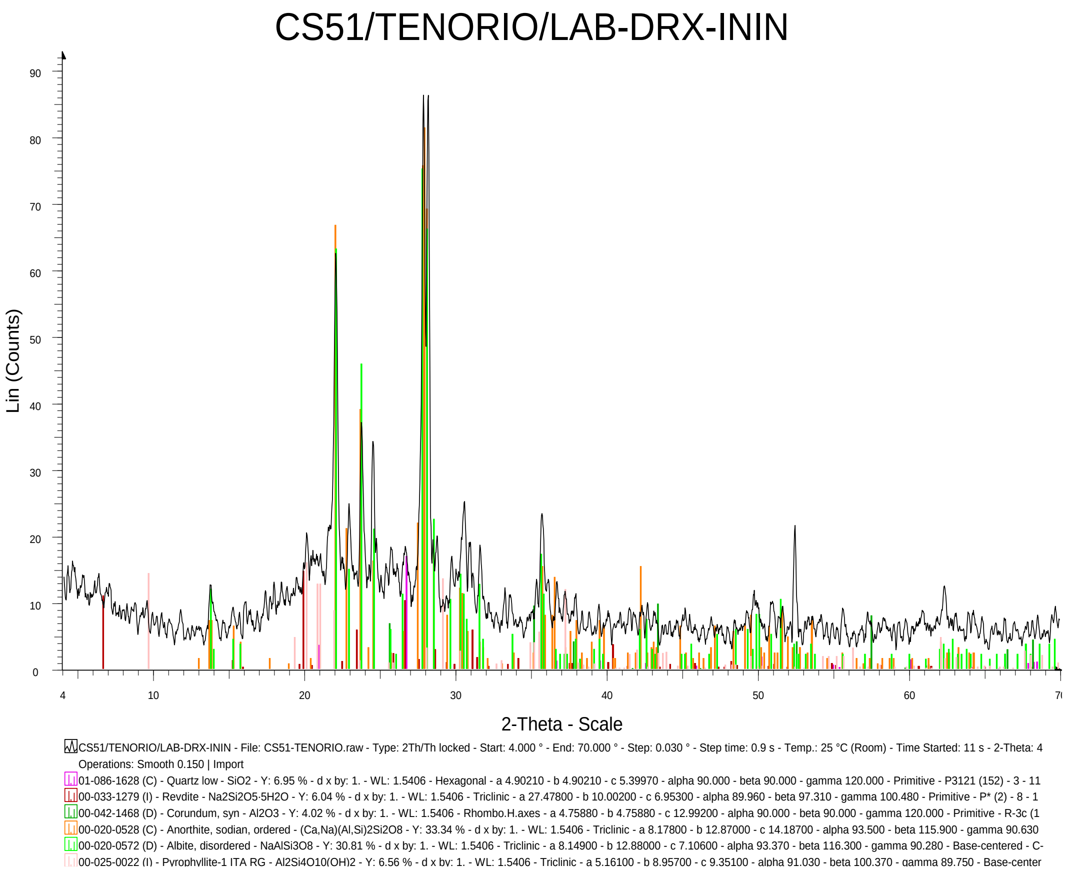

Figure E.7. X-ray diffraction pattern of pottery sample 051.

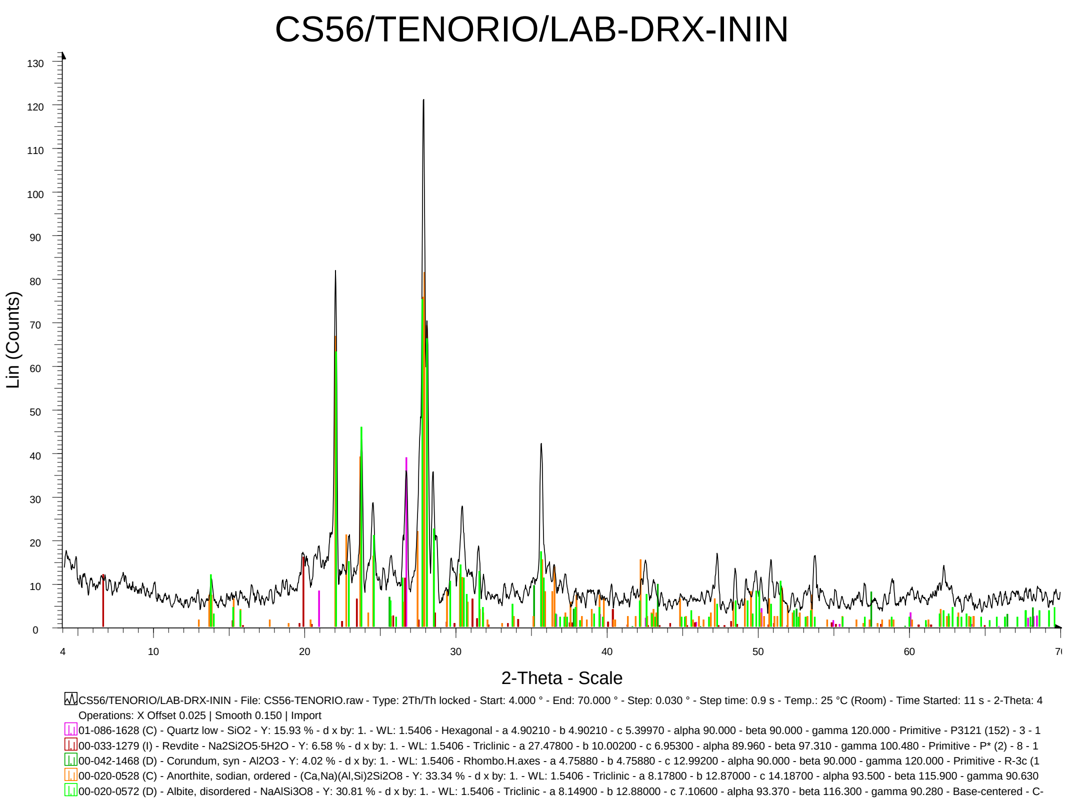

Figure E.8. X-ray diffraction pattern of pottery sample 056.

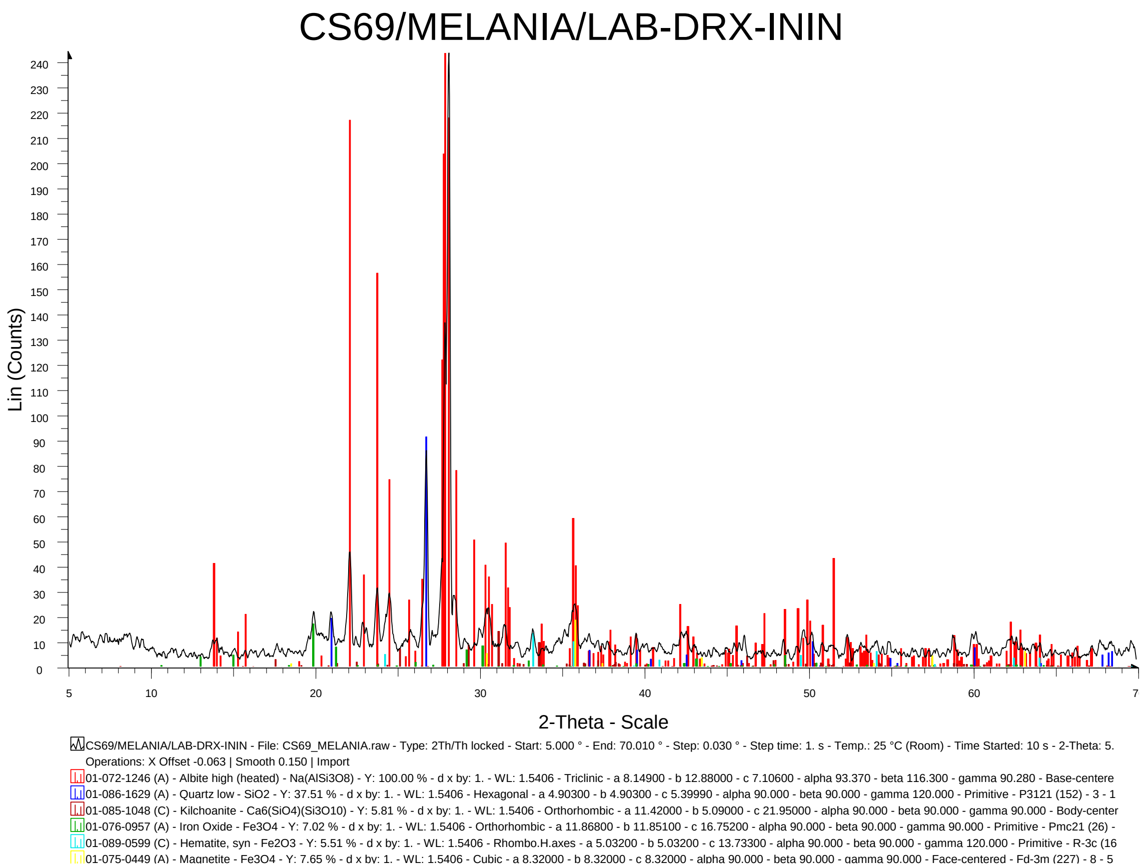

Figure E.9. X-ray diffraction pattern of pottery sample 069.

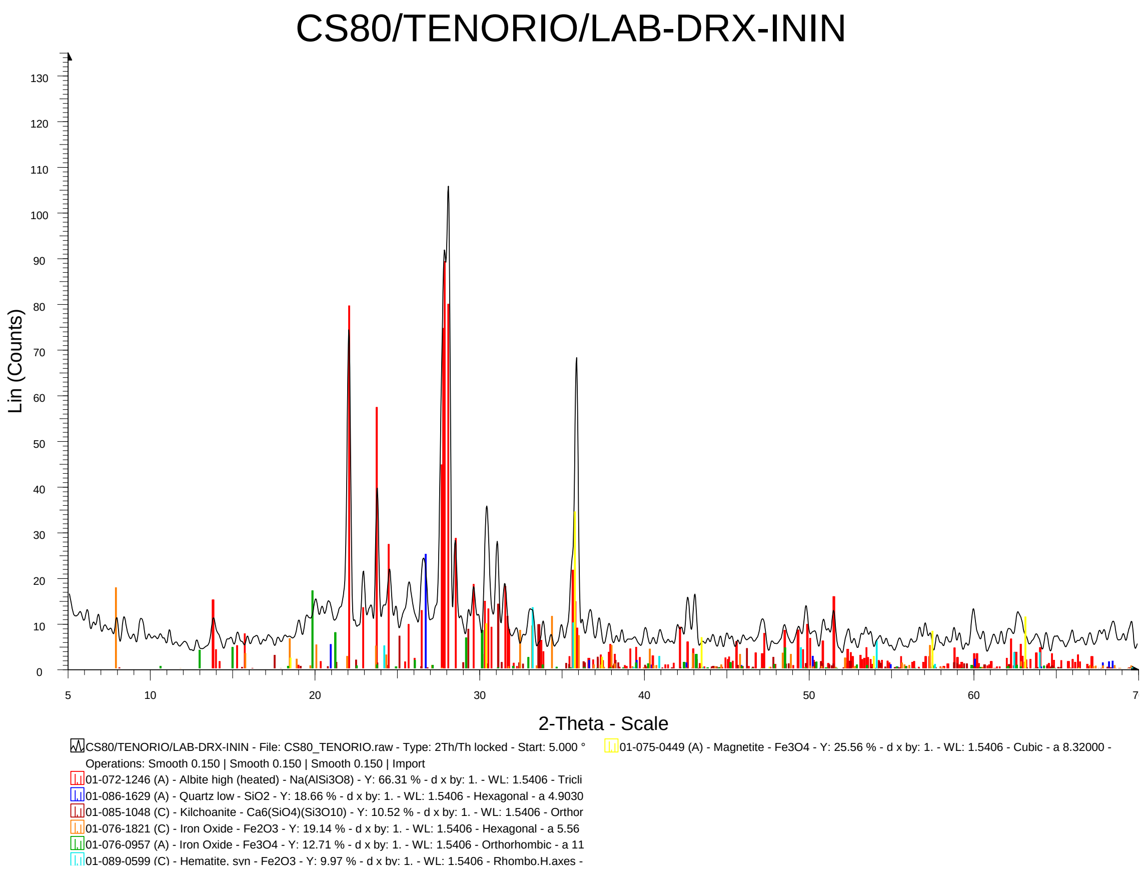

Figure E.10. X-ray diffraction pattern of pottery sample 080.

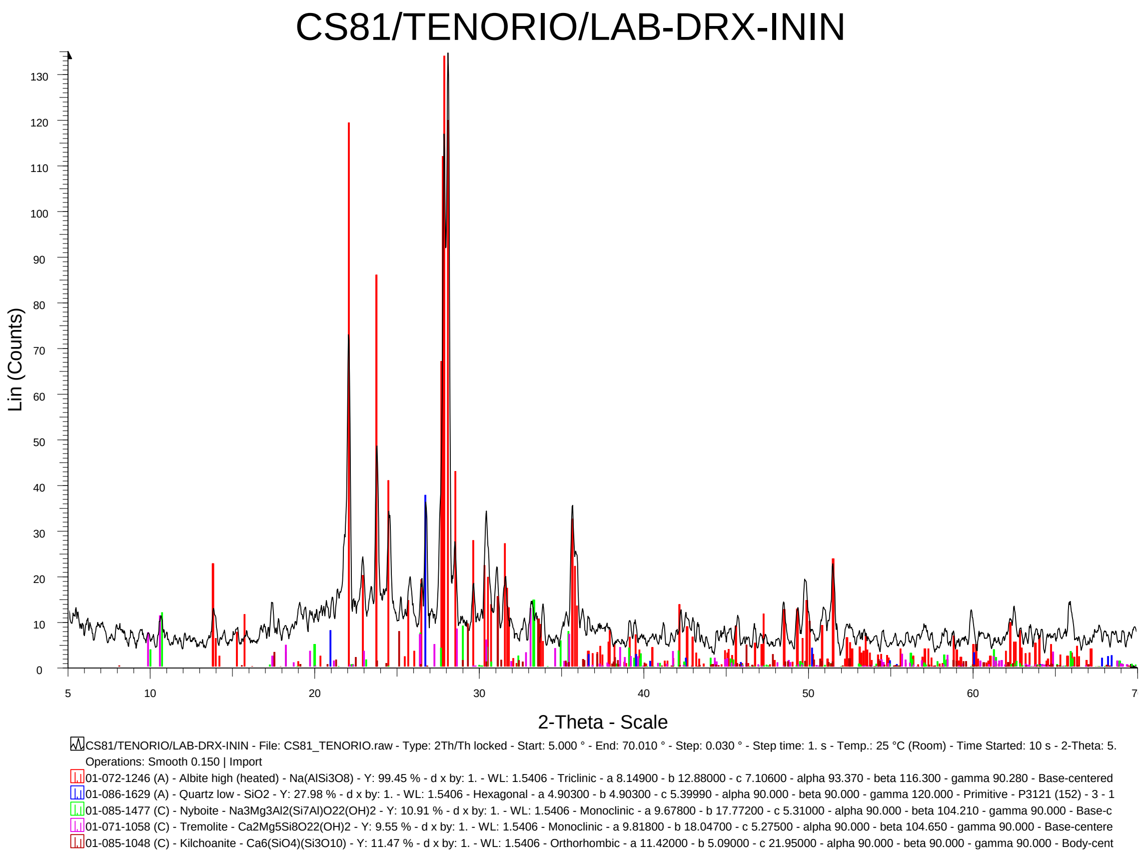

Figure E.11. X-ray diffraction pattern of pottery sample 081.

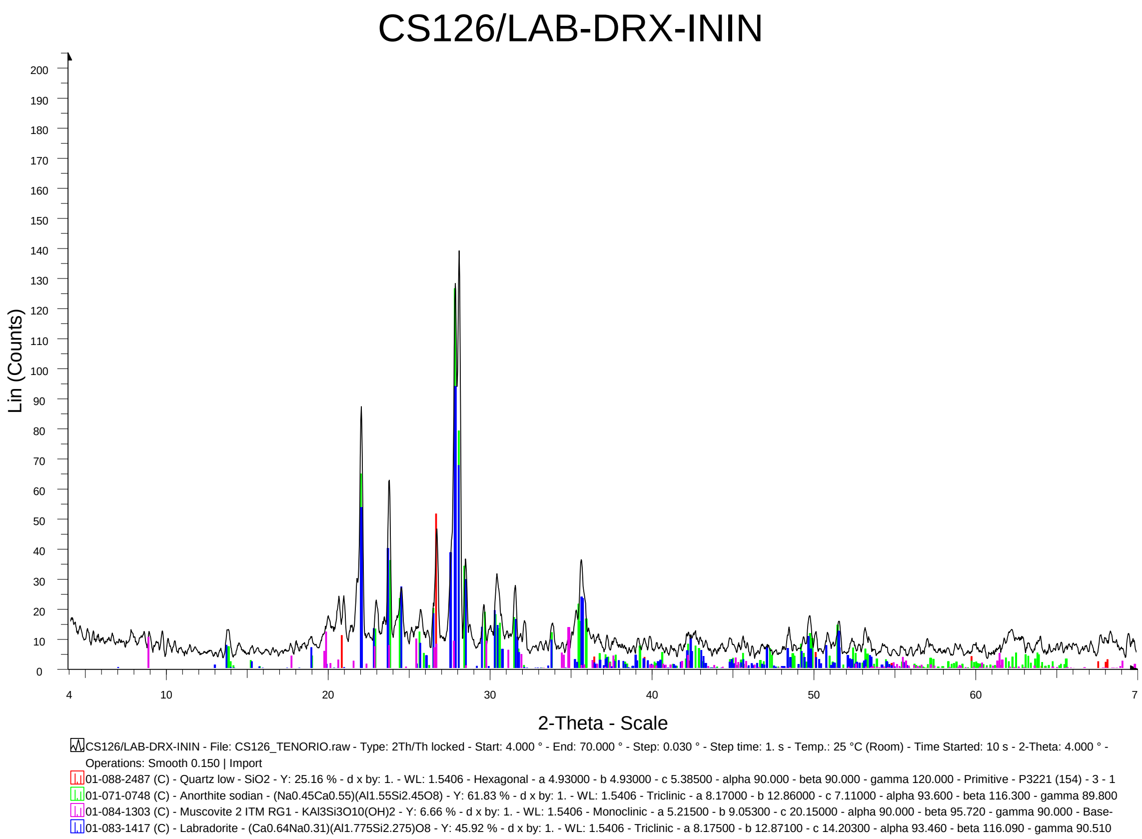

Figure E.12. X-ray diffraction pattern of pottery sample 126.

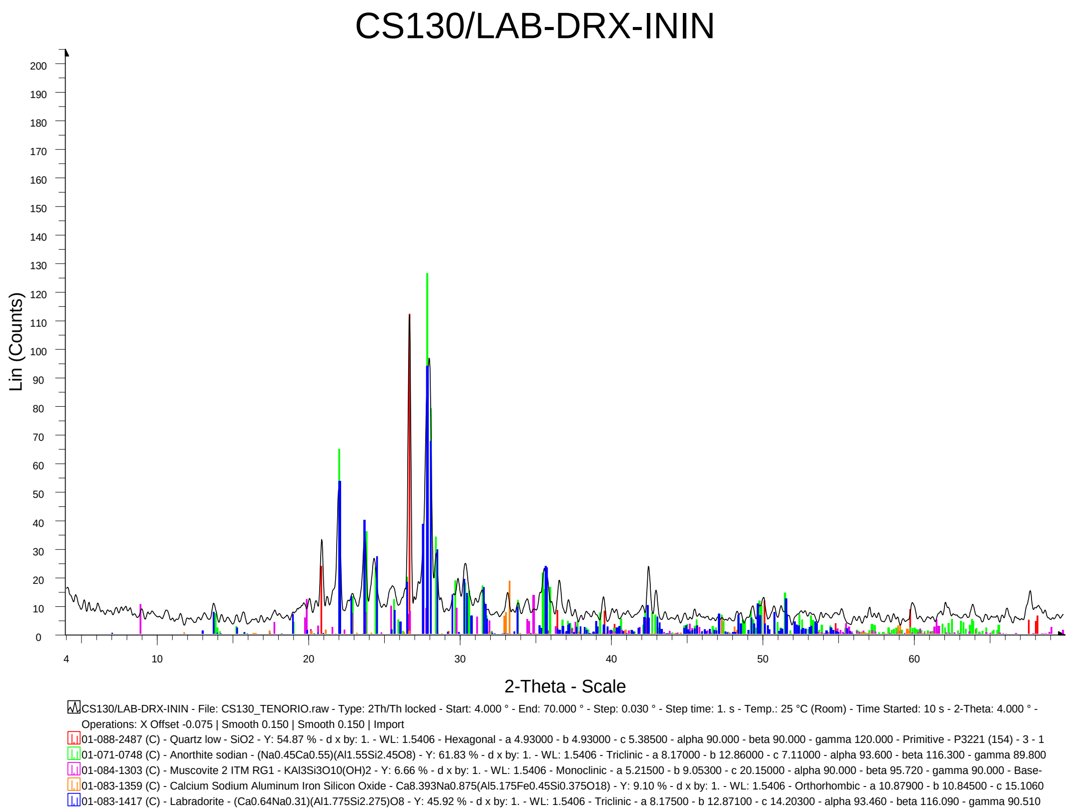

Figure E.13. X-ray diffraction pattern of pottery sample 130.

