Production and Consumption of Middle Islamic Ceramics (1000 – 1500 CE) in Western Asia: Regional Practices in an Interconnected World

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Preface Declaration

This thesis is the result of my own work and includes nothing which is the outcome of work done in collaboration except as declared in the preface and specified in the text. It is not substantially the same as any work that has already been submitted before for any degree or other qualification except as declared in the preface and specified in the text. It does not exceed the prescribed word limit for the Archaeology and Anthropology Degree Committee.

Abstract

Production and Consumption of Middle Islamic Ceramics (1000 – 1500 CE) in Western Asia:
Regional Practices in an Interconnected World

Kyra Kaercher

The thesis presents a stylistic and technological study on Western Asian ceramics dating from 1000–1500 CE. The production and consumption of ceramics is used as a proxy to explore how social practices at the local level were formulated within the broader framework of Islam. The Islamic world has been studied as a relatively cohesive whole, due to the perceived connectivity of religion. This top-down approach favors elites (economic or political), larger cities, and precious materials (silk, porcelain, metals, etc.). This bias is mirrored in archaeological research which tends to focus on large palaces/castles/mosques, capital and large cities, and prestige goods. This dissertation focuses on the full repertoire of ceramic assemblages, not just glazed wares, to emphasize the potters' choices in creating the ceramics, as well as the consumers' choices in acquiring and using the ceramics. Both choices (production and consumption) are influenced by a myriad of factors, including vessels' function, environment, and socio-cultural contexts. For this dissertation, I have three main questions: (1) What is the range of ceramic technology and style across Western Asia in the Middle Islamic period? How can the study of ceramic technology elucidate the ceramic traditions existing at these sites/regions? What is the structure of ceramic craft organization in these areas? (2) How can the ceramic traditions in combination with social dimensions of ceramic production be used to connect sites, regions, and interregional areas? How does the consumption of ceramics indicate links between these areas? (3) What can the study of ceramic traditions in the Middle Islamic period tell us about the connections between rural areas and larger urban areas?

This dissertation focuses on 12 ceramic assemblages from various sites across Western Asia, all dating from 1000 – 1500 CE. These ceramics are recovered from both survey and excavation of sites of different natures, including eight rural sites (Erbil Plain Archaeological Survey (seven sites), Firuzabad), three intermediate types of sites (Nippur, Hasanlu, Chal Tarkhan), and a capital city (Rayy). The majority of the assemblages are from rural sites, but a few are from non-rural sites to lend a comparative edge and help define what is and is not rural. The ceramics are analyzed using a combination of macroscopic observation, thin-section petrography, portable X-Ray fluorescence (pXRF), and Fourier Transform Infrared Spectroscopy (FT-IR). These analyses are specifically selected to establish the potential provenience of the ceramics, reconstruct technical choices and social practices, and characterise production and consumption traditions. This area has been discussed as a homogenous whole (from 600 CE to present) under the assumption that the spread of Islam brought all areas under the larger cultural mainframe. However, this dissertation shows that there is heterogeneity in both ceramic consumption and production. The established overarching links do not seem to be influenced by the spread of Islam as the ceramic traditions identified (forms, fabrics, functions) also are present before the rise of Islam in these areas. This bottom-up approach marks significant contributions to Islamic Archaeology by shedding light on the diversity of dynamics that existed in local areas and among local populations and how these local dynamics play in the interconnected societies of Western Asia during the Middle Islamic period.

Acknowledgments

This dissertation arose out of my interest in how ceramics can tell us about social aspects of the past. This has led me to multiple field projects from Syria to Egypt and finally to Iraq. This project started as a study on the ceramics of the Neo-Assyrian kingdom of Musasir and questions revolving around the combination of identities between Assyria and Urartu. However, in excavating the site of Gird-i Dasht, we found four meters of Islamic material. This shifted my questions from the Neo-Assyrian period into the Islamic period, focusing on the social aspects of ceramics. To help broaden this assemblage, I looked for comparable material from the region, and was able to add material from EPAS, as well as legacy data from various museums. Sadly, I was not able to export any of the material from Gird-i Dasht, and so the project shifted once again to focusing on just the survey and legacy data. However, this does show the usefulness of this type of material in terms of analyzing larger networks of social practice. My first thanks must go to Drs. Michael Danti and Richard Zettler for all their help and support over the years, from my time at BU to allowing me to become the ceramicist on the Gird-i Dasht project. Their advice and support through the ups and downs of this process has been invaluable.

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This dissertation is dedicated to my parents, Les and Terri Kaercher, and my sister Jamaica whose unconditional love and support made this dream come true.

Chapter Artwork Sources:

The figures at the start of the chapters are all found on Middle Islamic ceramics, from across Western Asia. They are stamped, glazed, painted, and barbotine onto various vessels. All were digitized by myself. Some are discussed in the text.

Chapter 1: Rayy; 9th – 11th Centuries; 35-7-295; Penn Museum
Chapter 2: Rayy; 11th – 13th Centuries; 37-11-168; Penn Museum
Chapter 3: Rayy; 11th – 13th Centuries; 37-11-34; Penn Museum
Chapter 4: Rayy: 9th – 11th Centuries; 35-7-356; Penn Museum
Chapter 5: Nisbis: 12th – 14th Centuries; 1912,0715.1; British Museum
Chapter 6: Rayy: 9th – 11th Centuries; 35-7-835; Penn Museum
Chapter 7: Koyunjik; 12th – 14th Centuries; 1851,1009.120; British Museum
Chapter 8: Nineveh; 12th – 14th Centuries; 1934,0316.11; British Museum

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1 The Islamic World: Thesis Groundwork, Aims, and Structure

The Islamic world has been studied as a relatively cohesive whole, due to the perceived connectivity of religion. This top-down approach favors elites (economic or political), larger cities, and precious materials (silk, porcelain, metals, etc.). This bias is mirrored in archaeological research which tends to focus on large palaces/castles/mosques, capitals and large cities, and prestige goods. Islam connected vast geographical areas across Africa, Asia, and parts of Europe between 600 CE to the present day (Insoll 1999; Milwright 2010; Northedge 1999; Walker *et al.* 2021). However, variations existed in religious (Abar 2019; Khanbaghi 2006; Waardenburg 2004), political (Bosworth 2019; 2007; Lambton 2013; Sluglett & Currie 2014), economic (Amitai 2001; Goldberg 2012; Hassan 1972; Shatzmiller 1993), and social spheres (Chamberlain 2002; Insoll 1999; Milwright 2010; Shoshan 1991; Walker *et al.* 2021). By overlooking these variations, scholars neglect the local cultural practices which illustrate the complexity of the social fabric of the Islamic period. This dissertation presents a stylistic and technological study of Middle Islamic (1000 – 1500 CE) ceramics from Western Asia (more specifically the present-day countries of Iraq and Iran). The production and consumption of ceramics is used as a proxy to explore how social practices at the local level were formulated and linked within the broader framework of the Islamic world.

1.1 Research Context

Islamic archaeology is a term used to encompass a large spread of material culture dating from the seventh century to the present day across various landscapes (Insoll 1999; Milwright 2010; Northedge 1999; Rugiadi 2014; Walker *et al.* 2021; Whitcomb 2007). It also draws on many different disciplines, from archaeology to art history, architecture, religion, ethnography, anthropology, epigraphy, and numismatics. Rugiadi (2014, p. 4028) states, "Research into the Islamic Period relates to elements and structures (such as mosques, madrasas, graveyards and funerary monuments, government buildings, monetization) that directly represent Islam as a religious and institutional entity or elements and structures (such as the water supply system, communications network, agricultural exploitation, production and commercialization of goods) that involve the socioeconomic organization of urban and rural territories, connected with either the Muslim majority or minor religious groups such as Christians, Zoroastrians, Jews, and minor Islamic sects such as the so-called Assassins." This variation in social practices fits the definition of Islamicate Culture (Hodgson 1974), including cultural manifestations which are not directly related to Islamic religion, but are part of the "social and cultural complex historically associated with Islam and Muslims, both among Muslims themselves and even when found among non-Muslims" (p.54). This terminology has been recently critiqued by scholars stating that you cannot separate Islam (the religion) from Islam (the culture and larger world) (Ahmed 2016). This debate also rages in Islamic archaeology.

There is a large debate over the term 'Islamic Archaeology' and whether it is the archaeology of a historical period or whether it is the archaeology of a religion and the associated material culture (Insoll 1999; Milwright 2010; Walker *et al.* 2021). Milwright (2010, p. 6) states Islamic archaeology, like Islamic history or art history is a cultural-historical term that deals with "aspects of the past in regions where the ruling elite has professed the faith of Islam." This means that the archaeology deals with material both made and consumed by Muslim and non-Muslim communities within the historically defined regions and periods. However, Milwright points out that Islamic archaeology also deals with daily life (irrigation, manufacturing, international trade), which he terms the secular domain. Insoll (1999) argues that the Islamic religion relates to all aspects of life, and as such Islamic archaeology is more an archaeological study of religion. This archaeology is based on the concept that Islam, as a religion, is linked with society, and that religion is the framework on which society is constructed. The organization of space, the decoration and shapes of artifacts, manufacturing and trade, and diet can be understood to identify the presence of Muslim communities, and hence define Islamic archaeology in an area. Insoll (1999) discusses diversity in Islam, as practices, sects, and traditions may change based on the different regions, but this all falls into the larger Islamic religious framework. According to Islamic thought, when a community joins Islam, they become part of a larger community, the *ummah*, and as such, the economy, social structure, and organization of the area should be recognizable to other areas as an Islamic area. Insoll states that even under the *ummah*, regional differences do and should occur, but the larger structure underlying life is the same. Even with understanding these regional differences, the archaeology of Islam as a study of religion seems to negate the experiences of religious minorities living under Islamic rule. By defining some aspects of life as Islamic, other aspects are left understudied. As Milwright (2010) points out, this is especially clear in border areas, or areas between Islamic and non-Islamic polities, as well as in negotiations over other aspects of identity, such as linguistic, ethnic, tribal, and economic divisions.

One of the larger problems with Islamic archaeology defined as the archaeology of religion is the strict dichotomy between Islamic and pre-Islamic, with some scholars largely ignoring the previous periods (e.g. Samarra (Herzfeld 1923; 1927; 1930; 1948), Nishapur (Wilkinson 1973)) and others largely ignoring the Islamic period (e.g. Nineveh (Campbell Thompson & Hutchinson 1929; Layard 1849; 1853), Susa (de Morgan 1896; Loftus 1857), Hasanlu (Danti 2014; Dyson 1956; 1957; 1958)), instead of understanding the Islamic period as a continuation of history (Danti 2004; Insoll 1999; Milwright 2010; Northedge 1999). It has also long been held that Islamic archaeology is the realm of 'local' archaeologists, i.e. archaeologists from the region that is under study, and not of much interest to ‘western’ archaeologists, hence, much of the literature on the Islamic period is published in Arabic or Farsi, and not read by many ‘western’ archaeologists. The lack of sources exclusively in Arabic, Persian, or Kurdish is also a shortcoming of this dissertation.

Early excavations of Islamic sites (ca. pre-1950s) tended to focus on the large, high-profile sites, and materials that were brought back for further study were those of high aesthetic value, including complete vessels to be displayed in museums (Milwright 2010, p. 3-5; Northedge 1999, p.1080-1081; Whitcomb 2007). The second phase of excavations (ca. 1950s – 1990s), also focused on larger sites, such as citadels, ports, desert castles, caravanserai, but with a larger focus on economic and political changes in these cities (Milwright 2010, p. 3-5; Walker *et al.* 2021, p. 5-7; Whitcomb 2007). These excavations also tended to focus on clarifying or identifying missing information from the written texts, analyzing more remote places (Hasanlu (Danti 2004); Eastern Iran Survey (Spooner 1969)), looking at settlement patterns (Adams 1981; Gibson 1972), or revising chronologies (Northedge 1996). More recent excavations and surveys (post-1990s) focused more on socio-cultural or historical problem solving (Müller-Weiner 2017; Walker *et al.* 2021; Walker 1999; Whitcomb 2007). Research into the Islamic period has been focused on larger questions (e.g. the spread of Islam, the interplay between Christianity and Islam, the development of long distance trade networks), rather than just large excavations and uncovering large buildings or material culture. This recent turn also sees an interest in the lives of non-elite groups, in both urban and rural settings (Milwright 2010, p. 6)**.** This thesis falls into the current phase of Islamic archaeology by investigating the production and consumption of all ceramics, which remain understudied.

1.2 Islamic Ceramics

Islamic ceramics have been studied mainly under an art historical lens, focusing on the development of artistic styles, glazes, and stonepaste fabrics. These issues are then linked to known production centers or periods to create chronologies or dispersal patterns of ceramics. Early research on Islamic ceramics was focused on museum collections of entire pieces from the art market (Fehérvári 2000, p. 15–19; Grube 1976; Lane 1947; 1957; Watson 2004, p. 11–13; 2020, p. 18–20). These studies were then supplemented by archaeological excavations of various sites such as Samarra (Northedge 1996; Sarre & Mittwoch 1905), Hama (Riis & Poulsen 1957), Nishapur (Rante & Collinet 2013; Wilkinson 1973), Siraf (Whitehouse 1979), Qala’at Ja’bar (Tonghini 1998), Raqqa (Jenkins-Madina 2006; Tonghini & Henderson 1998) and large surveys (Adams 1981; Priestman 2020; 2005). More recent research has included archaeometric methods to assess the development, dispersal, and technology of various ceramic elements including glaze (Greene 2007; Hallett *et al.* 1988; Hill *et al.* 2007; Klesner *et al.* 2019; Mason & Keall 1991a; Mason & Tite 1997; Matin *et al.* 2018; Salinas *et al.* 2019; Ting & Taxel 2020; Wolf, *et al.* 2003), stonepaste (Mason 1995b; 1997b; 1997c; 1997d; 2001; 2004; Rugiadi 2011; Tite *et al.* 2011), and cooking pots (Bartl *et al.* 1995; Eiland & Williams 2001; Holmqvist 2019; 2009; Sacco *et al.* 2020). However, the focus of these studies is mainly on the glazed ceramics (except for the few studies on cooking pots), which account for only about 10% of what is found archaeologically, but over 90% of what is presented in museums (Jenkins-Madina 2006; Priestman 2020; 2005; Rante 2014; Tonghini 1998; Watson 2004; 2004; 2020; Wilkinson 1973).

Watson (2020, p. 18) states that "Best-quality wares are evidently more susceptible to changes in style and fashion and are therefore the most interesting and informative". This belief in the superiority of high-quality ceramics has led to more research on these ceramics over the plain or coarser ceramics of the period. This bias hinders research into the overall Islamic period, in that survey sites are given broad dates because of the lack of glazed 'dateable' materials (Nováček pers. comm. 2018; Tonghini pers. comm. 2018) and this limits the information which can be gleaned from rural sites. This focus on the glazed ceramics also neglects the developments, connections, and spread of coarse ceramics, which are more indicative of the economy and social connections of the majority of non-elite and rural populations. However, it has been shown that undecorated, coarser ceramics are better for identifying ceramic technology, variations in the *chaîne opératoire*s and ceramic specialization (Holmqvist 2019; 2009; Roux 2017; 2020; Taxel 2014). As Stark states, "Utilitarian ceramics and mundane goods are more indicative of social boundaries than those consciously manipulated for conveying information" (1998, p. 211). Therefore, these types of ceramics elucidate potters' and consumers' choices, communities of practice, and connections between sites.

Ceramics have many properties which make them pervasive on archaeological sites. However, the presence of ceramics does not mean that they were a highly valued material. Ceramics were not elite goods at any point in the Middle Islamic period. The more valued vessels were made of metals (preferably silver or gold), glass, and rock crystal. This value is also shown in treatises written at the time such as *al-Resāla al-ṣenāʿiya* (Treatise on Arts and Professions) by Mir Fendereski which mentions artistic professions from blacksmithing to philosophy but does not mention ceramics (Rizvi 2005). Textual sources (*Kitab fi macrifat al-hiyal al-handasiya by Ibn al-Razzaz* (al-Jazari, 1204; Translated by Hill 1974), the Geniza Archive (Goitein 1973), and Coptic papyri (Vorderstrasse 2005) show that metal vessels, especially those in gold and silver, are highly prized by the elite. Very few ceramics are mentioned in texts, except for a few porcelains which appear in the Geniza Archive (Goitein, 1973), and various Coptic papyri (Vorderstrasse, 2005). Gascoigne's (2013) study of cooking vessels shows the price of one pot in 1229 was $5/8^{th}$ a dirham, and 2 jugs for fat was 1.5 dirhams compared to 1/2 – 5 dinars for a porcelain cup (Gascoigne 2013). Vorderstrasse's (2005) study of the textual record also illustrates the scarce mentions of ceramic vessels in texts, focusing more on the metal vessels and terms for various shapes and sizes in Coptic papyri. Most of these other materials do not survive on archaeological site, either due to recycling (e.g. metal and glass), or disintegration (organics). Pottery is one of the more prevalent artifacts found on an excavation due to its preservation. However, ceramics are a non-elite material in the Islamic period, even in the case of the stonepastes and finer glazed ceramics (Taxel 2014; Watson 2017).

This dissertation focuses on the full repertoire of ceramic assemblages, not just the fine vessels, to emphasize the potters' choices in creating the ceramics, as well as the consumers' choices in acquiring and using the ceramics. Both choices (production and consumption) are influenced by a myriad of factors, including the vessels' function, environment, and socio-cultural contexts. These choices can then be analyzed to look at connections between sites, regions, and the larger world. The fine decorated ceramics can be used to look at relatively quick changes in the style and design of the ceramics, but by also analyzing the coarser and undecorated ceramics, scholars can analyze the deeper connections between sites. Since ceramics are a learned technology, scholars can use the technological process (*chaîne opératoire*) to identify the embedded social markers (Rice 2005; Roux 2017; 2019; 2020; Tite 2008). These markers can then be used to link producers, distributors, and consumers across sites, regions, and the larger world (Roux 2020).

1.3 Rural Sites, Urban Centers, and the Intermediate Areas

The definitions of space vary across disciplines, throughout history, and between authors. This creates a confusing mix of terms when trying to identify sites. Islamic scholars (al-Istakhri, 1967 (d. 957 CE); al-Muqaddasi, 2001 (d. 991 CE); al-Bakri, 2003 (d. 1094 CE) classified the Islamic world into various regions, with larger urban centers and rural hinterlands (Antrim 2018, 20; Sluglett & Currie 2014). These were recorded in various atlases which begin with a discussion of the physiognomy of the earth illustrated by a world map, a general account of world history, and then the rest is divided into the regions (Antrim, 2018: p, 21). These regions are mainly defined on economic bases (who is paying taxes to whom), but also include other factors like geography, political boundaries, or religious divisions. These are normally linked back to the urban centers, creating a type of core-periphery model (Abu-Lughod 1989; Müller-Weiner 2017; Walker 1999). Studies of these regions rarely focus on the social aspects, partially due to the idea that Islam is identified as a religion, culture, and civilization combined into one package (Insoll 1999; Voll 1994). More recent studies are beginning to question this narrative, and ceramics are used to identify regions and sub-regions (Holmqvist 2019; Müller-Weiner 2017; O'Doherty *et al.* 2016; Priestman 2005; Taxel 2014). However, the linkages between these regions, or even between the sub-regions, are little studied. By analyzing these networks, we begin to understand the differences and similarities among these regions and better understand the diverse nature of settlements in the Islamic world.

For this dissertation mainly archaeological and Islamic textual definitions are used for the various areas and sites discussed. First, rural areas are open areas with a low population density, small site size, an agricultural economic basis, lower social complexity and a more unplanned settlement system (Adams

1981, p, 22; McPhillips 2014, p. 6387). Rural settlements are seen as secondary both in complexity as well as size and importance to urban sites (McPhillips 2014, p. 6387). Urban areas are defined by constricted areas with a high population density, a non-agricultural economic basis, higher social complexity, and a planned settlement system (Smith 2011; 2020). Urban sites have a higher degree of social complexity and heterogeneity, as well as larger site size as compared to rural settlements. There are also areas that I have termed intermediate due to the mixing of characteristics between rural and urban. These sites are planned with a specific function (military, elite residence, rest-stops/markets). These are attested in Islamic texts as *ribāt/ kale or caravanserai,* denoting a different function from other urban or rural sites. These three categories of areas and sites have various material culture present, from rural sites containing less luxury/elite goods, to intermediate sites containing items associated with their function.

In this dissertation eight sites fit the classification of rural sites, the seven Erbil Plain Archaeological Survey sites, and Firuzabad. One site is an urban site, that of Rayy, and three are intermediate sites, Nippur (a possible provincial capital), Hasanlu (a possible military outpost), and Chal Tarkhan (an elite residence). These sites were chosen due to the access to materials, but also because they give a cross-section of Islamic society, from rural farmsteads to urban central cities. These sites have varied ceramic assemblages stretching from the 11th to 15th centuries. By defining the assemblages at each site and linking them with other sites, we begin to see patterns connecting sites both in the various defined regions (by economic/political/geographical boundaries) as well as in the social sphere. Analyzing these links presents new information on the social connections that may be present between these sites, indicating the diversity of the rural areas.

1.4 Research Aims and Research Objectives

The primary focus of this research is to investigate the extent to which social practices differ between rural and urban areas in the Middle Islamic period, in order to explain the connections between these areas. Specifically, my research questions are: (1) What is the range of ceramic technology and style across Western Asia in the Middle Islamic period? How can the study of ceramic technology elucidate the ceramic traditions at these sites/regions? What is the structure of ceramic craft organization in these different areas? (2) How can the ceramic traditions in combination with social dimensions of ceramic production be used to connect sites, regions, and larger areas? How does the consumption of ceramics indicate links between these areas? (3) What can the study of ceramic traditions in the Middle Islamic period tell us about the connections between rural areas and larger urban areas?

These questions will be addressed through the following research objectives, to:

1. Document the variation in style and technology of the ceramics, on macroscopic and microscopic levels

2. Determine the potential provenances of the ceramic assemblages based on compositional groups with reference to the geological information available
3. Reconstruct the *chaîne opératoires*, including the choices of raw materials, forming, surface finish, and firing methods
4. Reconstruct the social practices by combining the *chaîne opératoires* with functional and social data gathered from macroscopic analysis
5. Characterize the craft organization based on variations in the ceramic technology and social practices
6. Elucidate the variations in connections between sites, regions, and larger areas, and define the levels of interaction in the larger interconnected world

To achieve these aims, this dissertation focuses on the ceramic assemblages of 12 sites, rural, urban and intermediate across Western Asia, all dating to the Middle Islamic period. These assemblages were then analyzed by macroscopic (forms, fabrics, and function) and microscopic (thin section petrography, portable X-Ray Fluorescence, and Fourier Transform Infrared Spectroscopy) methods. The resultant data elucidates the technology used to create the various categories of ceramics. The groupings were then described using the *chaîne opératoire* approach, which allows for a comparison of data across sites in a systematic way. The ceramic traditions identified, with their use of raw materials, technological styles, design motifs, and functions, are used to link the sites to one another. These various ties explore the connections between sites, regions, and the larger world to establish what linked the various areas. The networks are then investigated to understand the variation present in the Islamic world. The combination of methods and approach is also relevant to the study of shared traditions and exchange of manufactured objects in other regions and temporal periods.

1.5 Structure of Thesis

To contextualize Middle Islamic ceramic corpuses, Chapter 2 gives a brief introduction to the history of the Middle Islamic period (1000 – 1500 CE), an archaeological background of the sites that are analyzed, and a geological summary of each of the regions. Chapter 3 provides an overview of the theoretical underpinnings of this research, discussing the principles of *chaîne opératoire*, ceramic traditions, communities and constellations of practice, craft organization, and regionalization processes in interconnected spaces. Chapter 4 summarizes the methodology used for all analyses, including macroscopic (form, fabric, function) and microscopic (thin section petrography, portable X-Ray fluorescence, Fourier transform infrared spectroscopy) procedures. It also includes information on sampling procedures, statistical analysis, and the description of the *chaîne opératoire*. Chapters 5 and 6 present the data gathered both macroscopically (Chapter 5) and microscopically (Chapter 6). Chapter 5 presents the various fabrics, forms, and functions of the ceramics at each site, and examines the entire ceramic assemblages. Chapter 6 summarizes the microscopic and technological analyses. Chapter 7 discusses the results of the study, the *chaîne opératoires*, ceramic traditions, and examines the links between sites, regions, and larger entities. Lastly, Chapter 8 summarizes the findings of the study, how they answer the research questions, and formulates future directions which guide further investigations into the Middle Islamic period of Western Asia.

2 The Middle Islamic Period in Western Asia: History, Archaeology, and Geology

This chapter gives a brief overview of the history, archaeology, and geology of Western Asia during the Middle Islamic period (ca. 1000 – 1500 CE). The first part focusses on a historical overview highlighting the changing political structure, as well as some of the cultural and economic changes that occur alongside the politics. The second part is concerned with the regional histories and archaeological background for the various sites that are used in this study. This history overview is less concerned with names of rulers and specific battles, and more concerned with overarching societal changes which may have affected material culture, regional economies, and networks. The third part of the chapter discusses the regional geologies in preparation for the petrographic discussion (Chapter 6.1).

2.1 General Islamic Era History of the Region

After Muhammad's death in 632 CE, his successors established the Umayyad Caliphate which extended from North Africa to Eastern Iran, and from Azerbaijan to Eastern Africa. In 750 CE, the Umayyad Caliphate was replaced by the Abbasid Caliphate. This brought changes in religious, political, and geographical spheres. The Abbasids moved the capital from Damascus to Baghdad, incorporating more Persian traditions into the social spheres. This included traditions of divine rulership and statecraft, using Persian history as a legitimizing method, as well as Persian cultural practices (Sourdel 1970). Another large shift was the incorporation of various ethnicities in all places of power instead of an Arab ruler class placed on a non-Arab or Arab lower class (Sourdel 1970). The location of the Caliphate in central Iraq led to a combination of Persian, Hellenistic, Arab, Turkish, and Byzantine cultures, traditions, teaching, and learning. The Abbasid Caliphate (750 – 820 CE) is also known as the "Islamic Golden Age" where Islamic civilization flourished in the realms of literature, theology, philosophy, and natural sciences (Lombard 1975; Renima *et al.* 2016). The Abbasids expanded the territorial extent of the empire and established long distance trade routes reaching from the Atlantic Ocean to China and to the southern tip of Africa (Sluglett & Currie 2014, p. 40-41).

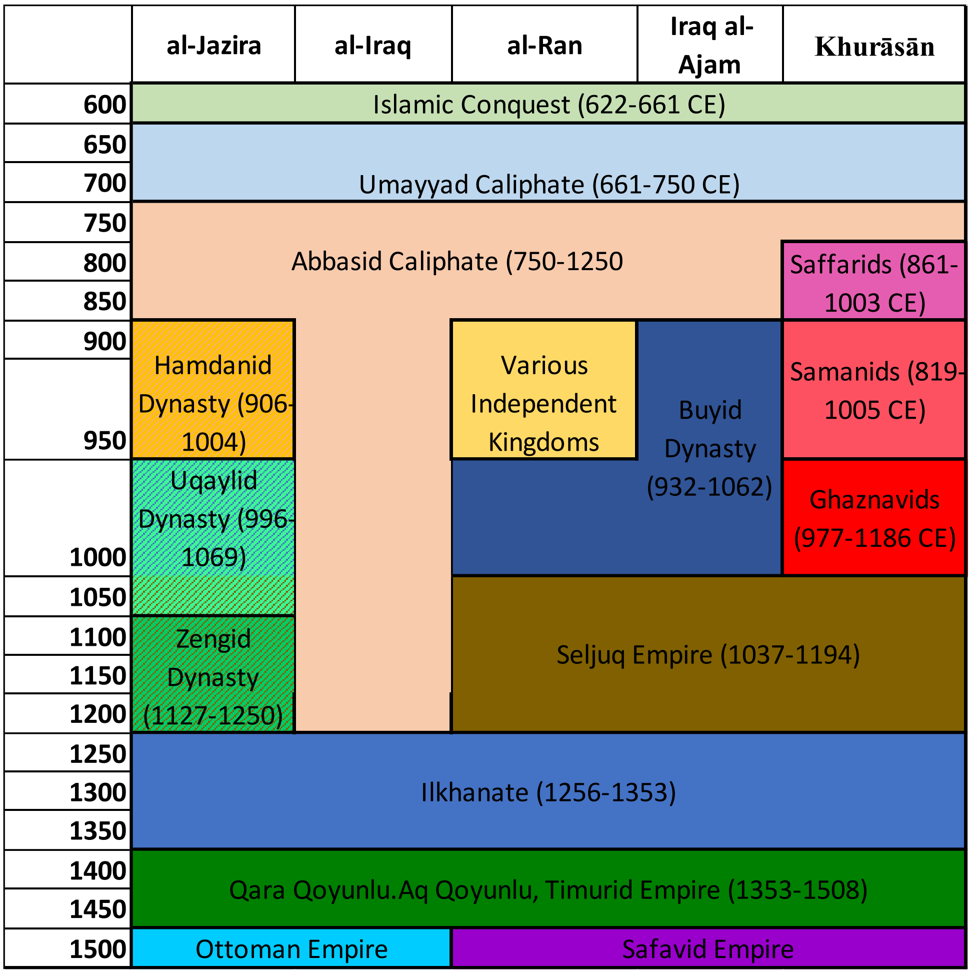

Figure 2.1: Timeline of the five various regions and their changing political structures. The crosshatched boxes illustrate the relatively independent kingdoms under larger rule.

In 945 the Buyid Dynasty of Iran conquered Baghdad and overtook the Abbasid Caliphate. The Buyids originated in Persia, and there was an anti-Arab, pro-Persian identity with attempts by various scholars at the time to provide the Buyids with a genealogy stretching back to the Sassanids, and linking their line with the *Shahanshah*, rather than the Arab Caliphs (Donohue 2003). As a way to legitimize their rule to the Arab peoples in Iraq and the Jazira, the rulers allowed the Abbasid Caliphal line to continue as religious heads of the dynasty. Under the Buyids, traditional Muslim festivals and practices from Iraq were introduced into Iran, scholars tried to systematize and intellectualize Shi'a theology and law, and there was a wide tolerance of other faiths like Christianity, Judaism, and Zoroastrianism (Donohue 2003). In 1037 the Buyids were overthrown by the Seljuqs.

The Seljuqs (1037 – 1194) originated in the Turkish steppes north of the Caspian and Aral Seas and entered the Islamic world in Khwarazm and Transoxania as part of the local power struggles (Bosworth 2019, p. 187). In the 11th century the Seljuqs took Baghdad from the Buyids, and became the political rulers of the Abbasid Caliphate. They organized their political state on the Perso-Islamic monarchic pattern with a supreme sultan supported by a Persian and Arab bureaucracy and multi-ethnic army directed by Turkish slave commanders, supplemented by tribal contingents (Bosworth 2019, p. 187).

Under their rule, Persian became the language of culture, there was a spread of Sufism, and they supported the construction of madrasas throughout their territory (Durand-Guédy 2015). With the rise of the Seljuqs, there was an increase in nomadism and pastoralism from Afghanistan to Anatolia and an increased degree of Turkicisation (languages, cultures, religions, ethnicities, etc.) (Peacock 2015). By 1072, the empire reached its territorial height including Afghanistan, Anatolia, Armenia, Georgia, Iran, Iraq, Syria, Transoxania, and Yemen. After 1092, the areas under Seljuq control broke into independent kingdoms, and the Abbasid Caliphs regained power in Southern Iraq.

Ghengis Khan invaded Transoxiana in 1218 which brought the Islamic sphere into contact with the Mongol Empire (Allsen 2001; Danti 2004; Jackson 2017). After Ghengis Khan's death in 1227, Hülegü, was tasked with recovering the lands in Western Asia. He defeated the Isma'ilis of northern Persia in 1256, the Abbasid Caliphate in Baghdad in 1258, and was stopped in Syria by Mamluk forces in 1260 (Jackson 2017). After the death of the Great Khan Qubilay in 1294, links with the main Mongolian rulership loosened, and the Ilkhans adopted Islam as their main religion, illustrating a large shift away from their Mongolian roots (Jackson 2017). Under the Ilkhanids, overland trade networks with China were re-opened, and the mixing of cultures, materials, and foods from the Mediterranean to China occurred. This mixing of cultures is present in the multi-ethnic, multi-religious, multi-lingual nature of the Ilkhanid courts (Allsen 2001; Jackson 2017).

After the demise of the Ilkhanate in 1353, various successor states appeared across the territory. The first was the Jalayirid Amirs (1340–1432) who succeeded the Ilkhanate in Iraq and Azerbaijan (Bosworth 2019, p. 267). Under the Jalayirid rulership, the arts and especially miniature paintings flourished. However, this period was marked by plague, and as such the economy was severely impaired and did not recover until the mid-16th century. The second was the Timurid Empire (1370–1507) which arose in Transoxiana and under Timur (Tamerlane) and expanded to the west (Savory 1964). Timur saw himself as the successor to Genghis Khan, and much of the area stayed the same (culturally, linguistically, politically) under his rule. The third was the Qara Qoyunlu (1351–1469) who controlled territories in Eastern Anatolia, Azerbaijan, Iraq, and western Persia (Bosworth 2019, p. 273). The last state was the Aq Qoylunu (1396–1508) who began in Diyar Bakr, and included eastern Anatolia, Azerbaijan, and Persia (Bosworth 2019, p, 276). The Qoylunu states were relatively under the control of the Timurid Empire, and as such the culture, language, and political leanings mimicked those of the empire (Arjomand 2016). These states were conquered by the Ottomans in 1503 in Iraq, and the Safavids in 1507 in Iran.

2.2 General Islamic Archaeology of Western Asia

Archaeological research into the Islamic period began in the early 1900s with large excavations at Dura-Europos (Cumont 1926; Rostovtzeff 1929), Kish (Reitlinger 1935), Nishapur (Wilkinson 1973; 1986), Raqqa (Kouchakji 1923; Kūhel 1938; Sarre 1921; Sarre & Herzfeldt 1911; Sauvaget 1948), Rayy (Miles 1938; Schmidt 1934; 1935a; 1935b; 1936; Vignier 1914), Samarra (Herzfeld 1912; 1930; Sarre *et al.* 1925; Sarre & Herzfeldt 1911), Susa (De Morgan *et al.* 1900; Koechlin 1928), and Wasit (Safar 1945), and large surveys undertaken by Sarre and Herzfeld (1911 – 1920), Deitz (1918), and Schmidt (1940). These excavations and surveys were focused on recording the large high-profile sites of symbolic importance, and many uncovered palaces, mosques, minarets, shrines, and some domestic houses. The surveys extensively covered the landscape of Iraq and Iran and described the architecture and monuments discovered (Bell 1911; Herzfeld 1912; Sarre 1901; Sarre & Herzfeldt 1911). The focus in this period was to uncover monumental buildings, understand the architecture and date the sites, palaces, and mosques, to tie into the larger historical narratives. The ceramics were largely divided into glazed, unglazed, and imported (porcelain and stonepaste) wares which were collected and brought back to fill western museums. By the 1930s, the ceramics were studied to form chronological markers, type sites, and indexes of trade, especially with China (Koechlin 1928; Reitlinger 1935; Sarre 1921; Sarre *et al.* 1925). Most of this research was focused on glazed and imported wares, and unglazed wares, especially undecorated wares were rarely if ever accounted for. The categories were then subdivided based on the type of decoration (monochrome glazed, splash glazed, sgraffiato, underglaze painted, appliquéd, painted, moulded).

With the outbreak of WWI and WWII, excavations largely stopped in the region. This meant that the materials brought back from excavations and located in museums were highly studied. However, since the expeditions largely brought back highly decorated, glazed, or porcelain/stonepaste wares, the focus was on their typologies and chronologies (Ettinghausen 1936; Hobson 1932; Kelekian 1910; Lane 1947; 1957; Migeon 1922; Pope 1945; Pope & Ackerman 1939; Reitlinger 1938; 1945; 1951; Sarre 1935; Sauvaget 1932). These studies expanded on the excavated typologies, but much of the stratigraphic context was ignored, or had been lost, and these studies were supplemented with unprovenanced material gathered from the art market. Analysis of ceramic technology began to be incorporated within the typologies and chronologies, if only for the glazed material. The typologies of the studied ceramics were subdivided between simple (monochrome glazing) and complex (Underglaze painted stoneware) with imports such as porcelain being identified as the impetus for the creation of certain types of glazing (Opaque, splashed, sgraffiato) (Lane 1947; 1957; Reitlinger 1938; Sarre 1935; Sauvaget 1932). Areas of production were identified (Raqqa (Sarre 1925), Kashan (Reitlinger 1938), and Samarra (Herzfeld 1930)), based on the morpho-stylistic features of ceramics found on the sites, alongside the wasters, and few kilns.

Excavations between the 1950s – 1990s at ʻAna (Northedge *et al.* 1988), Abu Sarifa (Adams 1970), Dura Europos (Baird 2018), Hasanlu (Danti 2004); Kish (Gibson 1972; Moorey 1978), Raqqa (Abdu'l-Haqq 1951; al-Khalaf & Kohlmeyer 1985; Grube 1963; Heusch & Meinecke 1989; Meinecke & Heusch

1985; Saliby 1954; 1956; Toueir 1985), Samarra (Northedge 1996), Siraf (Whitehouse 1979), Sultaniyya (Gandiavi 1979), Susa (Kervran 1977; Rosen-Ayalon 1974; Whitcomb 1985), Takht-e Sulayman (Naumann & Naumann 1976), and Qala'at Jabar (Sourdel 2010; Tonghini 1998; Zaqzuq 1985) carried on these early typologies, but soon modified them. Large surveys, such as those in southern Iraq (Land Behind Baghdad (Adams 1965), Akkad Survey (Adams 1972), Kish (Gibson 1972)) and northwestern Iran (Hasanlu Archaeological Project (Dyson 1956; 1957; 1958), Solduz Survey (Voigt 1976; 1983), Ushnu-Solduz Survey (Pecorella & Salvini 1982) led to a larger understanding of the extent of more rural Islamic sites. The excavations were mainly still focused on citadels, ports, desert castles, and larger sites; however, some of this research was focused on smaller dynasties, and relatively unknown periods historiographically (i.e. 'Ana, Abu Sarifa Hasanlu, Maragha, Takht-e Sulayman). The large sites (Kish, Raqqa, Rayy, Samarra, Susa) were revisited, and the stratigraphy of the older excavations was recorded, and new units were opened (Meinecke & Heusch 1985; Moorey 1978; Northedge 1996; Rante & Collinet 2013; Rante 2014; Saliby 1954; 1956; Whitcomb 1985).

With the development of a more scientific approach to archaeological excavations, recordings of stratified ceramics were used to strengthen the chronologies of various types, leading to the periodization of some of the ceramics (i.e. Iznik ware, Kubachi ware, Safavid ware). However, most of the research was still focused on the glazed and stonepaste wares. Unglazed wares, albeit the decorated wares (incised, impressed, appliqué, painted, burnished, moulded) as well as cooking wares also began to be discussed in the literature, and made their way into typologies and chronologies (Adams 1970; Gibson 1972; Kervran 1977; Whitehouse 1979). Lastly with the excavations of rural and semi-rural sites, regional changes and aspects of the ceramic corpus were also discussed (Ali 2010; Müller-Weiner 2017; Walker 2016). During this period, a revision of museum collections also occurred, with various museums publishing their Islamic ceramics in large volumes (Allan 1991; Bagherzadeh *et al.* 1981; Caiger-Smith 1985; Carswell 1985; Contadini 1998; Crowe 2002; Ettinghausen & Grabar 1987; Fehérvári 1973; 2000; Golombek *et al.* 1996; Grube 1976; Jenkins 1983; Atil 1990; Watson 2004; 2020).

Beginning in the 1990s, scientific studies of ceramics discussing technology and provenience began to be published (Mason and Golombek, 1990; Mason, 1995a, 1995b, 1997b, 1997c, 1997d, 1997d, 2004; Mason and Tite, 1997; Hill, Speakman and Glascock, 2004; Wood *et al.*, 2007; Tite, Wolf and Mason, 2011; Tite *et al.*, 2015; Matin, Tite and Watson, 2018). Once again, the main focus of these scientific studies was on the glazed and stonepaste wares, mainly from museum collections. Most of these studies were aimed at either understanding the technology behind the glazing or identifying the production areas of certain types of ceramics. For example, Mason's articles on medieval lustre ware (1997a, 1997b, 1997c, 1997d), and his subsequent book (2004), analyzes lustre ware in-depth, across western

Asia using scientific, archaeological, and historiographical resources to both identify the method of manufacture, where the ceramics were first made, and how they were spread across the region. This has continued with the rest of the stonepaste wares (Mason & Tite 1994a; Milwright 2008; Rugiadi 2011; Tite *et al.* 2011). Once again, unglazed plain wares have been ignored in favor of the more decorated wares.

Excavations since the 1990s were limited to specific areas on sites, including industrial areas (Nishapur, Rayy and Raqqa (Henderson 1996; Rante 2007; 2008; 2010; 2016; Rante & Collinet 2013; Tonghini & Henderson 1998)), citadels (Erbil, Nishapur, and Qala'at Jabar (Nováček 2008a; Nováček *et al.* 2013; Petrik *et al.* 2020; Rante & Collinet 2013; Sourdel 2010)), Mosques (Isfahan, Nishapur (De Bonis *et al.* 2017; Ḵāniki 1995; Rante & Collinet 2013; Genito & Saeidi Anaraki 2011)), and domestic architecture (Isfahan, Nishapur, Erbil (Ḵāniki 1995; Nováček 2008a; Rante & Collinet 2013; Genito & Saeidi Anaraki 2011)). These excavations and surveys were focused on research into socio-cultural, economic, political or historical questions, rather than uncovering and dating large cities. This has led to a more in-depth study of the ceramics, including the unglazed material. With the focus of some excavations being on industrial areas, kiln sites are being excavated and understood (Nishapur and Raqqa), providing a broader understanding of ceramic production, and centers of the production. Along with production, archaeologists are also starting to report and analyze the unglazed material (De Bonis *et al.* 2017; Nováček 2008a; Petrik *et al.* 2020; Priestman 2005; Rante 2007; 2008; 2014; Tonghini 1998; Tonghini & Henderson 1998; Vezzoli 2008). This dissertation fits into the last stage of research, analyzing the unglazed material, production techniques, and larger socio-cultural phenomenon.

2.3 Regional Islamic Era History and Archaeology

The areas from this dissertation are broken into five different regions, northern Iraq, southern Iraq, northwestern Iran, central Iran, and eastern Iran. These areas match with areas as described by Islamic geographers living during the Middle Islamic period. These regions were developed and mapped in the 'Atlas of Islam' tradition, began by Abu Zayd al-Balkhi in the early 10th century (Antrim 2018, p. 20). These atlases begin with a discussion of the physiognomy of the earth, illustrated by a world map, a general account of the world, and the rest is divided into regions (Antrim 2018, p. 21). The regions this dissertation will focus on are al-Jazira (Figure 2.2: 5), al-Iraq (Figure 2.2: 6), al-Ran (Figure 2;2: 7), Iraqi al-Ajam (Figure 2.2: 8), and Khurāsān (Figure 2.2: 17).

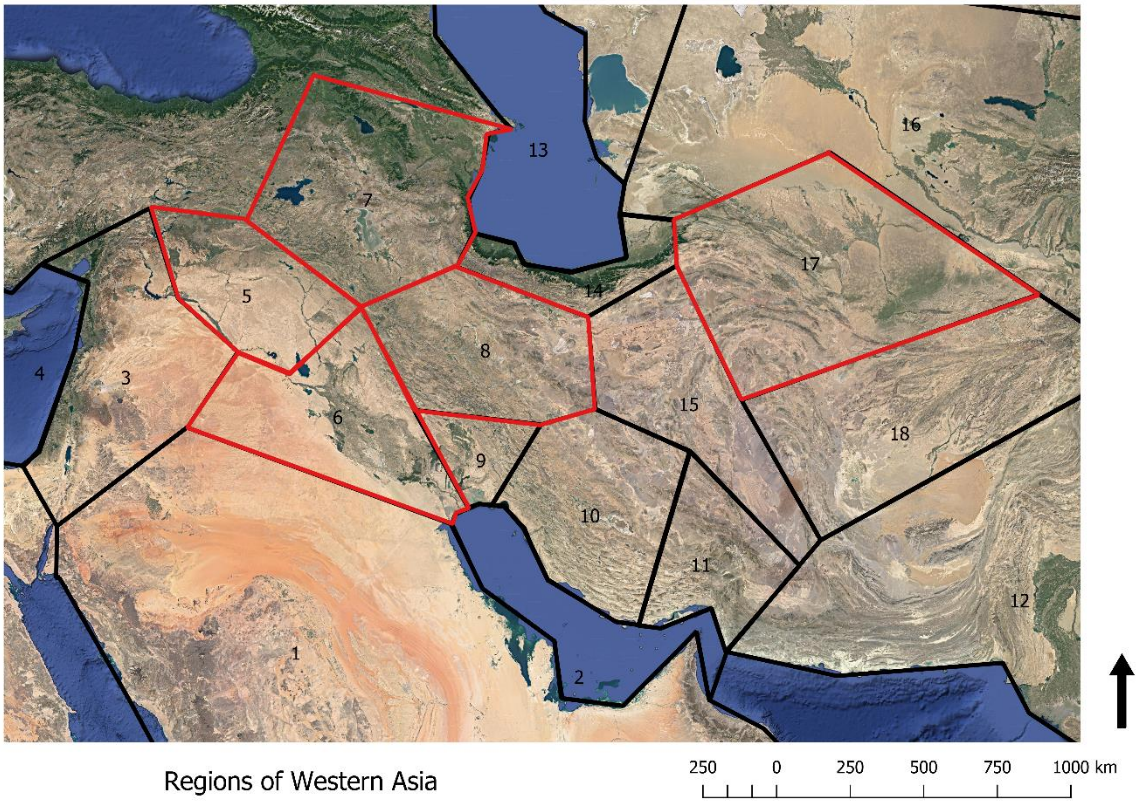

Figure 2.2: Regions of the Islamic World after al-Istakhri and Ibn Hawqal. Regions in red are ones focused on in this project. Regions are 1) Diyār al-'Arab, 2) Bahr Fārs, 3) al-Shām, 4) Bahr al-Rūm, 5) al-Jazīra, 6) al-'Irāq, 7) Armenia/ al-Ran/ Azerbaijan, 8) al-Jibāl/ Iraqi al-Ajam 9) Khūzistān, 10) Fārs, 11) Kirmān, 12) al-Sind, 13) Bahr al-Khazar, 14) al-Daylam/Tabaristan, 15) Mafāza Khurāsān, 16) Mā Warā' al-Nahr, 17) Khurāsān, 18) Sijistan (after Antrim 2018: Fig. 3).

2.3.1 *Northern Iraq (al-Jazira)*

The region of al-Jazira (Figure 2.2: 5) encompasses the territory of the Upper Tigris and Euphrates River systems in present day northern Iraq, northeastern Syria, and southeastern Turkey. Two main cities in the eastern part of this region are Mosul and Erbil (Figure 2.3). This area was brought under Islamic control in 641 CE and passed into Abbasid control around 750 CE (Honigmann *et al.* 2007; Nováček *et al.* 2013). Under Abbasid control, the Hadhbānī Kurds ruled Erbil, and extended their territory into the region around Mosul (James 2006). Under the Buyids, the 'Uqaylid Dynasty was established in Mosul, and they extended their territory from Baghdad to Aleppo by 1085 (Honigmann *et al.* 2007). They were replaced by the Zengid Dynasty in 1112. During this period, Erbil was under the control of the Begteginid Dynasty (Bosworth 2019; Nováček *et al.* 2013).

The Mongol forces attacked Erbil in 1237 but were repelled until 1258, and Mosul fell in 1262 (Honigmann *et al.* 2007; Nováček *et al.* 2013). After the Ilkhanate, this region was incorporated into the Jalayirid Dynasty. Timur visited Mosul in the late 14th century, made a pilgrimage to Nebi Yunus and Nebi Jirjis, and restored parts of the city. He placed the Aq Qoyunlu as governors in Diyar Bakr, and Mosul (Bosworth 2019; Honigmann *et al.* 2007). Erbil is not mentioned in the sources during the

14th century and scholars assume its historical trajectory follows that of Mosul (Nováček *et al.* 2013). This region has mainly been under the control of the main Iraqi and Iranian empires but was given a degree of independence in terms of local dynasties as governors of the region. The large plains located along the foothills allowed for surpluses of rain-fed agriculture, and the control and monetization of this agricultural surplus was the economic basis of the larger political realms (al-Duri 1970; Kennedy 2002). The Tigris and Euphrates Rivers as well as the desert to the south, led to massive trade routes passing through the Jazira. Controlling this area allowed for the taxation and control of trade routes from Europe to China, via the Jazira.

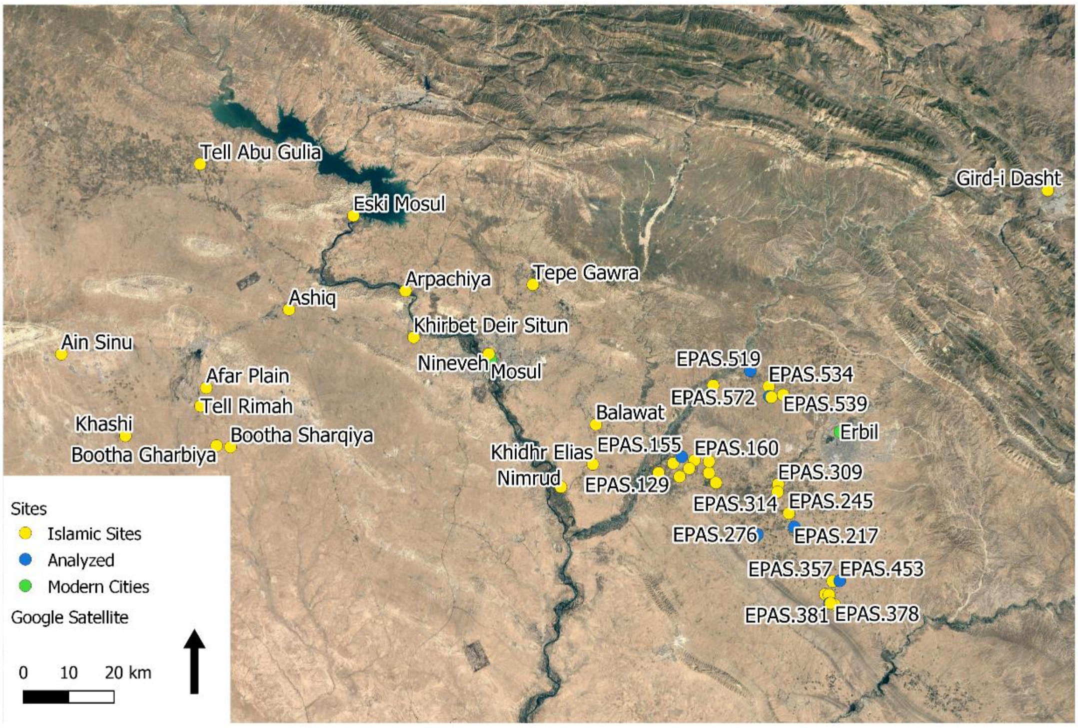

Figure 2.3: Islamic sites in the al-Jazira Region.

2.3.1.1 EPAS Sites

The Erbil Plain Archaeological Survey (EPAS) is centered around the city of Erbil in Iraqi Kurdistan. The project was started in 2012 to map archaeological sites and landscape features from the Neolithic to present. The survey region covers 3200 square km between the Upper and Lower Zab Rivers with the city of Erbil at its center (Figure 2.3). The EPAS sites provide a case-study for analyzing regional variation in northern Iraq. These sites, in the hinterland of both Erbil and Mosul, provide a snapshot of rural life in this area. By sampling seven of these sites from various parts of the plain we begin to see intraregional interactions, as well as interactions with larger areas. These sites were all chosen from the EPAS dataset due to their dating as one period Middle Islamic sites based on the ceramics.

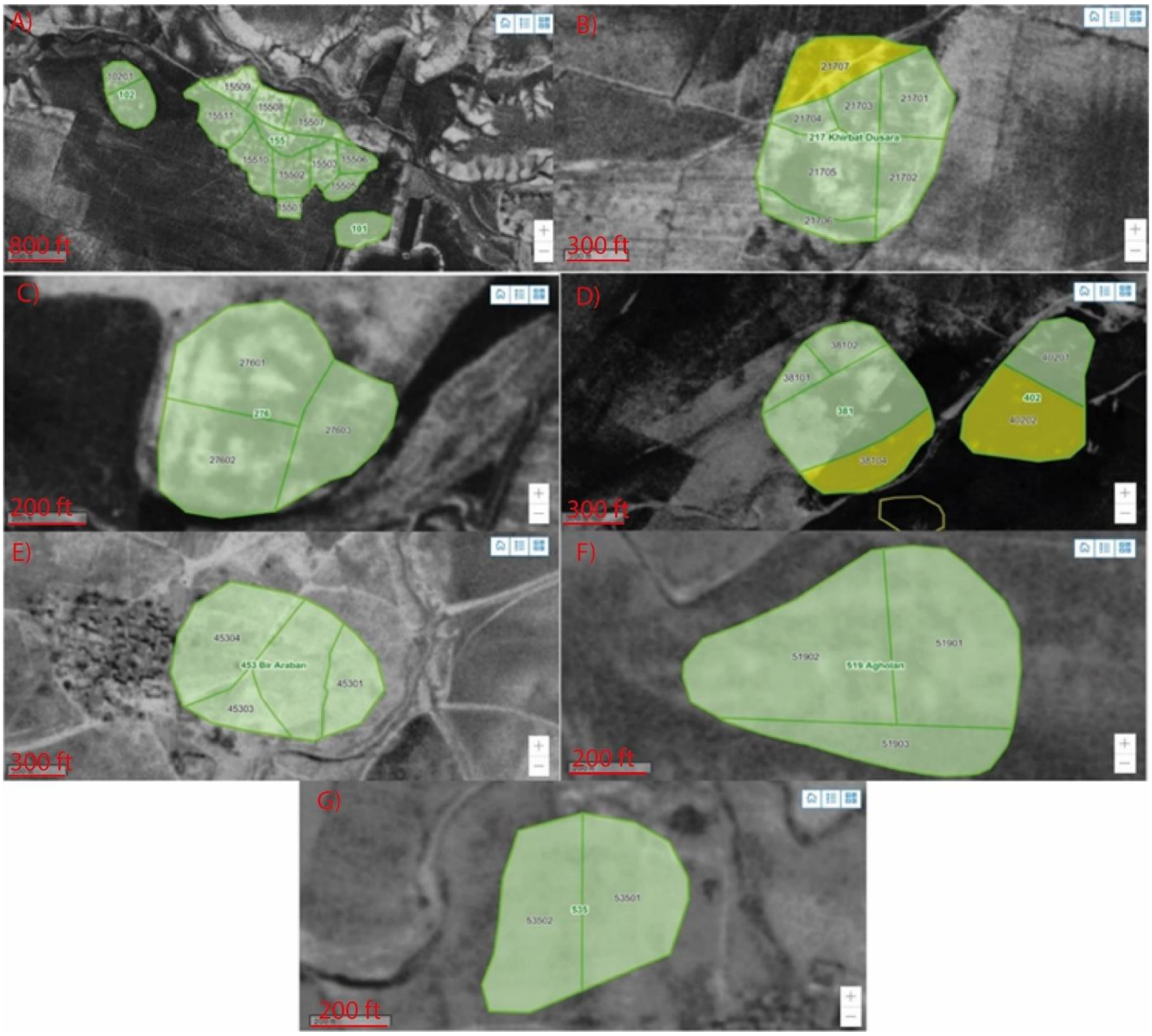

Figure 2.4: Maps of EPAS sites, A) 155, B) 217, C) 276, D) 381, E) 453, F) 519, G) 535. From Jason Ur.

Site 155 was surveyed in 2013 and was a large sprawling complex of mounds on the left bank of a broad water drainage (Figure 2.4: A). The drainage dates to the Neo-Assyrian Period (Ur *et al.* 2021), but Site 155 is Middle Islamic based on the ceramics. It is 12.43 ha and was divided into eleven areas. Each of the areas produced around the same amount of pottery showing a relatively dense habitation over the entire site. In section one, there was a square baked brick foundation with possible inside walls. This area had both ceramic wasters and metal slag indicating a possible industrial area.

Site 217 (Khirbat Dusara) was surveyed in 2016 (Figure 2.4: B). It is an Islamic settlement with a series of low mounds measuring 6.2 ha. It was divided into six sections and areas four, five, and six had a high density of baked brick. Areas two, three, and four had high densities of ceramics, indicating the possible center of the settlement. A large cut exposed an area about 10 meters long that shows burn layers of roughly 1.5 meters deep. This burn layer caps the top of the mound and may be why the settlement was abandoned.

Site 276 was surveyed in 2016 and measures around 2.1 ha (Figure 2.4: C). It was divided into four sections, and sections one and two had the most ceramics. No surface features were recorded at this site.

Site 381 was surveyed in 2017 and measures around 4.4 ha (Figure 2.4: D). It was divided into three areas, all with good visibility. Area one had a single structure and contained the most ceramics. The few baked bricks marked the structure, but it was highly eroded. There is a site next to 381 (Site 402) but this site dates to the Late Islamic and Modern periods.

Site 453 (Bir Araban) was surveyed in 2018 and measures around 5.7 ha (Figure 2.4: E). No surface features were recorded, and sections one and two had the most ceramics. These sections also seemed to be on top of a small hill.

Site 519 (Agholan) was surveyed in 2018 and had three collection areas (Figure 2.4: F). There was relatively good visibility, but low sherd density. It measured 7.39 ha. No surface features, baked brick, or production debris were recorded, and section one had the most sherds present.

Site 535 was surveyed in 2018 and is a shallow-mounded site that bordered the outlying buildings of a town (Smailawa?) (Figure 2.4: G). It measured 4.09 ha. Section one of this site contained the most sherds and is also the closest to the modern village.

2.3.2 *Southern Iraq (al-Iraq)*

The region of al-Iraq (Figure 2.2: 6) encompasses present day southern Iraq from the modern city of Tikrit south to the Persian Gulf. The main cities in this region include Baghdad, Basra, Kufa, and Wasit (Figure 2.5). Most of these cities were established as military garrisons during the Islamic conquests, gained importance during the Abbasid Caliphate, and fell into decline after the Mongol invasions and subsequent periods (Djait 2007; Duri 2007; Pellat & Longrigg 2007; Sakly & Darley-Doran 2007).

Various revolts occurred in al-Iraq during the 9th and early 10th centuries based on religious and ethnic divisions (Djait 2007; Duri 2007; Pellat & Longrigg 2007; Sakly & Darley-Doran 2007). The Buyids took Baghdad and Wasit in 945 and Kufa began its decline with the growth of the nearby settlement of al-Hilla (Djait 2007; Duri 2007; Sakly & Darley-Doran 2007). Towards the end of the Buyid period, al-Iraq became fragmented into different independent regions. In 1055, Toghril Beg conquered Baghdad and added it to the Seljuq Empire. Around 1194, the Seljuqs were overthrown, and the Abbasid Caliphate regained power.

In 1258, the Mongol forces took Baghdad, and reportedly heavily damaged the larger cities and surrounding regions (Jackson 2017; Kennedy 2005). Wasit, located in the middle of fertile agricultural lands, was reconstructed under the Ilkhanate, and Baghdad also was restored and became a provincial center (Duri 2007; Safar 1945; Sakly & Darley-Doran 2007). Until 1340 Baghdad remained under Ilkhanate control and was administered by a governor with a military garrison. Under the Ilkhanate, Christians were exempt from paying taxes, and rebuilt churches and schools. The Jewish population rose to prominence between 1284–91, but a revolt killed a large number of the population in 1291. After the Ilkhanate converted to Islam (1295), Muslim endowments were patronized, but tensions still ran high between Sunnis and Shi'as (Duri 2007; Jackson 2017). After the Ilkhanate, al-Iraq fell under the control of the Jalayirid Dynasty, the Qara Qoyunlu, and the Aq Qoyunlu before joining the Ottoman Empire in 1534 (Djait 2007; Duri 2007; Pellat & Longrigg 2007; Sakly & Darley-Doran 2007). Southern Iraq was the base of the Abbasid Caliphate, and due to its central location, became the crossroads of various empires. The Silk Roads crossed from the Mediterranean through Baghdad on their way to either Rayy (overland route) or Basra (overseas route). The control of the Tigris and Euphrates in this region allowed for the control over multiple resources from across the Middle East, and the highly irrigated nature of the floodplain allowed for large agricultural surplus. This surplus also allowed for large cities such as Baghdad, Basra, Samarra, and Wasit to flourish and develop into large political, economic, and social capitals.

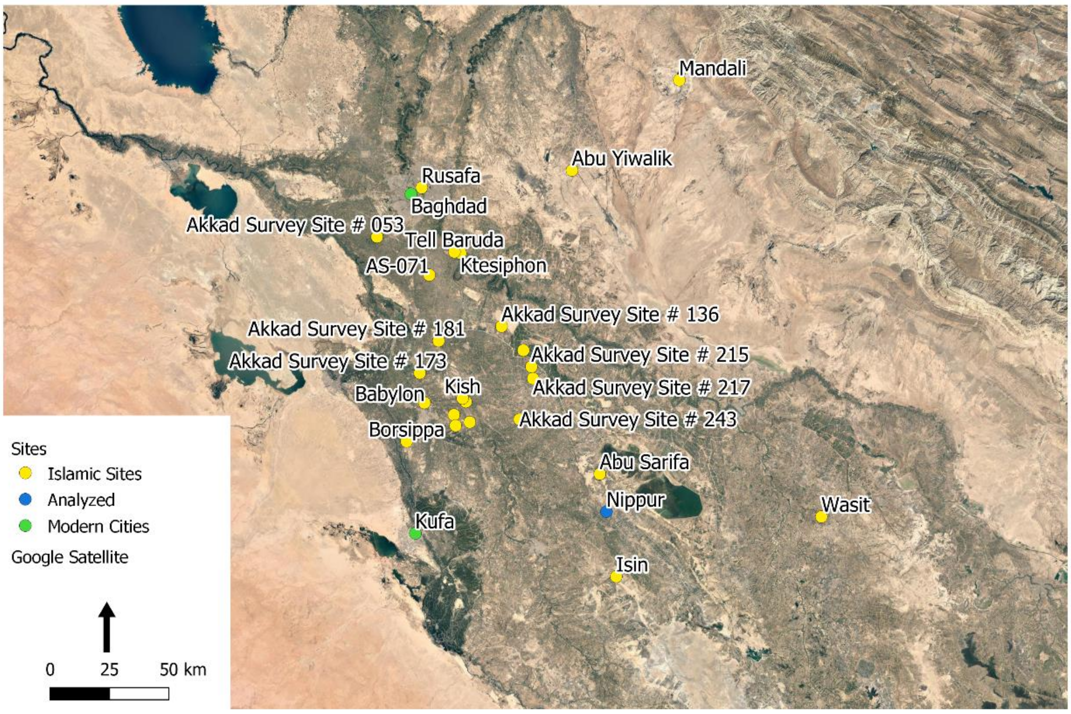

Figure 2.5: Islamic sites in al-Iraq.

2.3.2.1 Nippur

Nippur has been excavated since 1851 by Layard, the University of Pennsylvania (1889 – 1900) and the University of Chicago (1948 – 1990) (Gibson 1992; Gibson *et al.* 1998). Islamic Nippur was not a focus of the excavation until the 1986 season but remains have been found dating from the Early Islamic to the Ilkhanid period. An area of Early Islamic pottery production lies between the ziggurat and the northeastern city wall, including several kilns, wasters, and mounds of ash (Gibson 1992). By about 800 CE, the main mounds were abandoned, and settlement was restricted to a small village alongside a canal located northeast of the ziggurat (Gibson 1992). During the Ilkhanid Period (1200 – 1400 CE), a new canal was constructed from the northwest along the ancient city wall, joining with the Abbasid canal before continuing southwards. The small site (Area M; Figure 2.6), was the last archaeological occupation in the Nippur vicinity before small villages arose during the Ottoman Period (Gibson 1992).

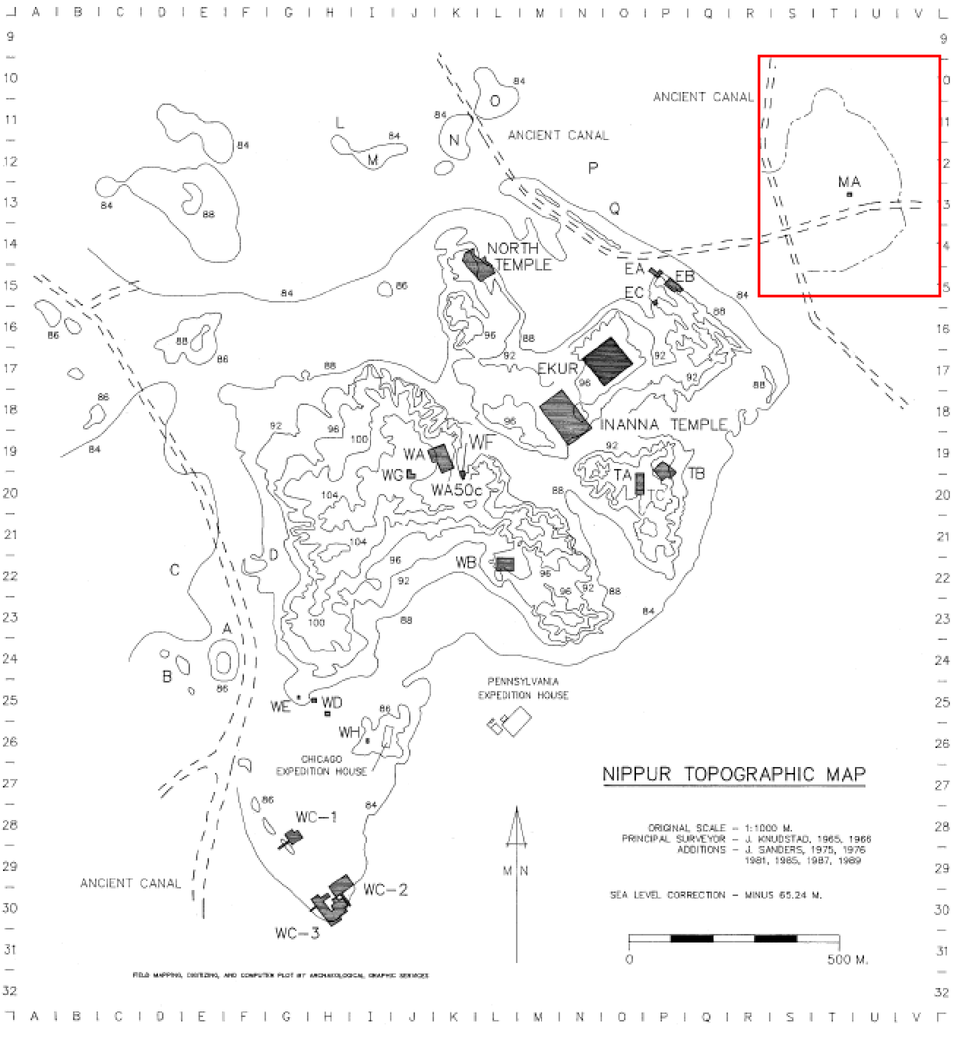

Figure 2.6: Topographic map of Nippur with Area M highlighted in a red box (Gibson, Armstrong and McMahon, 1998: Fig.1).

The Middle Islamic material at Nippur was found in Area M (Figure 2.6). In 1985, Brandt noticed the site and surface survey revealed coins and pottery dating to the 14th century (Gibson *et al.* 1998). The shifting sand dunes uncovered mudbrick walls on the surface, and excavators opened a ten-meter-square (MA) in 1987. These walls were only preserved for a few courses, and surfaces and floors were not well preserved (Gibson *et al.* 1998). This was a one-phase occupation which included glazed and unglazed ceramics, and a few coins. The excavators noticed the similarities between the cruder handmade wares and 19th century sites in the vicinity. However, the glazed material constituted a relatively high percentage on the site and is dateable to the 14th century. Gibson notes the canal that passes the site is not straight, but rather winds through the countryside possibly indicative of local initiative rather than strong governmental control (Gibson *et al.* 1998).

The ceramics include footed bowls with underglaze decoration in black or blue in patterns of roulettes, squared circles, and flower motifs, but none of the characteristically post-Ilkhanid motifs, leading to a hypothesized date ending in the 14th century. A silver coin dates to the reign of Abu Sa'id, the last Ilkhan, and another coin dates to Muhammad Bahadur (1418 – 52 CE). Glass objects were also recovered, possibly dating to an earlier period, and possibly brought to site from the Abbasid occupation nearer to the canal. The stamped decorated sherds are also hypothesized to have been brought from the Abbasid site as well (Gibson *et al.* 1998).

Nippur was chosen for this dissertation as it is a site in southern Iraq with excavated Middle Islamic material. This one phase area (Area M) shows a domestic space dating to the Middle Islamic period. Nippur was close to the provincial seat of Wasit, and based on the ceramics and coins, Nippur may have also been a provincial seat.

2.3.3 *Northern Iran (al-Ran)*

The al-Ran region (Figure 2.2: 7) encompasses the present-day countries of Azerbaijan, Armenia, and Georgia, and parts of northwestern Iran and eastern Turkey. Since the material for the dissertation is all centered around Lake Urmia (Figure 2.7), this regional history will focus on the parts of northwestern Iran, namely around the city of Tabriz.

Al-Ran fell to the Islamic conquests in 642 CE (Minorsky *et al.* 2007). The city of Tabriz was a regional center under the Abbasids, and the Rawwadid Dynasty (955 – 1116), of Yemini origin, was placed as governors. In 1054, Toghril Beg conquered Tabriz, and brought it under Seljuq control (Minorsky *et al.* 2007). This area was sometimes highly controlled by the Seljuqs with governors from the Seljuq royal family to being a semi-independent principality. The Mongol conquest of the area started in 1220, when the Mongol forces demanded more and more tribute until they militarily took the area in 1256 (Jackson 2017; Minorsky *et al.* 2007). The Ilkhanids made Tabriz a capital city and after their conversion to Islam in 1295, destroyed all the non-Islamic shrines, temples, churches, and synagogues, and began building public buildings and mosques (Minorsky *et al.* 2007). After the demise of the Ilkhanate, the region remained relatively independent, albeit nominally under the control of the Jalayirids, Qara Qoyunlu, and Aq Qoyunlu until the Safavids took the area in 1500 (Minorsky *et al.* 2007). Al-Ran is in a highly mountainous region, and as shown in its history, is the home to various independent kingdoms. Most of these kingdoms are relatively tribal and pledged their allegiance to the larger political entities at the time. During the Ilkhanate, the southern portion of this region was used as wintering pastures for the Mongol elite, and larger capitals were built in this area (Danti 2004), leading to more centralized control over this region. The Qoyunlu dynasties were also from this region and were able to unify competing independent kingdoms.

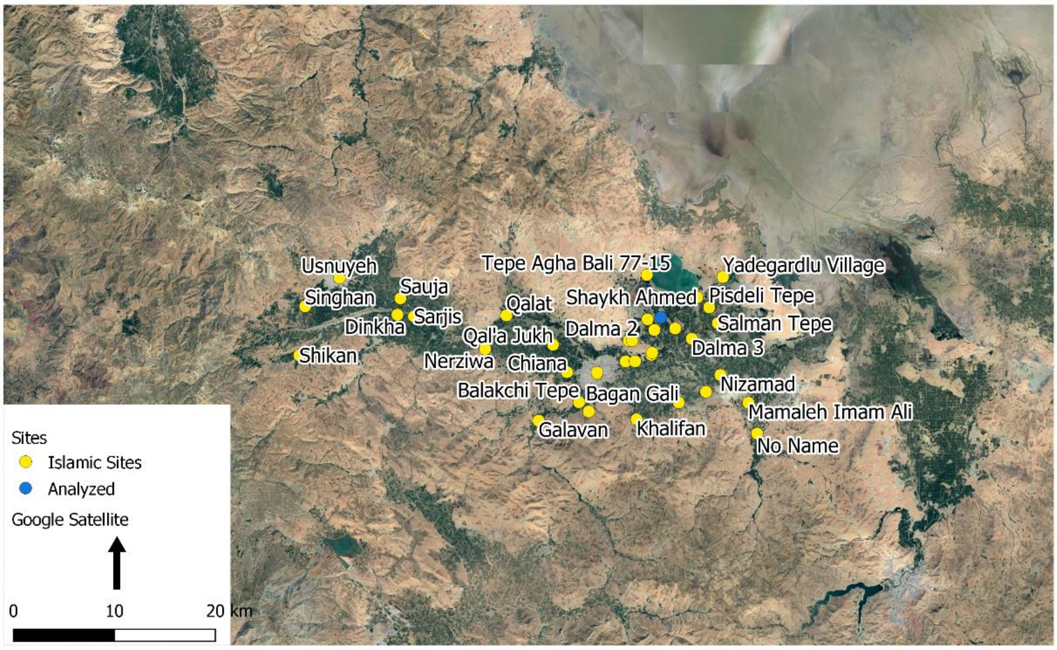

Figure 2.7: Islamic sites in al-Ran.

2.3.3.1 Hasanlu

The site of Hasanlu is located near the southern shore of Lake Urmia in northwestern Iran, in the Gadar River Valley (Figure 2.7). It is the largest site in the valley with a high mound or 'Citadel Mound' rising 25 m above the plain and measuring 200 m in diameter (13 ha) and a low mound or 'Outer Town' reaching 8 m above the plain and measuring 600 m across at its largest point (23 ha) (Figure 2.8). Hasanlu was excavated by a joint expedition of the University of Pennsylvania Museum, the Metropolitan Museum of Art, and the Archaeological Service of Iran under the direction of Robert Dyson. This project ran from 1956–1968 and is most recognized for its substantial Iron Age remains. The extensive documentation of this site and the remains dating to the Ilkhanid Period are discussed in Danti 2004, *The Ilkhanid Heartland: Hasanlu Tepe (Iran) Period I.*

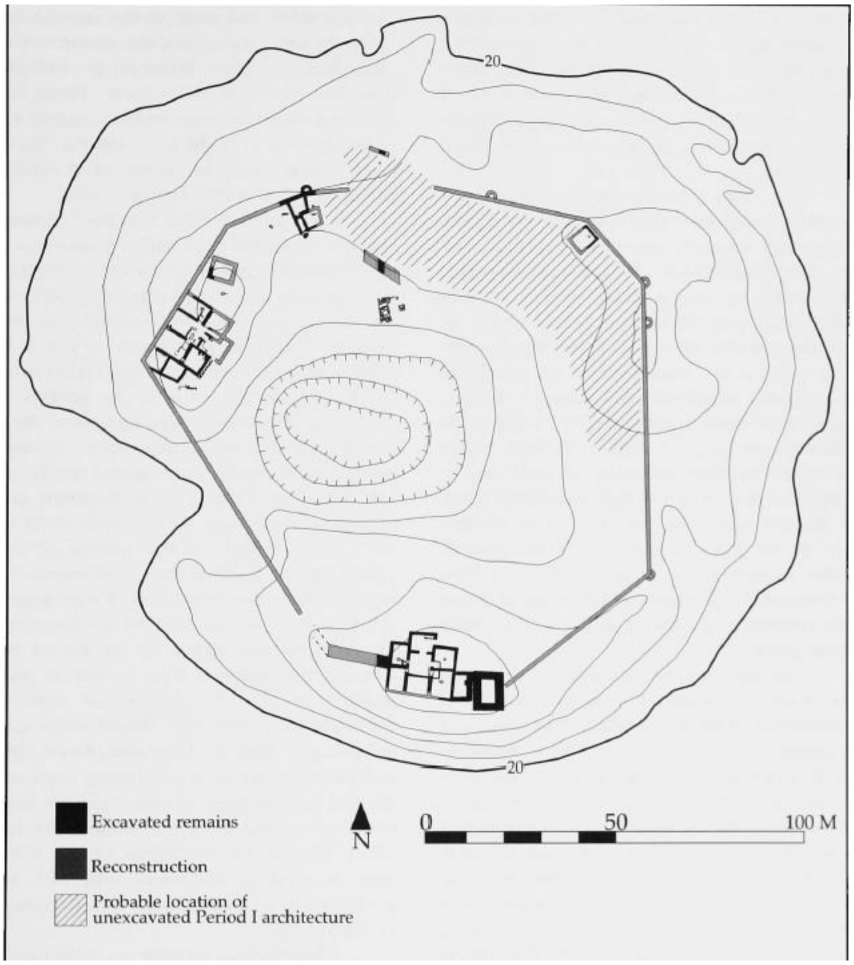

Figure 2.8: Hasanlu I reconstruction based on aerial photos. Steins 1936 sketch map and 1956 – 1962 excavations (Danti 2004: Fig. 29).

The Islamic remains are from Hasanlu Period I, found mainly on the high mound, and dated to the late 13th and early 14th centuries CE (Danti 2004). No radiocarbon samples were recovered from this phase of excavation, and neither were coins nor other datable inscriptions, and as such, the dating of the site was due to similarities of glazed ceramics and architecture (Danti 2004). The presence of Lajvardina Ware dates the settlement to this period, and the presence of Geruz Ware shows a continuity with the previous Seljuq ceramic traditions. However, the absence of typical Seljuq wares, including splash-sgraffiato and champlevé decoration as well as the coloring of the glaze divides this assemblage from the previous Seljuq ceramics (Danti 2004, p. 65). The absence of 15th century wares, like Kubachi style ware, and blue on white wares, places the end of habitation at Hasanlu in the 14th century (Danti 2004, p. 66).

The building remains on the high mound consist of a possible fortification wall, and five buildings. At the corners of the walls there were circular bastions, made of mud brick and stone approximately 3 m in diameter (as found in Building IV). There were also square towers also made of mudbrick with stone footings in Building II, possibly Building V, and possibly to the southwest of Building III (Danti 2004). There is some evidence for a ditch surrounding the fortification wall, outside of Building III. The buildings are all laid out in a ring around the high mound, and in coordination with the fortification wall. The center of the settlement was probably a large open space and the buildings entered off that plaza. Several rooms had ovens, with their openings placed relatively level with the floor surface. These had ceramic flues leading from the base of the oven to the floor, possibly for air drafting to the fire. In Operation VII J-K, a larger thicker wall along the fortification wall was found, and only a small portion was exposed. It was possibly associated with the stone paved stairway and a wall footing, possibly indicating a large important structure at the center of the settlement (Danti 2004, p. 66). This would match with the Mongol custom of placing important buildings at the center of the settlement, facing south (Masurya 1997).

The finds in these buildings suggest a typical range of domestic activities occurred in and around the houses, including food preparation, spinning, and weaving (Danti 2004, p. 49), but no ceramic production was identified (kilns or wasters). The ceramic assemblage with the size of Buildings I and III, and the fortification wall suggest a simple agricultural village with a degree of affluence, and possibly a strategic significance for the site (Danti 2004). Comparisons with Taşkun Kale (ca. 1300 – 1450) and Gritille (11th to 12th centuries) illustrate that Hasanlu could be a *ribāṭ*, or military garrison, post house, relay station, or caravanserai. The presence of prestige goods (Lajvardina Ware, stonepaste ware), along with the planned settlement, lead Danti to propose Hasanlu as a node of central control for the region, a garrison, and/or the residence of a local administrator (Danti 2004, p. 66).

Hasanlu was chosen for this dissertation as it is a small site with excavated Middle Islamic material. The excavated spaces included towers and domestic architecture, but the ceramics recorded and exported to the Penn Museum were of higher quality serving wares. This site is fortified, but it is unknown what its purpose was, if it was just a fortified rural site, or a more prominent military garrison. Therefore, it is an interesting contrast to the other sites in this dissertation.

2.3.4 *Central Iran (Iraqi al-Ajam)*

The region of Iraqi al-Ajam (Persian Iraq), or al-Jibal (Figure 2.2:8), consists of mainly present-day central Iran. The material for this dissertation is from Rayy and the surrounding area, and as such this history will focus on that of Rayy (Figure 2.9).

Rayy fell to the Islamic conquests around 640 CE and during the Umayyad Caliphate, multiple revolts occurred (Minorsky & Bosworth 2007; Rante 2015). With the shifting of central power from Damascus to Baghdad during the Umayyad/Abbasid change, Iraqi al-Ajam became a more central territory, and as such Rayy was rebuilt between 758 and 768 (Rante 2015, p. 16). Rayy was a center of power of the eastern Abbasid Caliphate, located on the Silk Road and had a large military outpost. Hence its governors were linked with the royal family of the Abbasid Caliphs. The Buyids took Rayy in 942, and with their center of power originating along the Caspian Sea, the area around Rayy became a central political region, and ties between it and Iraq were strengthened, leading to the region's name, Iraqi al-Ajam. The Seljuqs took Rayy is 1042, and Rayy became a large center of production and trade of various luxury goods (silks, textiles, ceramics, perfumes, etc.) (Rante 2015, p. 24). In 1092 the empire reached its height, and after the Seljuks moved their capital to Isfahan, the city began to gradually decline (Minorsky & Bosworth 2007).

The Mongols took Rayy in 1220 and there are disputes about the level of destruction at Rayy in terms of the massacres of the populace and large-scale destruction of the city. No archaeological evidence has been found to indicate either of these events (Rante 2015, p. 25). The populace of Rayy shrank, but the city was never abandoned, and the citadel was rebuilt by 1304 (Minorsky & Bosworth 2007; Rante 2015). Timur took the area in 1384 and by 1404 a Spanish envoy referred to Rayy as a ruin, with no inhabitants (Minorsky & Bosworth 2007). The area surrounding Rayy is bounded on the north by the Alborz Mountains, and to the south by a desert. Therefore, the route through northern Iran must pass through this area. The fertile plain allowed for agricultural surpluses and large population centers. The city of Rayy was the capital of various political dynasties, until being abandoned during the Timurid Empire.

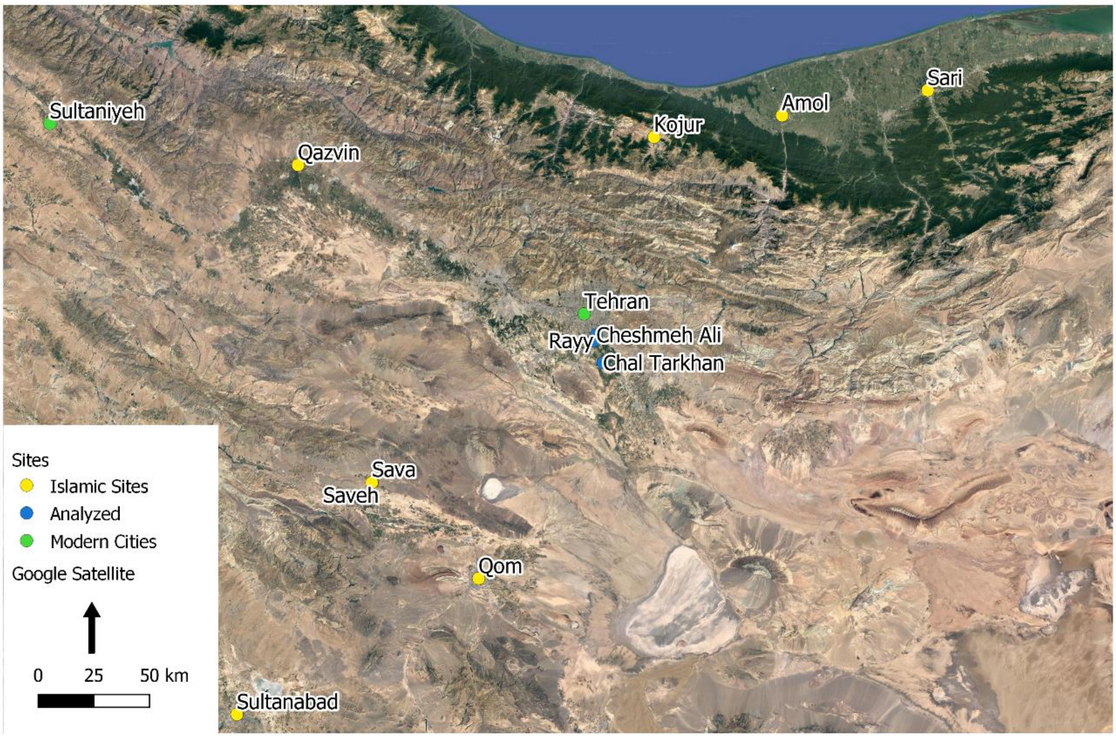

Figure 2.9: Islamic sites in Iraqi-al Ajam.

2.3.4.1 Rayy and Chal Tarkhan

The first western accounts of Rayy were written by Sir James Morier and Sir William Ouseley who visited the site between 1810 and 1830. Throughout the 19th century, various non-systematic excavations were carried out on different parts of the site, by both western expeditions and Iranian commercial excavations (Rante 2010). The first systematic excavation was performed between 1934 and 1936 by Schmidt under the auspices of the Penn Museum and Boston Museum of Fine Arts (Schmidt 1934; 1935a; 1935b; 1936). The sherds used in this dissertation are from this excavation (Figure 2.10).

Rayy is a multicomponent site dating to various periods extending from the Neolithic to present day. The city of Tehran surrounds the site of Rayy and has almost completely covered the ancient city. The Islamic levels date from the Umayyad to Timurid periods (ca. 800 – 1450 CE). Schmidt chose Rayy as an excavation site because of its *key geographical position at the crossing of ancient routes from north to south and east to west, and its importance from median times to the final destruction by Tamerlane" (Schmidt 1934 as quoted in Treptow, 2007, p. 14). Schmidt's excavations were located at Cheshmeh Ali, the Citadel, and the Government Quarter or Šahrestān (Schmidt 1934; 1935a; 1935b; 1936).