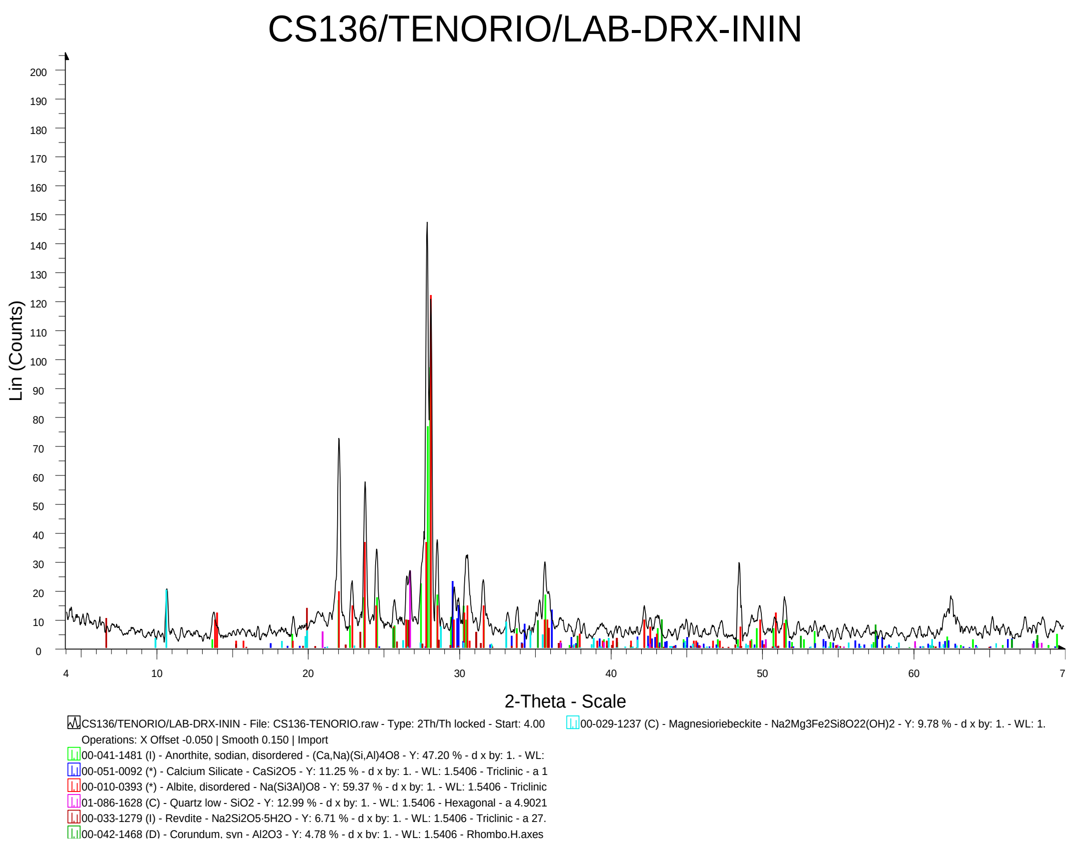

Figure E.14. X-ray diffraction pattern of pottery sample 136.

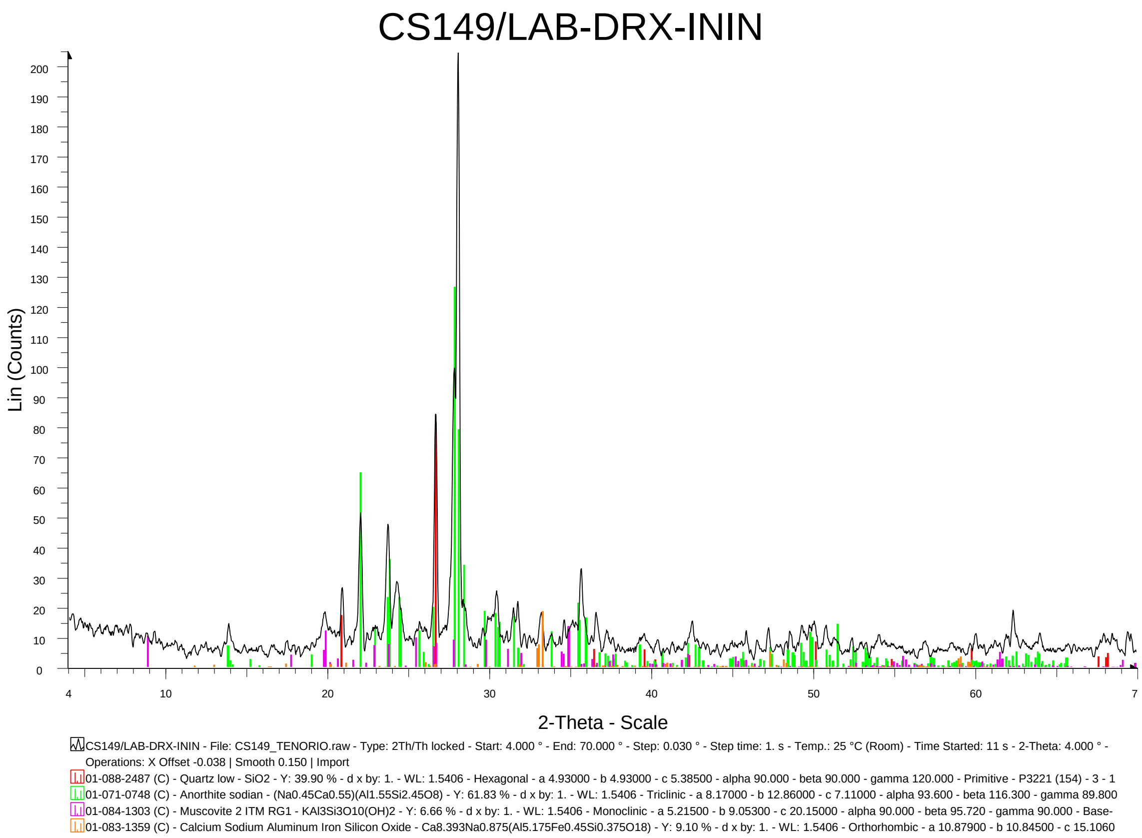

Figure E.15. X-ray diffraction pattern of pottery sample 149.

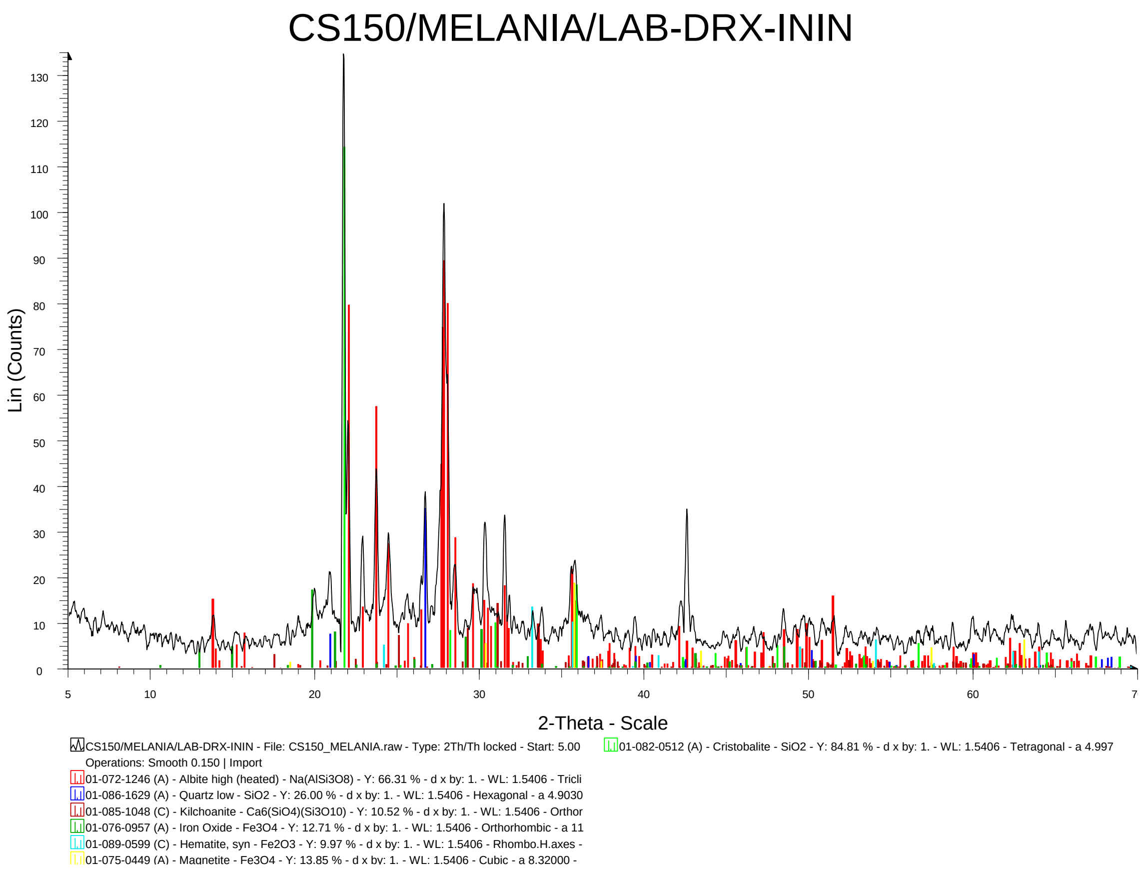

Figure E.16. X-ray diffraction pattern of pottery sample 150.

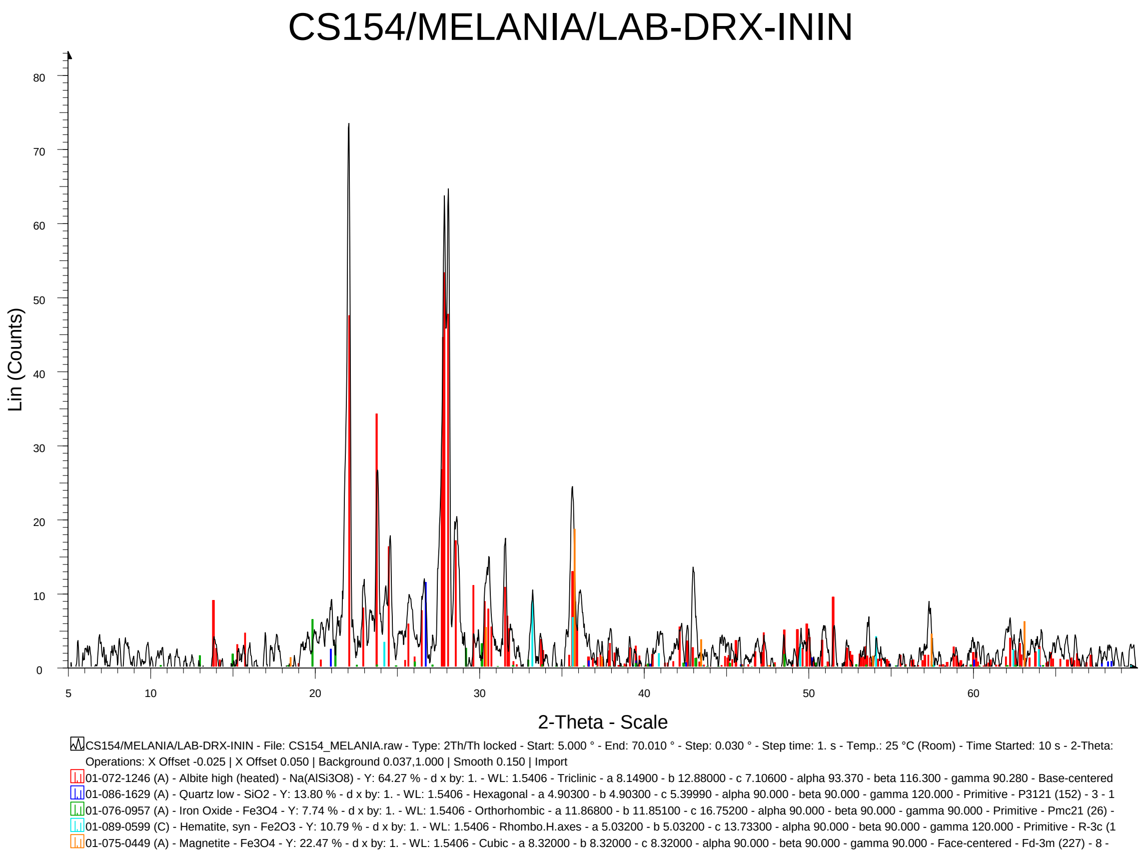

Figure E.17. X-ray diffraction pattern of pottery sample 154.

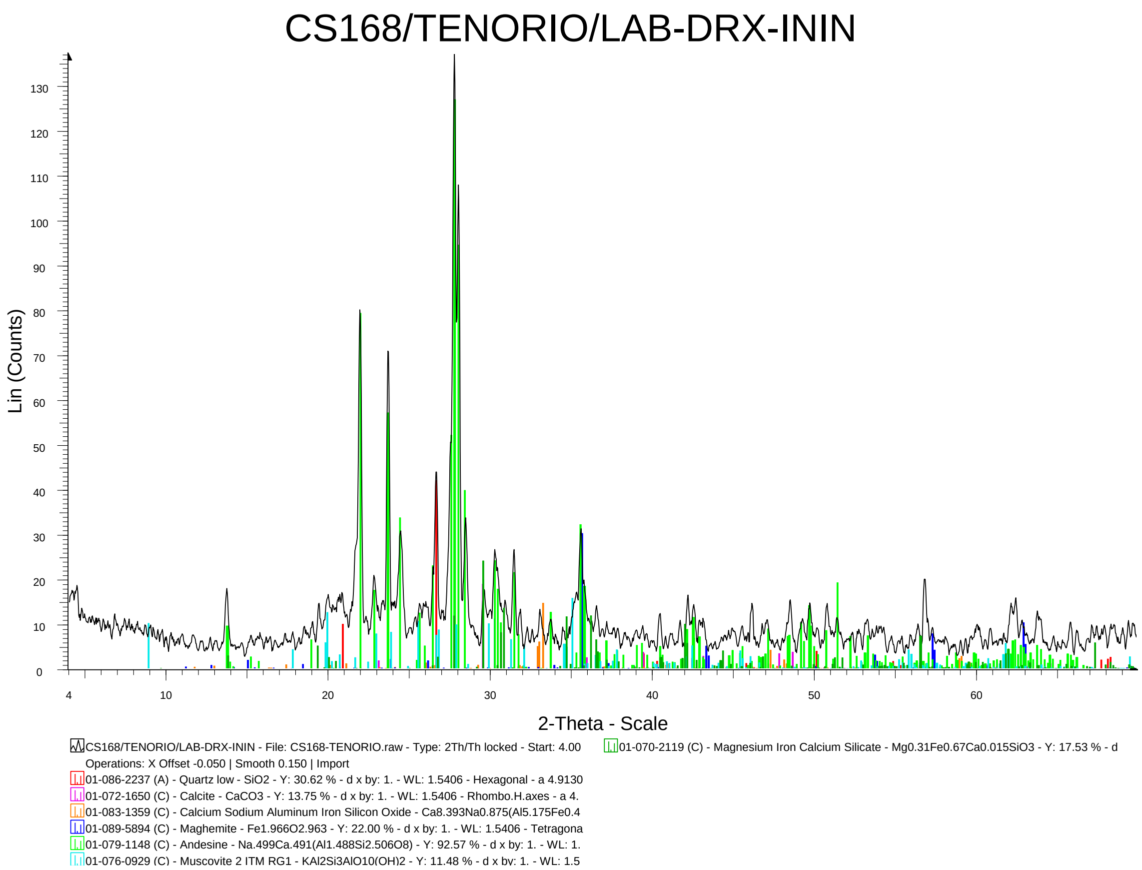

Figure E.18. X-ray diffraction pattern of pottery sample 168.

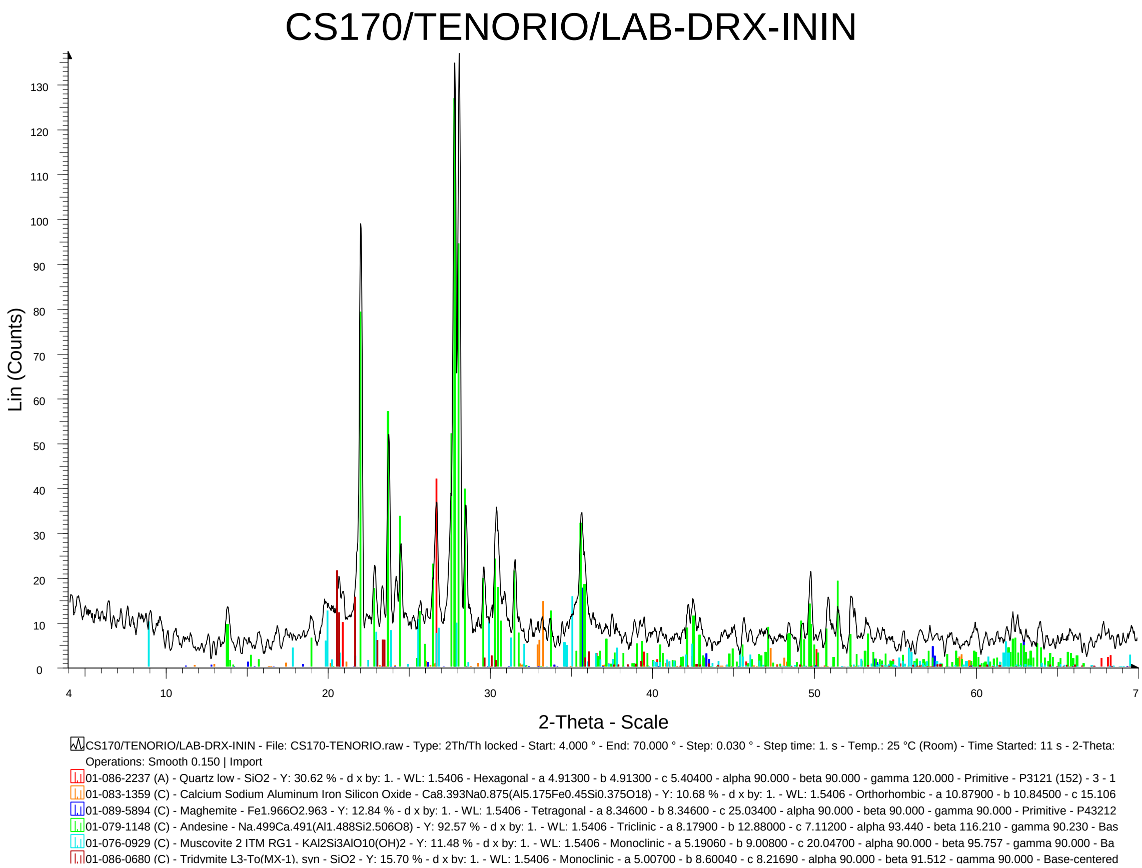

Figure E.19. X-ray diffraction pattern of pottery sample 170.