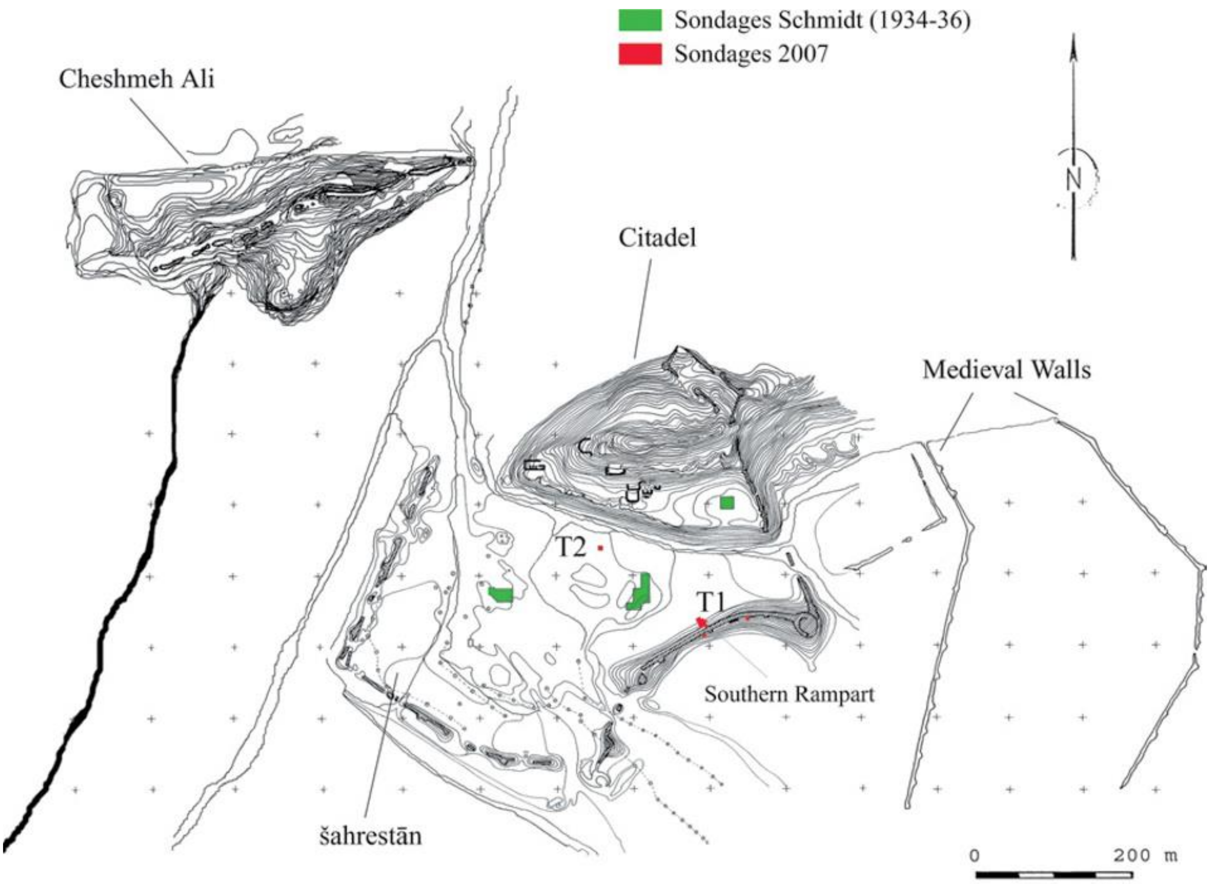

Figure 2.10: Topographic map of Rayy (Rante, 2015, p.51).

Cheshmeh Ali is more well known for its Neolithic remains, but Schmidt excavated a 2 m deep Islamic layer (Schmidt 1936). Schmidt was more interested in the earlier periods and didn't thoroughly record the Islamic period objects. The few that were recorded dated to the Middle and Early Islamic occupations (Keall 1979).

Schmidt's excavations on the citadel show it was occupied from pre-Islamic times until the Mongol invasions, and again during the Timurid period. The majority of occupation dates to the 7th – 9th centuries based on the ceramic evidence. The Middle Islamic period is also attested via a coin dated to the first half of the 11th century, and a later occupation dating to the Timurid empire is also attested by coins dated to 1432 (Schmidt 1936).

Schmidt first excavated the governmental quarter in 1934, where he focused on two mounds. The one mound contained a possible mosque dating to the Abbasid or Umayyad period based on coin dating. The second mound contained a madrasa dating to the Seljuq period. Rante (2010) notes a difference in the ceramic fabrics of the Abbasid occupation (8th – 9th centuries), and the later occupation. The fabric tends to become lighter and more of a buff-orange, and molded fragments of dark red fabric date to the 10th – 11th centuries. Sgraffiato and slip-painted fragments also appear. The layer above this includes a higher quantity of glazed ware, including lustre wares and dates to the 11th – 12th centuries. During this period the inner city was at its largest expanse. A 2 cm thick burned layer capped the Seljuq occupation and has been associated with the destruction of Rayy by the Mongols. A few post-Mongol sherds were found mixed with the topsoil (Rante 2010).

Schmidt's excavations were never fully published; a couple of preliminary reports were published in 1935 and 1936, and unpublished summaries are located at the Oriental Institute Archives (Treptow 2007). One kiln was found during the excavations, located on the mound of Cheshmeh Ali (Schmidt 1934). However, many of the ceramics recorded in the excavations were wasters, illustrating ceramic production at the site. Rante re-opened excavations in 2006, but again, no kilns were identified. This could be because kilns tended to be located on the outskirts of the city, and today, those lie under the suburbs of Tehran.

Chal Tarkhan is located 20 km south of Rayy and was excavated in 1936 by the Rayy Expedition under the direction of Schmidt. Two large buildings were partially excavated (Main Palace and Subsidiary Palace) and a large rectangular mound (Citadel Mound) was left unexcavated. The buildings had extensive painted stucco sculpture, which is what led the excavators to the site, but only the stuccoes and coins minted at Rayy were published (Miles 1938; Thompson 1976). All other finds have remained unpublished, along with the excavation contexts and maps (Kröger 1990). Kröger states the site was constructed in late Sassanian times and existed through the Umayyad period.

Rayy was chosen as an urban comparison to the rest of the rural areas to help test the hypothesis of rural vs. urban material culture in this dissertation. The site of Chal Tarkhan was mixed into the Rayy sample and provides another look at an intermediate site with the same material culture as Rayy. The links established between Rayy and Chal Tarkhan are much stronger than any other links in this dissertation, illustrating the influence Rayy had on the larger Iraq al-Ajam region. This also provides a counterpoint to the networks developed for the other regions.

2.3.5 *Eastern Iran (Khurāsān)*

The region of Khurāsān (Figure 2.2: 17) consists of the central Iranian plateau, the largest city being that of Nishapur (Figure 2.11). Durand-Guédy states that "The history of Khurāsān between the 7th and 13th centuries is the history of a marginal region becoming a centre and then again a margin (2015, p. 2)". Khurāsān fell to the Islamic forces in 651, and they placed local governors in charge and settled up to 250,000 Arab people in the region (Daniel 1979; Honigmann & Bosworth 2007). This area fluctuated between the Arab governors and those of the local dynasties until 900, and by 1030 Nishapur became the provincial capital (Honigmann & Bosworth 2007). The Seljuqs occupied the region in 1037 and in 1187 Malik Shah rebuilt Nishapur (Durand-Guédy 2015; Honigmann & Bosworth 2007). In 1221 the Mongols took Nishapur, and like Rayy, they reportedly destroyed the settlement (Honigmann & Bosworth 2007; Stubbs 2006). After the Mongol conquests, most of Khurāsān's cities were in ruins, and people had moved to the rural areas as described by European and Muslim travellers (Marco Polo, Ibn Battuta, Hamd Allah Mustawfi; Bosworth 2011). There was also a shift away from agriculture to nomadic or semi-nomadic pastoralism. With the Ilkhanid center being in Iraqi al-Ajam, Azerbaijan, and Iraq, Khurāsān was largely ignored (Bosworth 2011; Durand-Guédy 2015). After the Ilkhanate, various independent dynasties arose in Khurāsān. Timur conquered the region in 1381 and established his capital at Samarkand (Bosworth 2011). Nishapur was abandoned sometime in the 15th century, and Khurāsān fell to the Safavids in 1510. Khurāsān has various mountain regions and valleys and is bordered by the steppe to the north. Most of the habitation in this region is located along the steppe, with only a few large population centres in the valleys (Nishapur). Therefore, much like al-Ran, various independent kingdoms arose in these mountains, some of whom pledged allegiance to the larger political entities.

Figure 2.11: Islamic sites in Khurāsān.

2.3.5.1 Firuzabad

Much of the data for this dissertation is from the Eastern Iran Survey conducted by Pigott, Bockstoce, and Spooner in 1969 (Ingraham 1975; Spooner 1969). The survey was part of a larger research project by Spooner analyzing the cultural ecology of the desert and semi-desert regions of eastern Iran, as well as settlement patterns and use of the desert from the prehistoric to pre-modern times (Ingraham 1975; Pigott 1970; Spooner 1969). This survey area was divided into quadrants, with the main focus on the northern quadrant (Figure 2.11). The first three quadrants did not include much in the way of archaeological remains, except for a few possible copper mines that had been used in the past. Quadrant four had seven sites stretching from the middle/late 1st millennium BCE to the Late Islamic period (Figure 2.11). Some of this material uncovered in the last phase was exported to the Penn Museum.

Tepe Firuzabad is located south of the modern village of Firuzabad and is a large mound with a circumference of 500 m, and approximately 20 m tall. There is evidence of commercial digging about 20 years before the survey (ca. 1940) bisecting the mound, and various pits dug into the mound for mud brick extraction. Locals reported the commercial digging found an Achaemenid coin on the mound (Ingraham 1975, p. 39). To the east of the mound is a pre-Mongol minaret. The surface scatter, and the few pieces from the stratigraphic cut are mainly Islamic, a few glazed pieces, but mainly undecorated or chaff tempered wares. Pieces of stone vessels were also found. Firuzabad dates to the 11th – 14th centuries (Ingraham, 1975, p. 69).

Firuzabad was chosen as it is a rural site on the eastern border of Iran. This presents a spatial comparison of ceramics from across Western Asia. The historiography of the site is much different from the other sites in this dissertation which presents an interesting comparison on how the ceramics are influenced by various other political, economic, and social spheres.

2.4 Geological Background of Regions

Five geologic regions are described below: (1) al-Jazira and the Erbil Plain; (2) al-Iraq, and the area surrounding Nippur; (3) al-Ran and the area around Hasanlu; (4) Iraq al-Ajam and the Tehran Plain around Rayy; and (5) Khurāsān and the area around Firuzabad. These regions are discussed to characterize the petrographic analysis in Chapter 6.1. Iraq is located in the center of the 'Fertile Crescent' which is a topographically low area that runs northwest-southeast and contains the youngest sediments in Iraq. The central depression is formed by the Tigris and Euphrates Rivers, and heavy irrigation has taken place in the south. To the east of the central depression lies an area with lines of hills, separated by broad depressions, forming the foothills of north and northeast Iraq (Jassim & Goff 2006). Iran is part of the Alpine-Himalayan orogenic belt that extends from the Atlantic Ocean to the Western Pacific. The country is divided into nine geological zones. The two main zones this dissertation is focused on is the Sanandaj-Sirjan Zone in the northwest, and the Central Iran Structural Zone. The Central Iran Zone is constructed of the Alburz Fore Deep, and the Tabas Wedge (Ehlers 2001; Ghorbani 2013). Alluvial soils, either wind or water eroded, cap most formations across Western Asia. These are the most recent sediments and are the most accessible soils. The other formations have varying degrees of accessibility related to their depth, exposure, and location.

Era	Period		MYA	North Iraq	South Iraq	Northwest Iran	Central Iran	Eastern Iran
Quaternary	Holocene		0.01	**Alluvium**	**Alluvium**	**Alluvium**	**Alluvium**	**Alluvium**
	Pleistocene		1.8			**Bakhtiari**	Kahrizak	
	Pliocene	Upper		**Mukdadya (Bakhtiari)**	**Dibdibba**		Bakhtiari	Hezardarreh
		Lower	5.3	**Bai Hasan (Bakhtiari)**	**Zahra**	Agha Jari	**Hezardarreh**	
	Miocene	Upper		**Injana (Upper Fars)**	**Injana (Upper Fars)**	Razak, **Upper Red**	**Upper Red**	**Upper Red**
		Middle		**Fatha (Lower Fars)**	**Fatha (Lower Fars)**	Gachaaran		
		Lower	23	**Jeribe**	**Jeribe**	**Qom**	**Qom**	
					Nfayil			
Tertiary	Oligocene	Upper		**Euphrates**	**Euphrates**	**Pabdeh**	**Lower Red**	
		Lower	33.9		**Ghar**	**Pabdeh, Lower Red**		
	Eocene	Upper		**Pila Spi/Avanah**	**Dammam**	Pabdeh, Kaskan	Alborz Green Beds	
		Middle		**Gercus**			**Karaj**	**Eocene/ Palaeocene Volcanics**
		Lower	55.8	Sinjar/Khurmala	Rus, Jill, **Aalij**	Pabdeh, Amira		
	Paleocene		65.5	**Kolosh Formation**	**Umm Er Radhuma**, Akasht			
Mesozoic	Cretaceous		146.5	Balambo	Awasil, Mauddud, Nahr Umr, Shu'Aiba, Zubair, Garagu	Gwpi, Ilam, **Garau**	**Tiz Kuh**	
	Jurassic	Upper		Chia Gara, Barsarin, Naokelekan	Zangura, Makhul, Gotnia, Najmah	Golnia, Najmeh, Sargdu, Mus, Adaniha, Neyriz	Magu, Pecten, Baghanshah, Holjdak, Badamu	**Magu (Parvadeh, Baghamshah, Qal'eh Dokhtar, Esfandiar)**
		Lower	199.6	Sargelu, Sehkaniyan, Sarki	Sargelu, Muhaiwar, Alan, Adiyah, Ubaid		Shemshak	**Shemshak, (Hojedk, Badamu, Ab-e-Haji)**
	Triassic		252.2	Baluti, Kurra Chine, Geli Khana	Mulussa, Zor Hauran	Dashtak, Anby, Kangan	**Elika**	**Nayband**
Paleozoic	Permian	Upper			Gaara	Dalma, Ruteh	**Ruteh**, Nesen	Nesen, Ruteh
		Lower	299	Chia Zairi	Chia Zairi	Faraghan	Dorud	Dorud
	Carboniferous	Upper	318	Harur, Ora	Harur, Ora		Dozda, Ilanqareh	**Sardar, Jamal**
		Lower	359.2	Kaista	Kaista			
	Devonian		416	Pirispiki	Pirispiki	Zakoon	Mall	Padeba, Shirgesth, Shotori
	Silurian		443	Chalki	Chalki	Sareh Chahan		Niur
	Ordovician		488.3	Khabour	Khabour	Slyahu	Lashkarak	Qelli
	Cambrian					Milla	Milla	Milla
			542			Laloon	Laloon	Laloon
	Pre-Cambrian					Zaigun, **Barut**	Zaigun, Barut	Zaigun
						Soltaneh	Soltaneh	Kahar
			1000			Kahar	Kahar	

Figure 2.12: Geological Eras and formations across Western Asia. Formation names in bold are discussed in the text.

The Paleocene (55.8–65.5 MYA) was marked by a marine transgression at the Cretaceous/Paleocene boundary (Starkie 1994). Between the Paleocene and Eocene (33.9–55.8 MYA) the area was marked by a period of subduction and volcanic arc activity which led to uplift along the northeastern margin of the Arabian Plate (Jassim & Goff 2006). During the Eocene, there was a widespread erosion of Iraq, followed by the re-establishment of marine conditions with reefs and lagoons forming (Starkie 1994). The majority of Iran was covered with an open sea, with volcanic vents in northern and central Iran (Harrison 1968). The beginning of the Oligocene (23–33.9 MYA) was marked by the opening of the Red Sea and Gulf of Aden. This period was also marked by a folding and thrusting of terrains along the northeastern margin of the Arabian Plate. Central and Eastern Iran was covered by a sea, but shallow water, reef, and back reef conditions were identified (Harrison 1968). The Miocene (5.3–23 MYA) was marked by the Savian movements which caused the formation of broad and shallow basins and was characterized by a change from a marine phase to a continental phase. This change is attributed to the collision of the Sanandaj-Sirjan Zone with the Arabian Plate (Sissakian *et al.* 2016). This collision resulted in the High Folded Zones of the Zagros, as well as a foredeep in the Foothill Zone of Iraq (Jassim & Goff 2006). In Iran, the seas shrank to shallow inland waters including straits, gulfs, and lagoons (Harrison 1968). During the Pliocene (1.8–5.3 MYA) the High Folded Zone continued to be uplifted, and anticlines and synclines were formed. River terraces and alluvial deposits were created during the Pleistocene (10000 YA–1.8 MYA). These river terraces and alluvial deposits continue to modify the landscape during the Holocene (Present–10000 YA). The majority of the raw materials for the pottery are from sedimentary rocks and clays, and the marine formations provide the majority of these sediments. The uplifts provided the formations along the mountains, and these include many of the igneous and metamorphic formations, influencing the materials used for tempering in these regions, and the nature of the clay.

2.4.1 *al-Jazira (Erbil Plain)*

The Erbil Plain is located at the foothills of the Zagros Mountains, and the edge of the Mesopotamian Plain. It is bounded by the Greater Zab River to the north, the Zagros Mountains to the east, the Little Zab River to the south and the Qaraqosh Mountains to the west. The plain is relatively flat with some low-lying hills. The Zab rivers are two main tributaries of the Tigris, the Greater Zab joining near present day al-Kuwayr, and the Little Zab joining at Azwai City. Both start in the high Zagros, with the Greater Zab starting in Turkey, and the Little Zab starting along the Iraq/Iran border. The main population center of Erbil covers a portion of the plain.

The foothills of the Zagros Mountains are associated with long anticlinal structures, with the oldest beds at the core, and the corresponding depressions are linked with broad synclines, where the oldest beds are the deepest (Ahmed 2019). These anticline and syncline structures contain Paleocene (Kolosh Formation), Eocene (Pila Spi, Avanah, Gercus Formations), Oligocene (Euphrates Formation), Miocene (Injana, Fatha, Jeribe Formations), Pliocene (Mukdadiya and Bai Hassan Formations) and Pleistocene (Alluvium) (Petrik *et al.* 2020; Sissakian *et al.* 2015).

During the Eocene, geological formations arose between the Low Folded and High Folded Zones. The Pila Spi Formation is marked by a large bituminous limestone ridge running from the northwest to southeast, with bands of marl and chert (Jassim & Goff 2006). This formation is intermixed with the Avanah Limestone Formation which contains white fossiliferous limestone and dolomitic limestones. The Pila Spi Formation overlays the Gercus Red Beds (red shales, sandstones, and mudstones) (Petrik *et al.* 2020). These formations were laid down in shallow lagoons. During the Oligocene, the area of northeastern Iraq was on the edge of the Euphrates Formation (limestone, marl, mudstone). The Jeribe Formation (dolomized limestone, argillaceous limestone, anhydrites) was laid down over the Euphrates Formation, and deposited in lagoonal environments Above this formation lies the Fatha (Lower Fars Formation) and Injana (Upper Fars Formation) which date to the Miocene. The Fatha Formation is located in a broad basin adjacent to the Zagros, and includes mudrocks, limestones, gypsum, marl, anhydrite, and halite (Al-Juboury & McCann 2008). It was deposited in a subsiding sag basin which could form sabkhas and salinas (Jassim & Goff 2006). The Injana Formation includes "continental coarse and medium-grained carbonate-rich sandstone alternating with brownish red siltstones, mudstones, and marls with rare freshwater limestone" (Al-Juboury 2009, p. 337).

The Pliocene Bakhtiari Formation is divided into the Bai Hassan and Mukdadiya Formations. These formations both overlay the Injana Formation. The Mukdadiya Formation is composed of clastics (red sandstones, grey mudstones, and siltstones) and was deposited in a fluvial environment (Jassim & Goff 2006). Some of these beds have cross-bedding with clay balls and channel fill sedimentary structures (Sissakian *et al.* 2015). The Bai Hassan Formation provides the majority of rocks for the alluvial fans, alternating thick and coarse conglomerates with red claystones and thin sandstones (Petrik *et al.* 2020).

Capping the Bakhtiari Formations are the Pleistocene and Holocene alluvial fans which were deposited along the basins and in the plains. These either consist of carbonates from the Pila Spi Formation, or carbonates and silicates from the Bai Hassan Formation with lesser amounts of igneous and metamorphic rocks. During the Holocene the alluvial fans have been eroded and washed out (Buday & Jassim 1987; Jassim & Goff 2006).

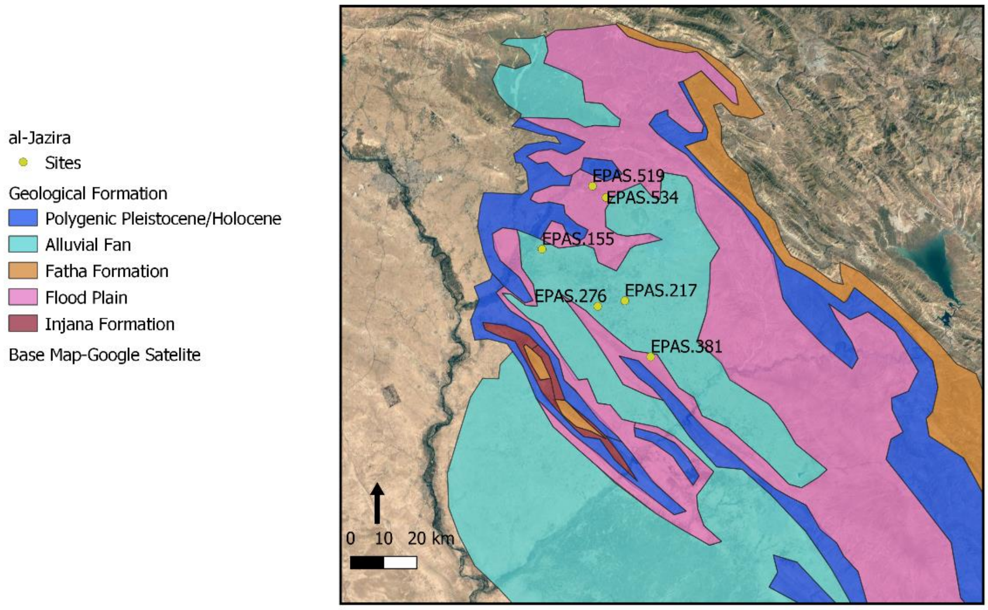

Figure 2.13: Geological map of northern Iraq (Based on Sissakian and Fouad 2012; Appendix 1).

In terms of mineralogical deposits, the area is mainly covered with alluvial sediments including clastics (mudrocks, red and brown sandstones, red and brown claystones) from the Fatha, Mukdadiya, and Bai Hassan Formations, carbonates (arenaceous, fossiliferous, and dolomitic limestones, dolomite) from the Fatha and Injana Formations, and evaporates (gypsum, halite, anhydrite) from the Fatha Formations. Few igneous and metamorphic fragments also appear and are linked with the Injana Formation (Figure 2.13; Mohammad *et al.* 2013). A report characterized the soils in Erbil as having calcic, gypsic, argillic, and salic horizons, with limited organic matter (Mohammad *et al.* 2013). Petřík et al's 2020 study identifies carbonate rich river settlements including micrite, sparite, fossils, and calcite crystals, microcrystalline and radiolarian chert, argillaceous rock fragments, metamorphic rock fragments, igneous rock fragments, mono- and poly-crystalline quartz, feldspar, plagioclase, and orthoclase. The clay minerals identified in the Erbil study included nintronite, illite, chlorite, and kaolinite, and the Injana and Fatha Formations produce palygorskite clays (Mohammad *et al.* 2013).

2.4.2 *al-Iraq (Nippur)*

Nippur is located on the Mesopotamian Plain, which runs from Wadi Tharthar in the northwest to the Arabian Gulf in the southeast. Nippur is approximately halfway between the modern courses of the Euphrates and Tigris Rivers and linked with both by a series of relict canals.

The area around Nippur is part of the Mesopotamian Zone of the Stable Shelf, bounded by the Pesh-i Kuh in the east, the Hemrin and Makhul in the north and various faults in the south (Jassim & Goff 2006). This zone is constructed of various formations including Paleocene (Umm Er Radhuma Formation), Eocene (Aaliji and Dammam Formations), Oligocene (Ghar and Euphrates Formations), Miocene (Nfayil, Jeribe, Fatha, and Injana Formations), Pliocene (Dibdibba and Zahra Formations), and Pleistocene/Holocene (Alluvium) (Jassim & Goff 2006).

During the Paleocene, several limestone formations were created including the Umm Er Radhuma (dolomitic limestone, dolomite, chalky limestone, chert) which was deposited in a supratidal sabkha environment (Jassim and Goff 2016). Along the eastern section of the Mesopotamia Zone, the Aaliji Formation (argillaceous marl, argillaceous limestone, shale, chert, glauconite) appears, and stretches to the east and north to the high Zagros. This formation was deposited in an open marine environment between two carbonate shoals (Jassim and Goff 2016).

The Dammam Formation (chalky, marly, clayey dolomitic limestones, porous, nummulitic limestones, shale) dates to the Eocene (Starkie 1994). The Gleb Member consists of breccia with fossiliferous limestone, shelly limestone, chert, mudstone, dolomitic limestone, and chalky limestone. This was deposited on a shallow marine shelf, with high salinity (Jassim & Goff 2006). During the Oligocene, the Ghar Formation (calcareous sandstone, marly limestone, red mudstone) was laid in a marginal marine, possibly deltaic environment (Jassim & Goff 2006). The Euphrates Formation covers the Ghar and Dammam Formations, and consists of basal conglomerate, shelly limestone, chalky limestone, and oolitic, brecciated, marly limestone (Sissakian *et al.* 2016). The Nfayil Formation includes a lower member of fossiliferous limestone, and an upper member of reddish-brown claystone, siltstone, and sandstone, with some horizons of limestone and green marl (Sissakian *et al.* 2016). The Jeribe, Fatha, and Injana Formations (described above) overlay the Nfayil Formation and were deposited in a lagoonal environment (Jassim & Goff 2006).

The Zahra Formation, along the margins of the Rutba subzone, consists of freshwater limestones, marls, and sandstone. This formation dates to the Pliocene and was laid in a freshwater environment (Jassim & Goff 2006). This formation lies alongside the Dibdibba Formation (sand and gravel of igneous rocks (granite), quartz, limestone, marl, silt). The Pleistocene and Holocene layers are formed of alluvial deposits mainly from the Tigris, Euphrates, Diyala, and Adhaim Rivers which creates alluvial fans from the foothill zone in the northeast or from desert wadis in the west (Jassim & Goff 2006). The flood plain consists of mudflats and sabkhas which are soft, saline mudflats and hold moisture during the dry season (al-Naqib 1967). Alluvial fans are common around Nippur, being the product of several cycles of sedimentation (Jassim & Goff 2006). The oldest fans are located near the Jabal Hemrin, the younger fans lie further down the Euphrates. They consist of poorly sorted coarse deposits of cobbles to finer grained better sorted layered fluvial sediments including minerals such as quartz, epidote, hornblende, orthopyroxene, augite, rutile, zircon, tourmaline, titanite, garnet, andalusite, sillimanite, kayanite, starolite, chromite, chlorite, barite, and celestite (Jassim & Goff 2006). The aeolian sands typically blow in the wind from the northwest to the southeast, depositing gypsum, moderately rounded quartz, limestone, calcareous silt, and feldspar grains (Jassim & Goff 2006).

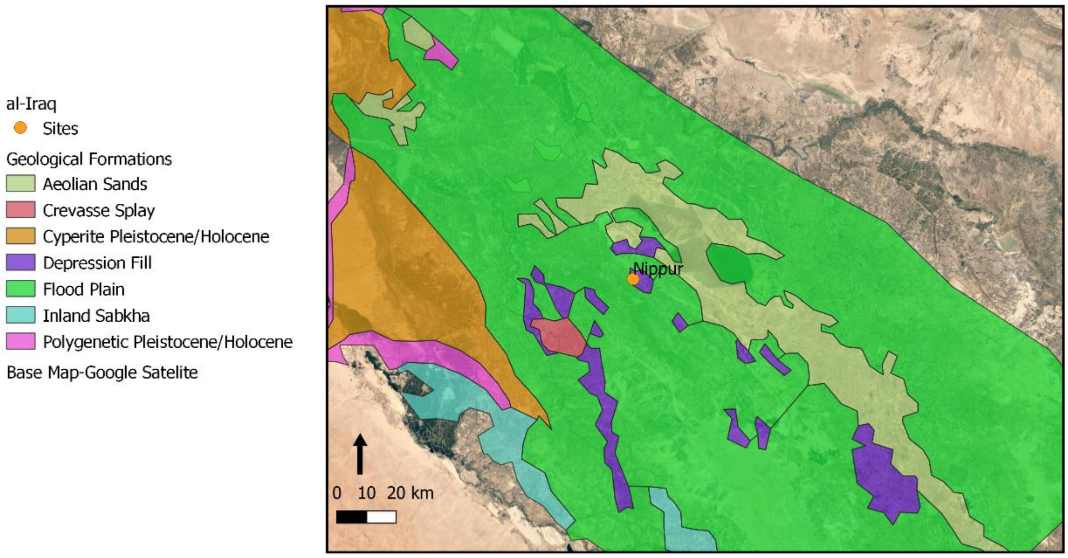

Figure 2.14: Geological map of the region around Nippur, Iraq (based on Sissakian and Fouad 2012; Appendix 1).

In terms of mineralogy, the Mesopotamian Plain consists of pebbly limestones, gypsum, quartzite, quartz, chert, and to a lesser extent metamorphics and igneous rocks (Figure 2.14). Most of the minerals are very well rounded and of a sand to pebble size, due to either traveling by river or being wind-blown (Jassim & Goff 2006). As Garzanti et al (2016; Fig. 3) show, the Mesopotamian floodplain contains relatively well-rounded grains of quartz, carbonate, volcanic, chert, and plagioclase (Figure 2.15: G and H). A petrographic study performed at Ur, located in the flood plain but to the southwest of Nippur, had inclusions of quartz, orthoclase, plagioclase, quartz, chert, quartzite, calcite, mudstone, igneous and metamorphic rocks (Kaercher 2017).

Figure 2.15: Petrography of Various Areas of Iraq "A) Metamorphiclastic detritus from the Bitlis massif (M = metamorphic lithic; m = mica). B) Cellular serpentinite (Sc) and foliated serpentine/schist (Ss) grains from ophiolites of the Zagros suture. C) Volcanic (V) chert (H) and carbonate (C) grains recycled entirely from Neogene molasse units of the foothills. Trunk-river systems: D) Euphrates sand rich in volcanic detritus including plagioclase (P) and clinopyroxene (p). (E) Tigris sand rich in sedimentary detritus (S = shale lithic; e = epidote). F) Carbonaticlastic Karun sand. Foreland-basin fill: G) Mesopotamian sediments derived from Euphrates and Tigris Rivers in subequal proportions. H) Rounded quartz grains (Q) recycled from Arabian sources mixed with finer-grained quartz-poor orogenic detritus in the Karbala area (calcareous grains stained with alizarine red). I) Carbonaticlastic Shatt al-Arab sand supplied entirely by the Karun River because Euphrates and Tigris bedload is trapped in Iraqi marshlands before reaching the Gulf. All photos with crossed polars; all blue bars for scale are 250 µm" (Garzanti et al 2016: Fig. 3).

2.4.3 *al-Ran (Hasanlu)*

Northwest Iran is mainly part of the Zagros Mountain chain and has the large salt-water Lake Urmia on its eastern side. Hasanlu is located on the plains of the Gadar River which flows from the High Zagros to Lake Urmia in an eastern direction. The plains surrounding the Gadar River are highly settled, as it is a large enough valley in the mountains to support agriculture.

Northwest Iran is marked by the division between the Sanandaj-Sirjan and Central Iran structural zone based on certain geological features (Ghorbani 2013; Ilkhchi 2009). The Sanandaj-Sirjan is marked by the presence of magmatic and metamorphic rocks of Paleozoic and Mesozoic eras (Ghorbani 2013). The Pre-Cambrian (Soltaneh-Barut Formation) is characterized by uplift and regression and deposited limestone, dolomite, and shale in northwestern Iran. Some of these formations bear trilobites and brachiopods of the Middle and Late Cambrian Period (Ghorbani 2013). The volcanic rocks of this period are of an andesitic-basaltic composition and contain granites and gabbros. In the Late Cretaceous period (Garau Formation), tectonic movements led to uplift, folding and faulting along the Zagros Mountains. The igneous rocks of this period are divided into three groups, volcanic rocks that occurred mainly as a result of continental rifting and subduction, intrusive rocks of mafic and granitic composition, and plutonic rocks of alkaline nature (Ghorbani 2013).

The Pabdeh Formation dates to the Eocene-Oligocene periods, and consists of shales, marls and limestones (Habibi *et al.* 2017). This formation includes various foraminifera and fossils. It accumulated in the Zagros sedimentary basin which was the result of an early collision between the Arabian and Iranian plates (Habibi *et al.* 2017). The Lower Red Formation (Oligocene) is laid on top of the Pabdeh Formation, and includes red evaporates and gypsiferous beds (Mohammadi *et al.* 2013). This formation is topped by the Qom Formation, dating to the Miocene. The Qom Formation was created after the closure of the Tethyan seaway which formed the Qom basin (Karevan *et al.* 2014). This formation is constructed of limestone, marls, and evaporites (Karevan *et al.* 2014). The Upper Red Formation consists of red sandstone, and mudstone with red or purplish-gray breccia or conglomerate (Rafiei *et al.* 2011). The Bakhtiari Formation caps the previous formation and dates to the Pliocene. It is formed of pebbles of red and yellow chert, limestone, radiolarite rock fragments, and gypsum (Harrison 1968). This formation is then topped by Paleocene and Holocene alluvium, in the form of river terraces and alluvial fans.

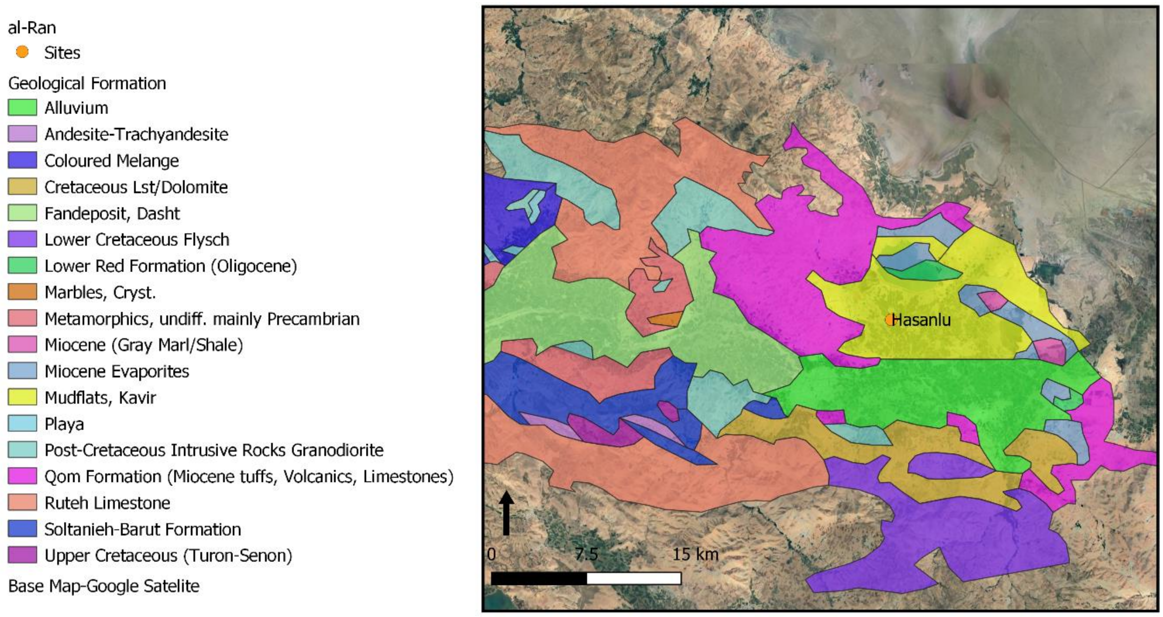

Figure 2.16: Geological map of northwestern Iran (based on Geological Staff of the Iran Oil Company 1957; Appendix 1).

The geological map of Iran shows multiple sources for minerals found at Hasanlu (Figure 2.16). There is one small outcropping of ultrabasic rocks including serpentinite and gabbro-amphibolite located near the border with Iraq. The Gadar River then flows through an upper Permian limestone outcrop into the alluvial plains. On the other side of the alluvial plain, outcroppings of limestone and post-cretaceous intrusive rocks of granodiorite are present. A petrographic study of Iron Age ceramics from Hasanlu included, schists, diorites, amphibolites, gneisses, biotites, muscovites, siltstones, granites, quartz, cherts, calcites, serpentinites, limestones, siltstones, and opaques (Kaercher 2015).

2.4.4 *Iraqi al-Ajam (Rayy and Chal Tarkhan)*

The Central Iranian Plain is bounded by the Alborz (or Elburz) Mountains and Caspian Sea to the north, the Zagros Mountains to the West and South, and the Dasht-i Kavir desert to the East. Rayy and Chal Tarkhan are located in the foothills of the Alborz Mountains and the fringes of the Kavir Desert.

The Central Iranian Plain includes rocks of all ages, from the Pre-Cambrian to the Quaternary with several episodes of orogeny, metamorphism, and magmatism occurring (Ehlers 2001). These sites sit on the western edge of the Alborz Fore Deep, a low-lying area along the Alborz Mountains which starts at Tehran and moves eastward to Afghanistan. During the Permian, the Ruteh Formation, which includes marl, chert, and fossiliferous limestones, was laid down in marine conditions (Mahdavi & Vaziri 2010). This formation also includes corals, foraminifera, and algae. This formation was capped by the Triassic Elikah Formation with dolomitic slaty limestones and dolomites. This formation was deposited along the shelves of the paleo-Tethys and Neo-Tethys seas (Mahdavi & Vaziri 2010).

The Tiz Kuh Formation contained salt beds and domes, as well as shaly limestones and dates to the Cretaceous Period (Porlak *et al.* 2020). This formation was laid down in various environments including lagoons (mudstone, wackestone, packstone), shoals (orbitinolina grainstone), and open marine (orbitolina wackestone/packstone) (Porlak *et al.* 2020). The volcanic Karaj Formation and Alborz Green Beds date to the Eocene. These formations included tuffs, pillow basalt, and pyroclastics. The Eocene was marked by a period of volcanic activity, which was then eroded in the Late Eocene and early Oligocene (Guest *et al.* 2006). These formations were created in an intracontinental volcanic arc related to the subduction along the Zagros suture zone (Zanchi *et al.* 2009). This was capped during the Oligocene and Miocene by the Lower Red, Qom, and Upper Red Formations as discussed in the al-Ran section. These formations included mainly reddish mudstone, siltstone, conglomerates, and shales, marls, and sandstones.

The Hezardarreh Formation is an alluvial formation dating to the Pliocene. This formation includes conglomerates, sandstone, siltstone, and mudstone of pebbles and semi-rounded grains from the Karaj Formation (Japan International Cooperation Agency 2000; Khaksar & Khaksar 2012). This formation is constructed by erosion, both from water and wind along the foothills of the Alborz Mountains (Khaksar & Khaksar 2012). This alluvial formation is then covered by Pleistocene and Holocene alluvial deposits consisting of conglomerates of gravel. The alluvium is made of gravel terraces and river fans of water borne and sorted deposits (Japan International Cooperation Agency 2000).

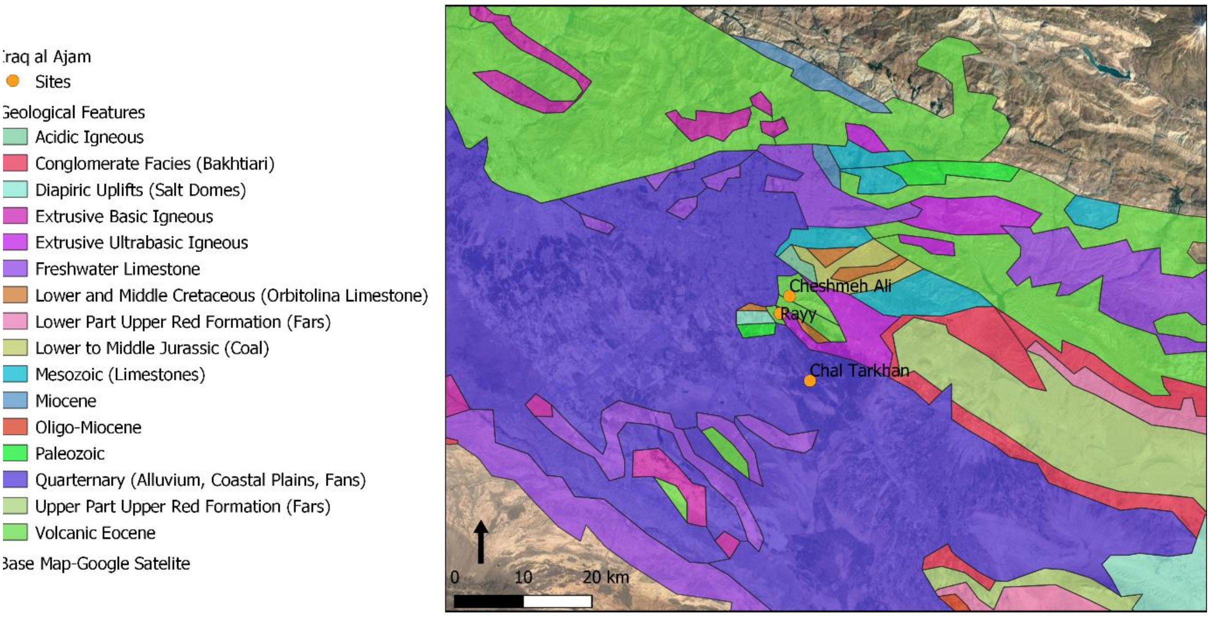

Figure 2.17: Geological map of central Iran (based on Geological Staff of the Iran Oil Company 1957; Appendix 1).

The geological map of the Tehran area shows various outcroppings of minerals (Figure 2.17). The Alborz Mountains are marked by volcanics, both extrusive and intrusive basic and ultrabasic varieties, limestone, and sandstones. The foothills include limestone, salt domes, and coal beds, whereas the plain is alluvium and river fans. A petrographic study of ceramics from Cheshmeh Ali identified diorites, granodiorites, gabbros, granites, basalt, andesites, dacites, pyroclastics, marl, siltstone, and calcareous sandstone (Wong *et al.* 2010).

2.4.5 *Khurāsān (Firuzabad)*

The Kashmar Valley is located in eastern Iran and follows the Sish Taraz River which flows in an east-west direction. This valley is approximately 100 km long and 25 km wide. It is bordered on the north by the Alborz Mountains and to the south by the East Iranian Range. The western part of the valley runs into the Kavir Desert, the eastern part into the mountains of Afghanistan. This valley is heavily settled, because of its agricultural potential.

The Kashmar Valley is located between the Doruneh Fault and Uzbak-Kuh Faults which separate the Yazd, Tabas, and Lut Blocks and the Alborz Fore Deep. The Lut Block consists of Jurassic metamorphic basement, sedimentary rocks and Mesozoic and Cenozoic intrusive volcanic rocks (Berberian 1977). The geology of the Lut and Tabas Blocks are treated much like the geology of central Iran, albeit with a slightly different morphological process.

During the Carboniferous (Sardar and Jamal Formations), the Lut Block underwent metamorphosis, and the formations include gneissic schists, amphibole schists, metaquartzite, and marble (Berberian 1977). During the Triassic and Jurassic, the Nayband, Shemshak, and Magu Formations were deposited on the Jamal Formation. The Lut Block was uplifted, and the Nayband limestones were deposited in small, low basins. These limestones were then metamorphized in the late Jurassic to form low grade schists, phyllites, quartzites, siltstones, sandstones, and slates (Berberian 1977). The Shemshak Group including the Ab-e-Haji, Hojedk, and Badamu Formations are groups of siliciclastic rocks which are predominately marine and calcareous. The Ab-e-Haji Formation consists of quartzose sandstone, the Badamu consists of ammonite rich dark oolitic limestones, marls, and siliciclastics, and the Hojedk consists of carbonates and sandstones (Wilmsen *et al.* 2009). The Magu Group, including the Parvadeh, Baghamshah, Qal'eh Dokhtar, and Esfandiar Formations, are groups of siliciclastic and sandstone rocks laid down in shallow water. The Parvadeh included limestones, the Qal'eh Dokhtar consists of sandstones, the Baghamshah is formed of marly silts and sandstones, and the Esfandiar is constructed of limestones (Wilmsen *et al.* 2009).

During the Eocene and Paleocene, post-tectonic volcanism occurred, and this formation includes basal conglomerate, tuffs, gabbro, diorite, granodiorite, and hornfels (Berberian 1977). Along the edges of the faults, sandstones, shales, limestones, ashes and lavas occurred, along with flysch and reef-limestones (Harrison 1968). During the Oligocene, the Lut Block was lifted, and the Tethys Ocean surrounded the area. The Red Beds of the Miocene lay on top of the Eocene formations (Berberian 1977). These beds included red evaporites, limestones, sandstones, and conglomerates (Harrison 1968). During this period, salt beds and domes also appear. This is then topped by eroded alluvium from the mountain ranges.

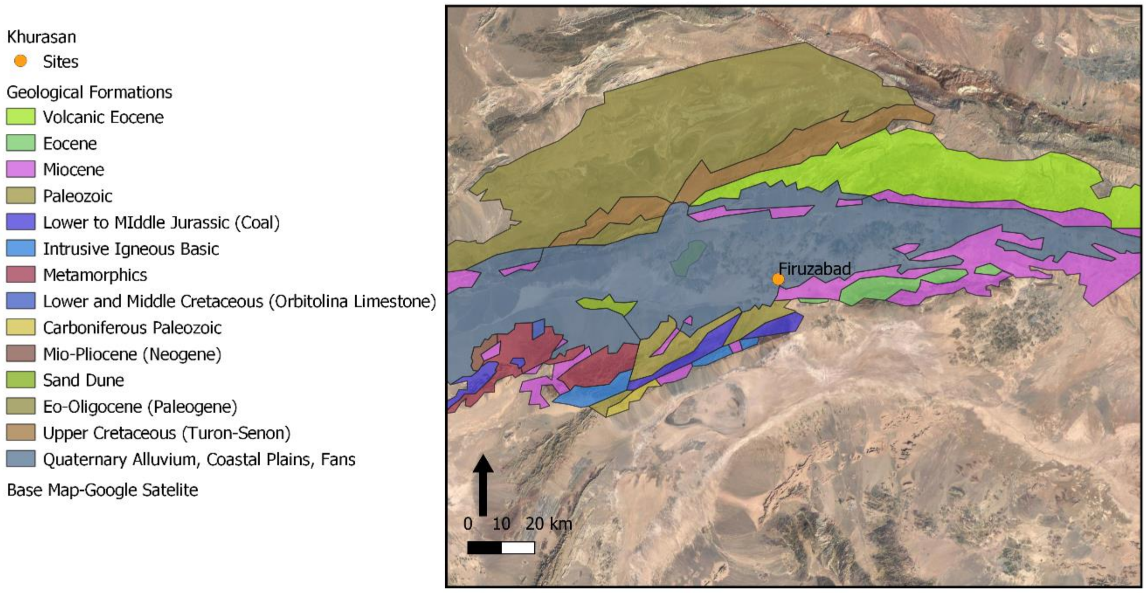

Figure 2.18: Geological map of eastern Iran (based on Geological Staff of the Iran Oil Company 1957; Appendix 1).

The geological map shows various sources of minerals from volcanic Eocene to intrusive basic igneous rocks to metamorphics (Figure 2.18). Orbitolina limestones and salt/sand dunes are also present, as well as quaternary alluvium. Petrographic studies of ceramics from Nishapur include minerals such as schist, amphibolite, marble, quartzite, gneiss, migmatite, granite, greenstones, meta-greywacke, pyroxenites, serpentinite, basalt, and conglomerates (Rante & Collinet 2013).

2.5 Summary of History, Archaeology, and Geology

These five regions all have their own histories, but larger political changes affected all areas. The incorporation of all areas mentioned into the Abbasid, Seljuq, and Ilkhanate realms brought these large areas into contact with each other, for varying amounts of time. However, each region did return to smaller independent kingdoms between the larger unified periods. Each political change also brought about a social and economic change, but these are rarely recorded. Some of the dynasties were more nomadic (Buyids, Ilkhanids), whereas others were more urban (Abbasids, Seljuqs). However, through all these changes, agricultural surplus allowed for the flourishing of long-distance trade, and connections between the Mediterranean and China passed through this area. The consolidation of these diverse areas into larger conglomerations like the Abbasid Caliphate or Seljuq Empire, brought the remoter areas into closer contact with central areas, and allowed for the wider spread of material culture around Western Asia. This dissertation draws on excavations and surveys across Western Asia to analyze the role of regionalization in the Islamic period. By using ceramic data from modern surveys and excavations as well as legacy data that has not been fully published, or analyzed scientifically, this dissertation seeks to understand ceramic traditions across Western Asia, both at the local, regional, and interregional scale.

3 A Framework for Understanding Production and Consumption of Ceramics

Ceramics are manifestations of interactions between makers, consumers, materials, and society. As a learned craft they encode social markers and therefore help identify social practices of both the producers and consumers. This is not to say that pots equal people, or pots do not equal people, rather that pottery can be used to investigate social practices of various people involved with their manufacture and use. The analysis of the social dimension of ceramics moves away from the typical spatio-chronological frameworks used in many Islamic ceramic studies including art historical interpretations (Fehérvári 1973; Lane 1947; 1957; Watson 2004; 2020), evolutionary approaches to new technologies (Carswell 1985; Kessler 2012; Mason 1995b; 1997a; 1997b; 1997c; 1997d; 2004), and the spread of new technologies (Carvajal Lopez 2019; Klesner *et al.* 2019; Mason & Keall 1999; Mason & Tite 1994b).

Potters produce ceramics that are socially and stylistically acceptable as well as functional within the limits of technology and the raw materials present (Gosselain 1992, p. 560). In this dissertation, I adopt the *chaîne opératoire* approach to reconstruct the ways these ceramics are being made, specifically highlighting the factors contributing to the decisions surrounding the manufacture and consumption of ceramics. The reconstructed *chaîne opératoire* will provide a systematic way to explore how communities of practices developed. It is through mapping and comparing these communities of practices across the landscape that begin to link various processes at the local, regional, and interregional scales, creating constellations of practices (Roddick & Stahl 2016, p. 4-14). The communities and constellations of practice are analyzed to indicate connections between sites and regions. This chapter aims to create a framework to understand the social practices behind the manufacture and consumption of Islamic ceramics across rural, urban, and intermediate regions.

3.1 Technological Style, Technological Choice, and the Chaîne Opératoire

Technological studies focus on the raw materials and production of ceramics (Binford 1965), functional studies on utilitarian and instrumental uses of ceramics (Sackett 1990), and stylistic studies focused on emblematic aspects of ceramics (Dietler & Herbich 1998). Wiessner (1990) illustrates via ethnographical research that the boundaries between technology, function, and style are highly blurred. There is not a direct way of studying one or another of these aspects, as ceramics are made of all three. Conceptualizing these three distinct categories masks the role of social and cultural factors in conditioning technological choices and functional evaluation (Letchman 1977). Wiessner (1990) also states that the behaviors behind these aspects of style are socially informed and reflect a shared understanding of the way things are done.

The *technologie et culture* school of thought is strongly influenced by Mauss's (1935) 'ways of doing'. This approach emphasize links between cognition and technological choice, looking at processes by which variation is created during the manufacturing sequence (Bourdieu 1977; Levi-Strauss 1963; Mauss 1935; Stark 1998). This approach understands products as outcomes of various choices throughout manufacturing, use, and discard processes constituting the fundamentals of two related concepts technological style (Letchman 1977) and technological choice (Lemonnier 1986; 1992).

Technological style as proposed by Letchman (1977) is based on ethnographic studies and shows that potters can achieve similar aims in different ways, but these choices are embedded in the social contexts in which the potters learn and practice their craft (Stark 1998). Technological style reflects the (un)-conscious decisions which affect technological choice, therefore, style has function (Sillar & Tite 2000; Wobst 1977). This 'style' is found in all parts of production and is reflective of the beliefs of people involved, both at the individual and community levels (Dobres 2000; Hegmon 1998). This can be used to help group cohesion or highlight group differences, and should be explored within its own socio-cultural context (Binford 1965; Hegmon 1998; Wobst 1977). Technological style as described by Letchman has been used in ethnographic accounts of potters from around the world (Creswell 1983; 1996; DeBoer 1990; Gosselain & Livingstone Smith 1995; Henrickson & McDonald 1983; Lemonnier 1992; 1993; Longacre 1991; Pikirayi & Lindahl 2013).

Technological choice as discussed by Lemonnier (1986, 1993) includes technological features as an interplay between technology and society (Hegmon 1992). Lemonnier argued that the individuals make choices throughout the production sequence, all of which affect the finished outcome, and the social context of its use (Lemonnier 1993; Schiffer & Skibo 1987). The techniques used in manufacturing are social productions guided by a set of constraints and are a physical rendering of mental schemes learned through traditions. Mental processes underline and direct the actions on the material, and as such are embedded in a broader symbolic system (Lemonnier 1993). These choices are stable through time and space as they are unconscious and automated behaviors. This leads to every stage of manufacture being a locus of expression; however functional, environmental, and manufacturing aspects can constrain these choices (Lemonnier 1993). Lemonnier also stresses the active decision making of individuals, and the social knowledge which is being reproduced.

Both of these approaches discuss the conscious and unconscious decisions which are present in manufacturing processes (Schiffer and Skibo, 1987; Lemonnier, 1993; Stark, 1998; Hommel, 2014). The environment and availability of resources also plays a part in decision making and potters can choose multiple ways of creating the same outcome (Martinón-Torres 2002; Sillar & Tite 2000). This shows that only culturally derived choice may not explain all steps in the manufacturing process. In order to understand these choices, cultural, environmental, or functional, the use of the *chaîne opératoire* has been shown to be effective at illustrating the various steps in the creation of artifacts.

3.1.1 *Chaîne Opératoire*

"Techniques are at the same time gestures and tools, organized in sequence by a true syntax which gives the operational series both their stability and their flexibility" (Leroi-Gourhan 1964, p. 164). To understand the techniques in constructing pottery, the *chaîne opératoire* was established to help link technical and cultural behaviors in object manufacture (Roux 2017). This arose out of the technological style discussion and ethnoarchaeological research on pottery construction in order to identify the correlation between technological behaviors and social groups (Dietler & Herbich 1998; Gosselain 1992, p. 560; Hommel *et al.* 2016; Lemonnier 1992; 1993; Livingstone Smith 2000; Roux 2017, p. 102; Schiffer & Skibo 1987; Sigaut 1994; Sillar & Tite 2000). The basis of the *chaîne opératoire* is the technical behaviors used to construct a vessel from the gathering and preparation of the raw material to the finished product. Based on the potter and finished product they wish to create, these larger operations may have various steps and sub-steps, and different courses of action may be taken throughout the *chaîne opératoire* to create the different vessels. By using ethnographic studies of various potting cultures around the world, the *chaîne opératoire* has been linked with anthropological theory to better understand the cultural behaviors of the potters.

The creation of ceramics is a learned technological behavior, and as such, cultural behaviors are passed down during the teaching/learning process. The *chaîne opératoire* is an inherited way of doing things and as such cultural behaviors are embodied in the finished product (Dobres 2000; Ingold 2001; Leroi-Gourhan 1964). Since these behaviors are always transmitted through teachers within the same social group, the transmission of the skills helps to maintain the cohesion of the group and can determine the social perimeters and boundaries of a group (Letchman 1977; Livingstone Smith 2000; Roux 2013). As such, changes within the technological boundaries are expressions of cultural history, and technical traditions are powerful chronological and cultural markers, especially when stylistic features are not important.

Gosselain (2018, p. 9–12) proposed three types of relations between potters, relating to various stages of the *chaîne opératoire*. The first, clay extraction, processing, and firing, are conducted on a communal basis with shared norms and knowledge. This indicates short and non-formal interactions that take places in shared practice settings, where potters learn from each other about raw material procurement, processing recipes, or tool usage. The second, shaping and roughing out of the vessel, and tool handling are processes that require skills gradually acquired from an experienced potter. Potters rarely change the techniques used during this phase, since they are based on motor habits. These habits are not visible on the final product and cannot be mimicked without long-term direct interactions between the potters. The third, pre-forming, decoration, pre-firing, and post-firing, are visible on the finished pot, and the techniques are acquired and can be changed by ephemeral interaction. This is considered mediated interaction (Gosselain, 2018).

To interpret the *chaîne opératoire*, Roux (2017) argues for including socioeconomic, historical, and evolutionary data of the production, distribution, and circulation of the ceramics at a macro-regional scale. Sillar and Tite (2000) analyze the potters' choices in accordance with their overall context, looking at five areas of choice: raw material(s), tools, energy sources, techniques, and the sequence (chaîne opératoire). These are all discussed in terms of the "constraints imposed by the performance characteristics required for each activity within the overall life cycle, or behavioural chain of an artifact" (Sillar & Tite 2000, p, 4). Each choice is co-dependent on other choices, which form vessels with specific properties and characteristics (Livingstone Smith, 2000). The potter makes these choices based on their idea of the finished product, its intended function, its situational context, its mechanical properties, and its visual and tactile properties. By using the *chaîne opératoire*, we can identify patterns of cultural descent, and endogenous/exogenous evolutionary phenomena in relationship with the producers and consumers. Lastly, Roux (2013) argues that where the *chaîne opératoire* is linked by inherited technological behaviors, there is historical continuity in the social group. Where it is not linked, social groups are not interconnected, and there is an emergence and/or expansion of new groups and the disappearance of previous groups.

Schiffer's (1976) behavioural chain includes the manufacturing practice as explained by the *chaîne opératoire,* and expands it to include the use, maintenance, reuse/recycling, and discard of the object in order to better understand the complete life histories (Appadurai 1986; Dobres 2000; Lewis & Arntz 2020; Schiffer 1976; Skibo & Schiffer 2008). This expansion of the *chaîne opératoire* allows for a deeper understanding of not only the technological practice, but also the interplay between people and things (Skibo & Schiffer 2008). More recent scholarship combines the use and discard of the object into the *chaîne opératoire*, without including the behavioural chain (Lewis & Arntz 2020; Martinón-Torres 2002).

3.1.2 *Scientific Methods Used to Reconstruct the Chaîne Opératoire*

The use of archaeometry aids in identifying various stages of the *chaîne opératoire* (Martinón-Torres & Killick 2015; Sillar & Tite 2000). Archaeometric methods have been particularly useful in understanding the social construction of technology. Letchman's technological style (1977) was discussed using archaeometric analysis of the surface appearance of gold and copper alloys and the subsequent value system. Lemonnier's (1992) study incorporated both archaeometric as well as ethnoarchaeological research to incorporate the processes of manufacture with the sociocultural contexts (Martinón-Torres & Killick 2015). In terms of ceramic analysis, the use of ceramic petrography has been instrumental in identifying the tempering, forming, surface treatment, and firing of vessels (Baldi 2016; 2018; 2021; Day 1989; Hommel *et al.* 2017; Livingstone Smith 2000; Quinn 2013; Roux 2013; 2017; 2019; 2020; Sillar & Tite 2000). Archaeometric methods help to better uncover the mechanical processes involved in the *chaîne opératoire*, and the choices behind these steps. Sillar and Tite (2000, p, 4) identify five areas of choice in technology, raw material procurement, tools used to shape the raw material, energy sources, the techniques used, and the sequence which links the other four choices into a finished product. Each of these choices can be investigated using archaeometric approaches, and these approaches can aid in uncovering the social, functional, or environmental processes behind the choices (Livingstone Smith 2000; Martinón-Torres & Killick 2015; Sillar & Tite 2000).

This dissertation uses an expanded *chaîne opératoire* much like Schiffer's behavioural chain to analyze not only the production of the ceramics, but also their consumption (discussed below). The *chaîne opératoires* used in this study begin with the functional categories, and are then divided based on technological choices, of inclusions, forming, surface treatments/decorations, and firing as determined by archaeometric and visual analysis. This dissertation links these various stages to different aspects, whether that is potters' choices, mechanical properties, or environmental options. In understanding why certain choices are being made at each stage, we can begin to untangle the reasoning behind the stages and choices. The potters' choices can then be analyzed in terms of social aspects, which are then used to look at larger social constructs as shown below.

3.2 Consumption Practices

Ceramics are made in a specific socio-cultural context, in response to demand by consumers. Therefore, the consumers drive the production of the ceramics. Consumption, defined as how people socialize material goods, can identify people due to the way things display social status, and how they are connected to one another (Mullins 2011, p. 135). Consumption in this dissertation is discussed in terms of changing forms (and differences in functions) as well as surface treatments and decorations.

The archaeology of consumption is a material social practice involving the use of objects rather than their production or distribution (Dietler 2010; Miller 1995; Mullins 2011, p. 136). Consumption is a social process where people construct symbolically laden material worlds which they inhabit, and which act back upon them (Deetz 1977; Dietler 2010; Mullins 2011; Rogers 1990). Two main areas are present in the archaeology of consumption, the first being the structural processes that deliver goods to consumers, like "marketing networks, state trade mechanisms, dominant ideologies, or underlying cultural and ethnic identities, all of which shape how certain things end up with specific people and are defined in particular ways" (Mullins 2011, p. 134). This approach embeds consumption in broader systemic influences and uses consumption as a domain with semiotic code to be deciphered (Barthes 1961; Bourdieu 1984; Levi-Strauss 1978; Sahlins 1976). The second definition focuses on "consumers' conscious symbolic agency, revolving around how people actively define the meaning of things, often in opposition to dominant ideology, the state, or broader economic interests" (Mullins 2011, p. 134). This active role of consumers appeared as a critique of the structuralist view, with agents influencing consumption behaviors (Appadurai 1986; Friedman 1994; McCracken 1990; Miller 1985; Mintz 1985; Rutz & Orlove 1989). Mullins argues for the archaeology of consumption to be a conceptual framework for how people socialize material goods, which recognizes the agency of consumers and how goods assume meanings. Consumption revolves around the acquisition of things to confirm, display, accent, mask, and imagine self-identified groups, instead of reflecting these groups, like social status, ethnicity, or gender (Mullins 2011, p. 135). Much like the previous discussions on style and identity, consumption is an active way of analyzing material culture to classify collective identity.

Early studies of consumption revolved around trade, supply, demand, and economics (Adams 1976; Baugher-Perlin 1982; Bell 1947; Kidd 1954; Quimby 1966). These studies also focused on colonialization, acculturation of European goods, and ways of dating overall assemblages of material goods. In reacting to this Eurocentric and colonialist model, Dietler (2005) discusses the local communities as discriminating consumers and advocates for a focus on four elements: the context of consumption (Where the objects are found); patterns of association (what goods are associated with each other); relative quantitative representations within sites and across regions (how many goods there are); and spatial distribution of specific goods (what are the distribution patterns across space). In terms of ceramic analysis, Dietler states that rather than using the typologies and chronologies, understanding the consumption of ceramics "requires examining much more carefully the particular things that were consumed and the ways they were consumed: that is, examining closely the specific *properties* and *contexts* of objects and practices in order to understand the social and cultural logic of the desire for them and the social, economic, and political roles that their consumption played" (Dietler 2010, p. 226). By exploring the social life of classes of objects by following commodity chains or commodity networks (Collins 2000; Hansen 2000; Mintz 1985, p. 253) we can begin to expose and analyze the linkages between decisions, actions, and effects of consumers and those of the producer.

The archaeology of consumption is used in this dissertation to analyze why ceramics appear on sites. Since this dissertation deals mainly with survey material, a full discussion of ceramic consumption is not possible (i.e. identifying functions of various contexts, site specific functions). However, the use of the ceramics can be used to associate the sites with one another, both intra- and interregionally. This is mainly done through the presence/absence of various forms and surface decorations. The consumption of these ceramics can be used to mark self-identified groups, (i.e. the presence of Lajvardina Ware at

Hasanlu shows connections with the elite Ilkhanid social sphere). It is also important to note that ceramics do not exist in a vacuum and are a functional category of material. Ceramics are used to store, transport, process, and serve various other objects. We can then begin to identify the consumption of other items via the ceramics (i.e. foodways (Mullins 2011), medicines (Pradines 2016), drinks (Ghouchani & Adle 1992) etc.). This study does not necessarily expand on these other uses of ceramics, rather uses the decoration and form to infer broad functional categories that are then compared in terms of the consumption of the ceramics themselves.

3.3 Communities and Constellations of Practice

The practice of creating artifacts is embedded in the social dimension. As one learns how to make or do something, social and cultural norms are also passed along. This could be as simple as taboos such as never painting the Prophet Muhammad's face, or more complex cultural aspects. Much of this learning and encoding of behaviors has been witnessed by ethnographers observing pottery making around the world (Ingold & Lucas 2007; Kamp 2001; Krause 1985; Minar 2001; Robb 2007; Sillar 2000). Palsson states "learning entails the transmission of culture, a mental code or script that exists prior to and independent of human activities, a recipe for action analogous to a book or grammar or a dictionary" (1994, p, 903). This theory separates learning from doing and embeds both in cultural rules (Lave 1990). Learning can be theorized in two main ways namely a cognitive science approach (Coolidge & Wynn 2016; Hutchins 1995; Ingold 2000; Malafouris 2004; Toren 1999) and an activity theory approach (Cole 1990; Engestrom 1999; Engestrom & Escalante 1996; Vygotsky & Cole 1978). However, as Lave (1993) shows, these can also be combined, as activities structure cognition, and cognition is stretched across mind, body, activity, and setting.

Since learning is an "integral part of generative social practice in the lived world" (Lave & Wenger 1991, p, 35), we can begin to understand communities of practice. Communities of practice are constructed through "mutual engagement, a joint enterprise, and a shared repertoire of doing" (Wenger 1998, p, 73). When more than one community is combined, constellations of practice are created. Constellations of practice are groups of communities that may slightly vary across large distances in space or time but share historical roots (Wenger 1998).

Communities of practice do not necessarily have well defined boundaries or group memberships, and are not restricted to situations where a skill can develop sufficiently for a certain kind of performance (Roddick 2009, p. 69). As Ingold states, "each generation contributes to the next not only by handing on a corpus of representations, or information in the strict sense, but rather by introducing novices into contexts which afford selected opportunities for perception and action, and by providing the scaffolding that enables them to make use of these affordances" (Ingold 2000, p. 354).

These communities are linked with the construction of identities, as one negotiates the community of practice, one is also reaffirming or negotiating various identities. This provides a linkage from the activities and tasks to social relations and identity. As Linehan and McCarthy (2000, p. 440) identify states of tension which allow for people to engage with an activity or practice, or withdraw from it, leading to being a 'part of' but at the same time 'different from' a community. Communities of practice are essential in forming identities and values, but also have cognitive effects on how we experience the world (Roddick, 2009, p. 73). Like the discussion above, these activities structure cognition, but cognition defines the world. These communities of practice are more than indicators of social boundaries, as ethnographies have shown communities of practice existing across social, political, and economic boundaries (Barth 1969; Jones 1997; Joyce 2004; Pauketat 2000; Wenger 1998).

When looking at larger groups than a community of practice (which can include multiple social/political/economic groups and various geographical regions) the term constellations of practice can be used. Constellations of practice share historical roots, face similar conditions, have members in common, share artifacts, have geographic relations of proximity or interaction, have overlapping styles or discourses, and are competing for the same resources (Wenger 1998, p. 127). These constellations may not have a discursive element and may not be overtly acknowledged or conceptually identified or named. There also may not be overarching control, and connections may be intentional or due to emerging circumstances (Joyce 2004; Pauketat 2000; Wenger 1998). Livingstone-Smith (2000) in his ethnographic studies of potters in Cameroon, states that constellations of practice are created through the effect of ruptures in social interaction networks, and that regional identity can be linked to these constellations.

In this dissertation, the *chaîne opératoire* is used to identify similar manufacturing techniques at sites, and between regions, and these are grouped into various communities and constellations of practice. This approach allows for a systematic way of comparing ceramic assemblages across large spaces. To build the communities of practice, analyzing the processes which are mechanical and learned via repeated practice is the most common method (Gosselain 1992; Roux 2017; 2020). These mechanical processes include the preparation of the clay, the addition of temper, and the forming techniques. Potters from the community learn where to gather the clay, where to access and how to prepare the temper, how to form the vessels (slabmade, coilmade, wheelmade, etc) and how to fire them. All of these mechanical choices are used to create specific vessels, therefore, to identify a community, one specific vessel form, used for a specific purpose (i.e. long-necked water storage vessel) would be made with the same clay, temper, and forming technique. The non-mechanical choices (including surface treatments) do not require muscle memory to perform (except some artistic cases) and therefore, are less likely to identify communities of practice, but rather can identify communities of consumption. If there are no communities of practice present, each vessel may be made differently, using different clay sources, tempering recipes, or forming techniques. However, if vessels are being made by the same potter, similarities would exist, for that potter's active period. Therefore, to identify communities there needs to be some generational time depth. To identify constellations of practice the same framework is used, but some variations are present. The use of various clay sources or tempering agents may vary due to local geology, but the percentages of temper and forming techniques should be the same, as the potters are connected by these motor skills. Once these communities have been defined, we can begin to link them across larger distances, with similar historical roots, thereby creating constellations of practice. Both the communities and constellations can help to isolate larger socio-cultural connections which are encoded in the ceramics.

3.3.1 *Craft Organization and Specialization*

Craft specialization is a way to organize production but has been defined based on "behavior and material variety in extractive and productive activities" (Rice 1981, p. 220), the amount of "output per capita…within the population" (Tosi 1984, p, 23), and a "repeated provision of some commodity or service in exchange for some other" (Costin 1986, p. 238). Costin (1991) identifies four parameters which describe the organization of production (Figure 3.1).

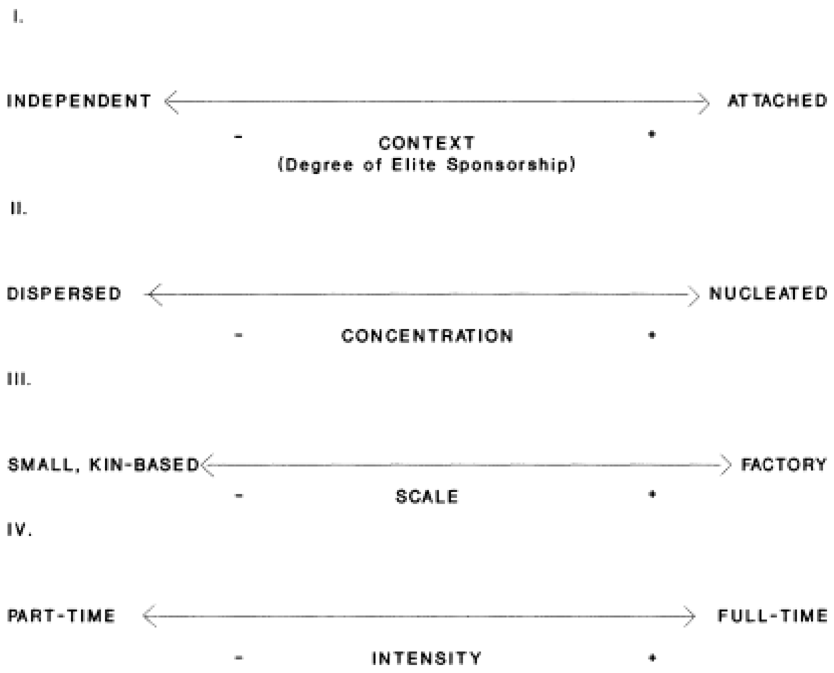

Figure 3.1: Costin's four parameters of the organization of production (Costin, 1991, Fig. 1.4).

The first parameter, context of production, is described as the affiliation of the specialists and the demand for their wares. This ranges from attached production, where manufacture is sponsored or managed by institutions or patrons to independent production where there is no oversight. The concentration of production is defined as the geographic organization of production. This ranges from dispersed, where specialists are evenly distributed throughout the landscape, to nucleated where producers are located together. The third parameter is the scale of production which is defined by the composition of the production unit and ranges from small, individual based production to large factory-based production. Lastly, the intensity of production is the amount of time specialists spend on the object. This ranges from part time specialists to full time specialists (Costin 1991). These can then be used to identify various specialized production categories (Figure 3.2).

	Context		Concentration		Scale (Composition)		Intensity	
	Attached	Independent	Nucleated	Dispersed	Labor	Kin-based	Part-time	Full-time
Individual		X		X		X	(X)	(X)
Dispersed workshop		X		X	X			X
Community		X	X			X	(X)	(X)
Nucleated workshop		X	X		X			X
Dispersed corvee	X			X	(X)	(X)	X	
Individual retainer	X		(X)			(X)		X
Nucleated corvee	X		X		X		X	
Retainer workshop	X		X		X			X

Figure 3.2: Costin's Multidimensional Typology of Specialized Production based on Parameters (Costin 1991, Table 1.1).

This dissertation is concerned with mainly the first four categories, individual specialization, dispersed workshops, community specialization, and nucleated workshops. Individual specialization is defined by individuals or households producing for local consumption, dispersed workshops are workshops producing for local consumption, community specialization is individual or household-based production located in a single community, producing for local consumption, and nucleated workshops are larger workshops located within a community for regional consumption (Costin 1991, p. 9). These categories are all marked by independent production, both nucleated and dispersed concentration, small- and large-scale composition, and a mixture of part-time and full-time specialists. Due to the nature of the data collected for this dissertation, and the survey nature of most collections, I have identified two types of production, structured production (nucleated concentration and labor-based composition: Nucleated and Dispersed Workshops) and unstructured production (dispersed concentration and kin-based composition: Individual and Community). The structured production may indicate workshops, but there are various issues with defining anything that is not household or individual production as a workshop production (Costin 2020).

“And know, O, brother, that every human craftsman requires a teacher (*ustādh*) from whom he learns his craft or his science, and that his teacher in turn requires a teacher before him, and so on until one is reached whose knowledge does not derive from any human being” (From the eighth epistle of the first series of the *Rasa’il Ikhwan al-Safa* (Encyclopedia of the Brethren of Purity; Anonymous 10th – 11th centuries, Basra; as cited in (Milwright 2017, p, 22)). In the Islamic period, all knowledge is said to come from God, and passed down through the generations. This includes both handicrafts, as well as more theoretical knowledge such as philosophy, mathematics, and theology. By the 10th century, various craft traditions had coalesced into various guilds (*tariqa* or *ta’ifa)* (Baer 1964; Cahen 1970; Lewis 1937; Rafeq 1991). Guilds were more than groups of producers, rather they were a social community with their own rituals, initiations, and traditions (Milwright 2017, p. 29). Guilds had senior masters, journeymen, and apprentices, and in larger settlements, guilds could also be constructed of multiple workshops. However, guilds are only attested in larger cities, or attached to various marketplaces (Milwright 2017, p. 30). Guilds would have very different communities of practice from one another due to the secrecy of production techniques and competition between the guilds. This is not seen in this dissertation, but could be due to the nature of the data, if an analysis of one type of vessel form/function was performed, guilds may be identified (see Tonghini and Henderson, 1998; Mason, 2014; Mulder, 2015).

In Milwright’s anthology (2017), he highlights two passages about the organization of labor (2.14 and 2.15; p.37). The first text concerns the practices in a metal workshop in Damascus in the late 20th century, and the second text concerns the craft organization in rural areas, among the Bedouin, also dating to the late 20th century. Here we see a very structured practice in the first text, in a workshop, with masters and apprentices dividing the labor based on their skill set. The second text shows an unstructured organization, where the craftspeople could not be easily identified (blacksmith and saddlers) and are mixed into the community. Even though these two examples are from the 20th century and relate more to metal material, the organization of ceramic production can also be classed as structured or unstructured, and these examples do highlight a difference between urban and rural production. Urban production seems to be more structured, with various workshops creating the vessels, whereas the rural production is more unstructured, community practice. This could be due to the access to resources (in urban settings there is more competition for resources), the need for the products (in rural areas there is not as much need and hence multiple individuals could make their own ceramics), and overarching hierarchies (in urban areas the division of city space, market stalls, and possible patronage of elites could influence the structured nature of the ceramic production).

3.4 Rural, Urban, and Intermediate Areas

The division between rural and urban areas is usually seen as a dichotomy, but in practice, the borders between the two are ambiguous. Rural areas are relatively open areas with a low population density, small site size, agricultural economic basis, lower social complexity, and a more unplanned settlement system (Adams 1981; McPhillips 2014). In the Islamic period, rural areas usually involve sites under 10 hectares, with a population of 150 – 300 people, a density of between 15 and 30 people/hectare, agriculturally based, with settlements that include one or two mosques, but little other public architecture (McPhillips 2014). When this type of site is mentioned in the textual record, they are seen as secondary to the urban sites (McPhillips 2014). In contrast, urban sites are defined by confined settlements with high population density, large site size, non-agricultural economic basis, higher social complexity, and a planned settlement system (Smith 2011; 2020). In the Islamic period, urban areas usually include sites above 50 hectares, with populations of over 1000 people, a density of over 20 people/hectare, a market or industrial economy, with settlements that include multiple mosques, palaces, markets, elite residences, public monuments, and public spaces (Alsayyad 1996). Urban centers are also classified by their higher degree of social complexity and heterogeneity, meaning that various groups (ethnic, religious, economic, political) exist in one settlement. However, in the Islamic period we also see the appearance of sites that do not exactly fit the characteristics of either of these sites. These are usually planned sites with specific (usually military) functions (*ribāt/ kale*). They can also be elite residences, semi-permanent nomadic camps, or rest-stops (*caravanserai*). These types of settlements are usually small in nature (under 10 hectares), with a higher population (up to 500 people), various functions, and a high degree of social complexity, with various social classes, ethnicities, and/or religions mixing. However, these sites are usually placed away from other settlements, and are highly fortified (Danti 2004, p. 66). Most of the population at these sites is impermanent with various groups moving through the settlements. These types of settlements contain a mixture of rural and urban criteria and are highly linked with other urban centers, rather than being self-sufficient.

The region identified by Islamic scholars (al-Istakhri, 1967 (d. 957 CE); al-Muqaddasi, 2001 (d. 991 CE); al-Bakri, 2003 (d. 1094 CE) were identified on economic bases (who is paying taxes to whom), but can also include other factors like geography, political boundaries, or religious divisions. These are normally linked back to the urban centers, creating a type of core-periphery model (Abu-Lughod 1989; Müller-Weiner 2017; Walker 1999). Cities are areas of connectivity and unity and placed in a network of dependent villages and rural areas. Cities also included the areas around the city, including suburbs and hinterlands. "We divided each region (*iqlīm*) into provinces (*kuwar*), assigned them metropolises (*amsar*), mentioned their capitals (*qasabāt*), and classified their chief cities (*mudun*) and military districts (*ajnād*). After that we depicted them and sketched their borders (*hudud*) and internal boundaries (*khitat*)" (al-Muqaddasi as cited in Antrim, 2012: p. 114). Regions are not created by locals for locals in a local language but are a category of territorial consciousness that these authors observed and understood (Antrim 2012). "Thus, regions were both closed and open – closed vessels for the enumeration of *fada'il* [merits] as well as for the organization of territorial 'building blocks' and open categories of identification, attachment, and belonging among Muslims. They were imagined as capacious catchment areas that 'caught' meanings and made possible multiple modes of belonging" (Antrim 2012, p. 131).

3.4.1 *Local vs. Regional*

The definition of local and regional areas have not been described in detail in most studies, with authors describing them in terms of geography with geographic patterning in material culture (Duff 2000, p. 71; Whalen & Minnis 2003). Local typically means within the site boundaries, and regional is a larger geographical or environmental feature (plain/mountain range/desert/steppe) (Kantner 2008; Alcock & Cherry 2004, p. 1–3). Ceramic patterning may also be added to these definitions (Hegmon *et al.* 2000, p. 2) and Arnold (1985) has laid out a definition based on access to ceramic resources. This definition is based on the distances of potters from the resources needed to manufacture the vessels (i.e. clay, water, fuel, temper, paint, glaze). This model comes with some caveats, namely the types of communities (sedentary vs. mobile), the types of resources, the topography and energy cost of reaching the resources, and the transport cost of materials. However, based on his analysis and drawing on the work of other ceramicists and ethnographers (Arnold 1985, p. 35), a few distinctions can be made (Table 3.1).

Table 3.1: Thresholds for various types of materials after Arnold (1985 p. 38-54).

Type of Material	Range of Geodesic Distance	Threshold A	Threshold B
Clay	1-50 km	Under 1 km	Under 7 km
Temper	1-25 km	Under 1 km	6-9 km
Slip/Paint	1-50 km	Under 10 km	10-50 km
Fuel	2-6 km	Under 5 Km	6-9 km

Based on these values, Arnold (1985, p. 58) states that communities less than 12 – 18 km apart are likely to have an overlapping resource area, and individual pottery production is difficult to determine based on paste alone (Arnold, 2000). Therefore, Arnold (1985; 2000; 2011) has defined local as within 10 km of a production zone (usually a site), and regional is outside of the site, but still in the ceramic distribution zone. For this dissertation, I have combined the two definitions, with the ceramic resource model used for local ceramics (i.e. within 10 km of a site), and regional being defined by both resource procurement, as well as topology and geography (i.e. the Erbil Plain).

By re-defining what makes each of these regions, and acknowledging they exist on a continuum, this allows us to focus on the diverse nature of settlements and populations across the Islamic world. By trying to understand the social nature of these regions we can begin to draw larger connections both intra- and interregional connections, focusing on the local populace, not just the elites living in the large cities, or in the relations between Islamic and non-Islamic peoples. Textual sources record the connections between cities; however, archaeology allows us to investigate the rural areas that are omitted from these records. This allows for more research into the complex social fabric of the Islamic world.

3.5 Summary of Ceramic Theory

By drawing on ceramic theories surrounding technological style and choice, the use of the *chaîne opératoire* and behavioural chain, we can begin to understand the social practices behind the manufacture of ceramics. The *chaîne opératoire* is used to analyze the production of various ceramics, and by comparing the *chaîne opératoire* of similar vessels (in terms of forms/functions) communities of practice can be identified. When added with the non-mechanical skills such as surface treatment and decoration, communities of consumption are identified. These communities can then be compared to other communities to identify constellations of practice which stretch across larger geographical distances. These communities and constellations are also analyzed to uncover various craft organization practices at the site, from structured practices (possible workshops/guilds) to unstructured practices (individuals or kin-based communities). The identification of communities of practice (via the *chaîne opératoire*) with the craft organization can lead to a more nuanced identification of practices on rural, urban, and intermediate sites. Rural sites have more communities of practice indicating an unstructured organization and possible different social groups (kin or community based). Urban sites have less communities of practice indicating a structured organisation (possibly workshops or guilds) and less social groups in terms of who was producing the ceramic. Intermediate sites would be more linked to the urban sites, due to the fact that they are highly connected with these sites in other areas, and so may have more communities of practice, but these may be more structured in organization (showing a mixing of local and imported knowledge). The identification of these areas is flipped when looking at communities of consumption, where the rural areas are more homogenous, with most consumers being from the same social groups, and urban areas are more heterogenous, with a mixture of social classes using ceramics for various functions. Once again, intermediate areas are a mix of the two, but also may have a higher proportion of imported ceramics from urban areas. These practices can be analyzed to identify the various areas, but also the links between rural, urban, and intermediate sites in the Middle Islamic period.

4 Methods and Materials

The research into the ceramics took a two-pronged approach, namely macroscopic and microscopic analyses to answer the questions presented in Chapter 1 (Table 4.1). The macroscopic approach included visual analysis, photography, and drawing of the samples, and this allowed for groupings of ware and form types to be identified across regions. This type of analysis is standard practice on archaeological sites (Orton & Hughes 2013; Rice 2005; Shepard 1976; Sinopoli 1991) and in museum identification (Fehérvári 2000; Golombek *et al.* 1996; Priestman 2020; Watson 2020). However, many of these studies are used for the identification of the wares for chronological and typological purposes. This dissertation takes these identifications a step farther into analyzing the changes in ceramic style within and between regions in order to identify consumption patterns and local agency.

The microscopic analyses included thin section petrography, portable X-Ray fluorescence (pXRF), and Fourier Transform Infrared Spectroscopy (FT-IR). These methods allowed for the analysis of both the mineralogical and chemical signatures of the materials as well as the methods of manufacture. Scientific techniques have been used in Islamic archaeology to better understand glazing technology (Lapuente & Perez-Arantegui 1999; Mason 2003; Mason & Golombek 1990; Ting & Taxel 2020), provenience (Carvajal Lopez *et al.* 2018; Carvajal Lopez & Day 2015; Fusaro *et al.* 2019; Hill *et al.* 2004; Martinez Ferreras *et al.* 2020; Mason & Keall 1990; Mason & Milwright 1998; Petrik *et al.* 2020; Tomber *et al.* 2020), and methods of manufacture of stonepastes (Mason 1995b; 1997b; 1997c; 1997d; 1997e; 2004; Mason & Keall 1991b; Mason & Tite 1994a). The combination of analyses presented here is rarely used in Islamic archaeology, with thin section petrography and scanning electron microscopy being the most common type of analysis. The samples previously used to answer the questions of provenience and technology adaptation are all glazed samples, mainly from art historical collections. This research expands into all ceramic types and understanding the technology and manufacture of all ceramics, not just the glazed pieces. This allows for the identification of ceramic traditions and understanding how they vary across sites and time.

Table 4.1: The analytical methods used, samples selected, and aims of research for this study.

Analytical Methods	Samples	Aims
Visual Examination	Site 155 (432) Site 217 (172) Site 276 (76) Site 381 (91) Site 453 (50) Site 519 (30) Site 535 (34) Nippur (121) Hasanlu (64) Rayy (96) Chal Tarkhan (9) Firuzabad (74)	(1) Recording attributes such as paste color, inclusions, surface treatment, and decoration (2) Formation of macroscopic groupings based on these attributes (3) Selection of samples for further testing
Thin Section Petrography	Site 155 (12) Site 217 (30) Site 276 (14) Site 381 (15) Site 519 (8) Site 535 (9) Nippur (14) Hasanlu (7) Rayy (29) Chal Tarkhan (5) Firuzabad (11)	(1) Identification of mineralogical composition of samples (2) Identification of technical practices (3) Determination of possible provenance of samples
pXRF	Same as Thin Sections	(1) Identification of chemical composition of samples (2) Determination of possible provenance of samples
FT-IR	Same as Thin Sections	Identication of relative firing temperatures

4.1 Sampling Methodology

The sampling methodology was different based on where the collections were located. I have divided them into their locations to discuss the sampling procedures for each.

Table 4.2: Site names, the original projects or museum, and number of samples.

Site Name	Project/Museum	Total Number	Sampled Number	Percentage of Sampled Material
Site 155	EPAS	432	12	2.70%
Site 217	EPAS	172	30	17.40%
Site 276	EPAS	76	14	18.40%
Site 381	EPAS	91	15	16.40%
Site 453	EPAS	50	0	0.00%
Site 519	EPAS	30	8	2.60%
Site 535	EPAS	34	9	2.60%
Nippur	Oriental Institute	121	14	11.50%
Hasanlu	Penn Museum	64	7	10.90%
Rayy	Penn Museum	96	29	30.20%
Chal Tarkhan	Penn Museum	9	5	55.50%
Firuzabad	Penn Museum	74	11	14.80%
	Total	**1255**	**154**	**12.30%**

4.1.1 *EPAS sites (Site 155, 217, 276, 381, 453, 519, 535)*

The samples from EPAS were collected during the survey of the sites (Chapter 2.3.1). Due to the survey protocols, rims, bases, and decorated pieces were collected, whereas other pieces were left in the field. These were then rough sorted and chronologically identified by Karel Nováček and placed in storage. When I arrived in 2019, I re-analyzed the entire collections of these sites using the macroscopic methods listed below, except drawing the sherds as Nováček provided them. I then selected a sub-sample of the sherds for export to Cambridge for the scientific analysis. I selected these sherds based on their ware types, decoration, and forms, trying for a broad collection to better elucidate local production of all ceramics rather than focusing on one type[1].