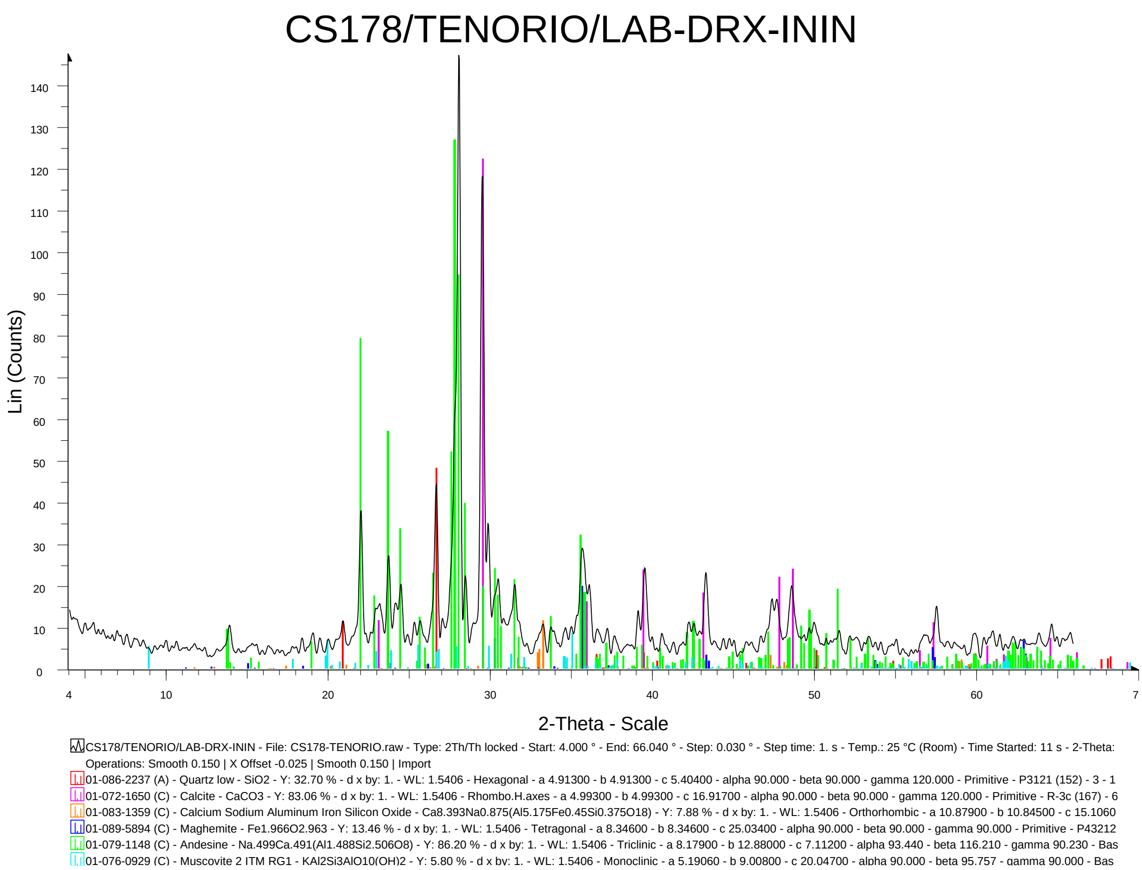

Figure E.20. X-ray diffraction pattern of pottery sample 178.

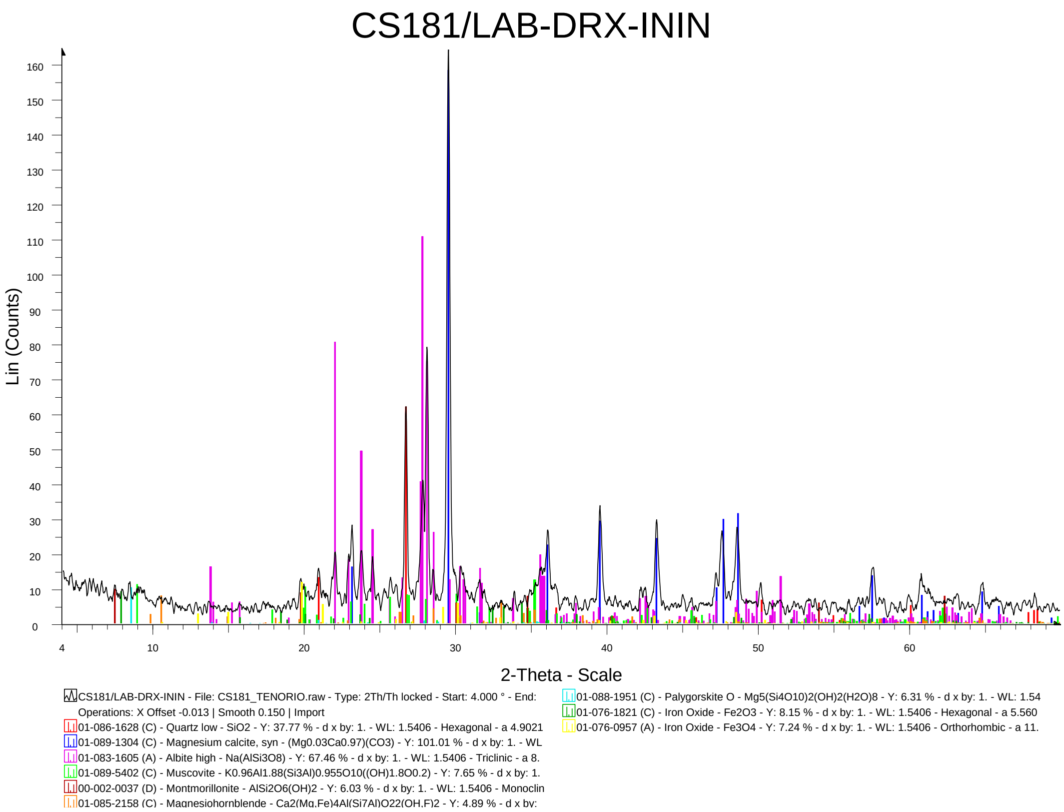

Figure E.21. X-ray diffraction pattern of pottery sample 181.

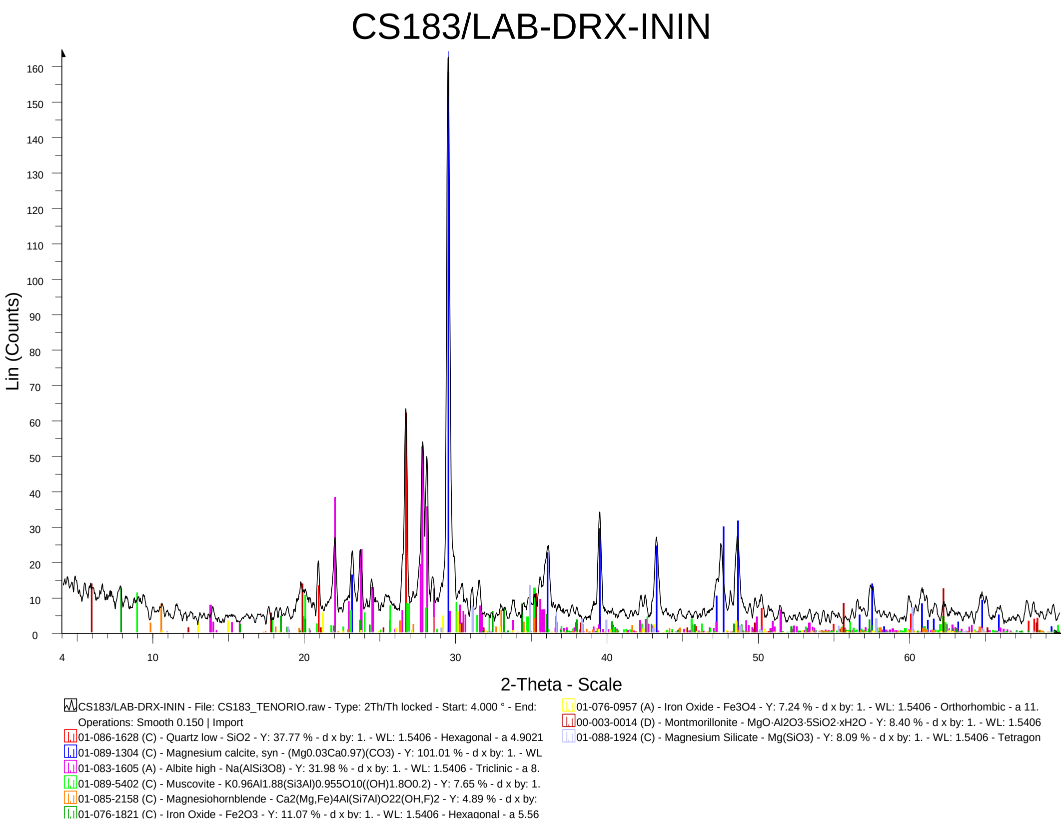

Figure E.22. X-ray diffraction pattern of pottery sample 183.

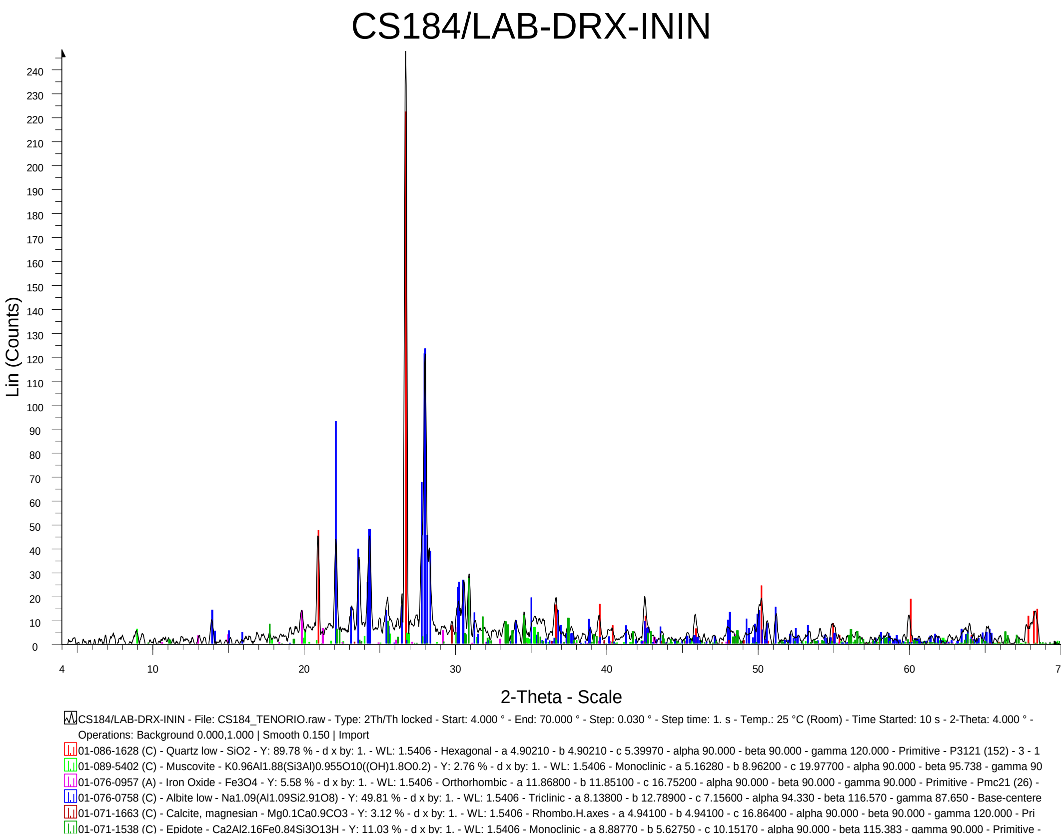

Figure E.23. X-ray diffraction pattern of pottery sample 184.

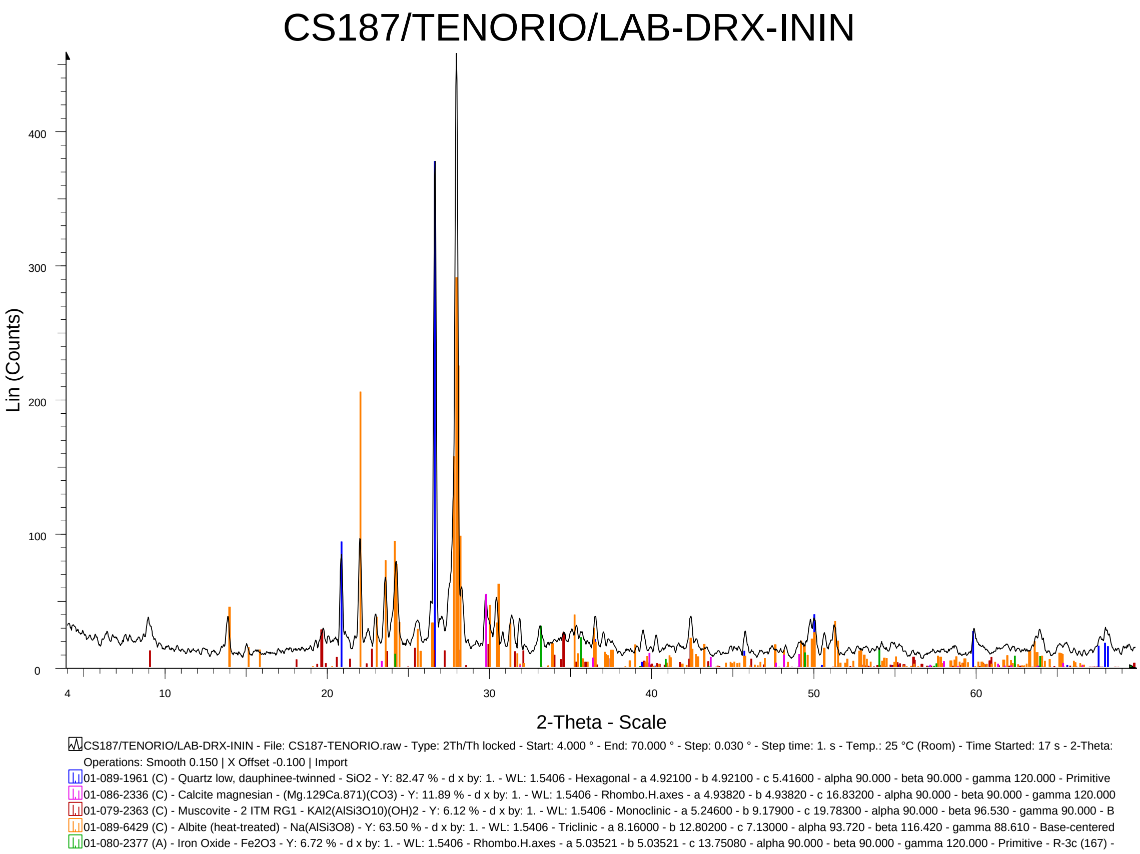

Figure E.24. X-ray diffraction pattern of pottery sample 187.

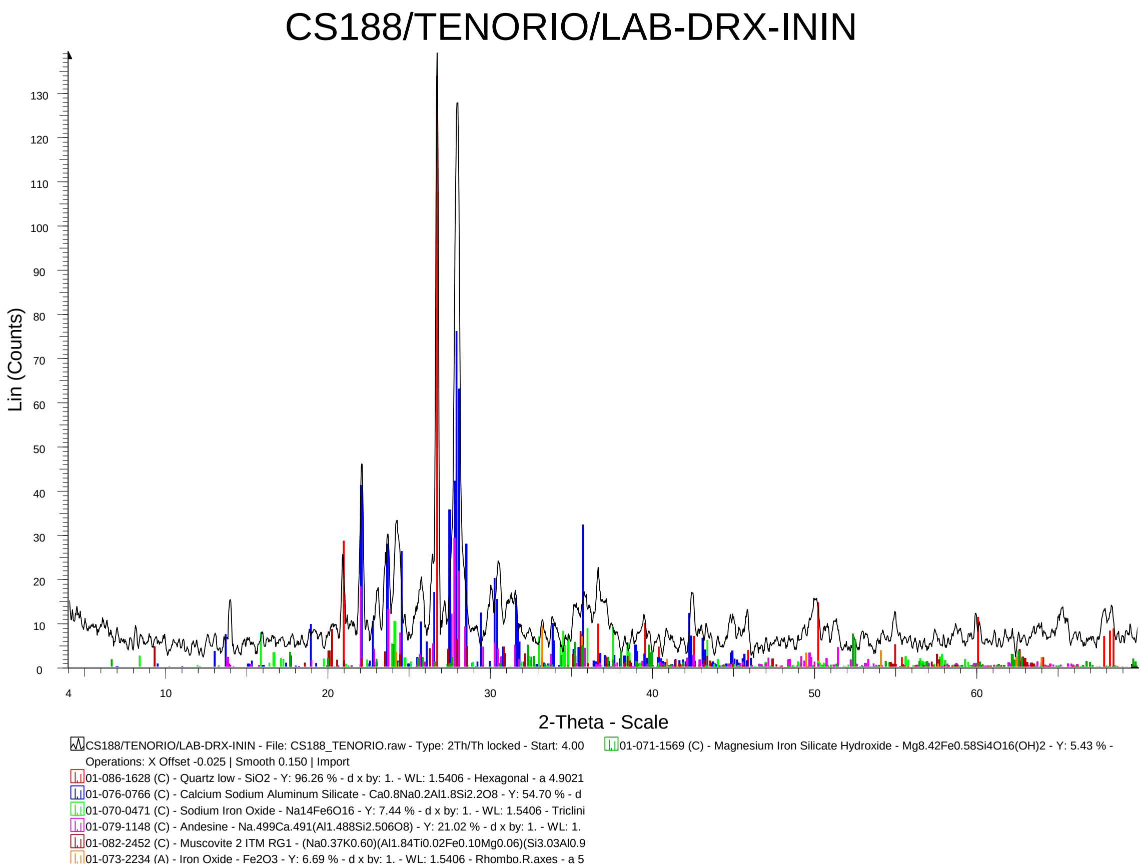

Figure E.25. X-ray diffraction pattern of pottery sample 188.