4.1.2 *Penn Museum (Hasanlu, Rayy, Chal Tarkhan, Firuzabad)*

Hasanlu was excavated as part of the Hasanlu Project (see Chapter 2.3.3). The Islamic period material is thoroughly discussed in Danti 2004. The ceramics from the Islamic levels were collected differently based on the season. Between 1956 – 1962, only diagnostic wares were collected from Phases I-IIIA, and specific ceramics (usually intact vessels) could be given an object number. Therefore, the amount of glazed wares represented is unusually high for an Islamic period settlement. These were then divided between the excavation and the Iranian Archaeological Service, and as such the collection I saw at the Penn Museum during my study trip in 2019 was more than 50% glazed material. When sampling for scientific analysis, I tried to even this by sampling more of the unglazed and coarser material to get a better control on the production methods of the vessels.

[1] Due to the sampling occurring on the last day, with the packing of storage, some of the selected pieces (mainly site 155) were packed away before they could be retrieved, and as such site 155 has a lower proportion of selected samples.

Rayy and Chal Tarkhan were both excavated by Schmidt in the 1930s (see Chapter 2.3.4), and very rarely diagnostic ceramics were recorded. The exception was stonepaste, porcelain, and complete vessels. These ceramics were spilt between the Iranian Department of Antiquities and the expedition, and the expedition's lot was further split between the Boston Museum of Fine Art, the Penn Museum, and the Oriental Institute. During my Penn Museum study trip in 2019, I looked at approximately 96 sherds from around 4200 sherds from Rayy and 9 of the 68 from Chal Tarkhan present at the Penn Museum, focusing on the unglazed sherds, with a few blue and green glazed pieces. These were described following the macroscopic protocols laid out below. Out of these I selected pieces for scientific analysis, focusing once again on the unglazed and coarser pieces to better understand the production methods of the vessels.

Firuzabad was surveyed during the Eastern Iran Archaeological Survey (see Chapter 2.3.5). Being a survey, diagnostic pieces were collected, photographed, and drawn, but most of the original documents have been lost. According to the archive, all pieces collected were exported for study at the Penn Museum, and during my study trip in 2019, 74 of the 113 pieces were analyzed according to the macroscopic methodology listed below. For the scientific analysis, pieces were chosen to gather a random sample of the various ware types identified.

4.1.3 *Oriental Institute (Nippur)*

The sherds from Nippur were recovered from Area M, and some surface scatter (see Chapter 2.3.2). This was a single-phase occupation, and all the sherds were recorded. A selection of sherds was exported to the Oriental Institute for further study. This export is what I was able to access during my study trip in 2020. These were mainly diagnostic pieces, including rims and glazed pieces. During the study trip, I re-analyzed these pieces using the macroscopic techniques below. I then selected pieces for scientific analysis, with about half the pieces selected being glazed. These were chosen to be a representative sample of the collection in the museum. These were combined with the published drawings and information from Gibson, Armstrong, and McMahon (1998).

4.2 Macroscopic Methodology

The macroscopic methodology employed visual examination (hand, hand lens, and USB Dinolite microscope) to identify the stylistic and some technological attributes of the pottery. I have divided this into two larger categories, ware type and form type. Variations in these attributes were used as a basis for groupings of the material which were used for both sampling for archaeometric methods as well as to identify local, regional, and interregional patterns.

4.2.1 *Ware*

Ceramic wares are a mixture of fabrics, surface treatments, and to some extent firing. The ware system devised for this dissertation was established to characterize the ceramics at Gird-i Dasht[2], in Iraqi Kurdistan (Kaercher 2016a; 2016b; Sharp & Kaercher 2018). This was then extended to other assemblages analyzed to keep a consistent recording pattern. The larger ware groups are alpha-numeric (Appendix 2) with the fabric color identified by the first number (1 – 8), thickness/inclusions by a letter (A – C), and surface decoration by a number/letter combination (1 – 10 a – g). For example, 3A7e2 is a fine sgraffiato glazed red fabric. The alpha-numeric coding system helps to define possible local vs. imported fabrics and regional fabric techniques. Using this system, we can gain more information on production technique as well as possible geographical locations and hence trade patterns (Rice 1976). These samples were all analyzed by eye, using a x10 hand lens, and a x40 Dino-Lite USB Microscope.

4.2.2 *Form*

The form typology was created, again mainly from the Gird-i Dasht assemblages in conjunction with multiple published typologies (Priestman 2005; Rante & Collinet 2013; Tonghini 1998; Wilkinson 1973). The ceramics were drawn according to standard ceramic techniques, and gathered into two main groups, bases and rims. These were then subdivided into five main categories (Appendix 3) based on the main forms (bases, trays, bowls, jars, miscellaneous). These categories were then subdivided into various groups based on characteristic designations (Orton & Hughes 2013; Rice 2005; Shepard 1976; Sinopoli 1991). Bowls were divided into shallow and deep based on rim angle (shallow bowls having rim angles less than 25%), and jars were subdivided based on the presence/absence of necks (no neck, short neck (under 2 cm), long neck (2 cm and over), and holemouth). Each of these designations was then divided based on rim shape and angle. Since most of the literature discusses the vessels in terms of the larger categories (Small/large bowls etc.), the larger subdivisions are more helpful, but the smallest category (variations in rim angles) does allow for us to analyze changes in space and time.

4.2.3 *Function*

The functional categories were created based on both ethnographic studies (Henrickson & McDonald 1983), as well as mechanical and morphological characteristics of the ceramics (Henrickson 1990; Henrickson & McDonald 1983; Rice 1996; Skibo 1992; Skibo *et al.* 1989; Smith 1988). I have divided the ceramic sample into five main categories (serving, food processing, cooking, storage, and other). Some of these have been subdivided (Storage into dry and liquid, Other into lid, handle, spout, lamp, nargileh, architectural). Appendix 5 illustrates a more-detailed flow-chart of decision processes for each functional category, but the main characteristics are summarized below and in Table 4.3. The sherds

[2] Gird-i Dasht was going to be the foundation of this dissertation, providing stratified Islamic ceramics, however, due to sampling and export issues, none of the sherds were exported for study. Therefore, this site was cut from the dissertation, but will hopefully be published as a separate article.

have all been placed in one category; however, a multitude of functions for one form or fabric/ware type may be identified.

Table 4.3: Main categories defining the functional types of vessels.

Functional Type	Main Fabric	Main Forms	Main Surface Treatment
Cooking	Mineral Tempered	Globular Jars, Short Neck Jars	Smoothed, Burnished
Food Processing	Vegetal Tempered	Trays, Deep Bowls, Basins	Smoothed
Serving	Fine/Untempered, Stonepaste, Porcelain	Ringed Bases, Shallow Bowls, Deep Bowls	Glazed, Smoothed
Storage	Fine/Untempered	Jars (All types)	Smoothed, Incised, Stamped
Dry Storage	Vegetal Tempered	Holemouth Jars, No Neck Jars	Rope Applique, Smoothed
Liquid Storage	Fine/Untempered	Long Neck Jars, Spheroconoical Vessels, Pilgirm Flasks, Spouts	Smoothed, Moulded, Barbotine
Architectural	Vegetal Tempered	Tile	Moulded
Nargileh	Mineral Tempered	Nargileh	Smoothed
Lamp	Fine/Untempered	Lamp	Smoothed
Lid	Fine/Untempered	Lid	Smoothed
Handle	Fine/Untempered	Handle	Smoothed

The functions were determined by the form and fabric of the vessels, and, to some extent, surface treatment, method of manufacture, and thickness of the sherds. Cooking vessels are typically shorter and squatter vessels with larger globular bases and a more restricted mouth (Henrickson & McDonald 1983). The fabrics are mainly of a high mineral temper (over 30% of the fabric), fired at a lower temperature in order to handle the changes in temperature with repeated firings (Tite *et al.* 2001, p. 309). These facets are then complimented by the presence of burning or burned organics attached to the sherds indicating repeated use of the vessel. Food processing vessels are typically larger trays and basins, to conform to the variety of activities including grinding, soaking, chopping, mixing, winnowing, drying, and/or smoking of food (Henrickson & McDonald 1983). These ceramics are typically thicker to accommodate the various activities, as well as tempered with vegetal matter. They are also rougher in their manufacture including more of the handmade ceramics as well as limited surface treatments (including rarely smoothing the surfaces) (Henrickson & McDonald 1983). Serving vessels are mainly shallow and deep bowls, moulded jars, and sherds with decoration. Serving vessels are typically used not only for their function, but also to display various aspects of the consumer's identity (Henrickson & McDonald 1983; McCracken 1990; Miller 1995). Therefore, most of the glazed wares are placed in this category, even if the form of the vessel is not known. These wares also tend to be of a finer manufacture, usually untempered with a wheelmade method of manufacture. This category also includes all the stonepaste and porcelain fabrics. Storage vessels are normally jars with mouths that are able to be closed (i.e. smaller than shoulders or with necks) (Henrickson & McDonald 1983). These vessels have a range of fabrics from untempered to mineral to vegetal temper, this could depend on what is being stored in the vessels, or if there are secondary functions for the vessels. The decoration on these vessels also ranges from smoothed to incised or stamped, possibly also correlating with what is being stored. Liquid storage vessels have restricted necks and are sometimes glazed. They also include the specialized spheroconical and pilgrim flask forms (Anderson 2004; Ghouchani & Adle 1992). The more specialized functions (architectural, nargileh, lamp) all have very specific forms from tiles to nargilehs to lamps. The lids, handles, and spouts are each in their own categories due to the fact they could be part of any functional vessel, where they can be placed in the functional category they are (i.e. handles from cooking pots are normally lugs, and have the same fabric as the other cooking vessels; stonepaste handles are placed in the serving function, etc.).

4.3 Microscopic Methodology

4.3.1 *Thin Section Petrography*

Thin section petrography was chosen as the main analytical method for understanding both the mineral structure of the ceramics, as well as the manufacturing technique. The mineralogy of the samples as well as the matrix and textures was used to assign the samples into fabrics or compositional groups (Freestone 1995; Middleton & Freestone 1991; Peacock 1970; Quinn 2013; Stoltman 1989; Whitbread 1995). Petrography, in conjunction with ethnographic research, allows for reconstructing different aspects of ceramic technology including paste preparation, forming techniques, surface decorations, and firing technology (Day 1989; Quin & Burton 2009; Quinn 2013; Rye 1981; Sillar & Tite 2000; Whitbread 2001). The mineralogy of the samples, in conjunction with geological maps can pinpoint the regions of manufacture of ceramics (Boileau *et al.* 2010; Day *et al.* 1999; Doherty 2000; Kiriatzi 2003; Quinn 2013; Whitbread 1995). These fabric groupings are representative of the manufacturing decisions the potters made at local, regional, and interregional levels. The ceramic recipes established from the petrography (along with the sourcing from the pXRF and firing from FT-IR) can be used to analyze the spread of ceramic technology across both time and space.

Petrography has been used by various scholars across the Islamic world, including Spain (Carvajal Lopez *et al.* 2018; Carvajal Lopez & Day 2015; Lapuente & Perez-Arantegui 1999), Egypt (Mason 1997d; Mason & Keall 1990), Levant and Syria (Mason 1997e; Mason & Milwright 1998; Ting *et al.* 2019; Ting & Taxel 2020), Iraq (Mason 1997c; Mason & Keall 1991b; Mason & Tite 1994a; Petrik *et al.* 2020), Iran (Hill *et al.* 2004; Mason 1997b; 2003; Mason & Golombek 1990; Tomber *et al.* 2020), and Central Asia (Fusaro *et al.* 2019; Klesner *et al.* 2019; Martinez Ferreras *et al.* 2020). However, most of these studies are concerned with the provenience of the vessels and the technology behind the glazing/stonepaste creation. This dissertation expands on the information gathered by petrography spatially, as well as theoretically, in analyzing the potters' choices rather than just provenience or glazing technology.

The preparation of thin sections included the removal of a thin slice of the sample, taken perpendicular to the vessel surface (except one sherd from Nippur (A163161), where a flake of the ceramic was used due to preservation issues). The sample was then impregnated in a mixture of Epothin epoxy resin and hardener, ground flat using silicon carbide sandpaper and aluminium oxide powder, and attached to a slide, using the Epothin epoxy resin and hardener. After hardening, the sample was ground to around 80 μm in a Buehler PetroThin thin sectioning system and then finished by hand polishing to around 30 μm in aluminium oxide powder, checked under the microscope by the clarity of the quartz. The finished thin sections were then studied under both plane polarized (PPL) and cross polarized (XPL) light of a Leica DM-EP Optical Microscope. This was done under x40, x100, and x250 magnification, depending on what was needed to identify the minerals.

Due to the different underlying geologies of each region, the ceramics from each region were analyzed separately. After being divided into regions (al-Jazira: EPAS, al- Iraq: Nippur, al-Ran: Hasanlu, Iraq al-Ajam: Rayy and Chal Tarkhan, and Khurāsān: Firuzabad), they were grouped based on the clay matrix, voids, and inclusions. The recording of the petrographic descriptions was done using a mixture of Quinn (2013) and Whitbread's (1995) ceramic thin-section descriptive systems (Appendix 6)[3]. This system records the microstructure (void shape, size, distribution and orientation of voids and inclusions), groundmass (color, optical characteristics, homogeneity), inclusions (coarse/fine/void ratio, sorting, measurements, frequency, types of fine and coarse fraction), concentration features (type, color, shape, size), and any comments. These descriptions provide a framework for the classification and characterization of fabric groups within the ceramic sample.

4.3.2 *Portable X-Ray Fluorescence (pXRF) Methodology*

pXRF was chosen for this study because of its non-destructive and inexpensive nature for the chemical characterization of archaeological ceramics. The inexpensive nature allowed for all 154 samples to be analyzed to create a large dataset needed to analyze regionalization. pXRF has been compared to higher sensitivity techniques like neutron activation analysis (NAA) and inductively coupled plasma-mass spectrometry (ICP-MS), and has been shown to distinguish geochemically different ceramic pastes which correlates with the more precise measurements (Forster *et al.* 2011; Hunt & Speakman 2015; Speakman *et al.* 2011). These studies do identify a discrepancy between the absolute concentrations

[3] This hybrid system was used because it was the system taught by Dr. Marie Claude Bouileau during the Center for the Analysis of Archaeological Materials Ceramic Petrography Course at the University of Pennsylvania, 2015.

identified by pXRF and NAA/ICP-MS, but as Johnson states: pXRF provides "Inaccurate elemental concentrations which pattern in accurate ways (2014, p, 564)." The use of pXRF has been shown to help characterize large sets of data for further analysis, both in ceramics, and with other materials (Forster *et al.* 2011; Frahm 2018; Frahm *et al.* 2014; Hein *et al.* 2007).

The accuracy and precision of pXRF are affected by many factors, the two main ones are surface effects and particle size of minerals in the sample (Holmqvist 2016). To mitigate these effects, the ceramics in this dissertation were first sampled for the petrography/FT-IR and pXRF was run on the flat, cut surface. This removed the surface contaminants as well as any error arising from the curvature of the sherd (Holmqvist 2016, p. 306-308). Errors could still occur due to the thickness of the sherd and the coverage of the window of analysis. To help with the particle and matrix size, each sample was run three times, stretching the length of the ceramic (Top, middle, bottom), and these numbers were then averaged (following (Williams-Thorpe, Potts and Webb, 1999; Forster *et al.*, 2011; Goren, Mommsen and Klinger, 2011)).

An Olympus Vanta handheld XRF analyzer equipped with a Rh anode tube and a large-area silicon drift director was used for the pXRF analyses. The analytical mode employed was the factory-built 'GeoChem', which allows for the two built in beams to fluoresce the heavier and lighter portions of the periodic table. The tube operated at 40kV and ~70µA for the heavier elements and 10kV and ~90µA for the lighter ones. This mode was calibrated by the manufacturer using dozens of SRMs. The samples were measured using a 40 mm^2 Si drift detector, and the Axon technology which enables high count rates and spectrum resolution. Each beam ran for 60s, meaning that the total test time was 120s for each measurement. Each sample was analyzed three times, and an average was taken for the analysis.

The calibration of the instrument and the 'GeoChem' mode was tested with two SRMs, NIST 679 (Brick Clay) and SARM 69 (Ceramic from South Africa; Jacobson, Van Der Westhuizen and Oosthuysen, 1998) (Appendix 9). The instrument identified 36 elements: Mg, Al, Si, P, S, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Rb, Sr, Y, Zr, Nb, Mo, Ba, W, Hg, Pb, and Th. Out of these measured elements, NIST 679 does not have a certified values for As, Se, Mo, W, and Hg, and SARM 69 does not have certified values for V, Ni, Cu, As, Se, Y, Zr, Nb, Mo, W, Hg, and Pb, therefore As, Se, Mo, W, and Hg were removed. Most measured elements for NIST 679 were relatively precise (<10% relative standard deviation[4] except V, Co, Nb, and Th). The same precision was recorded for SARM with only Nb and Ba registering higher than 10% relative standard deviation. In terms of accuracy, most elements had relative errors[5] under 25% (except NIST 679: Mg, Co, Ni, Cu, Nb, Pb, and Th, and SARM 69: P, V,

[4] Relative standard error = 100*(standard deviation/mean)
[5] Relative error = 100*(measured-standard)/standard

Co, Ni, Cu, Y, Zr, Nb, Pb, Th). Therefore, Co, Ni, Cu, Nb, Pb, and Th were removed from the analysis. This left the analysis with 12 elements that were relatively precise and accurate Al, Si, K, Ca, Ti, V, Cr, Mn, Fe, Rb, Sr, Zr).

4.3.3 *Fourier-Transform Infrared Spectroscopy Methodology*

Fourier Transform Infrared Spectroscopy (FT-IR) is a technique used to assess mineralogical composition of ceramics. FT-IR is able to identify both the crystalline minerals as well as the pseudo-amorphous phases of the fired clay. It is an easy to use, fast, and relatively inexpensive technique, and as such is widely used in archaeological sciences (Barilaro *et al.* 2008; Barone *et al.* 2011; De Benedetto *et al.* 2002; Shoval 2003; 2016). Infrared spectroscopy is based on the way infrared radiation interacts with a material (Shoval 2016, p. 510). The radiation is absorbed differently by different materials according to the structure and vibration of their bonds and crystalline lattices. The frequency absorbed by the material is characteristic of the structural and chemical composition of the material (Shoval 2016, p. 512). FT-IR is used both for identifying the minerals and base clays of the ceramic, but also the firing temperatures.

FT-IR is often used for determining an estimation of firing temperatures for ceramic material, leading to information on the technology of the firing and quality of the wares (Shoval 1994; 2003; 2016). FT-IR is beneficial for low-fired ceramics, as they are fired below the thermal crystallization of most minerals, and their meta-clay composition can be determined, which helps to identify firing temperature (Shoval 2016, p. 511). The firing of clay transforms the raw material into meta-clay through a process called dihydroxylation (Shoval *et al.* 2011). There are two main groups of ceramics, calcareous (calcite-rich) and non-calcareous based on their clay beds of origin, and their mineral inclusions depend on the type of raw material along with the firing temperature (Fabbri *et al.* 2014; Shoval *et al.* 2011).

FT-IR is rarely used in Islamic archaeology, but a few scholars use it to help reconstruct the technology for ceramics (Barilaro *et al.* 2008; Beltrame *et al.* 2019; Palamara *et al.* 2016) and tiles (Demirci *et al.* 2004; Guney & Caner 2020). The use of FT-IR in this study will expand the knowledge of firing temperatures on ceramics, especially unglazed materials.

The FT-IR spectra were obtained with a ThermoScientific Nicolet (series iS5) with OMNIC software. The sample was prepared by scraping a small amount of ceramic (ca. 1mg) from the core of the ceramic into a mortar and grinding to a fine powder with a pestle. To this was added KBr (ca. 150mg) and the sample was mixed and reground (Following procedures laid out by Shoval 2016). This was then pressed into a disk and the disk was placed in the machine. This type of sampling did not sort for various tempers and non-plastic components, but the sample was taken to only include the body, and not decoration (paint/glaze/etc.). This disk was then run for 60s and the absorbance was between .5 and 1.8, if not the disk was reground and pressed, and run again. This was run three times and the best run was chosen for analysis based on the smoothness of the peaks. All samples had a range between 4000 cm^{-1} and 400 cm^{-1} (Appendix 10).

The infrared spectrometer irradiates the material with the full spectrum of infrared light, and the machine measures the unabsorbed radiation. The absorption of specific wavenumbers by the material means some frequencies never reach the detector, and these intervals of absorption are recorded as the infrared spectra. Each mineral has its own specific bands which leads to the identification of the material. The spectra were evaluated with the Kimmel Standards to identify specific peaks such as calcite, quartz, and gehlenite. Estimates of firing temperature, including the shift of the main SiO band, the presence of primary or reformed calcite, and presence of various minerals (gehlenite, wollastonite, anorthite) divided the samples into four main groups as discussed in Chapter 6.3.

4.4 Evaluation Methods

4.4.1 *Statistical Methods*

The first statistical method used to classify the data was a hierarchical cluster analysis. Cluster analysis aims to produce groups where samples within the group are similar, and the samples between groups are different (Baxter 2003). This type of analysis produces a dendrogram which consists of branches (the links) and leaves (the samples). The tree can be cut at various points to isolate distinct clusters. The data first needs to be standardized, and then the (dis)similarity between rows is defined and an interpretation method is chosen. For this dissertation, the (dis)similarity is squared Euclidean distance, and the interpretation method chosen was Ward's method. These are the two most common methods used to perform a cluster analysis in archaeology. Euclidean distance is used to calculate the smallest distance among pairs of objects. Squared Euclidean distance is used to fit statistical estimates to data by minimizing the average of the squared distances between observed and estimated values (Randolph & Myers 2013). Ward's method analysis is normally used in archaeology to create a simplified cluster which can be used to identify a level of clustering (Baxter 2003).

The second method was Principal Component Analysis (PCA) which was used to transform the compositional data into a meaningful pattern. PCA examines the relationship between variables and among units (Baxter 2003; Bishop & Neff 1989; Fletcher & Lock 2005; Rice & Saffer 1982). PCA allows for the ability to compress a large dataset into principal components which are uncorrelated, as well as showing a low-dimensional representation of the data in a scree plot, component plot, and/or bivariate plot. The scree plot illustrated the variance represented by each principal component and this is a determining factor in which principal components should be used to demarcate the compositional groups (Baxter 2003). The two principal components with the greatest percentage of variance are plotted on the component and bivariate plots. The component plot shows the correlations of different elements and the degree to which each correlation is expressed in terms of directionality. The bivariate plot illustrates the groupings of the samples. These two plots together illustrate the relative weight of various elements in the compositional groups. The PCA was performed in SPSS, which calculated the correlation coefficients between the variables and transform them into principal components.

This dissertation uses hierarchical clustering which allows for groups of various sizes to be linked. Cases are treated as a size 1 at the smallest level of analysis each case is its own cluster, and then grouped until a single cluster, of all cases is present (Baxter 2003). The resulting dendrogram can be cut at any height producing clusters of samples that are similar. Once the clusters have been identified, the PCA can be used to help explore how the clusters are separated.

4.4.2 *Chaîne Opératoire*

To create the specific *chaîne opératoires* used in this study, I took the microscopic data (pXRF, petrography, and FT-IR) and added it to the macroscopic data (fabric type, method of manufacture, surface treatment/decoration). Since ceramics are created with a purpose, I began with a condensed version of the functional/use data (cooking, food processing, serving, storage, other; Chapter 5.4). Each of these were then broken down by addition of inclusions (based on petrographic and macroscopic data), method of manufacture (petrographic and macroscopic data), surface treatment/decoration (condensed macroscopic data), and firing temperature (FT-IR and macroscopic data).

4.5 Summary of Methods and Materials

In all, this thesis employs a variety of techniques from the macroscopic to the microscopic. These techniques record all steps in the ceramic life cycle from production to disposal. The analysis of production, from clay sources, to inclusions, to forming and decoration, to firing allows for the recreation of the *chaîne opératoire* and analysis of potters' choices and traditions. These can be investigated to analyze local, regional, and interregional practices.

5 Fabrics, Wares, Forms, and Functions of the Ceramic Assemblages

Macroscopic investigations of Islamic ceramics are traditionally defined by their typology, decoration, and surface treatments (or lack thereof), and sometimes the body color is mentioned. This is due to the classification of the wares (mainly divided by surface treatment and decoration) in museums, and the art historical questions being asked. Most of these questions surround the date of various wares, as well as where they were first produced. This chapter builds on these studies to analyze the dates of these ceramics, since they are mainly from survey collections. This chapter also focuses on the distribution of different wares across regions, not necessarily pinpointing where they were first made, but rather in terms of consumption practices, what sites utilized what type of ceramic. Lastly, this chapter seeks to understand the function of the ceramics with the help of ethnographic sources, defining how these ceramics were used in daily life.

As discussed in the methodology chapter (Chapter 4.2.1), this chapter uses broad ware categories which include both fabric and surface treatments/decoration. These categories are defined according to technical characteristics (clay, inclusions, color) and surface treatments/decoration and are all discussed in Appendix 2. This chapter gives a brief discussion of the fabric types, surface treatments/decorations, forms, and functions present in the sample under study. I then give a detailed discussion of each ceramic assemblage with comparanda from around the region where identifiable. This chapter ends with a broad summary of trends present in the collection. These trends and chronology are mainly based on the glazed wares present, due to the research that has been done on these assemblages.

5.1 Fabric Types

Islamic studies tend to name ware types mainly by decoration technique (Black on blue Ware, Sgraffiato Ware), or where they were first discovered (Raqqa Ware, Tell Minis Ware, Garrus Ware).

This more art historical approach ignores the types of fabrics used in the creation of these vessels, and creates large categories that may, in fact, have regional divisions. The more archaeological approach uses a hybrid classification system which still divides the ceramics mainly based on surface treatment/decoration but allowing for a description of the fabric to also be included (Priestman, 2005; Tonghini 2019 personal communication; Nováček 2020 personal communication;). This type of classification begins to answer questions about manufacture and regionalization; however, each classification tends to be site specific, and relatively unpublished, especially in terms of the undecorated wares. This creates confusion when trying to compare sites from different projects. Three fabrics were identified in this study, earthenwares (96.41%, N=1210), stonepaste wares (3.43%, N=43), and porcelains (0.16%, N=2).

Earthenwares are made from two different types of clay, calcareous and non-calcareous. Calcareous clays are a lime-rich clay (Quinn 2013, p. 94). These clays normally contain more than 6% CaO (Maniatis & Tite 1981) When fired this clay has a pale brown to pale red color depending on the firing atmosphere (Figure 5.1: A, C). The majority of samples in this dissertation fall into this category. Non-calcareous clays have a base of iron-rich clay (Quinn 2013, p. 95). These clays normally contain under 6% CaO (Maniatis & Tite 1981). These vessels tend to have a dark red color when fired (Figure 5.1: B). These samples are usually found in more mountainous regions.

Earthenwares normally have inclusions, and this assemblage is divided into three groups, fine mineral inclusions (sand sized or smaller <2 mm (barely visible to the naked eye)), coarse mineral inclusions (grit size or larger >2mm (individual grains are visible to the naked eye)), and vegetal inclusions. Inclusions are separate from temper in that they may just naturally occur, but this is only identifiable under a microscope. Therefore, the categories used do not distinguish between natural and added inclusions. These divisions are present in the petrographic study presented below (Chapter 6.1). The fine wares (Figure 5.1: A), make up 73.39% of the assemblage (N=888), coarse wares (Figure 5.1: B) make up 14.38% of the assemblage (N=174), and vegetal wares (Figure 5.1: C) make up 12.23% of the assemblage.

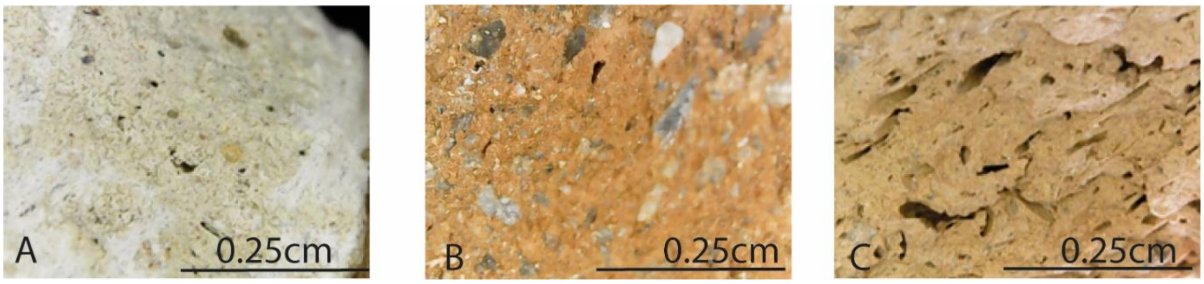

Figure 5.1: Three microphotographs of A) Fine calcareous (EPAS 217.1.1004.6), B) Coarse non-calcareous (EPAS 155.10.581.39), and C) Vegetal calcareous (EPAS 201.2.1005.3) fabrics taken with DinoLite USB Microscope.

Four main forming techniques were identified, handmade (18.75%, N=235), coilmade (14.13%, N=177), moulded (2.15%, N=27), and wheelmade (64.96%, N=814). Most of the handmade ceramics (slab, pinching, pulling) are handles (N=127) and spouts (N=16), leaving 92 handmade vessels. These are identifiable due to the uneven thickness of the sherds, as well as possible finger impressions left during the manufacturing process (Figure 5.2: A). Coilmade vessels tend to be larger closed vessels, or upper portions of larger jars. These can be identified due to the large ridges left on the surface, or the curved breaks along the edges, but if the vessel has been highly smoothed, identifying coil manufacture may be more difficult (Figure 5.2: B). Moulded vessels are pressed into a mould and are identifiable due to the fingerprints on the interior, and usually the highly decorated nature of the exterior (Figure 5.2: C). Wheelmade vessels have very even thickness and usually exhibit riling on the interior surfaces (Figure 5.2: D).

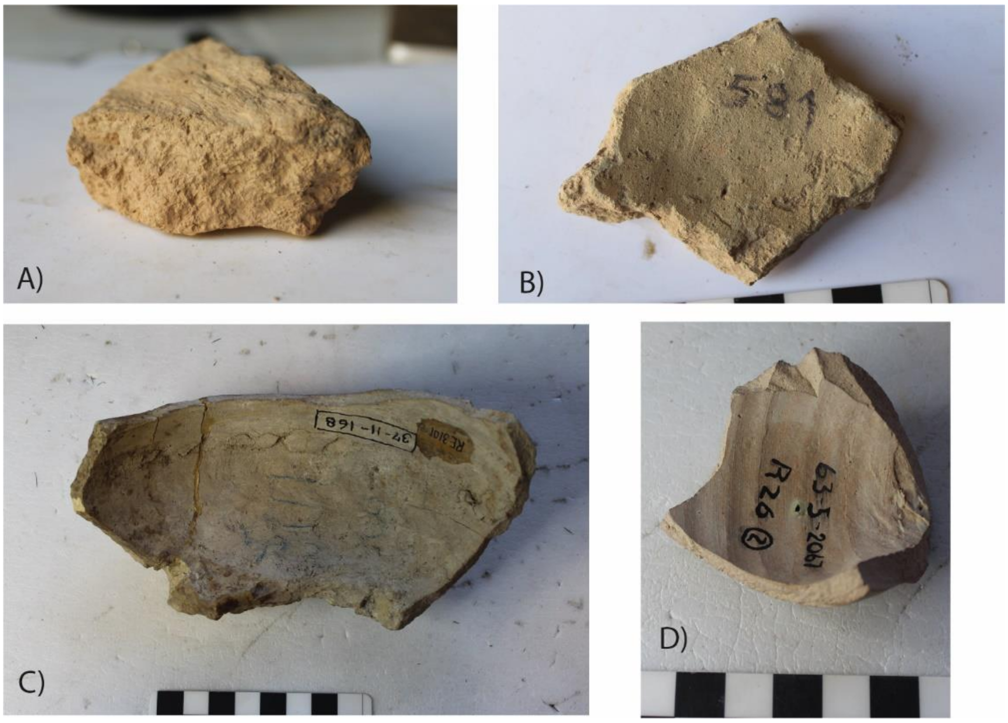

Figure 5.2: These photographs show A) Handmade (EPAS 217.2.1005.6), B) Coilmade (EPAS 155.10.581.25), C) Moulded (UPENN 37-11-168), and D) Wheelmade (UPENN 63-5-2067).

Stonepaste is created by combining crushed quartz, glass or frit, and white clay (Allan 1973; Mason & Tite 1994a). The clay forms the body and during the firing (1200 – 1350°C), the glass and quartz bond together to produce a hard, whiteish fabric (Allan 1973; Mason & Tite 1994a). The body is opaque rather than the translucence of porcelain and is often greyish or light brown rather than true white (Rice 2005). This fabric, also known as stoneware and fritware, is found on multiple Islamic sites. Stonepaste wares were developed in the 9th – 10th centuries CE and reached their height in the 12th – 14th centuries. The main hypothesis concerning the origins of this fabric are that it was developed in the eighth century CE possibly in Basra and then the technology spread to Fustat by the 10th century, and via Syria to Iran in the 12th century (Mason, 1997, 1997a, 1997b, 1997c). Ruigiadi (2011) shows that by 1086 there was an established production of stonepaste wares at Isfahan and hypothesizes an earlier date for the first production of this type of ware in Iran.

Porcelain is a thin, white, translucent vitrified ceramic that is fired at temperatures between 1200 and 1400°C. It is made of kaolin clay mixed with quartz and feldspars (Rice 2005). These sherds are hard, and thin, with no inclusions. This fabric is not native to Iraq or Iran and has been imported, probably from China. Larger centers including Fustat (Scanlon 1984) and Basra (Wood & Tite 2009) have pieces of blue and white porcelain, but it seems to be rarer at sites in Iran including Rayy (Rante 2015) and Nishapur (Rante & Collinet 2013). Nováček *et al.* record two pieces of porcelain at the Erbil Citadel, but state these may be more modern (2008, p. 292).

5.2 Surface Treatment/Decoration

A number of surface treatments (slipping, burnishing, smoothing, grooving) and decorations (incising, stamping, painting, glazing, moulding, and appliqué) were identified in this sample (Figure 5.3). For a larger discussion and literature on the developments and dating of these types of treatments/decorations, see Appendix 2.

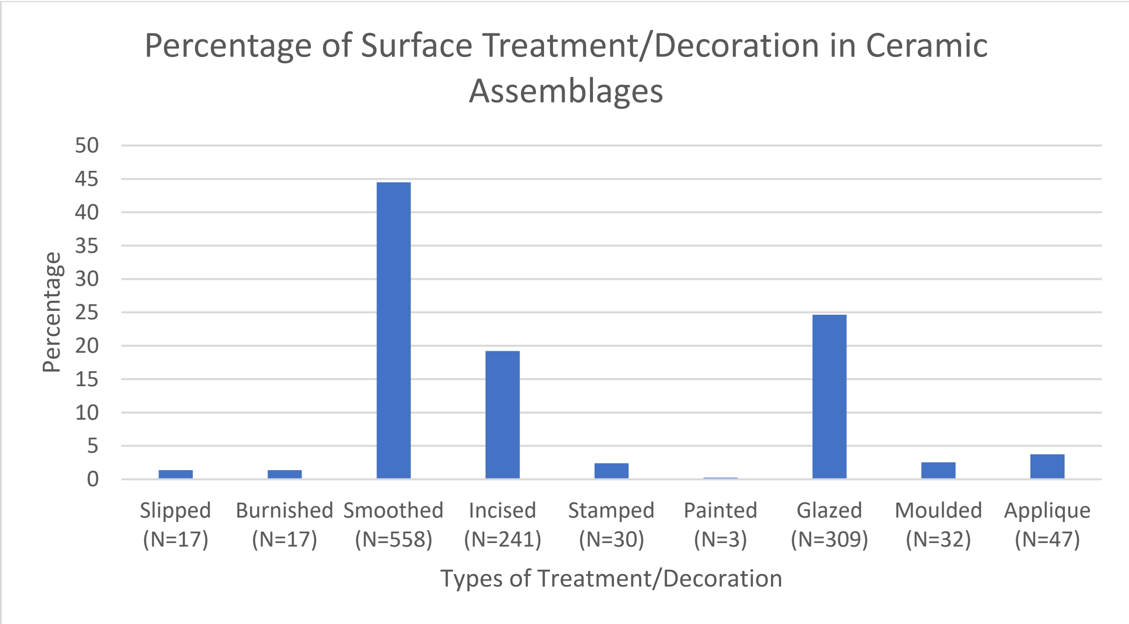

Figure 5.3: Percentage of surface treatments/decorations in the overall ceramic assemblages.

The majority of wares were either smoothed, incised, or glazed (this includes earthenwares, stonepaste wares, and porcelains; however stonepaste and porcelain were only glazed). These do not correlate with any clay or inclusion types. The incised decoration and glazing decorations can be subdivided into various categories with the help of art historical studies of ceramics in museums (Figure 5.4) (Jenkins, 1983; Fehérvári, 2000; Watson, 2004; Jenkins-Madina, 2006). In terms of vessels with more than one surface treatment (i.e. incised and glazed), they are placed in a sub-category of the uppermost surface treatment. For example incised and glazed sherds are placed in a sub-category of glazed wares, but in larger groupings end up under the larger umbrella of glazed wares.

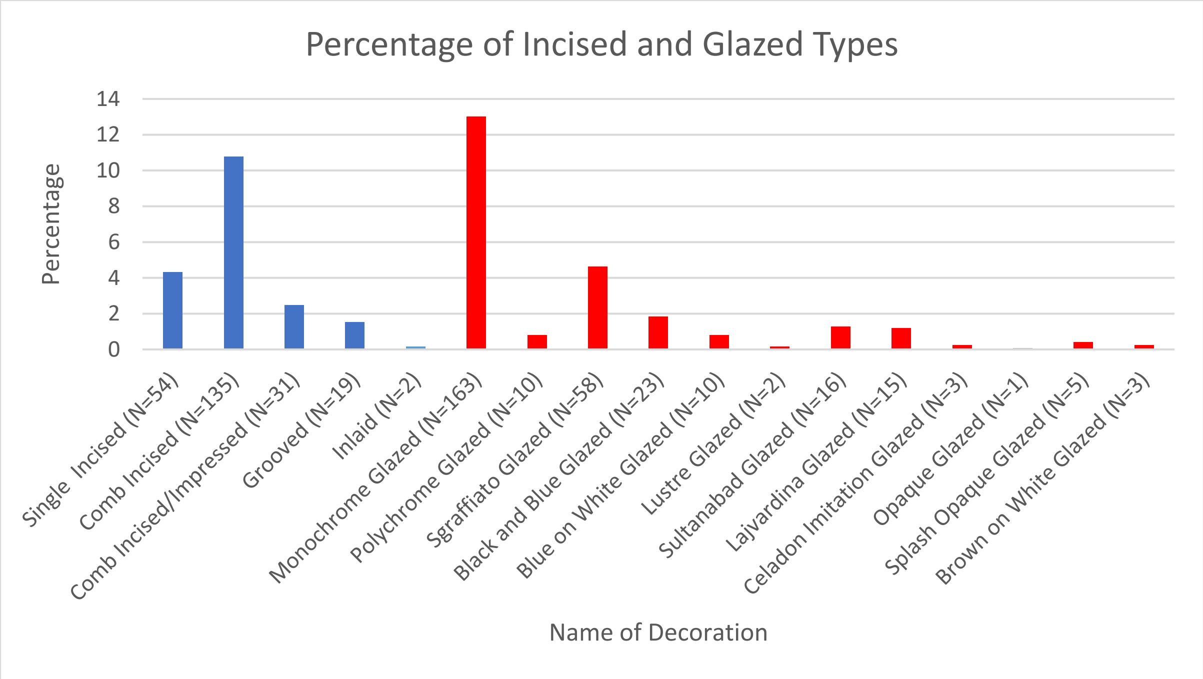

Figure 5.4: Percentages of individual incised and glazed decorations. Blue is larger incised category, red is larger glazed category.

The earthenwares are most commonly decorated by glazing, incising, grooving, stamping, and inlaying. The decoration is not determined by the types of inclusions, forming methods, or final forms of the vessels. The monochrome glazed wares have a mix of inclusions from fine to coarse to vegetal, and a mix of manufacturing techniques from wheel to coilmade. This illustrates a different functional use for these ceramics as discussed below. The rest of the assemblage of glazed earthenwares have fine inclusions and are wheelmade. The stonepaste wares had a variety of decoration from monochrome glazed in turquoise to black on blue, blue on white, Lustre, Sultanabad, Lajvardina, and Celadon imitation. The Lustre and Lajvardina wares are only made in stonepaste. The forming methods of stonepaste are hard to identify, and as such they have all been marked as wheelmade, but they may also have been mouldmade. The two porcelain pieces are a celadon and a blue on white piece, and both were probably wheelmade.

In terms of chronologies, some of the surface decorations are very well dated using artists signatures, dates on vessels, developments of artistic style and designs, and to some extent archaeological excavation (Jenkins 1983; Mason & Tite 1994a; Northedge 1999; Watson 2004). The ability to date the ceramics is most present in the glazed wares, and the subdivisions of these wares allow for the chronological divisions of the wares. However, the majority of wares are not glazed and typologies of these wares have been created for individual projects, but not published. This is also hindered by the fact that most of the archaeological projects are utilizing survey material, and as such a chronological division based on stratigraphy or radiocarbon dates does not exist (Nováček personal communication 2018; Tonghini personal communication 2018; Ahmed personal communication 2018).

5.3 Vessel Forms

Middle Islamic ceramic forms are not widely discussed in the literature. Most site reports have plates of ceramic drawings, but in the discussion forms are relegated to bowls or jars, and come secondarily to the ware and surface decoration (Fehérvári 2000; Nováček 2008b). Various archaeological studies have published ceramic corpuses from selected sites and surveys: Samarra (Northedge 1996; Sarre *et al.* 1925), Hama (Riis & Poulsen 1957), Raqqa (Jenkins-Madina 2006; Tonghini & Henderson 1998), Nishapur (Wilkinson 1973), Qal'at Ja'bar (Tonghini 1998), Ras al-Khaimah (Kennet 2004), and the Williamson Collection (Priestman 2005), but most of these sites are dated before the 11th century. Other studies focused on certain types of ceramics and discuss various forms present in the assemblages including: lustre ware (Mason 1997b; 1997c; 1997d; 1997e), glazed wares (Fehérvári 2000), and cooking wares (Holmqvist 2009). However, without well stratified excavations to pinpoint the changes over time in the ceramic forms, it is almost impossible to assign specific dates to these forms. Another issue complicating changing forms over time, is that forms seem relatively stable over time, from the seventh century (and earlier in some cases) to the 19th. This apparent uniformity might be caused by the lack of archaeological stratified materials from one site spanning this period, but in terms of survey data, not many variations in forms are noted (Nováček personal communication 2018; Tonghini personal communication 2018; Ahmed personal communication 2018).

For this dissertation, the ceramics were divided into four main categories, bases, open forms, closed forms, and other as discussed in Chapter 4.2.3. These are then subdivided into various categories (bases, trays, shallow bowls, deep bowls, basins, no-neck jars, short-neck jars, long-neck jars, holemouth jars, Spheroconical vessels, Nargilehs, Lamps, Pilgrim Flasks, lids, handles, and spouts) as shown in Figure 5.5. These forms were further subdivided into categories based on differences in rim or base shape, all described in more detail in Appendix 3. They are illustrated in Appendix 4: Plates 1 – 35. However, the discussion leaves the forms in the larger categories which allows for more comparisons to be made.

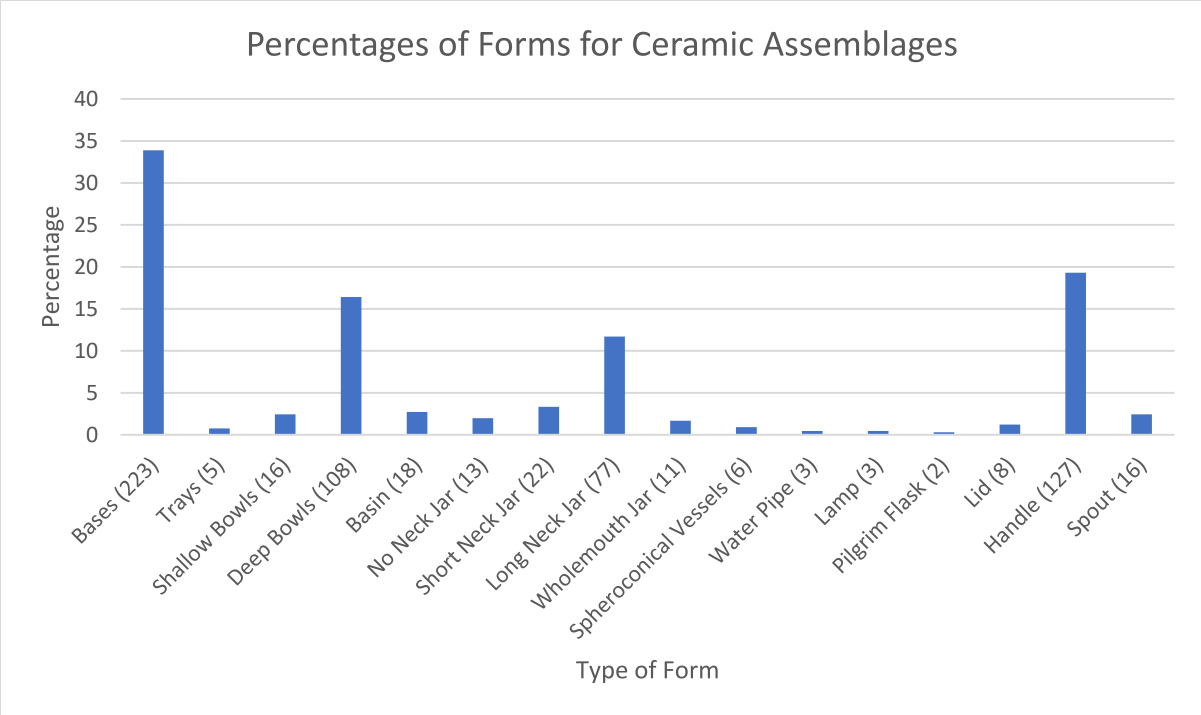

Figure 5.5: Percentages of forms for the overall ceramic assemblages.

In the overall collection, 658 sherds were placed into 16 vessel form categories. The majority (Figure 5.5) are bases, followed by deep bowls and long neck jars. The stonepaste and porcelains do tend to be bases and deep bowls, as do more of the decorated glazed wares, but other fabrics and surface treatments/decorations do not correlate with the other forms.

5.4 Vessel Function

The function of Islamic ceramics has not been discussed besides a general characterization of cookingware or tableware. These divisions have usually been made on technological or stylistic basis (i.e. mineral tempered is cookingware, glazed is tableware). However, the determination of functional attributes has led to meaningful groupings for utilitarian, undecorated wares (Kaplan 1994; Rice 1996). For further discussion on the use of function in ceramic studies see Chapter 4.4.3. I have inferred function based on both ethnographic studies (Henrickson & McDonald 1983), as well as mechanical and morphological characteristics of the ceramics (Henrickson 1990; Henrickson & McDonald 1983; Rice 1996; Skibo 1992; Skibo *et al.* 1989; Smith 1988).

I have divided the collection into five main categories (serving, food processing, cooking, storage, and other). Some of these have been subdivided (Storage into dry and liquid, Other into lid, handle, spout, lamp, nargileh, architectural). Below is a brief summary of the various functional categories (Figure 5.6) but see Appendix 5 for a more detailed discussion. The sherds have been placed in one main category, but a multitude of functions for one form or fabric/ware type is common. Serving vessels (N=446) are used to serve food or liquids and are made from earthenware (N=401), stonepaste (N=43), and porcelain (N=2). They are normally bases, and bowls but can rarely be jars. They have a variety of surface treatments, but the main ones are glazing, in all different types, painting, incising, and smoothing. Food processing vessels (N=59) are used to process food and are made of earthenwares in forms of trays, bowls, and basins. They are usually vegetal tempered and smoothed or incised. Cooking vessels (N=36) are earthenwares, usually mineral tempered, and are globular jars or bases. They are smoothed, burnished, and rarely incised and stamped. Storage vessels (N=569) are earthenwares, with all types of inclusions, and usually made into larger jars, with or without a neck. These were smoothed, comb incised, stamped, and rarely glazed. These can be tentatively divided into dry and liquid storage (Henrickson & McDonald 1983). Dry storage vessels as separated from the storage and liquid storage vessels (N=29) are a subset of storage vessels, used for storing grains, spices, or other dry goods. These are earthenwares, usually with vegetal temper, and are jars with short or no necks. These are usually smoothed or have a rope appliqué around the shoulder. Liquid storage vessels as separated from storage and dry storage vessels (N=100) are used for storing liquids such as water, milk, oil, or wine. These are earthenwares, usually have little to no inclusions, and are long neck jars. These are usually smoothed, but can be glazed, or have moulded or barbotine appliqué. Other functions including architectural pieces (tiles), nargileh, lamps, lids, handles, and spouts.

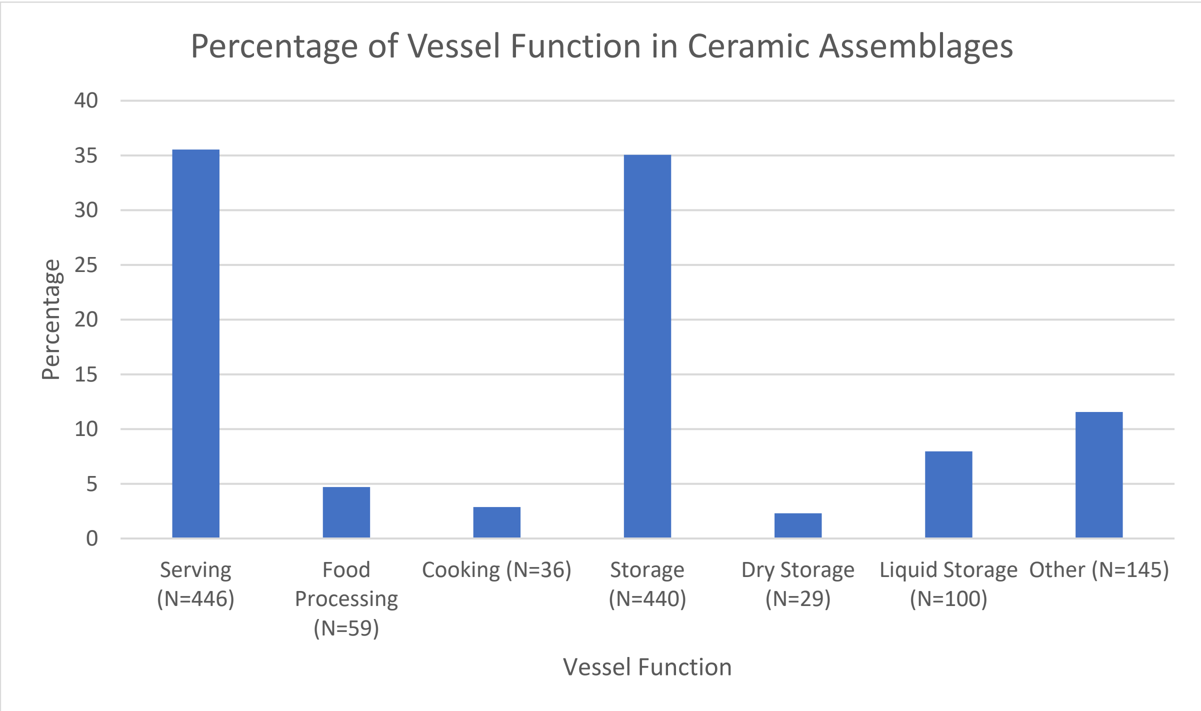

Figure 5.6: Percentages of vessel functions in the overall ceramic assemblages.

As shown in Figure 5.6, serving and storage are the two main functional categories. This could be due to the fact that most of the assemblages are from survey or selected sherds for export, which tend to prioritize decorated sherds, and most decorated sherds have a serving function (especially glazed and stonepaste/porcelain). The reason storage may be so large is it is a catch-all category for vessels that do not really fit the cooking, food processing, or serving categories; however, ethnographically, storage function tends to be one of the larger groups of ceramic function (Henrickson & McDonald 1983; Kaplan 1994; Rice 1996).

5.5 Inter-Site Variation of Macroscopic Observation

5.5.1 *EPAS 155 (11th – 14th Centuries CE)*

EPAS 155 had a total of 432 sherds. Of these, 381 were fine (88%), 23 were coarse (5%), and 28 were vegetal (7%). They were handmade (17%, N=77), coilmade (18%, N=79), moulded (3%, N=10), and wheelmade (62%, N=266). Of the handmade sherds, 70 were handles/spouts leaving seven handmade vessels (2%).

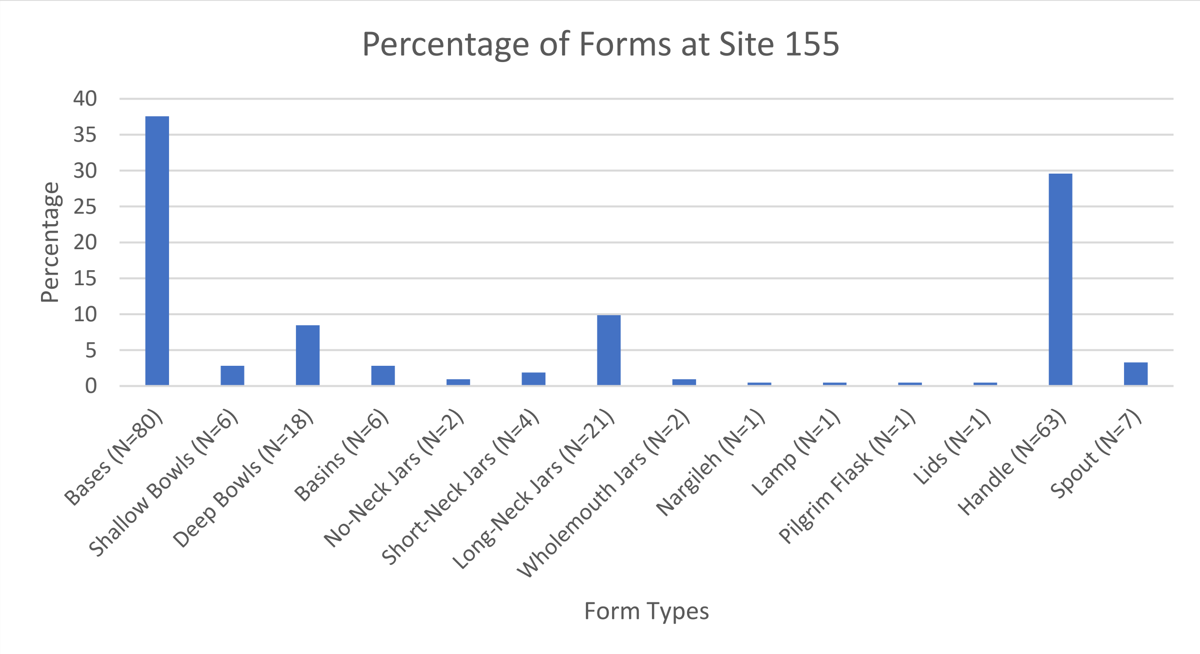

Figure 5.7: Percentage of various form types at Site 155.

At Site 155, 213 sherds were classified into various forms (Figure 5.7). The drawings of all the forms are located in Appendix 4: bases (Plate 1: 1 – 12), shallow bowls (Plate 1: 13 – 18), deep bowls (Plate 1: 19 – 22; Plate 2; 1 – 14), basins (Plate 2: 15 – 20, Plate 3: 1), no-neck jars (Plate 3: 2 – 3), short-neck jars (Plate 3: 4 – 5), long-neck jars (Plate 3: 6 – 13; Plate 4: 1 – 14), holemouth jars (Plate 4: 15 – 16), other (Plate 4: 17 – 22). Very few pieces have comparanda, but the lid is like those found at Nishapur dating from the 10th to 12th centuries (Plate 4:20; Wilkinson, 1973: no. 47). The one identified piece of a nargileh (*hooka, nafas, galyan, qalyan)* (Plate 4: 17) is identified due to the ledged shape with organic material and burning on the surface. Nargilehs are not attested until the 15th to 16th centuries (Elgood, 1970; Qasim *et al.*, 2019; Semsar, 1971), and so this piece may be extrusive, or an early version of this type of vessel. The lamp (Plate 4: 18) was identified by its shape; however, it is not able to be dated. The one piece of a pilgrim flask (Plate 14:19) could be dated anytime between the 10th and 15th centuries

(Watson 2004, p. 122). The rest of the forms roughly match the ceramic assemblages at Qal'at Ja'bar dating from the 11th – 14th centuries CE (Tonghini 1998: Fig. 104 – 144).

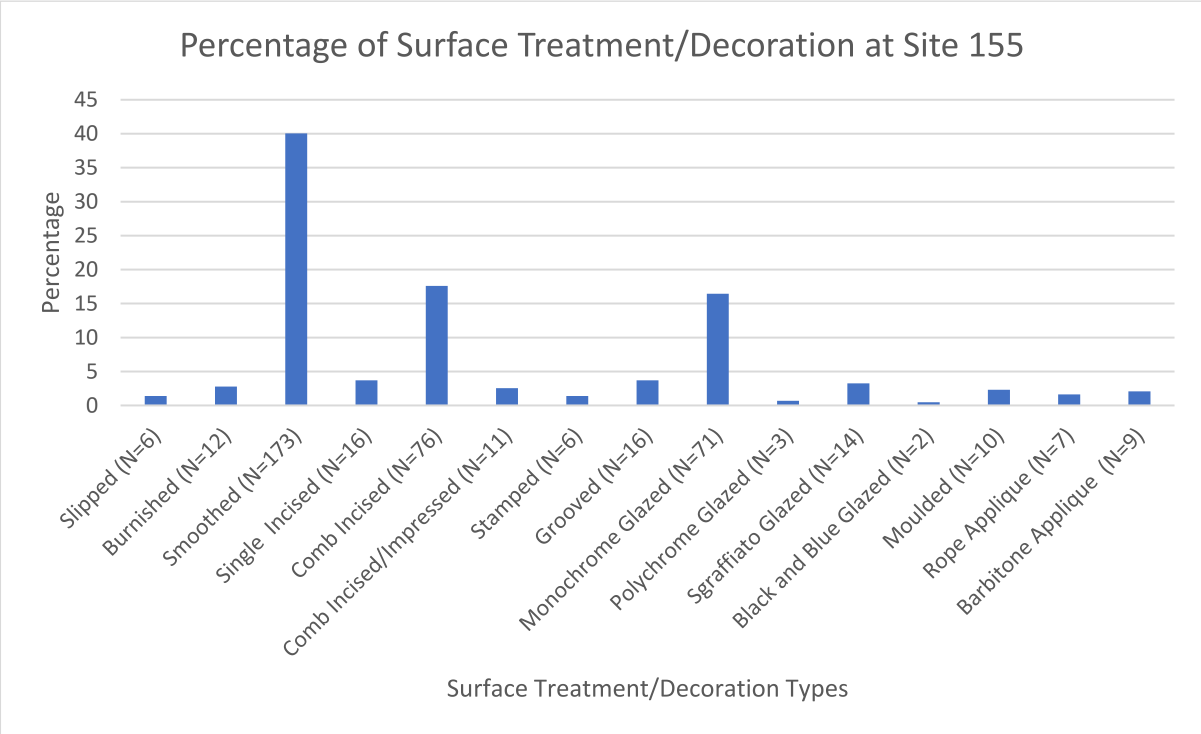

Figure 5.8: Percentage of various surface treatments/decorations present at Site 155.

At Site 155, smoothing was the most prevalent surface treatment/decoration (Figure 5.8). This is followed by comb incising and monochrome glazing. In terms of the incised decorations, comb incising was the most popular (Plate 5: 9 – 15), followed by single incised (Plate 5: 4 – 8), comb incised and impressed (Plate 5: 16; Plate 6:1 – 3), and stamped (Plate 6: 4 – 8). The designs for the incision are a mixture of straight lines, both horizontal and vertical, as well as wavy lines and zigzags. The comb incision tends to have between six and eight lines. These incisions were probably made when the clay was still wet, due to the more rounded nature of the incisions as well as the clay clustered along the incised edge. The comb impressing tends to also have around six dots, possibly using the same comb to do the incising and impressing. One piece (Plate 1:18) has impressed dots on an elongated ledged rim. Two pieces had square punctuates and one piece had tubular stamps added to the comb incised bodies. Lastly, one piece had a carved zigzag with comb incised lines (Plate 6: 1). These types of incising are very common, and it is almost impossible to assign a chronological date.

The stamped wares included both a piece with a rolling stamp with geometric impressions (Plate 6: 21), as well as pieces with stamps of dots, circles, and geometric designs (Plate 6: 4 – 8). Like the incising, stamping is common across time periods, and no dates could be assigned to this assemblage. Two types of rope appliqué were identified, the first which has one band along the shoulder of vessels, and a second which contained multiple lines of rope bands (Plate 5: 1). The bands are relatively thin, measuring one to two mm wide with long narrow slashes imitating the twisted rope (Plate 4: 8). The piece with multiple lines could possibly be an architectural fragment, due to the flatness of the other side. A few pieces of barbotine appliqué were identified (Plate 4: 22 – 25; Plate 5: 3, 5). The designs include geometric patterns of shapes, lines, and dots (Plate 4: 22). Barbotine appliqué is associated with water jars called *habb* (Sarre and Mittwoch, 1905; Reitlinger, 1951; Riis and Poulsen, 1957; Watson, 2004). Reitlinger (1951) dates these vessels to the Zangid period (1170 – 1220) and states these were made in northern Iraq and Syria, with a possible center at Mosul.

The second most prevalent group of decoration is monochrome glazed wares in green (N=49), turquoise (N=10), yellow (N=6), and blue (N=6). The yellow glaze may date to the 11th – 13th centuries (Kennet 2004), and the dark blue glaze may date to the 10th – 14th centuries (Lane 1957). EPAS 155 also had polychrome splashed wares, with green, yellow, and purple colors under a clear glaze. These date from the 10th – 13th centuries (Lane, 1957; Allan, 1991; Fehérvári, 2000; Watson, 2004). Fourteen sherds were identified as sgraffiato glazed, all had straight or curved lines carved into a white slip, and covered in dark or light green glaze (Plate 1: 2, 6, 15, 17; Plate 2:4, 9; Plate 6: 9 – 12). These are all related to the monochrome sgraffiato tradition dating from the 11th – 13th centuries (Lane, 1947; Fehérvári, 2000; Watson, 2004; Priestman, 2005). EPAS 155 has two pieces of black under blue glazed wares (Plate 1: 9; Plate 6: 13). Both have incised wavy lines or calligraphy/pseudo-calligraphy carved into the black. With the incising decoration through the black paint, this is more closely related to Iranian wares than Syrian wares (Lane 1947; Watson 2004). These pieces date to the 12th–13th centuries.

The majority of the moulded pieces have vegetal decoration, mainly arabesque motifs, with vines scrolling across surfaces rather than identifiable plants or flowers. Two types exist, one type has a vegetal motif on a plain background (Plate 6: 15) and the other has this motif on a background of small dots (Plate 6: 19, 20, 22). Mulder (2014, p. 169) states these motifs begin to predominate in the 12th – 13th centuries, and Nováček et al. (2008, p. 286) states the background of small dots is a Syrian and Iranian motif dating from the 12th – 13th centuries. Three pieces have more geometric decoration including bands (Plate 6: 14), bands with dots between the loops (Plate 6: 20), and rosettes (Plate 6: 16, 17). This type of design appears at Balis dating to the 12th – 13th centuries (Mulder 2014: Fig. 19). One piece (Plate 6: 18) could be from a pilgrim flask rather than jugs based on the shape.

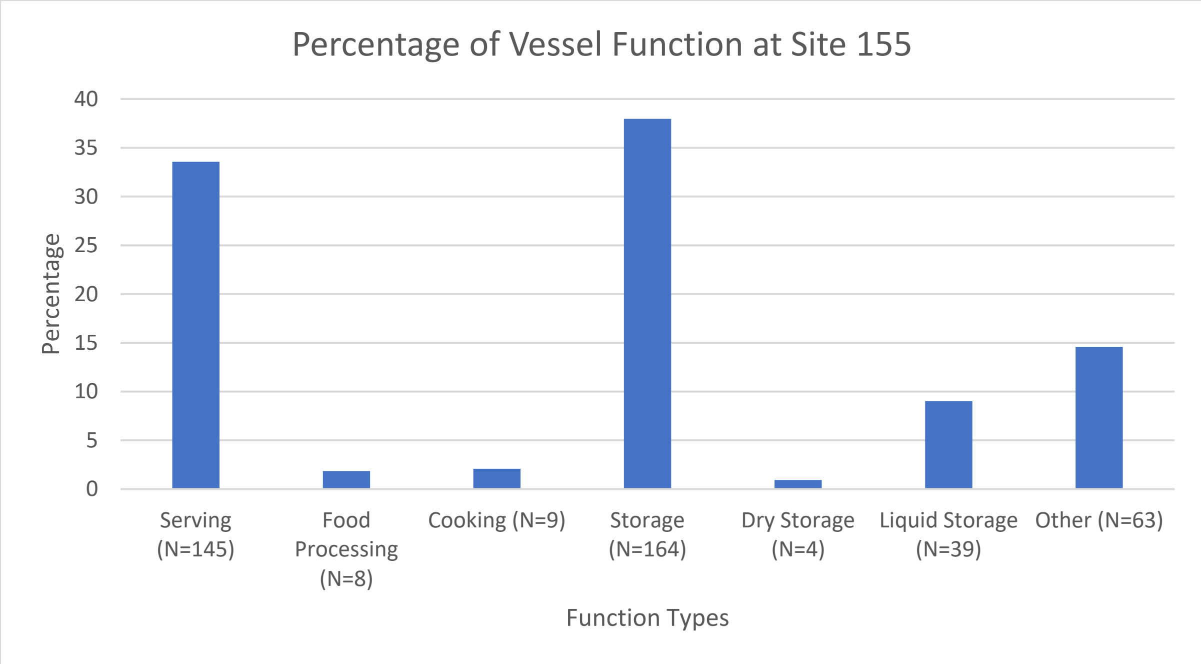

Figure 5.9: Percentage of various vessel functions at Site 155.

As shown in Figure 5.9, the largest function of these vessels is storage followed closely by serving and liquid storage. The storage vessels are mainly body sherds that are coil or wheelmade with comb incising, and appliqué. The liquid storage vessels are marked by the long neck jars which range in diameter from 6 to 27 cm. Most of these are fine and smoothed, a few are glazed or barbotine appliqué. Some of these may also been used as serving vessels. The serving vessels are marked by ringed bases and bowls, glazed and moulded decorations.

EPAS 155 matches other sites on the Erbil Plain, along with the Erbil Citadel. The dated comparanda is mainly the glazed material, with monochrome glazing dating from the 10^{th} – 15^{th} centuries, the splash glazed wares dating to the 10^{th} – 13^{th} centuries, the monochrome sgraffiato dating to the 11^{th} – 13^{th} centuries and the black under blue dating to the 12^{th} – 13^{th} centuries. The moulded pieces also date to the 12^{th} – 13^{th} centuries. The plain wares at this site match the Qal'at Ja'bar assemblages dating from the 11^{th} – 14^{th} centuries (Tonghini 1998). The variety in both wares and forms in this sample could point to a multiple phase occupation, with one phase being earlier, and one dating to the 12^{th} – 13^{th} centuries.

5.5.2 *EPAS 217 (11^{th} –13^{th} Centuries CE)*

EPAS 217 had a total of 172 sherds. Of these 89 were fine (52.5%), 42 were coarse (24%), 40 were vegetal (23%), and one was stonepaste (0.5%). They were handmade (30%, N=53), coilmade (20%, N=34), moulded (2%, N=3), and wheelmade (48%, N=82). Eighteen handles were handmade, the other 35 are handmade vessels.

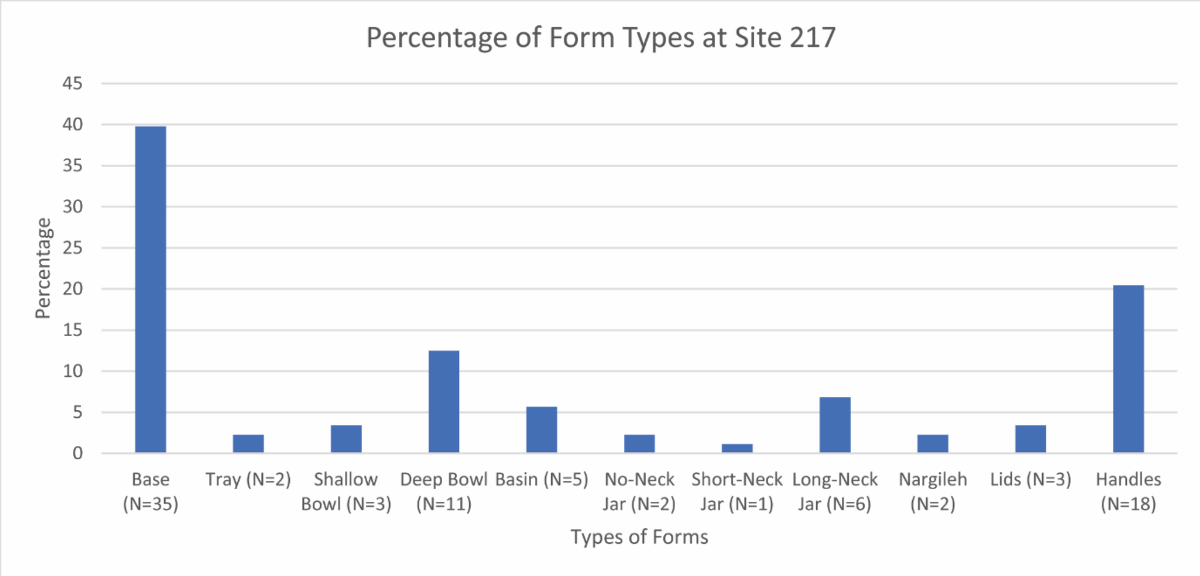

Figure 5.10: Percentage of various form types at Site 217.

In terms of forms, 88 pieces were classified into various forms (Figure 5.10). The drawings of all the forms are located in Appendix 4: bases (Plate 7:1 – 6, Plate 9:17), trays (Plate 7: 7 – 10), shallow bowls (Plate 7: 13), deep bowls (Plate 7: 11 – 12, 14 – 20, Plate 8: 1 – 6), basins (Plate 8: 2 – 5), no-neck jars (Plate 8: 7 – 8, 10), short-neck jars (Plate 8:9), long-neck jars (Plate 8: 11 – 16), and other (Plate 9: 1 – 5). The nargilehs (Plate 9: 1 – 2) are a more distinctive form due to the ledged rim and burned organic residue; however, no comparanda has been found for these pipes. Smoking via nargileh (*hooka*, *nafas*, *galyan*, *qalyan)* is not attested until the 15th – 16th centuries (Elgood, 1970; Qasim *et al.*, 2019; Semsar, 1971). The lids (Plate 9: 3 – 5) are similar to those found at Nishapur dating from the 10th – 12th centuries (Wilkinson, 1973: no. 47). The forms roughly match the assemblages at Qal'at Ja'bar dating from the 11th–14th centuries CE (Tonghini 1998: Fig. 104 – 144).

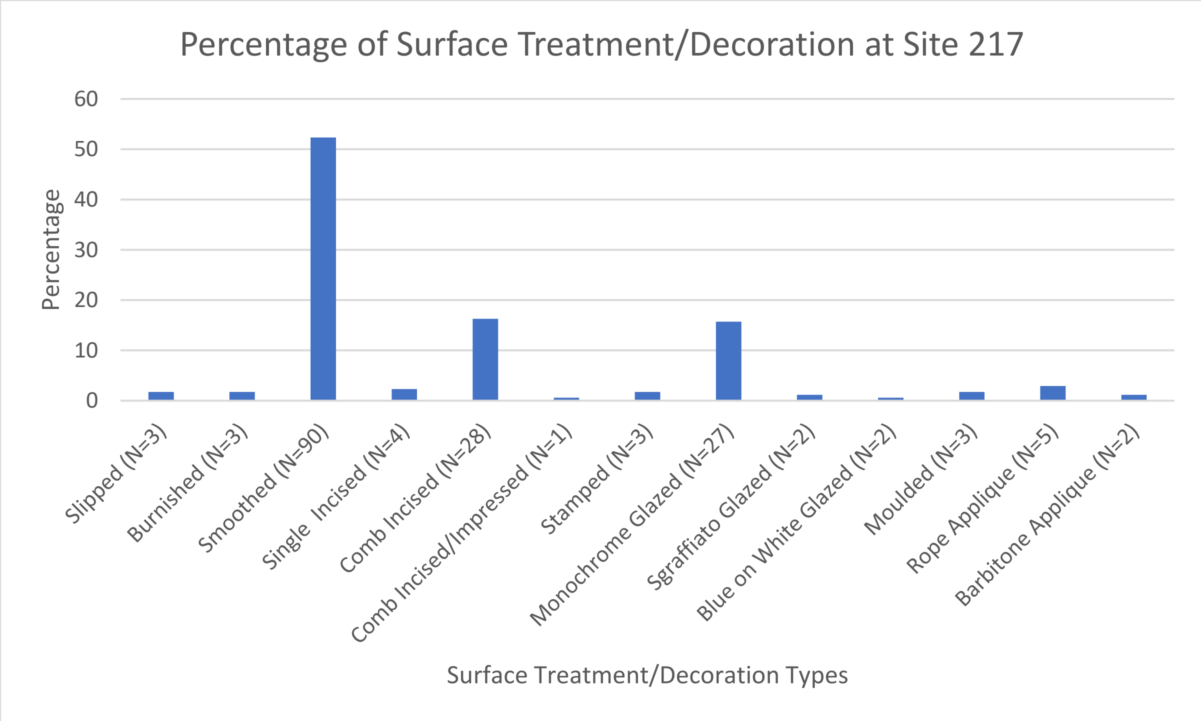

Figure 5.11: Percentages of the various surface treatment/decoration at Site 217.

As shown in Figure 5.11, smoothing is the most common surface treatment/decoration followed by comb incising in straight and wavy patterns, usually with six to eight lines (Plate 9: 8 – 12). One piece also has comb impressed dots added to the comb incising (Plate 9: 7). Lastly, some of the ledged rims have impressed comb dots on their surface (Plate 7: 13). These types of incising do not have a chronological date associated with them. EPAS 217 has three pieces of moulded ware, all body pieces. These pieces include vegetal motifs (Plate 9: 13), stars or rosettes (Plate 9: 14), and vertical lines (Plate 9: 15). The erosion and size of the pieces make the dating of them difficult, but based on the comparisons with EPAS 155, these also probably date to the 11th – 13th centuries (Mulder 2015).

The appliqué wares have various types. Rope appliqué is thicker and taller than the other EPAS sites, possibly illustrating a different date to this sample; however, no comparanda was found to establish a date. One piece is a join between two larger slabs and has impressed concentric circles along the band (Plate 9: 18). Lastly, the barbotine appliqué (Plate 8: 8; Plate 9: 19) has lines and dots added to the surface. Barbotine appliqué experienced a revival in the 12th – 13th centuries, along with this type of decoration being associated with water jars called *habb* (Sarre and Mittwoch, 1905; Reitlinger, 1951; Riis and Poulsen, 1957; Watson, 2004). Reitlinger dates these vessels to the Zangid period (1170 – 1220) and states these were made in Northern Iraq and Syria.

In terms of glazed ceramics, the largest category is monochrome glazing in yellow (N=4), turquoise (N=12), green (N=9), and blue (N=1). The yellow glaze may date to the 11th – 13th centuries (Kennet 2004), and the dark blue glaze may date to the 10th – 14th centuries (Lane 1957). The sgraffiato wares have straight and curved lines under a dark green glaze, (Plate 9: 16) similar to pieces dating from the 11th – 13th centuries (Lane, 1947; Fehérvári, 2000; Watson, 2004). EPAS 217 has one piece of blue on white glaze, a highly eroded tall ring base (Plate 9:17). The piece is slipped, with thin blue lines in a crosshatch pattern under a clear glaze. Based on the design I would place it earlier in the blue on white tradition, possibly even Abbasid blue on white (10th – 12th centuries) (Northedge 1996). EPAS 217 has one piece of stonepaste ware (Plate 9: 6) with a monochrome turquoise glaze. The piece has a carination, but is not large enough to stance, and there is no comparanda, besides stonepaste dating after the 11th centuries ((Mason and Tite, 1994b; Mason, 1995, 2001).

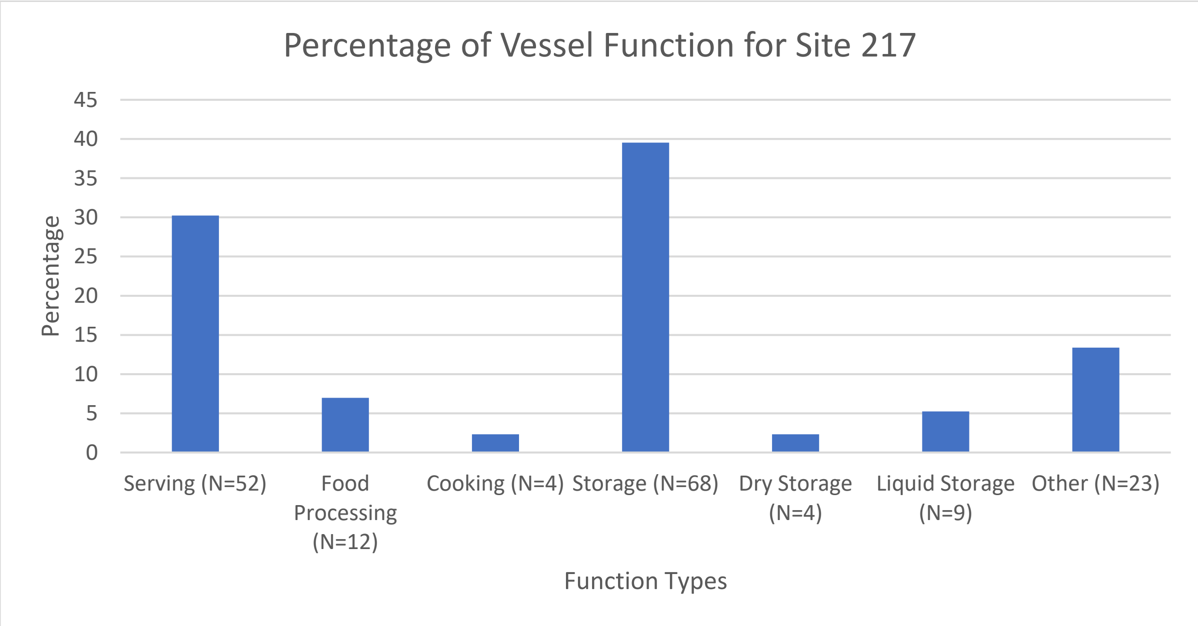

Figure 5.12: Percentage of various vessel functions for Site 217.

As shown in Figure 5.12, the largest function of these vessels is storage followed by serving and food processing. The storage vessels are mainly body sherds that are coil or wheelmade with vegetal inclusions. The dry storage vessels are marked by the no neck jars, as well as coilmade and vegetal inclusions. The incised and stamped decoration tends to be on these vessels as well. The serving vessels are marked by ringed bases and bowls, glazed and moulded decorations. The food processing vessels are trays, basins, shallow bowls, and deep bowls, all with vegetal inclusions and the majority are handmade.

The sample from EPAS 217 matches that of the other sites on the Erbil Plain and Erbil Citadel. The plain ware assemblage generally matches that of Qal'at Ja'bar dating from the 11th – 14th centuries (Tonghini 1998). The glazed wares also fall into this range with the sgraffiato, monochrome yellow, and monochrome blue wares dating from the 11th – 13th centuries. The one piece of blue on white is possibly Abbasid in date, from the 10th – 12th centuries. The moulded wares and stonepaste piece both date from the 11th to 13th centuries. This site could also be a multiple phase occupation site, with the variation in the forms and wares indicating a possible change over time.

5.5.3 *EPAS 276 (12th – 14th Centuries CE)*

EPAS 276 had a total of 76 sherds. Of these, 46 were fine (61%), 13 were coarse (17%), and 17 were vegetal (22%). They are handmade (29%, N=22), coilmade (7%, N=5), moulded (4%, N=3), and wheelmade (60%, N=46). Sixteen handles and spouts were part of the handmade assemblage, and as such six vessels were handmade.

In terms of forms, 44 pieces were classified into forms (Figure 5.13). The drawings of all the forms are located in Appendix 4: trays (Plate 10: 1), shallow bowls (Plate 10: 2 – 4), deep bowls (Plate 10: 5 – 9), long-neck jars (Plate 10: 10 – 14), and other (Plate 10:15). The forms roughly match the assemblages at Qal'at Ja'bar dating from the 11th – 14th centuries CE (Tonghini 1998: Fig. 104 – 144).

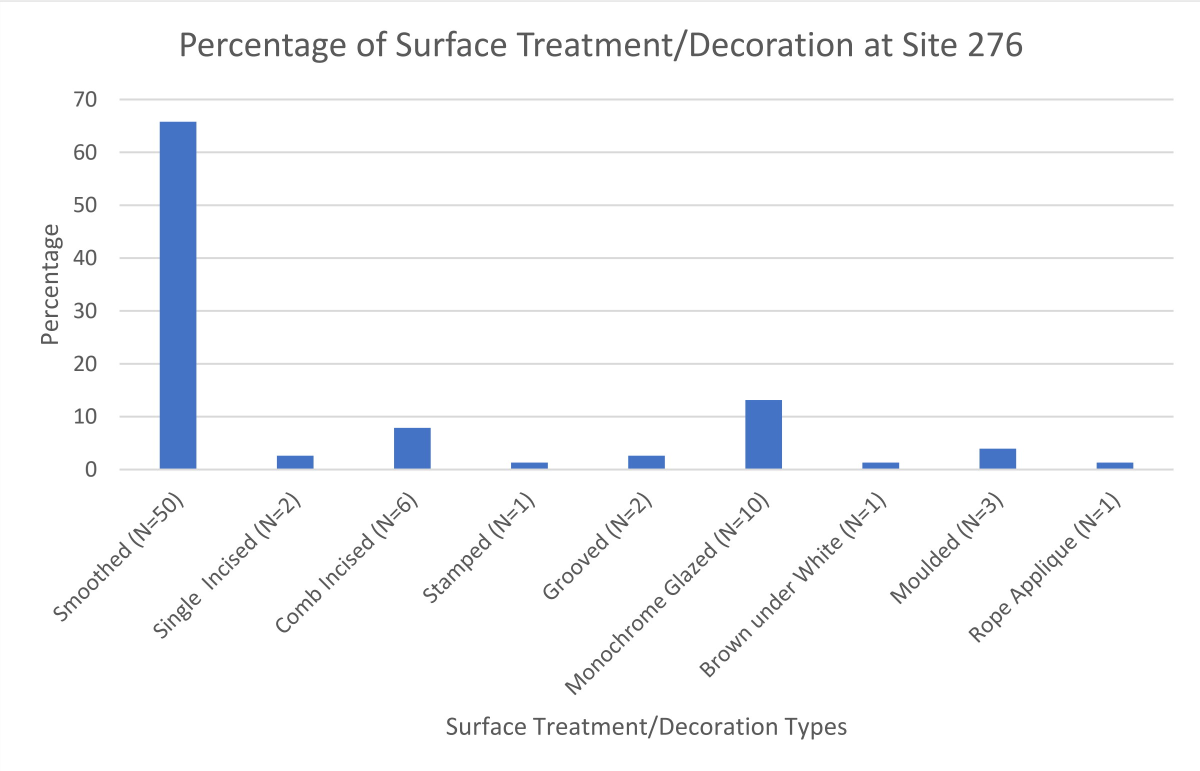

Figure 5.13: Percentage of various surface treatment/decoration at Site 276.

As shown in Figure 5.13, the majority of sherds were smoothed, followed by monochrome glazing in turquoise (N=3), green (N=6), and yellow (N=1). Kennet (2004: 44, Table 3) places this speckled yellow glazing in the 11th – 13th centuries at Kush. Comb incising in straight lines, usually six to eight lines is present, as is single incising in a deep zigzag. Moulded wares are the next most populous with one piece having horizontal moulded bands (Plate 10: 16), one piece (Plate 10: 18) having stars/rosettes on one side of the band and interwoven bands with dots between on the other side. The third piece (Plate

10: 19) has a roundel of a bird (missing its head) standing on something which is highly eroded. The background is covered in tiny dots, and it is encircled by a band with incised circles. According to Mulder (2014, p.170) birds are the most common form of animals depicted and date from the 12th – 15th centuries. This is a relatively flat piece, and as such may have been on a pilgrim flask with the roundel in the center, rather than a band of roundels along the top of a jug. The one stamped piece (Plate 10: 17) has stamps with a zigzag geometric pattern, but no comparanda was found to help date this piece. Due to the size of the stamp and the geometric pattern it is probably in the Islamic period (Simpson, personal communication 2017). The brown on white piece (Plate 10: 8) has brown vertical lines on a white slip under a clear glaze. This could be related to the slip painted wares, dating to the 11th – 13th centuries (Lane, 1947; Wilkinson, 1973; Watson, 2004). Lastly, Site 276 has one piece of a rope appliqué decoration (Plate 10: 9). This sherd has a parallel band with thin slice marks resembling the twisting of rope. The appliqué is thin much like both the 155 and 535 rope appliqué decorations.

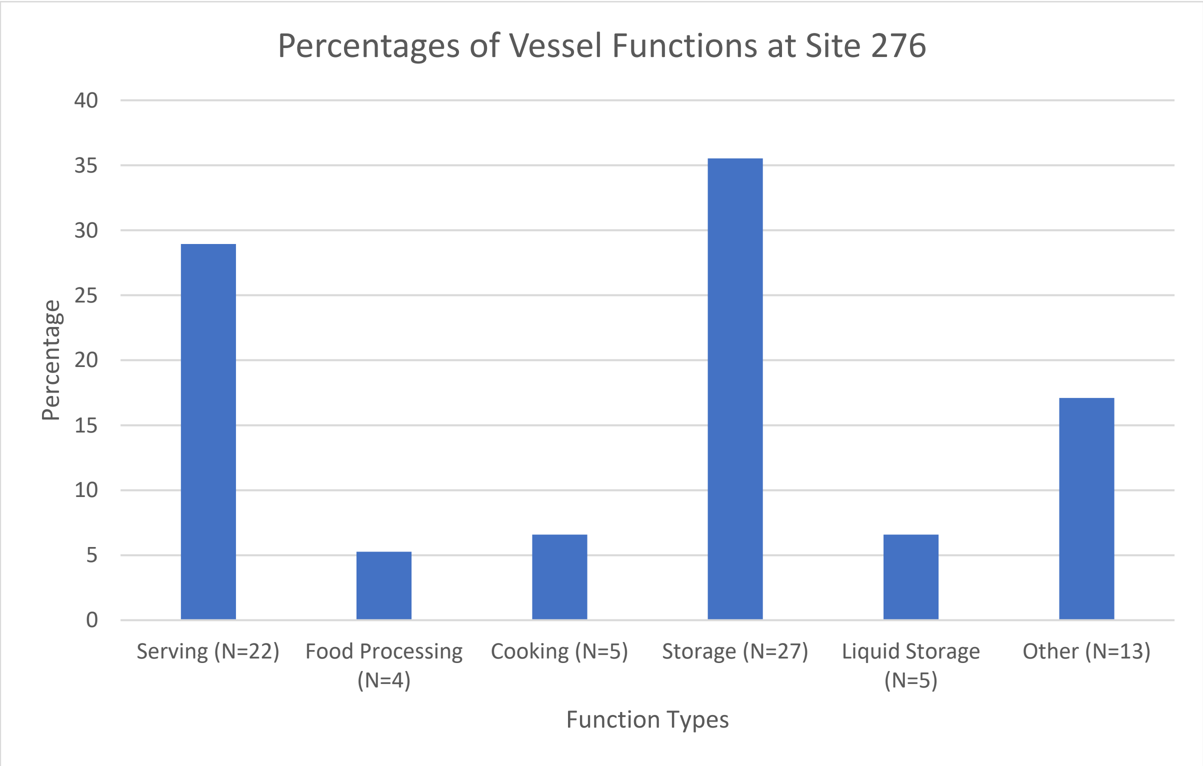

Figure 5.14: Percentages of various vessel functions at Site 276.

As shown in Figure 5.14, the largest function of these vessels is storage followed by serving and cooking. The storage vessels are mainly body sherds that are coil or wheelmade with vegetal inclusions. The incised and stamped decoration tends to be on these vessels as well. The serving vessels are marked by ringed bases and bowls, monochrome and brown on white glazing, and moulded decorations. The moulded wares are parts of smaller jugs or larger jars, probably for the serving of liquids. The moulded wares could also be used for liquid storage. Cooking functions are marked by high mineral inclusions and the presence of burning on the exterior of the vessels.

EPAS 276 matches ceramics from the rest of the Erbil Plain, Erbil Citadel, and the plain wares roughly match Qal'at Ja'bar dating from the 11th – 14th centuries (Tonghini, 1998; Nováček, 2008). The slip painted piece as well as the yellow glazed piece are dated to the 11th – 13th centuries, and the moulded wares with birds date from the 12th – 15th centuries. This site is more than likely a one period site based on the relatively similar forms, fabrics, and surface treatments present.

5.5.4 *EPAS 381 (11th – 13th Centuries CE)*

EPAS 381 had a total of 91 sherds. Of these, 62 were fine (68%), 19 were coarse (21%), and 10 were vegetal (11%). They are handmade (21%, N=19), coilmade (15%, N=14), moulded (1%, N=1), and wheelmade (63%, N=57). Handles and spouts account for 10 of the 19 handmade forms, so handmade vessels are 10% of the entire sample.

The 91 sherds were classified into various form categories (Figure 5.15). The drawings of all the forms are located in Appendix 4: shallow bowls (Plate 11: 1 – 2), deep bowls (Plate 11: 3 – 4), basins (Plate 11: 5 – 6), no-neck jars (Plate 11: 7), long-neck jars and (Plate 11: 8 – 12). The forms do roughly match the assemblages at Qal'at Ja'bar dating from the 11th – 14th centuries CE (Tonghini 1998: Fig. 104 – 144).

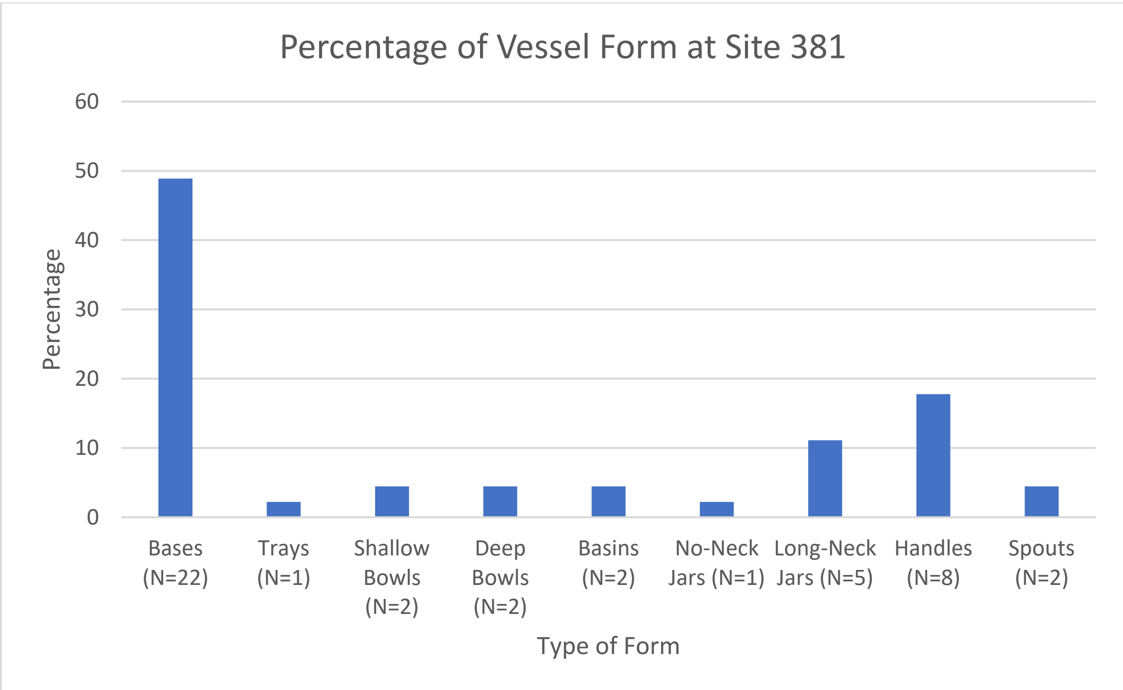

Figure 5.15: Percentage of various vessel forms at Site 381.

In terms of decoration, the majority were smoothed, followed by monochrome glazing in turquoise (N=6), and green (N=4), and comb incising (Figure 5.16). The one piece of comb incised/impressed has tubular stamps above an incised line (Plate 11: 14). This type of incising has existed from pre-

Islamic times to the Ottoman period but seems to reach a height in the early Islamic period (Nováček, personal communication, 2018). The four moulded wares are all from jars, albeit of varying sizes. One piece (Plate 11: 18) has vertical parallel lines and a handle. The second piece (Plate 11: 16) has vegetal motifs on a background of roundels. The third piece (Plate 11: 15) has stars/rosettes on one side of the band and interwoven bands with dots on the other, like the one piece from EPAS 276. The fourth piece (Plate 11: 17) is divided into two registers above the band between hemispheres. The lower register has five lines of stars/rosettes. The upper register has vegetal motifs on a background of roundels. This decoration is on the upper portion of the body. This pieces with the filled background are similar to the Syrian tradition of moulded wares dated from the 12th – 13th centuries (Mulder 2015, 169; Nováček 2008b, 286).

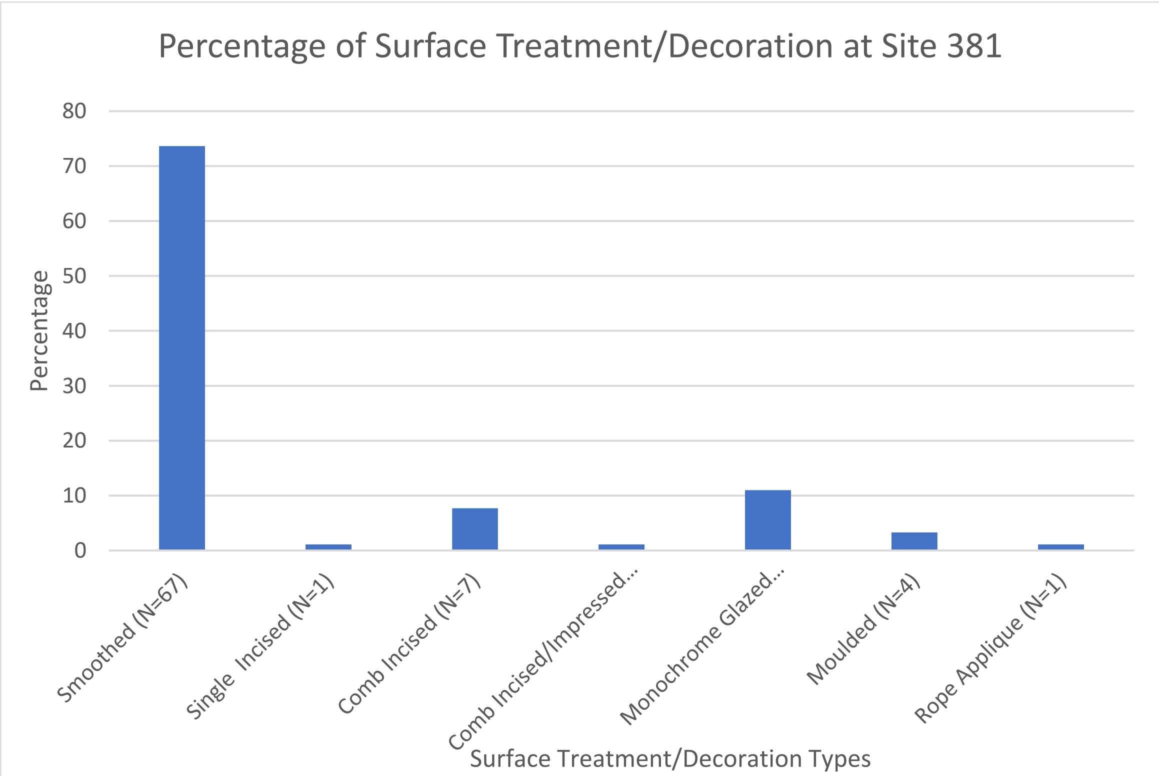

Figure 5.16: Percentage of various surface treatment/decoration types at Site 381.

As shown in Figure 5.17, the largest function of these vessels is storage followed by serving and food processing. The storage vessels are mainly larger flat or protruded bases with a diameter of ca. 10cm. They also tend to be coil or handmade, of a coarse fabric. The incised decoration tends to be on these vessels as well. The serving vessels are marked by ringed bases, monochrome glazing, and moulded decorations. The moulded wares are parts of smaller jugs or larger jars, probably for the serving of liquids. The moulded wares could also be used for liquid storage. Food processing vessels are marked by basins and trays, along with shallow and deep carinated bowls. These are all vegetal tempered and handmade, and diameters are between 15 and 20 cm.

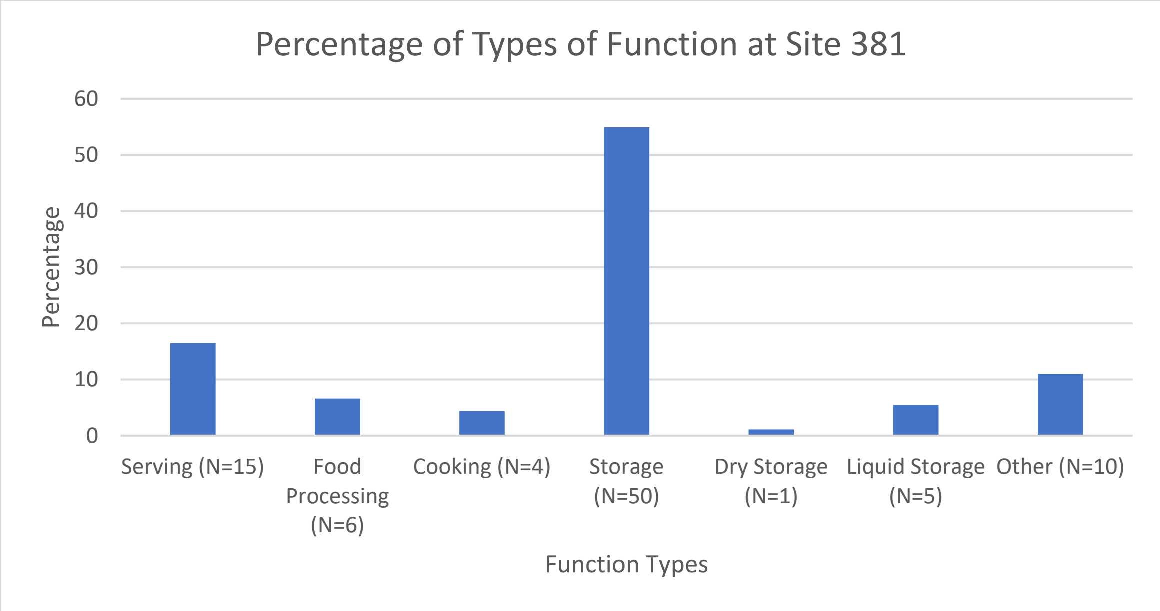

Figure 5.17: Percentage of various vessel functions at Site 381.

EPAS 381 does not have many exact comparanda; however, the large portion of sherds match the rest of the Erbil Plain, the Erbil Citadel, and Qal'at Ja'bar (11th – 14th centuries)(Nováček, 2008; Tonghini, 1998). The placement of the moulded designs on the upper parts of the shoulder and the vegetal motifs on roundels date from the 12th – 13th centuries. This site is more than likely a one period site based on the relatively similar forms, fabrics, and surface treatments present.

5.5.5 *EPAS 453 (11th – 13th Centuries CE)*

EPAS 453 had a total of 50 sherds. Of these, 29 were fine (58%), 13 were coarse (26%), and eight were vegetal (16%). The sherds were handmade (8%, N=4), coilmade (6%, N=3), and wheelmade (86%, N=43). Three of the four handmade sherds were handles, leaving one handmade vessel

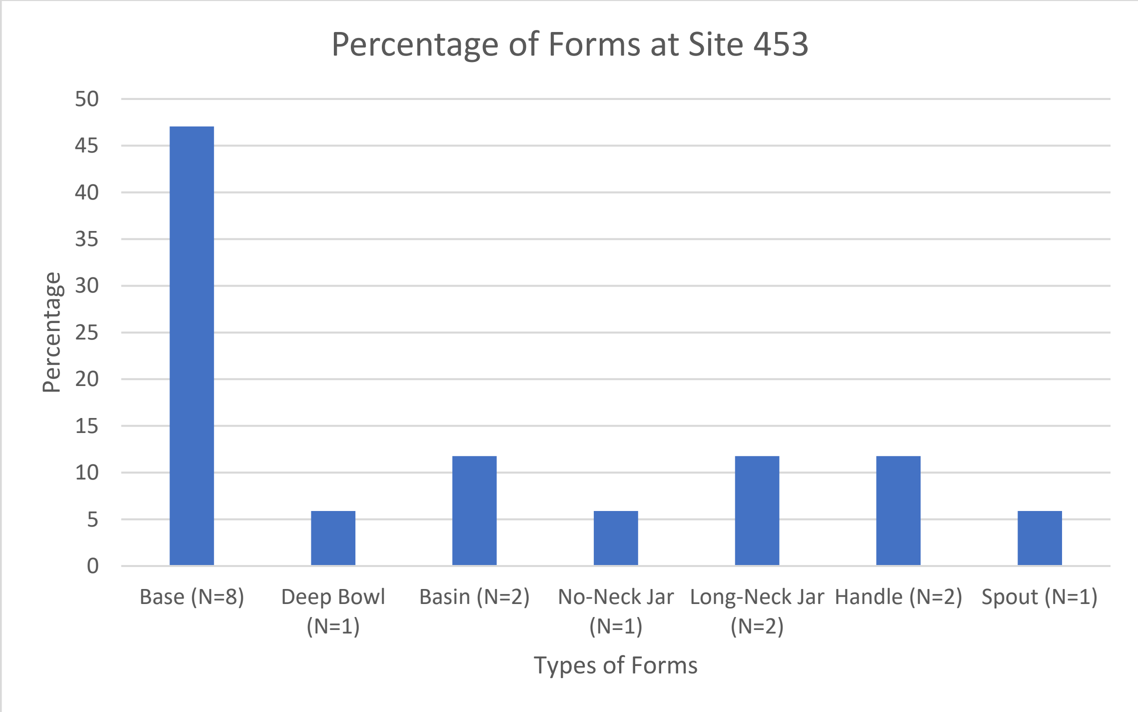

Figure 5.18: Percentage of various forms at Site 453.

The 50 sherds were classified into various forms (Figure 5.18). The drawings of all the forms are located in Appendix 4: bases (Plate 12: 1 – 4), deep bowls (Plate 12: 5), basins (Plate 12: 7 – 8), no-neck jars (Plate 12: 6), long-neck jars (Plate 12: 9 – 10), and other (Plate 12: 11).

In terms of decoration, the majority were smoothed (78%, N=39), followed by monochrome glazed (8%, N=4) in turquoise (N=3) and blue (N=1), the rest were incised (8%, N=4), black slipped (2%, N=1), burnished (2%, N=1), and sgraffiato glazed (2%, N=1). The blue glazed piece is a spout, possibly for a lamp as the tip of the spout does have burning present (Plate 12: 15). The sgraffiato glazed piece has vertical lines under a green glaze. No direct comparanda was found for this assemblage based on forms or surface treatment/decoration; however, it does generally match the other sites on the Erbil Plain, the Erbil Citadel (Nováček 2008b), and Qal'at Ja'bar (Tonghini 1998).

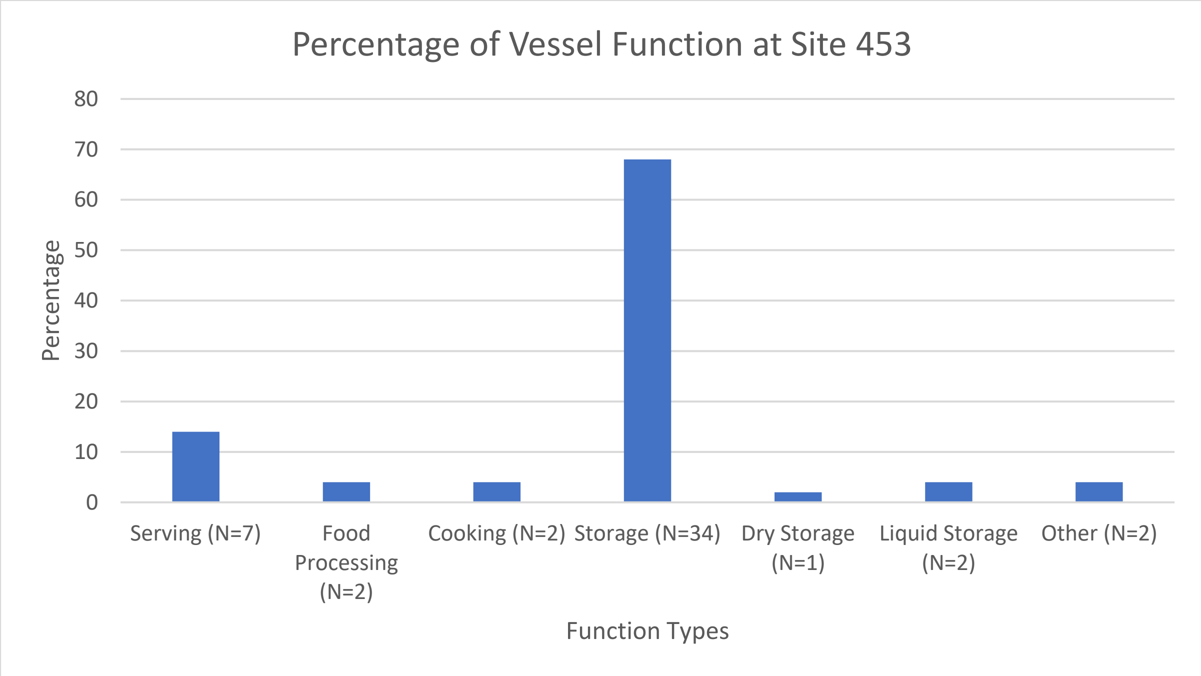

Figure 5.19: Percentage of various vessel functions at Site 453.

As shown in Figure 5.19, the largest function is storage. This is due to the flat bases with larger diameters indicating larger vessels, as well as the coilmade and handmade nature of these sherds. The two food processing vessels are vegetal tempered basins, with squared rims. The serving vessels at site 453 are made of fine ware, have short ring bases, are glazed, or smoothed. The two liquid storage vessels (Plate 12: 9 – 10) have long necks, but their rims are six and eight centimetres, which may mean they could be used for serving as well.

EPAS 453 does not have many comparanda with other sites, only the sgraffiato ware dating from the 11th – 13th centuries is present. However, it does match the other sites on the Erbil Plain, the Erbil Citadel, and Qal'at Ja'bar (11th – 14th centuries). Like EPAS 519 and 535, this is a single period site based on the relatively similar forms, fabrics, and surface treatments present.

5.5.6 *EPAS 519 (12th – 14th Centuries CE)*

EPAS 519 had a total of 30 sherds. Of these 25 were fine (83%), three were coarse (10%), and two were vegetal (7%). The sherds were handmade (20%, N=6), coilmade (3%, N=1), and wheelmade (77%, N=23). The handmade sherds were handles and spouts, so the vessels themselves were coilmade or wheelmade. In terms of forms, 21 sherds were categorized, there were 11 bases (52%), three deep bowls (14%), one long neck jar (5%), three handles (14%) and three spouts (14%) (Plate 13: 1 – 12).

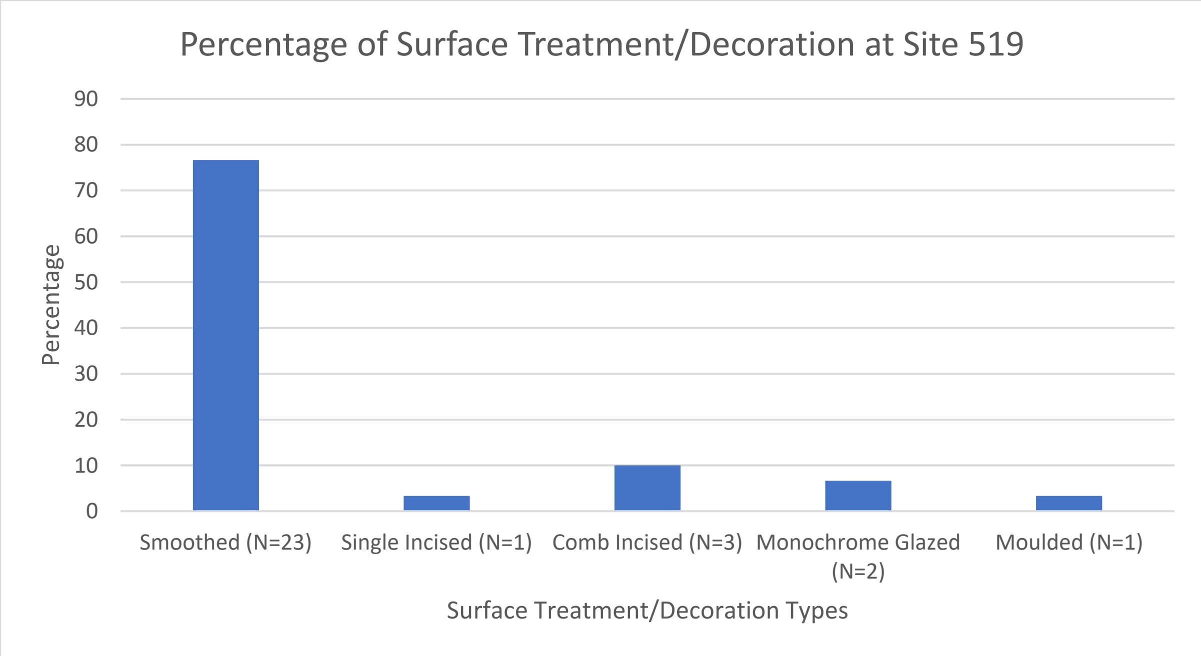

Figure 5.20: Percentage of various surface treatments/decoration at Site 519.

As shown in Figure 5.20, smoothing is the most common surface treatment/decoration. The two monochrome glazed pieces were both turquoise glazed. The one moulded piece (Plate 13: 9) has decoration below the neck join and consists of two roundels. One roundel has incised dots which are possibly rosettes, and the second has a fleurs-de-lys type motif surrounded by a ring. Between these roundels are dots and a solid triangle. This could be part of Mulder's heraldic decoration type (2014, p.174) dating to the 13th–14th centuries.

In terms of the function of various ceramics at this site, the majority were probably used for storage (56%, N=17), based on the flat bases measuring five to ten cm in diameter, indicating a larger vessel. Serving vessels (20%, N=6) are marked by the fineness of the fabric, glazing, moulding, and smoothing, as well as deep bowls. One handle was identified as having a cooking function, based on the high mineral temper and firing present. Two pieces (Plate 13: 8, 10) were identified as a liquid storage jar due to the long neck form. This could have also been used for serving due to the diameter of the rim (6 cm). The rest of the pieces are classed as other (Handles/spouts; 16%, N=5).

EPAS 519 does not have many exact pieces for comparanda both in form and ware types, but generally matches the other sites on the Erbil Plain, the Erbil Citadel (Nováček et al. 2008), and Qal'at Ja'bar (Tonghini 1998). Because of the rough match with Qal'at Ja'bar, these ceramics date between the 11th – 14th centuries, and with the moulded piece and turquoise glazing, possibly dates to the later part of this range, namely the 12th—14th centuries This site is more than likely a one period site based on the relatively similar forms, fabrics, and surface treatments present.

5.5.7 *EPAS 535 (12th – 14th Centuries CE)*

EPAS 535 had a total of 34 sherds. Of these 31 were fine (91%), one was coarse (3%) and two were vegetal (6%). The sherds were handmade (29%, N=10), coilmade (18%, N=6), and wheelmade (53%, N=18). Nine of the ten handmade sherds were handles. In terms of forms, 21 pieces were broadly categorized, nine pieces were handles, and eight pieces were bases, and four pieces were rims, but were too small to stance and therefore no forms were identified (Figure 13: 13 – 17).

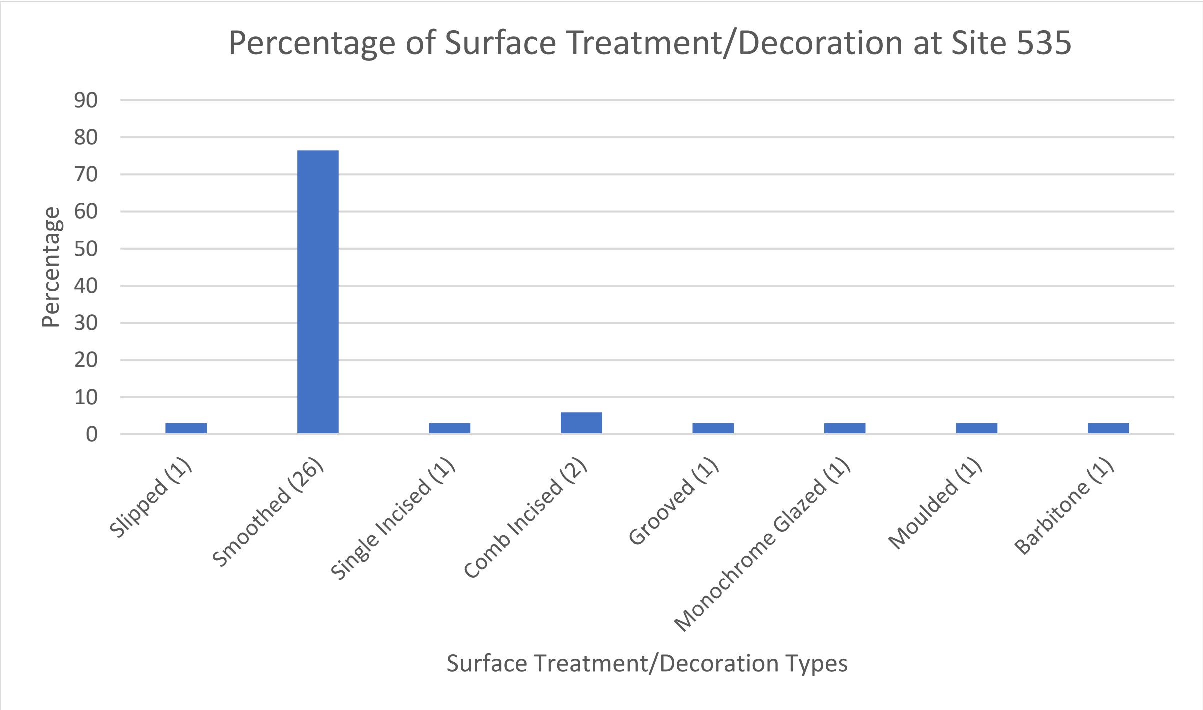

Figure 5.21: Percentage of various surface treatments/decorations at Site 535.

As shown in Figure 5.21, smoothing is the most common surface treatment/decoration. The one monochrome glazed piece has eroded turquoise glaze. The one moulded piece has vegetal arabesques on a background of small dots (Plate 13:17). This piece has been placed in a Syrian tradition of moulded wares dated from the 12th – 13th centuries (Mulder 2015, 169; Nováček 2008b, 286).

In terms of the function of the various ceramics at this site, the majority were probably used for storage, based on the handmade/coilmade method of the body sherds, possibly indicating larger vessels. The one piece of glazed ware was on a thick (1 cm) sherd, leading to the hypothesis that this vessel was used for storing items, possibly liquids. One piece was identified as a cooking function based on the mineral inclusions in the fabric. Eight sherds were identified as having a serving function, based on their very fine fabric as well as their decoration. One was grooved and the other was moulded, the remaining three pieces were parts of long neck jars, possibly of bottles. The rest are categorized as other functions (handles).

EPAS 535 does not have many exact pieces for comparanda but does tend to match the other sites from the Erbil Plain, the Erbil Citadel (Nováček 2008b), and Qal'at Ja'bar (Tonghini 1998). This site is more than likely a one period site based on the relatively similar forms, fabrics, and surface treatments present.

5.5.8 *Nippur (12th – 15th Centuries CE)*

Nippur had a total of 121 sherds. Of these 70 were fine (58%), 36 were coarse (30%), six were vegetal (5%), seven were stonepaste (6%), and two were porcelain (1%). The sherds were handmade (30%, N=37), coilmade (7%, N=8), moulded (1%, N=1), and wheelmade (62%, N=75). Six of the handmade sherds were handles/spouts/lids, and so there are 31 handmade vessels.

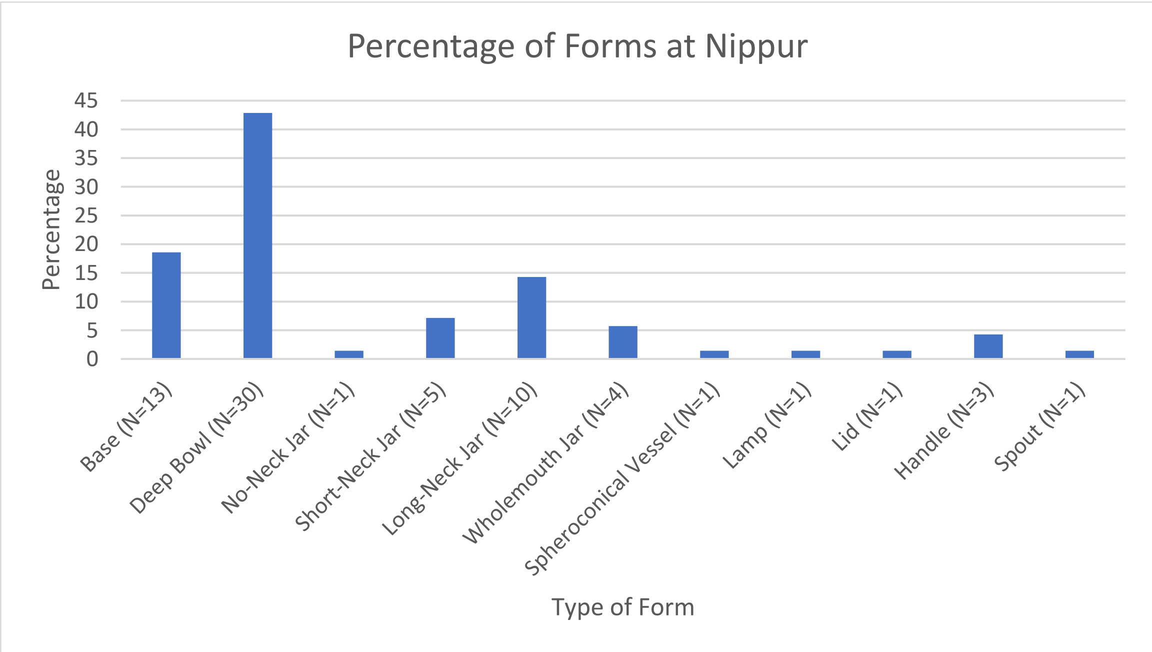

Figure 5.22: Percentage of various forms at Nippur.

At Nippur, 70 sherds were classified into various forms (Figure 5.22). The drawings of all the forms are located in Appendix 4: bases (Plate 14: 1 – 13), deep bowls (Plate 15: 1 – 11, Plate 16: 1 – 7; Plate 17: 1 – 8, Plate 18: 1 – 3), no-neck jars (Plate 18: 4), short-neck jars (Plate 18: 5 – 8, Plate 19: 1), long-neck jars (Plate 19: 2 – 12), holemouth jars (Plate 20: 1 – 5), and other (Plate 20: 6 – 7). These do not have much comparanda, but are similar to vessels published from Wasit (Safar 1945), Quseir al-Qadim (Whitcomb & Johnson 1979), and Adam's survey (Adams 1981). In terms of the special forms, spheroconical vessels are the most recognizable due to their restricted necks and very thick walls (Plate 21: 1). They date from the 10th – 14th centuries (Ettinghausen 1965). The lamp does not have a spout (Plate 20: 6), and as such is probably the portion of the lamp that holds the oil. It has no comparanda for dating. The lid (Plate 20: 7) is similar to those found at Nishapur dating from the 10th – 12th centuries (Wilkinson, 1973: no. 47).

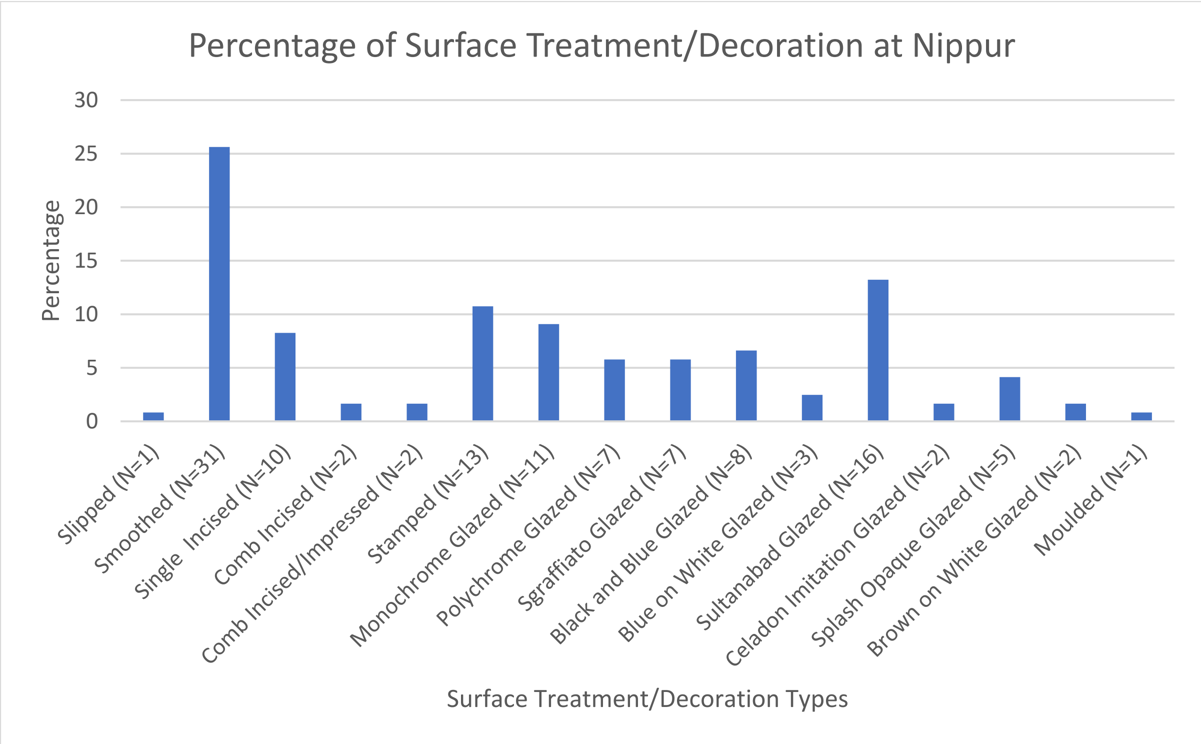

Figure 5.23: Percentage of various types of surface treatments/decorations at Nippur.

As shown in Figure 5.23, smoothing is the most common surface treatment, followed by Sultanabad glazed, stamped, and monochrome glazed. Incised sherds are both single and comb incised, as well as impressed. They are cross hatched (Plate 19: 8, Plate 20: 4), wavy incisions, straight incisions, and possible vegetal motifs (Plate 20: 2). One body sherd, with a handle, and incised wavy lines around the shoulder carination (Plate 19: 10) has parallels with sherds from Wasit (Safar 1945: Fig. 15: no. 14), but the form is very common. Two pieces are impressed, one with comb incising and impression (Plate 21: 5), and one with cross hatching (Plate 21: 4). These have parallels at Samarra (Iraqi Government, Department of Antiquities, 1940: pls. 43, 44), Hama (Riis and Poulsen, 1957, Figs. 93 -- 4), and Wasit (Safar, 1945: Fig. 15, no.14), all dating to the 12th –14th centuries. One piece had an impressed rim (Plate 18: 6), which is related to one published by Whitcomb and Johnson (1982: Pl. 46: I, L, N, P), from Quseir al-Qadim, dating to the 14th centuries. Thirteen sherds had stamped designs in a variety of geometric and possibly vegetal motifs (Plate 21: 7 – 17). The geometric motifs consist of cross hatching, straight lines, curved lines, dots, and shapes with dots inside them (Plate 21: 8 – 9, 12 – 13, 15 – 17). The vegetal motifs include four possible flowers (Plate 21: 7, 10 – 11, 14). Stamping exists throughout time, and as such no date has been assigned to this assemblage. Nippur has one piece of spheroconical vessel (Plate 21: 1), with incised lines in a possible pseudo-calligraphic design. As stated above, these vessels can date between the 10th and 15th centuries.

Many of the pieces from Nippur were glazed. In terms of monochrome glazing, colors ranged from turquoise (N=6), brown (N=2), blue (N=1), and green (N=2). Two of the turquoise glazed pieces have a ridged surface which was covered in the glaze (Plate 22: 2 – 3), leading to darker lines appearing on the surfaces. Watson (2004, p. 454) states that ribbed walls covered in a glaze is derived from Chinese celadon dating from the 13th century onwards. This is more identifiable in the Rayy piece (below), but the pieces at Nippur could be related to this tradition. In terms of the polychrome glazing, two sherds have dark brown spots under a yellowish glaze (Plate 21: 4), and the rest have yellow, green, and brown pigments under a clear glaze (Plate 14: 1, Plate 21: 5). These are related to the main splash glazed decoration, dating from the 11th – 13th centuries (Lane, 1947; Gibson, Armstrong and McMahon, 1998; Fehérvári, 2000; Watson, 2004) .

The sgraffiato wares have three main categories, incised lines under a monochrome glaze, incised lines under a splash glaze, and comb incised lines under a monochrome glaze. The first category has curved lines, and possible calligraphic or pseudo-calligraphic writing under a green glaze (Plate 14: 3, 7; Plate 15:2, Plate 22: 8 – 10). These belong to the monochrome sgraffiato tradition, dating from the 11th – 13th centuries (Lane, 1947; Fehérvári, 2000; Watson, 2004). The second category has straight, curved, and possible calligraphic or pseudo-calligraphic incising (Plate 22: 6 – 7), under green and yellow splash glaze. These are all related to the splash glazed sgraffiato tradition (8th – 13th centuries), and date to the earlier part of this period (Sarre, 1925, p.76; Whitehouse, 1979, p.59). The last type (Plate 19: 10) has comb incised lines on the exterior shoulder of a jar and is green glazed (cf. Rosen-Ayalon, 1974, p.151; Pl. 94A). This piece is dated earlier, possibly Abbasid (9th – 11th centuries; Lane, 1947, p.12).

The black under blue glazing at Nippur has thick and thin black lines under a turquoise glaze. Most of the designs are geometric (Plate 14: 5, Plate 15: 2, 11; Plate 18: 2, Plate 22: 11 – 15) including a checkerboard design (Plate 22: 12), and vegetal motifs. These wares are comparable with the black under blue wares dated from the 12th – 14th centuries. The decorations match those in Safar (1945) showing connections with other sites in the south. Safar dates these wares to the Ilkhanid/Post-Ilkhanid periods. These wares are more related to the so called ‘Raqqa wares’ in both decoration and body, than the Iranian ‘Silhouette wares’ (Safar, 1945; Lane, 1957; Fehérvári, 2000; Watson, 2004). They are made in both earthen and stonepaste fabrics.

Blue on white ware is present at Nippur, one sherd (Plate 22: 14) has blue lines and clusters of four dots under a clear glaze. This is similar to a sherd in the Royal Ontario Museum (909.42.7) dating to the 15th century from Damascus. However, this piece is stonepaste, whereas the example from Nippur is on earthenware, possibly moving the date a bit earlier.

The largest glazed category at Nippur consists of the Sultanabad wares. Sultanabad ware is known for its blue and black painting under a clear or greenish glaze and dates from the 13th – 14th centuries (Safar, 1945; Lane, 1957; Adams, 1981; Fehérvári, 2000). Both the clear and greenish glazes are present at Nippur. The clear glazes have geometric motifs in black and blue (Plate 14: 6, 12; Plate 15: 8; Plate 22: 17, 21), possible animal motifs (Plate 14: 13), and lines and dots (Plate 22: 18). The greenish glazes have geometric motifs in black and blue (Plate 14: 8; Plate 15: 9; Plate 17: 2) and vegetal motifs (Plate 14: 9; Plate 15: 9, 10; Plate 18: 3; Plate 22: 15, 19, 20). These match Adams (1965) Ilkhanid Type A, and post-Ilkhanid Type C categories, and Safar (1945) Level II, Ilkhanid/Post-Ilkhanid categories. Both date the assemblage to the 12th–14th centuries (Safar, 1945; Adams, 1965). Sultanabad ware can also be found on stonepaste. The stonepaste designs include black lines in a crosshatch pattern with blue dots (Plate 11: 16), and geometric shapes in black and blue (Plate 15: 6). These wares all have parallels with the site of Wasit, dating to the Ilkhanid and post-Ilkhanid periods (Safar, 1947, Fig. 18 – 21). They also have some similarities with polychrome underglaze painted wares at Raqqa dating to the 13th century (Jenkins, 2006, p.159 – 161). Another related sherd (Plate 15: 7) has clusters of black dots under a clear glaze, this could be related to a Sultanabad piece in the Tareq Rajab Museum from Iran dating to the 13th – 14th centuries (Féhérvári 2000: No. 286, CER1767TSR).

Splash opaque glaze has pigments in black and blue, both geometric and vegetal under an opaque white glaze. Two sherds (Plate 14: 2, 4; Plate 17: 1) with blue and black spots under a clear glaze matches a couple sherds from the British Museum (1914,1010.6; 1914,1010.8) dating to the 9th—10th centuries from Antinoupolis. This coloring is also similar to a vessel in Jenkins (1983: 6: no. 4) and a sherd in the Royal Ontario Museum (990.152.251), dating to the 9th – 10th centuries Iraq. This type of glazing also is found with a light blue pigment on the rim and down the body (Plate 15: 4). This sherd has no comparanda but based on the color and pattern of the glaze, it probably dates to the 11th – 13th centuries.

Brown on white glazing, may be related to the slip painted wares of the earlier Abbasid, but the decorations on the sherds from Nippur have not been found in the literature. One sherd (Plate 22: 25) has clusters of four brown dots and a brown scalloped painting on the rim under a clear glaze, the dots are similar to the blue on white and black dots discussed above. The other sherd (Plate 22: 26) has brown or black paint in triangular spots with curved lines under a clear glaze.

Two pieces of porcelain from Nippur were recovered. The first is blue on white porcelain (Plate 14: 10), with a blue floral pattern. Blue on white porcelain was made in China in the eighth century and exported to Western Asia until the 16th century. The height of the export/import was during the Song and Yuan Dynasties (960 – 1368) but was lessened under the Ming (1368 – 1644) (Kessler 2012). This ware is very common in terms of motif and form, and as such a date is hard to attribute. The second (Plate 14: 11) has a celadon glaze on the exterior and a blue line on the interior. The celadon color matches that of the Yaozhu potters who adopted the style of the Yue celadon, with its olive-green coloring. The celadon glazing reached its height during the Song Dynasty (960 – 1279) (Gompertz 1980). The piece strongly resembles porcelain from Jingdezhen, made in 1751 as illustrated by sherds belonging to the Nanking Cargo (Howard 1997: 29, cat. 19). The earlier celadons do not seem to have a blue and white component on the interior.

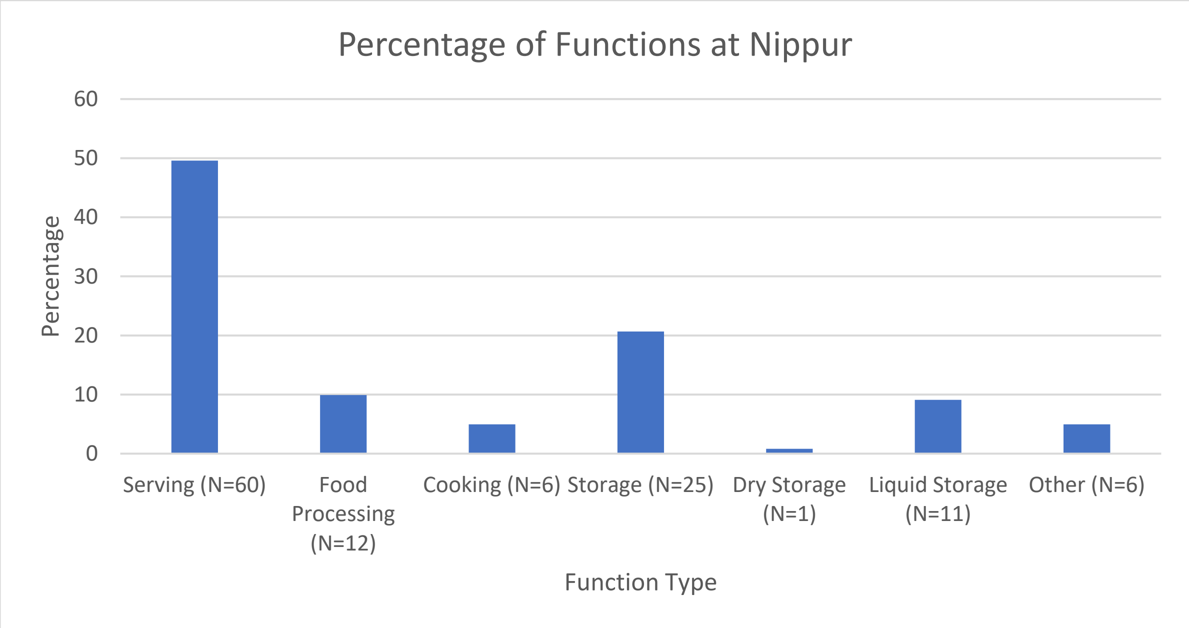

Figure 5.24: Percentages of different vessel functions at Nippur.

As seen in Figure 5.24, serving is the most common function established at Nippur, storage is second, and food processing is third. The high percentage of serving vessels may be due to the presence of the stonepaste wares, porcelains, and the amount of glazed wares. These assemblages were sampled from the excavations and brought back to the Oriental Institute for further study, skewing the sample. This is also seen in the fact the publication records many more coarse and vegetal fabrics that were not seen in the museum. The majority of the storage vessels have vegetal inclusions, are coilmade or handmade, and have been stamped. The food processing function was determined by deep handmade, coarse bowls, some are incised, but the majority are smoothed.

Gibson, Armstrong, and McMahon (1994) date Nippur Area M to between 1250 and 1450 based on comparanda in the ceramics with Wasit (Safar 1945), and two coins, one dated to 1316 – 1335 and another to 1418 – 1452. The ceramics date to this time range, with a few pieces dating a bit earlier. The splash opaque glazed wares (9th – 11th centuries), the sgraffiato wares (11th – 13th centuries), the comb incised and green glaze sherd (9th – 11th centuries) date a bit earlier and may be an earlier occupation on or near the Ilkhanid occupation. Down the canal there is a recorded Abbasid site, and these pieces may be related to that occupation of Nippur. The Ilkhanid occupation is dated by incised sherds (12th – 14th centuries), black under blue glazed wares (12th – 14th centuries), Sultanabad wares (12th – 14th

centuries), the ribbed glazed sherds (13th – 15th centuries), stonepaste ware (13th – 15th centuries), and porcelain (11th – 19th centuries). Nippur has large connections with the rest of Western Asia and area M is a single occupation Ilkhanid phase with strong links to Wasit, another Ilkhanid center. Nippur also has buff ware ceramics imitating designs found on stonepaste, showing a possible local imitation of finer wares.

5.5.9 *Hasanlu (12th – 14th Centuries CE)*

Hasanlu had a total of 64 sherds. Of these, 29 were fine (25%), 8 were coarse (13%), and 27 were stonepaste (42%). The sherds were handmade (2%, N=1), coilmade (2%, N=1), moulded (2%, N=1), and wheelmade (94%, N=61). Twelve sherds were categorized into vessel forms (Figure 5.25). The drawings of all the forms are located in Appendix 4: bases (Plate 23.1), deep bowls (Plate 23: 2 – 6), long-neck jars (Plate 23: 7 – 9), and other (Plate 23: 10 – 11). The lamp (Plate 23: 11) does not have a spout and as such is probably the portion of the lamp that holds the oil. It resembles the one from Nippur but has no comparanda for dating. The pilgrim flask (Plate 23: 10) has flattened sides and broken loop handles but unlike most flasks, this is not decorated. This type of flask is similar in shape to one in the Los Angeles County Museum of Art (M.2002.1.140), from Syria dating to the mid-12th century. The everted neck, circular body, and placement of handles are all similar, but the piece in the museum is stonepaste and highly decorated.

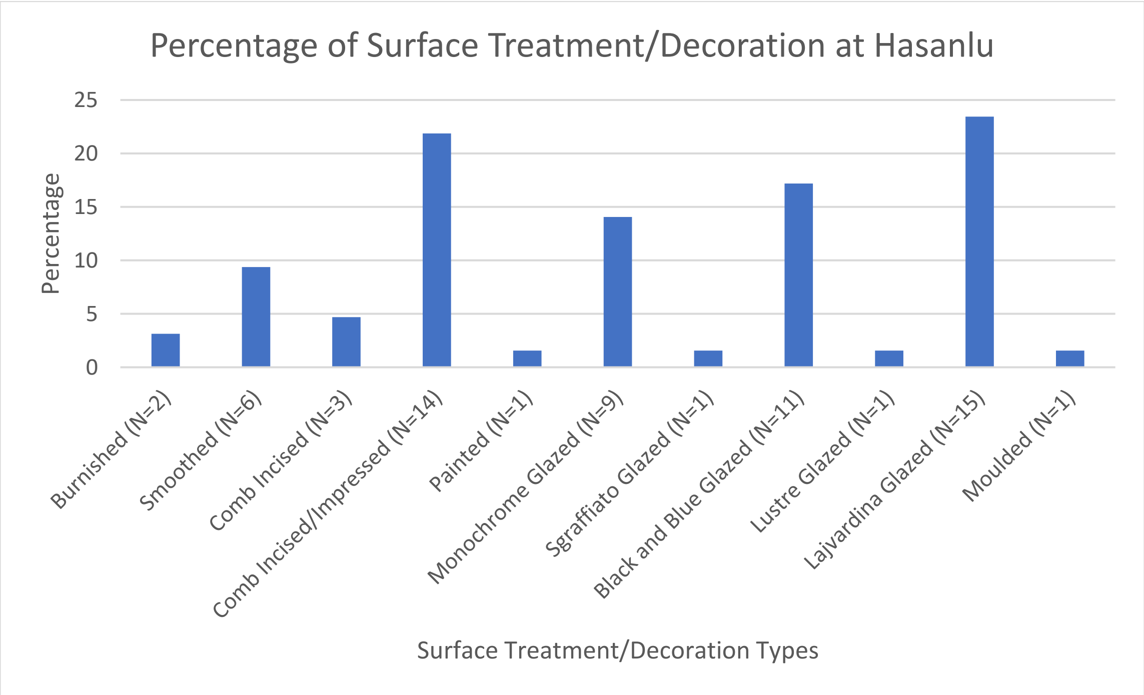

Figure 5.25: Percentage of various types of surface treatments/decorations at Hasanlu.

As shown in Figure 5.25, the most populous surface treatment/decoration at Hasanlu was comb incised/impressed followed by Lajvardina glazed, black and blue glazed, and monochrome glazed ceramics. It is important to note that most of these categories have multiple sherds, but they probably are from one or two main vessels based on the decoration, fabric, thickness of sherds, and design similarities across all sherds. The same is for the majority of the Lajvardina Wares, these possibly make up three to four separate vessels based on the decoration.

The comb incising is found in wavy and zigzag decoration (Plate 23: 2 – 5). The incising and impressed decoration has elongated hexagonal incisions filled with dots (Plate 22: 9). The bottom of the neck has a ledge for a filter that is missing. The filter and shape of the vessel dates it to the 11th – 14th centuries (Lane, 1957; Whitcomb and Johnson, 1979; Fehérvári, 2000; Watson, 2004). Two body sherds have moulded grooves and dot impressions in lines (Plate 24: 14). The rest of the pieces all probably belong to the same vessel but could not be joined (Plate 24: 6 – 13). These pieces have parallel incised lines much like basketry, with dots in some of the squares. Parallels are found in Watson (2004, p.106) reportedly from Afghanistan dating to the 11th century, Nishapur (Wilkinson, 1973, p.305:43a; p.322: 98) dating to the 11th and 12th centuries, and Iran or Central Asia dating to the 10th – 11th centuries (Fehérvári, 2000, No. 254). Hasanlu has a moulded body sherd (Plate 24: 15) with two registers both with vegetal motifs on a dotted background. The upper register seems to have more floral motifs whereas the lower register has more abstract arabesque type vegetal motifs. This matches with the other examples and places this example in the 12th – 13th centuries (Watson, 2004; Nováček, 2008; Mulder, 2015).

At Hasanlu, one body sherd is wheelmade with faint reddish lines painted on the surface (Plate 23:16). Glazing is the most popular category, and at Hasanlu, these are in a variety of subcategories. Nine sherds are monochrome glazed in green (N=6, Plate 24: 17), blue (N=2), and brown/black (N=1). The brown/black glaze could be due to post-depositional burning or overfiring of the vessel. One piece (Plate 23: 6) of sgraffiato glazed ceramic was recovered with two parallel incised lines on the interior around the carination, and a wavy line around the rim. This bowl has comparanda with Haraba-Gilan (Aslanov, Ibragimov and Kaskaj, 1997, p.420; Pl. 10) and a bowl from the Tareq Rajab Museum (Féhérvári 2000, no. 84, CER536TSR). Féhérvári (2000, p.84 –85) states these wares date to the 12th – 13th centuries into the early Ilkhanid period

At Hasanlu, four types of decoration on the stonepaste are present. The most common is underglaze black under blue painted ware with vegetal and geometric motifs. One deep bowl (Plate 23: 3; Plate 24: 22) has patterns of leaves on the exterior and abstract lines on the interior. Danti dates this piece to the 13th – 14th centuries (Danti 2004:42). This piece has comparisons with Kashan (Lane 1947, p.45: Fig. 86 and 91; Grube 1976, p.189: no. 136) and Takht-i Sulaiman (Kiani 1978, p.63: no. 115). The rest of the pieces (Plate 24: 21) are too small to distinguish patterns.

The Lajvardina ware at Hasanlu is more than likely part of two vessels. The first (Plate 23: 4) is a deep bowl with blue glaze and red and gold paint in vertical lines on the exterior. The rest of the pieces (Plate 24: 23 – 33) are possibly related to a larger vessel with a short mouth (see Danti, 2004, Color Plate C for an example from the MET). Danti also records a short jar neck from Hasanlu which was not viewed in the museum (Danti, 2004, Color Plate B:1). They could also be related to a larger necked vessel as evidenced by a carinated neck piece recorded by Danti (2004, Color Plate D: 6). The patterns on these 14 pieces are mainly geometric with some vegetal and animal (bird) motifs. They are mostly very small and determining which form they belong to is almost impossible. Lajvardina dates from the late 12th to mid-14th centuries CE (Grube, 1976; Naumann and Naumann, 1976; Luschey-Schmeisser, 1990, p.381-82; Allan, 1991; Golombek, 1996, p.126; Komaroff and Carboni, 2002; Watson, 2004).

The Lustre ware piece (Plate 23: 5) has a white body with clear glaze, and a lustre painting of words in a stylized Kufic inscription under the rim on the exterior, and horseshoes and dots/circles on the rim. Danti states this piece is of the Kashan style and has been dated to the earlier 13th century (Watson, 1985, p.108 – 9: Fig. 87; Danti, 2004, p.42). Nováček *et al.* (2008) record fragments of lustre ware at the Erbil Citadel (Fig. 25:18 – 20). Rante (2015) records two lustre sherds in the excavations at Rayy (2006 – 2007) dating to ca. 12th century.

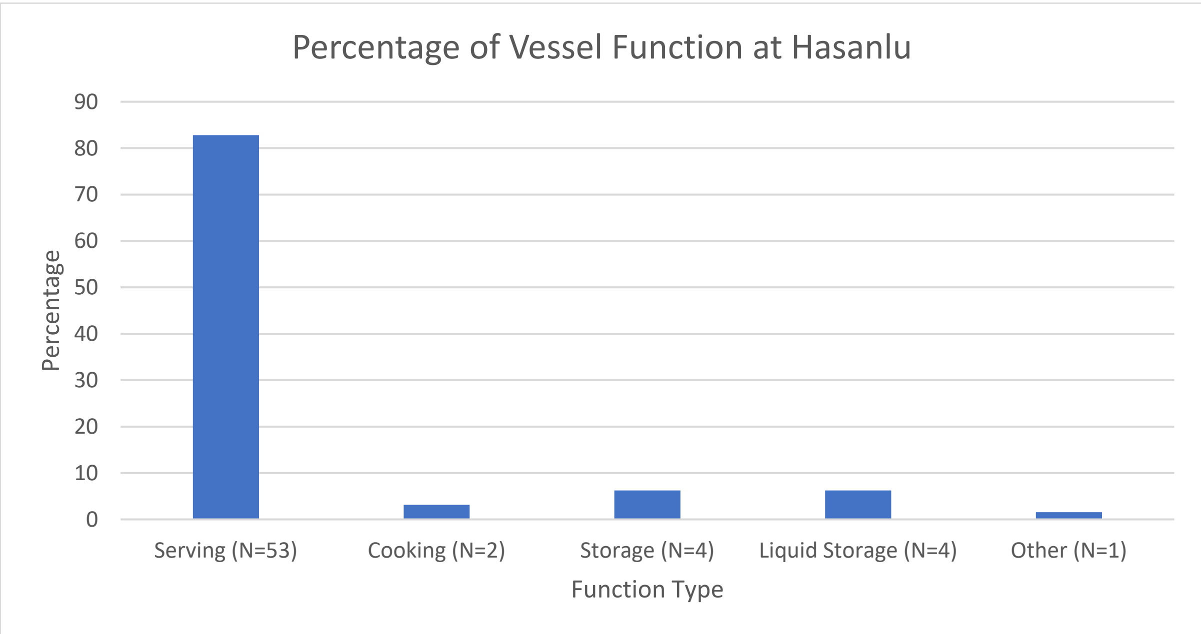

Figure 5.26: Percentage of various vessel functions at Hasanlu.

As shown in Figure 5.26, the largest function is serving, followed by storage, liquid storage, and cooking. The high percentage of serving function is probably due to the many pieces of various wares that are part of one vessel. However, Hasanlu is also a much finer sample than other sites, also leading to a higher percentage of serving functions.

The absence of strictly Seljuq period glazed wares (Min'ai, types of sgraffiato and turquoise glazed earthenwares), along with a multitude of Lajvardina wares and one piece of Lustre ware dates the settlement to the late 12th century to the early 14th century (Danti 2004). The excavations at the site show a one phase site, which was relatively short-lived based on the archaeological evidence. No typically 15th century material was recovered (Kubachi style blue on white, porcelains, Iznik ware), so placing the end of occupation in the 14th century fits the material. The material at Hasanlu contains more stonepaste and highly glazed and decorated material than the surrounding sites. The unglazed materials with their various forms (deep and shallow bowls, cooking pots, and large jars) do show domestic activities occurring at the site. The monochrome glazed and incised wares show a continuity with previous Seljuq ceramics in the area, but the introduction of the Lajvardina, underglaze painted, and Lustre wares illustrate some type of prosperity at the settlement.

5.5.10 *Rayy (9th – 12th Centuries CE)*

Rayy had a total of 96 sherds. Of these, 90 were fine (94%), 4 were coarse (4%), and 2 were stonepaste (2%). The sherds were handmade (1%, N=1), coilmade (10%, N=10), moulded (7%, N=7), and wheelmade (82%, N=78). The handmade piece is part of a handle.

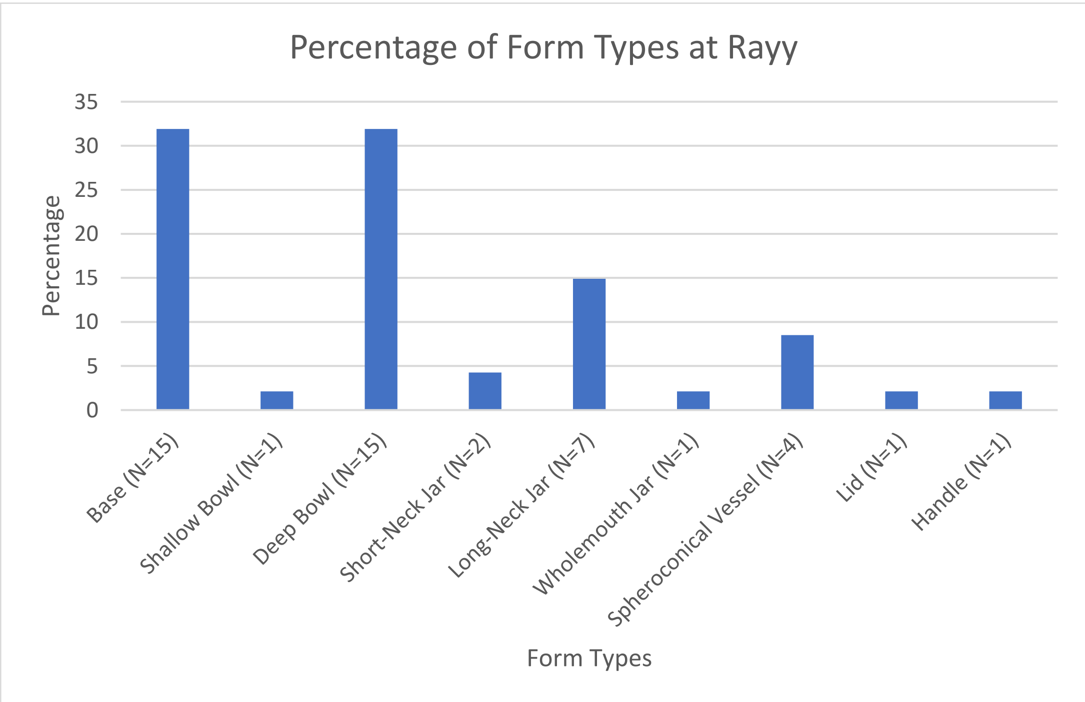

Figure 5.27: Percentage of various form types at Rayy.

Of the sherds at Rayy 47 were categorized into form types (Figure 5.27). The drawings of all the forms are located in Appendix 4: bases (Plate 25: 1 – 15), shallow bowls (Plate 25: 16), deep bowls (Plate 26: 1 – 13, Plate 27: 1 – 2), long-neck jars (Plate 27: 4 – 13), holemouth jars (Plate 27: 14), other (Plate 27:

15 – 16; Plate 28: 1 – 5). These forms generally match the other forms from Rayy (Rante 2015) as well as those from Nishapur (Rante & Collinet 2013; Wilkinson 1973) and Samarra (Sarre *et al.* 1925). In terms of the special forms, spheroconical vessels (Plate 28: 1 – 5) are the most recognizable due to their restricted necks and very thick walls. They date from the 10th – 14th centuries (Ettinghausen 1965). The lid (Plate 27: 15) is similar to those found at Nishapur dating from the 10th – 12th centuries (Wilkinson, 1973: no. 47).

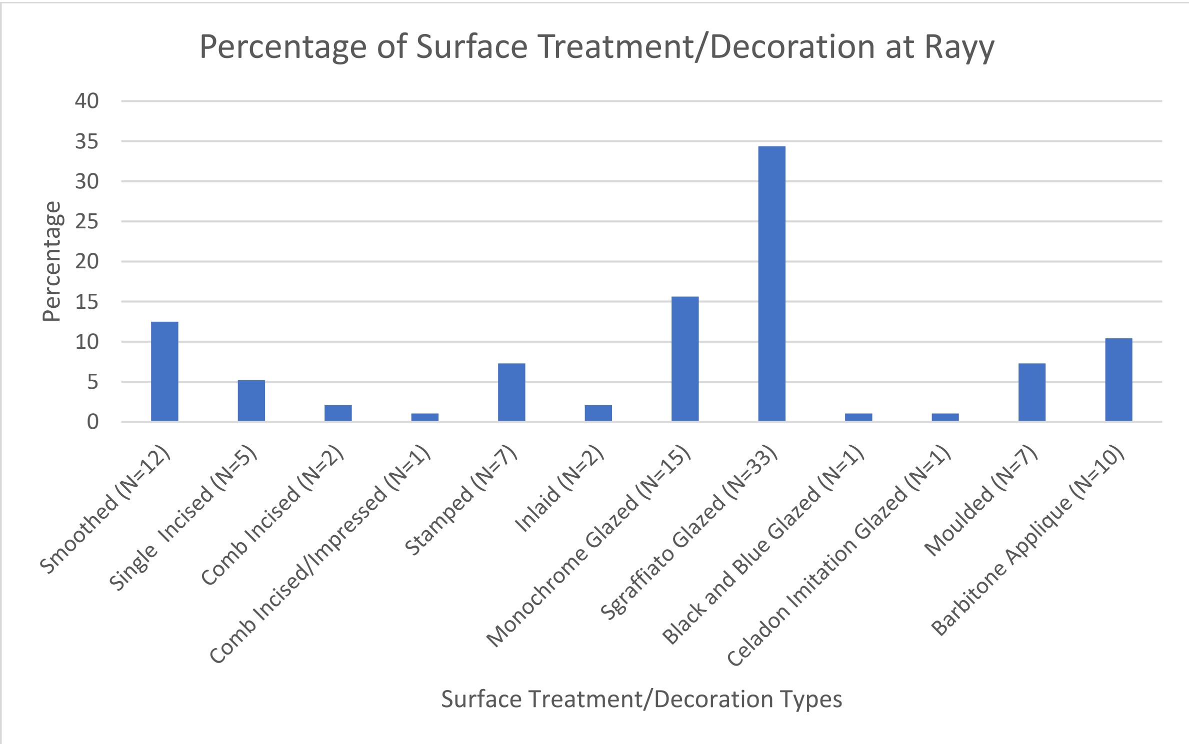

Figure 5.28: Percentage of various surface treatments/decorations at Rayy.

As shown in Figure 5.28, sgraffiato glazed is the most populous ceramic type in the glazed assemblage, followed by monochrome glazed, barbotine appliqué, stamped, and moulded. The incised ceramics at Rayy are much different from other incised assemblages studied. Instead of straight or wavy lines, the sample at Rayy has vegetal motifs (Plate 28: 11), birds (Plate 28: 12), and geometric designs (Plate 28: 7 – 10, 13). No exact comparanda were found for these sherds, but they do belong to the single incised tradition as discussed by Tonghini (1998) and Wilkinson (1973). The incised and impressed sherd Plate 27: 12) is part of a long-necked vessel. The shoulder and body of the vessel is covered in incised half circles with lines of seven dots impressed in the circles. This matches a piece in the Tareq Rajab Museum from Iran or Central Asia dating from the 10th – 11th centuries (Féhérvári, 2000; no. 254, CER1365TSR).

At Rayy there were three stamped pieces, with lines of stamped roundels with geometric incisions (Plate 27: 3, 8, 11; Plate 29: 1, 3 – 4). There was one part of a very large jar (Plate 29: 1) with its upper portion filled with five lines of repeating star shaped stamps with a rope appliqué at the bottom. Two pieces had triangular impressions (Plate 27: 3, 11). One piece of a long neck jar had a handle with a thumb stop, and that possibly places it in the 9th – 11th centuries. The two pieces (Plate 27: 6; Plate 28: 14) have inlaid turquoise stonepaste squares in the body. These more closely match inlaid ceramics from Qal'at Ja'bar (Tonghini 1998: pl. 70 – 72) rather than those from Nishapur (Rante and Collinet 2013: Fig. 107). These pieces date before the 13th century.

The largest moulded piece (Plate 29: 5) had a lower portion decorated with stars or rosettes below the band of clay joining the two hemispheres. The upper portion has three registers. The lowest register includes triangular and intertwined geometric motifs. On top of this is Naskhi script on a background of vegetal arabesques. The top register has illegible Kufic script, possibly pseudo-writing on a plain background. A handle has been attached over the left edge of these registers. The inscriptions are usually benedictions or blessings (Mulder 2014, p. 172). The positioning of the script, on the shoulder of the vessel with a background of tiny rings and dots, and fish also points to 12th – 13th century production (Mulder 2014). Kufic script was the standard script for monuments and books until around the 11th century when the more cursive Naskhi script took precedence (Wilkinson, 1973, p.329). Having a vessel with both styles of writing places it in the 11th – 13th centuries.

Four pieces of spheroconical vessels were looked at, but the Penn Museum records 46 vessels and vessel fragments. They have various decorations from teardrops (Plate 28: 2), rosettes (Plate 28: 3, 5), and teardrops and roundels (Plate 23: 4). The roundels in the last piece have possible letters in Naskhi script, but like above, they did not make much sense on their own. These sherds have parallels with other pieces from Rayy at the museum (UPM 37-11-657; UPM 37-11-658) and have been dated to the Islamic II periods at Rayy (11th – 13th centuries; Schmidt, 1935b, 1936; Rante, 2015).

The monochrome glazing present in the assemblage consisted of green glaze (N=9), green and blue glaze (N=1), blue glaze (N=2) and turquoise glazed (N=2). Two pieces were monochrome glazed over a corrugated body, one was with eroded blue (matching the pieces from Nippur) (Plate 29: 2), and the other is covered in a green celadon, possibly making it a celadon imitation stonepaste (Plate 30: 22; cf. Sarre 1925: Tafel XXIII; Jenkins, 1983, p.28; no. 31). This piece could date to the 15th – 17th centuries (Fehérvári 2000; Jenkins 1983).

The sgraffiato wares at Rayy are the most common glazed forms. Three types were identified, sgraffiato under a splash glaze, sgraffiato under a clear or opaque white glaze, sgraffiato under a monochrome glaze. The pieces with splash glazing have curved and straight lines (Plate 25: 6, 13, 16; Plate 26: 4, 5, 8; Plate 30: 14 – 18), writing or pseudo-writing (Plate 25: 3, 14; Plate 26: 7; Plate 30: 19 – 20) under green, yellow, and/or purple/brown splashes. One full profile (Plate 26: 6) has curved incised lines under a clear glaze with green and purple pigments in a dot and line pattern. This type of sgraffiato, incised lines under a splash or polychrome glaze began in the eighth century, possibly as a way to contain the pigments (Watson 2004) and extends until the 14th centuries. A subset of the sgraffiato splash glazing are pieces that may have been filled in black. One piece (Plate 27: 14) has very deep horizontal and diagonal lines under a splashed green glaze. The deep carving and crossing design are similar to a piece in Watson (2004, p.263), dating to the 12th – 13th centuries. However, the form and glaze coloring of the piece from Rayy is very different. The second piece (Plate 26: 2), has a carved vegetal design with a darker pigment added and it is covered in a yellow splash glaze. This piece is similar to a piece in Watson (2004, p.411) with the carved design and yellow glaze. This piece is from Egypt, dating to the 14th century. This piece also matches yellow sgraffiato ware in the Fitzwilliam Museum (cf. C.18.3-1948; C.4.1.-1919; C.4.21-1919) from Egypt dating to the 14th century. It is also similar to Watson (2004, p.264) dating to the 13th century.

The incised designs under clear or opaque white glaze are more complex than the other two types of sgraffiato. One full profile (Plate 26: 9) has a bird in a roundel on the base, on a background of incised straight lines, and the interior sides are covered in a vertical design on the background of incised diagonal lines. The top rim is green glazed, with the rest of the body being clear glazed. The bird in the roundel and the green pigment at the top match a piece in Watson (2004, p.256 – 257) from Iran and dating to the 11th – 12th centuries. It is an exact copy of a piece from the Detroit Institute of Arts (A.C.E. 1925: 32: no.6) from Iran dating to the 10th – 11th centuries. One base (Plate 25: 1), also has a bird’s head and cross with a background of straight lines under a clear glaze. This bird and cross matches Watson (2004, p.258) from Iran dating to the 11th – 12th centuries. The other pieces of this type of sgraffiato are vegetal motifs (Plate 30: 12), straight and curved lines (Plate 26.1; Plate 30: 11), possible writing (Plate 26: 3), and a star pattern (Plate 30: 13). The vegetal motifs match one from the Tareq Rajab Museum dating to Iran in the 12th century (Fehérvári, 2000, no.83; CER1743TSR). The possible writing may be an incised form of the word *Allah*. Overall, this type of sgraffiato, incising under a clear glaze especially with a hatched background, seems to be more popular in Iranian materials, and dates to the 11th – 12th centuries.

The monochrome sgraffiato wares have straight or wavy lines (Plate 26. 13; Plate 30: 3, 5 – 8, 10) under a dark green glaze. These all fit into the monochrome sgraffiato tradition, which existed alongside the splashed glazed sgraffiato tradition, dating from the 10th – 14th centuries (Allan 1991; Fehérvári 2000; Lane 1947; Watson 2004). One base (Plate 25: 5) has an excised design of a flower with vegetal motifs surrounding it, covered in a dark green glaze. This piece is related to the Garrus wares as the design is excised, leaving the background darker and the motifs lighter (Watson 2004, p.260; Danti 2004).

Rayy has one piece of black under blue glazing (Plate 30: 21), a small handle from a cup with horizontal black lines under a blue glaze. This is related to the black under blue tradition, and matches handles to cups found across Western Asia; however, it is made in earthenware whereas most of the published literature deals with stonepaste wares (Watson, 2004, p.336; Jenkins-Madina, 2006, p.111).

The appliqué wares at Rayy are highly decorated with vegetal motifs, incising, and impressing. These pieces have crosshatched and dotted incisions, slash incisions, and applied bands and dots (Plate 29: 8, 11, 13), vegetal motifs including flowers (Plate 29: 12), seeds (Plate 29: 6), stems (Plate 29: 7), and combinations of all these motifs (Plate 29: 10). These could belong to the same jar, or many similar jars. Many of the motifs of these body sherds are almost identical to those pictured in Watson (2004, p.97), with similar motifs, shapes, and styles of production. Watson states these were found in Susa and Iraq, and date to the eighth century (Gonnella 1999, Watson, 2004, p.97). Another piece from Iran or Central Asia has the same type of decoration, and is dated to the 12th – 13th centuries (Rosen-Ayalon, 1974, Pl. XVI/o-p, XVII/h-j; Fehérvári, 2000: No. 244). Another piece is much different (Plate 28: 6) with the barbotine ending in a tiny handle. This is also decorated with dots with holes and slash incisions. The last appliqué sherd (Plate 30: 4) has wavy appliqué lines and impressed dots under a green glaze. This type of decoration dates from the 8th – 10th centuries (Watson, 2004, p.160).

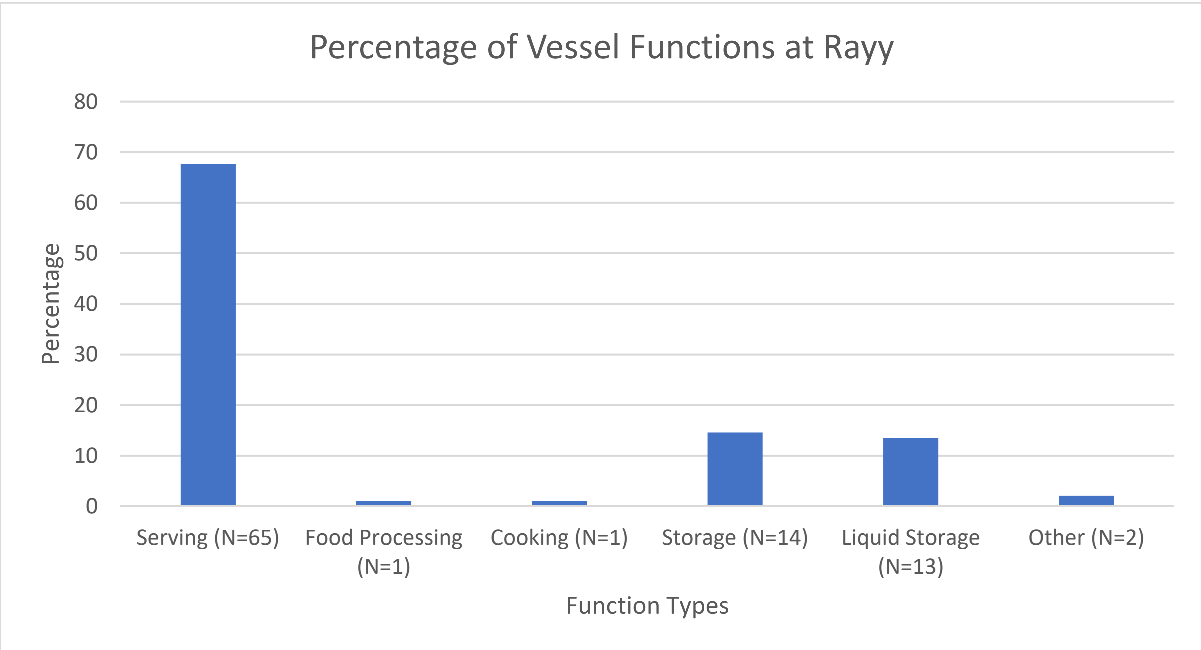

Figure 5.29: Percentage of various vessel functions at Rayy.

As seen in Figure 5.29, serving is the highest percentage of function at Rayy followed by storage and liquid storage. Like Nippur, serving is probably higher because of the fine nature of the wares, as well as the highly decorated pieces that were analyzed. This could be related to the fact that these pieces were exported from Rayy for study at the Penn Museum, and as such the finer pieces were prioritized.

The liquid storage function consists of a majority of spheroconical vessels, and as such this function could also contain transportation of liquids. The other storage ceramics are coarser, have incised, stamped, or inlaid decoration.

Rayy, as a large urban center, has a much higher percentage of higher quality wares, which leads to more comparanda with more exact dates. The single incised wares, thumb stops on handles, and the appliqué glazed ware date from the 9th – 11th centuries. The splash glazed wares, sgraffiato incised wares, and moulded wares date from the 11th – 12th centuries. This matches with Rante's (2015) assessment of the later periods of Rayy's occupation. When added to Rante's assessment, we can see Rayy's far flung connections to Egypt, China, and across Western Asia. The undecorated wares show comparanda with Nishapur, also leading to a 9th – 12th century date.

5.5.11 *Chal Tarkhan (7th – 13th Centuries CE)*

Chal Tarkhan had a total of nine sherds. Of these, eight were fine (88%), and one was stonepaste (12%). All were wheelmade. One was a base (Plate 31: 1), one was a deep bowl (Plate 31: 2), and one was a beaker (Plate 31; 3).

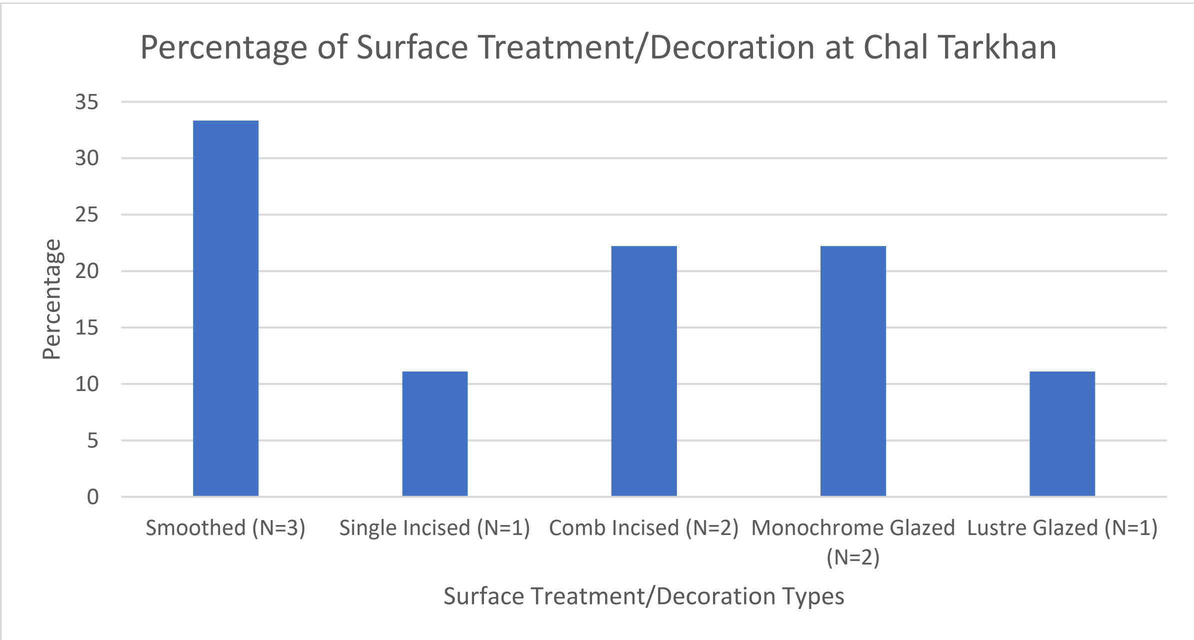

Figure 5.30: Percentage of various surface treatments/decorations at Chal Tarkhan.

As Figure 5.30 shows, smoothing is the most common surface treatment at Chal Tarkhan, followed by monochrome glazed and comb incised. One of the smoothed body sherds has been used as an ostracon (Plate 31: 7), many of these pieces are recorded at the Penn Museum but were not analyzed for this study. The monochrome glazing was in green (Plate 31:2) and brown (Plate 31:3). Incising had one straight line, or comb incising. The one almost complete jar has wavy lines on the shoulder and is preserved from the shoulder to the base (Plate 31: 1).

One piece from Chal Tarkhan (Plate 31: 6), has designs in black or lustre paint in three registers, the first has incised vegetal and possible bird roundels, the second has calligraphic writing, or pseudo-writing, and the third has geometric motifs. Blue glaze has been dripped down the side (cf. Watson, 2004, p.356 – 358; Jenkins-Medina, 2006, p.120 – 143). The blue glazing tends to highlight various decorations, roundels, or bands on the vessels (Caiger-Smith 1985). This dates to the 12th – 14th centuries.

In terms of function, six sherds were identified as serving vessels (66%), and three were identified as storage vessels (34%). This was due to surface decoration and size of diameters (the one comb incised vessel has a base diameter of 11 cm) determining larger vessels for storage.

Chal Tarkhan did not have very may diagnostic sherds for chronological purposes. However, this is an elite residence outside of Rayy, and historically, is dated from the late Sassanian to the early Islamic period (Kröger 1990). The one ceramic that can be assigned a date is the piece of lustre ware, dating to the 12th – 13th centuries. This could have been a surface find, or there could still be habitation at Chal Tarkhan at that later date. This fits with Chal Tarkhan being an elite residence for people of Rayy. A small sample of these ceramics was taken for comparisons with the Rayy assemblage.

5.5.12 *Firuzabad (11th – 13th Centuries CE)*

Firuzabad had a total of 80 sherds. Of these, 28 were fine (35%), 12 were coarse (15%), 35 were vegetal (44%), and 5 were stonepaste (6%). The sherds were handmade (14%, N=11), coilmade (19%, N=15), moulded (3%, N=2), and wheelmade (64%, N=52). Of the handmade sherds five were handles, and the other six were vessels.

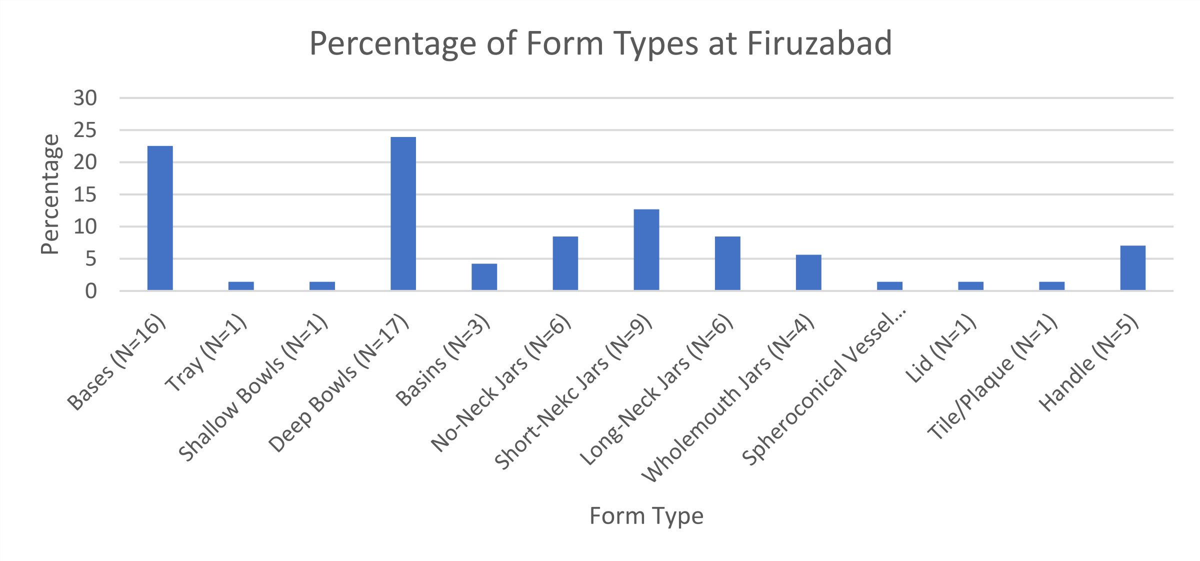

Figure 5.31: Percentages of various vessel forms at Firuzabad.