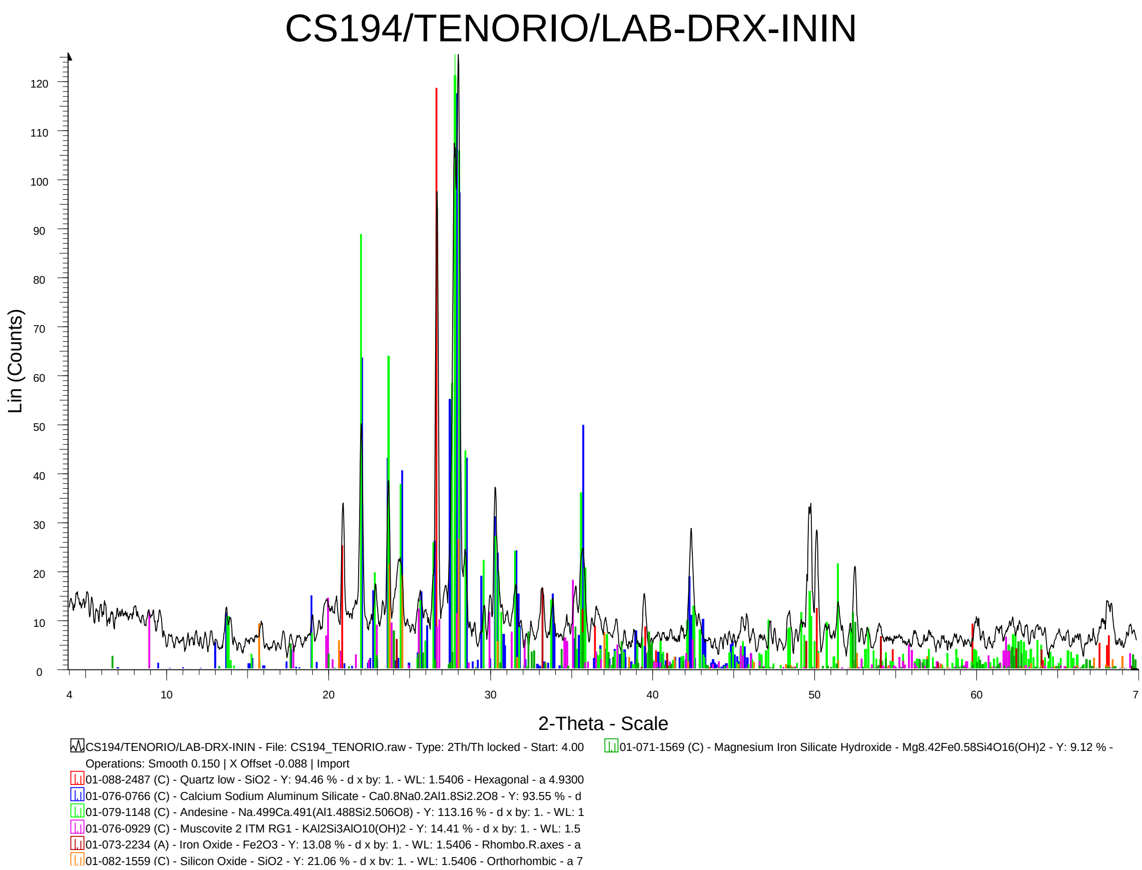

Figure E.26. X-ray diffraction pattern of pottery sample 194.

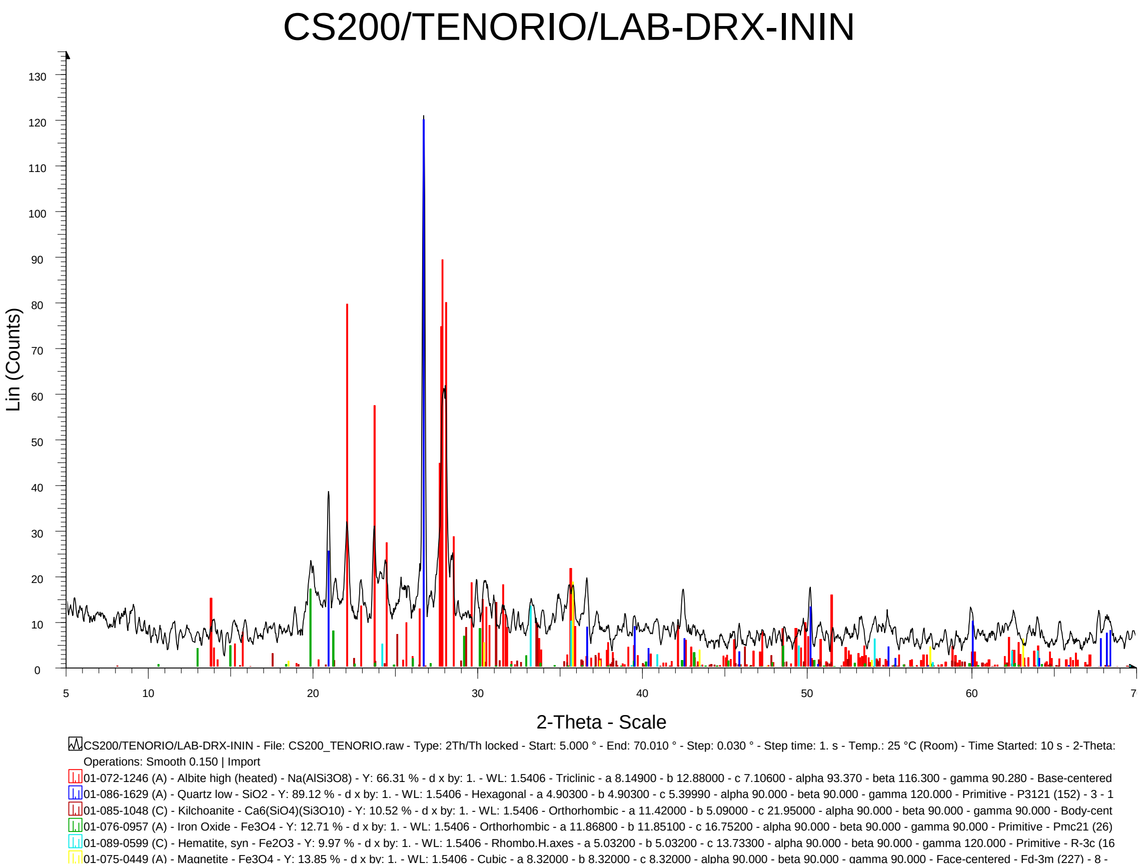

Figure E.27. X-ray diffraction pattern of pottery sample 200.

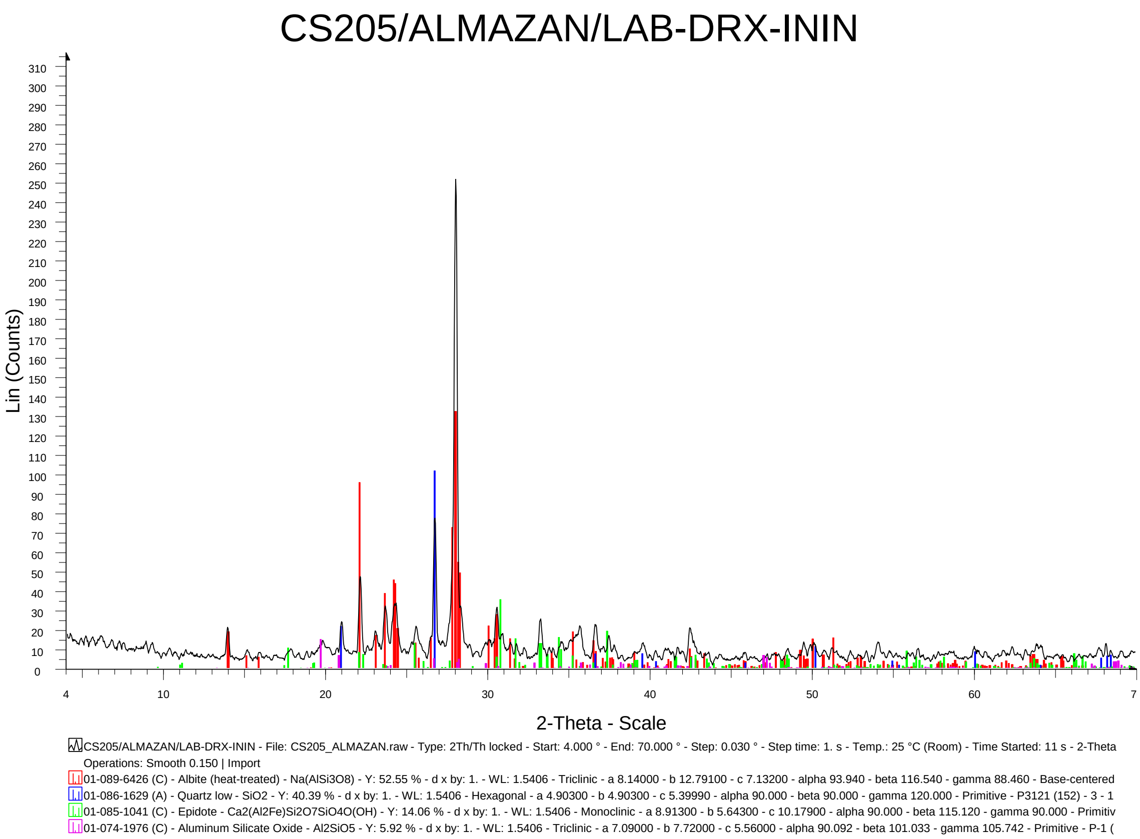

Figure E.28. X-ray diffraction pattern of pottery sample 205.

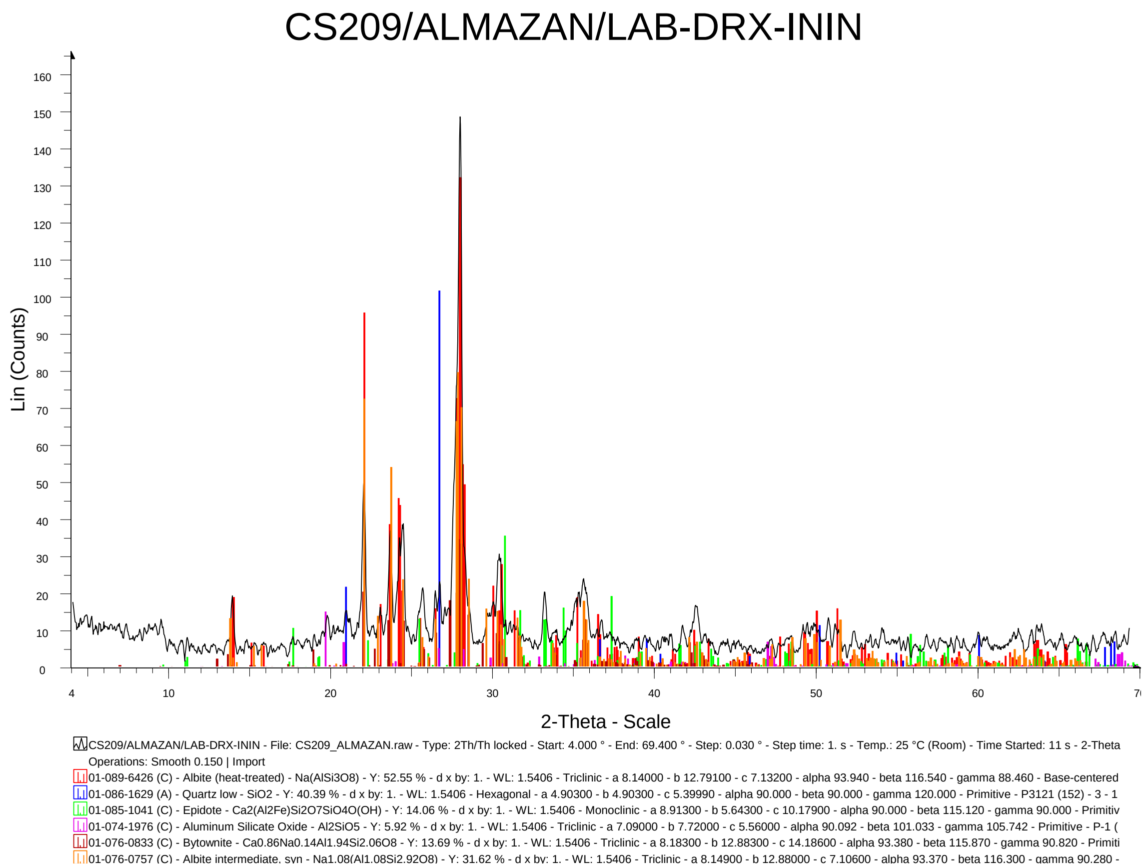

Figure E.29. X-ray diffraction pattern of pottery sample 209.

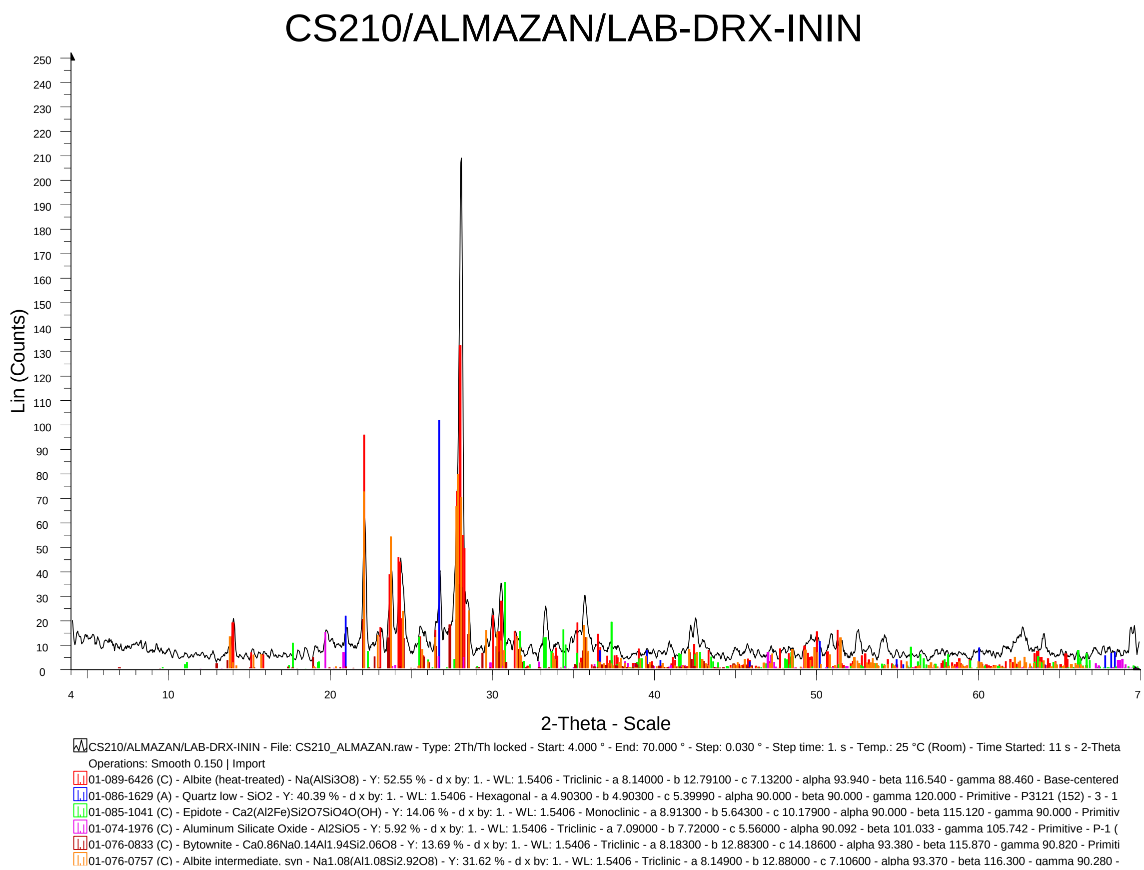

Figure E.30. X-ray diffraction pattern of pottery sample 210.

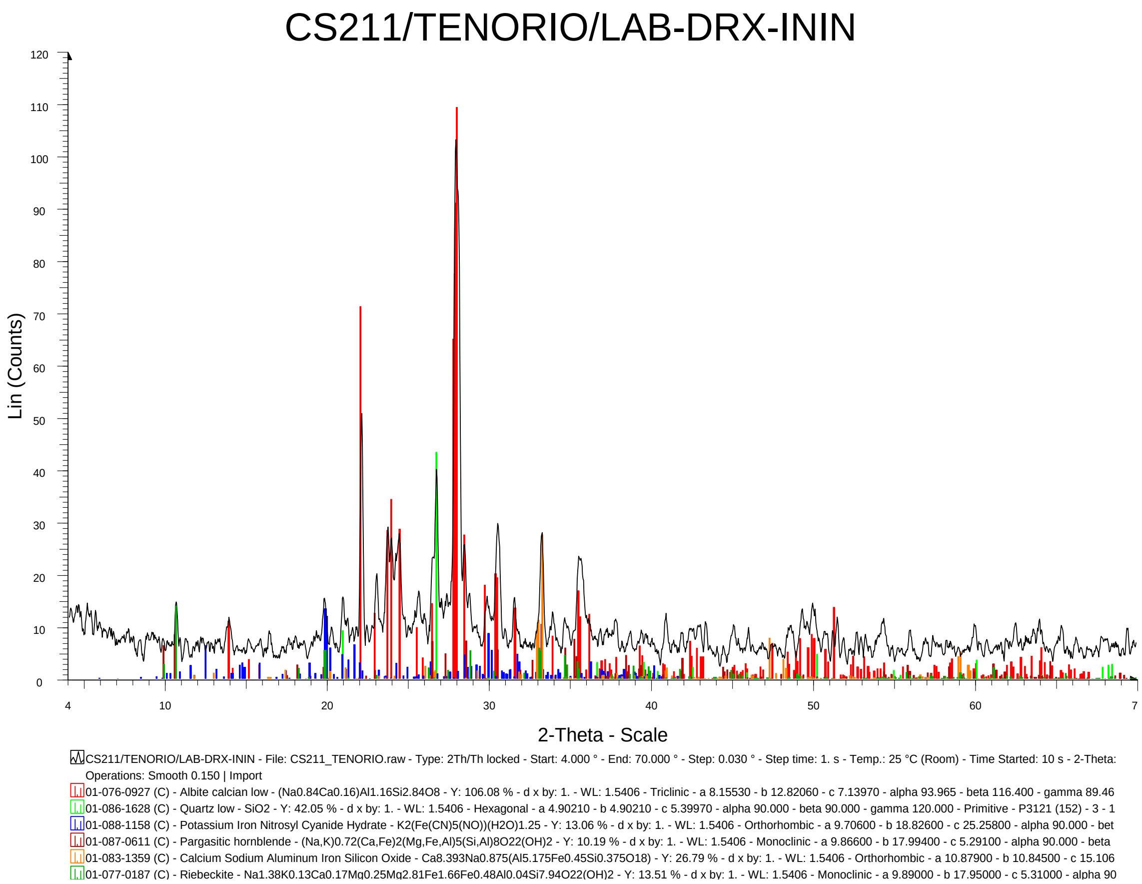

Figure E.31. X-ray diffraction pattern of pottery sample 211.

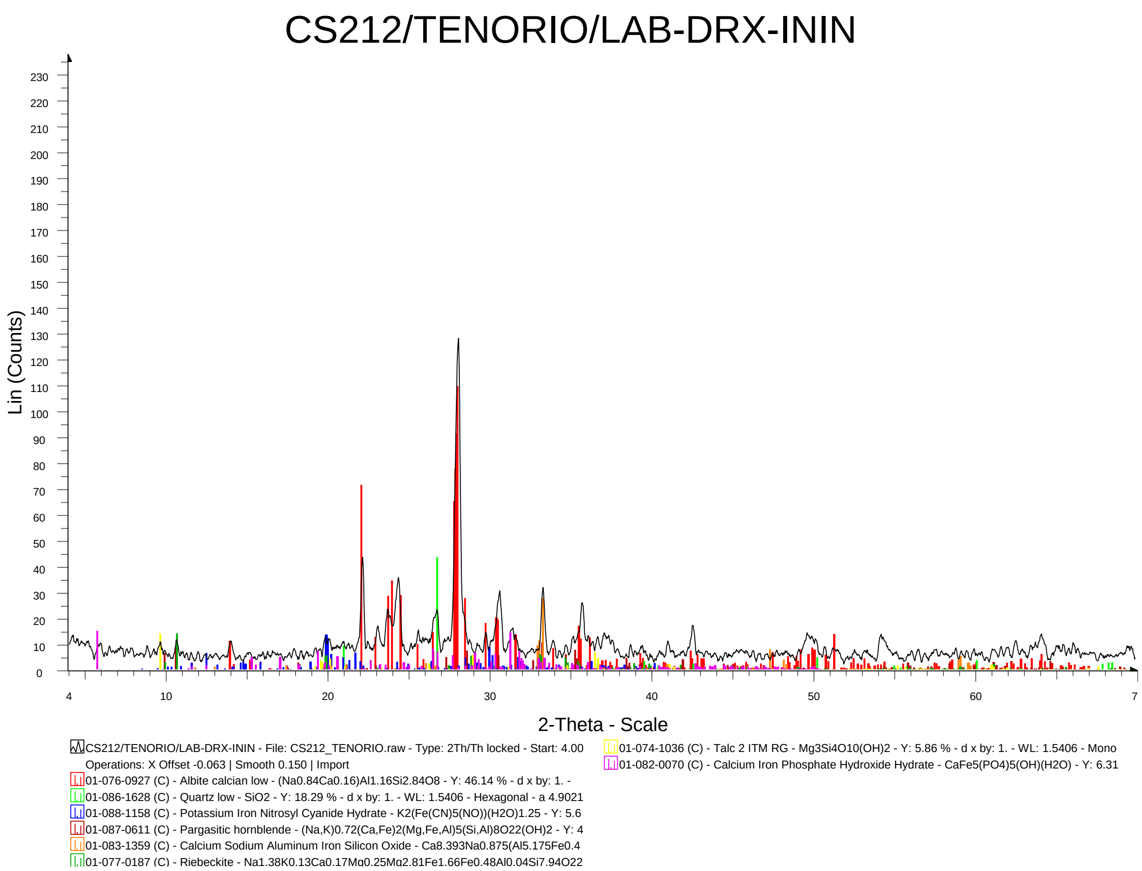

Figure E.32. X-ray diffraction pattern of pottery sample 212.