Firuzabad had 71 sherds that were able to be classified into forms (Figure 5.31). The drawings of all the forms are located in Appendix 4: bases (Plate 32: 1 – 17), trays (Plate 32: 18) shallow bowls (Plate 32: 19), deep bowls (Plate 32: 20 – 25; Plate 33: 1 – 12), basins (Plate 33: 13 – 14), no-neck jars (Plate 34: 1 – 6), short-neck jars (Plate 34: 7 – 16), long-neck jars (Plate 34: 17 – 22), holemouth jars (Plate 35: 1 – 3), other (Plate 35: 4 – 6, 20). These forms generally match the forms from Rayy (Rante 2015) as well as those from Nishapur (Rante & Collinet 2013; Wilkinson 1973). The one spheroconical vessel (Plate 35: 4) is the top of a bottle and it is very similar to a bottle from Nishapur recorded by Wilkinson (1973, p.353 no. 111). There is a groove around the neck, which Wilkinson states is very common at Nishapur (1973, p.323). This piece dates to the 10th century. The tile/plaque is a moulded piece (Plate 35: 20), with a rounded shape and flat back. The decorated side has a line of dots and an eroded design possibly an animal, vegetal arabesques, or calligraphy/pseudo-calligraphy. No comparanda has been found to elucidate the function of this piece or the dating.

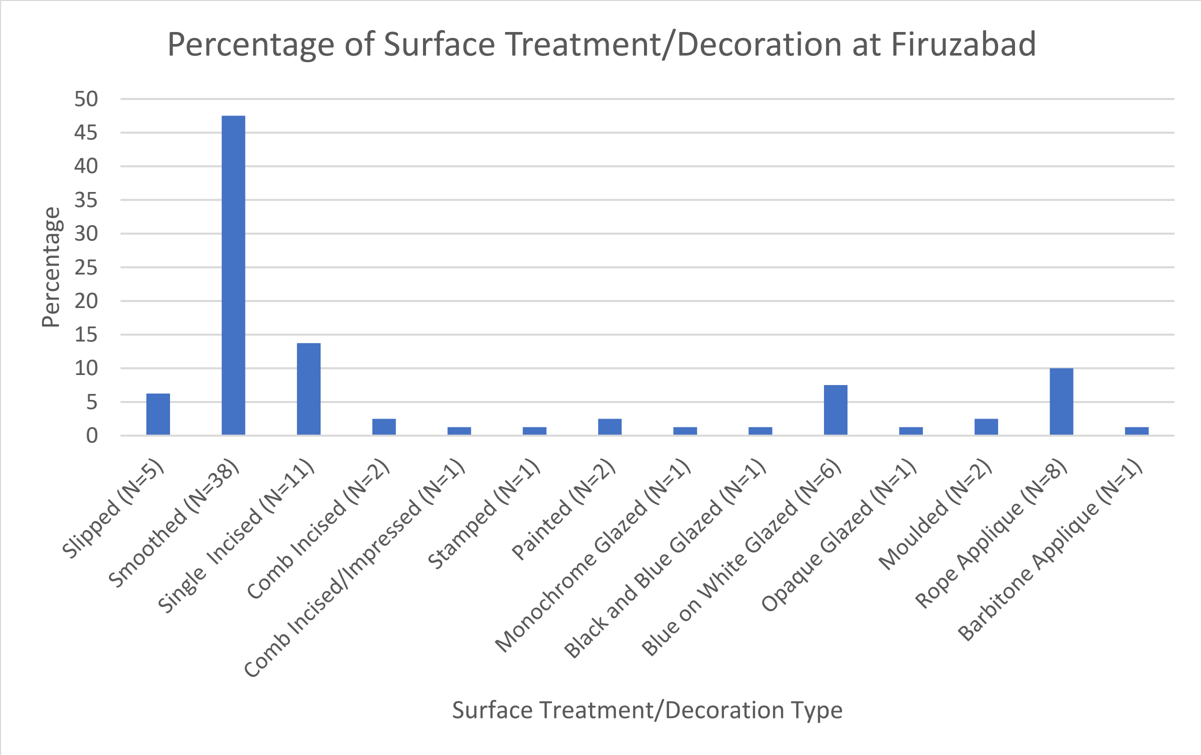

Figure 5.32: Percentage of surface treatment/decorations at Firuzabad.

As seen in Figure 5.32, smoothed is the most popular surface treatment followed by single incised, blue on white glazed, and rope appliqué. The tray/tile (Plate 32: 18) matches a glazed tile from Nishapur (Rante and Collinet 2013: Fig.106). Jar (Plate 34: 14) is similar to a Sassanian jar from Nishapur (Rante and Collinet 2013: Fig. 80:4), but the one at Firuzabad one has a band below the rim with fingerprint indents. In terms of incising, most pieces have straight and wavy lines (Plate 32: 20, 24, 25; Plate 33: 4, 11, 13, Plate 34: 13, 21; Plate 35: 1 – 3, 14 – 15, 17 – 19). The comb incised and impressed sherd (Plate 35: 16) has parallel incised wavy lines, two horizontal straight lines filled with four rows of dots, and a vertical wavy line. A basin from Nishapur has a similar design (Wilkinson, 1973, p.64) and dates to the 11^{th} – 12^{th} centuries. One sherd has finger impressed dots under the rim (Plate 34: 14) which is similar to a jar from Nishapur (Rante and Collinet 2013: Fig. 97: no. 16). This dates to the Nishapur IIIa period, from the 11^{th} – 12^{th} centuries.

Two painted pieces were found in this sample, one with black paint and an excised line (Plate 34: 4), and one with a red line (Plate 33: 12). No comparanda was found for these sherds, they do not match the handmade geometric painted wares (Johns 1998; Priestman 2005; Rosen-Ayalon 1974).

Two types of appliqué are present, a rope appliqué on the shoulder of vessels (Plate 33: 14; Plate 34: 6 – 8, 10, 16 – 17; Plate 35: 5), and thicker stamped bands in a zigzag pattern (Plate 35: 13). The rope appliqué tends to be smaller bands with slashes to indicate twisting rope, much like the pieces from

EPAS. The thick stamped bands of appliqué, which is sometimes glazed in monochrome colors, dates to the earlier 9th – 11th centuries (Rante & Collinet 2013; Wilkinson 1973).

The glazed and stonepaste wares were not seen at the Penn Museum but are recorded in Ingraham's thesis (1975); however, no photographs or drawings of the decorations were present. The opaque glazed piece (Plate 32: 7) has a concave base and is made of stonepaste, but no more information is recorded. Opaque glazed ware has been found throughout Western Asia from South Africa and Egypt to Thailand (Priestman 2011). Opaque glazed stonepaste dates from the 10th – 16th centuries (Fehérvári 2000; Lane 1947; Watson 2004). Eight pieces are recorded as blue on white glazed with a black "filler motif" (Plate 32: 16, 19, 21 – 22), four are marked as stonepaste, three are of coarse fabric, and one is vegetal (Ingraham, 1975: Plate VII). This type of ware and decoration is attested at Nishapur with 2.2% of the stonepaste assemblage being underglaze painted and appearing on or near the surface (12th – 13th centuries) (Rante and Collinet 2013: Fig. 105: 1 – 7). However, without more information, or seeing the pieces, not much more can be gleaned from them.

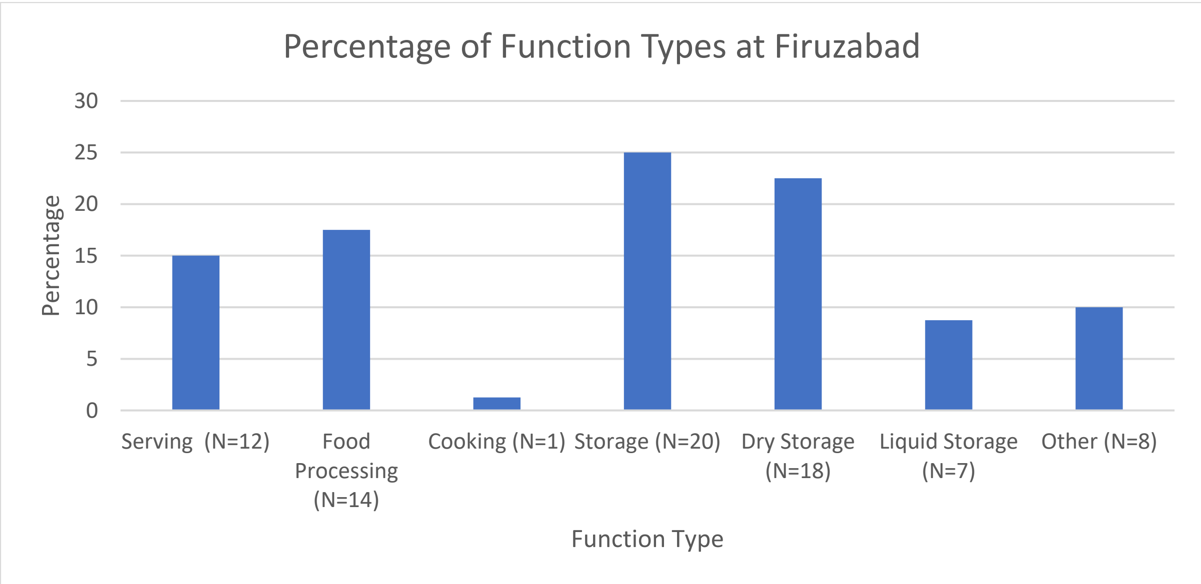

Figure 5.33: Percentage of various vessel functions at Firuzabad.

As seen in Figure 5.33, storage vessels are the most populous followed by dry storage and food processing. These categories are a bit more secure than the other sites because 70 of the 80 sherds at Firuzabad were able to be assigned a form and using forms to define functions is easier than just utilizing fabric and surface treatment/decoration. The ceramics at Firuzabad are also coarser than the other assemblages, leading to more storage functions. Like the other sites, incising and stamping tended to be on storage wares, whereas table wares are smoothed or glazed.

Firuzabad has a few diagnostic pieces, helping to date the ceramics to the 11th – 13th centuries. Most of the ceramics from Firuzabad match those from neighbouring Nishapur (c.240–1232 CE). It does seem that the ceramics at Firuzabad are coarser and more crudely fashioned (more coil and handmade wares) than those at Nishapur (as compared to Rante and Collinet 2013 and Wilkinson 1973). Ingraham (1975: Plate IV: no.39) records a kiln spacer, which gives evidence that there was production occurring at Firuzabad. The glazed wares recorded by Ingraham could help to narrow the dating, but they were not seen in the museum, and the drawings provided by Ingraham are not very helpful. The presence of the stonepaste wares, pushes the date to the later part of this chronological range. The rest of the assemblage closely resembles that from Nishapur. These show strong links with the site of Nishapur in this period.

5.6 Summary of Macroscopic Results

The ceramic sample for this dissertation has three main periods, a late Abbasid assemblage (10^{th} – 12^{th} centuries), a Seljuq assemblage (11^{th} – 13^{th} centuries), and an Ilkhanid assemblage (13^{th} – 14^{th} centuries). The late Abbasid assemblage is marked by spheroconical vessels, blue on white in geometric designs, splash opaque glazed decoration (blue and black under white opaque), polychrome glazing, and comb incising and appliqué under a monochrome glaze. Due to the survey nature of this sample, few similarities in forms were detected. This period was found at EPAS 155, EPAS 217, Nippur, Rayy, Chal Tarkhan, and Firuzabad. Some of the pieces (especially at Nippur and possibly at the EPAS sites) are possibly extrusive, and not part of the habitation of the site, due to the limited amount of material dated to these periods. However, at the other sites, there seems to be an extensive habitation dating to this period.

The Seljuq assemblage is marked by black under blue glazing, Lustre ware with blue glazing, corrugated wares with monochrome glaze, sgraffiato glazing, moulded wares with vegetal or animal motifs, and the presence of stonepaste. Some variation in forms was present, especially longer ledged bowls, which is common in stonepaste wares (Mason & Tite 1994a). This period was found at all the EPAS sites, Nippur, Rayy, Chal Tarkhan, and Firuzabad. At all of these sites, there seems to be some habitation dating to this period.

The Ilkhanid assemblage is marked by Lustre ware, Lajvardina ware, Sultanabad ware, Celadon Imitation ware, blue on white porcelains, and a predominance of stonepaste at the larger sites. Like the Seljuq assemblage, some form variation was noticed in the stonepaste, with the extension of the ledges on bowls, and hammerhead rims (Mason and Tite, 1994). However, the rest of the assemblage seemed relatively unchanged between periods. This period was found at Hasanlu and Nippur.

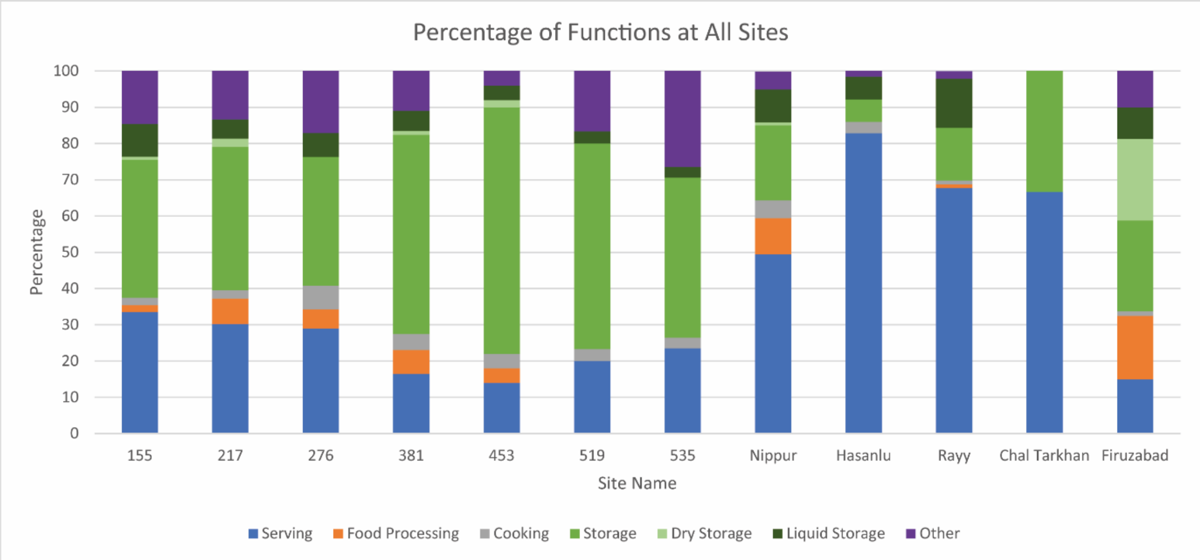

Figure 5.34: Percentages of various vessel functions of the ceramics at all sites.

To help divide sites into rural and urban settlements, besides their surface size, we can analyze their ceramics. Looking at the ceramics macroscopically, we can start to divide sites based on the presence or absence of various types of fabrics, surface treatments, and forms. It has been hypothesized that urban settlements, with their larger populations, connections with other markets, and more economic opportunities will have higher quality ceramics (Cassis *et al.* 2018; Klein 1991; Müller-Weiner 2017; Parikh & Petrie 2019; Pettegrew 2007). This seems to hold true for this sample as well, with the majority of stonepaste/porcelain/glazed wares being concentrated at the more urban sites (Nippur, Hasanlu, Rayy, Chal Tarkhan). Using survey data and museum collections creates a bias in the sample towards these wares at the expense of more utilitarian wares. However, the more urban sites seem to have access to these higher quality ceramics. Another way of analyzing these ceramics is to perform a functional analysis which raises some interesting points. As seen in Figure 5.34, the more rural sites have a higher percentage of storage wares (including the dry and liquid category) whereas the more urban sites have a higher percentage of serving wares. This could point to a difference in what vessel form and ware was being used for specific functions at the various sites. Variations in feasting or hosting of large groups may have very different tablewares present. For example, on my excavations in rural Kurdistan in 2013 – 18, when invited to houses for dinner, our hosts would often lay bread on the floor and pile the food on top, rather than serving it in bowls or plates. This could also have been done in the past, leading to fewer serving vessels being utilized at these rural sites. This could indicate different dining habits between rural and urban sites. The lack of cooking wares in the entire sample is also interesting to note, I only assign this function if there was visible burning on the surface of the vessel, along with the globular shape and this could have biased the sample. They could have also been using metal or stone vessels to cook with, removing cooking functions from ceramics. While metal and stone are more expensive, they last much longer than ceramic vessels. As discussed in Chapter 1, textual sources also record preferences for cooking in stone vessels for some recipes (Gascoigne 2013). With all of these caveats, there seems to be different patterns in ceramic utilization at rural and urban sites.

Lastly, this chapter sets out a baseline of the overall ceramic assemblages at these sites, and from these macroscopic investigations individual sherds were chosen for microscopic investigations. The actual sampling procedures varied (see Chapter 4) based on the type of data that was available, but for the most part, a general representative sample was taken, trying to skew towards the coarser, more undecorated wares since they are underrepresented in the literature. The results of this analysis are covered in the next chapter.

6 Archaeometric Analyses: Petrography, pXRF, and FT-IR Results

This chapter covers the results of the scientific investigations of the data. 154 samples were analyzed using thin section petrography, portable X-Ray Fluorescence (pXRF), and Fourier Transform Infrared Spectroscopy (FT-IR). A detailed description of each of the petrofabrics can be found in Appendix 7, photomicrographs of all fabrics in Appendix 8, pXRF data in Appendix 9, FT-IR spectra in Appendix 10, and a table illustrating the groupings of all sherds with context, ware, and form data in Appendix 11.

6.1 Petrography

All the terminology used in the below section can be found in Appendix 6 with illustrations. However, a quick overview of the terminology is presented here. First, in qualifying abundance of inclusions, various categories are used (Dominant (50 – 70%), Frequent (30 – 50%), Common (15 – 30%), Few (5 – 15%), Very Few (2 – 5%), Rare (0.5 – 2%), and Very Rare (<0.5%) (Quinn, 2013, pp. 89 – 90). The voids are categorized as vesticles (equant spherical voids with smooth edges), elongated (channels or planar voids, parallel, smoothed edges), and vughs (irregular shaped voids), and are classified by size micro (<0.05 mm), meso (0.05 – 0.5 mm), and macro (0.5 – 2 mm) (Quinn, 2013, p. 97). Coarse and fine fraction are divided based on gran size, with coarse fraction being equal to or more than 0.0625mm, and fine being less than 0.0625mm. In terms of spacing, single space means the inclusions or voids, are touching each other, double means there is a space of an inclusion between them, and open spacing is where there is more than one inclusion's space between the inclusions. The inclusions can also be divided into unimodal and bimodal distributions. Unimodal distribution is where the inclusion sizes have a normal distribution, and bimodal distribution is where they have two modes identified. The bimodal distribution is usually indicative of tempering, whereas the unimodal distribution usually indicates naturally occurring inclusions.

The samples from the al-Jazira region are from the Erbil Plain Archaeological Survey. These six sites have relatively similar underlying geology (see Section 2.5.1 for the geology of the region). This is reflected in the samples which are homogenous in mineralogical compositions, and the main clay fabric is calcareous with frequent to few quartz and opaques, and in some samples, few to rare micas, feldspars, micrite, and bivalve shells. These minerals all match the geology of the region, with the main sources of clay being from river alluvium. From the 87 sampled pieces, there were five petrofabric groups (E.1 – 5), and four outlying samples (E.6 – 9) (Appendix 7). The other inclusions are all attested in the region, especially the radiolarian chert (al-Zubaidi *et al.* 2021; Berna *et al.* 2007; Daszkiewicz *et al.* 2000; Petrik *et al.* 2020). Igneous and metamorphic rocks (granite, schist, rhyolite, etc.) are recorded to be present in the upper Zagros Mountains and could have been brought to the region either through the rivers, or possibly through trade of the finished vessels. In terms of firing, all vessels were probably fired above 800°C with the micrite beginning to dissolve and leaving reaction rims, as well as the lack of optical activity in the clay (Maniatis & Tite 1981; Quinn 2013).

The samples from the al-Iraq region are all from the site of Nippur. The geology of the region is mainly alluvium, both waterborne and airborne sediments (see Section 2.5.2 for a discussion of the geology of the region). The samples themselves are relatively homogenous, with the main clay fabric being relatively calcareous with frequent rounded quartz and opaques, and in some samples, few micas, feldspars, serpentinite, and shells. The majority of the samples match the geology of the region, with the main sources of clay being from river alluvium. Among the 14 samples three petrofabric groups (N.1 – 3) were identified with two outlying samples (N.4 – 5) (Appendix 7). The groups have inclusions, that could have derived from local geology, mainly sedimentary with a few rare igneous or metamorphic fragments. Minerals deriving from igneous and metamorphic rocks match those found further downriver at Ur, as well as the sediments collected along the Tigris (Garzanti *et al.* 2016; Kaercher 2017). One of the outlying petrofabrics could be imported from farther away with the presence of dolerite. Dolerite is an igneous rock with outcrops in the upper Zagros Mountains of northeastern Iraq and northwestern Iran. This is discussed more below. In terms of firing, all fabrics have a lack of optical activity in their matrix, illustrating a higher firing temperature (Whitbread 1995).

The samples from the al-Ran region are from the site of Hasanlu. The geology of the inclusions derives from metamorphic, igneous, and sedimentary rocks (see Section 2.5.3 for a discussion of the geology of the region). The samples themselves are relatively homogenous, with the main iron-rich clay fabric possibly from river alluvium, and including quartz, micas, and feldspars. Among the seven samples there was one petrographic fabric (H.1) and three outlying samples (H.2 – 4). In terms of firing, all vessels lacked optical activity which points towards a higher firing temperature (Whitbread 1995).

The samples from the Iraq al-Ajam region are from Rayy and the nearby site of Chal Tarkhan. The geology of the region consists of sedimentary, igneous and metamorphic, rocks (see Section 2.5.4 for a discussion of the geology of the region). The samples match the geology of the region with the main sources of clay being from the alluvial fans. The samples themselves are relatively homogenous, with the main clay fabric including frequent quartz, micas, and feldspars, and the clay is relatively iron rich. The 34 samples have been divided into five petrofabric groups (R.1 – 5) and two outlying samples (R.6 – 7). In terms of firing, the matrix of all but one sample lacked optical activity implying that these vessels were fired at a higher temperature (Whitbread 1995). One sample has an optically active matrix, suggesting that this vessel was fired at a lower temperature.

The samples from the Khurāsān region are all from the site of Firuzabad. The geology of the region consists of igneous, metamorphic, and sedimentary rocks (see Section 2.5.5 for a discussion of the geology of the region). The samples themselves are relatively homogenous, with the main clay fabric including frequent quartz, micas, and feldspars. The samples match the geology of the region, with the main sources of clay coming from river alluvium. Among the eleven samples there were three petrofabric groups identified (F.1 – 3) and one outlying sample (F.4). Some of the vessels lower fired evidenced by optical activity in the clay; some vessels were fired at a higher temperature based on the optical inactivity of the fabric. A few vessels may be overfired, as illustrated by the almost circular vesicles (Quinn 2013; Whitbread 1995). There is also clay mixing present at Firuzabad, with darker and lighter striations present (Ho & Quinn 2021; Quinn 2013).

In order to compare the manufacturing between regions, the majority of the discussion that follows broadly categorizes the petrographic groups into Fine/Untempered, Coarse/Mineral Temper, and Vegetal/Vegetal Temper. These categories are then discussed by the various petrographic groups. For more detailed descriptions of the fabrics see Appendix 7. For more microphotographs of all the ceramics in these categories see Appendix 8. In terms of surface treatments, I have discussed them where they appeared on the thin section; however, most of the surfaces were removed in the thin section manufacture.

6.1.1 *Fine/Untempered Fabrics*

6.1.1.1 Fine Quartz Rich Fabric (E.1a, E.1b, N.1a, N.1b, H.2, R.1, F.1)

Fine Quartz Rich Fabrics are defined by their calcareous clays, limited coarse fraction, and presence of quartz. These samples are marked by the presence of a homogenous brown matrix that is optically inactive (indicating a higher firing temperature after Whitbread, 1995). However, at Firuzabad, the matrix is slightly heterogenous, possibly indicating a clay mixing (Figure 6.1: D) (Ho & Quinn 2021). There are common to rare micro-vughs and very rare meso-elongated voids and orientations of the voids and inclusions range from random to strongly oriented in parallel to the margin of the thin sections (preferred orientation) The preferred orientation displayed by the voids and inclusions indicate these vessels were formed using a potter’s wheel, whereas the more random orientation indicates a handmade forming technique. At Hasanlu, some of the elongated voids are slightly curved, indicating a possibly fossiliferous clay material (Figure 6.1: A) (Quinn 2013).

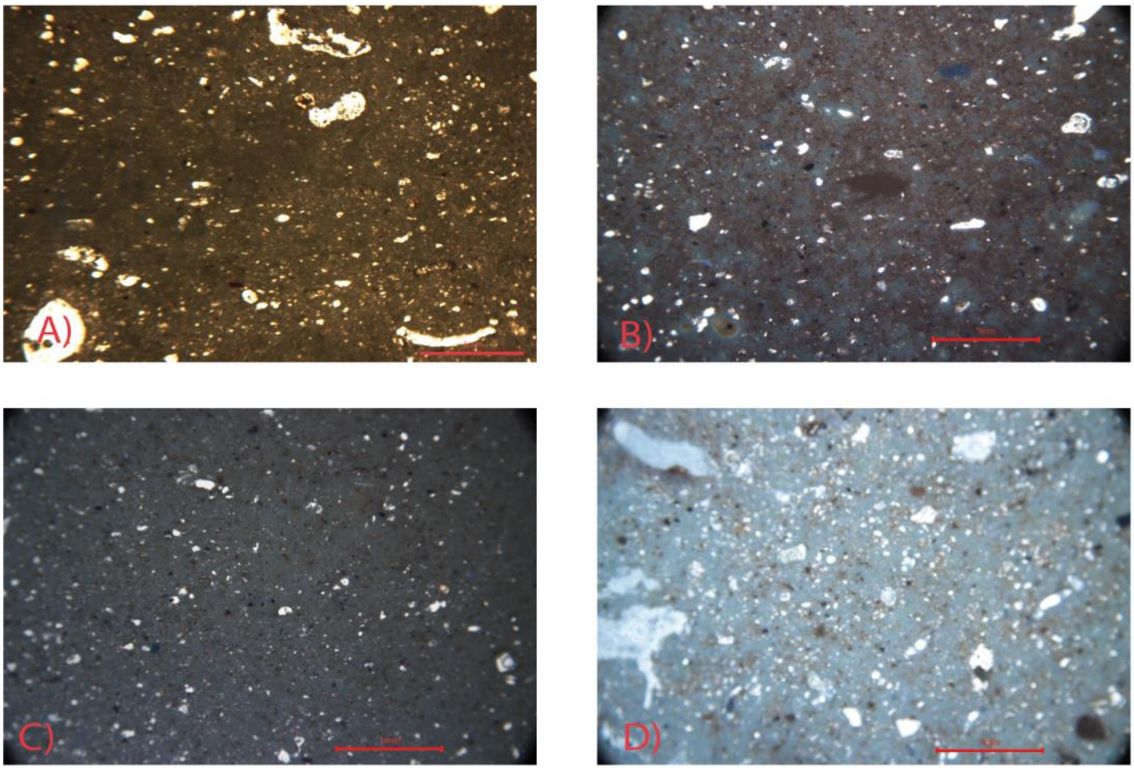

Figure 6.1: Photomicrographs of the Fine Quartz Rich Fabrics. A) Possible Microfossils, CA200363; B) CA200342, C) CA200234, D) Possible Clay Mixing, CA200356. All PPL and x4

Due to the unimodal nature of the inclusions, and the relative rarity of coarse fraction, the clay might have been levigated to remove the coarser-grained inclusions. This could also be indicative of a very fine natural clay. The choice of this fine clay, or the levigation of a coarser clay would allow for finer vessels to be made, with thinner walls.

The al-Jazira fabrics (Figure 6.1: B – C; E.1a, E.1b) include rare quartz, chert, opaques (possibly hematite or other iron rich pellets), micritic limestone, muscovite, orthoclase feldspar, quartzite, shell, and radiolarian chert in the coarse fraction. The Erbil Plain is a floodplain of eroded alluvium, which consists of limestone, marls, cherts, mudstones and sandstones. The presence of the micritic limestone is linked to the Fatha Formation, and the cherts are part of the Pila Spi Formations. Both of these formations lie along the Qaraqosh and Zagros foothills and underlie the alluvial plains between these two ranges. The quartzite and muscovite may be from the Injana Formation, which appears in the Qaraqosh range and in the upper Zagros Mountains. These inclusions indicate a local, if not regional provenience.

The al-Iraq fabrics (N.1a, N.1b) include frequent quartz, opaques, few quartzite, muscovite, and rare chert, plagioclase feldspar and shell. All of these inclusions are present in the aeolian sands which surround Nippur, consistent with a local manufacture.

The al-Ran fabric (Figure 6.2: A; H.2) include few quartz, rare chert, and very rare quartzite and plagioclase feldspar. The chert is likely derived from the Jurassic formations that underlie the alluvium, and the quartzite is from the Milla Formation, located in the upper Zagros. The very weathered sub-rounded nature may illustrate that this rock was transported via the Gadar River to Hasanlu. The formations are consistent with a local manufacture of these vessels.

The Iraq al-Ajam fabric (Figure 6.1: D; R.1) include frequent quartz, common chert, few muscovite, plagioclase feldspar, biotite, rare quartzite, possible biotite schist and serpentinite. Chert is probably from the Ruteh Formation, located in the Alborz Mountains. Muscovite, plagioclase feldspar, and biotite are related to the metamorphic and igneous rocks (Karaj, Ruteh, Dorud, Shemshak, Kahar Formations), also located in the Alborz Mountains. Quartzite is from either the Milla or Karaj Formations, which underlie the floodplain surrounding Rayy. Lastly, biotite schist and serpentinite are from either the Shemshak or Kahar Formations. The Shemshak Formation is located as an outcrop in the foothills of the Alborz, and the Kahar Formation extends under the Rayy plain. These all indicate a local, or regional area of manufacture.

The Khurāsān fabric (F.1) include common quartz and plagioclase feldspar, few biotite, and rare muscovite, quartzite, serpentinite, epidote, mudstone, basalt, greywacke, and orthoclase feldspar. Biotite, muscovite, epidote, and feldspars could have come from the metamorphic/igneous rocks in the Eocene/Paleocene volcanics, or Shemshak, Ruteh, Dorud, Sardar, Jamal, or Kahar Formations. These formations are located along the Alborz Mountains to the north of Firuzabad. Basalt is from the Eocene/Paleocene volcanics, or the Ruteh or Dorud Formations. The Ruteh and Dorud Formations are present along the East Iranian Range to the south of Firuzabad. Mudstone and greywacke are from the Hezardarreh Formation, which covers most of the valley floor. Lastly, quartzite and serpentinite are from the Kahar Formation which is located underneath the alluvium and the Hezardarreh Formation which is present under Firuzabad. These inclusions are all consistent with a local manufacture of the ceramics.

Table 6.1: Type of surface treatment, petrographic group, and scientific number of samples with decoration in thin section.

Type of Surface Treatment	Petrographic Group	Scientific Number
Incising	E.1a	CA200261
		CA200293
	E.1b	CA200247
	N.1a	CA200723
No Slip Glazed	E.1a	CA200316
	E.1b	CA200295
		CA200300
	R.1a	CA200349
Quartz Slip Glazed	N.1a	CA200726
		CA200727
	R.1a	CA200344
Wollanstonite Slip Glazed	N.1a	CA200725
	R.1a	CA200372
Paint Under Glaze	E.1b	CA200234
		CA200318
Organic Residue	E.1a	CA200294

The two surface treatments identified via petrography are incised and glazed. The incised sherds have at least three groves along the edge, some shallower than others (Figure 6.2: A – C). Some of these edges have post depositional sparry calcite along the edges indicating it is not due to the manufacturing of the thin section (Figure 6.2: C). There are three types of glazing present, ones with no slip (Figure 6.2: E), ones with quartz rich slip (Figure 6.2: F), and ones with wollastonite slip (Figure 6.2: G). Two samples from Nippur have corrugated edges with the quartz rich slip and a bluish glaze. Most of the other glazes are clear or slightly cloudy. Two of the pieces have a dark brown layer under the glaze, possibly indicating painting (Figure 6.2: H). No differences were noted in terms of the surface decoration in comparison with sites or mineralogy.

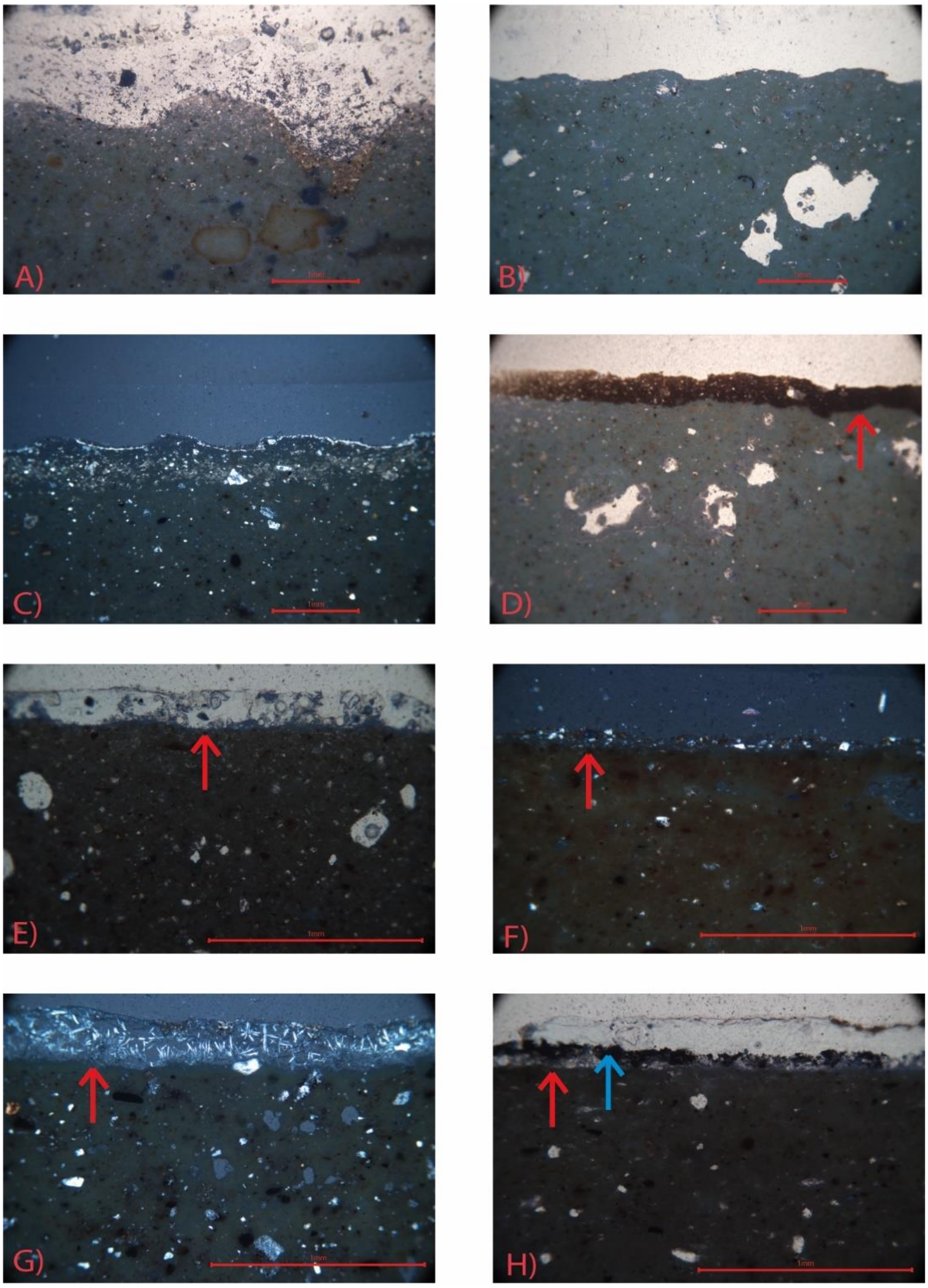

Figure 6.2: Photomicrographs of various surface treatments for Fine Quartz Rich Fabric. A) Incised, CA200261, PPL x40; B) Incised, CA200293, PPL, x40; C) Incised CA200247, XPL, x40; D) Organic residue (marked with red arrow), CA200294, PPL, x40; E) Glaze, no slip (marked with red arrow), CA200295, XPL, x100; F) Glaze, quartz slip (marked with red arrow), CA200344, XPL, x100; G) Glaze, wollastonite slip (marked with red arrow), CA200372, XPL, x100; H) Quartz slip (marked with red arrow), paint (marked with blue arrow), glaze, CA200234, XPL, x100.

6.1.1.2 Fine Biotite Rich Fabric (E.2a, E.2b, N.2, H.3, R.2a, R.2b)

Fine Biotite Rich Fabrics are defined by their reddish color, limited coarse fraction, and presence of biotite and iron-rich nodules. The matrix is homogenous red throughout the sample and optically inactive (indicating a higher fired temperature after Whitbread 1995). The samples have common to rare micro-vughs, and very rare meso-elongated voids, with weak to strong preferred orientation (Figure

6.3). The preferred orientation of voids and inclusions indicate the use of a potter's wheel, whereas the more random orientations indicates a handmade forming technique. The inclusions are unimodal in distribution, and there is very rare coarse fraction. As above, this could indicate a levigation of the clay, or a naturally occurring very fine clay. The choice of this fine clay, or the levigation of a coarser clay would allow for finer vessels to be made, with thinner walls.

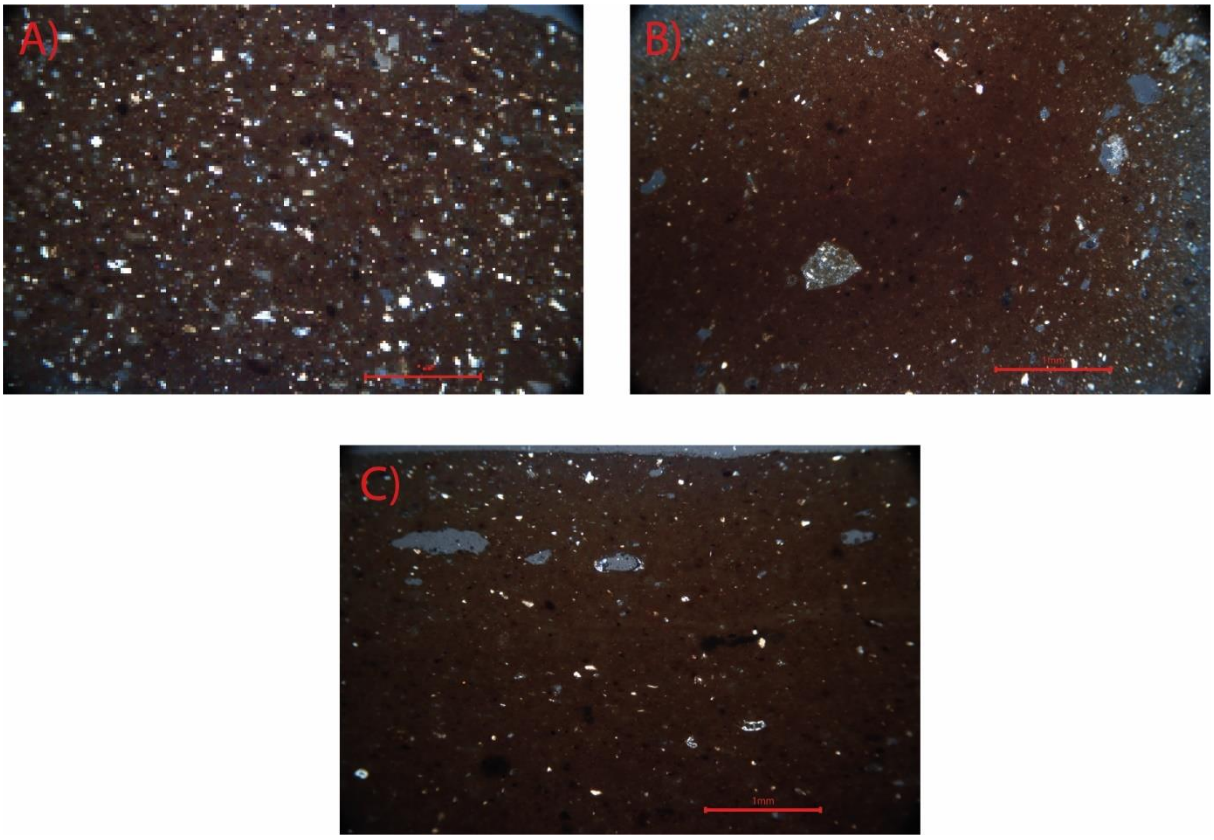

Figure 6.3: Photomicrographs showing the variation of the Fine Biotite Rich Fabrics. A) Wheelmade with parallel alignment, CA200236; B) Random alignment with larger inclusions, CA200331; C) Weakly aligned inclusions CA200350. All XPL x40.

In the al-Jazira fabrics (Figure 6.3: A – B; E.2a, E.2b), the coarse inclusions are few to rare quartz, opaques (iron-rich pellets), micritic limestone, chert, muscovite, biotite, radiolarian chert, shell, and a sedimentary rock fragment. Biotite could be found in river sediments, derived from the Pliocene to Eocene clastics that underlie the Erbil Plain (Petrik *et al.* 2020). As in the Fine Quartz Rich Fabric, the presence of micritic limestone is linked to the Fatha Formation with chert being part of the Pila Spi Formation. Both formations lie along the Qaraqosh and Zagros foothills, underlying the alluvial plains between these two ranges. Quartzite and muscovite may have come from the Injana Formation, which appears in the Qaraqosh Range and in the upper Zagros Mountains. These inclusions appear in samples from all EPAS sites illustrating a local or at least regional manufacture.

In the al-Iraq fabric (N.2), there are frequent quartz, few quartzite, muscovite, serpentinite, and rare opaques, biotite, chert, shell, and epidote in the coarse inclusions. As in the Fine Quartz Rich Fabric, most of these inclusions are part of the aeolian sands, and alluvial fans. Epidote and serpentinite are part of the alluvial fans which overly the Arabian shield. Quartzite is found in the Khabour Formation, which underlies the alluvial fans around Nippur. These inclusions indicate a local area of manufacture.

In the al-Ran fabric (Figure 6.3: C; H.3) the coarse inclusions are common quartz and biotite, rare chert, biotite schist, and opaques, and very rare micritic limestone and serpentinite. As with the Fine Quartz Rich Fabric, the quartz and limestone can be from any formation, whereas chert and serpentinite are from the Jurassic formations, and schist and biotite are from the various metamorphic rocks of the Dalma Formation, or the pre-Cambrian basin. The Jurassic formations are located under the alluvium surrounding Hasanlu, and the metamorphic formations are located around the edges of the Gadar River valley. Biotite schist is sub-rounded and very weathered, indicating an older formation, possibly brought to site via the Gadar River. These inclusions are all consistent with a local manufacture of the vessels at Hasanlu.

In the Iraq al-Ajam fabrics (R.2a, R.2b) coarse inclusions are common quartz, biotite, few chert, plagioclase feldspar, rare muscovite, very rare mudstone, quartzite, serpentinite, micritic limestone, zircon, quartzite, sparry calcite, possible basalt, amphibolite, and possible trachyte. Chert is probably from the Ruteh Formation, biotite, muscovite, and plagioclase feldspar are related to the metamorphic and igneous formations, quartzite is from the Milla or Karaj Formations, and serpentinite is from the Shemshak or Kahar Formations. Mudstone is from the Hezardarreh, Upper Red, or Dalichai Formations, of which there are outcrops around Rayy. Basalt, trachyte, and basic igneous rocks are all from the Ruteh or Dorud Formations with outcrops in the foothills of the Alborz Mountains. Micritic limestone can be from one of various limestone formations but is probably from the Tiz Kuh Formation due to its location, The Tiz Kuh Formation has outcrops just north of Rayy in the foothills. Amphibolite and hornblende are probably from the Kahar Formation, located under the Rayy plain. Zircon is from the Shemshak Formation, which also runs under the plain. Lastly, the calcite could be from any of the limestone or evaporate formations. The coarse inclusions all point to a local manufacturing area.

Table 6.2: Type of surface treatment, petrographic group, and scientific number for decorated sherds for the Fine Biotite Rich Fabrics.

Type of Surface Treatment	Petrographic Group	Scientific Number
No Slip Glazed	E.2a	CA200280
Quartz Slip Glazed	E.2a	CA200242
		CA200245
	E.2b	CA200241
		CA200250
	N.2a	CA200729
	R.2a	CA200325
	R.2b	CA200300
Quartz Slip	E.2a	CA200306

The surface decorations noted in the thin sections of the Fine Biotite Rich Fabric include no slip under the glaze, quartz slip under the glaze (Figure 6.4: B), and a quartz slipped layer (Figure 6.4: A). The slip on CA200306 is lighter than the body but is a definite layer in the thin section. The glazes range from clear to greenish to slightly cloudy. No differences were noted in terms of the surface decoration in comparison with sites or mineralogy.

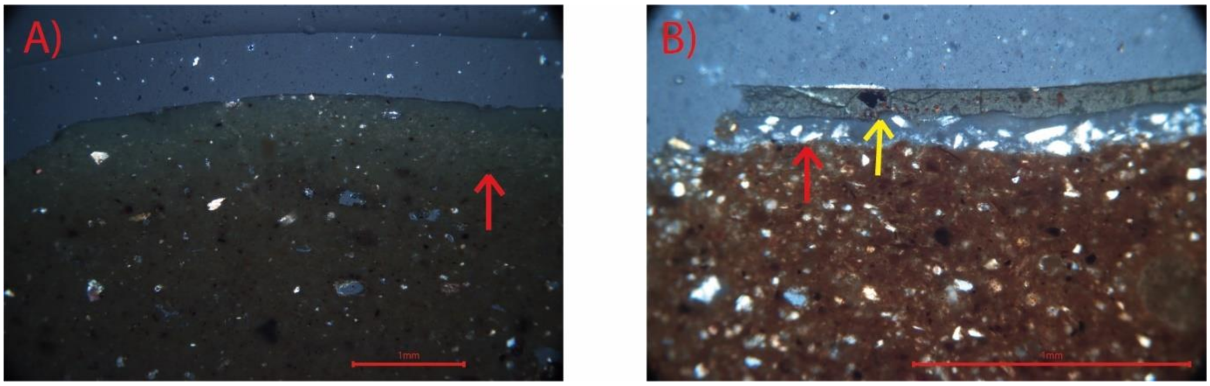

Figure 6.4: Photomicrographs of various surface treatments in Fine Biotite Rich Fabric A) Slip (marked with red arrow), CA200306, XPL, x40; B) Quartz rich slip (marked with red arrow) under a yellowish glaze (marked with yellow arrow), CA200250, XPL, x100.

6.1.1.3 Sedimentary Rich Fabric (R.3)

This Sedimentary Rich Fabric is only found at Rayy. It is untempered but does have more inclusions than the other two fine fabrics discussed above. This fabric has common micro-vughs and few meso-vughs. The inclusions are double-spaced in the coarse and fine fraction with no preferred oriented to the edge. The matrix is homogenous brown. There is some variation in the size of the fine and coarse fraction, but they all fall into a unimodal distribution. This combined with the fact that the inclusions are well sorted points to the fabric not being tempered, and the inclusions are naturally occurring.

The coarse inclusions (Figure 6.5) are characterized by the presence of common quartz and micritic limestone, few biotite, plagioclase feldspar, quartzite, and chert, and rare hornblende, a fine grained basic igneous rock, biotite schist, mudstone, calcite, and possible basalt and trachyte. These inclusions are discussed in the preceding section (Section 6.1.1.2). However, the abundance of coarse inclusions is more frequent in this fabric than in the Fine Biotite Rich Fabric. The mineralogy still points to a local area of manufacture.

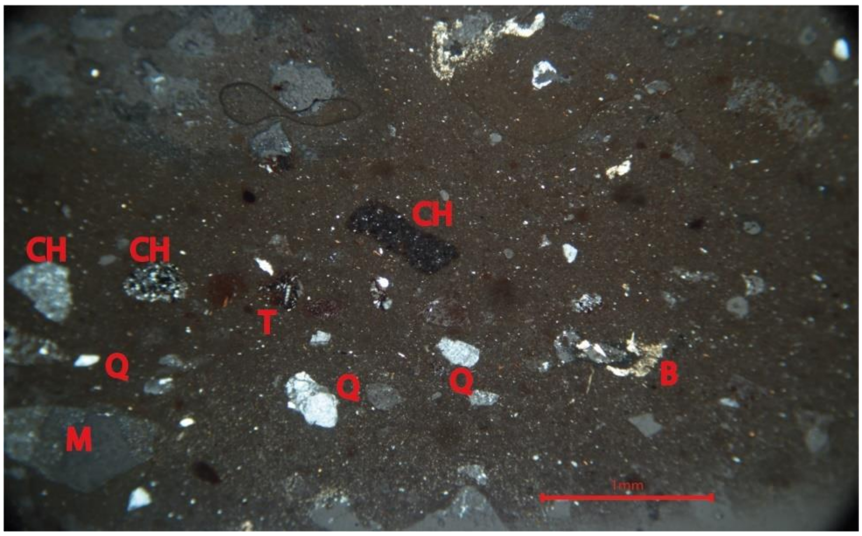

Figure 6.5: Photomicrograph showing inclusions CH-chert, T-trachyte, B-basalt, Q-quartz, and M-mudstone, CA200323, XPL, x40.

6.1.1.4 Quartz Rich Fabric (F.4)

This fabric is only found at Firuzabad and is very dense with few micro-vughs. The inclusions are open spaced in the coarse fraction, and single spaced in the fine fraction illustrating a fine fabric. The voids and inclusions do not display preferred orientation. The matrix is homogenous grey and optically inactive. There is some variation in the size of the fine and coarse fraction, but they all fall into a unimodal distribution, and hence the minerals are probably naturally occurring in the fabric.

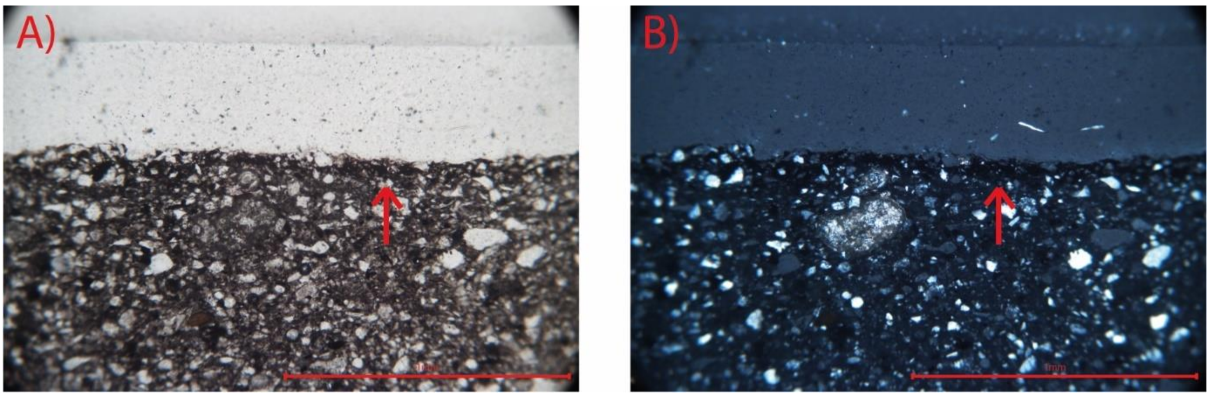

Figure 6.6: Photomicrograph of Quartz Rich Fabric and dark slip (marked with red arrow). CA200361, A) PPL, B) XPL, both x100.

The coarse inclusions (Figure 6.6) are few quartz, rare chert and plagioclase and very rare epidote. Quartz is found in all formations, plagioclase feldspar and epidote are found in most metamorphic/igneous rocks, and the chert is found in Ruteh Formation. In the fine fraction there is dominant quartz, and as such it could be a proto-stonepaste or stonepaste fragment. This fabric is very similar to the stonepaste ware found at Nishapur (Rante & Collinet 2013, 95: Fig. 62e). However, they state that due to the presence similar minerals and rocks in all stonepaste sampled at Nishapur, they could not establish the manufacturing provenience. This means these fabrics could be made close to Nishapur or brought in from farther away. The same is true for this sample. This sample does have a dark band along one edge, possibly indicating a dark grey slip on the vessel (Figure 6.6).

6.1.2 *Coarse/Mineral Tempered Fabrics*

6.1.2.1 Quartz and Quartzite Tempered Fabric (E.6, E.7, E.8, N.4, R.4)

The Quartz and Quartzite Tempered Fabrics are defined by their calcareous clays, quartz rich fine fraction, and bimodal nature of inclusions. They are relatively dense with few micro- and meso-vughs. The inclusions have no to strong preferred oriented to the edge of the sample. The preferred orientation of voids and inclusions indicate a wheelmade method of manufacture, whereas no preferred orientation indicates a handmade forming technique. A few have a spiral orientation indicating possible relict coils and hence a coilmade forming technique (Figure 6.7: A, C).

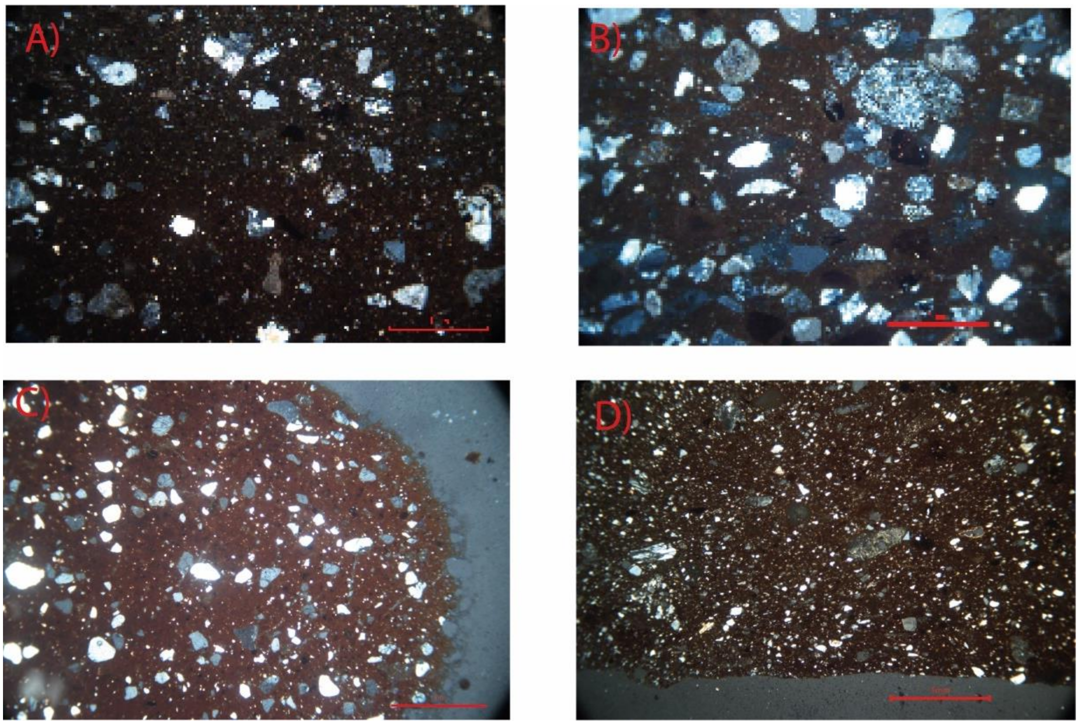

Figure 6.7: Photomicrographs of variations in Quartz and Quartzite Tempered Fabrics. A) Possible relict coil, CA200288; B) Random alignment, CA200278; C) Possible relict coil, CA200724, D) Random alignment, CA200340. All XPL, x40.

The matrix is homogenous in color and optically inactive, illustrating a higher firing temperature (Whitbread 1995). However, the color varies from greenish (R.4), to yellowish brown (E.6) to red (E.7, E.8, N.4). The various color indicate different types of firings and underlying minerals in the clay between sites. The poorly sorted bimodal nature of the inclusions, especially quartzite, quartz, chert, and limestone along with their slightly angular nature possibly point towards a crushed sand temper being added to these clays.

The al-Jazira fabrics (Figure 6.7: A – B; E.6, E.7, E.8) are marked by the presence of common quartzite and few to rare opaques, quartz, chert, micritic limestone, shell, orthoclase feldspar, biotite schist, plagioclase feldspar, shell, and possible rhyolite, granite, and basalt. As above, quartz, chert, and limestone are found across the region, in the alluvium and along the foothills of the Qaraqosh and Zagros Mountains. Quartzite and biotite schist are possibly from the Injana Formation in the Qaraqosh or Zagros Mountains, but as this formation also underlies the alluvial plain, it could be from there as well. Rhyolite, granite, basalt, and serpentinite are possibly from the Kata Rash Formation in the upper Zagros Mountains, but due to its rare nature and sub-rounded form in this sample, was probably brought to the site naturally, either by wind or water. The poorly sorted bimodal nature of the inclusions, especially quartzite, quartz, and chert, along with their slightly angular nature possibly point towards a crushed quartz sand temper being added to the fabric. All the inclusions point to a regional manufacture.

The al-Iraq fabrics (Figure 6.7: C; N.4) have coarse inclusions of frequent quartz and very rare mudstone and chert. These are all present near Nippur in the alluvial fans, leading to a probable local manufacture. The poor sorting and bimodal grain size, with the sub-angular nature of the quartz points towards using a quartz sand which has been crushed as a tempering agent. The mudstone and chert are probably naturally occurring inclusions as they are sub-rounded and present in the alluvial fans.

The Iraq al-Ajam (Figure 6.7: D; R.4) inclusions are frequent quartz, common biotite, few orthoclase feldspar, mudstone, chert, plagioclase feldspar, micritic limestone, and rare hornblende, calcite, serpentinite, and quartzite. As with other samples from Rayy, quartz and calcite could be from any formation and biotite and feldspars are from any metamorphic/igneous rocks that surround Rayy. Chert is probably from the Ruteh Formation, located along the foothills of the Alborz Mountains. Mudstone is from the Hezardarreh, Upper Red, or Dalichai Formations all of which exist around Rayy. Micritic limestone, like above is probably from the Tiz Kuh Formation. Hornblende and serpentinite are from the Kahar Formation, which underlies the Rayy Plain. Lastly, quartzite is from the Milla or Karaj Formations which also extend under the plain. Based on this mineralogy, these vessels were probably all made locally. These samples were probably tempered by crushed sand containing quartz, feldspars, and limestone due to the angularity of the inclusions, and their bimodal nature.

6.1.2.2 Sedimentary Tempered Fabric (E.3a, E.3b, E.3c)

Sedimentary Tempered Fabrics are all found on the Erbil Plain. They are defined by their relatively dense fabrics, rounded sedimentary inclusions, and a bimodal distribution of inclusions. They are relatively dense with few micro- and meso-vughs. The inclusions are double to open spaced in the fine fraction and single to double in the coarse fraction and do not have a preferred orientation to the edge with some possible relict coils present (Figure 6.8). Most of the samples are homogenous across the sample but vary between samples from yellowish to reddish brown. A few samples (3) are heterogenous across the sample with a reddish-brown edge and a black core indicating a shorter firing time, or variable firing temperatures (Whitbread 1995). The matrix in all samples is optically inactive.

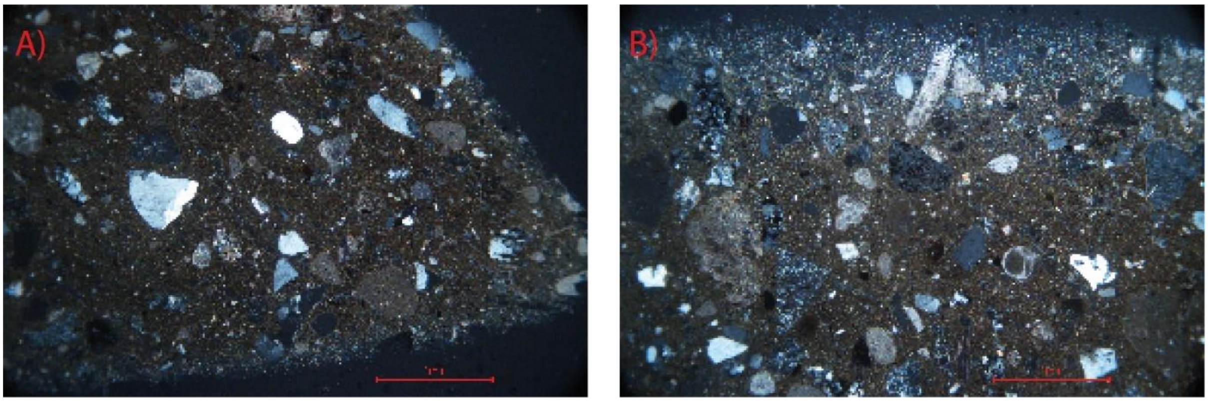

Figure 6.8: Photomicrograph of sample CA200268 illustrating two possible relict coils, both XPL, x40.

All subgroups have similar mineralogy (Figure 6.9), consisting of frequent to few chert, micritic limestone, quartz, quartzite, metamorphic rock (hornfel?), and few to rare biotite schist, amphibole, sparry calcite, siltstone, mudstone, opaque, radiolarian chert, serpentinite, shell, plagioclase feldspar, calcite, epidote, orthoclase feldspar, muscovite, biotite, and possible gneiss. Micritic limestone in some samples has begun to dissolve leaving darker reaction rims around the minerals. The bimodal distribution points towards the addition of a sand-based temper (mainly sedimentary rocks, with rare metamorphics). The sub-rounded to rounded nature of the inclusions point towards an alluvial, either wind or water based, sediment.

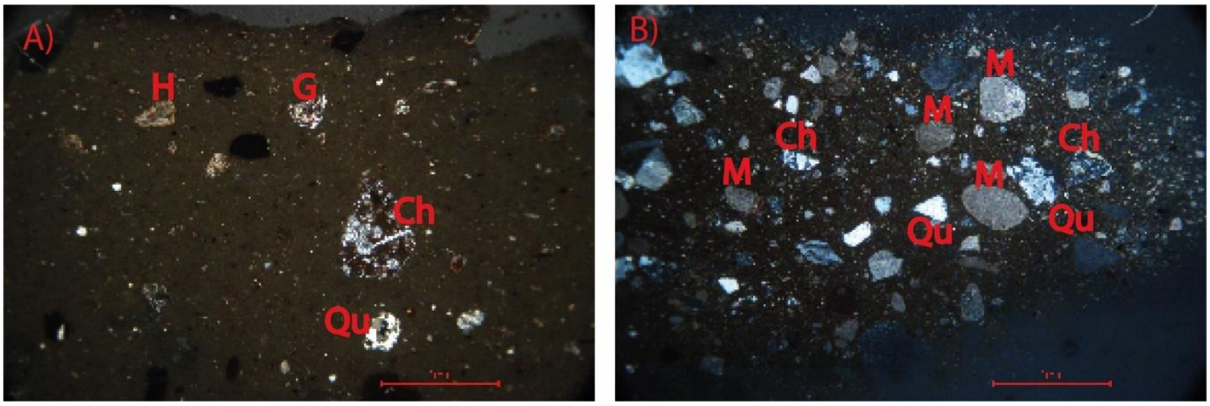

Figure 6.9: Photomicrographs of various inclusions in the Sedimentary Tempered Fabric, A) CA200240; B) CA200276. Both XPL x40. H-hornblende, G-gneiss, Ch-chert (A has radiolarian chert), Qu-quartzite, M-micritic limestone.

In terms of mineralogy, the sources of chert, limestone, and quartzite have been discussed above (6.1.1.1). The presence of non-foliated metamorphic rock (hornfel?), serpentinite, and biotite schist appear in the Injana Formation in the Qaraqosh and upper Zagros Mountains. Siltstone and mudstone are related to multiple formations, but the reddish mudstone is probably from either the Injana or Gercus Formations, and the greyish mudstone is from the Mukdadiya Formation, all of which underlie the Erbil Plain. Amphibolite and gneiss are related to the Injana Formation, and the three sites where these sherds were recovered, are located near the base of the Qaraqosh Mountains (217, 276) and the Zagros foothills (519). Sparry calcite could be from the Chia Gara Formation, which underlies the Erbil Plain; however, with all the other formations including limestones, mudstones, and sandstones this sparry calcite could be from any formation. These vessels are probably being made locally to where they were recovered.

Table 6.3: Surface treatment, petrographic group, and scientific number for the decorated Sedimentary Tempered Fabrics.

Type of Surface Treatment	Petrographic Group	Scientific Number
Incised	E.3a	CA200307
		CA200253
Quartz Slip Glaze	E.3a	CA200279

The surface decorations present in the petrography were incised and a quartz slip under a clear glaze. No differences were noted in terms of the surface decoration in comparison with sites or mineralogy.

6.1.2.3 Sand Tempered Fabric (N.3)

The Sand Tempered Fabric was only found at Nippur and is defined by the moderately sorted bimodal inclusions, calcareous clays, and a mixture of sedimentary inclusions. The inclusions are single- to double-spaced in both coarse and fine fractions. The matrix is homogenous brown and optically inactive. There are rare meso-vughs and frequent shrinkage cracks in the matrix. The voids and inclusions are weakly aligned to the edge.

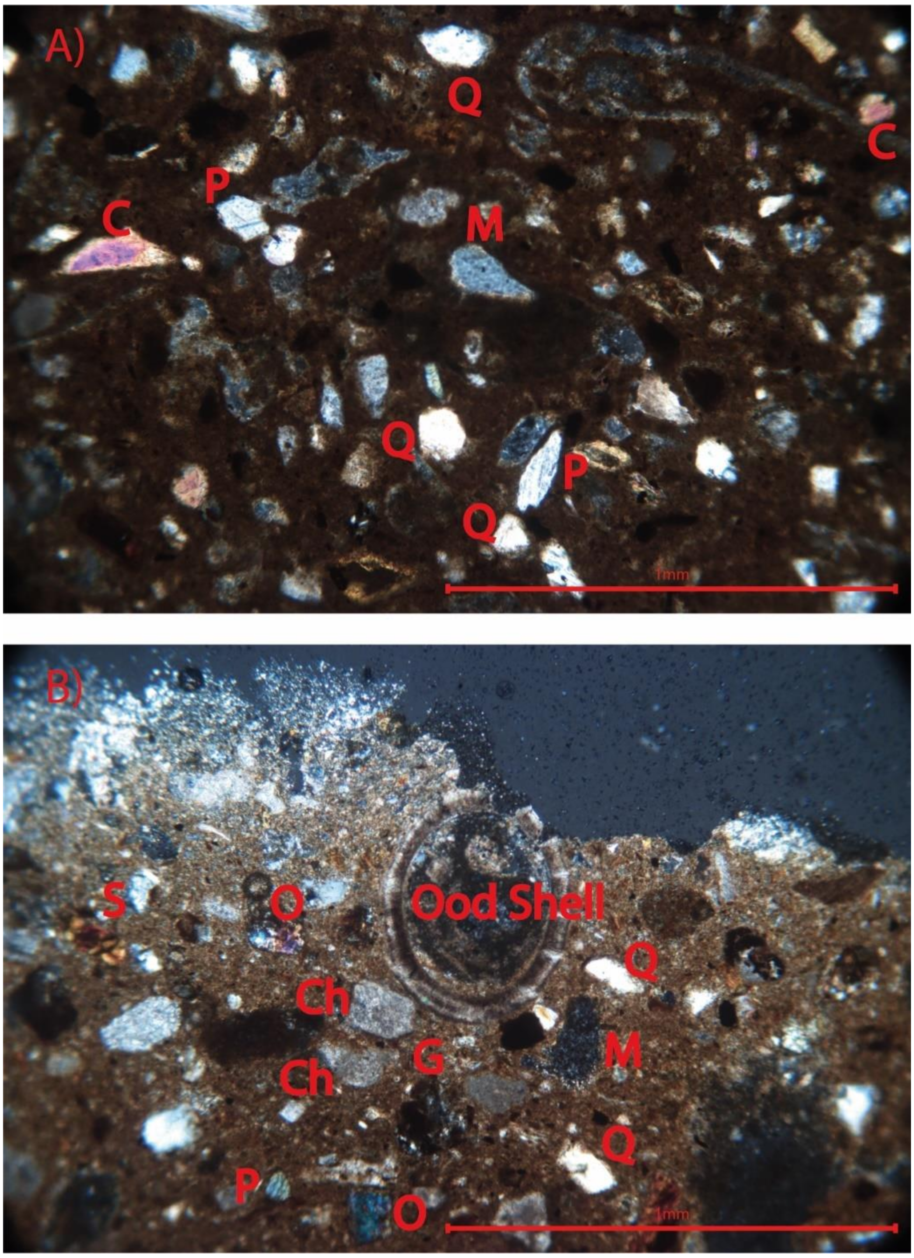

Figure 6.10: Photomicrograph of Sand Tempered Fabrics A) CA200733, B) CA200734, both XPL, x100. Q-quartz, P-plagioclase feldspar, C-calcite, M-mudstone, Ch-chert, O-olivine, S-serpentinite, G-granite.

The inclusions in the coarse fraction (Figure 6.10) consist of frequent quartz, common plagioclase feldspar, olivine, calcite, serpentinite, ood shell, few mudstone, opaques, bioclast shell, chert, quartzite, hornblende, and very rare basalt, biotite, granite, and muscovite. The Khabour Formation includes the quartzite and is located under the alluvial fan surrounding Nippur. Quartz, granite, mudstone, biotite, and muscovite are present in the Dibdibba Formation, which runs under the alluvial fans. The alluvial fans also include serpentinite, hornblende and olivine. The Sabkhas include the calcite and shells, and the aeolian sands are made up of quartz, chert, and plagioclase feldspar. Basalt originates from either the highlands of Turkey, or in the upper Zagros Mountains. Due to basalt’s very rare nature in these samples, and its rounded shape, it was brought to the Nippur region via the Euphrates or Tigris Rivers. This fabric was tempered by a sedimentary sand which included quartz, plagioclase feldspar, olivine, calcite, and serpentinite. This is due to the bimodal nature, as well as the angular nature of these grains, indicating the sand was probably crushed before the addition. It was made locally to Nippur.

6.1.2.4 Basalt and Trachyte Tempered Fabric (R.5a, R.5b)

The Basalt and Trachyte Tempered Fabrics were only found at Rayy and are defined by their mineralogy, dense fabric, and biotite and iron-rich clay. The matrix has few micro- and meso-vughs, and rare meso-elongated voids, double-spacing of inclusions in coarse fraction, and the voids and inclusions do not illustrate a preferred orientation. The coarse inclusions are poorly sorted and bimodal, leading to these samples probably being tempered. The matrix color of both subgroups is homogenous reddish brown.

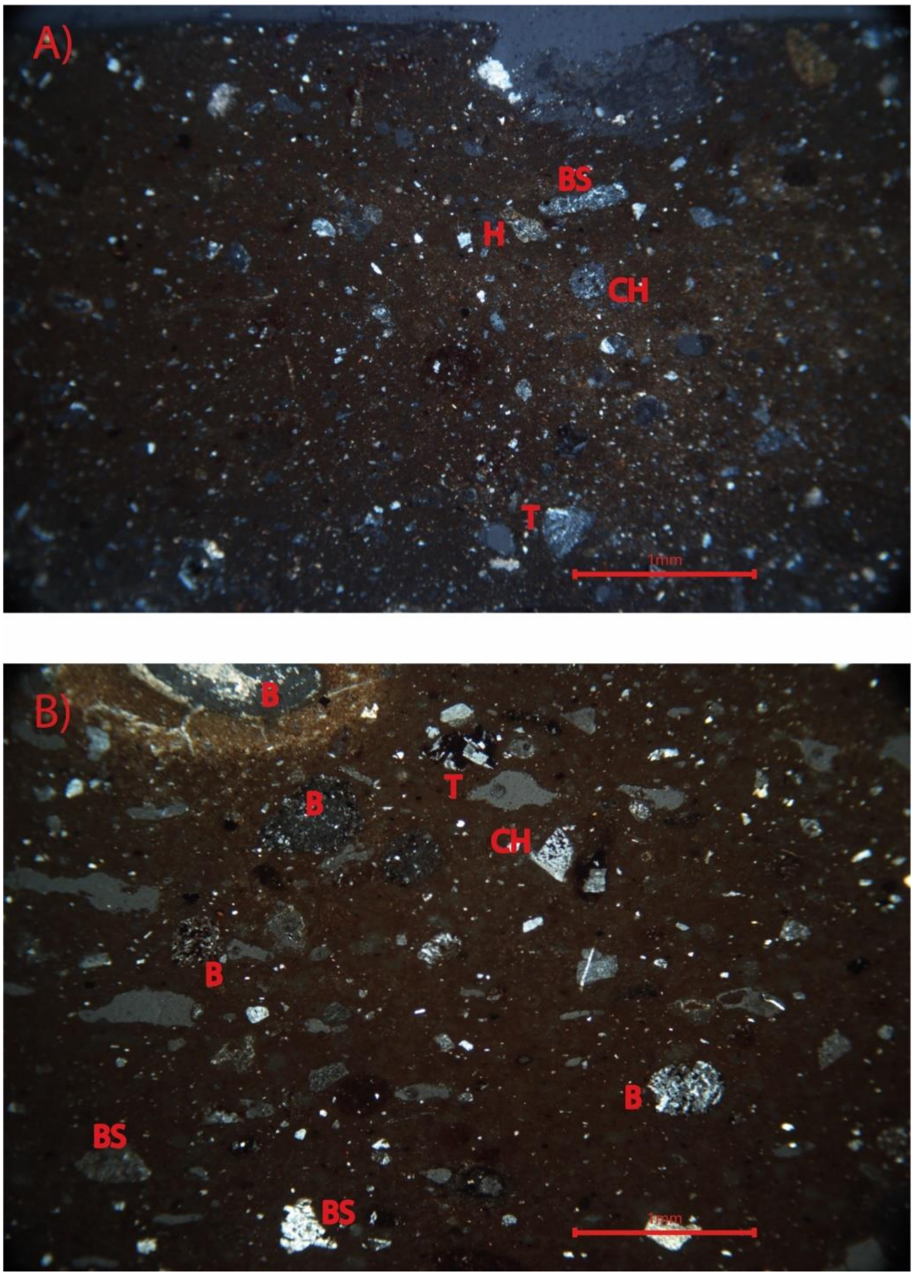

Figure 6.11: Photomicrograph of inclusions in Biotite and Trachyte Fabrics A) Biotite schist, chert, trachyte, CA200324; B) Various cherts, biotite schist, trachyte, CA200371. All XPL x100. B-basalt, BS-biotite schist, CH-chert, H-hornblende, T-trachyte.

The coarse fraction (Figure 6.11) has common quartz, biotite, few chert, mudstone, plagioclase feldspar, biotite, serpentinite, basalt, trachyte, and orthoclase feldspar, and rare chert, calcite, muscovite, micritic limestone, a fine grained foliated metamorphic rock, quartzite, dolomitic limestone, epidote, and hornblende. Like other samples from Rayy, quartz and calcite could have been from any formation, whereas biotite, feldspar, and muscovite could have derived from the metamorphic/igneous rocks which are in the foothills surrounding Rayy. Basalt and trachyte could have originated from the Ruteh or Dorud Formation, and the chert is probably from the Ruteh Formation. These formations are located along the foothills of the Alborz Mountains. Mudstone is from the Hezardarreh, Upper Red, or Dalichai

Formations all of which can be found around Rayy. Micritic limestone, like above is probably from the Tiz Kuh Formation, but may also be found in the Karaj, Dalichai, Elika, Mall, and Barut Formations. All these formations surround the Rayy plain. Hornblende, epidote, serpentinite, and metamorphic rock are all probably from the Kahar Formation, which underlies the Rayy Plain. Lastly, quartzite is from the Milla or Karaj Formations which also extend under the plain. Based on this mineralogy, these samples were probably all made locally. These samples were probably tempered by a crushed igneous sand, identified due to the angular bimodal nature of the inclusions.

6.1.2.5 Schist and Limestone Tempered Fabric (E.4)

Schist and Limestone Tempered Fabric is only found on the Erbil Plain. It is defined by the poorly sorted nature of inclusions, and the bimodal grain size points to this fabric being tempered by various types of schist and limestone. This is a coarse-grained fabric with frequent shrinkage cracks surrounding the inclusions. The distribution of inclusions is single-spaced in the coarse and fine fractions, and the grain size is coarser than all other fabrics, with a mode grain size of 0.46 mm, and the largest inclusion measuring 2.10 mm. The inclusions have a preferred orientation to the edge, leading to them probably being wheelmade. The matrix is homogenous in color, and optically inactive.

The coarse inclusions are common to few biotite schist, chert, quartzite, sillimanite schist, amphibolite, limestone and few to rare quartz, muscovite, opaques, orthoclase feldspar, and plagioclase feldspar (Figure 6.12). Schists, limestone, and amphibole are weathered with the amphibolite altering to chlorite, and the sillimanite altering to clay. These are related to the Walash and Qandil Formations, located along the Zagros thrust zone. Limestone is from the Jeribe Formation, along the foothills of the Zagros. These formations do not extend under the Erbil Plain, and there is no water source linking the upper Zagros (in the east) with the western Erbil Plain. Therefore, the vessels were possibly made along the foothills or higher up in the Zagros and exchanged to site 217 on the western edge of the Erbil Plain.

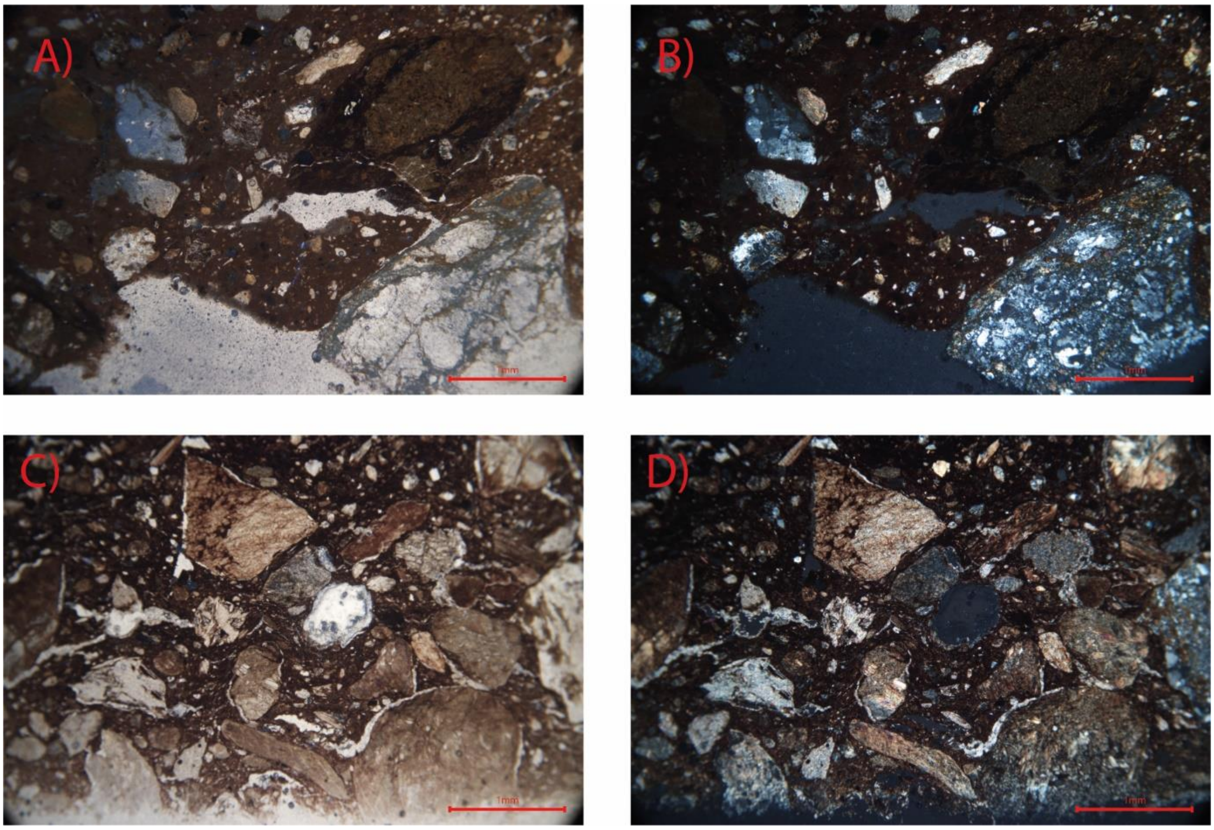

Figure 6.12: Photomicrographs of samples from Schist and Limestone Fabric. A and B) CA200257 with serpentinite, sillimanite schist, amphibolite, and chert, PPL and XPL, x40, C and D) Sample CA200262 with amphibolite, chert, limestone, and schist, PPL and XPL, x40.

6.1.2.6 Schist Tempered Fabric (H.1)

Schist Tempered Fabric is found at Hasanlu and is defined by the presence of various inclusions derived from metamorphic and igneous rocks with poor sorting and bimodal grain size (Figure 6.13). The matrix is reddish brown and homogenous throughout the sample. The inclusions are single- to double-spaced in the coarse fraction and double-spaced in the fine fraction. There are common meso-vughs and few meso-elongated voids in the fabric. The voids and inclusions are weakly to strongly oriented to the edge, pointing towards a wheelmade forming technique.

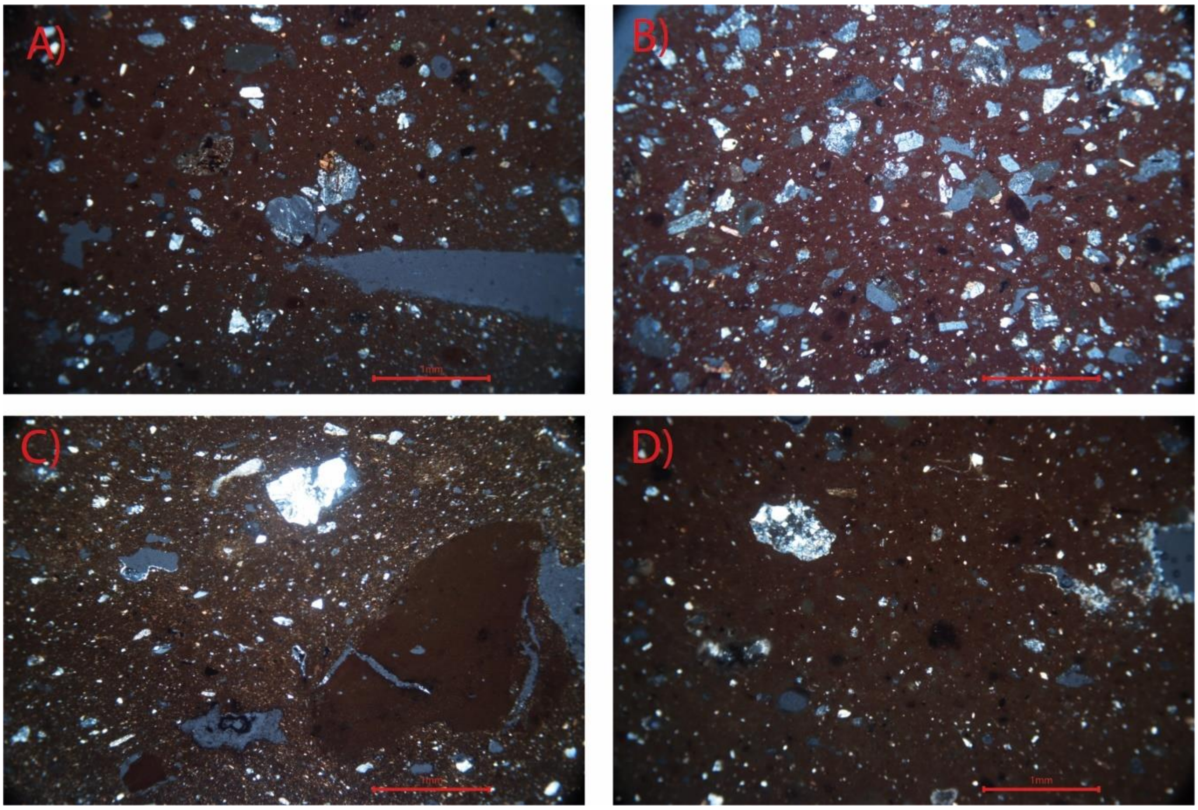

Figure 6.13: Photomicrograph of samples showing angularity of inclusions and weak to strong orientation A) CA200364, B) CA200365, C) CA200366, D) CA200368, all XPL x40.

The coarse inclusions consist of frequent quartz, serpentinite, hornblende, common quartzite, opaques, limestone, chert, possible quartz schist, few biotite, possible biotite schist, basalt, and rare plagioclase feldspar and muscovite. Quartz and limestone can be found in most formations around Hasanlu, including the Qom Formation and mudflat/alluvium. Chert, serpentinite, and hornblende are all found in the Jurassic formations, mainly the Garu Formation which underlies the mudflats and alluvial deposits. Basalt could have come from multiple formations including the Ruteh, Lower Red, Faragan, and Soltaneh. There are outcrops of the Lower Red and Soltaneh Formations near Hasanlu. Schists could have come from various metamorphic formations of the Jurassic period, the Dalma Formation, or the pre-Cambrian basin. These formations are located in the upper Zagros Mountains and were probably brought close to Hasanlu by the Gadar River. Lastly, quartzite is probably derived from the Milla Formation, which is also located in the upper Zagros. The inclusions point to a local area of manufacture.

Table 6.4: Type of surface treatment, petrographic group, and scientific number for decorated Schist Tempered Fabrics.

Type of Surface Treatment	Petrographic Group	Scientific Number
No Slip Glaze	H.1	CA200366
Quartz Slip Glaze	H.1	CA200368

Two of the samples have glaze present on their edges. CA200368 has a quartz rich slip and a clear to bluish glaze (Figure 6.14: A – B), and CA200366 has a clear glaze with no slip (Figure 6.14: C – D).