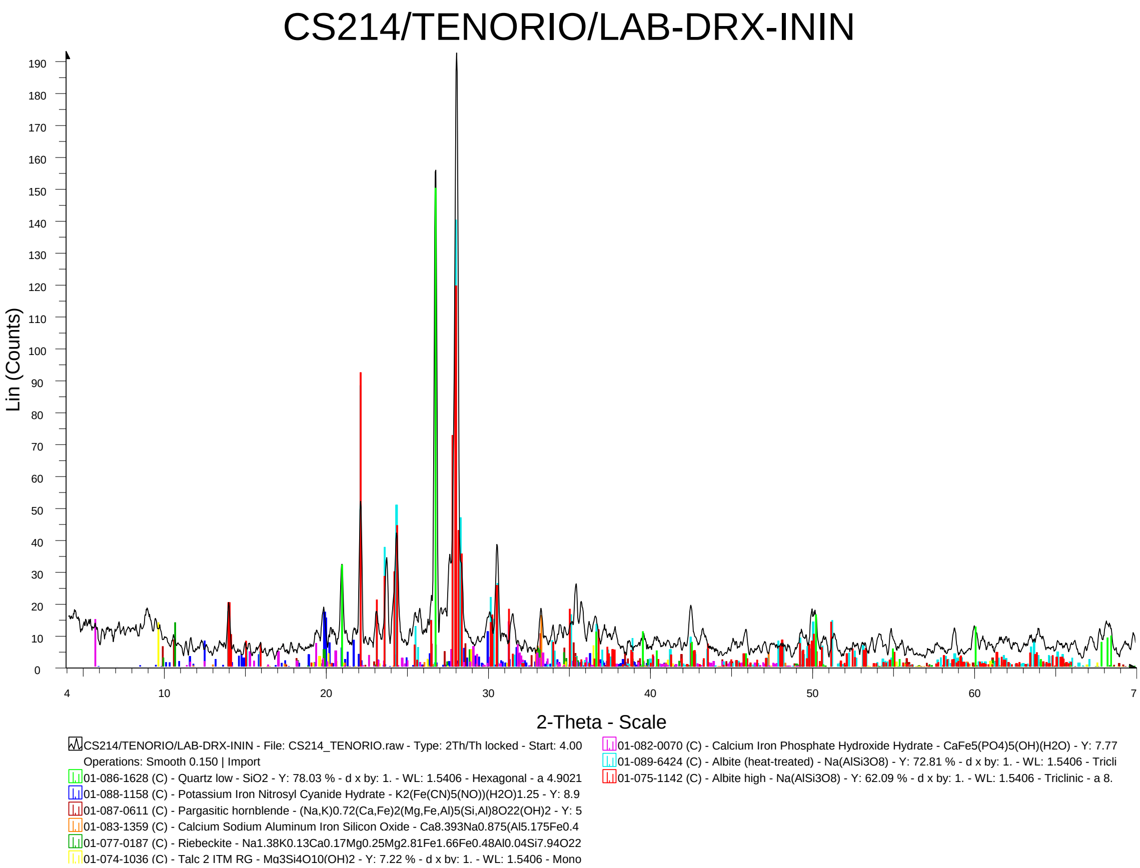

Figure E.33. X-ray diffraction pattern of pottery sample 214.

Table E.1. Qualitative mineralogy by XRD and final compositional groups. Key: ++, major; +, moderate, minor, or trace.

								Clay minerals		
Petrographic group: Sample	Plagioclase	Quartz	Calcite	Iron Oxide	Mica	Epidote	Amphibole	Smectite	Palygorskite	Pyrophyllite/ Talc
Colima Valley Group										
024	++	+				+				
154	++	+		++						
Salado River Basin Group 1										
005	++	+								
015	+	+			+					
021	++	+			+					
136	++	+					+			
149	++	++	+		+					
194	++	++		+	+					
Salado River Basin Group 2										
043	++	++								
056	++	+								
126	++	+			+					
168	++	++	++	+	+					
Tecomán Coastal Plain Group 1										
178	++	++	++	+	+					
Tecomán Coastal Plain Group 2										
181	++	++	++	+	+		+	+	+	
183	++	++	++	+	+		+	+		
Group H										
184	++	++	+	+	+	+				
Western Coast Group 1										
187	++	++	+	+	+					
188	+	++		+	+					
214	++	++	+				+			+
Western Coast Group 2										
211	++	++	+				+			

Petrographic group: Sample	Plagioclase	Quartz	Calcite	Iron Oxide	Mica	Epidote	Amphibole	Clay minerals		
								Smectite	Palygorskite	Pyrophyllite/ Talc
Group E										
209	++	++				+				
Group F										
205	++	++				+				
212	++	+	+				+			+

REFERENCES

Abbott, David R. 2000. *Ceramics and Community Organization among the Hohokam*. Tucson: The University of Arizona Press.

Acosta, Rosario, Susana Ramírez, and Luis Gómez. 1998. "Desarrollo sociocultural de la cuenca de Sayula durante la época prehispánica." In *El occidente de México: arqueología, historia y medio ambiente*, edited by Ricardo Ávila, Jean-Pierre Emphoux, Luis G. Gastélum, Susana Ramírez, Otto Schöndube, and Francisco Valdez, 101-118. Guadalajara, Mexico: Universidad de Guadalajara and ORSTOM.

Alcántara Salinas, Saúl Andrés. 2006. "Informe de los trabajos realizados en el Rescate Arqueológico 'La Primavera 2005'." Unpublished technical report at the INAH Technical Archive, Mexico City.

Alcántara Salinas, Saúl Andrés. 2007. "Rescates arqueológicos en Colima. Colección cerámica." Unpublished catalogue at the INAH Colima Centre.

Alcántara Salinas, Saúl Andrés. 2016. "La tumba de adobe: una cista funeraria de la fase cultural Armería (600-900 d.C.) en Colima." Paper presented at the XVII Encuentro Iberoamericano de Valorización y Gestión de Cementerios Patrimoniales, Santo Domingo, Dominican Republic, October 2016.

Almendros López, Laura, Dora Angélica Correa Fuentes, Maritza Cuevas Sagardi, Marina González Saravia González Saravia, Fernando Manuel González Zozaya, Rafael Platas Ruíz, Cynthia Marcela Polanco Isais, María Emilia Rangel Brun, and Juan Carlos Reyes Garza. 2012. *Geometrías de la imaginación. Diseño e iconografía de Colima*. Colima and México, D.F.: Secretaría de Cultura de Colima and CONACULTA.

Alvarado Méndez, Héctor, Julio Romo Ramírez, Pedro Munguía Rojas, and Rafael Vázquez Tortoledo. 2000. *Carta Geológico-Minera Manzanillo E-13-2-5*. 1:250,000. Pachuca: Servicio Geológico Mexicano.

Álvarez Pineda, Juan Manuel, Margarita Carballal Staedtler, María Antonieta Moguel Cós, Juan Carlos Olivares Orozco, Erika Patjane Alonso, Claudia Trejo Rodríguez, and Arturo Monteros Guijón. 2009. "Informe preliminar. Proyecto salvamento arqueológico L.T. Tapeixtles-Tecomán, Colima." Unpublished technical report at the INAH Technical Archive, Mexico City.

Angulo, Jorge. 2007. "Early Teotihuacan and Its Government." In *The Political Economy of Ancient Mesoamerica: Transformations during the Formative and Classic Periods*, edited by Vernon L. Scarborough and John E. Clark, 83-99. Albuquerque: University of New Mexico Press.

Anthony, John W., Richard A. Bideaux, Kenneth W. Bladh, and Monte C. Nichols, eds. 2001. *Handbook of Mineralogy*. Chantilly, VA: Mineralogical Society of America. http://www.handbookofmineralogy.org/.

Appadurai, Arjun. 1986. “Introduction: commodities and the politics of value.” In *The social life of things: commodities in cultural perspective*, edited by Arjun Appadurai, 3-63. Cambridge: Cambridge University Press.

Arnold, Dean E. 2000. “Does the Standardization of Ceramic Pastes Really Mean Specialization?” *Journal of Archaeological Method and Theory* 7(4): 333-75.

Arnold, Dean E., Hector Neff, and Roland L. Bishop. 1991. “Compositional Analysis and “Sources” of Pottery: An Ethnoarchaeological Approach.” *American Anthropologist* 93(1): 70-90.

Arnold, Dean E., Hector A. Neff, Roland L. Bishop, and Michael D. Glascock. 1999. “Testing Interpretative Assumptions of Neutron Activation Analysis: Contemporary Pottery in Yucatán, 1964-1994.” In *Material Meanings: critical approaches to the interpretation of material culture*, edited by Elizabeth S. Chilton, 61-84. Salt Lake City: The University of Utah Press.

Arnold, Philip J., III. 1991. *Domestic ceramic production and spatial organization: a Mexican case study in ethnoarchaeology*. Cambridge: Cambridge University Press.

Aronson, Meredith. 1996. “Technological Change: Ceramic mortuary technology in the Valley of Atemajac from the Late Formative to the Classic Periods.” *Ancient Mesoamerica* 7: 163-69.

Arthur, John W. 2003. “Brewing beer: status, wealth and ceramic use alteration among the Gamo of south-western Ethiopia.” *World Archaeology* 34(3): 516-28.

Baron, Joanne. 2016. “Patron Deities and Politics among the Classic Maya.” In *Political Strategies in Pre-Columbian Mesoamerica*, edited by Sarah Kurnick and Joanne Baron, 121-52. Boulder: University Press of Colorado.

Barrios, Feliciano, and José Manuel García Ruiz. 2000. *Carta Geológico-Minera Comala E13-B34*. 1:50,000. Pachuca: Servicio Geológico Mexicano.

Bauer, Andrew M., and Steve Kosiba. 2016. “How things act: An archaeology of materials in political life”. *Journal of Social Archaeology* 16(2): 115-41.

Baus Reed Czitrom, Carolyn. 1978. *Figurillas sólidas de estilo Colima: una tipología.* Colección Científica 66. México, D.F.: INAH and SEP.

Baxter, M. J., and I. C. Freestone. 2006. “Log-ratio compositional data analysis in archaeometry.” *Archaeometry* 48(3): 511-31.

Bayman, James M. 1999. “Craft economies in the North American Southwest.” *Journal of Archaeological Research* 7(3): 249-99.

Beekman, Christopher S. 1996. “El Complejo El Grillo del centro de Jalisco: una revisión de su cronología y significado.” In *Las cuencas del Occidente de México: época prehispánica*, edited by Eduardo Williams and Phil C. Weigand, 247-91. México, D.F. and Zamora, México: CEMCA, ORSTOM, and El Colegio de Michoacán.

Beekman, Christopher S. 2008. “Corporate Power Strategies in the Late Formative to Early Classic Tequila Valleys of Central Jalisco.” *Latin American Antiquity* 19(4): 414-34.

Beekman, Christopher S. 2010. “Recent Research in Western Mexican Archaeology.” *Journal of Archaeological Research* 18: 41-109.

Beekman, Christopher S. 2016. “Conflicting Political Strategies in Late Formative to Early Classic Central Jalisco.” In *Political Strategies in Pre-Columbian Mesoamerica*, edited by Sarah Kurnick and Joanne Baron, 97-120. Boulder: University Press of Colorado.

Bell, Betty. 1971. “Archaeology of Nayarit, Jalisco, and Colima.” In *Archaeology of Northern Mesoamerica. Part 2*, edited by Gordon Ekholm and Ignacio Bernal, 694-753. Handbook of Middle American Indians, Vol. 11. Austin: University of Texas Press.

Beltrán Medina, José Carlos. 1991. “Los Concheros del Puerto de Salagua.” Licenciatura thesis, Escuela Nacional de Antropología e Historia.

Beltrán Medina, José Carlos. 2005. “Playa del Tesoro.” In *Tesoros de Colima*: *Hallazgos de ayer y hoy*, 42-45. México, D.F.: Editorial Raíces, Gobierno del Estado de Colima, and Universidad de Colima.

Beltrán Medina, José Carlos, and Lourdes González Barajas. 2007. “La cerámica y las figurillas de Playa del Tesoro.” In *La producción alfarera en el México antiguo. Volumen IV*, edited by Beatriz Leonor Merino Carrión and Ángel García Cook, 165-85. México, D.F.: Instituto Nacional de Antropología e Historia.

Berdeja Martínez, Julio Adolfo. 1999. “Rescate Arqueológico Hospital Universitario y Tercer Anillo Periférico.” Unpublished technical report at the INAH Colima Centre.

Berdeja Martínez, Julio Adolfo. 2000. “Rescate Arqueológico Rancho San Francisco.” Unpublished technical report at the INAH Colima Centre.

Blanton, Richard E., Gary M. Feinman, Stephen A. Kowalewski, and Peter N. Peregrine. 1996. “A Dual-Processual Theory for the Evolution of Mesoamerican Civilization.” *Current Anthropology* 37(1): 1-13.

Blomster, Jeffrey P., Hector Neff, and Michael D. Glascock. 2005. “Olmec Pottery Production and Export in Ancient Mexico Determined Through Elemental Analysis.” *Science* 307: 1068-72.

Borgna, Elisabetta. 2004. “Aegean Feasting: A Minoan Perspective.” *Hesperia: The Journal of the American School of Classical Studies at Athens* 73(2): 247-79.

Braekmans, Dennis, and Patrick Degryse. 2017. “Petrography: Optical Microscopy.” In *The Oxford Handbook of Archaeological Ceramic Analysis*, edited by Alice M. W. Hunt, 233-265. Oxford: Oxford University Press. http://dx.doi.org/10.1093/oxfordhb/9780199681532.001.0001.

Brand, Donald D. 1960. *Coalcoman and Motines del Oro. An Ex-Distrito of Michoacan, Mexico*. Austin: University of Texas Press.

Bruman, Henry J. 2000. *Alcohol in Ancient Mexico*. Salt Lake City: The University of Utah Press.

Brumfiel, Elizabeth M. 1998. “The Multiple Identities of Aztec Craft Specialists.” *Archeological Papers of the American Anthropological Association* 8(1): 145-52.

Brumfiel, Elizabeth M., and Timothy K. Earle. 1987. “Specialization, exchange, and complex societies: an introduction.” In *Specialization, Exchange, and Complex Societies*, edited by E. M. Brumfiel and T. K. Earle, 1-9. Cambridge: Cambridge University Press.

Butterwick, Kristi. 2002. “Comida para los muertos: el arte de los banquetes en el Occidente.” In *El Antiguo Occidente de México: Arte y Arqueología de un Pasado Desconocido*, edited by Richard F. Townsend and Carlos Eduardo Gutiérrez Arce, 93-109. Colima: Gobierno del Estado de Colima.

Cabrera Cabello, Marco Antonio. 2007. “Informe Final de Rescate Arqueológico Parte del predio Rancho Blanco.” Unpublished technical report at the INAH Technical Archive, Mexico City.

Carot, Patricia. 2013. “La larga historia purépecha.” In *Miradas renovadas al Occidente indígena de México*, edited by Marie-Areti Hers, 133-214. México, D.F.: UNAM, INAH, and CEMCA.

Chávez Torres, Román Aurelio, and María Antonieta Moguel Cos. 2009. “Proyecto de Salvamento Arqueológico Terminal de Gas Natural Licuado Manzanillo. Segundo Informe Parcial.” Unpublished technical report at the INAH Technical Archive, Mexico City.

Childe, V. Gordon. 1925. *The Dawn of European Civilization*. London: Kegan Paul.

Childe, V. Gordon. 1956. *Piecing together the past*. London: Routledge and Kegan Paul.

Clark, John E. 1995. “Craft specialization as an archaeological category.” *Research in Economic Anthropology* 16: 267-94.

Clark, John E. 2007. "Mesoamerica's First State." In *The Political Economy of Ancient Mesoamerica: Transformations during the Formative and Classic Periods*, edited by Vernon L. Scarborough and John E. Clark, 11-46. Albuquerque: University of New Mexico Press.

Clark, John E., and Stephen D. Houston. 1998. "Craft specialization, gender, and personhood among the postconquest Maya of Yucatan, Mexico." *Archeological Papers of the American Anthropological Association* 8(1): 31-46.

Clark, John E., and William J. Parry. 1990. "Craft Specialization and Cultural Complexity." *Research in Economic Anthropology* 12: 289-346.

Clarke, David L. 1968. *Analytical archaeology*. London: Methuen.

Correa-Ascencio, Marisol, Ian G. Robertson, Oralia Cabrera-Cortés, Rubén Cabrera-Castro, and Richard P. Evershed. 2014. "Pulque production from fermented agave sap as a dietary supplement in Prehispanic Mesoamerica." *Proceedings of the National Academy of Sciences of the United States of America* 111(39): 14223-28.

Cortés, Hernán. 2005 [1519-1534]. *Cartas de Relación*. México, D.F.: Editorial Porrúa.

Costin, Cathy Lynne. 1986. "From Chiefdom to Empire State: Ceramic Economy Among the Prehispanic Wanka of Highland Peru." PhD dissertation, University of California, Los Angeles.

Costin, Cathy Lynne. 1991. "Craft Specialization: Issues in Defining, Documenting, and Explaining the Organization of Production." In *Archaeological Method and Theory 3*, edited by Michael B. Schiffer, 1-56. Tucson: The University of Arizona Press.

Costin, Cathy Lynne. 1998. "Introduction: craft and social identity." *Archeological Papers of the American Anthropological Association* 8(1): 3-16.

Costin, Cathy Lynne. 2005. "The Study of Craft Production." In *Handbook of Methods in Archaeology*, edited by H. D. G. Maschner and C. Chippindale, 1032-1105. Walnut Creek: AltaMira Press.

Cresswell, R. 1976. "Avant-propos." *Techniques et culture* 1: 5-6.

Cultrone, G., E. Molina, C. Grifa, and E. Sebastián. 2011. "Iberian ceramic production from Basti (Baza, Spain): first geochemical, mineralogical and textural characterization." *Archaeometry* 53(2): 340-63.

Dabney, Mary K., Paul Halstead, and Patrick Thomas. 2004. "Mycenaean Feasting on Tsoungiza at Ancient Nemea." *Hesperia: The Journal of the American School of Classical Studies at Athens* 73(2): 197-215.

Davenport, Bryce, and Charles Golden. 2016. “Landscapes, Lordships, and Sovereignty in Mesoamerica.” In *Political Strategies in Pre-Columbian Mesoamerica*, edited by Sarah Kurnick and Joanne Baron, 181-216. Boulder: University Press of Colorado.

David, Cybèle, Diana Platas, and Luis Manuel Gamboa Cabezas. 2007. “Estudio comparativo de las prácticas funerarias en Chupícacuaro, Guanajuato, y Buenaventura, Estado de México, durante la fase Ticomán.” In *Dinámicas culturales entre el Occidente, el Centro-Norte y la Cuenca de México, del Preclásico al Epiclásico*, edited by Brigitte Faugère, 85-110. Zamora, Mexico: El Colegio de Michoacán and CEMCA.

Davis, Sarah C., Emily R. Kuzmick, Nicholas Niechayev, and Douglas J. Hunsaker. 2017. “Productivity and water use efficiency of *Agave Americana* in the first field trail as bioenergy feedstock on arid lands.” *Global Change Biology Bioenergy* 9(2): 314-25.

Day, Peter M., Evangelina Kiriatzi, Alexandra Tsolakidou, and Vassilis Kilikoglou. 1999. “Group Therapy in Crete: A Comparison Between Analyses by NAA and Thin Section Petrography of Early Minoan Pottery.” *Journal of Archaeological Science* 26: 1025-36.

Day, Peter M., Maria Relaki, and Edward W. Faber. 2006. “Pottery making and social reproduction in the Bronze Age Mesara, Crete.” In *Pottery and Society: the Impact of Recent Studies in Minoan Pottery*, edited by M. H. Wiener, J. L. Warner, J. Polonsky, and E. E. Hayes, 22-72. Boston: Archaeological Institute of America.

Day, Peter M., Maria Relaki, and Simona Todaro. 2010. “Living from pots? Ceramic perspectives on the economies of Prepalatial Crete.” In *Political Economies of the Aegean Bronze Age*, edited by D. J. Pullen, 205-29. Oxford: Oxbow Books.

de Alcalá, Jerónimo. 2010 [1540]. *Relación de Michoacán*. Zamora, Michoacán: El Colegio de Michoacán.

DeMarrais, Elizabeth, Luis Jaime Castillo, and Timothy Earle. 1996. “Ideology, Materialization and Power Strategies.” *Current Anthropology* 37(1): 15-31.

Deraga, Daría, and Rodolfo Fernández. 1994. “Las Tumbas de Tiro de El Moralete, Colima.” *Barro Nuevo* Edición Especial: 27-30.

Dias, M. Isabel, M. Isabel Prudencio, M.A. Pinto De Matos, and A. Luisa Rodrigues. 2013. “Tracing the origin of blue and white Chinese Porcelain ordered for the Portuguese market during the Ming dynasty using INAA.” *Journal of Archaeological Science* 40: 3046-57.

Dietler, Michael. 2001. “Theorizing the Feast: Rituals of Consumption, Commensal Politics, and Power in African Contexts.” In *Feasts; archaeological and ethnographic perspectives on food, politics, and power*, edited by Michael Dietler and Brian Hayden, 65-114. Tuscaloosa: The University of Alabama Press.

Dietler, Michael, and Brian Hayden. 2001. “Digesting the Feast–Good to Eat, Good to Drink, Good to Think: An introduction.” In *Feasts; archaeological and ethnographic perspectives on food, politics, and power*, edited by Michael Dietler and Brian Hayden, 1-22. Tuscaloosa: The University of Alabama Press.

Dobres, Marcia-Anne. 2010. “Archaeologies of Technology.” *Cambridge Journal of Economics* 34: 103-14.

Donnan, Christopher B. 1971. “Ancient Peruvian potters’ marks and their interpretation through ethnographic analogy.” *American Antiquity* 36(4): 460-66.

Earle, Timothy. 1981. Comment to “Evolution of Specialized Pottery Production: A Trial Model.” *Current Anthropology* 22(3): 230-31.

Earle, Timothy. 2002. *Bronze Age Economics: The Beginnings of Political Economies*. Boulder: Westview Press.

Eglash, R. 2006. “Technology as material culture.” In *Handbook of Material Culture*, edited by Christopher Tilley, Webb Keane, Susanne Küchler, Mike Rowlands, and Patricia Spyer, 329-40. London: SAGE.

Eisleb, Dieter. 1971. *Westmexikanische Keramik*. Berlin: Staatliche Museen Preussischer Kulturbesitz.

Elizondo, Miguel. 2007. “El recorrido en busca de yacimientos y bancos de arcilla.” In *Arcillas y alfarería en Colima*, edited by Victoria Novelo, 20-23. Cuadernos de Investigación 1. Colima: Universidad de Colima.

Elizondo Mata, Miguel. 2007. “Anexo 5. Descripción de yacimientos y bancos de arcilla.” In *Arcillas y alfarería en Colima*, edited by Victoria Novelo, 78-84. Cuadernos de Investigación 1. Colima: Universidad de Colima.

Esposito, Arianna, and Julien Zurbach. 2014. “Technological standardization and cultural contact: some methodological considerations and two case studies.” In *Understanding standardization and variation in Mediterranean ceramics*, edited by Antonis Kotsonas, 39-48. Leuven: Peeters.

Evans, Susan Toby, and David L. Webster, eds. 2001. *Archaeology of Ancient Mexico and Central America: An Encyclopedia.* New York and London: Garland Publishing.

Fargher, Lane F. 2007. “A Microscopic View of Ceramic Production: An Analysis of Thin-Sections from Monte Albán.” *Latin American Antiquity* 18(3): 313-32.

Feinman, Gary M. 1999. “Rethinking Our Assumptions: Economic Specialization at the Household Scale in Ancient Ejutla, Oaxaca, Mexico.” In *Pottery and People: a dynamic interaction*, edited by James M. Skibo and Gary M. Feinman, 81-98. Salt Lake City: The University of Utah Press.

Feinman, Gary M. 2000. “Dual-processual theory and social formations in the southwest.” In *Alternative Leaderships Strategies in the Prehispanic Southwest*, edited by Barbara Mills, 181-204. Tucson: The University of Arizona Press.

Feinman, Gary M., and Linda M. Nicholas. 2007. “The Socioeconomic Organization of the Classic Period Zapotec State.” In *The Political Economy of Ancient Mesoamerica: Transformations during the Formative and Classic Periods*, edited by Vernon L. Scarborough and John E. Clark, 135-47. Albuquerque: University of New Mexico Press.

Flad, Rowan K., and Zachary X. Hruby. 2007. “”Specialized” Production in Archaeological Contexts: Rethinking Specialization, the Social Value of Products, and the Practice of Production.” *Archeological Papers of the American Anthropological Association* 17(1): 1-19.

Foias, Antonia E., and Ronald L. Bishop. 2007. “Pots, Sherds, and Glyphs: Pottery Production and Exchange in the Petexbatun Polity, Petén, Guatemala.” In *Pottery Economics in Mesoamerica*, edited by Christopher A. Pool and George J. Bey III, 212-36. Tucson: The University of Arizona Press.

Fournier, Patricia, Juan Cervantes Rosado, and M. James Blackman. 2006. “Mito y realidad del estilo epiclásico Coyotlatelco.” In *El fenómeno Coyotlatelco en el centro de México: Tiempo, espacio y significado*, edited by Laura Solar, 53-82. México, D.F.: INAH.

Fowles, Severin M., Leah Minc, Samuel Duwe, and David V. Hill. 2007. “Clay, Conflict and Village Aggregation: Compositional Analyses of Pre-Classic Pottery from Taos, New Mexico.” *American Antiquity* 72(1): 125-52.

Freestone, Ian C. 2001. “Post-depositional changes in archaeological ceramics and glasses.” In *Handbook of Archaeological Sciences*, edited by D. R. Brothwell and A. M. Pollard, 615-25. Chichester: John Wiley & Sons.

Gaitán Ammann, Felipe. 2005. “With a Hint of Paris in the Mouth: Fetishized Tootbrushes or the Sensuous Experience of Modernity in Late 19th Century Bogotá.” In *Archaeologies of Materiality*, edited by Lynn Meskell, 71-95. Oxford: Blackwell Publishing.

Galicia Flores, María Judith. 2014. “Descripción de un asentamiento rural en Higueras del Espinal: una unidad doméstica de la época Armería, Colima.” Paper presented at the XXX Mesa Redonda de la Sociedad Mexicana de Antropología, Santiago de Querétaro, Mexico, August 2014.

Galicia Flores, María Judith, and Olay Barrientos, María de los Ángeles. 2011. “Informe Técnico Final Salvamento Arqueológico ‘Quinta El Tívoli’.” Unpublished technical report at the INAH Technical Archive, Mexico City.

Glascock, Michael D., and Hector Neff. 2003. “Neutron activation analysis and provenance research in archaeology.” *Measurement Science and Technology* 14(9): 1516-26.

Glatz, Claudia, Anne Kandler, and James Steele. 2011. "Cultural Selection, Drift and Ceramic Diversity at Boğazköy-Hattusa." In *Evolutionary and interpretive archaeologies: a dialogue*, edited by E. E. Cochrane and A. Gardner, 199-226. Walnut Creek: Left Coast Press.

Gómez Chávez, Sergio. 2002. "Presencia del occidente de México en Teotihuacán. Aproximaciones a la política exterior del Estado teotihuacano." In *Ideología y política a través de materiales, imágenes y símbolos. Memoria de la Primera Mesa Redonda de Teotihuacan*, edited by María Elena Ruiz Gallut, 563-625. México, D.F.: UNAM, IIA, IIE, and INAH.

González Zozaya, Fernando, Rafael Platas Ruiz, and Maritza Cuevas Sagardi. 2007. "Presencia, uso e importancia de la planta del mezcal en el Colima prehispánico. Una mirada a través de su representación en los contextos funerarios." In *III Foro Colima y su Región: Arqueología, antropología e historia*, edited by Juan Carlos Reyes G., 1-18. Colima: Secretaría de Cultura, Gobierno del Estado de Colima. http://www.culturacolima.gob.mx/imagenes/foroscolima/3/10.pdf.

Goren, Yuval, Hans Mommsen, and Jörg Klinger. 2011. "Non-destructive provenance study of cuneiform tablets using portable X-ray fluorescence (pXRF)." *Journal of Archaeological Science* 38: 684-96.

Gosden, Chris. 2005. "What Do Objects Want?" *Journal of Archaeological Method and Theory* 12(3): 193-211.

Gosselain, Olivier P. 1998. "Social and Technical Identity in a Clay Crystal Ball." In *The Archaeology of Social Boundaries*, edited by Miriam T. Stark, 78-106. Washington, D.C.: Smithsonian Institution Press.

Grim, Ralph E., and Georges Kulbicki. 1961. "Montmorillonite-high temperature reactions and classification." *American Mineralogist* 46(11-2): 1329-69.

Hamilakis, Yannis. 1998. "Eating the Dead: Mortuary Feasting and the Politics of Memory in the Aegean Bronze Age Societies." In *Cemetery and Society in the Aegean Bronze Age*, edited by Keith Branigan, 115-32. Sheffield: Sheffield Academic Press.

Hayden, Brian. 2001. "Fabulous Feasts: A Prolegomenon to the Importance of Feasting." In *Feasts; archaeological and ethnographic perspectives on food, politics, and power*, edited by Michael Dietler and Brian Hayden, 23-64. Tuscaloosa: The University of Alabama Press.

Healan, Dan M. 2004. "Extracción prehispánica de obsidiana en el área de Ucareo-Zinapécuaro, Michoacán." In *Bienes estratégicos del antiguo occidente de México. Producción e intercambio*, edited by Eduardo Williams, 33-76. Zamora, Mexico: El Colegio de Michoacán.

Hegmon, Michelle. 1998. "Technology, style, and social practices: archaeological approaches." In *The Archaeology of Social Boundaries*, edited by Miriam T. Stark, 264-79. Washington, D.C.: Smithsonian Institution Press.

Hegmon, Michelle, Margaret C. Nelson, and Mark J. Ennes. 2000. “Corrugated Pottery, Technological Style, and Population Movement in the Mimbres Region of the American Southwest.” *Journal of Anthropological Research* 56(2): 217-40.

Hegmon, Michelle, Margaret C. Nelson, and Karen Gust Schollmeyer. 2016. “Experiencing Social Change: Life during the Mimbres Classic Transformation.” *Archeological Papers of the American Anthropological Association* 27(1): 54-73.

Henderson, Julian. 2000. *The Science and Archaeology of Materials: An investigation of inorganic materials.* London: Routledge.

Hernández Díaz, Verónica. 2013. “Las formas del arte en el antiguo Occidente.” In *Miradas renovadas al Occidente indígena de México*, edited by Marie-Areti Hers, 21-78. México, D.F.: UNAM, INAH and CEMCA.

Hernández Olvera, Joel, Alejandro Meraz Moreno, and Ma. Antonieta Moguel Cos. 2012. “Prácticas funerarias durante las fases Colima y Armería en un sitio costero de Manzanillo, estado de Colima.” In *Memoria del VII Foro Colima y su Región: Arqueología, antropología e historia*, 20-38. Colima: Secretaría de Cultura, Gobierno del Estado de Colima, and CONACULTA. http://www.culturacolima.gob.mx/imagenes/foroscolima/7/VII-FORO-COLIMA-Y-SU-REGION.pdf.

Hers, Marie-Areti. 2013a. “Introducción.” In *Miradas renovadas al Occidente indígena de México*, edited by Marie-Areti Hers, 11-20. México, D.F.: UNAM, INAH and CEMCA.

Hers, Marie-Areti. 2013b. “Un nuevo lenguaje visual en tiempos de rupturas (600-900 d.C.).” In *Miradas renovadas al Occidente indígena de México*, edited by Marie-Areti Hers, 215-52. México, D.F.: UNAM, INAH and CEMCA.

Hilditch, Jill. 2014. “Analyzing technological standardization: revisiting the Minoan conical cup.” In *Understanding standardization and variation in Mediterranean ceramics*, edited by Antonis Kotsonas, 25-38. Leuven: Peeters.

Hodder, Ian. 1982. *Symbols in action: Ethnoarchaeological studies of material culture*. Cambridge: Cambridge University Press.

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

Hruby, Julie. 2014. “Moving from ancient typology to an understanding of the causes of variability: a Mycenaean case study.” In *Understanding standardization and variation in Mediterranean ceramics*, edited by Antonis Kotsonas, 49-58. Leuven: Peeters.

Hurcombe, Linda. 2007. “A sense of materials and sensory perception in concepts of materiality.” *World Archaeology* 39(4): 532-45.

Ilieva, Petya. 2014. “Regional standardization and local variation: the case of the North Aegean G 2-3 ware.” In *Understanding standardization and variation in Mediterranean ceramics*, edited by Antonis Kotsonas, 85-96. Leuven: Peeters.

Ingold, Tim. 1990. “Society, nature and the concept of technology.” *Archaeological Review from Cambridge* 9(1): 5-17.

Inomata, Takeshi. 2016. “Theories of Power and Legitimacy in Archaeological Contexts: The Emergent Regime of Power at the Formative Maya Community of Ceibal, Guatemala.” In *Political Strategies in Pre-Columbian Mesoamerica*, edited by Sarah Kurnick and Joanne Baron, 37-60. Boulder: University Press of Colorado.

Instituto Nacional de Estadística, Geografía e Informática [INEGI]. 1994. *Carta Geológica Lázaro Cárdenas E13-6-9*. 1:250,000. México, D.F.: INEGI.

Instituto Nacional de Estadística, Geografía e Informática [INEGI]. 1998. *Anuario Estadístico. Colima.* Colima: INEGI and Gobierno del Estado de Colima.

Hull, Sharon, Mostafa Fayek, Frances Joan Mathien, Phillip Shelley, and Kathy Roler Durand. 2008. “A new approach to determining the geological provenance of turquoise artifacts using hydrogen and copper stable isotopes.” *Journal of Archaeological Science* 35: 1355-69.

Jarquín Pachecho, Ana María, and Enrique Martínez Vargas. 2005. “La Campana.” In *Tesoros de Colima*: *Hallazgos de ayer y hoy*, 38-41. México, D.F.: Editorial Raíces, Gobierno del Estado de Colima, and Universidad de Colima.

Jarquín Pacheco, Ana María, and Enrique Martínez Vargas. 2007. “La cerámica del Epiclásico y Posclásico temprano en la región de Colima.” In *La producción alfarera en el México antiguo. Volumen IV*, edited by Beatriz Leonor Merino Carrión and Ángel García Cook, 187-209. México, D.F.: Instituto Nacional de Antropología e Historia.

Jiménez Betts, Peter. 2007. “Alcances de la interacción entre el occidente y el noroeste de Mesoamérica en el Epiclásico.” In *Dinámicas culturales entre el Occidente, el Centro-Norte y la Cuenca de México, del Preclásico al Epiclásico*, edited by Brigitte Faugère, 157-63. Zamora, Mexico: El Colegio de Michoacán and CEMCA.

Johansen, Peter G., and Andrew M. Bauer. 2011. “Reconfiguring the ‘Political’ in the Reconstruction of Past Political Production.” In *The Archaeology of Politics: The Materiality of Political Practice and Action in the Past*, edited by Peter G. Johansen and Andrew M. Bauer, 1-28. Newcastle upon Tyne: Cambridge Scholars Publishing.

Jorge, Ana. 2009. “Technological Insights into Bell-Beakers: A Case Study from the Mondego Plateau, Portugal.” In *Interpreting Silent Artefacts: Petrographic Approaches to Archaeological Ceramics*, edited by Patrick Sean Quinn, 25-46. Oxford: Archaeopress.

Joyce, Arthur A., and Sarah B. Barber. 2015. “Ensoulment, Entrapment, and Political Centralization: A Comparative Study of Religion and Politics in Late Formative Oaxaca.” *Current Anthropology* 56(6): 819-46.

Joyce, Arthur A., Sarah B. Barber, Jeffrey Brzezinski, Carlo J. Lucido, and Víctor Salazar Chávez. 2016. “Negotiating Political Authority and Community in Terminal Formative Coastal Oaxaca.” In *Political Strategies in Pre-Columbian Mesoamerica*, edited by Sarah Kurnick and Joanne Baron, 61-96. Boulder: University Press of Colorado.

Kabata-Pendias, Alina. 2011. *Trace Elements in Soils and Plants*. Boca Raton: CRC Press.

Kan, Michael, Clement Meighan, and H. B. Nicholson. 1970. *Sculpture of Ancient West Mexico: Nayarit, Jalisco, Colima*. Los Angeles: Los Angeles County Museum of Art.

Kelly, Isabel. 1939-1971. Six volumes of field notes. Museo Regional de Guadalajara, Jalisco, Mexico.

Kelly, Isabel. 1947a. *Excavations at Apatzingan, Michoacan*. New York: Viking Fund.

Kelly, Isabel. 1947b. “Ceramic Provinces of Northwest Mexico.” In *El Occidente de México*. *Cuarta Reunión de Mesa Redonda*, 55-71. México, D.F.: Sociedad Mexicana de Antropología.

Kelly, Isabel. 1949. *The Archaeology of the Autlán-Tuxcacuesco Area of Jalisco: II. The Tuxcacuesco-Zapotitlán Zone*. Ibero-Americana 27. Berkeley and Los Angeles: University of California Press.

Kelly, Isabel. 1968. “Exploraciones en Colima.” Paper presented at the Museo Nacional de Antropología, 24 July 1968.

Kelly, Isabel. 1978. “Seven Colima Tombs: An interpretation of ceramic content.” *Contributions of the University of California Archaeological Research Facility* 36: 1-26.

Kelly, Isabel. 1980. *Ceramic Sequence in Colima: Capacha, an Early Phase*. Tucson: The University of Arizona Press.

Kelly, Isabel. 1989 [1939]. “An Archaeological Reconnaissance of the West Coast: Nayarit to Michoacán.” In *Homenaje a Isabel Kelly*, edited by Yólotl González, 71-74. Colección Científica 179. México, D.F.: INAH.

Kirchhoff, Paul. 1992. “Mesoamérica.” In *Una definición de Mesoamérica*, 28-45. México, D.F.: Instituto de Investigaciones Antropológicas.

Kopytoff, Igor. 1986. “The cultural biography of things: commoditization as process.” In *The social life of things: commodities in cultural perspective*, edited by Arjun Appadurai, 64-94. Cambridge: Cambridge University Press.

Kotsonas, Antonis. 2014. “Standardization, variation, and the study of ceramics in the Mediterranean and beyond.” In *Understanding standardization and variation in Mediterranean ceramics*, edited by Antonis Kotsonas, 7-24. Leuven: Peeters.

Krishnan, K., and Veena Rao. 1994. “A study of clay paste preparation by potters through grain size analysis.” *South Asian Studies* 10(1): 113-17.

Kurnick, Sarah. 2016. “Paradoxical Politics: Negotiating the Contradictions of Political Authority.” In *Political Strategies in Pre-Columbian Mesoamerica*, edited by Sarah Kurnick and Joanne Baron, 3-36. Boulder: University Press of Colorado.