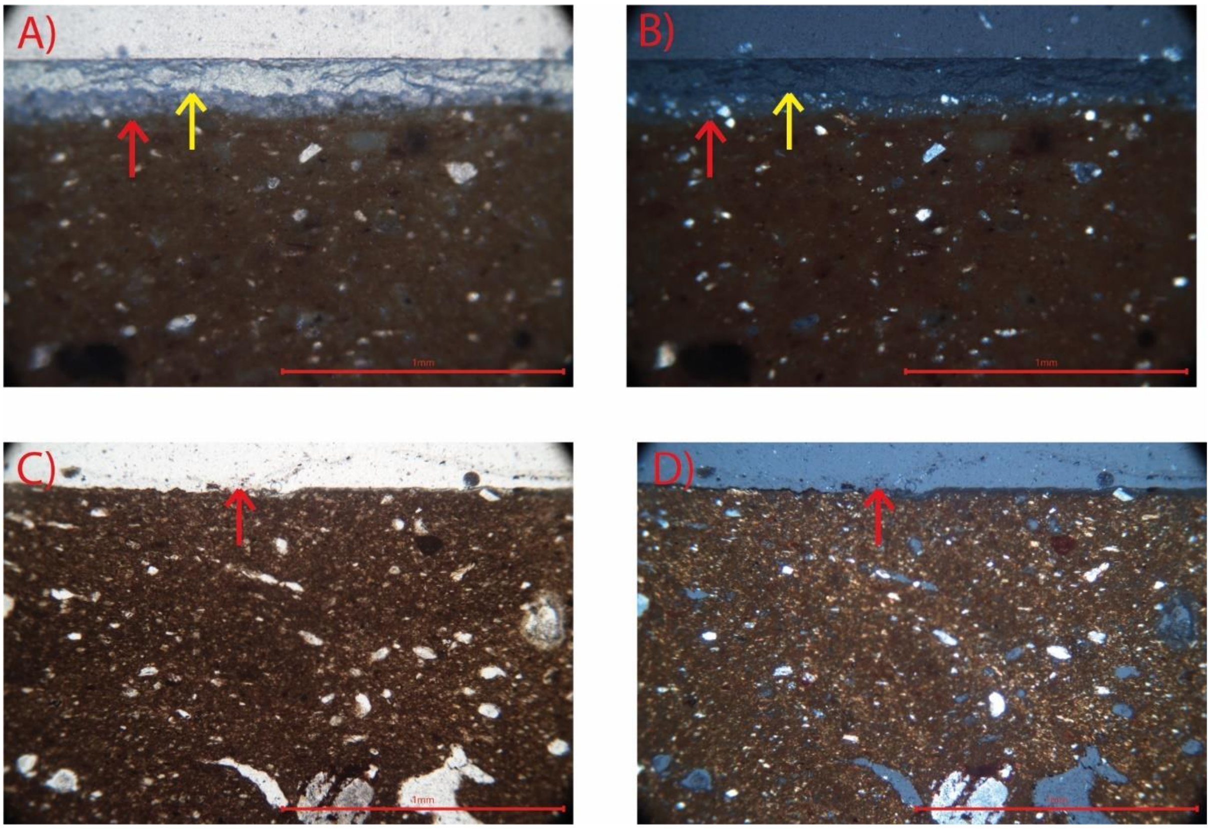

Figure 6.14: Photomicrograph showing glazing techniques, A and B) CA200368, clear glaze (yellow arrow) on top of quartz slip (red arrow), C and D) CA200366, clear glaze (red arrow) on top of body. A and C) PPL, B and D) XPL all x100.

6.1.2.7 Dolerite Tempered Fabric (N.5)

The one piece of Dolerite Tempered Fabric is found at Nippur and defined by the presence of olivine dolerite. The fabric is relatively dense with rare micro-vughs and few shrinkage cracks. The inclusions are single- to double-spaced in the coarse fraction and open-spaced in the fine fraction. The inclusions and voids are randomly aligned, pointing to the possible use of handmade or coilmade method of manufacture. The matrix is homogenous brown and optically inactive.

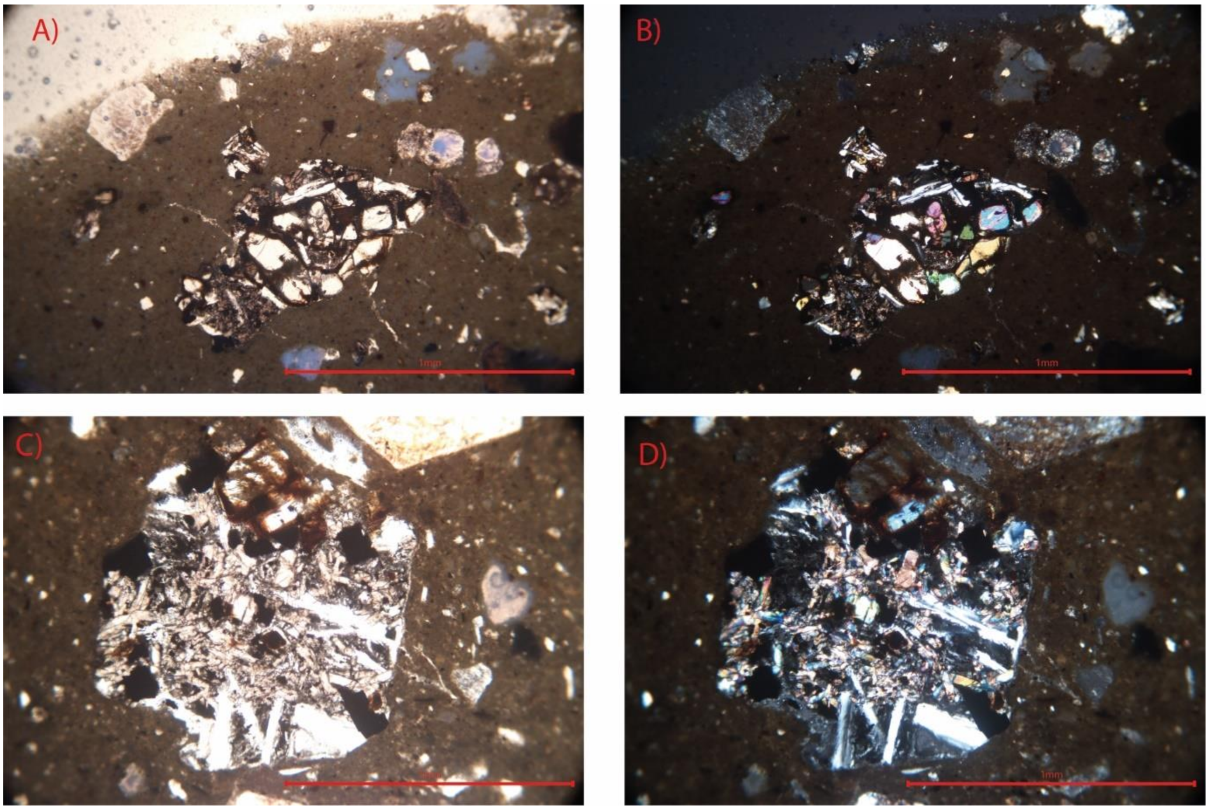

Figure 6.15 Photomicrograph of olivine dolerite fragments from sample CA200735. A and C) PPL, B and D) XPL all x100.

The coarse inclusions are frequent olivine dolerite (Figure 6.15), few chert, quartz, serpentinite, olivine, plagioclase feldspar, mudstone, and quartzite. Mineralogically, this fabric does not match the area around Nippur. Olivine dolerite, as an igneous rock, is found along the high folded zones of the Zagros (northeast and eastern Iraq, northwest and western Iran) and a study on basalt stone tools found in Iraq points to northeast of Iran (around Nishapur) as a source for olivine dolerite (al-Zubaidi *et al.* 2021). Based on the frequency of dolerite, this vessel was possibly manufactured in the Zagros, with dolerite coming from the Gercus Formation. The vessel would have then been exchanged to Nippur.

6.1.2.8 Igneous and Scoria Tempered Fabrics (F.2a, F.2b, F.2c)

The Igneous and Scoria Tempered Fabrics are all found at Firuzabad. They are defined by their extrusive igneous rocks, heterogeneous fabrics, and a lack of preferred orientation of inclusions and voids. This fabric has common meso-vughs, few to rare meso-elongated voids, and rare macro-vughs. The matrix is heterogenous, and a speckled b-fabric indicating a possible mixing of clays, as well as a low firing temperature (Quinn 2013). The inclusions are single- to double-spaced in both coarse and fine fraction. In all samples, the inclusions in the coarse fraction are poorly sorted with an overall bimodal grain size distribution pointing towards a tempering of the fabric.

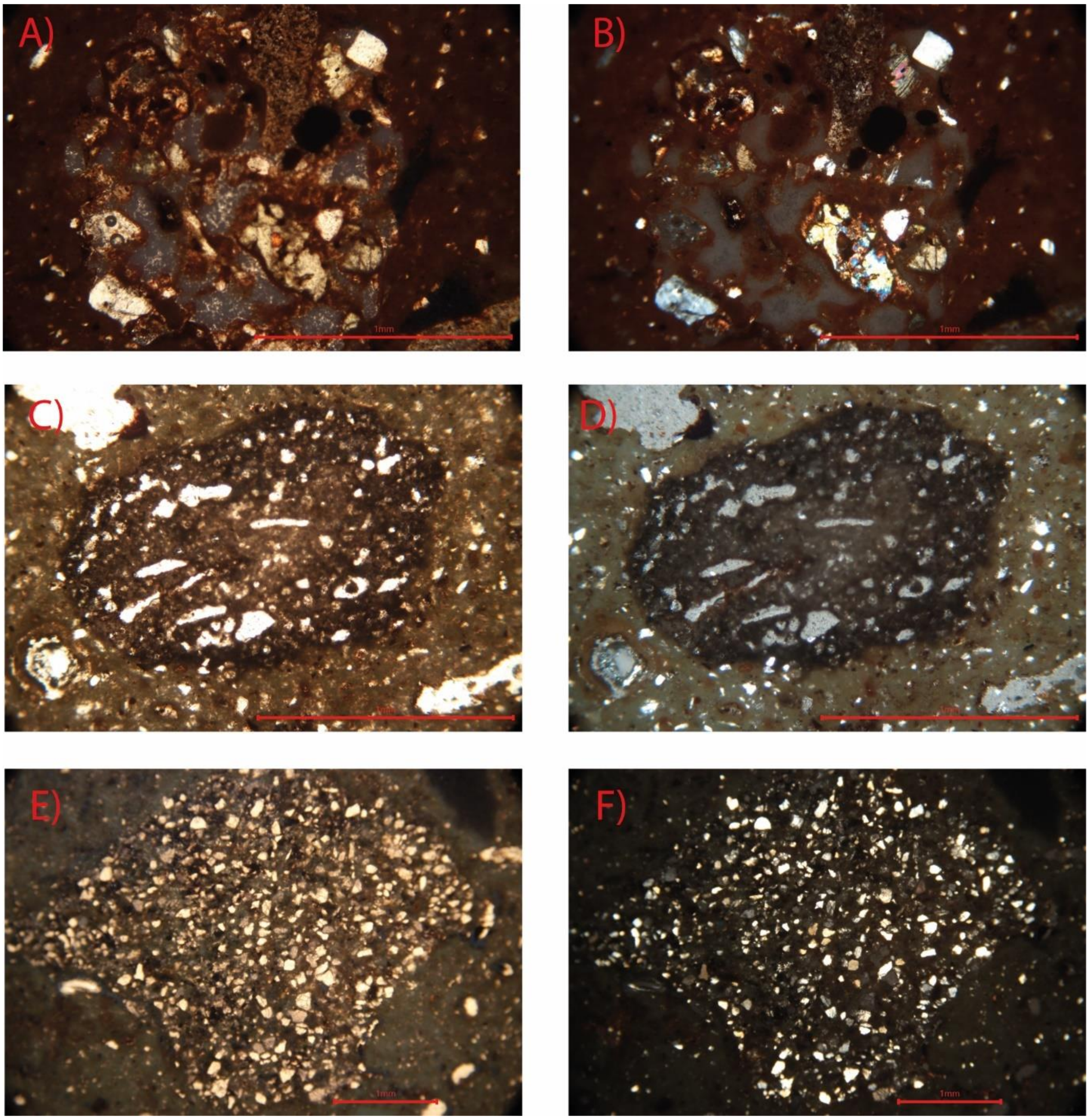

Figure 6.16: Photomicrographs of rock inclusions in samples A and B) Conglomerate fragment in CA200359 PPL and XPL, x100; C and D) Scoria fragment in CA200358, PPL and XPL, x100; E and F) Sandstone fragment in CA200358, PPL and XPL, x40.

The coarse inclusions are common quartz, biotite, possible andesite, plagioclase feldspar, few scoria (Figure 6.16: C and D), chert, micritic limestone, greywacke, possible trachyte, rare serpentinite, mudstone, sandstone (Figure 6.16: E and F), quartzite, conglomerate rock fragment (Figure 6.16: A and B), very rare amphibolite, epidote, and possible gneiss. Quartz could be from any formation. Biotite, plagioclase feldspar, and epidote could be from any of the metamorphic or igneous rocks in the Eocene/Paleocene volcanics, Shemshak, Ruteh, Dorud, Sardar, Jamal, or Kahar Formations. These formations are located along the Alborz Mountains to the north of Firuzabad. Andesite and scoria are both extrusive igneous rocks, and as such come from the Eocene and Paleocene volcanic formations located along the Alborz Mountains. Greywacke, mudstone, and conglomerate are probably from the

Hezardarreh Formation underlies the valley. Micritic limestone is probably from the Magu group (Parvadeh and Esfandiar Formations) located along the foothills of the Eastern Iranian Range. The sandstone could be related to the Magu group (Baghamshah, Qaleh Dokhter Formations), or the Hezardarreh, Dorud, Milla, and Laloon or Zaigun Formations. All these sedimentary rocks are located close to Firuzabad. Trachyte is found in the Ruteh or Dorud Formations, and the chert is from the Ruteh Formation located along the Eastern Iranian Range to the south of Firuzabad. Serpentinite, amphibolite, hornblende, and quartzite are related to the Kahar Formation, which underlies the valley in which Firuzabad is located. Lastly, the possible gneiss (which includes very weakly foliated quartz, plagioclase, and biotite) is from the Shemshak Formation which includes weakly foliated rocks. This formation is located in the Eastern Iranian Range. These inclusions are consistent with a local manufacture of these vessels.

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6.1.3 *Vegetal Tempered Fabrics*

6.1.3.1 Vegetal Tempered Fabric (E.5a, E.5b, R.6)

This is a relatively homogenous group with elongated void, pointing to the use of vegetal matter as temper. The voids are common meso-elongated voids and frequent meso-vughs. Some of the voids are slightly curved, and most have post-depositional sparry calcite in the voids. Some of the elongated voids have dark spots in along the edges or in the voids, identifying it as vegetal, possibly chaff. Both voids and inclusions have a preferred orientation to the edge indicating the use of a potter's wheel. Due to the size and amount of these mineral inclusions present, they are probably naturally occurring, whereas the vegetal matter has been added to the fabric.

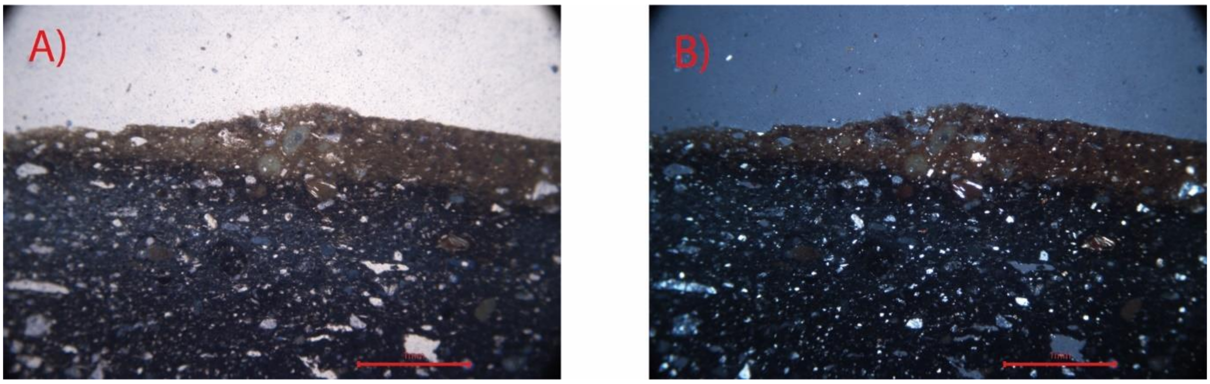

Figure 6.17: Photomicrographs showing the darker core, lighter edges, and elongated voids indicating vegetal temper, CA200332, PPL and XPL, x40.

The matrix color varies depending on the firing, from homogenous brown to heterogenous red to black (Figure 6.17). The homogenous samples have been fired for a longer time, with a steady temperature, and in an oxidizing atmosphere (Whitbread 1995), and the heterogenous samples show evidence of a shorter firing time, variable firing temperatures, or a reducing atmosphere, leaving a dark core with a reddish/brownish edge.

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The al-Jazira (Figure 6.18; E.5a, E.5b) samples have the same mineralogy, with the fine fraction including few quartz, opaques, micritic limestone, and rare quartzite, chert, muscovite, calcite, plagioclase feldspar and epidote. Like other fabrics, quartz, limestone, chert, and calcite are from the Fatha and Pila Spi Formations along the foothills of the Zagros and underlie the Erbil Plain. The presence of these minerals and rocks are found in the alluvial and flood plain consistent with a local manufacture of these vessels. Quartzite and muscovite could have come from the Injana Formation, which appears in the Qaraqosh range and in the upper Zagros.

The Iraq al-Ajam (Figure 6.17; R.6) fine inclusions have frequent quartz, common mudstone, few felsic igneous rock fragment, rare epidote and quartzite, and very rare chert and plagioclase feldspar. Quartz could have derived from any formation, whereas the epidote, feldspars, and igneous rock fragments are from any of the metamorphic/igneous rocks that underlie Rayy. The felsic nature of the igneous rock points to an origin in the Lower Red or Alborz Green Beds Formations. Chert is probably from the Ruteh Formation. These three formations are located along the foothills of the Alborz Mountains. The mudstone is from the Hezardarreh, Upper Red, or Dalichai Formations all of which exist around Rayy. Lastly, the quartzite is from the Milla or Karaj Formations which underlie the plain. These are all consistent with a local manufacture of the vessels.

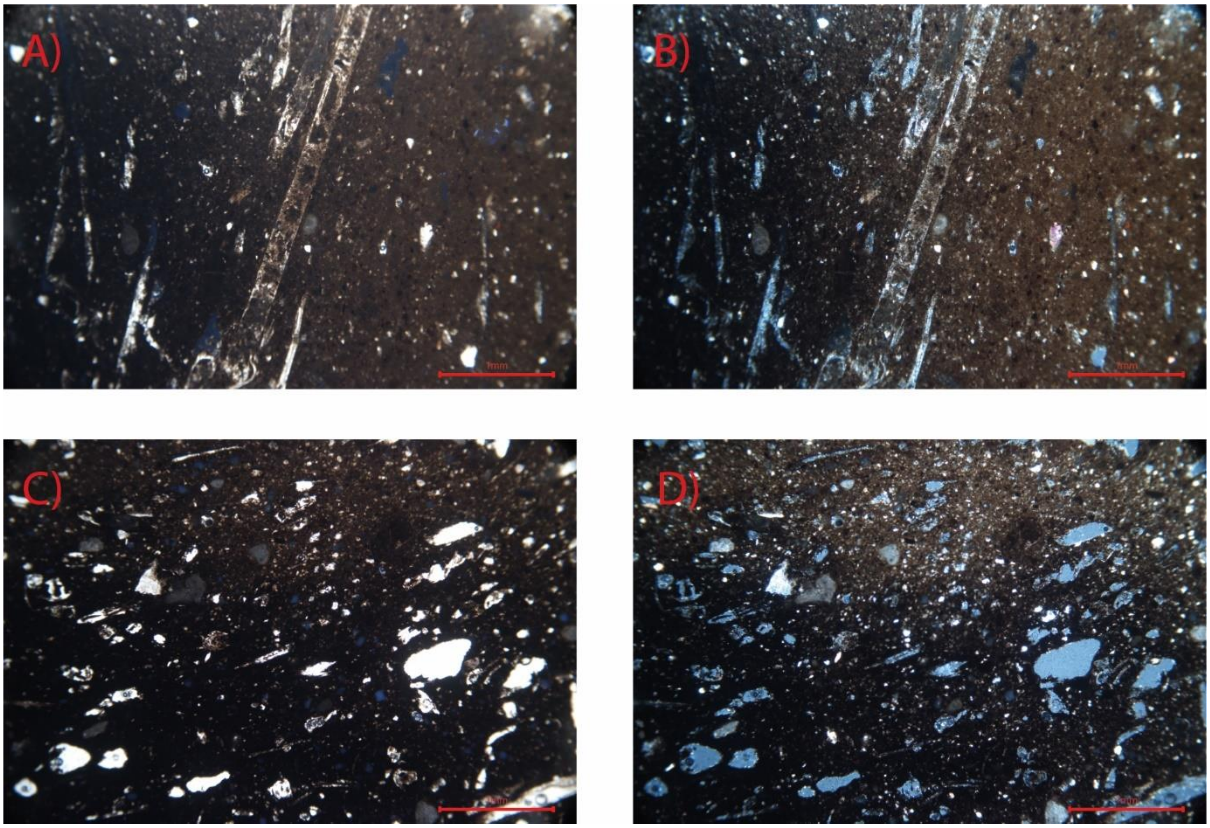


Figure 6.18: Photomicrographs showing various vegetal tempering and changes in fabric color. A) and B) CA20256 with segmented vegetal inclusion, PPL and XPL, x40, C) and D) CA200302 with smaller vegetal inclusions and darker towards bottom, PPL and XPL, x40.

6.1.3.2 Vegetal and Mineral Tempered (E.5c, R.7, F.3a, F.3b)

The Vegetal and Mineral Tempered Fabrics are very similar to the Vegetal Tempered Fabrics. They are relatively porous fabrics with common meso-elongated voids. Most of these voids are relatively straight with darker edges, indicating a vegetal inclusion that has burned out. However, these samples also have more coarse inclusions which are moderately to poorly sorted with an overall bimodal grain size distribution indicating this fabric was tempered with organic matter and mineral inclusions (quartz, mudstone, sandstone, igneous rock fragment). The subrounded nature of these point towards a non-crushed temper.

The matrix is homogenous red and in al-Ran is a striated b-fabric. The striations are weakly aligned to the edge, and the high level of optical activity points to a lower firing temperature (Whitbread 1995). The matrix is optically inactive in the al-Jazira samples. In Khurāsān, the fabric is heterogenous and may indicate clay mixing, like the fine samples from Khurāsān demonstrate (section 6.1.1.1). However, the color and optical activity of all samples indicate a longer firing time at a steady temperature.

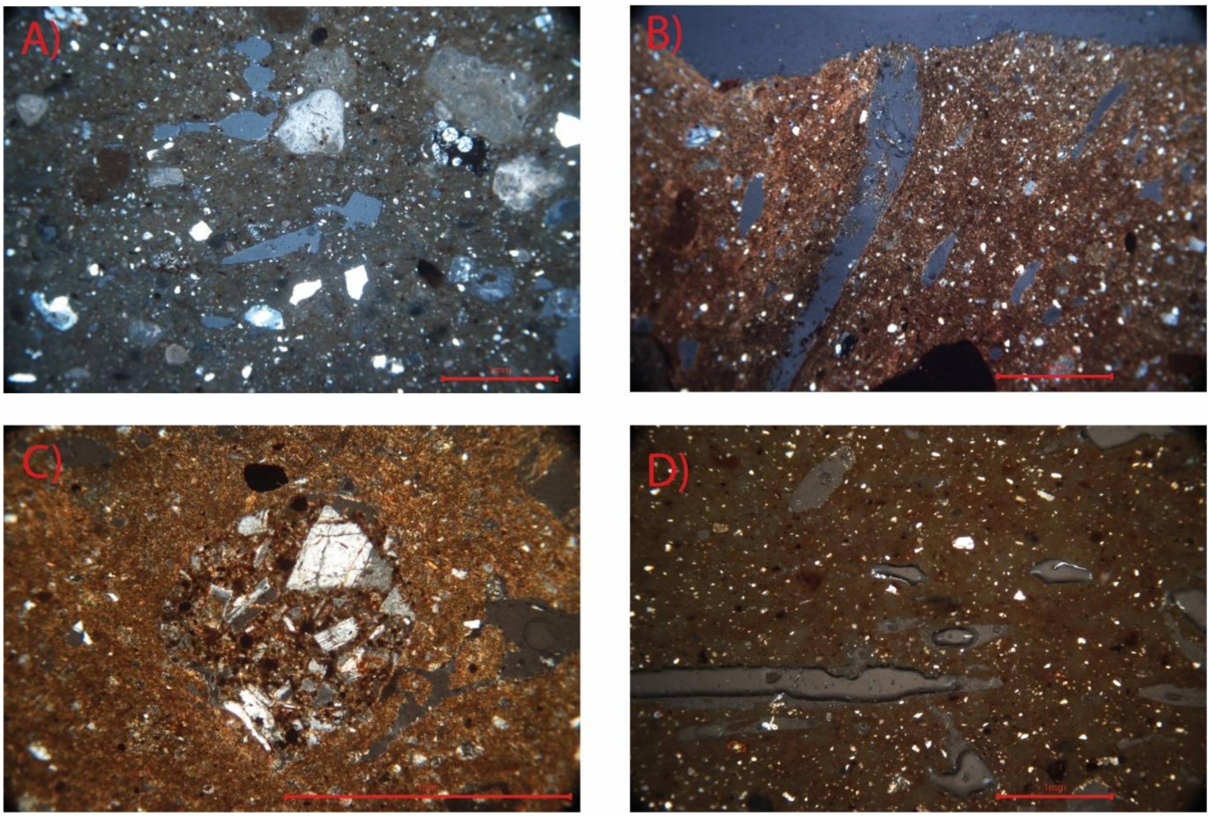


Figure 6.19: Photomicrograph of various inclusions A) Vegetal and quartz, chert, micritic limestone, CA200311, XPL, x40; B) Vegetal and quartz, CA200339, XPL, x40; C) Vegetal and andesite fragment, CA200352, XPL, x100, D) Vegetal and quartz, CA200355, XPL, x40.

The al-Jazira (Figure 6.19: A; E.5c) inclusions are common to few micritic limestone, quartz, chert, biotite schist, sparry calcite, and opaques, and rare quartzite, radiolarian chert, mudstone, serpentinite, plagioclase feldspar, shell, and epidote. Micritic limestone, chert, biotite schist, sparry calcite, and mudstone, along with vegetable temper are all probably added due to their bimodal grain size. They are also all sub rounded to rounded, which points to alluvial sand being used, either air or water borne. As above, the limestone and cherts are linked to the Qaraqosh and Zagros foothills and underlie the alluvial plains. Biotite schist, serpentinite, and quartzite are from the Injana Formation in the Qaraqosh or Zagros Mountains. Mudstone, calcite, and feldspars are part of the alluvium as well as many different formations. These inclusions point to a local or regional area of manufacture for these vessels.

The al-Ran (Figure 6.19: B; R.7) inclusions are common quartz, few mudstone, and serpentinite, and rare biotite schist(?), sandstone, plagioclase feldspar, a felsic rock fragment, zircon, and quartzite. Quartz could be from any formation whereas the zircon, feldspar, and igneous rock fragments are from any of the metamorphic/igneous rocks that can be found around Rayy. The felsic nature of the igneous rock points to the Lower Red or Alborz Green Beds Formations as a source. These formations are located along the foothills of the Alborz Mountains. Mudstone is from the Hezardarreh, Upper Red, or Dalichai Formations all of which exist around Rayy. Serpentinite and schist are both from the Kahar or Shemshak Formations, located as outcrops north of Rayy in the Alborz Mountains. Sandstone could be from any of the sedimentary formations, and is probably from the Hezardarreh, Karaj, Dalichai, or Milla Formations, all of which lie beneath the plain of Rayy or as outcrops in the foothills surrounding the plain. Lastly, quartzite is from the Milla or Karaj formations which also extend under the plain. Due to the bimodal nature of the mineral inclusions, this fabric was probably tempered with sedimentary sands, as well as vegetal particles. The inclusions point to a local area of manufacture.

The Khurāsān (Figure 6.19: C-D; F.3a, F.3b) coarse inclusions are common quartz, quartzite, plagioclase feldspar, micritic limestone, few biotite, and calcite, rare serpentinite, greywacke, muscovite, and orthoclase, very rare epidote and orthoclase feldspar and possible andesite (Figure 6.19: C), trachyte, and hornblende. Biotite, muscovite, feldspars, and epidote could be from any of metamorphic or igneous rocks belonging to Eocene/Paleocene volcanics, or Shemshak, Ruteh, Dorud, Sardar, Jamal, or Kahar Formations. These formations are located along the Alborz Mountains to the north of Firuzabad. Andesite is from the Eocene and Paleocene volcanic formations located along the Alborz Mountains. Greywacke is probably from the Hezardarreh Formation which is located along the valley floor. Micritic limestone is probably from the Magu group (Parvadeh and Esfandiar Formations) located along the foothills of the Eastern Iranian Range. Trachyte is from the Ruteh or Dorud Formations also along the Eastern Iranian Range. Serpentinite, hornblende, and quartzite are related to the Kahar Formation, which underlies the valley. These fabrics are probably tempered with vegetal particles as well as an igneous sand. The inclusions point towards a local area of manufacture.

6.1.4 *Stonepaste (E.9, H.4)*

The two stonepaste fabrics are very dense with few meso and microvughs. The distribution of inclusions is single, and the matrix is vitrified, as illustrated by the black color. It is optically inactive. Mason (1995) identifies the range of stonepaste as including 8 to 10 parts quartz to one-part crushed glass and one-part of a fine white clay. The clay bonds the material together and combines with the glass during firing to cement the quartz together. Mason also states that stonepaste is challenging to identify chemically due to the homogeneity of quartz, the technological determinants in glass, and the amount of clay utilized (1995a, 307). The main inclusions are quartz but the two samples have different secondary minerals as well as the shapes and clarity of the quartz indicating two distinct recipes.

The main inclusions in the al-Jazira sample are quartz with few opaques and rare chert and quartzite, all well sorted with a unimodal grain size (Figure 6.20). Geologically, it is almost impossible to determine where this piece was made, with just quartz as the main mineral. Using the methodology laid out by Mason (1995), specifically for characterizing stonepastes, this fabric has 40 – 50% clear quartz, 36% slightly cloudy quartz, 30% matrix, 2% chert and 2% reddish opaques. None of the quartz shows evidence of shearing or stress. The grain shape is 70% angular and elongated, 25% angular and equant and 5% subrounded and equant (mainly the opaques). The grain size is classed as fine with most inclusions between 0.0125 and 0.025mm. Based on these measurements, this fabric matches the Mashhad fabric as described by Mason (1995), but that does not mean it is from the Mashhad region.

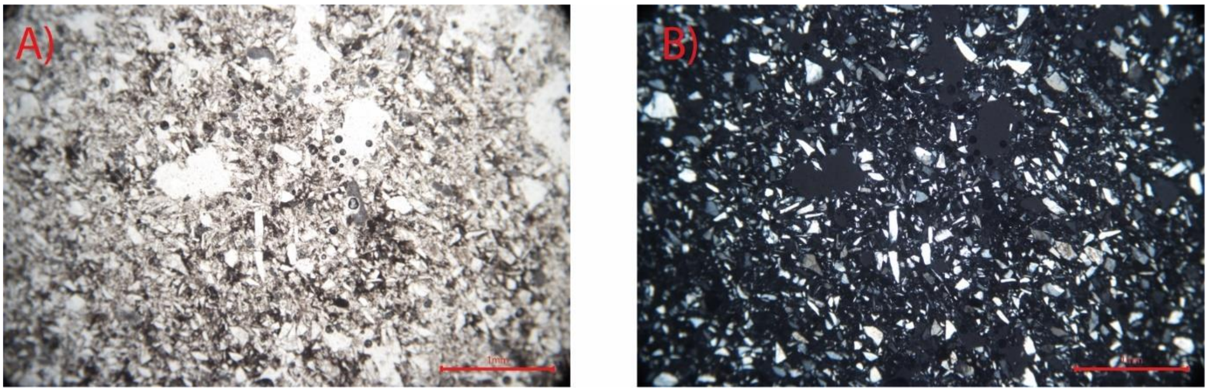


Figure 6.20: Photomicrograph of Stonepaste Fabric CA200264 showing the mineralogy of the piece in PPL and XPL, x40.

The main inclusions in the al-Ran sample are quartz with few opaques and rare calcite and chert, all well sorted with a unimodal grain size (Figure 6.21). This fabric has 40% slightly cloudy quartz, 15% clear quartz, 15% cloudy quartz, 15% matrix, 6% very cloudy quartz, 5% reddish opaques, 2% calcite. About 15% of the quartz grains show evidence of shearing. The grain shape is 60% angular and elongated, 30% angular and equant, and 10% rounded and equant. The grain size is classed as coarse with most inclusions between 0.025 and 0.05mm. Based on these measurements, this fabric matches the Zahidan 2 fabric as described by Mason (1995), but once again, this does not mean it was made in Zahidan.

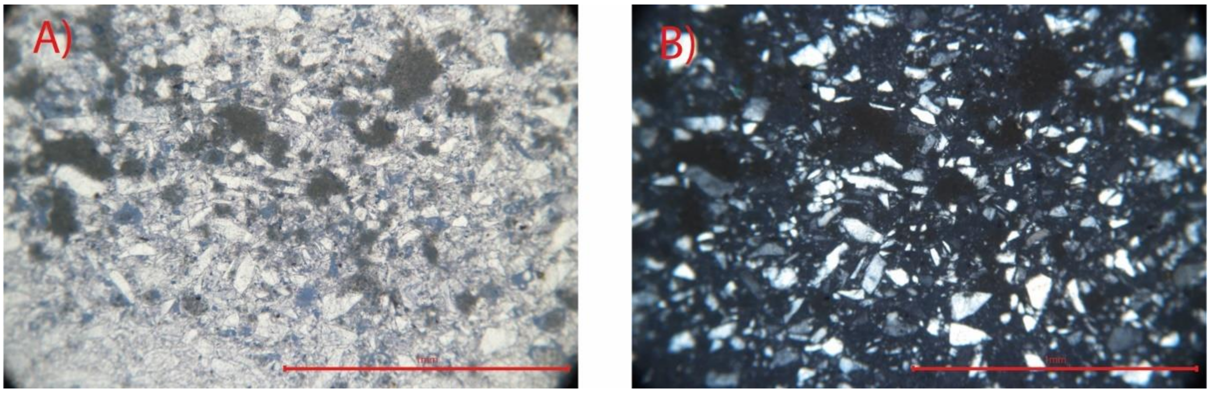


Figure 6.21: Photomicrograph of Stonepaste Fabric CA200367 showing minerals and alignment of inclusions A) PPL, B) XPL, Both at x100.

6.2 PXRF

An initial Principal Component Analysis (PCA) was conducted to identify any variation within the samples due to compositional characteristics. This test was performed based on the parameters discussed in Chapter 4.4.2 with twelve variables (Al, Si, K, Ca, Ti, V, Cr, Mn, Fe, Rb, Sr, Zr) see Appendix 9 for a full list of values for each sample. Three outliers (two stonepaste and one quartz tempered ceramic) were removed, due to their very high Si values, and the PCA was conducted again. Two components were extracted with eigenvalues of 5.079 and 1.797 representing a total variance of 57.9%. Various attempts have been used to maximize the variation that micht have existed among the samples. First, as shown in Figure 6.22, calcium is carrying a lot of matrix and to mitigate the effect of it, I removed the Ca concentration from the overall composition, renormalized the data, and submitted the renormalized data to another round of PCA, but the change was not significant. Second, I converted the data with log10 to normalize the values, and this did not produce a significant change. Therefore, I carried out the PCA and HCA on the unaltered composition (in ppm) of all samples.

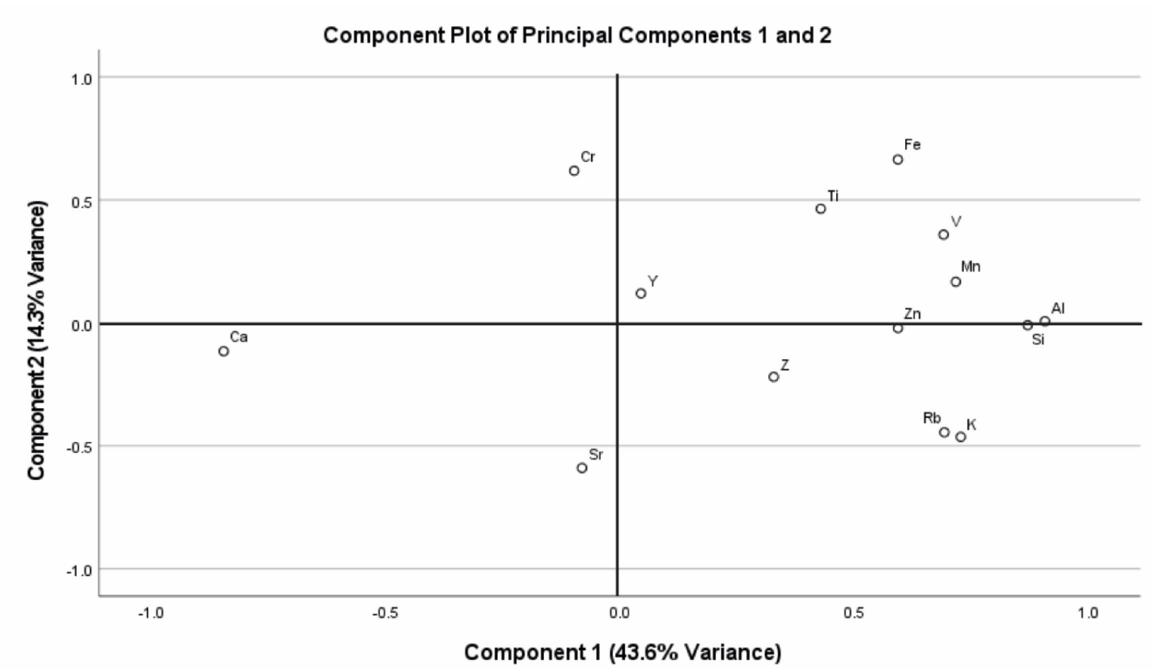


Figure 6.22: Component plot of principal components 1 and 2 showing 57.2% of total variance of the pXRF data of 151 samples.

By plotting these two components, two broad clusters of samples can be recognized (Figure 6.23). The samples (n=95) scattering on the left side are distinguishable by their relatively higher Ca, Sr, Cr values, whereas the samples in the right cluster (n=56) have higher Al, Si, and K values. The left cluster tends to correlate with the samples from al-Iraq and al-Jazira regions, whereas those on the right are correlated with samples from al-Ran, Iraq al-Ajam, and Khurāsān regions.

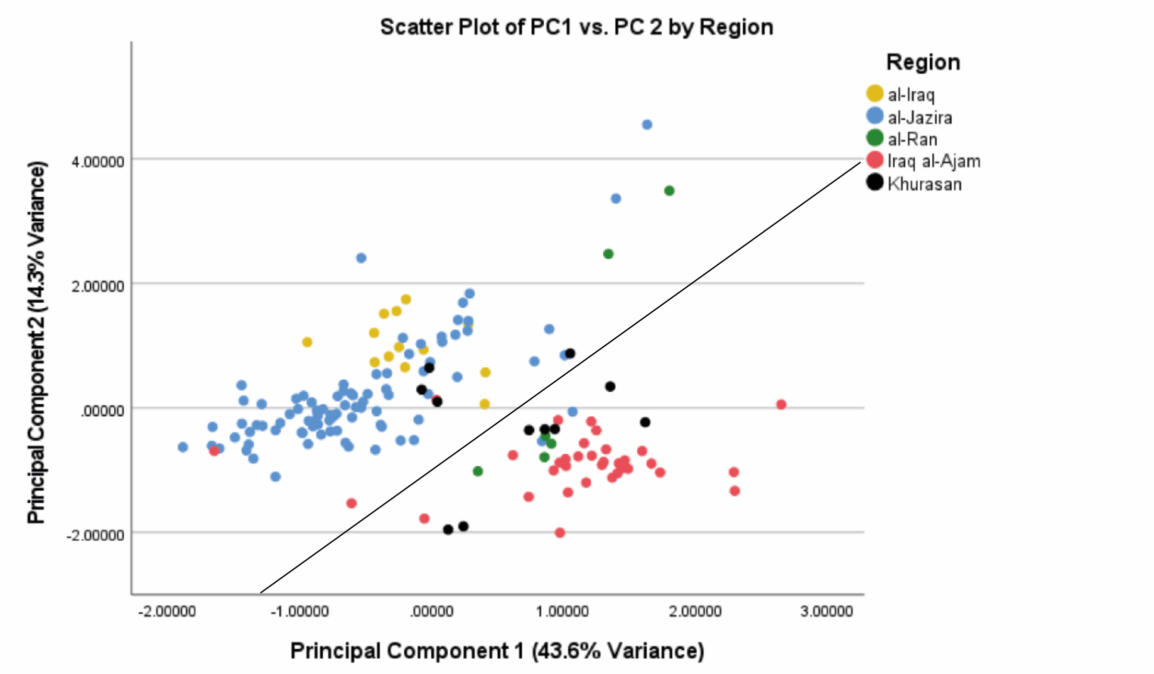
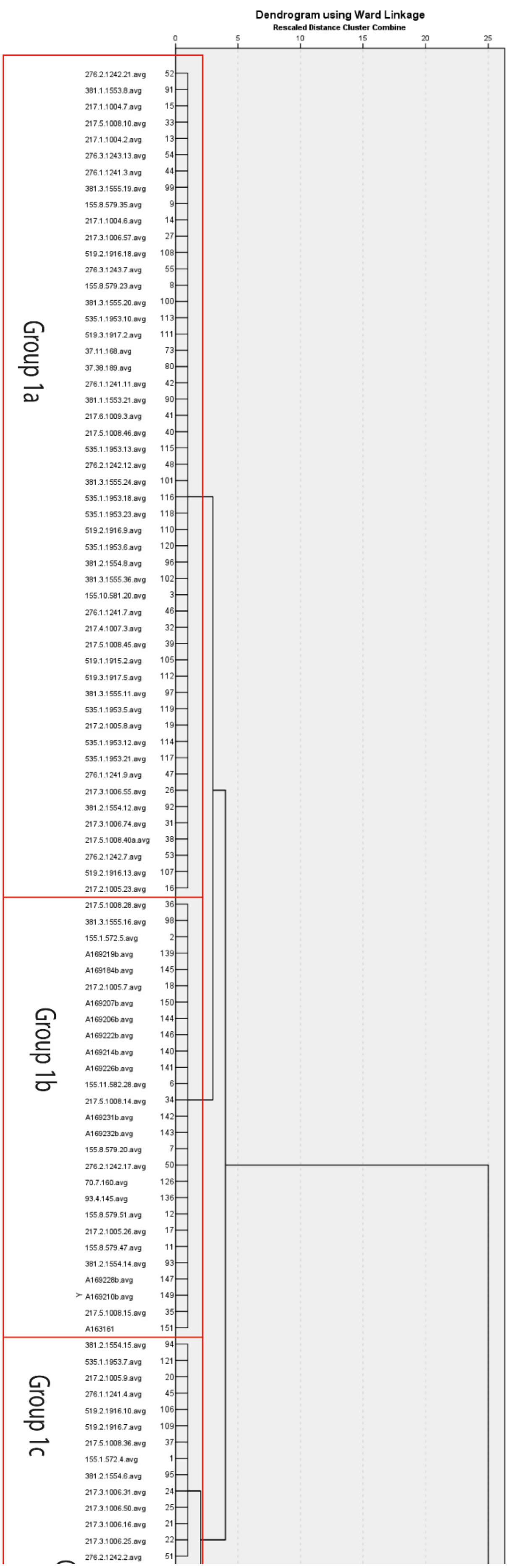


Figure 6.23: Scatter plot of principal component 1 vs. 2 at 57.2% variance, showing groupings of regions in different colors illustrating two main groups.

To help classify the samples in these groups, a hierarchical cluster analysis was performed using Ward's linkage method and squared Euclidean distance. Through this, seven clusters were identified (Figure 6.24). The data is divided into two main groups, with the first group being subdivided into four (Groups 1a – 1d), and the second group being subdivided into three (Groups 2a – 2c). This first division is related to the PCA results, with the first group having higher Ca/Cr/Sr values, and the second having higher Si/Al/K values. The statistical descriptions of each group are found after the discussion of the groups (Table 6.5).

6.2.1 *Group 1a (33%, N=52)*

Group 1a has the highest Ca and Sr values and lowest Al, Si, Fe, K, Ti, Mn, V, and Rb values compared to the other subgroups in Group 1. It includes samples from the EPAS sites (155 (N=3), 217 (N=13), 276 (N=9), 381 (N=9), 519 (N=6), 535 (N=8)) as well as two from Rayy. More than half of these samples belong to the fine quartz rich untempered petrographic groups (E.1a, E.1b, R.2b, N=34). The rest belong to the mineral tempered fabrics (E.3a, E.3b, E.3c, R.3, N=13) and vegetal tempered fabrics (E.5a, E.5b, E.5c, N=4). The majority of sherds (N=24) are smoothed, followed by incised (N=13), and glazed (N=9). The remaining sherds are moulded (N=3), stamped (N=1), and slipped (N=1). Although



temper, whether it is mineral or vegetal was added to the paste of some samples, the overall frequency of temper is low. As such, the chemical composition is likely reflective of the clay that was used to make the vessel rather than measuring larger pieces of temper. The high Ca and Sr values are found across the Erbil Plain (Mohammad *et al.* 2013), and as such cannot be pinpointed to a certain site or clay source. However, two moulded sherds from Rayy do have distinct chemical compositions from the other sherds at Rayy. One sherd is a moulded jar (CA200341/37-11-168) and the other is a long neck smoothed jar with a sharply carinated neck (CA200343/37-38-189). It is interesting to note that all the moulded wares (N=3, site 217, 381, and Rayy) in this study belong to this chemical group possibly indicating the existence of exchange of these objects. Since the main group is mainly found in the Jazira region, a Jazira community of production for these moulded wares, with Rayy being a possible community of consumption is suggested.

6.2.2 *Group 1b (16%, N=25)*

Group 1b has the highest Fe and Cr values and lowest Sr and Zr values as compared to the other subgroups in Group 1. It is found on various sites in EPAS (155 (N=5), 217 (N=5), 276 (N=1), 381 (N=2)), the site of Nippur (N=12), Hasanlu (N=1) and Firuzabad (N=1). The majority of sherds from Nippur fall into this category (12 of 14 sherds) with a mixture of petrographic groups (both mineralogically and texturally). Therefore, this group is probably local to Nippur. In terms of the EPAS sites, it is interesting to note that these sites are in the western part of the plain, away

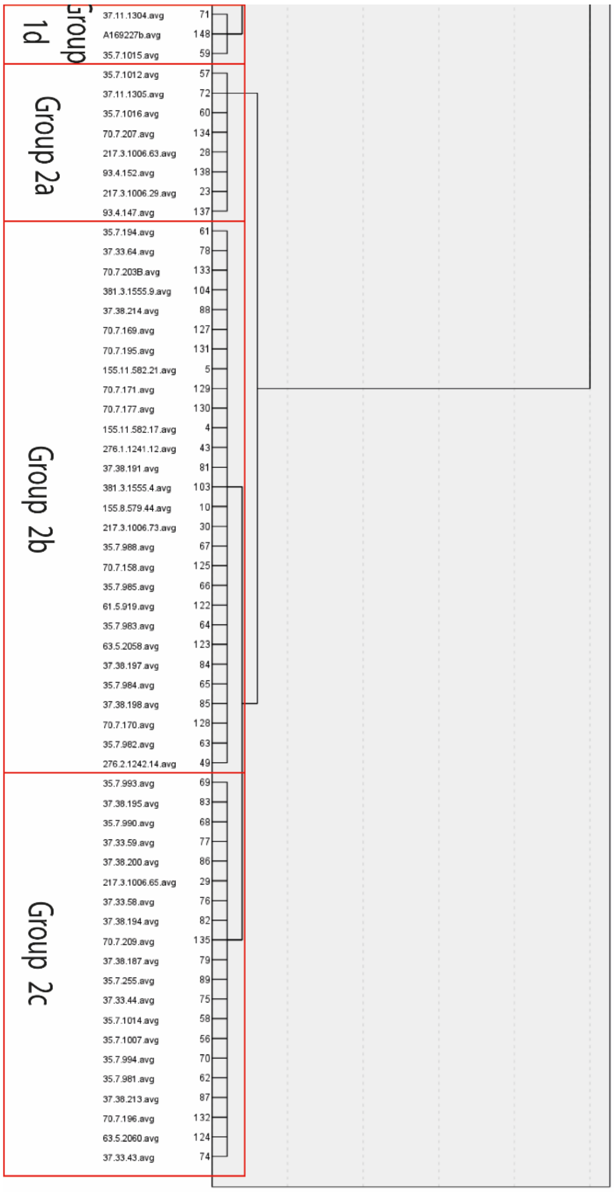


Figure 6.24 Hierarchical Dendrogram of the Seven Clusters Illustrating their Linkages and Related Clusters.

from the Zagros Mountains. Along with the petrographic analysis – which shows that these fabrics have different mineralogical and textural characteristics – these sites are located on alluvial plains, and as such the pottery is probably made locally rather than transported from Nippur. The piece from Firuzabad has a vegetal and micritic limestone tempered fabric which could place it into this category, still being locally made (near Firuzabad), and not brought in from another region. This could point to a different source of clay being used around the site, and this one piece has been given its own sub-fabric (F.3a) as well. The piece from Hasanlu is an untempered fine quartz rich fabric (H.2). This could indicate a different clay source being utilized from the other Hasanlu vessels, or this piece could have been brought in from elsewhere. In terms of surface treatment, half (N=14) of the samples are glazed which could be giving the higher values of Cr appearing in the dataset, as it is a colorant used to produce a dark green to black color (the glaze on most of these sherds is green). The majority of the samples from EPAS that are glazed (N=8) all of them have a green glaze. However, the rest of the samples from EPAS are either smoothed or incised, so the higher Cr is not directly related to the green glaze (as also seen with the various glazing colors and non-glazed ceramics at Nippur also have this signature.

6.2.3 *Group 1c (8%, N=13)*

In terms of chemical analysis, Group 1c is in the middle of the other groups in all elements identified, there are no highs or lows in the elements identified. It is found at all the EPAS sites (155 (N=1), 217 (N=6), 276 (N=2), 381 (N=2), 519 (N=2), 535 (N=1)). There are various petrogroups identified including untempered (E.1b, E.2a, E.2b), mineral tempered (E.3a, E.3b, E.3c), and vegetal tempered (E.5a, E.5b, E.5c), as well as various surface treatments mainly smoothed, but also burnished, incised, slipped, stamped, and glazed. This variation points towards the clay source being utilized, and this is probably local to the various sites, which all share the same basic geology.

6.2.4 *Group 1d (2%, N=3)*

Group 1d has the highest levels of Al, Si, K, Ti, Mn, V, Rb, and Zr and lowest values of Ca and Cr compared to the other subgroups in Group 1. It included two samples from Rayy and one sample from Nippur. This group does not match with any petrographic group, including untempered (R.2a), a vegetal and sedimentary temper (R.7), and an igneous temper (N.3), and various surface treatments with two being smoothed (Rayy and Nippur) and one stamped (Rayy). The igneous temper (basalt, granite) along with feldspars in N.3 could be giving a higher Al, K, and Ti, values. However, based on the petrographic data the N.3 sample matches the two other N.3 samples (PXRF Group 1b) and not the two from Rayy in terms of mineralogy; as such, this sample is probably made locally. Such variation may be due to the natural variation in the clay sources or analytical error, something that will be verified by further analysis using a bulk chemistry technique that has lower limits of detection. The two pieces from Rayy could indicate a different clay source being utilized, due to the lower amount of Al, Si, K, and higher values of Ca as compared to the other samples from Rayy. However, like the sherd from Nippur, the petrography (R.2a and R.7) matches the local region with untempered to vegetal and mineral temper.

6.2.5 *Group 2a (19%, N=29)*

Group 2a has the highest levels of K, V, Mn, Fe, Rb, Zr and lowest values of Al, Ti, and Sr compared to the other subgroups in Group 2. It has samples from EPAS site 217 (N=2), Rayy (N=3), Firuzabad (N=1) and Hasanlu (N=2). These samples were untempered biotite rich fabric (R.2a), or tempered with metamorphic (E.4, H.1), igneous (R.5a), and quartz (R.4, F.4). The higher chemical elements in these samples can be attributed to the presence of biotite in the clay sources, as well as the igneous and metamorphic tempers that include Rb, Fe, Zr, and K. The two samples from site 217 are biotite and sillimanite schist tempered, leading to a higher concentration of these elements. These pieces were probably made in the Erbil Plain rather than originating in Iran. The two pieces from Hasanlu are an untempered fabric which is high in biotite and iron concentrations, leading to them being grouped in this category. The sample from Firuzabad is highly tempered with quartz which should have a higher Si value, but this is not indicated in the concentration, this could indicate an error in the measurement of the sample. Lastly the three pieces from Rayy, two are inlaid with frit and one is incised. They are of three different fabrics based on petrography, untempered (R.2a), igneous tempered (R.5a), and quartz tempered (R.4). Like the Firuzabad sample, the quartz tempered Rayy sample has higher Si values, (they are the highest in the group). The biotite and iron in these fabrics could be placing these samples into this group.

6.2.6 *Group 2b (18.1%, N=28)*

Group 2b has the highest levels of Si, Ca, Sr, and lowest values of Cr compared to the other subgroups in Group 2. It is found at sites both in the EPAS region (155 (N=3), 217 (N=1), 276 (N=2), 381 (N=2)), Rayy (N=10), Chal Tarkhan (N=1), Hasanlu (N=2), and Firuzabad (N=7). Within the group there is a mixture of petrographic groups with untempered (E.2a, E.2b, R.1, R.2a, R.2b, F.1), sedimentary and igneous tempered (E.3b, R.5a, R.5b), quartzite tempered (E.7, E.8), igneous tempered (H.1, F.2c, F.2b), and vegetal tempered (R.6, R.7, F.3b). In the EPAS sites, three are glazed, which could generate the higher Si and Sr values due to the higher silica content of glaze. Two are also quartz and quartzite tempered, giving a higher Si value. In terms of sites, these sites are on the western edge of the plain farther away from the Zagros, which may give the Ca a higher reading, closer to those in Group 1 (Ca and Sr are also positively correlated so as one increases so does the other). The remaining vessels are untempered fine ware vessels, and as such could be locally made, with a different clay source from the others, or they could be brought in from elsewhere. At Rayy, eight samples are untempered, and two samples are vegetal tempered. There was probably a local source of clay being exploited to create these vessels due to the mix of petrographic groups present. The sample from Chal Tarkhan is glazed, which increases the Si and Sr values, placing it into this subgroup rather than Group 2c. The two samples from Hasanlu are both schist tempered and glazed. The schist could be giving a higher reading of silica (due to the presence of quartz in schist), but the application of a green glaze could also be adding to the higher Si and Sr values. At Firuzabad, the samples are either smoothed (N=4), appliqué (N=2) or incised (N=1), a mixture of petrographic groups and forms consistent with a local manufacture of the vessels. Of the eleven samples from Firuzabad, seven of them are present in this group.

6.2.7 *Group 2c (12.8%, N=20)*

Group 2c has the highest levels of Al and Ti and lowest values of Si, K, Ca, V, Mn, Fe, Rb, and Zr compared to the other subgroups in Group 2. It is found at sites 217 (N=1), Rayy (N=12), Chal Tarkhan (N=4) Hasanlu (N=1), and Firuzabad (N=2). Within the group there are various petrographic groups from non-tempered (E.1b, R.1, R.2a, R.2b, H.3, F.1), sedimentary and quartz tempered (R.3, R.4) and igneous tempered (R.5a, R.5b, F.2a). Most of the samples were untempered (N=15) indicating the pXRF is measuring the clay rather than the temper. The piece from 217 is a moulded ware that is untempered, and it may have been brought in from another region, due to the lack of this group in the Erbil Plain. The samples from Rayy and Chal Tarkhan are a mixture of smoothed, glazed, and incised wares. The majority of samples from Chal Tarkhan (4/5) are from this group, with the other sample in Group 2b, possibly due to the glaze increasing the Si content. The majority of the samples from Rayy and Chal Tarkhan were smoothed and untempered, pointing to a local origin of the clay fabric. At Hasanlu, one sherd is glazed, and it could have originated from a local source or have been brought in from outside the region. Of the two samples at Firuzabad, one was slipped and has igneous temper, and the other is smoothed and untempered. The combination of these two petrographic groups and ware types possibly indicates a local provenience of the clay, especially since the forms do not match forms from the other sites studied.

6.2.8 *Outliers (1.8%, N=3)*

Three outliers were identified, due to their very high silica content (35 – 45%) and very low levels of all other elements. These three matched the two stonepaste wares (one from site 217 and one from Hasanlu) and a quartz tempered ceramic from Nippur (CA200724).

Table 6.5: Table showing the minimum (Min.), maximum (Max.), mean value (Mean), and standard deviation (St. Dev.) for each of the compositional groups of 155 samples by pXRF.

Compositional Groups		**Al %**	**Si%**	**K%**	**Ca%**	**Ti%**	**V%**	**Cr%**	**Mn%**	**Fe%**	**Rb%**	**Sr%**	**Zr%**
1a	Min	4.89	18.65	0.92	12.56	0.3	0	0.01	0.06	3.11	0	0.03	0.01
(Iraq 1)	Max	7.92	26.26	2.16	17.23	0.48	0.01	0.26	0.09	4.85	0.01	0.08	0.02
N=51	Mean	5.85	21.35	1.42	14.87	0.38	0.01	0.04	0.08	3.83	0.01	0.05	0.01
	St.Dev	0.71	1.62	0.24	1.31	0.03	0	0.03	0.01	0.38	0	0.01	0
1b	Min	4.71	18.37	0.75	8.63	0.31	0.01	0.02	0.06	2.97	0	0.03	0
(Iraq 2)	Max	7.48	23.45	3.4	12.81	0.49	0.02	0.09	0.11	5.64	0.01	0.11	0.02
N=28	Mean	6.18	21.13	1.44	10.74	0.42	0.01	0.04	0.08	4.54	0.01	0.05	0.01
	St.Dev	0.61	1.22	0.51	1.03	0.05	0	0.01	0.01	0.61	0	0.02	0
1c	Min	4.05	14.29	0.89	12.71	0.24	0	0.02	0.03	2.91	0	0.02	0.01
(Iraq 3)	Max	5.06	18.25	1.58	19.86	0.4	0.01	0.04	0.08	3.64	0.01	0.09	0.01
N=14	Mean	4.73	16.86	1.28	15.39	0.35	0.01	0.03	0.06	3.3	0	0.05	0.01
	St.Dev	0.25	1.22	0.19	1.63	0.04	0	0.01	0.01	0.19	0	0.02	0
1d	Min	2.96	8.87	1.08	7.33	0.22	0.01	0.02	0.06	3.26	0	0.02	0.01
(Iran 1)	Max	4.77	16.58	1.69	13.01	0.47	0.02	0.05	0.13	4.78	0.01	0.03	0.02
N=3	Mean	4.04	12.7	1.44	9.58	0.36	0.01	0.03	0.09	4.22	0.01	0.03	0.02
	St.Dev	0.95	3.85	0.32	3.02	0.13	0	0.02	0.04	0.84	0	0.01	0
2a	Min	7.61	27.58	0.73	1.29	0.25	0.01	0.02	0.07	4.18	0	0.01	0.01
(Iran 2)	Max	9.56	33.14	2.57	4.26	0.76	0.02	0.12	0.17	7.49	0.01	0.05	0.02
N=8	Mean	8.63	30	1.91	2.42	0.51	0.02	0.05	0.1	5.76	0.01	0.03	0.02
	St.Dev	0.67	2.12	0.67	0.93	0.15	0	0.03	0.03	1.36	0	0.01	0.01
2b	Min	6.3	23.32	1.19	5.25	0.31	0.01	0.01	0.05	3.67	0	0.02	0.01
(Iran 3)	Max	9.08	27.89	2.81	11.24	0.51	0.02	0.06	0.14	5.84	0.01	0.1	0.02
N=28	Mean	7.73	25.16	2.04	8.2	0.41	0.01	0.03	0.09	4.47	0.01	0.05	0.01
	St.Dev	0.62	1.21	0.45	1.53	0.05	0	0.01	0.02	0.59	0	0.02	0
2c	Min	8.21	26.83	1.63	5.76	0.36	0.01	0.02	0.07	3.93	0.01	0.03	0.01
(Iran 4)	Max	9.7	31.22	3.14	12.76	0.49	0.02	0.06	0.13	5.37	0.01	0.07	0.02
N=20	Mean	8.82	28.98	2.36	8.62	0.41	0.01	0.02	0.1	4.42	0.01	0.05	0.02
	St.Dev	0.36	1.1	0.32	1.89	0.03	0	0.01	0.01	0.4	0	0.01	0
Outliers	Min	0.7	31.7	0.5	1.12	0.1	0	0.04	0.01	0.47	0	0.01	0
N=4	Max	9.3	37	1	3.76	0.9	0	0.1	0.14	6.3	0	0	0
	Mean	4.4	34.9	0.8	2.19	0.4	0	0.1	0.06	2.5	0	0	0
	St.Dev	4.4	2.87	0.3	1.39	0.4	0	0.1	0.07	3.3	0	0	0

6.3 *Fourier Transform Infrared Spectroscopy*

FT-IR is used to identify the mineralogical phases characteristic of the samples, which can be used as a proxy to estimate the firing temperature. Three compositional groups based on the presence/absence of $CaCO_3$ were identified (Calcareous, non-calcareous, stonepaste; Figure 6.25; Appendix 10).

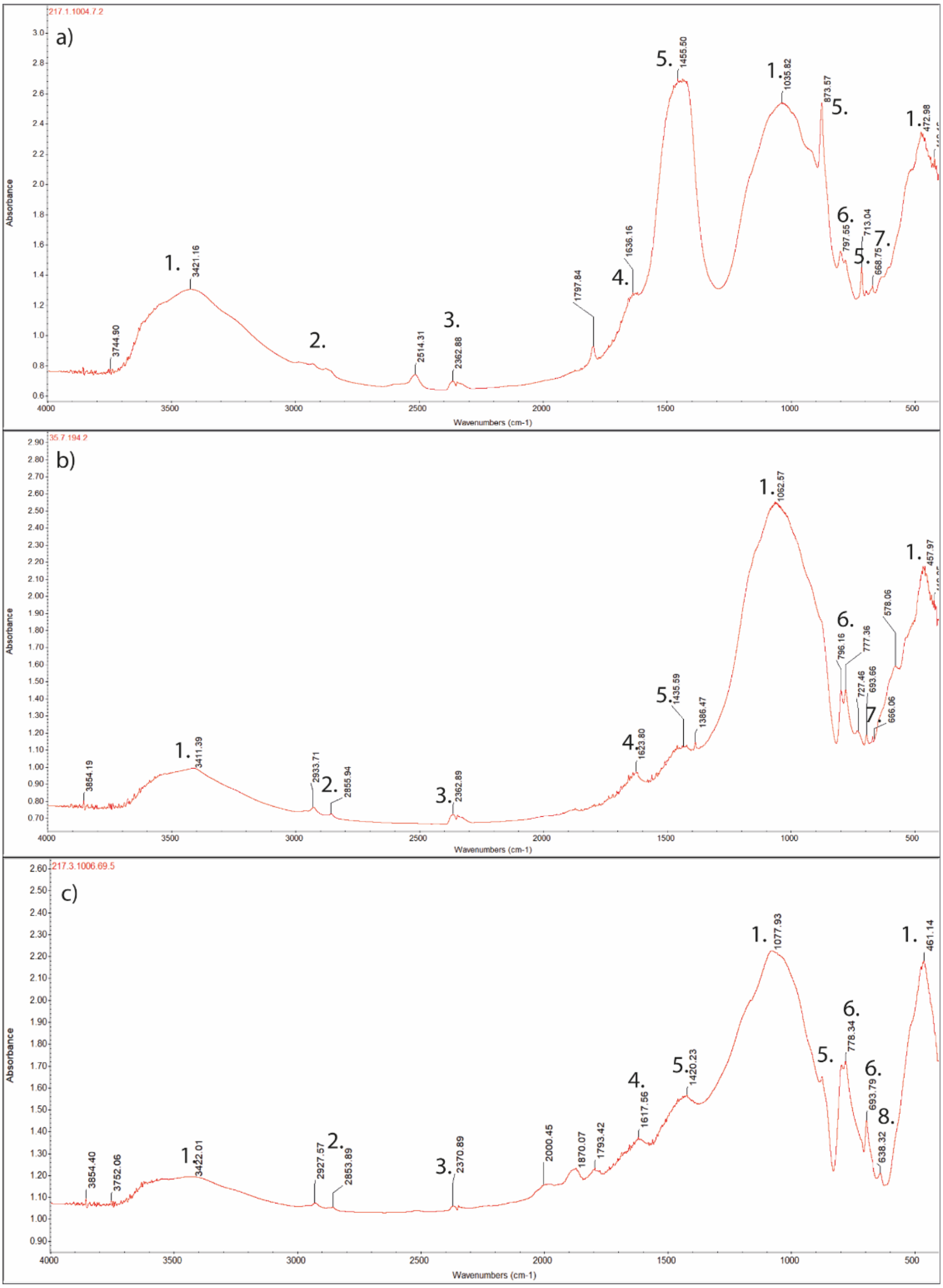


Figure 6.25: Grouping of FT-IR results a) Calcareous clay, b) Non-Calcareous clay, c) Stonepaste. 1. Fired Clay, 2. Organics, 3. CO2, 4. H2O, 5. CaCO3, 6. Quartz, 7. Anorthite (CaAl2Si2O8), 8. Microcline.

These full spectra show commonalities across all samples, with most having a shallow double hump between 2950 and 2850 cm^{-1}, which has been attributed to the presence of organic matters (C-H stretching) (Saikia *et al.* 2016; Shoval 2016). There is also a double notch for CO_2 between 2350 and

2300 cm^{-1}. This is from the atmosphere when taking the sample. Most samples have a peak around 1630 indicating H_2O, also from the sample preparation and atmosphere. Lastly, most samples have a double peak of quartz (between 795 and 778 cm^{-1}).

Group 1 (calcareous) (Figure 6.25: A) has a high amount of $CaCO_3$ (between 1420 and 1450 cm^{-1}) relative to the peak of fired clay (between 1028 and 1077 cm^{-1}). Calcite appears in three peaks throughout the spectra. The first peak, (between 1420 and 1450 cm^{-1}) indicates both primary and secondary (or reformed) calcite. The primary calcite appears between 1420 and 1430, and secondary calcite between 1430 and 1450. Primary calcite disappears between 600°C and 750°C (Shoval 2003; Shoval and Beck 2005; Sadek 2017; Trindade et al. 2009), and so the presence of reformed or secondary calcite indicates a firing temperature of higher than 700°C which will be discussed in the next section. Calcite's second and third peak (872 – 874 cm^{-1} and 712 – 714 cm^{-1}) are more indicative of secondary calcite, especially the latter peak.

Group 2 (non-calcareous) (Figure 6.25: B) has a low amount of $CaCO_3$ (between 1420 and 1450 cm^{-1}) relative to the peak of fired clay (between 1028 and 1077 cm^{-1}). The rest of the minerals present in the calcareous samples appear in the non-calcareous samples.

Group 3 (stonepaste) (Figure 6.25: C) has higher quartz peaks (795 and 778 and a third peak at 693 cm^{-1}) relative to the fired clay (between 1028 and 1077 cm^{-1}). The two peaks (2000 and 1870 cm^{-1}) are in bands of C=O stretching, namely SiO_2 overtone and SiO_2 combination (Krivoshein *et al.* 2020). This illustrates a larger silicate presence than groups 1 and 2.

6.3.1 *Firing Temperature*

The estimation of firing temperature is based on the presence or absence of different minerals in the sample, the shift of the main SiO band, and the presence of primary or reformed calcite. This is more easily seen in the spectra between 1200 and 400 cm^{-1}.

When a material is fired, minerals decompose, reform, and recrystallize at various temperatures. Figure 6.26 shows the mineralogical transformation of minerals found in clay at various temperatures. The first transformation occurs at 300°C with the disappearance of goethite, and at 500°C, the clays begin to alter to metaclays (i.e. kaolinite to metakaolinite/ smectite to metasmectite). At 700°C $CaCO_3$ begins to decompose, and calcite is almost gone by 800°C. Between 800 and 1100°C quartz begins to decompose, diminishing drastically at around 1100°C (Trindade *et al.* 2009, 348). Between 800 and 900°C new silica crystalline phases appear, including gehlenite, wollastonite, larnite, and alumina. Gehlenite and wollastonite can react with the SiO_2 to create anorthite ($CaAl_2Si_2O_8$), in less calcareous samples.

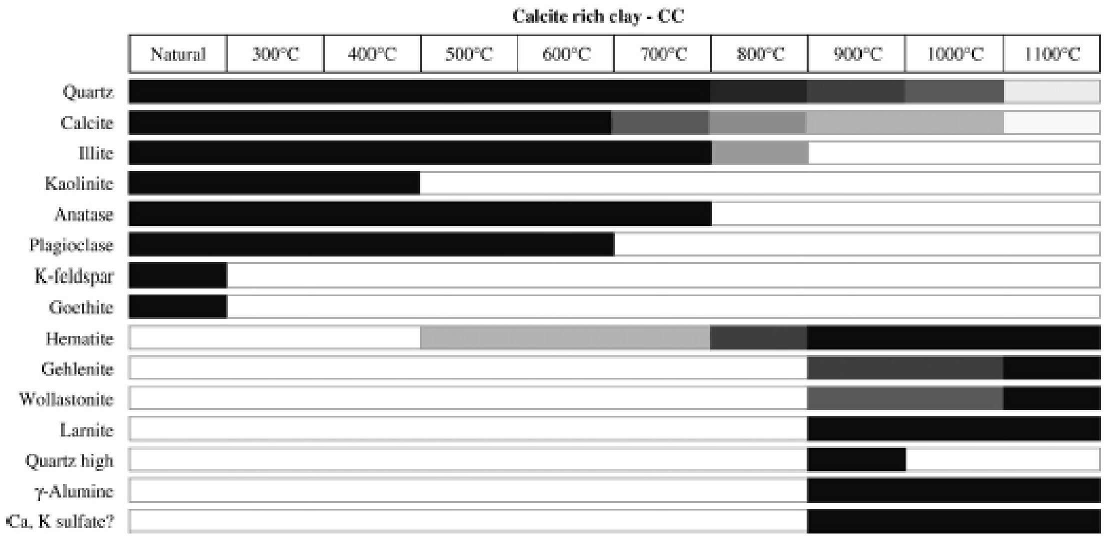


Figure 6.26: Diagram representing mineralogical transformation in calcite rich clay induced in heating in the 300 – 1000°C temperature range (Trinidade et al. 2009: Fig. 4).

The shift of Si-O band is based both on the heating of ceramics as well as original minerals and clays. Therefore, without a geological sample, only an estimation of firing temperatures can be presented. Table 6.6 shows the Si-O band at various firing temperatures from experimental firings across the world. This gives an idea of the shift of the Si-O band. Most unheated clays have an Si-O band around 1033 cm^{-1}, and this increases as temperature rises. At 800°C a double band appears in most samples. Based on this information, the samples are divided into four groups, low (below 700°C), medium (700 – 800°C), high (800 – 900°C), and very high (over 900°C).

Table 6.6: Si-O band shifts at temperatures between 0 and 1000°C.

Study	**Site**	**Unheated**	**200°**	**400°**	**600°**	**700°**	**800°**	**900°**	**1000°**
Kimmel Standards	Israel	1033	1032	1038	1043	1039	1064	1066	1069
Shoval and Beck 2005	Tell Hadar, Israel				1035	1036	1052/1081	1078	
Mentesana 2019	Phaistos, Crete				1035	1035	1045/1078	1080	
Shoval 1994	Tell Michal, Israel	1033				1042	1050/1078	1082	
Berna 2015	Tell Dor, Israel	1035		1032	1041	1048	1084	1087	1091
Perisic et al. 2020	Vinca, Serbia	1031			1040	1040	1040/1082	1082	1081
Palanivel and Rajesh Kumar 2010	Tamilnadu, India		1038	1045	1054		1085		

6.3.1.1 Low Firing (14.2%, N=22)

Ceramics fired around 600°C have the clay altering to metaclay, and most still have primary calcite present 1420 – 1430 cm^{-1}. The first calcite peak runs between 1437 and 1419 cm^{-1}, the second between 877 and 871 cm^{-1} and the third between 713 and 712 cm^{-1} (Figure 6.27). All these peaks are relatively narrow and sharp indicating primary calcite. No new silica crystalline phases have appeared (gehlenite, wollastonite, larnite). In terms of the Si-O peaks, the first peak is broad, almost box like between 3447 and 3385 cm^{-1}, the second is a relatively narrow with sharp topped peak between 1038 and 1020 cm^{-1}, and the last is a relatively narrow peak between 465 and 454 cm^{-1}. In the refiring studies the main peak is between 1033 and 1040 cm^{-1} between unfired and 600°C (Berna *et al.* 2007; Mentesana *et al.* 2019; Palanivel & Rajesh Kumar 2011; Perisic *et al.* 2016; Shoval 1994; Shoval & Beck 2005). Combined with the curve of the first peak and the sharp peaks of the other two, this points to a lower firing temperature. The non-calcareous clay (Group 2; Figure 6.27: B) shows other peaks at 722 cm^{-1} which has been identified as geikielite (Saikia *et al.* 2016), and at 566 cm^{-1} which has been identified as metakalonite (Yin *et al.* 2019). Geikielite is a clay mineral, and present at lower fired temperatures. The calcareous sample does have some anorthite, but this would be present in the sample rather than forming during firing based on the other mineral peaks.

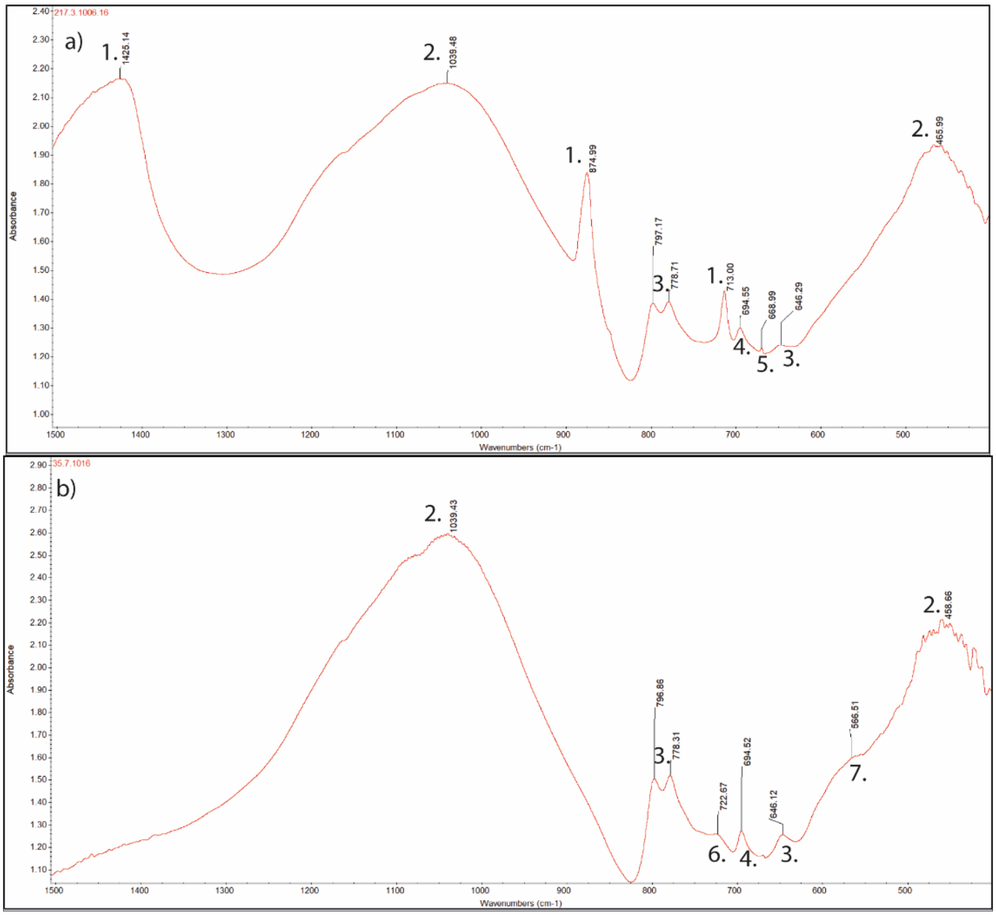


Figure 6.27: FT-IR spectra showing firing minerals from both a) Calcareous and b) Non-Calcareous groups (1500-400 cm-1). 1. Calcite, 2. Fired Clay, 3. Quartz, 4. Anorthite, 5. Orthoclase 6. Geikielite 7. Metakaolinite.

6.3.1.2 Medium Firing (20.8%, N=32)

In ceramics fired around 700°C the clay has altered to metaclay, and secondary calcite is present along with some primary calcite (in the thin sections this is most prevalent in the voids). The feldspars have almost disappeared, and no new silica crystalline phases have appeared (gehlenite, wollastonite, larnite). In terms of the Si-O peaks, the first is a broad peak between 3427 and 3406 cm^{-1}, the second is a sharp peak between 1062 and 1047 cm^{-1}, and the third is also a sharp peak between 470 and 461 cm^{-1} (Figure 6.28). The broad first band, sharp peaked second and third peaks, and stretch in the second peak are all indicative of firing around 700°C The calcite peaks are between 1437 and 1431 cm^{-1}, between 878 and 874 cm^{-1}, and between 713 and 712 cm^{-1}. The calcite peaks are almost all constructed of secondary calcite, showing the loss of primary calcite between 600 and 700°C. The calcareous group has the main elements, calcite, clay, quartz, with some anorthite and orthoclase. This shows the feldspars are not completely gone, leading to a temperature of under 800°C. The non-calcareous group has more micas and feldspars, and less calcite. However, these are all still present and just beginning to burn out at around 700°C.

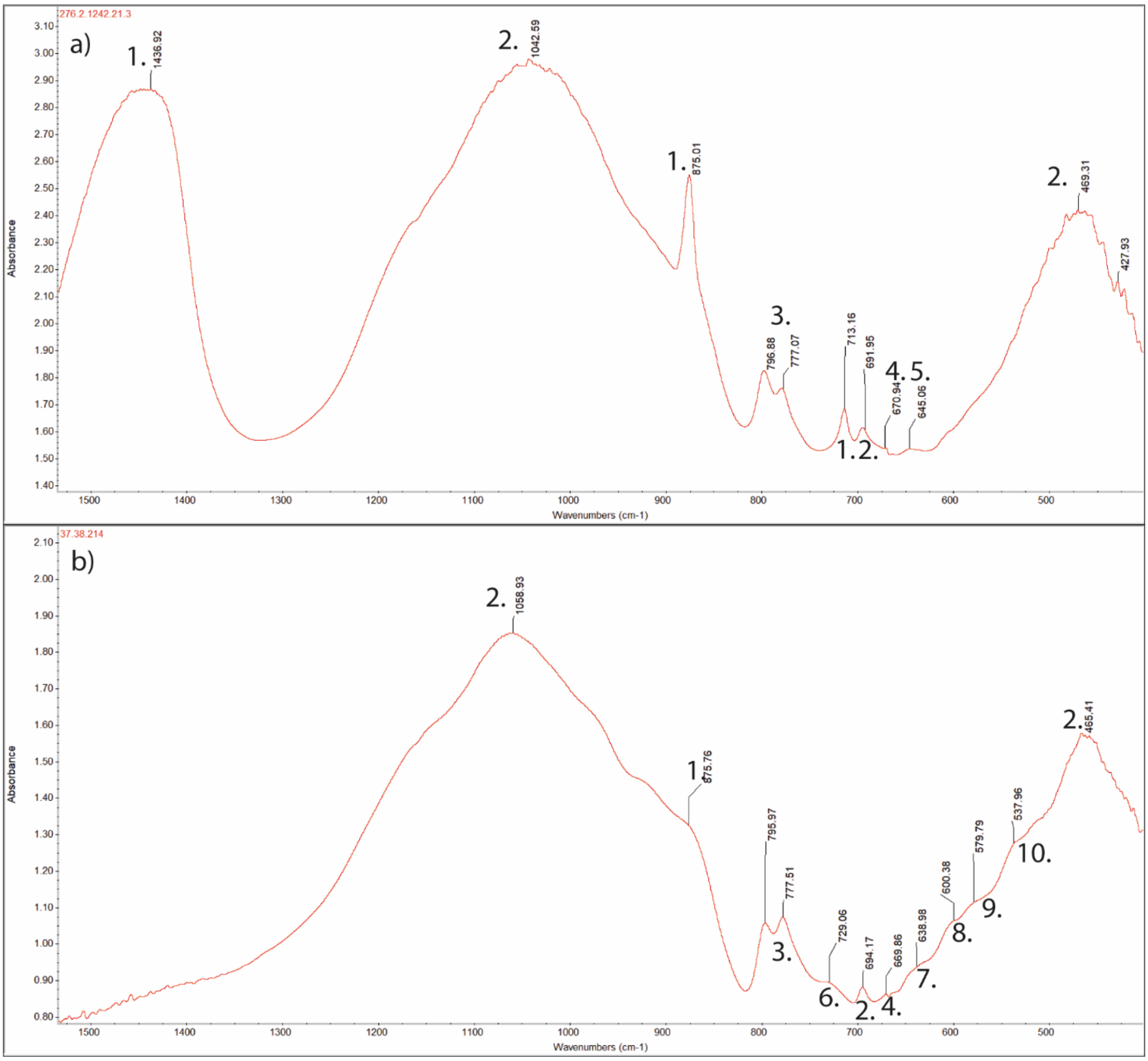


Figure 6.28: FT-IR spectra of two groups a) Calcareous and b) Non-Calcareous, showing various minerals present around 700°C. 1. Calcite, 2. Fired Clay, 3. Quartz, 4. Anorthite 5. Orthoclase, 6. Andesite 7. Microcline, 8. Gypsum, 9. Labradorite, 10. Oligoclase.

6.3.1.3 High Firing (31.2%, N=48)

Ceramics fired around 800°C have clays that have completely altered to metaclay, and some minerals recombine into new silicate minerals. The primary calcite is all depleted and replaced with secondary calcite, which is also mixed with the secondary calcite from deposition. In terms of the Si-O band, the first is much wider than the other firings, between 3447 and 3408 cm^{-1}, with a few having a double peak. The second band is also much wider with double peaks common. The double peaks are at 1081 and 1038 cm^{-1}, whereas the broader single peaks are between 1068 and 1038 cm^{-1}. The third band is also much wider than the previous firings and exists from 472 to 442 cm^{-1} (Figure 6.29). These broader bands, and especially the double peaks, indicate a firing temperature of around 800°C. The $CaCO_3$ peaks are between 1458 and 1420 cm^{-1}, 876 and 874 cm^{-1}, 713 and 712 cm^{-1}. The first peak is much broader than the previous groups indicating a secondary calcite source. The calcareous clay has the typical calcite, quartz, and clay bands with other clays, anorthite, oligoclase, feldspar and gehlenite. The presence of gehlenite along with the quartz at 1166 cm^{-1} illustrate a firing temperature of around 800°C. In the non-calcareous clays, the presence of quartz, clay, along with anorthite, oligoclase, and palygorskite clay (Madejova *et al.* 2017), with the broad bands of metaclay and quartz at 1166 cm^{-1} show a firing temperature around 800°C.

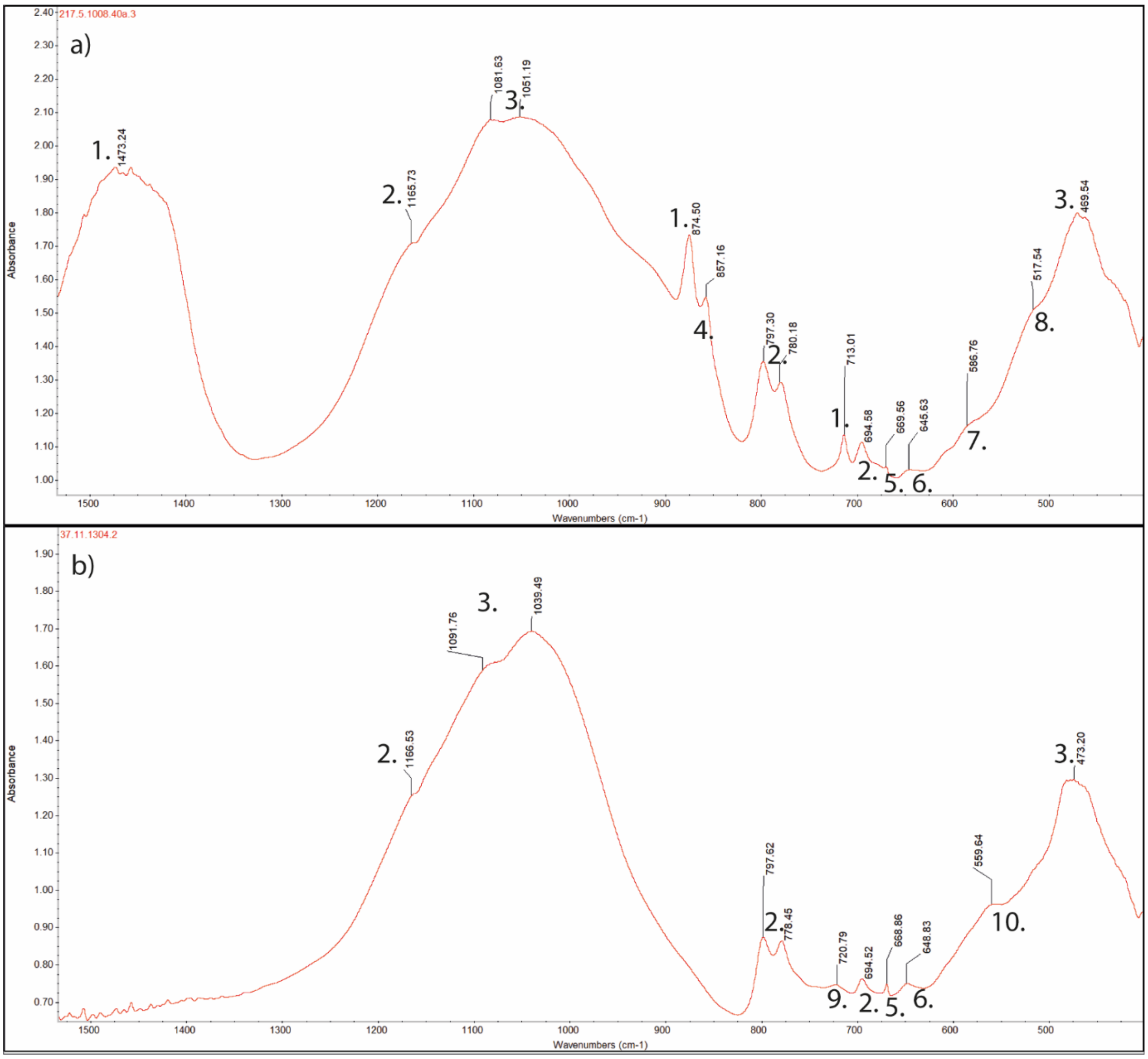


Figure 6.29: FT-IR spectra of two groups a) Calcareous and b) Non-Calcareous, showing various minerals present around 800°C. 1. Calcite 2. Quartz 3. Fired Clay 4. Montmorillonite clay 5. Anorthite, 6. Orthoclase, 7. Feldspar, 8. Gehlenite, 9. Andesite, 10. Palygorskite.