Kurnick, Sarah, and Joanne Baron, eds. 2016. *Political Strategies in Pre-Columbian Mesoamerica*. Boulder: University Press of Colorado.

Lazzari, Marisa. 2005. “The Texture of Things: Objects, People, and Landscape in Northwestern Argentina (First Millennium A.D.).” In *Archaeologies of Materiality*, edited by Lynn Meskell, 126-61. Oxford: Blackwell Publishing.

Lazzari, Marisa. 2016. “Stones to Build a World: Circulation and Value of Materials in Pre-Columbian Northwestern Argentina.” *Cambridge Archaeological Journal* 26(1): 1-22.

Lebrón de Quiñones, Lorenzo. 1952 [1554]. *Relación Breve y Sumaria de la Visita Hecha por el Lic. Lorenzo Lebrón de Quiñones, Oidor del Nuevo Reino de Galicia, por Mandado de su Alteza*. Guadalajara, Mexico: Ediciones de la Junta Auxiliar Jalisciense de la Sociedad Mexicana de Geografía y Estadística.

Lechtman, Heather. 1977. “Style in Technology-Some Early Thoughts.” In *Material Culture: Styles, Organization, and Dynamics of Technology*, edited by H. Lechtman and R. Merrill, 3-20. St. Paul: West Publishing.

Leiva García, Pavel Carlos. 2007. “Informe preliminar del Rescate Arqueológico ‘Nuevo Milenio III’.” Unpublished technical report at the INAH Colima Centre.

Leiva García, Pavel Carlos, and María Judith Galicia Flores. 2015. “Sistemas de enterramientos en el valle de Colima: un estudio a partir de los rescates y salvamentos arqueológicos.” Paper presented at the XVI Encuentro Iberoamericano de Valorización y Gestión de Cementerios Patrimoniales, Lima, Peru, October 2015.

Lemonnier, Pierre. 1986. “The Study of Material Culture Today: Toward an Anthropology of Technical Systems.” *Journal of Anthropological Archaeology* 5: 147-86.

Lemonnier, Pierre. 1993. "Introduction." In *Technological Choices: Transformation in Material Cultures since the Neolithic*, edited by Pierre Lemonnier, 1-35. London: Routledge.

Liot, Catherine, Susana Ramírez Urrea, Javier Reveles, and Carmen Melgarejo. 2007. "Producción, distribución y relaciones interregionales en la cuenca de Sayula del 500 al 1100 d.C." In *Dinámicas culturales entre el Occidente, el Centro-Norte y la Cuenca de México, del Preclásico al Epiclásico*, edited by Brigitte Faugère, 165-200. Zamora, Mexico: El Colegio de Michoacán and CEMCA.

Livingstone Smith, A. 2000. "Processing Clay for Pottery in Northern Cameroon: Social and Technical Requirements." *Archaeometry* 42(1): 21-42.

Livingstone Smith, Alexandre, and Aline Viseyrias. 2010. "Shaping Kabambian Pottery: Identification and Definition of Technical Features." *The Open Anthropology Journal* 3: 124-41.

Long, Stanley V., and R. E. Taylor. 1966. "Suggested Revision for West Mexican Archaeological Sequences." *Science* 154(3755): 1456-59.

Longacre, William A. 1999. "Standardization and Specialization: What's the Link?" In *Pottery and People: a dynamic interaction*, edited by James M. Skibo and Gary M. Feinman, 44-58. Salt Lake City: The University of Utah Press.

López Mestas Camberos, Lorenza. 2005. "Producción especializada y representación ideológica en los albores de la tradición Teuchitlán." In *El antiguo occidente de México: nuevas perspectivas sobre el pasado prehispánico*, edited by Eduardo Williams, Phil C. Weigand, Lorenza López Mestas, and David C. Grove.

López Mestas Camberos, Lorenza. 2007. "La ideología. Un punto de acercamiento para el estudio de la interacción entre el occidente de México y Mesoamérica." In *Dinámicas culturales entre el Occidente, el Centro-Norte y la Cuenca de México, del Preclásico al Epiclásico*, edited by Brigitte Faugère, 37-50. Zamora, Mexico: El Colegio de Michoacán and CEMCA.

López Mestas Camberos, Lorenza, and Jorge Ramos de la Vega. 2002. "La excavación de la tumba de Huitzilapa." In *El Antiguo Occidente de México: Arte y Arqueología de un Pasado Desconocido*, edited by Richard F. Townsend and Carlos Eduardo Gutiérrez Arce, 56-73. Colima: Gobierno del Estado de Colima.

Luhr, James F., and Ian S. E. Carmichael. 1980. "The Colima Volcanic Complex, Mexico." *Contributions to Mineralogy and Petrology* 71: 343-72.

Lyons, Patrick D., and Alexander J. Lindsay, Jr. 2006. "Perforated Plates, Migration, and Roosevelt Red Ware." *Old Pueblo Archaeology* 44: 1-5,10.

Maggetti, Marino. 1982. "Phase Analysis and Its Significance for Technology and Origin." In *Archaeological Ceramics*, edited by Jacqueline S. Olin and Alan D. Franklin, 121-33. Washington, D.C.: Smithsonian Institution Press.

Manzanilla, Linda. 2003. “El proceso de abandono de Teotihuacan y su reocupación por grupos epiclásicos.” *Trace* 43: 70-76.

Manzanilla, Linda. 2004. “Sistemas Complejos en Mesoamérica.” In *Introducción a la Arqueología del Occidente de México*, edited by B. Braniff Cornejo, 179-214. Mexico City: Universidad de Colima, CONACULTA, and INAH.

Martin, Simon. 2016. “Reflections on the Archaeopolitical.” In *Political Strategies in Pre-Columbian Mesoamerica*, edited by Sarah Kurnick and Joanne Baron, 241-77. Boulder: University Press of Colorado.

Martínez, V., E. Tsantini, J. M. Gurt, and S. Pidaev. 2008. “Provenience and Technological study of the ceramics coming from the archaeological sites of Termez, Kampyr Tepe and Zar Tepe in Uzbekistan.” In *Preliminary Reports of the work of the International Pluridisciplinary Archaeological Expedition to Bactria 2008*. *Volume III*, edited by J. M. Gurt, S. Pidaev, A. M. Rauret, and S. Stride, 231-347. Uzbekistan and Barcelona: Institute of Archaeology of the Academy of Science of the Republic of Uzbekistan and Department of Prehistory, Ancient History and Archaeology of the University of Barcelona.

Martinón-Torres, Marcos, and David Killick. 2015. “Archaeological Theories and Archaeological Sciences.” In *The Oxford Handbook of Archaeological Theory*, edited by Andrew Gardner, Mark Lake, and Ulrike Sommer. http://dx.doi.org/10.1093/oxfordhb/9780199567942.013.004.

Martinón-Torres, Marcos, Xiuzhen Janice Li, Andrew Bevan, Yin Xia, Kun Zhao, and Thilo Rehren. 2014. “Forty Thousand Arms for a Single Emperor: From Chemical Data to the Labor Organization Behind the Bronze Arrows of the Terracota Army.” *Journal of Archaeological Method and Theory* 21(3): 534-62.

Matos Moctezuma, Eduardo. 1994. “Mesoamerica.” In *Historia Antigua de México. Volumen I: El México antiguo, sus áreas culturales, los orígenes y el horizonte Preclásico*, edited by Linda Manzanilla and Leonardo López Luján, 49-73. México, D.F.: INAH, UNAM, and Miguel Ángel Porrúa.

Meighan, Clement W. 1972. *Archaeology of the Morett Site, Colima*. Berkeley and Los Angeles: University of California Press.

Meighan, Clement W. 1974. “Prehistory of West Mexico.” *Science* 184(4143): 1254-61.

Meissner, Nathan J., Katherine E. South, and Andrew K. Balkansky. 2013. “Figurine Embodiment and Household Ritual in an Early Mixtec Village.” *Journal de la Société des Américanistes* 99(1): 7-43.

Meskell, Lynn. 2005. “Introduction: Object Orientations.” In *Archaeologies of Materiality*, edited by Lynn Meskell, 1-17. Oxford: Blackwell Publishing.

Michelaki, Kostalena, Leah Minc, and John O'Shea. 2002. "Integrating Typological and Physico-Chemical Approaches to Examine the Potter's Choice: a case from Bronze Age Hungary." In *Modern Trends in Scientific Studies on Ancient Ceramics*, edited by V. Kilikoglou, A. Hein, and Y. Maniatis, 313-22. BAR International Series 1011. Oxford: Archaeopress.

Migeon, Gérald, and Grégory Pereira. 2007. "La secuencia ocupacional y cerámica del cerro Barajas, Guanajuato, y sus relaciones con el centro, el occidente y el norte de México." In *Dinámicas culturales entre el Occidente, el Centro-Norte y la Cuenca de México, del Preclásico al Epiclásico*, edited by Brigitte Faugère, 201-30. Zamora, Mexico: El Colegio de Michoacán and CEMCA.

Miksa, Elizabeth J., and James M. Heidke. 2001. "It All Comes Out in the Wash: Actualistic Petrofacies Modeling of Temper Provenance, Tonto Basin, Arizona, USA." *Geoarchaeology* 16(2): 177-222.

Milller, Daniel, and Christopher Tilley. 1984. "Ideology, power and prehistory: An introduction." In *Ideology, power and prehistory*, edited by Daniel Miller and Christopher Tilley, 1-16. Cambridge: Cambridge University Press.

Miller, Eugene F. 1980. "What Does Political Mean?" *The Review of Politics* 42(1): 56-72.

Millon, René. 1993. "The Place Where The Time Began: An Archaeologist's Interpretation of What Happened in Teotihuacan History." In *Teotihuacan: Art from the City of the Gods*, edited by Kathleen Berrin and Esther Pasztory, 16-43. New York: Thames and Hudson.

Mills, Barbara J., and Patricia L. Crown. 1995. "Ceramic Production in the American Southwest: An Introduction." In *Ceramic Production in the American Southwest*, edited by Barbara J. Mills and Patricia L. Crown, 1-29. Tucson: The University of Arizona Press.

Minc, L. D., and R. J. Sherman. 2011. "Assessing Natural Clay Composition in the Valley of Oaxaca as a Basis for Ceramic Provenance Studies." *Archaeometry* 53(2): 285-328.

Mommsen, H. 2001. "Provenance determination of pottery by trace element analysis: Problems, solutions and applications." *Journal of Radioanalytical and Nuclear Chemistry* 247(3): 657-62.

Morales, Juan José. 1978 [1778]. *Iztlahuacán y sus Pueblos.* México, D.F.: Club del Libro Colimense.

Morgan, Catherine, and Todd Whitelaw. 1991. "Pots and Politics: Ceramic Evidence for the Rise of the Argive State." *American Journal of Archaeology* 95(1): 79-108.

Mountjoy, Joseph B., and María de los Ángeles Olay Barrientos. 2005. "La arqueología de Colima." In *Tesoros de Colima*: *Hallazgos de ayer y hoy*, 22-35. México, D.F.: Editorial Raíces, Gobierno del Estado de Colima, and Universidad de Colima.

Munguía Rojas, Pedro, Luciano Hernández Noriega, and Tonatiuh Escamilla Torres. 1996. *Carta Geológico-Minera Manzanillo E13-B43*. 1:50,000. Pachuca: Servicio Geológico Mexicano.

Murakami, Tatsuya. 2016. "Entangled Political Strategies: Rulership, Bureaucracy, and Intermediate Elites at Teotihuacan." In *Political Strategies in Pre-Columbian Mesoamerica*, edited by Sarah Kurnick and Joanne Baron, 153-80. Boulder: University Press of Colorado.

Naamoun, T. 2002. "Uranium tailings of "Schneckenstein" (Germany) reservoir of contaminants." In *Tailings and Mine Waste '02*, 231-41. Lisse: A.A.Balkema Publishers.

Neff, Hector. 2000. "Neutron Activation Analysis for provenance determination in archaeology." In *Modern Analytical Methods in Art and Archaeology*, edited by E. Ciliberto and G. Spoto, 81-134. New York: John Wiley & Sons.

Neff, Hector, Ronald L. Bishop, and Edward V. Sayre. 1989. "More Observations on the Problem of Tempering in Compositional Studies of Archaeological Ceramics." *Journal of Archaeological Science* 16: 57-69.

Neff, Hector, Jeffrey Blomster, Michael D. Glascock, Ronald L. Bishop, M. James Blackman, Michael D. Coe, George L. Cowgill, Ann Cyphers, Richard A. Diehl, Stephen Houston, Arthur A. Joyce, Carl P. Lipo, and Marcus Winter. 2006. "Smokescreens in the Provenance Investigation of Early Formative Mesoamerican Ceramics." *Latin American Antiquity* 17(1): 104-18.

Novella, Roberto, Javier Martínez, and M. Antonieta Moguel. 2002. *La Costa Norte de Michoacán en la época prehispánica*. BAR International Series 1071. Oxford: Archaeopress.

Novelo, Victoria, ed. 2007a. *Arcillas y alfarería en Colima*. Cuadernos de Investigación 1. Colima: Universidad de Colima.

Novelo, Victoria. 2007b. "Situación general de la alfarería en Colima." In *Arcillas y alfarería en Colima*, edited by Victoria Novelo, 14-19. Cuadernos de Investigación 1. Colima: Universidad de Colima.

Noyola, Andrés. 1994. "Análisis preliminar de la cerámica del fraccionamiento San Juan, Atoyac, Jalisco." In *Contribuciones a la arqueología y etnohistoria del Occidente de México*, edited by Eduardo Williams, 55-91. Zamora, Mexico: El Colegio de Michoacán.

Ohnersorgen, Michael A., and Mark D. Varien. 1996. "Formal Architecture and Settlement Organization in Ancient West Mexico." *Ancient Mesoamerica* 7: 103-20.

Olay Barrientos, María de los Ángeles. 1993. “Las tumbas de tiro de Las Ánimas, Colima.” *Arqueología Mexicana* 4: 78-80.

Olay Barrientos, María de los Ángeles. 1994. “El Colima prehispánico. Un intento de regionalización.” *Barro Nuevo* Edición Especial: 17-26.

Olay Barrientos, María de los Ángeles. 2004a. “Arqueología de Colima.” In *Introducción a la Arqueología del Occidente de México*, edited by B. Braniff Cornejo, 271-308. Mexico City: Universidad de Colima, CONACULTA, and INAH.

Olay Barrientos, María de los Ángeles. 2004b. *El Chanal, Colima. Lugar que habitan los custodios del agua.* Colima and México, D.F.: Universidad de Colima and INAH.

Olay Barrientos, María de los Ángeles. 2012. *Volcán de Fuego: cuna del agua, morada del viento*. *Desarrollo social y procesos de cambio en el valle de Colima: una propuesta de interpretación. Volumen II.* México, D.F. and Zamora, México: Instituto Nacional de Antropología e Historia and El Colegio de Michoacán.

Olay Barrientos, María de los Ángeles, Rafael Platas Ruiz, Maritza Cuevas Sagardí, Tobías García Vilchis, and Jaime Aguilar Rodríguez. 2008. “Informe / Dictamen Relativo a la 1ª Etapa del Salvamento Arqueológico de la Terminal Marítima de Gas de Manzanillo (TMGM).” Unpublished technical report at the INAH Technical Archive, Mexico City.

Olivares Orozco, Juan Carlos, and María Judith Galicia Flores. 2010. “Interacción de Regiones Culturales de Colima y Jalisco. Proyecto Arqueológico Gasoducto Manzanillo-Guadalajara.” Paper presented at the XXIX Mesa Redonda de la Sociedad Mexicana de Antropología, Puebla de Zaragoza, Mexico, July 2010.

Oliveros Morales, Arturo. 2007. “Reflexiones sobre las dinámicas culturales, a partir de un sitio arqueológico del Formativo medio en Michoacán.” In *Dinámicas culturales entre el Occidente, el Centro-Norte y la Cuenca de México, del Preclásico al Epiclásico*, edited by Brigitte Faugère, 23-36. Zamora, Mexico: El Colegio de Michoacán and CEMCA.

Orton, Clive, Paul Tyers, and Alan Vince. 1993. *Pottery in archaeology*. Cambridge: Cambridge University Press.

Overholtzer, Lisa, and Wesley D. Stoner. 2011. “Merging the social and the material: Life histories of ancient mementos from Central Mexico.” *Journal of Social Archaeology* 11(2): 171-93.

Padilla Lozoya, Raymundo. 2006. *El huracán del 59. Historia del desastre y reconstrucción de Minatitlán, Colima*. Colima: Universidad de Colima.

Peacock, David P. S. 1982. *Pottery in the Roman World: an ethnoarchaeological approach*. London and New York: Longman.

Pérez Lambán, Fernando, Javier Fanlo Loras, Jesús V. Picazo Millán, and José María Rodanés Vicente. 2014. "Ceramic variability and social organization in the Early Iron Age settlement of Cabezo de la Cruz (Zaragoza, northeast Spain)." In *Understanding standardization and variation in Mediterranean ceramics*, edited by Antonis Kotsonas, 97-114. Leuven: Peeters.

Pollard, Helen Perlstein. 1994. "Ethnicity and political control in a complex society: the Tarascan state of prehispanic Mexico." In *Factional competition and political development in the New World*, edited by Elizabeth M. Brumfiel and John W. Fox, 79-88. Cambridge: Cambridge University Press.

Pollard, Helen Perlstein. 1996. "La Transformación de Élites Regionales en Michoacán Central." In *Las cuencas del Occidente de México: época prehispánica*, edited by E. Williams and P. C. Weigand, 131-56. Zamora, Mexico: ORSTOM, El Colegio de Michoacán, and CEMCA.

Pollard, Helen Perlstein. 1997. "Recent Research in West Mexican Archaeology." *Journal of Archaeological Research* 5(4): 345-84.

Postgate, J. N. 2007. "The Ceramics of Centralisation and Dissolution: A Case Study from Rough Cilicia." *Anatolian Studies* 57: 141-50.

Prehistoric Ceramics Research Group. 2010. "The study of prehistoric pottery: general policies and guidelines for analysis and publication." *Occasional Papers* 1 and 2.

Quesada, Pablo. 2007. "Características de las arcillas." In *Arcillas y alfarería en Colima*, edited by Victoria Novelo, 37-44. Cuadernos de Investigación 1. Colima: Universidad de Colima.

Quinn, Patrick Sean. 2013. *Ceramic Petrography: The Interpretation of Archaeological Pottery & Related Artefacts in Thin Section*. Oxford: Archaeopress.

Rasmussen, Kaare Lund, Guillermo A. De La Fuente, Andrew D. Bond, Karsten Korsholm Mathiesen, and Sergio D. Vera. 2012. "Pottery firing temperatures: a new method for determining the firing temperature of ceramics and burnt clay." *Journal of Archaeological Science* 39: 1705-16.

Reedy, Chandra L. 2008. *Thin-section Petrography of Stone and Ceramic Cultural Materials*. London: Archetype.

Renfrew, Colin. 1986. "Varna and the emergence of wealth in prehistoric Europe." In *The social life of things: commodities in cultural perspective*, edited by Arjun Appadurai, 141-68. Cambridge: Cambridge University Press.

Reyes Garza, Juan Carlos. 1995. *La Antigua Provincia de Colima. Siglos XVI a XVIII*. Historia General de Colima. Volumen II. Colima: Gobierno del Estado de Colima, Universidad de Colima, and CNCA.

Reyes Garza, Juan Carlos. 2000. *Al pie del volcán: los indios de Colima en el virreinato*. Colección Historia de los pueblos indígenas de México. Mexico City: CIESAS, INI, and Gobierno del Estado de Colima.

Rice, Prudence M. 1981. "Evolution of Specialized Pottery Production: A Trial Model (and Comments and Reply)." *Current Anthropology* 22(3): 219-40.

Rice, Prudence M. 1987. *Pottery analysis: a sourcebook.* Chicago: The University of Chicago Press.

Rice, Prudence M. 1989. "Ceramic diversity, production, and use." In *Quantifying diversity in archaeology*, edited by Robert D. Leonard and George T. Jones, 109-17. Cambridge: Cambridge University Press.

Rice, Prudence M. 1991. "Specialization, Standardization and Diversity: a retrospective." In *The ceramic legacy of Anna O. Shepard*, edited by Frederick W. Lange and Ronald L. Bishop, 257-79. Niwot: University Press of Colorado.

Rodríguez-Ramírez, A., M. Caballero, P. Roy, B. Ortega, G. Vázquez-Castro, and S. Lozano-García. 2015. "Climatic variability and human impact during the last 2000 years in western Mesoamerica: evidence of late Classic (AD 600-900) and Little Ice Age drought events." *Climate of the Past* 11: 1239-48.

Rosales Franco, Enrique, and Virgilio Rodríguez Lara. 2010. *Carta Geológico-Minera Colima E13-B44*. 1:50,000. Pachuca: Servicio Geológico Mexicano.

Roux, Valentine, and Marie-Agnès Courty. 2005. "Identifying Social Entities at a Macro-Regional level: Chalcolithic Ceramics of South Levant as a Case Study." In *Pottery Manufacturing Processes: Reconstruction and Interpretation*, edited by Alexandre Livingstone Smith, Dominique Bosquet, and Rémi Martineau, 201-14. BAR International Series 1349. Oxford: Archaeopress.

Salgado Ceballos, Carlos Andrés. 2007. "Las fases cerámicas Colima y Armería: una reconsideración." Licenciatura thesis, Universidad de las Américas-Puebla.

Salgado Ceballos, Carlos Andrés. 2008. "Continuidad y Ruptura: Las Nuevas Tradiciones y el ocaso de la Tradición de Tumbas de Tiro en Colima y el sur de Jalisco." Unpublished paper.

Salminen, R., M. J. Batista, M. Bidovec, A. Demetriades, B. De Vivo, W. De Vos, M. Duris, A. Gilucis, V. Gregorauskiene, J. Halamic, P. Heitzmann, A. Lima, G. Jordan, G. Klaver, P. Klein, J. Lis, J. Locutura, K. Marsina, A. Mazreku, P. J. O'Connor, S. Å. Olsson, R.-T. Ottesen, V. Petersell, J. A. Plant, S. Reeder, I. Salpeteur, H. Sandström, U. Siewers, A. Steenfelt, T. Tarvainen. 2005. *Geochemical Atlas of Europe. Part 1: Background Information, Methodology and Maps*. Espoo: Geological Survey of Finland. http://www.gtk.fi/publ/foregsatlas/.

Santacreu, Daniel Albero. 2011. "What The Fire Says: Firing Strategies In Bronze Age Potteries From The Balearic Islands (1700-850 B.C.)." *The Old Potter's Almanack* 16(1): 1-4.

Santacreu, Daniel Albero. 2014. *Materiality, Techniques and Society in Pottery Production: The Technological Study of Archaeological Ceramics through Paste Analysis*. Warsaw and Berlin: De Gruyter Open.

Sassaman, Kenneth E., and Wictoria Rudolphi. 2001. “Communities of Practice in the Early Pottery Traditions of the American Southeast.” *Journal of Anthropological Research* 57(4): 407-25.

Sauer, Carl. 1948. *Colima of New Spain in the Sixteenth Century*. Ibero-Americana 29. Berkeley and Los Angeles: University of California Press.

Scarborough, Vernon L., and John E. Clark, eds. 2007. *The Political Economy of Ancient Mesoamerica: Transformations during the Formative and Classic Periods*. Albuquerque: University of New Mexico Press.

Schöndube Baumbach, Otto. 1994. *El pasado de tres pueblos: Tamazula, Tuxpan, Zapotlán*. Guadalajara, Mexico: Universidad de Guadalajara.

Schöndube Baumbach, Otto. 2005. “Colima y el Occidente de México.” In *Tesoros de Colima*: *Hallazgos de ayer y hoy*, 12-21. México, D.F.: Editorial Raíces, Gobierno del Estado de Colima, and Universidad de Colima.

Secretaría de Agricultura y Recursos Hidráulicos [SARH]. 1990. *Sinopsis Geohidrológica del Estado de Colima*. México, D.F.: SARH and Comisión Nacional del Agua.

Secretaría de Programación y Presupuesto [SPP]. 1981. *Síntesis Geográfica de Colima*. México, D.F.: SPP and Coordinación General de los Servicios Nacionales de Estadística, Geografía e Informática.

Secretaría de Programación y Presupuesto [SPP]. 1982. *Carta Geológica Colima E13-3*. 1:250,000. México, D.F.: SPP.

Secretaría de Programación y Presupuesto [SPP]. 1984. *Carta Geológica Tecomán E13B54*. 1:50,000. México, D.F.: SPP.

Sevilla del Río, Felipe. 1973. *Breve estudio sobre la Conquista y fundación de Coliman*. México, D.F.: Colección Peña Colorada.

Sharer, Robert J. 2007. “Early Formative pottery trade and the evolution of Mesoamerican civilisation.” *Antiquity* 81: 201-03.

Shennan, Stephen. 1994. “Introduction: archaeological approaches to cultural identity.” In *Archaeological Approaches to Cultural Identity*, edited by Stephen Shennan, 1-32. London: Routledge.

Shennan, Stephen. 1997. *Quantifying Archaeology*. Iowa City: University of Iowa Press.

Shennan, Stephen. 2006. “Analytical Archaeology.” In *A Companion to Archaeology*, edited by John Bintliff, 3-20. Oxford: Blackwell Publishing.

Shepard, Anna O. 1971. *Ceramics for the archaeologist*. Washington, D.C.: Carnegie Institution of Washington.

Sillar, B., and M. S. Tite. 2000. "The Challenge of 'Technological Choices' for Material Sciences Approaches in Archaeology." *Archaeometry* 42(1): 2-20.

Sinopoli, Carla M. 1991. *Approaches to Archaeological Ceramics*. New York: Plenum Press.

Skibo, James M. 1999. "Pottery and People." In *Pottery and People: a dynamic interaction*, edited by James M. Skibo and Gary M. Feinman, 1-8. Salt Lake City: The University of Utah Press.

Skibo, James M. 2013. *Understanding Pottery Function*. New York: Springer.

Skibo, James M. 2015. "Pottery Use-Alteration Analysis." In *Use-Wear and Residue Analysis in Archaeology*, edited by Joao Manuel Marreiros, Juan F. Gibaja Bao, and Nuno Ferreira Bicho, 189-98. New York: Springer.

Skibo, James M., and Michael Brian Schiffer. 2008. *People and Things: A Behavioral Approach to Material Culture*. New York: Springer.

Small, David B. 2009. "The dual-processual model in ancient Greece: Applying a post-neoevolutionary model to a data-rich environment." *Journal of Anthropological Archaeology* 28: 205-21.

Smith, Adam T. 2011a. "Figuring the Political: The Stuff of Sovereignty in a Post-Evolutionary Archaeology." In *The Archaeology of Politics: The Materiality of Political Practice and Action in the Past*, edited by Peter G. Johansen and Andrew M. Bauer, 354-61. Newcastle upon Tyne: Cambridge Scholars Publishing.

Smith, Adam T. 2011b. "Archaeologies of Sovereignty." *Annual Review of Anthropology* 40: 415-32.

Smith, Scott C. 2016. *Landscape and Politics in the Ancient Andes: biographies of place at Khonkho Wankane*. Albuquerque: University of New Mexico Press.

Smith, Scott C., and John W. Janusek. 2014. "Political mosaics and networks: Tiwanaku expansion into the upper Desaguadero Valley, Bolivia." *World Archaeology* 46(5): 681-704.

Sommer, Ulrike. 2011. "Tribes, Peoples, Ethnicity: Archaeology and Changing 'We Groups'." In *Evolutionary and interpretive archaeologies: a dialogue*, edited by Ethan E. Cochrane and Andrew Gardner, 169-98. Walnut Creek: Left Coast Press.

Stark, Barbara L. 2007. "Out of Olmec." In *The Political Economy of Ancient Mesoamerica: Transformations during the Formative and Classic Periods*, edited by Vernon L. Scarborough and John E. Clark, 47-63. Albuquerque: University of New Mexico Press.

Stark, Miriam T., ed. 1998. *The Archaeology of Social Boundaries*. Washington, D.C.: Smithsonian Institution Press.

Stark, Miriam T. 1999. “Social Dimensions of Technological Choice in Kalinga Ceramic Traditions.” In *Material Meanings: critical approaches to the interpretation of material culture*, edited by Elizabeth S. Chilton, 24-43. Salt Lake City: The University of Utah Press.

Stark, Miriam T., and James M. Heidke. 1998. “Ceramic manufacture, productive specialization, and the Early Classic period in Arizona’s Tonto basin.” *Journal of Archaeological Research* 54: 497-517.

Stissi, Vladimir. 2014. “Standardization and Greek pottery, a broad view from far above.” In *Understanding standardization and variation in Mediterranean ceramics*, edited by Antonis Kotsonas, 115-31. Leuven: Peeters.

Stoltman, James B. 1999. “The Chaco-Chuska Connection: In Defense of Anna Shepard.” In *Pottery and People: a dynamic interaction*, edited by James M. Skibo and Gary M. Feinman, 9-24. Salt Lake City: The University of Utah Press.

Stoltman, James B., Joyce Marcus, Kent V. Flannery, James H. Burton, and Robert G. Moyle. 2005. “Petrographic evidence shows that pottery exchange between the Olmec and their neighbors was two-way.” *Proceedings of the National Academy of Sciences of the United States of America* 102(32): 11213-18.

Stoner, Wesley D., John K. Millhauser, Enrique Rodríguez-Alegría, Lisa Overholtzer, and Michael D. Glascock. 2014. “Taken with a Grain of Salt: Experimentation and the Chemistry of Archaeological Ceramics from Xaltocan, Mexico.” *Journal of Archaeological Method and Theory* 21: 862-98.

Stross, Brian. 1998. “Seven ingredients in Mesoamerican ensoulment: Dedication and termination in Tenejapa.” In *The sowing and the dawning: Termination, dedication, and transformation in the archaeological and ethnographic record of Mesoamerica*, edited by S. B. Mock, 31-40. Albuquerque: University of New Mexico Press.

Summerhayes, Glenn R. 1997. “Losing your temper: the effect of mineral inclusions on pottery analyses.” *Archaeology in Oceania* 32(3): 108-17.

Thér, R. 2016. “Identification of Pottery-forming Techniques Using Quantitative Analysis of the Orientation of Inclusions and Voids in Thin Sections.” *Archaeometry* 58(2): 222-38.

Thér, R., and M. Gregor. 2011. “Experimental reconstruction of the pottery firing process of Late Broze Age pottery from north-eastern Bohemia.” In *Archaeological Ceramics: A Review of Current Research*, edited by S. Scarcella, 128-42. BAR International Series 2193. Oxford: Archaeopress.

Tilley, Christopher. 2006. Introduction to Theoretical Perspectives. In *Handbook of Material Culture*, edited by Christopher Tilley, Webb Keane, Susanne Küchler, Mike Rowlands, and Patricia Spyer, 1-6. London: SAGE.

Tilley, Christopher, Webb Keane, Susanne Küchler, Mike Rowlands, and Patricia Spyer, eds. 2006. *Handbook of Material Culture*. London: SAGE.

Tite, M. S. 2008. "Ceramic production, provenance and use: a review." *Archaeometry* 50(2): 216-31.

Tomaszewski, Brian M., and Michael E. Smith. 2011. "Polities, territory and historical change in Postclassic Matlatzinco (Toluca Valley, central Mexico)." *Journal of Historical Geography* 37: 22-39.

Valadez Azúa, Raúl, Bernardo Rodríguez Galicia, and Alicia Blanco Padilla. 2007. "Flujos migratorios e influencias culturales entre el centro, el occidente y el noroccidente de Mesoamérica, vistos a través de la fauna doméstica." In *Dinámicas culturales entre el Occidente, el Centro-Norte y la Cuenca de México, del Preclásico al Epiclásico*, edited by Brigitte Faugère, 231-45. Zamora, Mexico: El Colegio de Michoacán and CEMCA.

Valdez, Francisco. 1996. "Tiempo, espacio y cultura en la Cuenca de Sayula." *Estudios del Hombre* 3: 15-36.

Valdez, Francisco, Catherine Liot, Rosario Acosta, and Jean Pierre Emphoux. 1996. "The Sayula Basin: Lifeways and salt flats of central Jalisco." *Ancient Mesoamerica* 7: 171-86.

van der Leeuw, S. E. 1977. "Towards a Study of the Economics of Pottery Making." In *Ex Horreo*, edited by B. L. Beek, R. W. Brant, and W. Gruenman van Watteringe, 68-76. Amsterdam: Universiteit van Amsterdam.

van der Leeuw, S. E. 1984. "Dust to Dust: A Transformational View of the Ceramic Cycle." In *The Many Dimensions of Pottery: Ceramics in Archaeology and Anthropology*, edited by S. E. van der Leeuw and A. C. Pritchard, 707-73. Amsterdam: Universiteit van Amsterdam.

van der Leeuw, S. E. 1993. "Giving the Potter a Choice: Conceptual Aspects of Pottery Techniques." In *Technological Choices: Transformation in Material Cultures since the Neolithic*, edited by Pierre Lemonnier, 238-88. London: Routledge.

VanValkenburgh, Parker, and James F. Osborne. 2012. "Home Turf: Archaeology, Territoriality, and Politics." *Archeological Papers of the American Anthropological Association* 22(1): 1-27.

Velasquez, Verónica, and Carlos Salgado-Ceballos. 2016. "Spanish olive jars in Campeche: Preliminary chemical characterization and provenance identification of early modern transport vessels in the Yucatán Peninsula (Mexico)." *Journal of Archaeological Science: Reports*. http://dx.doi.org/10.1016/j.jasrep.2016.10.007.

Vivó, Jorge A. 1992. “Horizontes culturales de Mesoamérica.” In *Una definición de Mesoamérica*, 22-27. México, D.F.: Instituto de Investigaciones Antropológicas.

Volioti, Katerina. 2014. “Dimensional standardization and the use of Haimonian *lekythoi*.” In *Understanding standardization and variation in Mediterranean ceramics*, edited by Antonis Kotsonas, 149-68. Leuven: Peeters.

Weigand, Phil C. 1996. “La evolución y el ocaso de un núcleo de civilización: la Tradición Teuchitlán y la arqueología de Jalisco.” In *Las cuencas del Occidente de México: época prehispánica*, edited by Eduardo Williams and Phil C. Weigand, 185-245. México, D.F. and Zamora, México: CEMCA, ORSTOM, and El Colegio de Michoacán.

Weigand, Phil C. 2004. “Arqueología del Centro-Oeste de Jalisco: la Tradición de Teuchitlán.” In *Introducción a la Arqueología del Occidente de México*, edited by B. Braniff Cornejo, 309-38. Mexico City: Universidad de Colima, CONACULTA, and INAH.

Weigand, Phil C. 2007. “States in Prehispanic Western Mesoamerica.” In *The Political Economy of Ancient Mesoamerica: Transformations during the Formative and Classic Periods*, edited by Vernon L. Scarborough and John E. Clark, 101-13. Albuquerque: University of New Mexico Press.

Weigand, Phil C., and Christopher S. Beekman. 2002. “La tradición Teuchitlán: surgimiento de una sociedad parecida al estado.” In *El Antiguo Occidente de México: Arte y Arqueología de un Pasado Desconocido*, edited by Richard F. Townsend and Carlos Eduardo Gutiérrez Arce, 39-55. Colima: Gobierno del Estado de Colima.

Weigand, Phil C., G. Harbottle, and E. V. Sayre. 1977. “Turquoise Sources and Source Analysis: Mesoamerica and the Southwestern U.S.A.” In *Exchange Systems in Prehistory*, edited by T. K. Earle and J. E. Ericson, 15-34. New York: Academic Press.

Wells, E. Christian, and Ben A. Nelson. 2002. “Chemical, Technological, and Social Aspects of Pottery Manufacture in the La Quemada Region of Northwest Mexico.” In *Archaeological Chemistry: materials, methods, and meaning*, edited by Kathryn A. Jakes, 185-98. Washington, D.C.: American Chemical Society.

Welsch, Robert L., and John Edward Terrell. 1998. “Material culture, social fields, and social boundaries on the Sepik coast of New Guinea.” In *The Archaeology of Social Boundaries*, edited by Miriam T. Stark, 50-77. Washington, D.C.: Smithsonian Institution Press.

Wendrich, Willeke. 2012. “Archaeology and Apprenticeship: Body Knowledge, Identity and Communities of Practice.” In *Archaeology and Apprenticeship: Body Knowledge, Identity and Communities of Practice*, edited by Willeke Wendrich, 1-19. Tucson: The University of Arizona Press.

Wenger, Etienne. 1998. *Communities of practice: Learning, meaning, and identity*. Cambridge: Cambridge University Press.

Whitbread, Ian K. 1986. “The characterisation of argillaceous inclusions in ceramic thin sections.” *Archaeometry* 28(1): 79-88.

Whitbread, Ian K. 1995. *Greek Transport Amphorae: A Petrological and Archaeological Study*. Exeter: British School at Athens.

Whitbread, Ian K. 1996. “Detection and interpretation of preferred orientation in ceramic thin sections.” In *Imaging the past: electronic imaging and computer graphics in museums and archaeology*, edited by Tony Higgins, Peter Main, and Janet Lang, 173-81. London: British Museum.

Wiessner, Polly. 1983. “Style and Social Information in Kalahari San Projectile Points.” *American Antiquity* 48(2): 253-76.

Williams, Eduardo. 1994. “Ecología Cerámica: Nuevo enfoque analítico en el Occidente de México.” In *Transformaciones Mayores en el Occidente de México*, edited by Ricardo Ávila, 253-68. Guadalajara, Mexico: Universidad de Guadalajara.

Williams, Eduardo. 1996. “Desarrollo cultural en las cuencas del Occidente de México: 1500 a.C. - 1521 d.C.” In *Las cuencas del Occidente de México: época prehispánica*, edited by Eduardo Williams and Phil C. Weigand, 15-59. México, D.F. and Zamora, México: CEMCA, ORSTOM, and El Colegio de Michoacán.

Williams, Eduardo, and Phil C. Weigand. 2004. “Introducción.” In *Bienes estratégicos del antiguo occidente de México. Producción e intercambio*, edited by Eduardo Williams, 13-31. Zamora, Mexico: El Colegio de Michoacán

Willey, Gordon R. 1992. “Mesoamerica.” In *Una definición de Mesoamérica*, 46-73. México, D.F.: Instituto de Investigaciones Antropológicas.

Willey, Gordon R., and Philip Phillips. 1958. *Method and Theory in American Archaeology*. Chicago: The University of Chicago Press.

Willey, Gordon R., and Jeremy A. Sabloff. 1980. *A History of American Archaeology*. San Francisco: Freeman and Company.

Winner, Langdon. 1993. “Upon Opening the Black Box and Finding It Empty: Social Constructivism and the Philosophy of Technology.” *Science, Technology, & Human Values* 18(3): 362-78.

Woodward, Ian. 2007. *Understanding Material Culture*. London: SAGE.

Zedeño, María Nieves. 1995. “The Role of Population Movement and Technology Transfer in the Manufacture of Prehistoric Southwestern Ceramics.” In *Ceramic Production in the American Southwest*, edited by Barbara J. Mills and Patricia L. Crown, 115-41. Tucson: The University of Arizona Press.

Zimbrón, David. 2007. “Las pruebas de laboratorio.” In *Arcillas y alfarería en Colima*, edited by Victoria Novelo, 24-34. Cuadernos de Investigación 1. Colima: Universidad de Colima.

Zizumbo-Villareal, Daniel, Fernando González-Zozaya, Angeles Olay-Barrientos, Rafael Platas-Ruiz, Mariza Cuevas-Sagardí, Laura Almendros-López, and Patricia Colunga-GarcíaMarín. 2009. “Archaeological Evidence of the Cultural Importance of Agave spp. in Pre-Hispanic Colima, Mexico.” *Economic Botany* 63(3): 288-302.