6.3.1.4 Very High Firing (33.8%, N=52)

Ceramics, including the stonepaste, fired around 900°C have clays that have completely altered to metaclay, and various minerals recombine into new silicate minerals (gehlenite, wollastonite, larnite, and alumina). The primary calcite is all depleted and replaced with secondary calcite. In terms of the Si-O band, the first is much broader than the other firings, sometimes with a sharp peak around 3750, but the main band is between 3447 and 3408 cm^{-1}. The second band is also much broader, and the peak is between 1077 and 1058 cm^{-1}. The third band; however, is much narrower than the previous firings and exists from 473 to 458 cm^{-1} (Figure 6.30). These broader bands, and the sharp peak in the third band, indicate a firing temperature of around 900°C. The $CaCO_3$ peaks are between 1456 and 1429 cm^{-1}, 874 and 873 cm^{-1}, and 713 and 712 cm^{-1}. The first peak is much broader than the previous groups indicating a secondary calcite source which is also supported by the narrowing of the second and third bands. However, the main evidence for the firing above 900°C is the presence of the new silicate minerals. The appearance of gehlenite (515 cm^{-1}), wollastonite (double peak at 975/915 cm^{-1}), and aluminium stretching (520 cm^{-1}) indicate the re-forming of clay minerals which occurs at above 900°C.

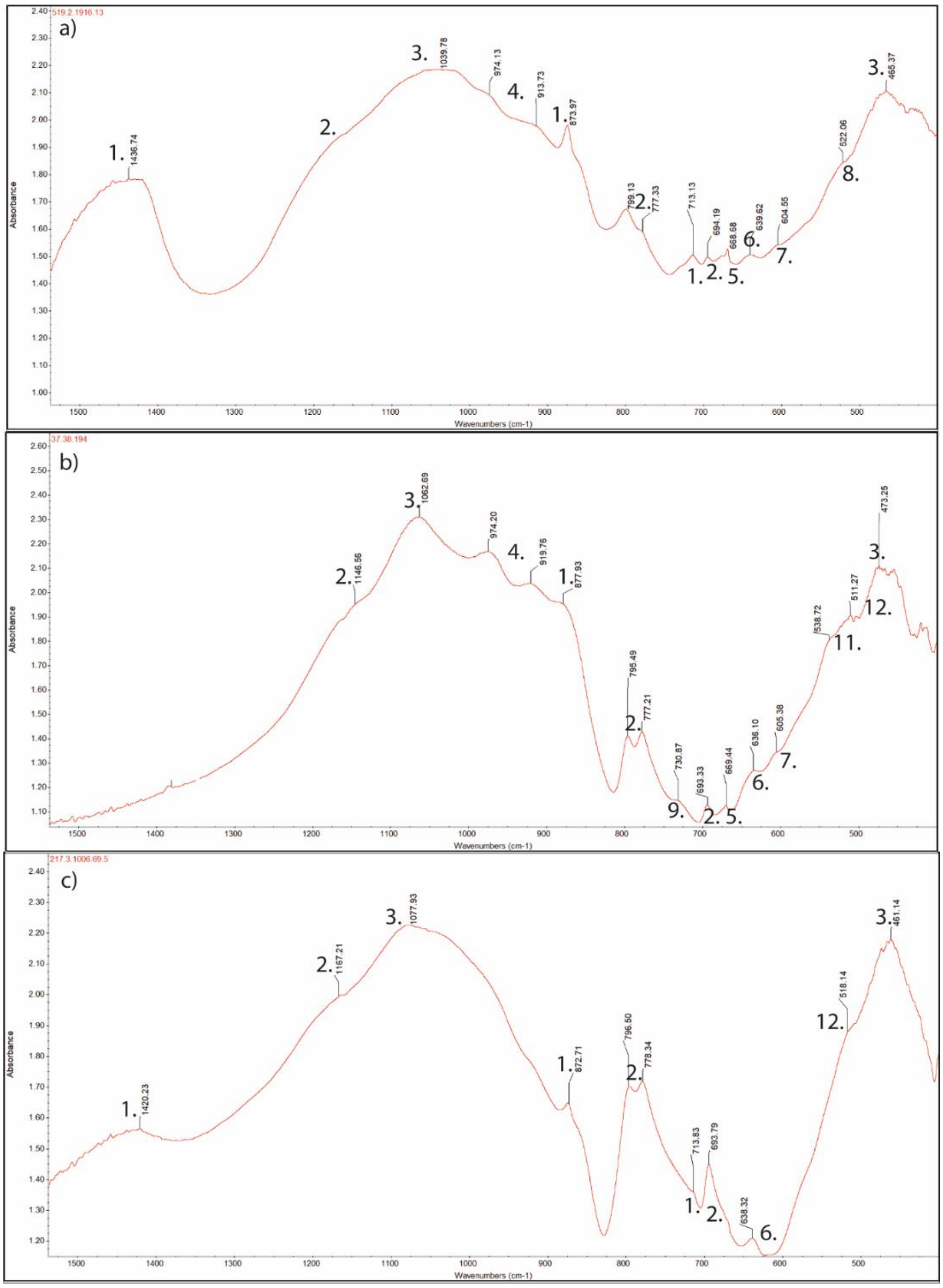


Figure 6.30: FT-IR spectra of three groups a) Calcareous, b) Non-Calcareous, and c) Stonepaste, showing various minerals present around 900°C. 1. Calcite, 2. Quartz, 3. Firing Clay, 4. Wollastonite, 5. Anorthite 6. Microcline, 7. Gypsum. 8. Aluminium stretching, 9. Andesite, 10. Oligoclase, 12. Gehlenite.

6.3.2 *Summary of FT-IR*

As seen in Figure 6.31, firing temperatures are not limited to one site or one ware type. Instead, there is a variety of firing temperatures being utilized, which is linked to the type of clay, tempering present, and surface treatment. In terms of distribution, most sites have a variety of firing temperatures present with low fired (Green), medium fired (Yellow), high fired (Blue) and very high fired (Red) being present at all sites except site 535. At 535, it seems that most were high or very high fired. However, at this site there is also a majority of fine wares, as discussed below. The larger sites (Hasanlu and Rayy) seem to have a higher firing regime, but this could be due to what was sampled rather than a true distribution.

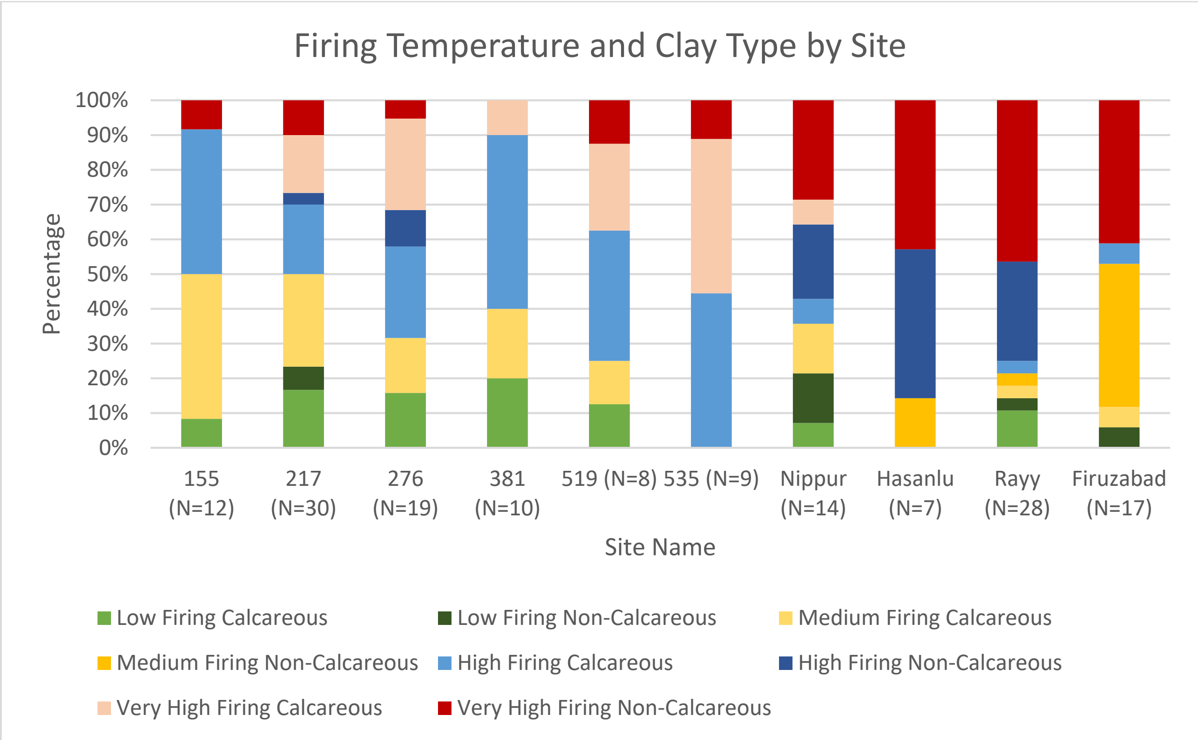


Figure 6.31: Firing temperature and clay type by site.

By looking at the distribution of the firing temperatures by tempering agent (Figure 6.32), we see that the lesser amount of temper, the higher the firing temperature. This matches with other studies on firing, where the addition of temper helps to lower the necessary firing temperature, especially when the temper is vegetal (Kilikoglou *et al.* 1995; 1998; Müller *et al.* 2010; Skibo *et al.* 2017; Tite *et al.* 2001).

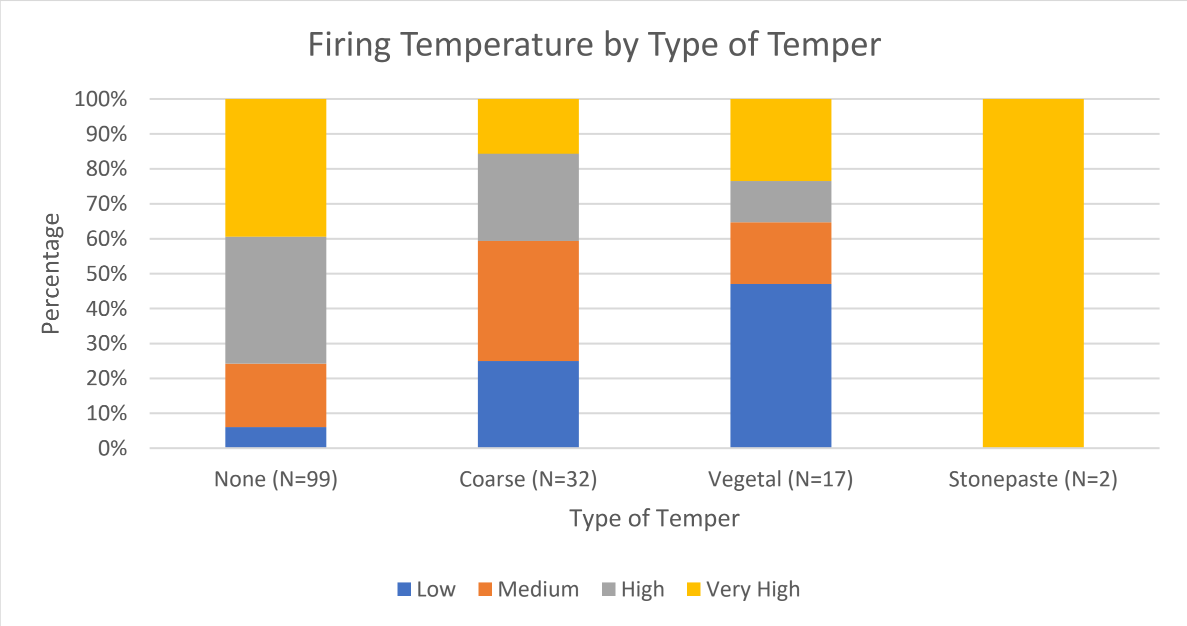


Figure 6.32: Firing temperature by the type of temper.

If we look at firing temperature by surface treatment (Figure 6.33), there is a mix of firing temperatures for finished vessels. Burnished vessels are the only category where the firing is constantly low, this could be because these vessels tend to be highly tempered (cooking ware pots) which are usually lower fired as discussed above. Glazed and moulded wares are high and very high fired, which matches the scholarship for glazed wares, which need a higher temperature for sintering (Guilherme *et al.* 2009; Molera *et al.* 2004; Pradell & Molera 2020). Moulded wares are usually untempered, and of a very fine fabric, which as discussed above, are usually higher fired.

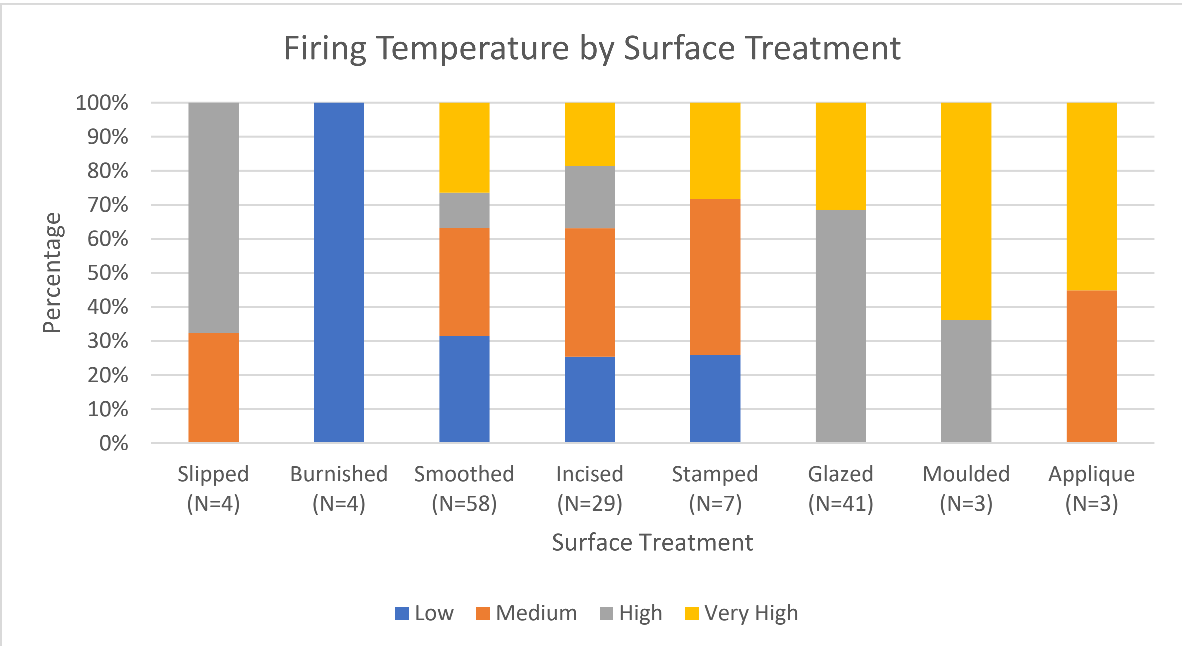


Figure 6.33: Firing temperature by the surface treatment/decoration.

Lastly, if we look at firing temperature by function (Figure 6.34), there are some patterns that emerge. The cooking and food processing vessels are lower fired (under 800°C), whereas the serving and storage vessels are higher fired (over 800°C). This could be related to the functions lower temperatures for the cooking vessels would allow for a stronger ceramic body with multiple reheating (Tite *et al.* 2001). It could also be related to the tempering agents, food processing vessels tend to be vegetal tempered, which as seen above tend to be lower fired (Kilikoglou *et al.* 1995). Serving vessels seem to be a bit higher fired than storage vessels, but they are higher fired than the cooking/food processing vessels. This could be due to their lack of temper or surface treatments/decoration. There was no difference in firing temperatures between petrographic of pXRF groupings.

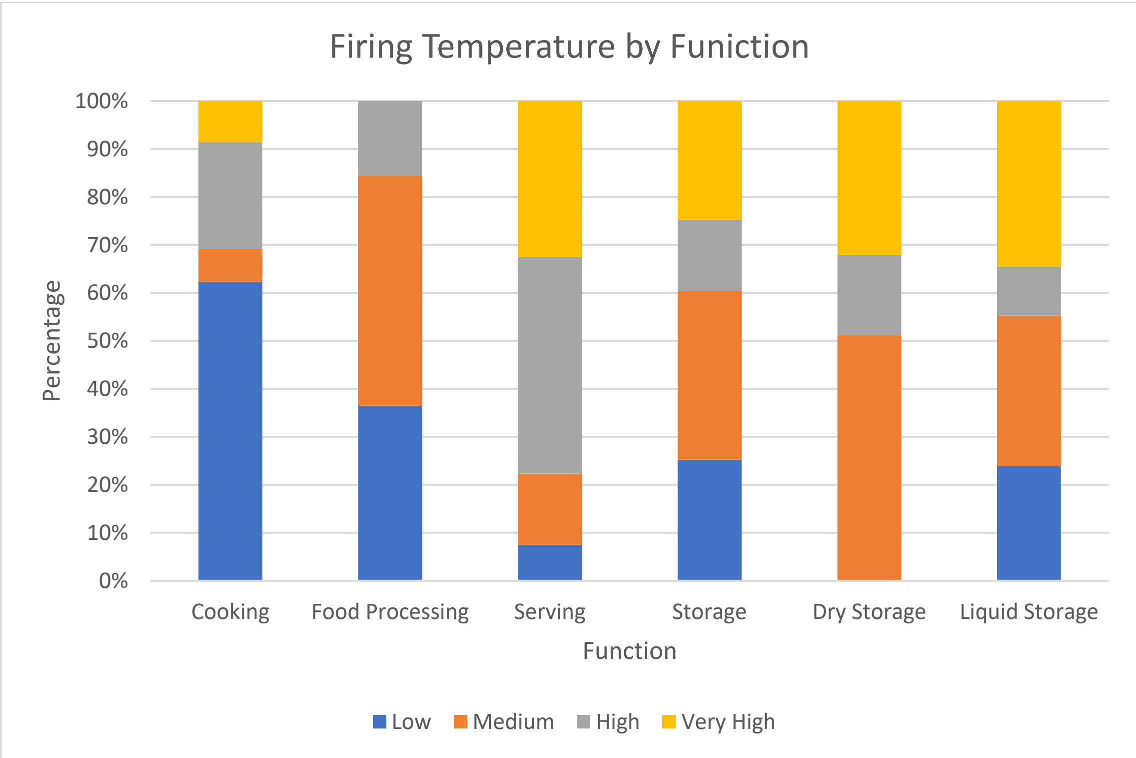


Figure 6.34: Firing temperature by vessel function.

6.4 Summary of Archaeometric Results

The results presented in this chapter illustrate a local provenience for most of the vessels related to where they were recovered. The two sherds that do not match are two moulded pieces from Rayy, with the pXRF data placing them with the Jazira samples, and petrographically they do not have any geological inclusions that identify their production zone. Another sample, the Dolerite Fabric from Nippur has dolerite which is found in Northern Iraq/Iran, but the geochemical signature matches with the rest of the samples from Nippur. This could have been traded into Nippur, and the clay sources used are similar in Nippur and the Jazira (as the Iraqi fabrics are relatively mixed), or the Dolerite minerals are making their way to Nippur, via various river paths.

Three main types of fabrics were identified, fine/no temper, coarse/mineral temper, and vegetal/vegetal tempered. Fine fabrics are the most populous category, followed by the coarser materials. However, these do not seem to have influenced the chemical compositions determined by pXRF. The firing temperatures vary, but the majority of samples were fired above 800° C (high or very high groups). The vegetal tempered ceramics tend to be lower fired, whereas the finer ceramics tend to be fired at higher temperatures. These links will be explored further in the next chapter.

7 Ceramic Traditions, Communities of Practice, and Interconnected Networks

This chapter incorporates information from the previous chapters to investigate the differences in ceramic traditions between rural and urban areas in the Middle Islamic period primarily to elucidate connections between these areas. This chapter starts by discussing the ceramic technologies of each of the functional categories of vessels. As a reminder of the discussion in Chapter 3, ceramic technology is a series of actions or techniques used to transform raw material into a finished vessel (Roux & Manzo 2018). This can be described using the *chaîne opératoire* (CO) approach (Cresswell 1976; Lemonnier 1986; Mills 2017; Roddick 2009). The CO approach describes the techniques from production to exchange, use, and in some cases discard. This is the full vessel life biography, but the ceramic technology uncovers the production stages of the CO. Ceramic traditions are patterned ways of doing things that exist in identifiable form over extended periods of time (O'Brien *et al.* 2010, p. 3797). Clay processing, tempering, and forming methods are the most stable of the CO stages, because they are not subject to change via copy and error, they require repeated direct interaction with master potters, and they are not changed due to the demands of consumers (Gosselain 1992; Roddick 2009; Roux 2019; 2020). On the other hand, surface treatments and decoration are more variable, and can indicate differences in consumer communities. These treatments are more likely to alter due to direct or indirect interactions, changing socio-cultural or geological environments, and consumer demand (Gosselain 1992; Roux 2020). Ceramic traditions allow us to understand the craft organization at the various sites, and to elucidate the difference between the rural, urban, and intermediate sites in terms of production and consumption. These will then be used to better understand the connections between these sites and the larger interconnected Islamic world.

The creation of the COs for this dissertation is discussed in Chapter 4.8. The 1255 sherds were classified into 156 different COs identified across all sites. The pXRF and petrography results show that most of the sherds (except two moulded pieces from Rayy) are made locally to the sites, or at least within the region. This is due to the similarities between the petrographic results and the regional geology, and the pXRF groupings as linked to the sites (Chapter 6). The tables in this chapter list the CO code, and are divided by function, type of tempering, the forming method, surface treatment, and firing, and the presence of these COs on the various sites. Therefore, CO1 in Table 7.1 is a cooking vessel that is fine/no tempered, handmade, smoothed, low fired and is found at Sites 155 and 217.

7.1 Ceramic Traditions and the **Chaîne Opératoire**

Potters produce ceramics that are socially and stylistically acceptable as well as functional within the limits of technology and the raw materials present. The following section discusses the various COs present for each functional group and some of the cultural behaviors that are embedded in these operations.

7.1.1 *Cooking Vessels*

Cooking vessels were identified by their globular shape, uneven firing, and the presence of burning on the vessel's surface. Sixteen different COs were identified. Cooking vessels account for 10 – 20% of sherds on excavated sites (Henrickson 1990; Tite *et al.* 2001); however, in this dissertation, they account for between one and four percent of all samples under study. This difference is likely reflective of sampling bias due to the fact that the samples were largely collected through survey (most cooking vessel fragments are not diagnostic unless they are base/rim sherds). With the limited number of sherds present at each site, it was not possible to distinguish dispersal patterns on the sites. It is worth noting that ceramics were not the only type of material used for cooking vessels. The Geniza Archive (870 – 1900), as well as various cooking books (al-Baghdadi's *Kitab al-Tabikh* (1226); al-Warraq's *Kitab al-Tabikh* (940 – 950)) recorded the use of metal, stone, and ceramic vessels (Gascoigne 2013). The cookbooks describe the different foods made with vessels of different materials and combined with the Geniza archive illustrate that most households probably had a mix of metal, stone, and ceramic vessels. At the site of Firuzabad, one ceramic was identified as a cooking vessel, and 39 stone vessels were recovered (possibly steatite, alabaster, or chlorite), but no burning was recorded (Ingraham 1975). The presence of the stone vessels could have accounted for the limited number of ceramic cooking vessels and indicate a distinct cooking tradition at this site.

Most of the cooking vessels were tempered with minerals, wheelmade, and have a smoothed surface (Table 7.1). The mineral temper is mainly crushed quartz or quartzite (petrographic groups E.3b, E.3c, E.8, N.4) with some vessels being tempered with rounded igneous/metamorphic rock fragments (petrographic groups E.4, N.3, H.1). The rounded igneous/metamorphic tempers could be from the addition of coarse-grained sands rather than crushed quartz/quartzite temper. Potters were probably using this type of temper intentionally due to the mechanical properties of quartz (Kilikoglou *et al.* 1995; Müller *et al.* 2010). The cooking vessels do show a distinct tempering pattern when compared to the rest of the functional categories, which utilize local sands as tempering agents. The handmade vessels tend to be short necked globular jars, whereas the wheelmade vessels tend to be deep bows with rounded rims. Based on the FT-IR analysis, the firing temperature varies, but the majority of the vessels were fired at low temperatures. Macroscopic observation records the presence of a dark firing core, implying that the vessels were fired in an incomplete oxidizing atmosphere and possibly a shorter firing time. The main variations in the COs are determined by the surface treatment.

Table 7.1: The COs present for cooking vessels.

Chaine Operatoire Code	Function	Temper	Forming	Surface	Firing	Total	al-Jazira							al-Iraq	al-Ran	Iraq al-Ajam		Khurasan
							155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad
CO1	Cooking	Fine/Untempered (E.1; F.4)	Handmade	Smoothed	Low	2	1	1										
CO2			Coilmade	Incised	Unknown	1		1										
CO3			Wheelmade	Slipped	Unknown	1	1											
CO4				Smoothed	Very High	1												1
CO5		Coarse/Mineral Tempered (E.3b; E.3c; E.4; E.8; H.1; N.3; N.4)	Handmade	Burnished	Unknown	1	1											
CO6				Smoothed	Low	12	4		4	1				3				
CO7				Stamped	Unknown	1								1				
CO8			Coilmade	Burnished	Unknown	1	1											
CO9			Wheelmade	Slipped	High	1								1				
CO10				Burnished	Low	5	2	2			1							
CO11				Smoothed	Low	1								1				
CO12					Medium	1		1										
CO13					Unknown	6	1			3	1	1						
CO14				Incised	High	3			1						2			
CO15		Vegetal Tempered (E.5b)	Wheelmade	Smoothed	High	1							1					
CO16		Vegetal and Mineral Tempered (R.7)	Wheelmade	Stamped	High	1										1		
					Total Sherds	**39**	**11**	**5**	**5**	**4**	**2**	**1**	**1**	**6**	**2**	**1**	**0**	**1**

The fabrics of cooking vessels are relatively easy to distinguish due to the higher proportion of mineral temper. Tite, Kilikoglou, and Venkins (2001) discuss the importance of the mechanical properties of cooking vessel fabrics including strength, toughness, and thermal shock resistance. They determined that the best cooking vessels were made with a high proportion of mineral temper and lower firing temperatures. Platy or fibrous temper are best (mica, wollastonite, shell) due to their ability to mitigate changes with repeated heating. Marble, quartz, or a quartz-rich sand is the next preferable choice of temper, with grog or untempered ceramics being the least favorable fabric for cooking vessels (Hoard *et al.* 1995; Kilikoglou *et al.* 1995; 1998; Müller *et al.* 2010; Tite *et al.* 2001; West 1992). The petrographic analysis identified nine petrofabrics in the cooking vessels, with limestone, quartz, schist, and vegetal inclusions. The vegetal inclusions were very rare, and one was mixed with quartz and schist. The vegetal inclusions would have given the fabric larger pores which would allow for the transfer of heat across the vessel. The rest of the mineral tempers are regional in nature, but all have 30% or more temper. Quartz is present in most samples, and is probably a technical choice due to the ability of quartz to expand while heating, and when it cools, contracts, leaving spaces in the clay matrix, hence it is better for thermal shock resistance (Tite *et al.* 2001, p, 309).

The tempering tradition identified in this study is different from earlier practices in the area, and as well as earlier Islamic cooking vessels. The petrography for the Neo-Assyrian site of Usu Aska in the Rania Plain revealed that the main tempering agent for their cooking vessels was calcite, and this seems to hold true for most of the earlier periods in the region (pers. obs; Lewis, Quinn and Carter, 2020; Alden *et al.*, 2021). The Neo-Assyrian period dates around 2000 years earlier than the period under study here; however, combined with the Chalcolithic assemblages (4000 BCE), does show a change in pattern across a long-time span. More comparable in date are the studies on the Early Islamic 'Brittle Ware' cooking vessels from northern Syria and the Levant (Oates and Oates, 1959; Catling, 1972; Franken and Kalsbeek, 1975; Schaefer and Falkner, 1986; Bartl, Schneider and Böhme, 1995; Northedge, 1996; Daszkiewicz, Krogulska and Bobryk, 2000).

'Brittle Ware' is defined by its red/brown surface, rich mineral temper, rough surfaces, and thin walls. It dates from the Hellenistic to Early Islamic periods, and is found mainly in the Levant, but also throughout northern Syria and Iraq (Adams 1970; Bartl *et al.* 1995; Northedge 1996; Oates & Oates 1959). Bartl, Schneider, and Böhme (1995) did a petrographic study of this ceramic in northeastern Syria, and defined five groups, all made with non-calcareous clays and various types of mineral temper. They hypothesize, based on the petrographic and geochemical groups, that these vessels were made in the Levant and exported to the Khabur region. In this dissertation, all cooking ceramics, except the sherd from Rayy, are made with calcareous clays; however, the inclusions are the same types of rocks/minerals as Brittle Ware. Brittle Ware has more temper, and thinner bodies than the materials discussed in this dissertation, illustrating a difference in ceramic traditions between these two assemblages. The use of non-calcite mineral temper is prevalent in this period and may be the impetus for this type of rock (quartz/igneous) temper in the Middle Islamic period. Brittle Ware disappears from the archaeological record around 900 CE (Bartl *et al.* 1995; Daszkiewicz *et al.* 2000).

The various surface treatments (slipped, burnished, smoothed, and incised) present in these traditions are more than likely due to consumer demands. This could be related to the types of cooking occurring (e.g. slipped and burnished treatments make the ceramic more watertight), or to the decoration of cooking wares (Gascoigne 2013). This could indicate preferences of various social groups at the sites. The various decorations could have been indicators of status, identity, and tastes of the consumers. Surface treatments are evident on vessels of all different forms and production techniques/traditions.

7.1.2 *Food Processing Vessels*

Food processing vessels are identified based on their forms (basins, trays), very large diameters, and the thickness of the sherds. Food processing includes activities such as grinding, soaking, chopping, mixing, winnowing, drying, and/or smoking. Some of these may overlap with the cooking function, but there was no burning identified on these sherds. Seventeen different COs were identified. Food processing vessels usually get lumped into cooking or storage functions and there is not much research into their various COs or differentiating the various food processes that may be linked with various forms. There is a lack of use marks (scraping/polishing/burning) on the sherds in these samples, and as such they probably were not used for the grinding or smoking/cooking of food. The vessels are mainly basins, which would be hard to close for long term storage, but shorter-term storage may be a secondary function of these vessels (Henrickson & McDonald 1983). These types of vessels are not normally separated in ceramic surveys, but due to their unique shape and various ethnographic studies (Ali 2010; David & Kramer 2001; Henrickson & McDonald 1983; Kramer 1985), these vessels should be the focus of more research. There are a restricted number of COs present which may point towards a relatively standardized way of making food processing vessels, depending on the type of food processing occurring. This could also be due to the limited number of food processing vessels in this sample. It is also helpful to note here that like cooking vessels, many of these functions could also be performed in stone or metal vessels.

Food processing vessels are not normally recorded as a separate category in the literature, usually being grouped in with cooking or storage vessels, so it is hard to determine the percentage of total sherds that represents this type of vessel. In these collections, they range from 1 to 18% of the sample from different sites. Firuzabad has the largest percentage of these vessels (18%) followed by Nippur (10%) and the EPAS sites (1 – 8%). Due to the nature of the surveys, no individual food processing areas were determined on any of the sites.

The majority of food processing ceramics were tempered with vegetal materials and smoothed on the surface (Table 7.2) (Skibo *et al.* 2017). The main variations in the COs are seen in the forming techniques. These ceramics had limited samples taken, and as such the mineralogy of the coarse/mineral tempered wares are unknown. The vegetal temper is probably chaff due to the size and shape of the voids. The two sherds that are vegetal and mineral tempered include chaff as well as sedimentary rock fragments (chert, mudstone, limestone). The squared basins and vessels with diameters larger than 40 cm tend to be handmade, otherwise there are no other differentiating factors (e.g. size of diameters, thickness of walls) for the use of different forming techniques. The reasoning behind this variation is unclear, as it may be related to potters' choice, or the activities taking place in these vessels.

Table 7.2: The COs present for food processing vessels.

Chaine Operatoire Code	Function	Temper	Forming	Surface	Firing	Total	al-Jazira							al-Iraq	al-Ran	Iraq al-Ajam		Khurasan
							155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad
CO17	Food Processing	Fine/Untempered	Handmade	Incised	Unknown	2	2											
CO18			Coilmade	Incised	Unknown	1	1											
CO19			Wheelmade	Smoothed	Unknown	2												2
CO20		Coarse/Mineral Tempered	Handmade	Smoothed	Unknown	7		1						6				
CO21				Incised	Unknown	4			1					3				
CO22			Wheelmade	Smoothed	Unknown	1			1									
CO23				Grooved	Unknown	1	1											
CO24		Vegetal Temper (E.5)	Handmade	Smoothed	High	18	2	8	2	5				1				
CO25				Incised	Unknown	1												1
CO26				Applique/ Barbotine	Unknown	2		2										
CO27			Coilmade	Smoothed	Unknown	2		2										
CO28				Incised	Unknown	2	1											1
CO29			Wheelmade	Smoothed	Unknown	10	1	2		1	2							4
CO30				Incised	Unknown	3												3
CO31				Applique	Unknown	2												2
CO32		Vegetal and Mineral Tempered (F.3; R.6)	Handmade	Smoothed	Low	1												1
CO33			Wheelmade	Smoothed	Medium	1										1		
					Total Sherds	**58**	**6**	**15**	**4**	**6**	**2**	**0**	**0**	**10**	**0**	**1**	**0**	**14**

Based on the macroscopic analysis, the atmosphere in which the vessels were fired varies, with the homogenous and heterogenous color of the cross section of the samples indicating firing in a complete oxidization to incomplete oxidization and reducing atmosphere. The homogenous coloring and complete oxidization indicates that the vessels were fired for a longer time at an even temperature allowing for the entire vessel to attain the same color. The heterogenous colored sherds, in contrast, are fired for shorter times and/or at uneven firing temperature which makes the color change across the sherd, usually with a darker core color indicating incomplete oxidization. These firing conditions vary by site, with Site 155, Rayy and Nippur having predominantly oxidized homogenous firing. The other sites have a mix of all types of firing regimes (oxidizing/homogenous, oxidizing/heterogenous, reducing/homogenous, and reducing/heterogenous) (Table 7.3). Some of the sherds (N=12; 20%) also show variation in color across the surface which may be an indication of open firing. The rim sherds with evidence of uneven firing all tend to be larger than 40 cm, and as such may be fired in an open firing rather than a kiln due to their large size. The other ceramics are probably fired in a kiln.

Table 7.3: Types of firing of food processing vessels by site.

Site	Oxidizing/ Homogenous	Oxidizing/ Heterogenous	Reducing/ Homogenous	Reducing/ Heterogenous	Total
155	8 (13%)				8 (13%)
217	7 (11%)	6 (10%)	1 (2%)	1 (2%)	15 (25%)
276		1 (2%)	2 (3%)	1 (2%)	4 (6%)
381	2 (3%)	3 (6%)		1 (2%)	6 (10%)
453	1 (2%)	1 (2%)			2 (3%)
Nippur	10 (16%)				10 (16%)
Rayy	1 (2%)				1 (2%)
Firuzabad	10 (16%)		4 (6%)		14 (25%)
Total	39 (63%)	11 (20%)	7 (11%)	3 (6%)	60 (100%)

7.1.3 *Serving Vessels*

Serving vessels were determined based on their forms (shallow/deep bowls, trays, jugs), the surface treatment/decoration, and fineness of the fabric. Thirty-six different COs were identified. Serving vessels are usually the most commonly discussed vessel type, they allow for comparison both spatially and temporally due to their highly decorated nature. The percentage of serving vessels in this dissertation ranges from 14 to 85%, with an average of 40% across all sites. The sherds analyzed from museums collections range from 60 – 85%, whereas the sherds from survey collections range from 14 – 40%. This variation is due to differing collection practices. Serving functions can also take place on a variety of materials from stone to metals and glass. Textual sources and artistic representations from the Middle Islamic period indicate that elites mainly used metal vessels for serving (Gascoigne 2013; Vorderstrasse 2005; Watson 2017).

The majority of serving vessels (83%) are fine or untempered, wheelmade, with a variety of surface treatments. There are some handmade and coilmade fine ceramics present, mainly at Sites 155 and 217. These handmade serving vessels also have a variety of surface treatments. The moulded serving vessels are similar across most sites in terms of decoration. The fine fabrics may use naturally fine clay, or they could be levigated to remove large inclusions. Two types of fabrics were identified, quartz rich and biotite rich which may show two different clay sources being used at most sites; however, they are not selected to make certain vessels. The coarser fabrics (5%) are tempered with chert, limestone, quartz in the al-Jazira region, schist in al-Ran, and quartz, mudstone, and serpentinite in Iraq al-Ajam. These are all probably local sands due to the rounded nature of the inclusions. These are also mainly wheelmade with a variety of surface treatments. The vegetal tempered ceramics (2.5%) are also mainly wheelmade, smoothed, and a few from Khurāsān are glazed or incised.

The firing temperature ranges from low to very high, and the majority are high (over 800°C). The fabrics have a consistent color across their body indicating a controlled firing with consistent temperature and length of firing. This control of the firing temperature possibly indicates a kiln firing instead of open fire.

As stated above, I have condensed the incised and glazed surface treatments into two broad categories: incised (single, comb, incised/impressed) and glazed (monochrome, polychrome, sgraffiato, black on blue, blue on white, Sultanabad, splash opaque, and brown on white). Understandably, each of these techniques has its own separate CO in terms of incising, painting, or layers of glaze, but all were the same in terms of forming techniques and firing temperatures, and as such were grouped together. From the outset, I decided that glazing technology was not the focus of this dissertation, and as such I did not investigate the various practices used to create the various glazed decorations.

Two surface treatments tend to be linked to specific forming processes. The first are jugs that are made in moulds. This specific method of manufacture was possibly done at specific workshops (Mulder 2015; Tonghini & Henderson 1998), but also the use of moulds does allow for the replication of intricate designs. The pXRF analysis indicates a similar chemical composition for all the moulded wares analyzed, as they grouped together into Group 1b. This could indicate a workshop in the Jazira manufacturing these ceramics. Two sherds from Rayy are probably not locally made as they group with sherds from the al-Jazira region based on pXRF and petrographic results. Their fabric was fine with only quartz inclusions, and as such their provenience cannot be established based on petrography. One of the moulded pieces (Plate 29: 5) has Kufic and Nashki script on it, and this is also a northern Iraqi/Syrian style on ceramics and monuments (Wilkinson 1973, p. 330). The similarities in production of these vessels across the entire sample indicate an exception to the local workshops that were creating the majority of the serving vessels.

The second surface treatment linked to a specific forming process are glazed bowls, which are all wheelmade. The use of the wheel makes it easier to mass produce these vessels, hence, these vessels are being made and decorated in large quantities for the wider community. The rest of the manufacturing traditions do not have specific surface treatments or forms associated with them. Therefore, the potters were not choosing to form their vessels in a specific way, rather they were probably forming them due to how they were taught.

Table 7.4: The COs present for serving vessels.

Chaine Operatoire Code	Function	Temper	Forming	Surface	Firing	Total	al-Jazira							al-Iraq	al-Ran	Iraq al-Ajam		Khurasan
							155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad
CO34	Serving	Fine/Untempered (E.1; E.2; H.2; N.1; N.2; R.1; R.2; R.3)	Handmade	Slipped	Unknown	1		1										
CO35				Smoothed	Unknown	3	2							1				
CO36				Grooved	Unknown	1	1											
CO37				Glazed	Unknown	3	2									1		
CO38			Coilmade	Smoothed	High	7	2	4					1					
CO39				Incised	Unknown	3	3											
CO40				Glazed	Unknown	2		1								1		
CO41				Moulded	Unknown	1		1										
CO42				Applique/ Barbotine	Unknown	3										3		
CO43			Moulded	Glazed	Unknown	1										1		
CO44				Moulded	High	21	9	2	3	3		1	1		1	1		
CO45			Wheelmade	Slipped	Unknown	4	4											
CO46				Burnished	Unknown	1	1											
CO47				Smoothed	Medium	4	2									2		
CO48					Very High	3							2			1		
CO49					Unknown	42	23	5	2	2	2	2	2			1		3
CO50				Incised	Unknown	22	3					1			14	2	2	
CO51				Grooved	Unknown	8	6		1				1					
CO52				Stamped	Low	1		1										
CO53					Medium	2										2		
CO54				Painted	Unknown	2									1			1
CO55				Glazed	High	228	82	29	8	7	4	2		50	8	35	2	1
CO56				Applique/ Barbotine	Unknown	6			1							5		
CO57		Coarse/Mineral Tempered (E.3; H.1; R.5)	Handmade	Smoothed	Unknown	3		1						2				
CO58				Incised	Unknown	1								1				
CO59				Applique	Unknown	1		1										
CO60			Coilmade	Smoothed	Unknown	1		1										
CO61			Moulded	Moulded	Very High	1				1								
CO62			Wheelmade	Smoothed	Unknown	9	1	5	1						2			
CO63				Inlaid	High	1										1		
CO64				Glazed	Very High	6				2						2		2
CO65		Vegetal Tempered (E.5b)	Coilmade	Smoothed	Unknown	1		1										
CO66			Wheelmade	Smoothed	Medium	6	1		3		1							1
CO67				Glazed	Unknown	1												1
CO68		Vegetal and Mineral Tempered (E.5c)	Wheelmade	Smoothed	Low	1			1									
CO69		Stonepaste (E.9; H.4)	Wheelmade	Glazed	Very High	43		1						7	27	2	1	5
CO70		Porcelain	Wheelmade	Glazed	Very High	2								2				
					Total Sherds	**446**	**142**	**54**	**20**	**15**	**7**	**6**	**7**	**63**	**53**	**60**	**5**	**14**

The stonepaste wares (10%) are made from a mixture of quartz, frit, and limited amounts of clay (Allan, 1973; Mason and Tite, 1994b; Mason, 1995; Mason, 2001). These are all wheelmade, glazed, and fired at very high (over 900°C) temperatures. Two of these pieces were analyzed microscopically and showed different recipes. The piece from Site 217 had quartz, opaques, chert, and quartzite whereas the Hasanlu piece had quartz, opaques, calcite, and chert. The percentages of clear and cloudy quartz also varied (see Ch.6.2.1.9 and Ch.6.2.3.4) showing two distinct recipes at these two sites. They also have differences in glazing, as Site 217 is monochrome turquoise and Hasanlu is Lajvardina, which may influence the stonepaste recipe. Stonepaste wares are difficult to provenance (Mason and Tite, 1994b; Mason, 1995; Mason, 2001; Rugiadi, 2011) due to the ubiquity of quartz and lack of research into the various recipes (Mason, 1995; Mason, 2001).

The two porcelain sherds (0.5%) from Nippur were both wheelmade, glazed (one in celadon, the other in blue on white) and fired at a very high temperature. Porcelain dating to the period under study was likely made in China with their access to kaolin clays and the long-established production techniques.

7.1.4 *Storage Vessels*

Storage vessels were identified by their shape (large jars, large flat bases) and thickness of the vessel's walls. They can be divided into two categories, dry storage (short necked jars, smoothed/undecorated), and liquid storage (long neck jars, slipped/burnished/glazed) (Henrickson 1990; Henrickson & McDonald 1983). Two special forms, spheroconical vessels and pilgrim flasks are identified as storage/transport vessels, but both are grouped into this larger storage category. Sixty-five different COs were identified.

Storage and transport vessels need to retain their contents and survive impact without cracking (Tite 2008). These vessels have somewhat restricted to very restricted necks, which are easy to cover with a lid or stopper. Temper accounts for less than 15% of the fabric which allows for microcracks to form to disperse energy, but not enough to make the ceramic brittle (Tite 2008). The vegetal temper allows for liquids to permeate the surfaces and keeps the liquids cooler due to evaporation (Eramo 2020). In some cases, the permeability of the surfaces was reduced (slipping, burnishing, glazing), which would cause less evaporation. Storage vessels are not normally present in metal or stone, except for possibly short-term storage; however, organic materials such as baskets, bags, or leather flasks may be used. The amount of COs present for storage vessels indicates a more site-specific method of manufacture and may be able to offer more insights into local and regional production of ceramics. At the survey sites, storage vessels comprise 40 – 70% of the total ceramics, whereas the ceramics that were exported to museums have 10 – 30% storage vessels. This difference is probably due to export of materials to the museums, where the finer decorated ceramics were prioritized rather than the different type of storage containers present at these sites. None of the sites had identified storage specific areas.

The main fabric is fine/no temper, followed by coarse/mineral temper, and vegetal tempered (Table 7.5). The same types of fabric are used to make both serving and storage vessels at most sites; however, the handmade and coilmade percentages are higher for storage vessels. Various methods of manufacture are evidenced including handmade, coilmade, moulded, and wheelmade. The surface treatments also vary, as do firing temperatures. The color was homogenous and dull through all samples indicating a standardized firing temperature and time for the individual vessels, but there are variations in the assemblages.

Table 7.5: The COs present for storage vessels.

Chaine Operatoire Code	Function	Temper	Forming	Surface	Firing	Total	al-Jazira							al-Iraq	al-Ran	Iraq al-Ajam		Khurasan
							155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad
CO71	Storage	Fine/Untempered (E.1; E.2; F.1; H.3; N.1; R.1; R.2; R.3)	Handmade	Smoothed	Very High	4	2	1		1								
CO72				Incised	Unknown	2	2											
CO73				Applique/ Barbotine	Unknown	2	2											
CO74			Coilmade	Slipped	High	3							1					2
CO75				Smoothed	Medium	1				1								
CO76					Very High	2	1											1
CO77					Unknown	21	6	3		6	1	1	2	1				1
CO78				Incised	Medium	64	52	5	2	3			1					1
CO79				Grooved	Unknown	1	1											
CO80				Stamped	Medium	9		1						7		1		
CO81				Painted	Unknown	1												1
CO82				Glazed	Unknown	1		1										
CO83				Applique	Unknown	2	1									1		
CO84			Moulded	Moulded	Unknown	7								1		5		1
CO85			Wheelmade	Slipped	High	1												1
CO86				Burnished	Unknown	6	5	1										
CO87				Smoothed	Low	5			2			1				2		
CO88					Medium	1										1		
CO89					High	4				2		2						
CO90					Very High	8			1	1		1				3		2
CO91					Unknown	147	58	13	13	21	17	7	7	2	1	1	1	6
CO92				Incised	Medium	1										1		
CO93					High	1										1		
CO94					Very High	3		1				1	1					
CO95					Unknown	53	27	9	1	1	4	2	1	3	1	2	1	1
CO96				Grooved	High	2	1		1									
CO97				Stamped	Unknown	7	2							2		3		
CO98				Inlaid	Low	1										1		
CO99				Glazed	High	13	5	1		1			1	1	1	3		
CO100				Applique/ Barbotine	Medium	12	9						1			1		1
CO101		Coarse/Mineral Tempered (E.3; E.6; E.7; F.2; H.1; N.3; N.5; R.4; R.5)	Handmade	Smoothed	Low	8		1						6	1			
CO102				Incised	Unknown	2								2				
CO103			Coilmade	Smoothed	Very High	5		2		2								1
CO104				Incised	Medium	15	3	5	2	1				1		1		2
CO105				Stamped	Very High	3								1		2		
CO106				Glazed	High	1									1			
CO107				Barbotine	Unknown	2	1	1										
CO108			Wheelmade	Slipped	Medium	3		1			1							1
CO109				Burnished	Unknown	2	1								1			
CO110				Smoothed	Low	1				1								
CO111					Medium	3				1				1	1			
CO112					Very High	2											2	
CO113					Unknown	22	3	1	1	5	9	1		1	1			
CO114				Incised	Low	1				1								
CO115					Medium	2		1								1		
CO116					Very High	1							1					
CO117					Unknown	12	1	6		2				2				1
CO118				Glazed	Unknown	1												1
CO119				Moulded	Unknown	1	1											
CO120				Applique	Very High	2				1								1
CO121		Vegetal Tempered (E.5)	Handmade	Smoothed	Medium	32	4	11	6	4	1		1					5
CO122				Incised	Unknown	3		1						1				1
CO123				Stamped	Unknown	1								1				
CO124				Applique/ Barbotine	Unknown	4	1	3										
CO125			Coilmade	Slipped	Unknown	1												1
CO126				Smoothed	Unknown	6	1	4			1							
CO127				Incised	Unknown	4	2			1								1
CO128				Stamped	Unknown	3	2		1									
CO129				Applique/ Barbotine	Unknown	3	1											2
CO130			Wheelmade	Slipped	Unknown	1	1											
CO131				Smoothed	Medium	15	5	1	3		3	2						1
CO132				Incised	High	8	3							1		1		3
CO133				Stamped	Unknown	1	1											
CO134				Applique	Unknown	4	1											3
CO135		Vegetal and Mineral Tempered	Coilmade	Applique	Very High	2												2
CO136			Wheelmade	Incised	High	1			1									
					Total Sherds	**563**	**206**	**74**	**34**	**56**	**37**	**18**	**17**	**34**	**8**	**31**	**4**	**44**

Fine fabrics are mainly wheelmade, followed by coilmade, handmade, and moulded. They have various surface treatments and firing temperatures. Most of the firing is high (above 800°). As stated above, the incising category includes single, comb, and incised/impressed, and it is interesting to note most of the incising in storage vessels tends to be comb incised in straight or wavy lines. Coarse/mineral tempered fabrics have inclusions of quartzite, chert, limestone, scoria, trachyte, schist, shell, dolerite, and basalt, depending on the region. The majority of these ceramics are wheelmade, with more limited amounts of coilmade and handmade. Smoothing and incising are the two main types of surface treatment/decoration, but some are stamped, glazed, moulded, or have appliqué/barbitone decoration. Firing ranges from low to very high, with very high and medium as the most prominent.

The vegetal tempered fabric probably contains chaff, due to the size and shape of the voids left behind. A few of these also have mineral inclusions of quartz, basalt, and trachyte. The production methods are evenly distributed between handmade, coilmade, and wheelmade, has surface treatments/ decorations of slipped, smoothed, incised, stamped, and appliqué, and firing ranging from low to very high, and the majority are medium fired (700 – 800°C).

A few sherds have bitumen on the interior surfaces making the vessels impermeable. Site 217 has the most with eight sherds, Sites 155, 519, 453, and Firuzabad have one sherd each. These twelve sherds have eleven COs present indicating a mix of traditions in manufacturing these vessels. Chaff tempered bitumen-lined ovoid jars were found dating from the 2nd century BCE and are linked to the production, storage, and transport of wine (Durand 2021). These were replaced in the Early Islamic period by bitumen-lined torpedo jars. The pieces with bitumen identified here are all body sherds with no discernible vessel shape. These could be used for the storage/transport of wine, or any other liquid. The mix of COs could illustrate different liquids being transported or stored at these various sites.

One specific form of serving/transport vessel was identified in these ceramics, the spheroconical vessels. These were all made of a dense untempered fabric that was moulded (CO84). These vessels were found at Nippur, Rayy, and Firuzabad, showing an overarching practice of manufacture. None were scientifically investigated so it is unknown if they are being made locally or exchanged, but previous research illustrates their far-reaching spread (Ettinghausen 1965; Ghouchani & Adle 1992; Pradines 2016). The similarities in the CO as well as their shape show a specific function for these vessels, and a possible controlled method of manufacture, illustrating a possible workshop manufacture. However, if they are all being made local to the sites of recovery, this may illustrate an overarching way of making a vessel for a specific function.

7.1.5 *Other Ceramics*

This group includes all other forms identified including handles (N=112), spouts (N=15), lids (N=8), lamps (N=3), possible architectural fragments (N=3), and smoking jars (N=3). Nineteen different COs were identified for this function. Except for the nargilehs, none of these were microscopically analyzed. Since these sherds were just recorded as part of the overall ceramic assemblages and not investigated much further, they are presented briefly below. The handles, spouts, and lids were made with fine, coarse, and vegetal inclusions, were handmade, and the majority were smoothed. Handles had a few more surface treatments including incised, grooved, and glazed.

The nargilehs are made from a mineral tempered fabric, one is handmade, and two are wheelmade. These have been fired at both high and low temperatures, and smoothed. There is organic residue around the tops of the pipes, as well as evidence of burning along the inside. These have been tempered with chert, limestone, and some schist, but all are well rounded indicating a sand (water or airborne) was added rather than a crushed rock. These also match other fabrics used for storage and serving vessels.

The three lamps are all made from fine wares, are moulded, and one is burnished while the other two are glazed. There is the presence of burning on the spouts identifying them as lamps. The architectural fragments included two possible tiles and a possible plaque. All are made with a vegetal fabric, the tiles are wheelmade and the plaque is moulded. The tiles are smoothed, and one is over fired causing warping. The plaque has a moulded design (Plate 35:20).

Table 7.6: The COs present for other vessels.

Chaine Operatoire Code	Function	Temper	Forming	Surface	Firing	Total	al-Jazira							al-Iraq	al-Ran	Iraq al-Ajam		Khurasan
							155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad
CO137	Smoking Vessel	Mineral Tempered (E.3)	Handmade	Smoothed	High	1		1										
CO138			Wheelmade	Smoothed	Low	2	1	1										
CO139	Architectural	Vegetal Tempered	Moulded	Moulded	Unknown	1												1
CO140			Wheelmade	Smoothed	Unknown	2										1		1
CO141	Lamp	Fine/Untempered	Moulded	Burnished	Unknown	2	1							1				
CO142				Glazed	Unknown	1									1			
CO143	Lid	Fine/Untempered	Handmade	Smoothed	Unknown	1								1				
CO144			Wheelmade	Smoothed	Unknown	5	1	2	1							1		
CO145		Coarse/Mineral Tempered	Handmade	Smoothed	Unknown	1												1
CO146		Vegetal Tempered	Handmade	Smoothed	Unknown	1		1										
CO147	Handle	Fine/Untempered	Handmade	Slipped	Unknown	2		2										
CO148				Smoothed	Unknown	77	41	6	7	7		1	9	2				4
CO149				Incised	Unknown	4	2	2										
CO150				Grooved	Unknown	6	6											
CO151				Glazed	Unknown	2			1							1		
CO152		Coarse/Mineral Tempered	Handmade	Smoothed	Unknown	17	4	8	1	1	1	1		1				
CO153		Vegetal Tempered	Handmade	Smoothed	Unknown	6	2	1	1					2				
CO154	Spout	Fine/Untempered	Handmade	Smoothed	Unknown	13	7		1	1		3		1				
CO155				Glazed	Unknown	1					1							
CO156		Coarse/Mineral Tempered	Handmade	Smoothed	Unknown	2			1	1								
					Total Sherds	**147**	**65**	**24**	**13**	**10**	**2**	**5**	**9**	**8**	**1**	**3**	**0**	**7**

7.1.6 *Summary of Technologies and Traditions*

This section described the various ceramic manufacturing processes observed for each vessel's functional category. Most ceramics were made locally (except the two moulded pieces from Rayy), either in the region, or at the site-specific location of recovery. The majority of ceramics are fine fabrics, wheelmade, and smoothed, with the surface treatment/decoration containing most of the variation in the CO. Local raw materials (clays and tempering agents) were used in all productions to make different types of vessels, but it is clear that the fabrics used to make the serving vessels are finer-grained than the cooking and food processing vessels. This could indicate two various practices. 1) The serving, food processing, and cooking vessels are being made by the same potters, but they are using different paste preparation methods for different vessel types, indicating a high level of producer's specialization. 2) Different organizations of potters are specialized in the production of different types of vessels, even though the same local raw materials are being used. This may indicate the presence of some sort of product-oriented specialization. Firing temperatures and procedures are relatively the same across Western Asia, probably using a kiln to reach the higher temperatures and more consistent firing. Food processing vessels were the only ones to show possible open firings due to the coloring changes on the surface of the vessels. Firuzabad shows the most variation in firing, and some vessels being overfired, which is not seen at the other sites. Most of the sites do not have recorded kiln structures or wasters present. Rayy has multiple kilns attested, which may indicate individual kilns are present for use by specific workshops. The lack of kilns at the other sites may indicate that there are fewer kilns present at the sites, showing possible kiln sharing in operation (Bernardini 2000).

7.2 Consumption Practices

Ceramics are made in a specific socio-cultural context, in response to demand by consumers. Therefore, the consumers' demand drove the production of the ceramics. Consumption, defined as how people socialize material goods, and due to the way objects display social status and how people are connected to one another (Mullins 2011). Consumption in this dissertation is discussed in terms of changing forms (and differences in functions) as well as surface treatments and decorations. The presence or absence of various ceramics at sites indicates what and how people consumed the ceramics. The majority of the ceramic descriptions are found in Chapter 5, but a summary is presented below.

7.2.1 *al-Jazira (EPAS)*

As shown in Chapter 5, the majority of the ceramics match those from Qal'at Ja'bar (Tonghini 1998) dating from the 11th – 14th centuries, in terms of both style and vessel form. The dating of these sites was determined mainly by the glazed and moulded assemblages, as that is the published chronological criteria. Some of the more decorated ceramics have links within the region as well as between regions. The fabrics range from 52% to 88% fine/no temper, 3% to 26% coarse/mineral tempered, and 6% to

23% vegetal tempered. They are mainly wheelmade ranging from 48% to 85%, followed by handmade (8% to 30%), coilmade (3% to 20%), and moulded (0% to 3%). They have a range of forms from long-neck jars (3% to 12%), deep bowls (0% to 12%), shallow bowls (0%-7%), and basins (0% to 12%). The majority of the sherds are smoothed (40% to 78%) followed by comb incising (5% to 17%) and monochrome glazing (0% to 17%). Functionally the ceramics of these sites are pretty evenly divided between storage and serving functions with all sites having more storage vessels than serving vessels. Sites 217, 381, and 453 also have food processing functions between 4% and 6%, and site 276 and 453 have cooking vessels at 4% to 6%.

Various types of decoration illustrated connections in this region as well as larger connections between regions. The stamping seen on the ceramics of these sites is similar, with rosettes and geometric designs dominating the assemblage. These are different from the stamps present at Nippur and Rayy. The stamping here is seen on storage vessels, similar to those at Nippur, but Rayy is different, with stamping on serving vessels. The rope appliqué in the Jazira does vary some with the size of the appliqué, but the majority is a thin line with slashes, which is present here and on a few pieces from Firuzabad. The larger bands with fingerprint indentations are present at some sites in the Jazira region, as well as Nippur. The Jazira sites also have barbotine decoration, much like that from Mosul (Reitlinger 1951), which is only present in this region. The majority of the moulded sherds have vegetal/arabesque/geometric motifs, with backgrounds of little roundels or rosettes. Nováček *et al.* (2008) states this type of moulding is more Syrian than Iranian, again showing links with the larger Jazira region. Lastly, the use of glaze shows connections with the wider Islamic sphere in terms of colorants and style. The few black on blue sherds are more similar to the Iranian Silhouette Wares rather than the Raqqa Wares, with the excising of the black paint to create the designs. One unique form is present, the nargilehs at Site 217 and Site 155. These may date a bit later (nargilehs are first mentioned in the 15th – 16th centuries), and as such may be extrusive to the habitation of the sites. The variations in the forms and surface treatments used influence the designations of functions. However, it is also indicative of various communities of consumption, which are choosing utilitarian ceramics, mainly for storage purposes. These are not necessarily decorated but can have some decoration as shown by the appliqué and incised vessels.

The sites of the al-Jazira are all possibly rural agricultural settlements, with the possible exception of Site 155 (due to its larger size). However, the function and manufacture of the ceramics on these sites are very similar, indicating relatively the same community(s) of consumption. The forms, fabrics, and styles are the same across the region, with limited variations in decorations which are probably related to larger stylistic changes occurring in the Islamic world. The more utilitarian ceramics do not change in terms of production or consumption illustrating a relatively stable community of consumption that is not changed by external influences.

7.2.2 *al-Iraq (Nippur)*

The ceramics at Nippur match the other Ilkhanid period sites in the al-Iraq region, including Wasit and Adam's Kish Survey, as well as Quseir al-Qadim on the Red Sea. Interestingly, there are not many stylistic similarities between Nippur and the other Ilkhanid site in this dissertation, Hasanlu in al-Ran. Nippur shares many decorative styles with Wasit, including incised and impressed sherds, black on blue glazed, and Sultanabad glazed ceramics (Safar 1945). The fabric at Nippur is mainly fine/untempered (58%), coarse or mineral tempered (30%), stonepaste (6%), vegetal tempered (5%), and porcelain (1%). These are normally wheelmade (62%), but 30% are handmade, 7% are coilmade, and 1% are moulded. The main forms are deep bowls (43%) followed by long-neck jars (14%). Twenty-five percent of the ceramics are smoothed, 12% are Sultanabad wares, and 11% are stamped. Nippur differs from the Jazira in that 50% of the vessel function is serving, followed by 29% storage and 10% food preparation. The decorated sherds illustrate the larger connections, but at Nippur we also see local variants of these decorated wares.

At Nippur, there are various Sultanabad sherds that are made in stonepaste as well as earthenwares. The blue on white, brown on white, and grooved blue glazed sherds are all earthenware at Nippur, but the same decorative motifs are found on stonepaste wares at other, urban sites, which may show a local imitation of an imported type of ceramic. The stamping at Nippur is unique, with floral and geometric patterns, and the stamping on storage vessels is consistent with the use of stamping on the Jazira sites, but different from Rayy. Nippur also has ties to regions beyond Western Asia with the two pieces of porcelain, as well as the spheroconical vessel.

The Middle Islamic period habitation at Nippur consisted of one building, with relatively high value ceramics. The size of this settlement is 13.5 ha, and so it is a medium size settlement in this dissertation. However, the presence of multiple types of ceramics (in fabrics, forms, and functions), illustrate a different role than an agricultural settlement. With the access to the finer materials, this could be a provincial center, like Wasit, or hold some other function (military, economic, or political). The more utilitarian wares are very similar, and illustrate a distinct community of consumption, choosing unglazed materials which are sometimes stamped or incised, for storage.

7.2.3 *al-Ran (Hasanlu)*

The Hasanlu ceramics mainly comprise finer serving vessels, as these were the main type of ceramic exported to the Penn Museum. These ceramics show regional connections with sites like Takht-i Suleiman, Kashan, and Haraba-Gilan. Hasanlu has 42% stonepaste, 25% fine/no tempered fabrics and 13% coarse/mineral tempered fabrics. These are mainly wheelmade (94%), with handmade, coilmade, and moulded wares all at 2%. The majority of the forms are deep bowls (43%), followed by long-neck jars (14%). In terms of decoration the majority of this assemblage is glazed (Lajvardina (23%), black on blue (17%), monochrome (14%)), followed by comb incised (22%). Serving vessels make up 82% of this assemblage. As stated throughout this dissertation, these percentages are highly related to the fact that these materials were exported to the Penn Museum and do not show the entire ceramic assemblages found at Hasanlu.

Al-Ran is known for the winter pastures of the Ilkhanate, and the capital of Soltanieh is near Hasanlu. With the center of the Ilkhanate situated in this area, the presence of more luxury ceramics (Lajvardina, Lustre, Stonepaste) is not unusual. A few sherds, mainly the incised and impressed vessels, have parallels with Afghanistan and Central Asia (Fehérvári 2000, p. 197; Watson 2004, p, 106; Wilkinson 1973). One piece of the incised/impressed vessel was analyzed and was consistent with a local manufacture, hence is probably copying a style familiar to the Mongols who are from Central Asia. Two pieces, the pilgrim flask and the moulded sherds both resemble Syrian decoration and forms, and may be a remainder of earlier habitation, brought back with the Mongols after their campaigns in Syria, or made in a Syrian style. These were not analyzed and as such their production center cannot be identified.

Hasanlu is a smaller site (3.1 ha), with the presence of multiple types of luxury glazed wares. This indicates a different function of this site from other smaller sites in this dissertation. Hasanlu was also a fortified site and may indicate a military garrison or fortified elite residence. The people living at this site were using elite ceramics which shows their connections with the elite Ilkhanid dynasty. Unfortunately, the museum sample did not contain many utilitarian vessels, but those that were analyzed were consistent with a local manufacture and matched those from the Jazira and Nippur. Therefore, the utilitarian practices on the site (food processing, cooking, storage) may illustrate larger connections with other rural areas.

7.2.4 *Iraq al-Ajam (Rayy and Chal Tarkhan)*

The two sites in Iraq al-Ajam are strongly linked. The small site of Chal Tarkhan is located 20 km away from Rayy and is described as an elite estate (Kröger 1990). Both of these sites had a majority of fine/ no tempered wares (88% to 94%), that were wheelmade (82% to 100%). Rayy had a majority of deep bowls (31%) with long-neck jars (15%) and spheroconical vessels (8%) being the most common forms. Chal Tarkhan had long-neck jars and deep bowls at 12% each. Both assemblages had serving functions at 66%, with storage ranging from 27% to 34%. Rayy had more glazed wares (49%), followed by smoothed (13%) and barbotine (10%), whereas Chal Tarkhan had smoothed wares (33%), comb incised wares (22%), and glazed wares (22%). The higher percentages of the glazed wares may be due to what was exported to the museum, as discussed throughout this dissertation.

The strong links between Rayy and Chal Tarkhan are confirmed by the types of ceramics found at the sites as well as the ceramic traditions, where five of the six COs identified at Chal Tarkhan are present at Rayy. These sites show variation from the other sites in this dissertation. The stamping at Rayy is found on fine serving vessels and very large pithoi, but with multiple stamps covering the bodies instead of a row of stamps like in al-Iraq and al-Jazira. The splash and monochrome glazing match those found at Samarra, Basra, and Susa, and the sgraffiato is comparable to pieces from Iran/Central Asia, and one piece is similar to one found in Egypt (Fehérvári 2000; Watson 2004). The corrugated and glazed piece as well as the imitation celadon are similar to pieces at Nippur and Samarra (Northedge 1996; Sarre & Mittwoch 1905), and the inlaid pieces resemble those from Qala'at Ja'bar (Tonghini 1998, p, 64). Two of the moulded pieces (as discussed above) are geochemically as well as stylistically linked to the Jazira and are two of the only pieces to indicate interregional trade in this study. The single incised pieces and barbotine sherds are very different from the other regions and have links with Susa and Central Asia (Watson 2004; Whitcomb 1985; Wilkinson 1973). Lastly, the presence of spheroconical vessels shows longer reaching connections. The site of Rayy is a main stop on the Silk Road, and the mixture of influences is expected at this site.

The larger variation in the ceramic styles at Rayy indicate the larger site and centrality of this urban center on the main trading routes. The finer fabrics at Chal Tarkhan along with the higher percentage of serving vessels, and lack of food processing/cooking vessels indicate a different function for this site than a rural agricultural settlement. The people at Chal Tarkhan are consuming the same types of ceramics as those at Rayy, and with the presence of the large architectural buildings at the site, this has been interpreted as an elite residence outside of Rayy. This seems to hold true in the ceramics as well, with the similarities in both the production and consumption practices at this site.

7.2.5 *Khurāsān (Firuzabad)*

The ceramics of Firuzabad match those at Nishapur and to some extent Rayy. Firuzabad has the largest difference in both fabric types as well as functional types from the other sites discussed in this dissertation. At Firuzabad, 44% of the ceramics are vegetal tempered, followed by fine/no temper (35%), coarse/mineral tempered (15%), and stonepaste (6%). It also has more coilmade (19%) and handmade (14%) forming techniques than the other assemblages, but wheelmade is still the main method (64%). Deep bowls are the most predominant forms (24%), followed by short-neck jars (12%), long-neck jars (7%), and no-neck jars (7%). The majority of these ceramics are smoothed (48%), followed by single incised (14%), rope appliqué (10%), and slipped (6%). The functions range from storage (25%), dry storage (22%), food processing (17%), and serving (15%).

At Firuzabad, it is interesting to note that no cooking vessels were recorded, but multiple stone vessels with burning were present. This is contrasted with the large amount of food processing vessels as compared to other sites. This could indicate differences in food preparation and cooking at Firuzabad versus the other sites. However, Firuzabad is connected with Nishapur in the decoration of the vessels, but the entire assemblage is coarser than that at Nishapur. This may indicate local potters imitating finer vessels from Nishapur. The few glazed pieces that are classed as serving vessels are mineral and chaff tempered, indicating a more local practice of manufacture, but imitating a larger decorative style.

Firuzabad is a larger-sized site (17.9 ha), with various ceramic forms, styles, and functions present. The ceramics are being made local to the site, but imitating larger decorative styles, which may illustrate a community of consumers that are connected with other sites, like Nishapur. The differences in food preparation and cooking between Firuzabad and the other sites is an interesting finding and deserves more investigation.

7.3 Communities of Practice

The technological knowledge behind the creation of the ceramics is similar across Western Asia. The capability to achieve a firing temperature higher than 800°C needed to create the glazed ceramics is present everywhere, as is the technical knowledge to create cooking vessels that will not shatter with constant re-heating. The ceramic traditions across these areas are also marked by similarities in finer serving vessels, both in stylistic as well as manufacturing arenas. There seems to be a preference in serving vessels throughout the region for finer, more decorated vessels including all types of glazing. These are shown to be manufactured everywhere, not just at the large regional centers (e.g. Erbil, Mosul, Kashan, etc.). At sites like Nippur and Firuzabad, we also see local copies of possibly finer glazed ceramics (Sultanabad Wares in stonepaste and earthenwares; vegetal tempered blue on white ware) intended for rural consumption. The combination of ceramic traditions with stylistic aspects elucidates the connections between regions, as well as highlighting the uniqueness present in rural ceramics.

Table 7.7: Presence of COs across sites.

Site	Total Sherds	Total COs	Unique COs	Shared COs
155	432	68	17 (25%)	50 (75%)
217	172	55	14 (25%)	41 (75%)
276	76	32	3 (9%)	29 (91%)
381	91	32	4 (12%)	28 (88%)
453	50	16	1 (6%)	15 (94%)
519	30	17	0 (0%)	17 (100%)
535	34	17	2 (11%)	15 (89%)
Nippur	121	37	7 (19%)	30 (81%)
Hasanlu	64	16	2 (12%)	14 (88%)
Rayy	96	27	10 (37%)	17 (63%)
Chal Tarkhan	9	6	1 (16%)	5 (84%)
Firuzabad	80	45	13 (29%)	32 (71%)

Table 7.7 illustrates the number of COs, and percentages of unique and shared COs at the various sites. The links between sites indicate similar practices in manufacturing (clay preparation, temper, manufacture, surface treatment and firing) as well as consumption practices. A Poisson regression was run to determine if changes in site size and number of ceramics changed the number of COs present, and this was found to be statistically significant ($p<0.01$). When plotted, site size is not statistically significant ($p=0.07$) compared to the number of COs; however, the number of ceramics gathered was positively correlated ($p<0.01$). This means that as the number of sherds increases the number of COs also increases. The number of COs present at the sites are not linked to site size, for example EPAS 155, Nippur, and Firuzabad are all about the same size (12 – 15 HA), Firuzabad has the most COs, followed by site 155, and Nippur. However, site 155 has the most unique COs of the three, but also has the largest ceramic collection. In terms of the rural/urban divide, the rural sites (EPAS) have more COs, but not necessarily more unique COs as compared to the intermediate and urban sites. This shows that rural sites (as defined by size and population density) can be more connected with other sites through shared COs (as seen with site 519 where 100% of its COs are shared with other sites in the Jazira). Site 381, Rayy and Firuzabad have about the same number of ceramics (80 – 96), but a range of COs from 27 to 45 with Firuzabad having the most. This could be due to Rayy’s ceramics being mainly finer serving wares, whereas Firuzabad has an entire assemblage from vegetal tempered architectural fragments to fine serving vessels. In terms of unique COs, the percentage ranges from 12 to 37, with Rayy having the most unique COs. This illustrates that there are differences in production and consumption at each site and comparing between sites provides a more complex picture than just a strictly rural/urban divide.

The al-Jazira sites are linked by similar ceramic traditions. The methods of making most storage and cooking vessels are broadly similar across the region. Each site within the region also had their own traditions, illustrating variation between sites. Some of the similar traditions may show intraregional exchange, with certain sites possibly producing a certain type of vessel; however, this could not be ascertained. If we hypothesize that each site was producing the complete repertoire of ceramics, some interesting observations can be made. The presence of multiple COs for creating similar vessels (e.g. coarse smoothed storage vessels: CO101, CO104, CO110 – 113) indicates that the production of ceramics is not a strictly controlled procedure, which highlights the probable presence of multiple potters at these sites. A different picture arises with the serving vessels, where there is one way of making moulded (CO44) or glazed (CO55; albeit variations in the glazing do make different COs that are not investigated here) ceramics. When compared to other sites, these types of ceramics have very few modifications showing a regional (and interregional) way of making these vessels. The standardized production of the higher decorated, serving vessels shows a connection into the larger spheres of the Islamic world. This illustrates a knowledge of these techniques that supersedes the local, site knowledge, showing larger linkages across areas. The similarities in the serving vessels could be due to the fact that serving vessels are placed on a table, therefore, others see the vessels, and hence are used for the presentation of various status markers (identity, politics, economics). These could also indicate similar food consumption practices (i.e. smaller bowls are for individual serving whereas larger platters are for communal consumption). However, as production techniques are also similar, this may indicate larger social connections in these vessels.

In terms of production, Nippur has seven unique COs, these are mainly seen in the cooking vessels and handmade storage vessels. The food processing vessels have links with the sites in the Jazira, but the raw materials are local to Nippur. This indicates a shared tradition of handmade food processing vessels existing at these sites but absent at the sites in Iran (most notably Firuzabad which has food processing vessels). Nippur dates later than the sites in the Jazira, and as such this tradition extends through the Middle Islamic period in these regions. Besides the glazed serving vessel (CO55) and stonepaste (CO69) traditions, no links were identified between Nippur and Hasanlu for now. This could be due to Hasanlu not having a full functional assemblage (missing cooking/food processing) or it could also have to do with the different people living at these sites. Hasanlu is located very near the Ilkhanid capital of Soltanieh, and as such tastes and manufacturing traditions are different between the center and edges of the Ilkhanate.

In terms of manufacturing processes, Hasanlu has 16 COs, with half of them exclusive to the site or related to one other site (10), mainly in the al-Jazira region. The other half are present at most sites (e.g. CO55: fine wheelmade glazed serving vessels, CO69: stonepaste serving vessels). The stonepaste may not have been made locally, and therefore may indicate a consumption practice rather than a manufacturing practice local to Hasanlu. Two traditions are unique to Hasanlu. The main ceramic tradition connections at Hasanlu are with the Jazira, and could be related to larger, older pottery traditions which connected the two areas.

Rayy has 27 COs present, of which ten are unique. Nine more have links with most other sites, and the rest have similarities to one or two sites, usually in the Jazira or Khurāsān. The majority of the links are present in serving vessels (CO40, CO55, CO44, CO50), but a few are storage vessels (CO87 – 95). The links between Chal Tarkhan and Rayy shows the region is highly linked both in stylistic terms but also in ways of making ceramics. The ceramics at Chal Tarkhan are local to the region, and as such may be coming from Rayy, especially since kilns were only found at Rayy. The limited amount of ceramic traditions present at Rayy (27 COs to 96 sherds, Site 381 has 32/91 for comparison) may show the presence of workshops which controlled the production of the ceramics. Workshops are also attested in the literature for Rayy, as well as in the archaeological evidence surrounding the kilns (Rante 2014; 2015).

In terms of the ceramic traditions, Firuzabad has 45 different COs identified, and of these 13 are unique to the site. The larger majority of the remaining COs match those from the al-Jazira region, namely Sites 155, 217, and 381. These are mainly food processing (CO28 – 30) and storage vessels (CO77 – 78, CO122, CO131). The ceramics are made locally, within the region, so the similar COs show some overarching ceramic traditions which are related to the similarities in manufacturing storage or food processing vessels (e.g. large vessels are not wheelmade, rather coilmade or handmade, with coarser/vegetal inclusions). At Firuzabad, the firing techniques are less well controlled, with the samples showing high fired fabrics, as well as overfired ceramics. Lastly, at Firuzabad, we do have evidence for the use of stone to create pots and this may account for the limited amount of cooking vessels on site. This may also show a different tradition of food processing and cooking in this region.

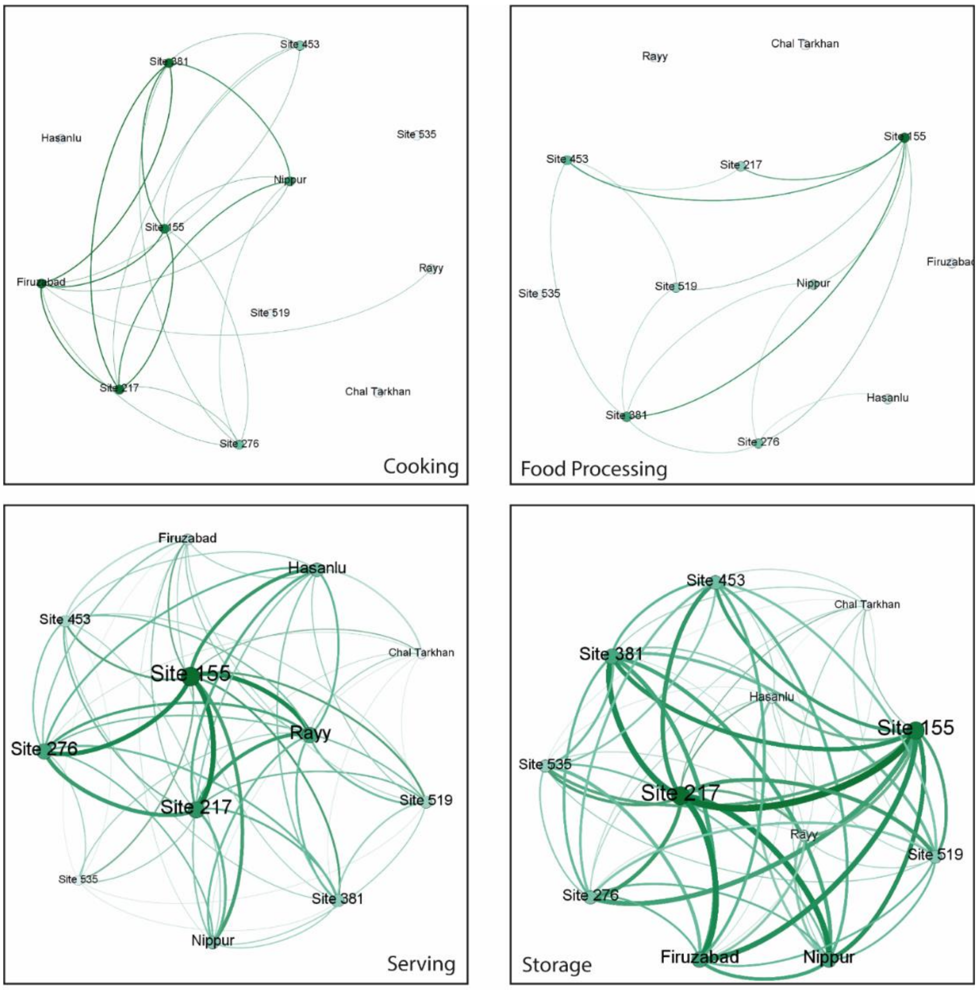


Figure 7.1: Illustration of connections of COs between sites.

Figure 7.1 illustrates some connections between the sites as determined by the COs. Each CO was put in as a link, and the more links that were identified, the thicker the lines between the sites. These diagrams are dependent on the amount of data present (e.g. storage has a much larger network due to the fact almost half of the ceramics are classified as storage vessels; Site 155 is more prominent due to the fact that it has the largest number of COs). These illustrations show a high connection between the al-Jazira sites, especially between sites 155 and 217. It also shows that there are much stronger links between all sites in storage vessels as compared to the other sites. With a more formalized network analysis, these links can become better elucidated, but that is not within the scope of this dissertation.

Communities of practice can be seen in this dissertation, for example, if we look at long-necked, smoothed storage vessels (Table 7.8), we can see various forming techniques that may indicate different communities. Long-necked smoothed storage vessels are found on all sites, and are usually the first or second most populous category. These vessels could be used to store various liquids, and may also be used to transport or serve these contents. The manufacturing of these vessels shows that wheelmaking is the predominant forming technique, and stretches across the entire area, possibly indicating a larger constellation of practice. However, at multiple sites there are variations in the forming techniques (i.e. Site 155 has fine and vegetal tempered fabrics made in the three different forming techniques). This may indicate multiple communities of potters at this site, and hence, multiple social groups. This is contrasted with Rayy which has one way of making these long-necked vessels (Fine, wheelmade), which has the possibility of one community of practice. This is discussed further below, with the idea of structured (possible workshops) and unstructured (independent or household-based potters) craft organization.

Table 7.8: Table illustrating various COs for long-necked smoothed storage vessels.

Chaine Operatoire Code	Temper	Forming	Total	al-Jazira							al-Iraq	al-Ran	Iraq al-Ajam		Khurasan
				155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad
CO71	Fine/No Teper	Handmade	4	2	1		1								
CO75-77		Coilmade	24	7	3		7	1	1	2	1				2
CO87-91		Wheelmade	165	58	13	16	24	17	11	7	2	1	7	1	8
CO101	Coarse/ Mineral Temper	Handmade	8		1						6	1			
CO103		Coilmade	5		2		2								1
CO110-11		Wheelmade	28	3	1	1	7	9	1		2	2		2	
CO121	Vegetal Temper	Handmade	33	4	11	6	4	1		1	1				5
CO126		Coilmade	6	1	4			1							
CO131		Wheelmade	15	5	1	3		3	2						1

Roux (2017), lays out a hypothesis of homogenous and heterogenous assemblages, and what this means for the communities at these sites. Homogenous ceramic groups are characterized by one technical tradition and therefore reflect one homogenous social group. Heterogenous assemblages have multiple technical traditions and therefore imply multiple social, technical, and/or learning groups. In terms of the above example of long-necked jars, the EPAS sites (especially 155, 217, 381, and 453), Nippur, and Firuzabad, all have relatively mixed assemblages with variations in tempering and forming techniques.

This may illustrate multiple social groups present at these sites. This doesn't necessarily work at the site of Rayy which shows one method, meaning it would be classed as a homogenous site, but when added with all the other information known about Rayy, we know that this is a very heterogenous site, with multiple social groups. This disconnect is probably from the sampling strategy, with only certain vessels recovered on sites and brought to the museums, therefore we are missing the majority of the ceramic assemblage. However, using a strategy like this, and the assessment of COs could help to better define sites found during survey, that traditionally may only be classed based on their size and possible population density. Even though the data from surveys can be spotty, we can begin to see these communities and constellations of practice which unite the sites under a larger overarching network.

7.3.1 *Craft Organization*

For the Islamic period, archaeological excavations have shown the presence of ceramic workshops at larger sites (Henderson *et al.* 2005; Molera *et al.* 2020; Mulder 2015; Rante & Collinet 2013; Rante 2014; Salinas *et al.* 2019). The identification and definitions of workshops are debated as they are more than just a production area, the way labor is organized, or the way resources are shared (Costin 2020; Di Paolo 2013; Rosen 2010). The identification of workshops in the Islamic literature is mainly due to textual sources discussing craft production at certain sites. These texts indicate production locations and the people working in those locations (masters and apprentices) for various crafts (Books (Ibn Hawqal 1967; Saeed *et al.* 2021; Von Karabacek 2001), Glass (al-Qaddumi 1996; Ibn Bassam 1968; Wulff 1966, p, 169–71), Metal (Allan 1979; Lewis 1943; Wulff 1966, p, 18–19), Silks and Textiles (Serjeant 1948; Levy 1938, 45–46; Watt *et al.* 1997; Wulff 1966, p, 223–24), Stonepaste (Allan 1973), Wood (Floor 2006; Levy 1938, 91; Wulff 1966, p, 99–100)). In the archaeological literature, workshops are used to denote production areas around kilns, where it is assumed there are multiple potters (from apprentices to masters), making ceramics in the same way (Gosselain 2018; Kanda 2017; Mason 2014; Mulder 2015; Roux 2017; Salinas *et al.* 2019; Spataro *et al.* 2021; Tonghini & Henderson 1998). There are also numerous studies on apprenticeships in ceramic workshops, mainly focusing on the artistic styles of painting (Mason, 2004; Treptow, 2007; Kanda, 2017; Holod pers. comm. 2018). These fit some properties identified by Costin (2020, p. 180): A) a special-purpose setting, B) artisans from various backgrounds work together, C) artisans are not related by kinship, but usually by social group, D) there is a functional speciality (i.e. the pottery makers are distinct from the decorators, who are distinct from the people who run the kilns), and E) the investment of capital for mass-production. However, most of these are difficult to identify archaeologically. Therefore, below I discuss the difference between a more structured craft organization (possibility of a workshop) and a less structured setting (more independent potters).

The presence of ceramic workshops shows a structured, very controlled way of creating ceramics (Costin 2020; Kanda 2017; Mason 2014; Rosen 2010). This study illustrates that this structure is not present at every site. Workshops make vessels in one way, utilizing the same raw materials from the same sources, the same forming techniques, same treatment/decoration techniques and firing processes (Crown 2007; Gandon *et al.* 2018; Kramer 1985; Roux 2003). Individual potters have more choices and depending on the community may access the same raw materials, use different forming techniques from other potters in the community, have different traditions of surface treatment/decoration, and various firing techniques. Depending on the community some of these traditions may be very similar or very diverse (Crown 2007; Gandon *et al.* 2018; Kramer 1985; Roux 2003).

Both more structured and unstructured types of ceramic production are present in this study. The larger production areas at Rayy, which are well documented, are also attested due to the same COs used to manufacture similar vessels. These may also be present at Hasanlu and Nippur, with their more limited number of COs as compared to finished vessels. At the more rural sites of the Jazira and Khurāsān, large numbers of COs for creating the same types of vessels are attested. Therefore, multiple potters were producing ceramics on sites, which illustrates a more unstructured way of creating ceramics. Due to the size of the sites, and lack of kiln evidence (except Site 155), there were local potters, possibly using the same kiln. This practice is attested ethnographically and archaeologically across the world (Bernardini 2000; Blackman *et al.* 1993; Milwright 2017, p. 116; Mitsuishi *et al.* 2013; Skibo 1992) which would account for the relatively standardized firing procedures noted (mostly above 800°C, homogenous color across the sherd, little to no overfiring). Instead of completely independent, individual potters, this could be evidence for community potting, where materials are gathered from the same or similar places, the forming techniques used depend on how the potters were trained (could be kin or social based learning), the types of surface treatments/decoration were added depending on consumer's demands, and then firing is done together in one kiln structure. The open firings (arguably for food processing vessels) could be done at any time and did not need to wait for a kiln to be in use. This could be done on a more individual basis. The more rural sites have a multitude of production techniques; however, they created vessels very similar to the larger more structured production. The larger connections in style and form drove the production and consumption of these vessels, but the rural areas created their vessels in their traditional ways, which illustrates the independent traditions. Ceramics, for the most part were not a highly controlled production (stonepaste may be an exception), allowing for various traditions to appear.

7.4 Summary of Discussion

The results presented in this discussion illustrate a difference in production and consumption of serving wares and non-serving wares. The non-serving wares have more varied manufacturing techniques that are often specific to the site of recovery. However, the consumption practices illustrate that there is a shared repertoire across Western Asia of vessel form and surface treatments. This indicates larger connecting processes that cannot be fully explored in the current study (e.g. food consumption practices). In terms of craft organization, the various ways of producing these ceramics illustrate a less structured, less controlled craft organization. This may be due to the nature of the function, since non-serving vessels would not need to be highly controlled, as there were no benefits (economic or political) to restricting access to these types of vessels. However, the variation in these vessels suggests that independent potters (or families of potters) created the ceramics at the local level, rather than consumers purchasing these vessels from larger central workshops. This is different from the serving wares, which all tend to be made the same way (with limited variation). This is also reflected in the vessel forms and surface treatments/decoration illustrating a common practice both in manufacture and consumption. That being said, the control over the production of serving ware was never a rigid one, as local potters were still allowed to make adaptations, as seen at Nippur and Firuzabad. However, at the larger sites (Rayy, Hasanlu), the limited ways of making and decorating these vessels may point towards a more structured craft organization, and possibly ceramic workshops, especially producing certain types of wares (moulded, glazed, stonepastes). This dissertation illustrates that even though these areas are connected by underlying aspects of culture, rural areas do have a degree of autonomy in the creation and use of the ceramic vessels.

8 Production, Consumption, and Regional Networks in the Middle Islamic Period

This thesis has provided a basis for the study of regional ceramics throughout Western Asia during the Middle Islamic period (1000 – 1500 CE). It shows wide ranging variation not only in the types of ceramics present in terms of their fabric, form, and function, but also in the technology used to create them. The sites under study ranged from small rural sites to large urban centres (Table 8.1).

Table 8.1: Summary of the sites and ceramic samples.

Region	Site Name	Time Period (Century)	Site Size (HA)	Type	Total Sherds	Percent Sampled	Number of COs present
al-Jazira	EPAS 155	11-14th	12.4	Rural	432	2.7%	68
	EPAS 217	11-13th	6.2	Rural	172	17.4%	55
	EPAS 276	12-14th	2.1	Rural	76	18.4%	32
	EPAS 381	11-13th	4.4	Rural	91	16.4%	32
	EPAS 453	11-13th	5.7	Rural	50	0.0%	16
	EPAS 519	12-14th	7.4	Rural	30	2.6%	17
	EPAS 535	12-14th	4.1	Rural	34	2.6%	17
al-Iraq	Nippur	12-15th	13.5	Intermediate	121	11.5%	37
al-Ran	Hasanlu	12-14th	3.1	Intermediate	64	10.9%	16
Iraq al-Ajam	Rayy	9-12th	550	Urban	96	30.2%	27
	Chal Tarkhan	7-13th	2.2	Intermediate	9	55.5%	6
Khurasan	Firuzabad	11-13th	17.9	Intermediate	80	14.8%	45

The ceramic samples contained sherds that ranged from porcelain bowls to vegetal tempered plaques. The majority of the ceramics were fine/untempered ceramics that were wheelmade with smoothed surfaces. The ceramics were characterized by function, divided into cooking, food processing, serving, storage and other. This was done based on vessel form, fabric, and decoration. The variety in these samples shows the mixture of various functions, styles, and productions at each site. However, there are overarching links between sites in styles, forms, and methods of manufacture. This illustrates an interconnected world, in terms of both the serving vessels (finer, highly decorated ceramics) and non-serving vessels (wheelmade, smoothed, comb-incised). The production methods of both of these types of ceramics also show differences with serving vessels being manufactured in more standardized ways, whereas non-serving vessels are being manufactured in unstandardized, local ways. These two ways of organizing the craft production illustrate variations in the social aspects of these regions. This in turn illustrates the complex social fabric existing across the Islamic world.

8.1 Ceramics Across the Middle Islamic Period

What are the differences in ceramic technology and style across Western Asia in the Middle Islamic period? How can the study of ceramic technology elucidate the ceramic traditions at these sites/regions?

Throughout the Middle Islamic period, the fabrics, tempering inclusions, firing procedures do not seem to change. This illustrates the continuity of ceramic production through this period. Even though the political and to some extent economic spheres were changing, the production of ceramics is not influenced. This also does not seem to change with the arrival of the Mongols, in terms of the coarser wares. However, the forms and decorations are influenced by these larger changes, with different fashions of decorations, and various forms appearing and disappearing throughout time. Therefore, the patterns of consumption are altered by political/economic/and social factors, whereas the patterns of production stay relatively the same.

Urban settlements, with their larger populations, connections with other markets, and more economic opportunities theoretically have higher quality ceramics. This does seem to hold true for this dissertation as well, with the majority of stonepaste/porcelain/glazed wares being concentrated at the more urban sites (Nippur, Hasanlu, Rayy, Chal Tarkhan). Even though using survey data (and data exported to museums) does bias the sample towards these wares and away from the more utilitarian wares, the more urban sites seem to have access to these higher quality ceramics.

In terms of the various functions of the ceramics, the more urban areas have a higher percentage of serving wares, but this could also be due to the biases in the dataset. Textual records report that the more elite populations are utilizing metal (especially silver and gold) and glass vessels for serving. However, this difference between a higher serving percentage at the more urban sites, and a higher storage percentage at the rural sites could indicate a difference in the functions of ceramics at these sites. In analyzing the ceramics, we must also keep in mind this is not the only material used for these functions. Textual sources record metal, stone, and organic mediums used for a variety of similar functions, and the survey at Firuzabad recorded multiple stone vessels. Without full assemblages of all artifacts (which is unattainable due to preservation) we may never know the exact role ceramics played in the Middle Islamic period. However, studying the ceramics can give some hints into the role, and begin to help elucidate the various functions occurring at the sites.

This study shows that most ceramics were made locally to the area in which they were recovered. The two moulded pieces from Rayy were possibly manufactured in the Jazira Region and found at Rayy based on the geochemical grouping, and the lack of geological specific minerals in the petrography (quartz and biotite are not site specific). One issue identified in this study in terms of sourcing for Islamic wares, is the limited resolution to determine site specific provenience for survey materials. The fine wares do not include enough distinct mineralogy to identify specific locations without clay sampling. The pXRF results were able to identify regions of manufacture, but unable to pinpoint a more specific area of manufacture. The collection of clay samples at or near these sites would have been helpful, as well as utilizing other methods (WD-XRF, LA-ICP-MS, or INAA) with the regional clay signatures to better identify more site-specific areas of manufacture.

The ceramic fabrics do not vary based on the vessel function (e.g. the fine fabric of serving vessels is the same as the fine fabric of storage vessels), but the proportions of inclusions do change across function (e.g. cooking vessels have more mineral inclusions, food processing vessels have more vegetal inclusions). The mineral tempering is mainly sorted sands, based on the variation in minerals and the rounded nature of inclusions. A few pieces do have some crushed inclusions (mainly quartz), indicating a different procedure. The vegetal inclusions are probably all chaff based on the size and shape of the voids. Firing temperatures and procedures are relatively the same across Western Asia, with only food processing vessels showing possible open firings. Firuzabad shows the most variation in firing, and some vessels are overfired, which is not seen at the other sites.

The ceramic assemblages dating from 900 – 1050 CE (Abbasid, Buyid, Independent) is marked by spheroconical vessels, blue on white geometric glazing, opaque splash glazed decoration, polychrome glazing, comb incising and impressing, and appliqué under a monochrome glaze. The most notable Abbasid ceramics from Iraq are the opaque glazed wares dating from the eighth century (Fehérvári 2000; Priestman 2011; Watson 2004). The unglazed assemblage of Abbasid ceramics is little understood and is similar to both Umayyad as well as Seljuq unglazed assemblages. Without excavations of sites that date to all these periods, a better grasp on changes in the unglazed assemblages is not possible. By the 10th century, the glazed wares of the Abbasid Caliphate stretched across Western Asia from Fustat to Samarkand, showing the influence and social/economic impact of the political powers of the caliphate. These wares are present in all regions, especially at Nippur, Rayy, and Firuzabad.

The ceramics dating from 1050 – 1250 CE (Seljuq, Independent) are marked by black under blue glazing, lustre wares with blue glazing, corrugated wares with monochrome glaze, sgraffiato glazing, moulded wares with vegetal or animal motifs, and the presence of stonepaste. Sgraffiato glazing was popular before the Seljuqs in Iran, but under their patronage, these wares extend across Western Asia. These ceramics could be covered in monochrome or splash glaze, and various types of sgraffiato is present (Geruz, Amol, Aghkand). The Seljuqs were Sunni Muslim and for the most part were receptive to animal and human figurines in art (Canby *et al.* 2016, p. 183) which is illustrated at the site of Rayy with incised birds both with and without glaze. Under the Seljuqs, underglaze painting techniques such as Minai and Lustre appeared, and in other parts of Western Asia the development of stonepaste fabrics began. Similar to the Abbasid Caliphate, not much attention has been focused on the unglazed wares of the Seljuq period, making survey material hard to distinguish. One of the unglazed vessel types that has been studied is the barbotine wares from Northern Iraq, which are dated to the Zengid Dynasty (Reitlinger 1951). The development of stonepaste fabrics has been discussed extensively, and the movement of the technology across Western Asia has been hypothesized to be due to the movement of potters from Syria to Iran, but Rugiadi's (2011) research shows an earlier development of stonepaste in Iran. Under the Seljuqs, ceramic decorative styles changed, and the technology to produce these styles also drastically changed. The technology was then spread across Western Asia.

The ceramics dating from 1250 – 1400 CE (Ilkhanid, Qara Qoyunlu, Aq Qoyunlu, Timirud) are marked by Lustre Ware, Lajvardina Ware, Sultanabad Ware, and other stonepaste wares. The stonepaste tradition that was established during the Seljuq period continued to be produced throughout the Ilkhanid period. Previous scholars stated that the Mongol invasions of the early 13th century destroyed the main kiln sites of Rayy, Kashan, Tabriz, and Isfahan (Allan 1991; Grube 1976; Lane 1957; Sarre *et al.* 1925); however, recent research has shown the continuity of production through the Ilkhanid period (Golombek 1996; Mason 1997b; Rugiadi 2011). The popularity of lustre and Lajvardina wares could be due to their imitation of metalwork vessels, which were also highly prized during this period (Morgan 2004). The Sultanabad ware is a continuation of Minai techniques developed under the Seljuqs, and may resemble Mongol brocades (Morgan 2004). Like the other periods, the undecorated ceramics have not been the focus of many studies, and as such, the changes in wares and forms were not addressed. It is interesting to note that the wares at Hasanlu do not match those at Nippur, and Nippur has earthenware copies of stonepaste ceramics. This difference could be because Hasanlu is located towards the center of the Ilkhanate, whereas Nippur is located on the edge.

The styles of the ceramics are changing with the various political and economic changes, as seen mainly in the glazed and decorated wares. The unglazed ceramic assemblage does not seem to change as much in terms of both fabrics and forms. This may change with better dating of the unglazed assemblages, and both temporal and regional differences may be elucidated with more excavation of stratified unglazed material. However, the manufacturing of both the serving and non-serving vessels do not seem to change throughout the Middle Islamic period.

8.2 Ceramic Traditions and Craft Organization

How can the ceramic traditions in combination with social dimensions of ceramic productions connect sites, regions, and larger areas? What is the structure of ceramic craft organization?

This study showed multiple ways of constructing the ceramic vessels. The total analyzed samples were divided into functional categories, and then each category was investigated using the CO. The COs were constructed using petrographic, FT-IR, and macroscopic data. In order to make the samples more comparable across the regions, I did condense some of the categories (i.e. Fine/ No Tempered materials included all the petrographic categories that fell into this larger category; All glazed wares were combined into one category and not subdivided based on the type of glazing). This did create some larger COs that linked regions; however, if all were kept separate in conjunction with the nature of the samples, there would be very few connections (i.e. Lajvardina Ware is only found at Hasanlu, so would not help to connect this site to the wider areas, but the manufacture of the stonepaste does bring Hasanlu into connection with the larger world).

The COs presented in this study do show various connections between the sites. The non-serving wares have more varied manufacturing techniques that are often specific to the site of recovery. However, the consumption practices illustrate that there is a shared repertoire across Western Asia of vessel form and surface treatments. This indicates larger connecting processes that are not established in this dissertation (e.g. food consumption practices, household size and structure). This is different from the serving wares, which all tend to be made the same way (with limited variation). This is also reflected in the vessel forms and surface treatments/decoration illustrating a common practice both in manufacture and consumption. There is a high degree of connections between the al-Jazira sites, especially between sites 155 and 217 as well as the connection between Rayy and Chal Tarkhan. This may show that regional connections are stronger than interregional connections, but with more analysis of materials in the various regions, this may change. With a more formalized network analysis, these links can become better elucidated, but that is not within the scope of this dissertation. This dissertation illustrates that even though these areas are connected by underlying aspects of culture, rural areas do have a degree of autonomy in the creation and use of the ceramic vessels.

Two types of craft organization were identified, a more structured, controlled organization, and a less structured, more independent organization. The more structured organization is attested at the larger sites where the same COs are used to manufacture similar vessels, mainly the serving vessels. This type of production may indicate ceramic workshops which are attested in textual sources at the larger sites (Rayy, Mosul, Raqqa, Kashan). The more independent organization is marked by multiple COs present at sites for making vessels of similar forms and functions. This suggests independent potters (or families of potters) are creating the ceramics rather than full time artisans. The relatively standard firing procedures (except for possibly at Firuzabad), indicate possibly kiln sharing and community potting traditions. The materials are gathered from the same or similar places, the forming techniques used depend on how the potters were trained (could be kin or social based learning), the types of surface treatments/decoration are added depending on consumer’s demands, and then firing is done together in one kiln structure. This could explain why so few kilns are identified on sites during survey. The more rural sites have a multitude of production techniques; however, the rural potters are creating vessels very similar to the larger more structured production. The larger connections in style and form are driving the production and consumption of these vessels, but in the rural areas, potters are creating vessels in their traditional ways, which illustrates the independent traditions.

8.3 Rural Sites, Urban Cities, and Intermediate Areas in the Islamic World

What can the study of ceramic traditions in the Middle Islamic period tell us about the connections between rural areas and larger urban areas?

The links established in both the manufacture and consumption of the ceramic assemblages elucidate the connections between rural and urban areas. The standardized production of the highly decorated, serving vessels shows a connection into the larger spheres of the Islamic world, whether that be political, economic, or social. Potters in rural areas are creating their own ceramics, albeit in a more international style, matching the needs of the consumers. This is also seen in the earthenware copies of stonepaste Sultanabad wares at Nippur, and the vegetal tempered blue on white wares at Firuzabad. Potters at the more intermediate sites have a mixture of practices, from their own ways of creating non-serving vessels to standardized ways of creating serving vessels. The potters also have higher proportions of serving vessels, possibly due to their connections with larger urban areas. As styles changed, the potters adapted, and the COs show the interlinking of the manufacturing practice.

Since ceramics are a learned practice, social information is encoded in the way ceramics are manufactured. The CO not only illustrates the mechanical processes of creating the ceramics, but also encodes social identities, as illustrated by ethnographic studies. Most of these practices are easier to decode through time, but in cases like this dissertation, where the time depth is a few generations, or unable to be established, we can begin to link potters across various regions. In this dissertation, the COs illustrate multiple communities of practice, and larger constellations linking these areas. It illustrates that even smaller, rural sites have multiple ways of manufacturing ceramics, and therefore multiple communities of practice. These communities may identify multiple social groups (kin based, ethnic based, economically based), living on these sites. This dissertation also shows larger constellations of practice, mainly in terms of wheelmade ceramics (Glazed CO55, smoothed long neck jars CO110 – 113, etc.). This indicates a larger underlying social group which linked these varied areas. Using a communities/constellations of practice approach can help to better define sites found during survey, that may be traditionally classed based on their size and possible population density. Even though the data from surveys can be spotty, we can begin to see these communities and constellations of practice which unite the sites under a larger overarching network.

Ceramics are made by producers to supply a demand from consumers. Therefore, the various forms and decorations present are all adapted to local needs. The confusion with dating the undecorated ceramics (especially from surveys) between the post-Assyrian and present day shows that ceramic traditions were present in these areas and did not change drastically with the advent of Islam, or later political/economic changes. Some of the new forms, materials, or decoration styles which appeared throughout the Islamic period could indicate changing practices in social or cultural spheres. For example, the shift from more geometric decoration to animal/figural decoration in the Seljuq period could identify the Sunni Islamic traditions. The presence of smaller bowls towards the later periods (especially in stonepaste) could indicate a change in food practice, either the food itself, or the way people were eating (individual bowls vs. large communal platters). Rural areas do tend to have more variation in the non-serving wares, and this may indicate various regional identities (i.e. the possible stone cooking vessels at Firuzabad). Studying the differences in practice allows us to identify local traditions, local knowledge, and local cultures which influence larger networks.

After the Islamic conquests Western Asia was brought under the rule of the Umayyads and subsequent Abbasids, Seljuqs and Ilkhanids. This linked the region under similar political and economic spheres, even if it was just larger urban cities. Each of these cities was supported by a network of interconnected sites and regions providing the agricultural surpluses that allowed for the long-distance trade to flourish. This burgeoning world-system (after Abu-Lughod (1989)) was solidified in the 13th century with the relative security provided by the Mongols on the routes to China. Europe, China, and to some extent Africa became connected in the economic and to some extent political spheres (i.e. European presence in Ilkhanate courts (Abu-Lughod, 1989)). The larger caliphates, empires, and dynasties allowed for some social and political norms (i.e. languages, ethnicities, religions, and political rule) to permeate the social fabric of the larger areas. The larger prosperity and relative stability of these political entities (especially during their heights) permitted the movement of people across the landscape, from itinerant religious scholars, to historians, merchants, and craftspeople (willing or not). The movement of people also formed connections between far flung regions. However, with the mixing of these people, local traditions persisted, and this can be seen in the ceramic corpuses of various sites. Studying these ceramics allows for us to understand the regional traditions of manufacture and consumption present. This bottom-up approach marks significant contributions to Islamic archaeology by shedding light on the diversity of dynamics that existed in local areas and among local populations. and how these local dynamics play in the interconnected societies of Western Asia during the Middle Islamic period.

This dissertation has shown the differences in ceramic production and consumption across Western Asia in the Middle Islamic period. These differences illustrate the varied nature of the populations living in both rural and urban areas. However, there are connections both within and between these regions, illustrating larger social connections. This area has traditionally been discussed as a homogenous whole (from 600 CE to present) under the assumption that the spread of Islam brought all areas under the larger cultural mainframe. However, this dissertation shows that there is heterogeneity in both ceramic consumption and production. The established overarching links do not seem to be influenced by the spread of Islam, as the ceramic traditions identified (forms, fabrics, functions) are present before the rise of Islam in these areas, and do not alter with the various political/economic/social changes seen across the region. Some designs and surface treatments did change, tied with changing political and economic forces, and new technologies were developed (stonepaste), but most ceramics did not alter throughout the period. This also makes it difficult to date the survey material found to the broader subdivisions within the post-Assyrian period. The study of unglazed, undecorated ceramics marks a significant contribution to Islamic Archaeology by shedding light on the diversity of dynamics that existed in local areas and among local populations and how these local dynamics play in the interconnected societies of Western Asia during the Middle Islamic period.

8.4 Future Directions

This study has shown the importance of using archaeometric methods to analyze all ceramics, not just the fine or glazed vessels. Utilizing techniques such as petrography, pXRF, and FT-IR allow us to better understand the communities living at these sites, and the nature of craft organization present. Studying all types of ceramics can begin to illustrate the social groups at these sites and allow for us to understand the diverse nature of these rural areas. That being said, future research should include more archaeometric methods (WD-XRF, LA-ICP-MS, SEM-EDS, INAA) in order to further characterize possible manufacturing sites, specific communities of practice, and more technical knowledge on how these ceramics were made. This will allow for more investigation into rural networks across the area.

The investigation into the function of ceramics should also be re-investigated in the Islamic period. This dissertation uses a classification system based on ethnographic studies as well as some technological inferences, but the use of textual sources present for the Islamic period could help to better define these ceramics (Milwright, 2017). The use of scientific methods such as Raman spectroscopy, organic residue analysis, and in some cases FT-IR could help to identify residues on the surface of the vessels, leading to a better understanding of the function. This type of functional analysis will provide the data needed to help reconstruct various social practices from foodways to feasting to the manufacture of various products (medicines, perfumes, etc.).

This study illustrates the potential of using survey materials and legacy data in reconstructing larger interconnecting networks; however, the sometimes-uneven quality of the information gathered can give biased results (i.e. ceramics that were exported to museums are usually glazed, fine wares, complete vessels, or other easily identifiable forms). Understanding the caveats to how the data was gathered and recorded is critical. The use of legacy data is very important, especially when sites are no longer accessible for further excavation (i.e. sites in Syria, sites like Rayy that are almost completely under modern day cities, or sites within the Eski Mosul Dam Survey which are now underwater). These collections can be useful not only in the art historical dating sense, but also in terms of looking at methods of manufacture and connections across large areas. Much of the material from larger excavations (Samarra, Rayy, Raqqa, Basra) are stored in museums, and are due for re-investigation to establish communities of practice, manufacturing techniques, and a better understanding of the social fabric of the Islamic Period, especially when dealing with the glazed material. Understanding that the museum ceramics are a curated sample of full assemblages hinders the exploration of all aspects of ceramic investigation, but there are many collections that have not been researched that are helpful (i.e. Firuzabad in this dissertation). The same goes for the ceramic assemblages at these museums that are from larger surveys (i.e. Akkad Survey, Hajji Firuz Survey, Reade and Oates Surveys of Northern Mesopotamia). These surveys tend to focus on the more rural areas, and much data is stored in Museum archives and collections but has not been studied.

Although the survey and museum data are instrumental in preserving information that may have otherwise been lost, the excavation of more rural sites, with stratigraphy dated by absolute methods is critical to better understand the changes in the ceramics during the Islamic period. The understanding of the stratigraphy of the unglazed material (and in some cases the glazed material) needs to be re-investigated at the larger sites, much like Rante (2015) at Rayy and Rante and Collinet (2017) at Nishapur have demonstrated. With the (re)opening of other regions to archaeological excavations, such as Iraqi Kurdistan, the ability to excavate single or multiple period Islamic sites is available. These excavations can use methods to provide absolute dates to the stratigraphy and hence provide a more secure chronological framework for the ceramics. Utilizing a standardized ceramic quantification system (like the one laid out by Barclay *et al.* 2016) across all projects will lend itself to a larger understanding of ceramic changes both spatially and temporally. This can then be used to understand larger issues in the Islamic world.

Another technique that could be used to characterize the linkages between these areas is Social Network Analysis. This technique creates models of interactions among the nodes (social entities), and can be used as a way of visualizing or summarizing datasets, testing hypotheses, and thinking about relationships (Knappett 2013; Mills 2017; Sindbœk 2013). This type of analysis is very flexible allowing for directional or un-directional flows of information, weighted or un-weighted links, and the ability to identify the impact of various nodes. This technique uses data and computer science methods to create the networks. These networks have been used to answer questions surrounding diffusion of innovations (Kandler & Caccioli 2016; Mills & Peeples 2019; Őstborn & Gerding 2014), religious and social movements (Borck & Mills 2017; Collar 2007; Peeples 2018), identity (Blake 2014; Hart 2012; Mills & Peeples 2019), provenience and trade (Gjesfjeld 2015; Mol *et al.* 2015; Mullins 2016; Orengo

& Livarda 2016), migration (Mills 2016; Mills *et al.* 2015) and political centralization and development of hierarchies (Fulminante 2012; Mizoguchi 2009). By analyzing the structure of these networks, scholars can begin to reconstruct the social nature and forces behind the networks. Therefore, this would be a very helpful technique to use to better understand the larger forces behind the connections in the Middle Islamic Period.

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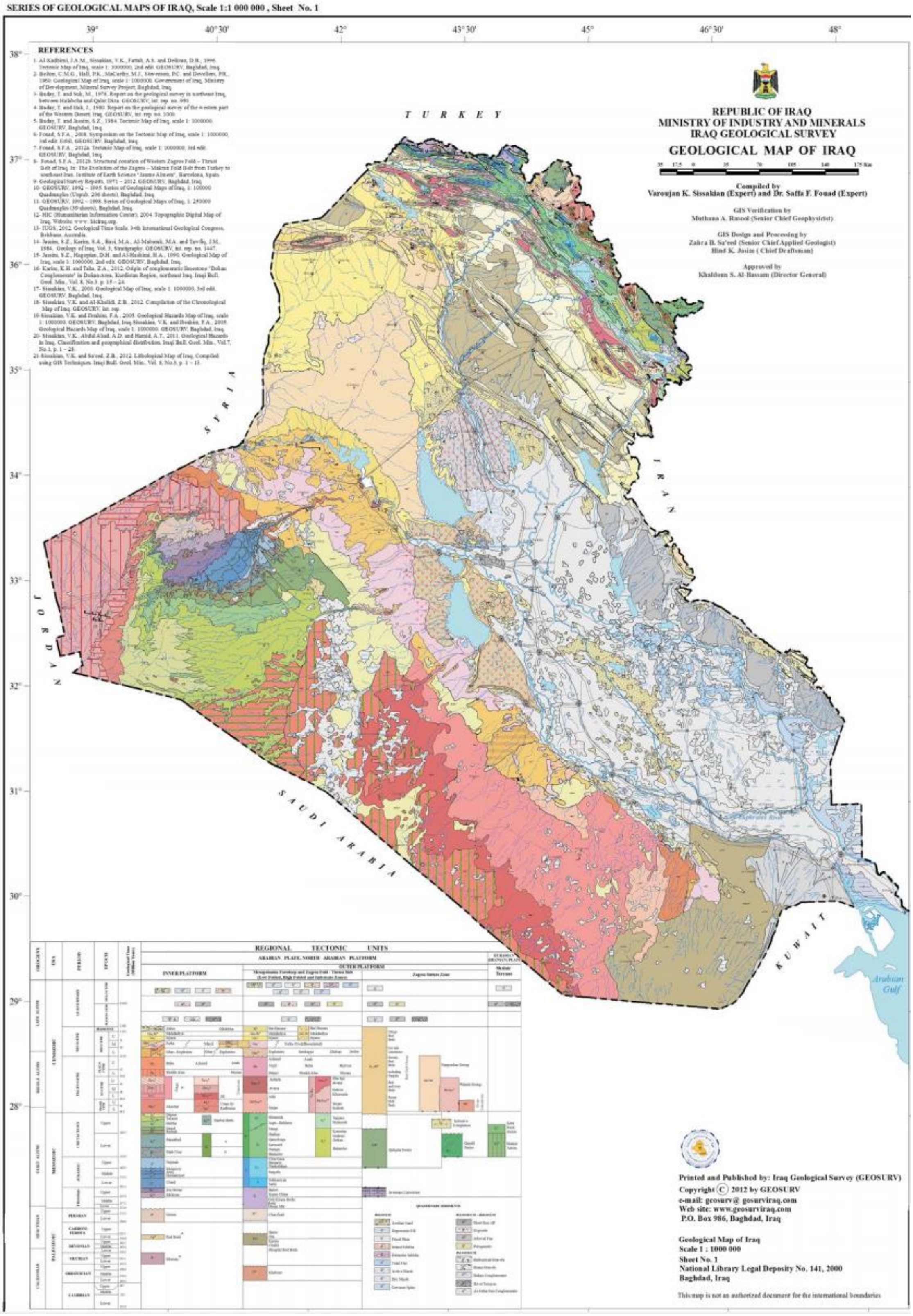
Appendix 1: Geological Maps



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Appendix 2: Ware Code Identification

- Earthenware
  - Slipped
    - 2A2 Fine Slipped Buff Ware
    - 2B2 Coarse Slipped Buff Ware
    - 2C2 Vegetal Slipped Buff Ware
    - 3A2 Fine Slipped Red Ware
    - 3B2 Coarse Slipped Red Ware
    - 3C2 Vegetal Slipped Red Ware
    - 4A2 Fine Slipped Gray Ware
    - 6B2 Coarse Slipped Cooking Ware
  - Burnished
    - 2A3 Fine Burnished Buff Ware
    - 3A3 Fine Burnished Red Ware
    - 3B3 Coarse Burnished Red Ware
    - 4A3 Fine Burnished Gray Ware
    - 6B3 Coarse Burnished Cooking Ware
  - Smoothed
    - 2A4 Fine Smoothed Buff Ware
    - 2B4 Coarse Smoothed Buff Ware
    - 2C4 Vegetal Smoothed Buff Ware
    - 3A4 Fine Smoothed Red Ware
    - 3B4 Coarse Smoothed Red Ware
    - 3C4 Vegetal Smoothed Red Ware
    - 4A4 Fine Smoothed Gray Ware
    - 4B4 Coarse Smoothed Gray Ware
    - 5C4 Vegetal Smoothed Green Ware
    - 6B4 Coarse Smoothed Cooking Ware
  - Incised/Impressed
    - Single
      - 2A5a Fine Single Incised Buff Ware
      - 2B5a Coarse Single Incised Buff Ware
      - 2C5a Vegetal Single Incised Buff Ware
      - 3A5a Fine Single Incised Red Ware
      - 3B5a Coarse Single Incised Red Ware
      - 3C5a Vegetal Single Incised Red Ware
      - 5A5a Fine Single Incised Green Ware
      - 6B5a Coarse Incised Cooking Ware
    - Comb
      - 2A5b Fine Comb Incised Buff Ware
      - 2B5b Coarse Comb Incised Buff Ware
      - 2C5b Vegetal Comb Incised Buff Ware
      - 3A5b Fine Comb Incised Red Ware
      - 3B5b Coarse Comb Incised Red Ware
      - 3B5c Coarse Comb Incised Red Ware
      - 5A5b Fine Comb Incised Green Ware
    - Combination
      - 2A5c Fine Combination Incised Buff Ware
      - 2B5c Coarse Combination Incised Buff Ware
    - Stamping
      - 2A5e Fine Stamped Buff Ware
      - 2B5e Coarse Stamped Buff Ware
      - 2C5e Vegetal Stamped Buff Ware
      - 3C5e Vegetal Stamped Red Ware
      - 6B5e Coarse Stamped Cooking Ware
    - Grooving
      - 2A5f Fine Grooved Buff Ware
      - 3B5f Coarse Stamped Red Ware
    - Inlaid
      - 2A5g Fine Inlaid Buff Ware

            - 2B5g Coarse Inlaid Buff Ware
    - Painted
        - 2A6 Fine Painted Buff Ware
    - Glazed
        - Monochrome
            - 2A7a Fine Monochrome Glazed Buff Ware
            - 2B7a Coarse Monochrome Glazed Buff Ware
            - 3A7a Fine Monochrome Glazed Red Ware
            - 3B7a Fine Monochrome Glazed Red Ware
        - Polychrome
            - 2A7b Fine Splash Glazed Buff Ware
            - 3A7b Fine Splash Glazed Red Ware
        - Sgraffiato
            - 2A7e2 Fine Sgraffiato Glazed Buff Ware
            - 3A7e2 Fine Sgraffiato Glazed Red Ware
        - Underglaze Painted
            - 2A7e3 Fine Underglaze Painted Buff Ware
            - 2B7e3 Coarse Underglaze Painted Buff Ware
            - 2C7e3 Vegetal Underglaze Painted Buff Ware
            - 3A7e3 Fine Underglaze Painted Red Ware
    - Moulded
        - 2A8 Fine Moulded Buff Ware
        - 2B8 Coarse Moulded Buff Ware
        - 2C8 Vegetal Moulded Buff Ware
        - 3A8 Fine Moulded Red Ware
        - 5A8 Fine Moulded Green Ware
    - Appliqué
        - Rope
            - 2A10a Fine Rope Appliqué Buff Ware
            - 2B10a Coarse Rope Appliqué Buff Ware
            - 2C10a Vegetal Rope Appliqué Buff Ware
            - 6B10a Coarse Rope Appliqué Cooking Ware
        - Barbitone
            - 2A10b Fine Barbitone Appliqué Buff Ware
            - 2B10b Coarse Barbitone Appliqué Buff Ware
            - 2C10b Vegetal Barbitone Appliqué Buff Ware
- Stonepaste
    - 7A7a Monochrome Glazed Stonepaste Ware
    - 7A7c Opaque Glazed Stonepaste Ware
    - 7A7d Imitation Celadon Stoneware
    - 7A7e3 Underglaze Painted Stonepaste Ware
    - 7A7f Lustre Glazed Stonepaste Ware
    - 7A7g Lajvardina Glazed Stonepaste Ware
- Porcelain
    - 8A7a Celadon Glazed Porcelain
    - 8A7b Blue on White Glazed Porcelain

Slipped Earthenware (2A2, 2B2, 2C2, 3A2, 3B2, 3C2, 4A2, 6B2)

Description: Slipped wares are divided from the overall undecorated wares based on the presence of a slip added to the vessel surface. The slips are usually of a different color than the fabric, and are either white, brown, red, or black. The vessels were created either by coiling or wheel throwing and usually have sand or grit inclusions. Overall, slipping occurs on all forms from table to storage to cooking wares. These wares are not mentioned separately in the literature and are usually lumped into the undecorated wares. This means there is no chronology, or comparisons to be made between this group and the undecorated wares found at other sites to help date this assemblage.

Fabrics: The fabric is a buff color (2.5Y 8/2 Pale Yellow; 5YR 7/6 Reddish Yellow; 5YR 8/2 Pinkish White; 7.5YR 5/4 Brown; 7.5YR 6/3 Light Brown; 7.5YR 7/4 Pink; 10YR 6/3 Pale Brown; 10YR 7/4 Very Pale Brown), red color (2.5YR 3/1 Dusky Red; 2.5YR 5/6 Red; 2.5YR 5/8 Red; 2.5YR 8/3 Pink; 5YR 6/6 Reddish Yellow; 5YR 7/4 Pink; 7.5YR 5/6 Red) or grey color (7.5YR 3/1 Very Dark Gray; 10YR 3/1 Very Dark Grey; 10YR 6/1 Grey; 10YR 7/2 light grey).

Inclusions are sand sized or smaller inclusions (Fine ware) (N=11), grit sized inclusions or larger (Coarse ware) (N=4) and vegetal Inclusions (N=2). The ware is handmade (N=2), coilmade (N=4) and wheelmade (N=11).

The surface is smoothed and a brown (5YR 5/3 Reddish Brown; 10YR 4/6 Dark Yellowish Brown, 10YR 5/3 Brown, 10YR 8/2 Very Pale Brown), red (2.5YR 5/8 Red, 5YR 4/6 Red; 5YR 5/3 Reddish Brown), gray (5YR 5/2 Reddish Gray, 7.5Y 5/1 grey), or white (2.5YR 8/2 Pinkish White; 5YR 8/2 Pinkish White; 7.5YR 8/3 Pink; 10YR 8/2 Very Pale Brown,) slip has been applied.

Fabric Codes: BR.br.3.2.2.2.S.b/o; BR.br.2.2.2.2.S.o; B.br.2.2.2.2.S.o; W.br.2.2.2.2.S.o, R.br.2.2.2.2.S/R.o; BR.br.3.2.2.2.S/R.o; BR.br.2.2.2.2.S/G.o; BR.br.3.3.2.2.S/G.o; B.br.2.2.3.3.R.s, BR.br.2.2.2.2.C.o, W.r.2.2.2.2.S.o; B.r.2.3.2.2.S.o; R.r.2.2.2.2.S.o; BR.r.2.3.3.3.S.o; R.br.3.2.2.2.S.o, B.r.2.2.2.2.R.o; R.r.2.3.3.3.R.o; BR.r.3.3.3.3.R.o, W.r.2.3.2.2.R/C.o; W.r.2.1.2.2.R/C.o; W.r.2.3.4.4.R/C.o; W.r.2.2.2.2.R/C.o; B.r.2.2.2.2.R/C.o; R.r.2.3.4.4.R/C.o G.g.2.2.2.2.S.o B.b.3.3.3.3.R.o; BR.b.3.2.2.2.R.o; BR.b.2.2.2.2.R.o; R.b.3.2.2.2.R.o; BR.br.3.2.2.2.R.o; G.g.2.2.2.2.R.o; R.b.2.2.2.2.R.o

Forms: This ware has Bases (n=5), No Neck Jars (N=2), Short Neck Jars (N=3), Long Neck Jars (N=1).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A2	4	1											5
2B2					1								1
2C2	1												1
3A2		1					1					3	5
3B2		1										1	2
3C2												1	1
4A2	1												1
6B2								1					1
Total	6	3	0	0	1	0	1	1	0	0	0	5	17

Links with other wares: Ahmed and Renette 2020: 2xx; Novacek et al. 2008: EC104; EC108; EC109; EC110; EC111; EC201; 202; Priestman 2005: Slip.B, IRBS

Parallels and Dating: No exact date has been established for this material.

Photographs:


8 cm


8 cm


8 cm

Burnished Earthenware (2A3, 3A3, 3B3, 4A3, 6B3)

Description: Burnished wares are separated based on the appearance of burnishing, ranging from single lines to a highly polished surface. They are usually wheelmade with sand or grit inclusions and range from buff to red fabric. Burnishing usually occurs on the tablewares, from shallow to deep bowls, and small jugs. These wares are not mentioned separately in the literature and are usually lumped into the undecorated wares. This means there is no chronology, or comparisons to be made between this group and the undecorated wares found at other sites to help date this assemblage.

Fabrics: The fabric is a buff color (5YR 8/2 Pinkish White; 7.5YR 5/4 Brown; 7.5YR 6/3 Light Brown; 7.5YR 7/4 Pink; 5YR 7/6 Reddish Yellow; 10YR 6/3 Pale Brown; 2.5Y 8/2 Pale Yellow), red color (2.5YR 5/6 Red; 2.5YR 8/3 Pink; 5YR 7/4 Pink; 7.5YR 5/6 Red; 5YR 6/6 Reddish Yellow; 2.5YR 3/1 Dusky Red), grey color (5Y 7/1 Light Grey; 7.5Y 5/1 grey, 10YR 3/1 Very Dark Grey; 10YR 6/1 Grey; 10YR 6/3 Pale Brown).

The inclusions are sand size or smaller (Fine) (N=9) and grit size or larger (Coarse) (N=9). It is handmade (N=1), coilmade (N=1), and wheelmade (N=16). The sherds are burnished ranging from slight burnishing marked by lines in a smoothed fabric to highly polished.

Fabric Codes: BR.br.3.2.2.2.S.b; BR.br.3.2.2.2.S.b; BR.br.2.2.2.2.S.b; BR.br.2.1.1.1.S.b; W.w.3.1.1.1.S.b; BR.br.3.2.1.1.S.b; BR.br.3.3.3.3.S.b, R.r.3.2.2.2.S.b; R.r.3.1.1.1.S.b; R.r.2.2.2.2.S.b; R.r.2.3.4.4.R.b; R.r.2.2.2.2.R/S.b; R.r.3.1.2.2.S/R.b; R.r.3.2.2.2.R/S.b; R.r.2.3.3.3.R.b G.br.2.2.2.2.S.b; G.g.2.2.2.2.S.b; B.b.3.3.3.3.R.b; BR.br.3.2.2.2.R/S.b; BR.b.3.2.2.2.R.b; B.b.2.1.1.1.R.b; BR.br.3.3.3.3.R.b; B.b.3.2.2.2.R.b; R.r.3.2.3.3.R.b

Forms: The forms for this ware are bases (N=6), Deep Bowls (N=1), No Neck Jar (N=1), Long Neck Jar (N=2), Lamp (N=1), and Pilgrim Flask (N=1).

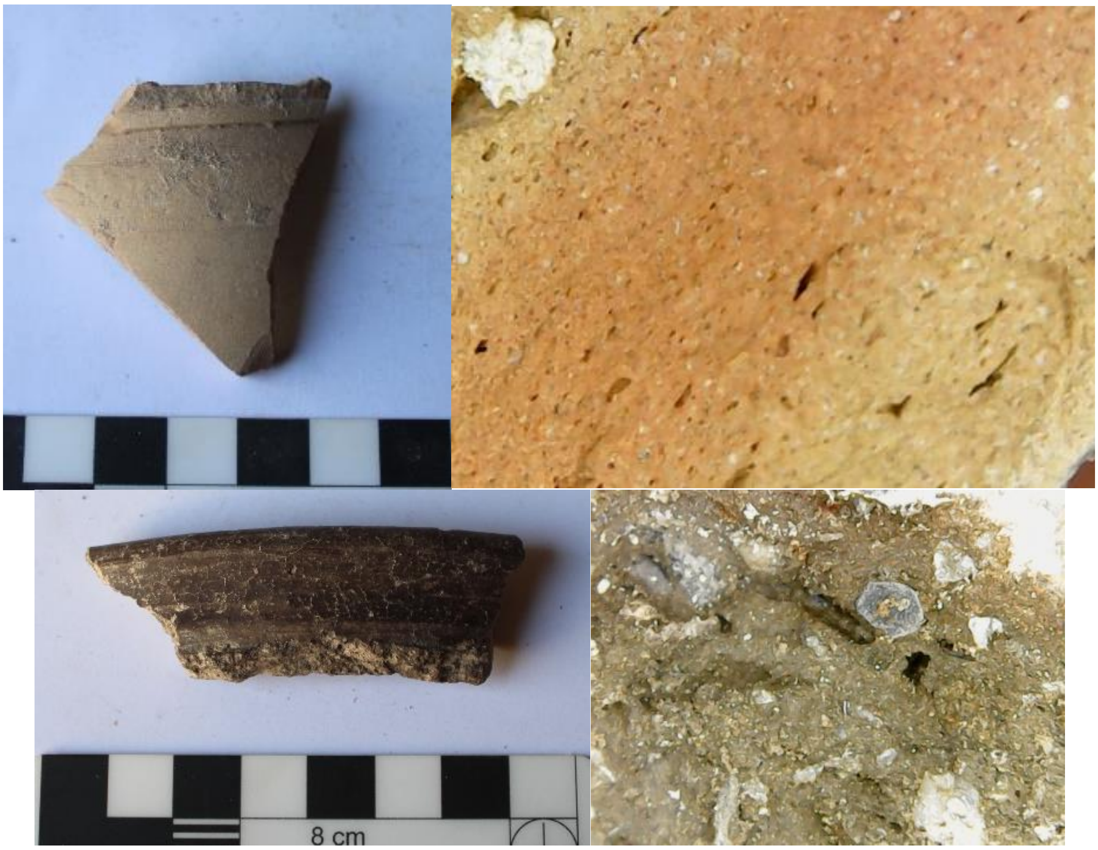
Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A3	3												3
3A3	2	1							1				4
3B3	2								1				3
4A3	2												2
6B3	3	2			1								6
Total	12	3	0	0	1	0	0	0	2	0	0	0	18

Links with other wares: Ahmed and Renette 2020: 2xx; Novacek et al. 2008: EC103; EC112; EC113; EC203; EC204; EC210; Priestman 2005: FINT; FIG, FIG.LV, GRIT, GRIT.LV, GROG, GROG.LV; CGW.N-ID

Parallels and Dating: No exact date has been established for this material.

Photographs:

Smoothed Earthenware (2A4, 2B4, 2C4, 3A4, 3B4, 3C4, 4A4, 4B4, 5C4, 6B4)

Description: Smoothed wares are separated based on their surface treatment ranging from light smoothing with the palm of a hand to almost burnished using a tool. These wares are not mentioned separately in the literature and are usually lumped into the undecorated wares. This means there is no chronology, or comparisons to be made between this group and the undecorated wares found at other sites to help date this assemblage.

Fabrics: The fabric is a buff color (2.5Y 8/2 Pale Yellow; 5YR 7/6 Reddish Yellow; 5YR 8/2 Pinkish White; 7.5YR 5/4 Brown; 7.5YR 6/3 Light Brown; 7.5YR 7/4 Pink; 10YR 6/3 Pale Brown), red color (2.5YR 5/6 Red; 2.5YR 8/3 Pink; 5YR 7/4 Pink; 7.5YR 5/6 Red; 5YR 6/6 Reddish Yellow; 2.5YR 3/1 Dusky Red), grey color (Gley 1 5/10Y Greenish Grey; 2.5YR 5/1 Reddish Grey; 5YR 4/1 Dark Grey; 10YR 3/1 Very Dark Grey; 10YR 5/1 Grey; 10YR 6/1 Grey; 10YR 6/3 Pale Brown), and green color (Gley 1 8/5GY Light Greenish Gray; 5Y 5/4 Olive).

This ware has sand sized or smaller inclusions (Fine) (N=356), grit sized or larger inclusions (Coarse (N=101), and vegetal inclusions (N=101). The ware is handmade (N=189), coilmade (N=48), mouldmade (N=1), and wheelmade (N=319).

The surface has been smoothed, sometimes with a tool which leaves marks. Other times has been smoothed with cloth/hands, when the clay was still wet which smooths the surface but does not leave tool marks.

Fabric Codes: BR.br.2.2.2.2.S.s; BR.br.2.1.1.1.S.s; BR.br.2.1.2.2.S.s; BR.br.3.3.2.2.S.s; W.w.2.1.1.1.S.s; W.w.2.2.2.2.S.s; W.w.3.2.2.2.S.s; R/BR.r/br.2.2.2.2.S.s; G.br.2.2.2.2.S.s; B.BR.2.2.2.2.S.s; BR.g.2.2.2.2.S.s; BR.br.2.3.3.3.R.s; BR.br.2.2.2.2.R/S.s; BR.br.3.2.2.2.R/S.s; BR.br.2.3.2.2.R/S.s; R.b.3.2.2.2.R.s; BR.br.2.3.4.4.R.s; GR.gr.2.2.2.2.R.s; BR.g.3.2.2.2.S/R.s; BR.r.2.3.3.3.R.s; R.br.2.3.3.3.R.s; O.br.2.2.2.2.R.s; G.br.2.2.3.3.R.s; BR.br.2.2.2.2.S/C.s; R.br.2.3.3.3.R/C.s; BR.br.3.3.4.4.R/C.s; BR.br.2.3.4.4.R/C.S; BR.br.2.1.1.1.S/C.s; R.r.2.2.2.2.S.s; R.r.2.1.1.1.S.s; B.r.2.2.2.2.S.s; R.r.2.3.3.3.S.s; GR.r.2.2.2.2.S.s; BR.br.2.2.2.2.S.s; BR.r.2.3.3.3.S.s; R.r.2.2.2.2.R.s; R.r.3.2.2.2.S/R.s; R.r.2.3.3.3.R.s; R.r.2.3.3.4.R.s; R.r.2.3.4.4.R.s; R.r.3.1.1.1.R.s; BR.br.2.3.2.2.R.s; BR.br.3.3.3.3.S/R.s; R.r.2.2.3.3.R.s; BR.r.2.2.3.3.R.s; R.br.2.2.2.2.R.s; BR.b.2.2.2.2.R.s; R.r.3.2.2.2.S/C.s; R.r.3.3.3.3.R/C.s; R.r.2.3.4.4.R/C.s; R.r.2.3.3.3.R/C.s;

R.r.2.2.2.2.S/C.s; R.r.3.3.4.4.R/C.s; G.g.2.2.2.2.S.s; G.g.3.2.2.2.S.s; G.g.3.1.2.2.R.s; G.g.2.3.2.3.R.s; GR.gr.2.3.2.2.R/C.s; GR.gr.2.2.3.3.R/C.s; GR.gr.2.2.2.2.S/C.s; G.g.2.3.3.3.S/C.s; B.b.2.1.1.1.R.s; R.b.2.1.1.1.R.s; BR.br.3.3.2.2.R.s; BR.b.2.3.2.2.R.s; G.g.2.2.2.2.R.s; R.br.3.2.3.3.S/R.s; BR.br.3.2.2.2.R.s; R.b.2.3.3.4.R.s; B.br.2.3.4.4.R.s

Forms: The forms of this ware are bases (N=136), trays (N=4), shallow bowls (N=9), deep bowls (N=34), basins (N=11), No Neck Jars (N=6), Short Neck Jar (N=9), Long Neck Jar (N=53), holemouth Jar (N=4), Nargilehs (N=8), Pilgrim Flask (N=1), and Lids (N=8).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A4	136	29	24	40	18	15	23	8	1	10	2	13	319
2B4	4	18	4	9	6	2		16	1			1	61
2C4	8	24	14	4	6	2	1	2				10	71
3A4	9	6	1	4	2	3	1	1		2	1	2	32
3B4	3	4	1	3	4			1	1			1	18
3C4	5	9	2	5	2							4	27
4A4	2			1								3	6
4B4		1											1
5C4	2											1	3
6B4	4		4	2	1	1	1	4				1	18
Total	173	91	50	68	39	23	26	32	3	12	3	36	556

Links with other wares: Ahmed and Renette 2020: 2xx; Novacek et al. 2008: EC101; EC103; EC105; EC107; EC108; EC109; EC112; EC205; Priestman 2005: FINT; FIG, FIG.LV, GRIT, GRIT.LV, GROG, GROG.LV; ORG.S, ORG.I, ORG.H; CGW.N-ID

Parallels and Dating: No exact date has been established for this material.

Photographs:


8 cm




8 cm


8 cm


Single Incised Earthenware (2A5a, 2B5a, 2C5a, 3A5a, 3B5a, 3C5a, 5A5a, 6B5a)

Description: Incised and impressed wares, which also includes carving/excising, continues a tradition that originated in the Sassanian and Umayyad periods (Grube 1976). Incised pottery has been found in Iraq dating from the 9th–14th centuries (Gibson et al 1998; Nováček et al 2008), Syria dating from the 8th–14th centuries (Tonghini 1998), and Iran dating from the 10th–12th centuries (Danti 2004; Wilkinson 1973). Tonghini points to the use of a needle or a pin being used for incised decoration and at Qal'at Jabar this tended to be highly stylised branches and leaf motifs along with more abstract patterns of dotted bands (Tonghini 1998: 64). This is also related to the scratched design as discussed by Wilkinson (1973) from Nishapur.

Fabrics: The fabric is a buff color (2.5Y 8/2 Pale Yellow; 5YR 7/6 Reddish Yellow; 5YR 8/2 Pinkish White; 7.5YR 5/4 Brown; 7.5YR 6/3 Light Brown; 7.5YR 7/4 Pink; 10YR 6/3 Pale Brown), red color (2.5YR 3/1 Dusky Red; 2.5YR 5/6 Red; 2.5YR 8/3 Pink; 5YR 6/6 Reddish Yellow; 5YR 7/4 Pink; 7.5YR 5/6 Red), green color (Gley 1 8/5GY Light Greenish Gray; 5Y 5/4 Olive), and grey color (10YR 3/1 Very Dark Grey; 10YR 6/1 Grey).

This ware has sand sized or smaller inclusions (Fine) (N=30), grit sized or larger inclusions (Coarse (N=12), and vegetal inclusions (N=12). The ware is handmade (N=11), coilmade (N=14), and wheelmade (N=29).

The ware has been smoothed and has a single incised line, either straight or wavy which is placed either around the rim or shoulder of the vessel. There are also more complex vegetal or geometric motifs incised with a single pointed tool.

Fabric Codes: BR.br.2.1.2.2.S.i; BR.br.2.3.3.3.S.i; BR.br.2.2.2.2.S.i; BR.br.3.2.2.2.R/S.i; BR.br.2.2.2.2.R/S.i; BR.br.3.3.3.3.2.R/S.i; BR.br.2.3.3.3.R.i; BR.br.3.3.4.4.R/C.i; BR.br.2.2.2.2.R/C.i; BR.br.2.3.3.3.R/C.i; BR.br.2.3.3.3.C.i; BR.br.2.3.3.3.S/R/C.i; R.r.2.2.2.2.S.i; BR.r.2.3.3.3.S.i; BR.r.2.2.2.2.S.i; R.r.2.3.3.3.S/R.i; R.r.2.2.3.3.R.i; R.r.3.3.3.3.S/C.i; R.r.3.4.4.4.S/R/C.i; GR.gr.2.1.1.1.S.i; GR.gr.3.2.2.2.S.i; BR.gr.2.2.2.2.S.i; GR.gr.3.3.3.3.S.i; BR.br.2.2.3.3.R.i; R.r.3.2.2.2.R.i; O.b.2.2.3.3.R.i; BR.b.2.2.3.3.R.i; BR.r.2.2.3.4.R.i; BR.br.2.2.3.3.R.i

Forms: The forms of this ware are bases (N=1), trays (N=1), deep bowls (N=9), basins (N=1), No Neck Jars (N=1), Short Neck Jar (N=1), Long Neck Jar (N=2), and Wolemouth Jar (N=4).

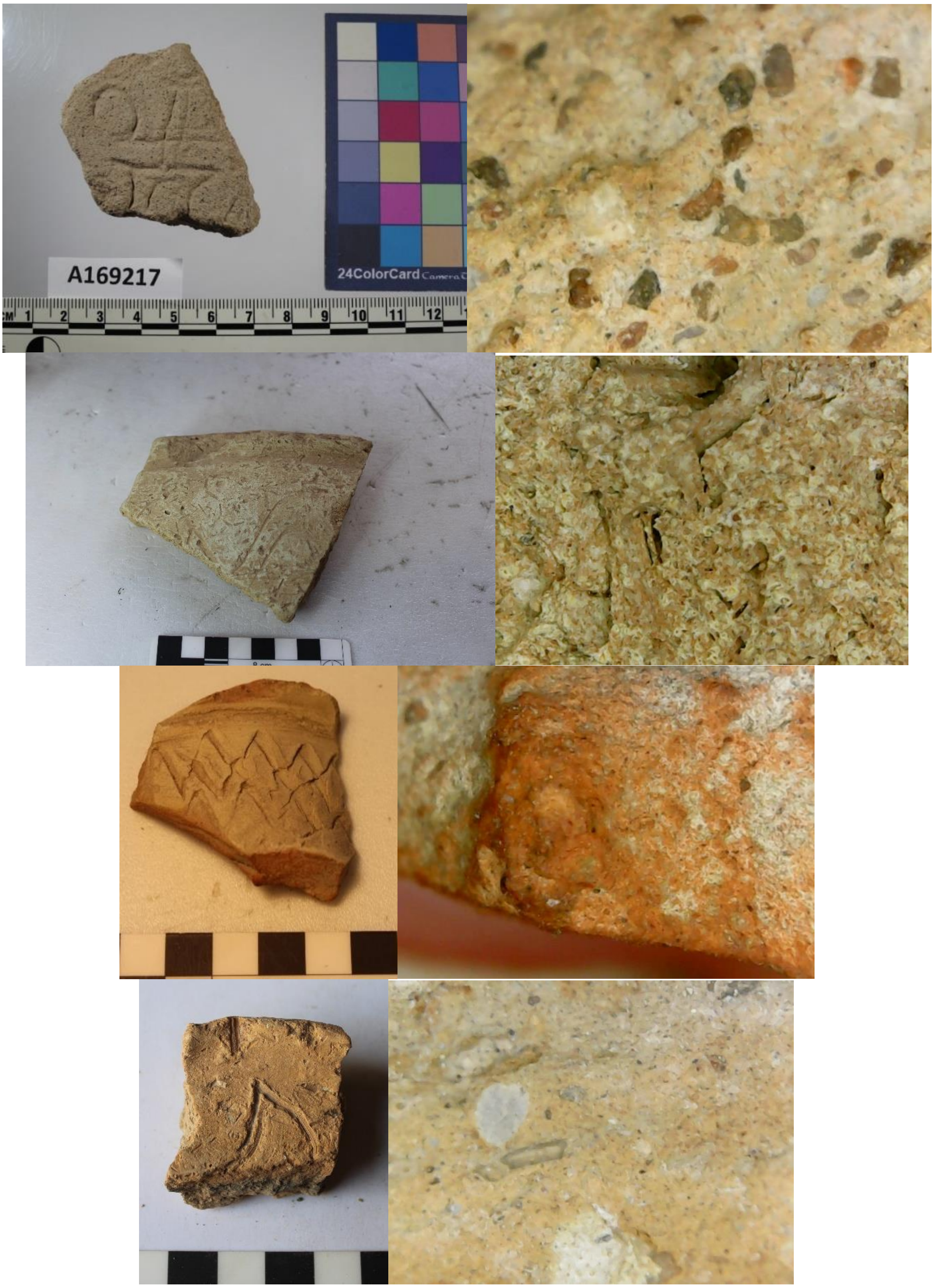
Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A5a	13	2			1	1	1	1		4	1	1	25
2B5a		1						6				1	8
2C5a	1	1		1				1				6	10
3A5a	2									1			3
3B5a								1				1	2
3C5a												2	2
5A5a					1			1					2
6B5a			1										1
Total	16	4	1	1	2	1	1	10	0	5	1	11	53

Links with other wares: Ahmed and Renette 2020: 2xx; Priestman 2005: INCIMP;

Parallels and Dating: This type of decoration dates from the 10th – 14th centuries.

Photographs:


A169217
24ColorCard

Comb Incised Earthenware (2A5b, 2B5b, 2C5b, 3A5b, 3B5b, 5A5b)

Description: Incised and impressed wares, which also includes carving/excising, continues a tradition that originated in the Sassanian and Umayyad periods (Grube 1976). Incised pottery has been found in Iraq dating from the 9th–14th centuries (Gibson et al 1998; Nováček et al 2008), Syria dating from the 8th–14th centuries (Tonghini 1998), and Iran dating from the 10th–12th centuries (Danti 2004; Wilkinson 1973). Comb incised ware, usually using a comb of 5-7 teeth, is known from the pre-Islamic period. At ʻAna, it is found in levels dating from the 11th -19th centuries (Northedge et al. 1988). According to Watson (2004: 106) comb incising reached its height during 10th – 11th centuries. However, no thorough study of this ware has been carried out and determining exact centuries of production is almost impossible.

Fabrics: The fabric is a buff color (2.5Y 8/2 Pale Yellow; 5YR 7/6 Reddish Yellow; 5YR 8/2 Pinkish White; 7.5YR 5/4 Brown; 7.5YR 7/4 Pink; 10YR 6/3 Pale Brown), red color (2.5YR 3/1 Dusky Red; 2.5YR 5/6 Red; 2.5YR 8/3 Pink; 5YR 6/6 Reddish Yellow; 5YR 7/4 Pink; 7.5YR 5/6 Red), and green color (Gley 1 8/5GY Light Greenish Gray; 5Y 5/4 Olive).

This ware has sand sized or smaller inclusions (Fine) (N=104), grit sized or larger inclusions (Coarse (N=23), and vegetal inclusions (N=6). The ware is handmade (N=6), coilmade (N=66), and wheelmade (N=61).

The surface is smoothed with comb incising of generally 5 or 7 lines. They are either straight or wavy lines, usually on the neck or shoulder.

Fabric Codes: W.w.3.2.2.2.S.i; BR.br.2.2.2.2.S.i; BR.br.2.2.2.2.R.i; BR.br.2.2.2.2.R/S.i; BR.br.3.3.2.2.S/R.i; BR.br.3.3.3.2.R/S.i; BR.br.2.3.3.3.R/S.i; BR.br.2.3.3.4.R.i; BR.br.2.3.3.3.R/C.i; BR.br.2.2.2.2.S/C.i; BR.br.3.3.3.3.R/C.i; R.r.2.2.2.2.S.i; BR.r.2.3.3.3.S.i; BR.r.2.2.2.2.S.i; R.r.2.2.3.3.R.i, GR.gr.2.1.1.1.S.i; GR.gr.3.2.2.2.S.i; GR.gr.3.3.3.3.S.i

Forms: The forms of this ware are bases (N=3), deep bowls (N=5), basins (N=3), Short Neck Jar (N=1), and Long Neck Jar (N=2).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A5b	64	15	4	4	2	3	1	1	1		2		97
2B5b	3	12	2					1					18
2C5b	5						1						6
3A5b	3								1	2		1	7
3B5b	1			3					1				5
3C5b												1	1
5A5b		1											1
Total	76	28	6	7	2	3	2	2	3	2	2	2	135

Links with other wares: Ahmed and Renette 2020: 2xx; Priestman 2005: INCIMP

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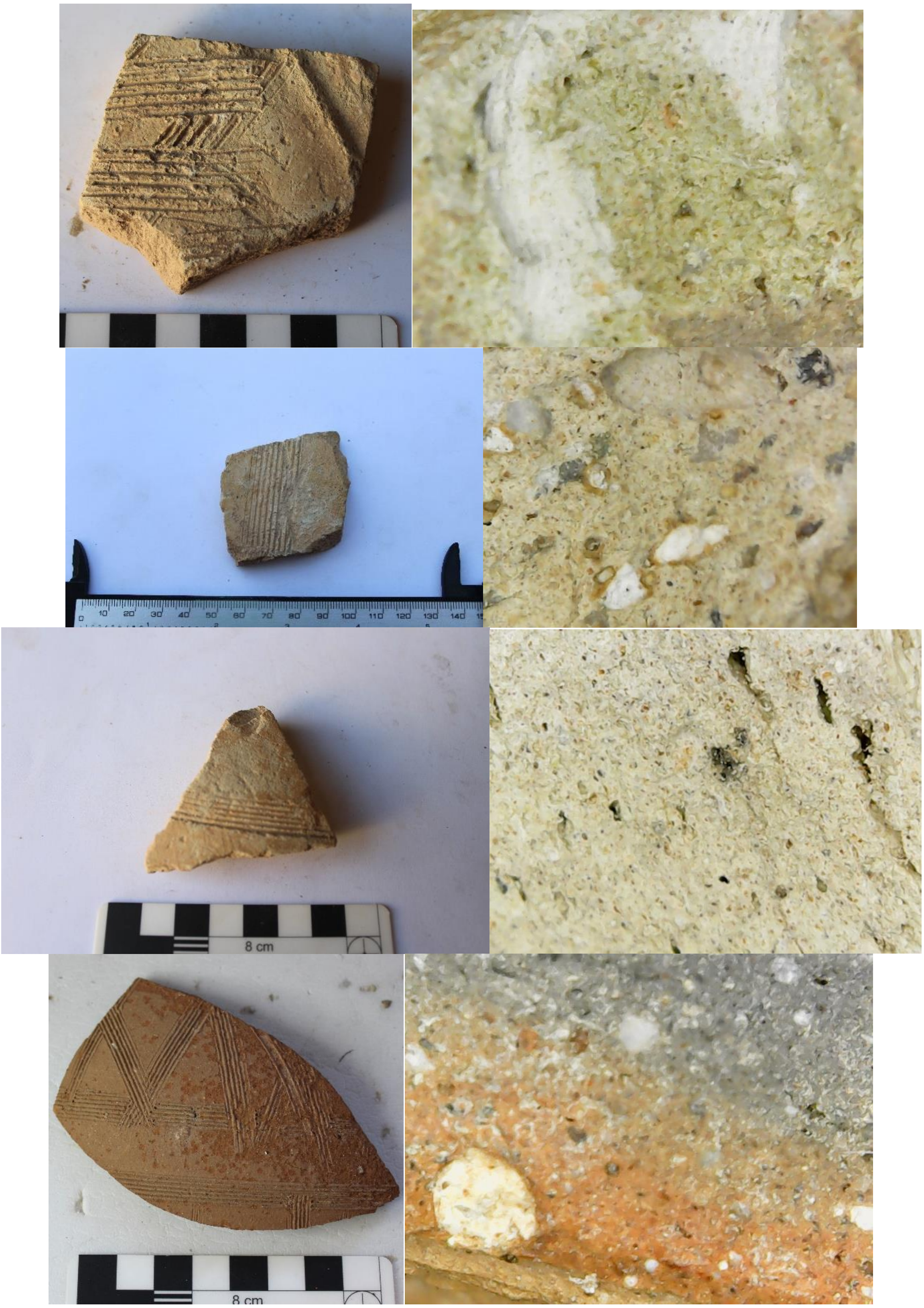
Parallels and Dating: No exact date has been established for this material.

Photographs:





Comb Incised and Impressed Earthenware (2A5c, 2B5c, 2C5c)

Description: Incised and impressed wares, which also includes carving/excising, continues a tradition that originated in the Sassanian and Umayyad periods (Grube 1976). Incised pottery has been found in Iraq dating from the 9th–14th centuries (Gibson et al 1998; Nováček et al 2008), Syria dating from the 8th–14th centuries (Tonghini 1998), and Iran dating from the 10th–12th centuries (Danti 2004; Wilkinson 1973). Sometimes the hollow tube and impressed comb designs were combined. These incisions usually occur on the necks of large storage jars, or smaller jugs used as table-wares. The use of a hollow tube was also used to create circular designs on the surface of the vessel (Figure 10:4, 7).

Fabrics: The fabric is a buff color (5YR 8/2 Pinkish White, 7.5YR 7/4 Pink, 7.5YR 5/4 Brown, 5YR 7/6 Reddish Yellow, 10YR 6/3 Pale Brown, 2.5Y 8/2 Pale Yellow) and has sand inclusions. Most of the ware is wheelmade (19) followed by coilmade (8). The fabric is a buff color (5YR 7/6 Reddish Yellow, 5YR 8/2 Pinkish White, 75YR 7/4 Pink, 7.5YR 5/4 Brown, 10YR 6/3 Pale Brown, 2.5Y 8/2 Pale Yellow).

This ware has sand sized or smaller inclusions (Fine) (N=26), grit sized or larger inclusions (Coarse (N=4), and vegetal inclusions (N=1). The ware is coilmade (N=12), and wheelmade (N=19).

The surface is smoothed with comb incising of generally 5 or 7 lines. They are usually straight lines with impressed lines of dots perpendicular and below the straight incised lines. Sometimes the impressions are made by a hollow tube and are located above the straight lines.

Fabric Codes: BR.br.2.2.2.2.S.i**;** BR.br.2.2.3.3.R.i/im; BR.br.2.3.2.2.R/S.i/im

Forms: The forms of this ware are shallow bowls (N=1) and long neck jars (N=2).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A5c	11								14	1			26
2B5c		1						1				1	3
2C5c				1				1					2
Total	11	1	0	1	0	0	0	2	14	1	0	1	31

Links with other wares: Ahmed and Renette 2020: 2xx; Priestman 2005: WINC

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Parallels and Dating: No exact date has been established for this material.

Photographs:

Stamped Earthenware (2A5e, 2B5e, 2C5e, 3C5e, 6B5e)

Description: Stamping is differentiated from impressing in that there is a tool used to create the specific design on the vessel (i.e. rosettes or crosses). Most scholars have treated stamping as a predecessor to moulded decoration, dating it from the 8th – 10th centuries (Watson 2004; Tonghini 1998). Islamic stamps tend to be smaller than the previous Sassanian ones, with more geometric designs, rather than the figural designs of Sassanian stamps (Simpson, personal comm. 5/16/2019). Stamped designs are present at 12th century Nishapur (Wilkinson 1973: 304: no. 39; 311: no. 64) and beginning in the 7th century at Samarra (Sarre 1925: 8 – 9).

Fabrics: The fabric is a buff color (2.5Y 8/2 Pale Yellow; 5YR 7/6 Reddish Yellow; 5YR 8/2 Pinkish White; 7.5YR 7/4 Pink; 7.5YR 5/4 Brown; 10YR 6/3 Pale Brown)

This ware has sand sized or smaller inclusions (Fine) (N=16), grit sized or larger inclusions (Coarse (N=6), and vegetal inclusions (N=6). The ware is coilmade (N=13), and wheelmade (N=11).

The surface has been smoothed with stamped decoration, usually creating bumps on interior where stamp has been placed. The decoration in the stamps is geometric, usually consisting of concentric circles, dots, or rosettes.

Fabric Codes: BR.br.2.2.2.2.S.im; BR.br.2.3.3.3.S.im; GR.br.2.3.2.2.S.im; BR.br.2.3.3.3.R.st; BR.br.2.3.2.2.R.st; BR.br.3.3.3.3.C/R.st; BR.br.2.3.2.2.R/C.st; BR.br.2.3.3.3.R/C.st

Forms: The forms of this ware are shallow bowls (N=1), short neck jars (N=3) and long neck jars (N=2).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A5e	3	1						7		5			16
2B5e								3		1			4
2C5e	3		1					2				1	7
3C5e		1											1
6B5e								1		1			2
Total	6	2	1	0	0	0	0	13	0	7	0	1	30

Links with other wares: Priestman 2005: WINC
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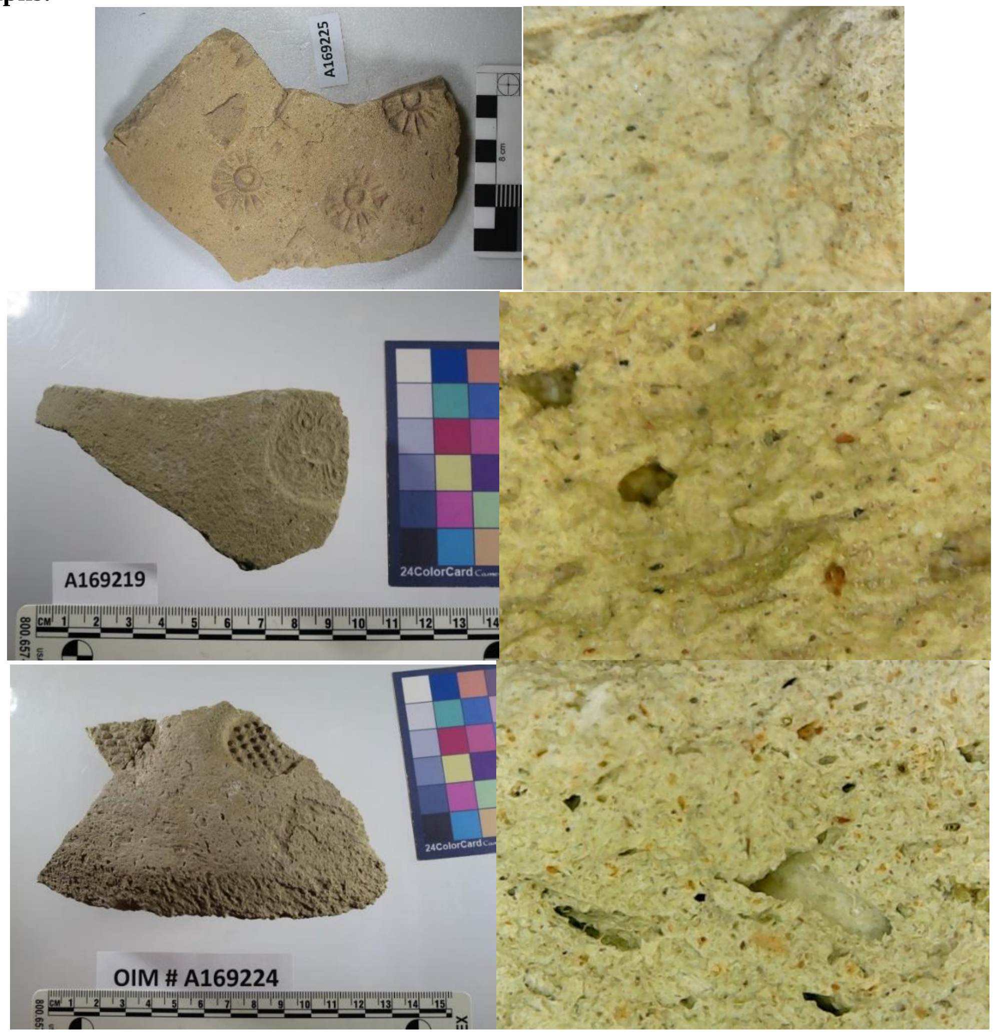
Parallels and Dating: No exact date has been established for this material.

Photographs:



Grooved Earthenware (2A5f, 3B5f)

Description: Grooved decoration is formed when a vessel is constricted at various heights, or larger tools are used to create a corrugated effect on the surface, rather than incised lines.

Fabrics: The fabric is a buff color (2.5Y 8/2 Pale Yellow; 5YR 7/6 Reddish Yellow; 5YR 8/2 Pinkish White; 7.5YR 7/4 Pink; 7.5YR 5/4 Brown; 10YR 6/3 Pale Brown).

This ware has sand sized or smaller inclusions (Fine) (N=19), grit sized or larger inclusions (Coarse (N=1). The ware is handmade (N=6), coilmade (N=1), and wheelmade (N=13).

The surface has been smoothed and grooves have been added, usually around the rim.

Fabric Codes: BR.br.2.2.2.2.S.g; BR.br.2.3.3.3.S.g; GR.br.2.3.2.2.S.g;

Forms: The forms of this ware are deep bowls (N=1), basins (N=1) and long neck jars (N=1).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A5f	15		2				1						18
3B5f	1												1
Total	16	0	2	0	0	0	1	0	0	0	0	0	19

Links with other wares: None were identified

.

Parallels and Dating: No exact date has been established for this material.

Photographs: None

Inlaid Earthenware (2B5g)

Description: This technique places already fired pieces of ceramic, usually glazed, or stonepaste ware, into the body of the ceramic (Tonghini 1998: 64). This decoration is not reported in large quantities at sites. Tonghini dates this to before the 13th century (Tonghini 1998: 64). At Nishapur, it is found in Phase IIIB, dating it to the 11th century (Rante and Collinet 2013: 155).

Fabrics: The fabric is a buff color (5YR 7/6 Reddish Yellow).

This ware has grit sized or larger inclusions (Coarse) (N=2). The ware is wheelmade (N=2).

The surface is smoothed with bluish frit inlays.

Fabric Codes: BR.br.2.2.2.2.S.in

Forms: The forms of this ware are long neck jars (N=2).

Distribution:

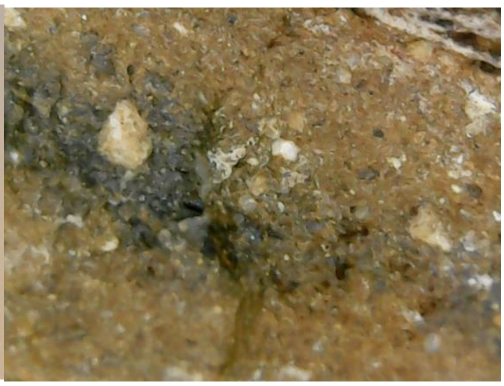
	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2B5g										2			2
Total										2			

Links with other wares:

.

Parallels and Dating: 11th – 13th century

Photographs:



Painted Earthenware (2A6)

Description: Painted wares vary throughout time and are relatively understudied during the Islamic period. Most of the painted ware in the Islamic period is known as proto-historic painted ware, as they tend to mimic earlier painted wares and are handmade (Johns 1998; Priestman 2005: Pl. 44–56, 60, 62; Whitcomb 1991). Vessels with pseudo-prehistoric painting have been found in Syria and Iran dating from the 11th–14th centuries CE (Johns 1998; Priestman 2005:67, Safar 1947: Fig. 20:33; Watson 2004:127, Whitcomb 1991).

Fabrics: The fabric is a buff color (7.5YR 5/4 Brown, 5YR 7/6 Reddish Yellow, 10YR 6/3 Pale Brown).

This ware has sand sized or smaller inclusions (Fine) (N=3). The ware is coilmade (N=1), and wheelmade (N=2).

The surface is smoothed with painted lines either straight or wavy, in black (5YR 4/1 Dark Gray, Gley2 5/10B Bluish Grey) or red (10R 5/4 Weak Red).

Fabric Codes: BR.br.2.2.2.2.S.p; BR.br.3.2.2.2.S.p; BR.br.2.1.1.1.S.p; BR.br.2.3.2.2.S.p

Forms: The forms of this ware are deep bowls (N=1) and no neck jars (N=1).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A6									1			2	3
Total									1			2	3

Links with other wares: Priestman 2005: PAW.FC; PAS.HC

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Parallels and Dating: Priestman (2004) places his painted wares in the 11th-13th C as based on the Kush/al-Mataf seriation, and with a possible origin in southern Iran.

Photographs:

Monochrome Glazed Earthenware (2A7a, 2B7a, 3A7a, 3B7a)

Description: Monochrome glazing is the most prevalent type of glazing on Islamic ceramics and as such a date for individual sherds is impossible to suggest. Green glazing is one of the earlier types of glazing dating from pre-Islamic times to the present (Lane 1947; Watson 2004). Turquoise glazing dates from the Parthian period until the present (Matson and Keall 1999). Blue glazing appeared in the mid-9th–10th century and lasted until the present (Priestman 2005:224). Brown and purple glazing appeared in the 9th century and lasted until the present (Kennett 2004: 40). The speckled yellow/orange, also known as mustard has been dated to the 11th century by Kennet (Kennet 2004: 35) and Priestman (2005: 257).

Fabrics: The fabric is a buff color (2.5Y 8/2 Pale Yellow; 5YR 7/6 Reddish Yellow; 5YR 8/2 Pinkish White; 7.5YR 5/4 Brown; 7.5YR 7/4 Pink; 10YR 6/3 Pale Brown) and red color (2.5YR 3/1 Dusky Red; 2.5YR 5/6 Red; 2.5YR 8/3 Pink; 5YR 6/6 Reddish Yellow; 5YR 7/4 Pink; 7.5YR 5/6 Red).

This ware has sand sized or smaller inclusions (Fine) (N=158) and grit sized or larger inclusions (Coarse) (N=2). The ware is handmade (N=4), coilmade (N=4), mouldmade (N=1) and wheelmade (N=151).

The surface has been smoothed, and sometimes a white slip is applied. A glaze has been added, with blue, green, orange, turquoise, or yellow colorants. The glaze has been applied on the exterior and interior of the vessels, usually the same color on both surfaces.

Fabric Codes: W.br.3.2.2.2.S.g; GR.br.3.2.2.2.S.g; GR.br.2.2.2.2.S.g; BL.br.3.2.2.2.S.g; BL.br.3.2.1.1.S.g; TQ.br.2.2.2.2.S.g; TQ.br.3.2.2.2.S.g; BL/GR.br.2.2.2.2.S.g; W/TQ.br.3.2.2.2.S.g; BL.w.2.2.2.2.S.g; GR.y.3.2.2.2.S.g; GR.r.3.2.2.2.S.g; BR.r.2.2.2.2.R.g; BL/W.br.2.2.2.2.R.s; GR.r.3.2.2.2.S.g; BL.r.2.2.2.2.S.g; GR.r.2.2.2.2.S/n.g; Y.r.3.2.2.2.S.g; TQ.r.3.2.2.2.S.g; W.r.2.2.2.2.S.g; GR/B.r.2.2.2.2.S.g; GR.r.3.3.3.3.R.g

Forms: The forms of this ware are bases (N=44), shallow bowls (N=1), deep bowls (N=18), beakers (N=1), Short Neck Jar (N=2), Long Neck Jar (N=5), Wolemouth Jar (N=1), and lamps (N=2)

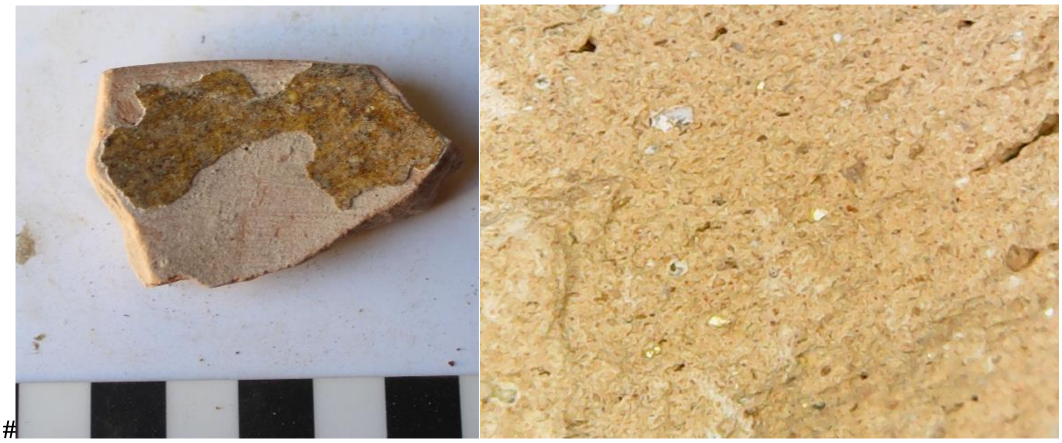
Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A7a	36	18	4	8	4	1	1	8	5	9	2	1	97
2B7a								1					1
3A7a	35	8	6	2		1		1	3	5			61
3B7a									1				1
Total	71	26	10	10	4	2	1	10	9	14	2	1	160

Links with other wares: Ahmed and Renette 2020: 1xx; Novacek et al. 2008: EC401, 402, 403, 404, 407; Priestman 2005: TIN.W1, TIN.B, TIN.T, ALK.1; ALK.3, YSPEC;

Parallels and Dating: 7th century - Present

Photographs:

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Polychrome Glazed Earthenware (2A7b, 3A7b)

Description: Polychrome glazed wares in this dissertation are mainly splash glazed wares. These were prepared with a white slip before the glaze was applied to the vessel. Blobs of green, brown, purple and/or yellow glazes were applied to the surface and topped by a thin coating of transparent glaze. When the bowl was fired, these colored glazes ran down the sides of the bowl, producing streaks on the steep interior or exterior sides of the bowl (Ettinghausen 1936; Wilkinson 1973:54). Splashed glazed wares were thought to be an imitation of Chinese three-colored wares but have been shown to be an indigenous development at Samarra, in eastern Iran, and Central Asia dating to the 9th century (Watson 2004:199). These ceramics have been recorded from the 9th–13th centuries in Iraq (Nováček et al 2008: Fig. 47–49) and Iran (Rante 2015: Fig. 96/3–5; Wilkinson 1973, no. 2–3, 9, 26) but not along the Euphrates (Jenkins-Madina 2006; Tonghini 1998:57-62).

Fabrics: The fabric is a buff color (2.5Y 8/2 Pale Yellow; 5YR 7/6 Reddish Yellow; 5YR 8/2 Pinkish White; 7.5YR 5/4 Brown; 7.5YR 7/4 Pink; 10YR 6/3 Pale Brown) and a red color (2.5YR 3/1 Dusky Red; 2.5YR 5/6 Red; 2.5YR 8/3 Pink; 5YR 6/6 Reddish Yellow; 5YR 7/4 Pink; 7.5YR 5/6 Red).

This ware has sand sized or smaller inclusions (Fine) (N=10). The ware is wheelmade (N=10).

The surface has been smoothed, and sometimes a white slip is applied. Pigments have been added, either as paint or as parts of the glaze in blue, green, yellow, brown, and turquoise. These have sometimes been allowed to run freely down the vessel, other times are kept in patterns or dots.

Fabric Codes: GR/BR.br.2.2.2.2.S.g; BR/Y.br.2.2.2.2.S.g; BL/GR.br.3.2.2.2.S.g; GR/BR.br/g.3.2.2.2.S.g; BL/B.3.2.2.2.S.g; GR/Y.br.3.2.2.2.S.g; GR/BR.r.3.2.1.1.S.g; Y/BR.r.3.2.1.1.S.g

Forms: The forms of this ware are bases (N=4) and deep bowls (N=1).

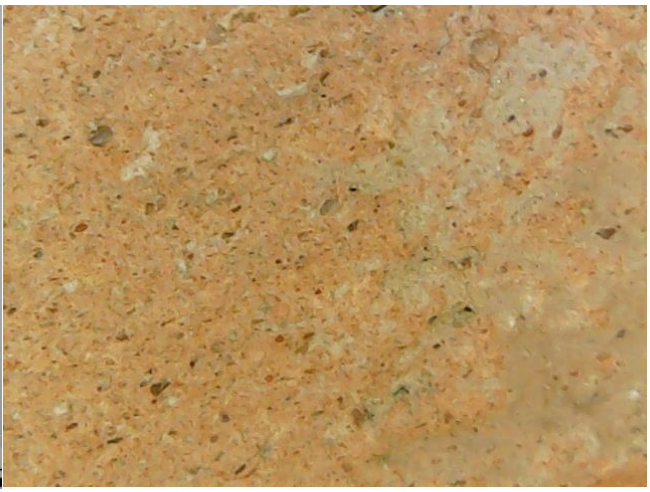
Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A7b	1							6					7
3A7b	2							1					3
Total	3							7					10

Links with other wares: Priestman 2005: SPL.P Ahmed and Renette 2020: 1xx; Novacek et al. 2008: EC405/410/412

Parallels and Dating: These ceramics have been recorded from the 9th–13th centuries

Photographs:



Sgraffiato Glazed Earthenware (2A7c, 3A7c)

Description: Sgraffiato ware developed out of early Abbasid slip incised pottery of the 9th century and became one of the most prevalent wares during the 11th and 12th centuries and lasts until the 16th century (Grube 1976; Nováček et al 2008; Watson 2014). It is present but relatively scarce in Iraq (Nováček et al 2008 Fig. 24:55, 56; Safar 1945: Fig. 19:83) and Syria (Tonghini 1998:62). In Iran, Sgraffiato Ware developed in the 11th century alongside Geruz Ware (Danti 2004:61–62). Geruz ware is distinct in that a design is carved into the slip exposing the body before glazing (Danti 2004: 61–62; Watson 2004:260–264). Three sgraffiato traditions were identified in this assemblage, incising under a monochrome glaze, usually green, incising under a clear glaze, and incising under a splash glaze in green, yellow and/or purple.

Fabrics: The fabric is a buff color (2.5Y 8/2 Pale Yellow; 5YR 7/6 Reddish Yellow; 5YR 8/2 Pinkish White; 7.5YR 5/4 Brown; 7.5YR 7/4 Pink; 10YR 6/3 Pale Brown) and a red color (2.5YR 3/1 Dusky Red; 2.5YR 5/6 Red; 2.5YR 8/3 Pink; 5YR 6/6 Reddish Yellow; 5YR 7/4 Pink; 7.5YR 5/6 Red).

This ware has sand sized or smaller inclusions (Fine) (N=58). The ware is wheelmade (N=58).

Smoothed surface with a white slip. Incised through the slip and has either a monochrome or polychrome glazing on top.

Fabric Codes: GR.r.3.2.2.2.S.i/g; GR.br.3.2.2.2.S.i/g. GR.br.2.2.2.2.S.i/g. BR.br.2.2.2.2.S.i/g; Y.br.2.2.2.2.S.i/g. W.br.3.2.2.2.S.i/g; Y.r.3.1.1.1.S.i/g; GR.r.3.2.2.2.S.i/g; GR.r.2.2.2.2.S.i/g; W.r.3.2.2.2.S.i/g; BL.r.3.2.2.2.S.i/g; Y/GR/BR.r.3.2.2.2.S.i/g; GR/Y.r.3.2.2.2.S.i/g; O/BR.r.2.2.2.2.S.i/g; BR.r.2.2.2.2.S.i/g; GR/BR/Y.r.3.2.2.2.S.i/g; GR.r.3.2.2.2.S.i/g

Forms: The forms of this ware are bases (N=11), shallow bowls (N=3), deep bowls (N=14), long neck jars (N=1), and Wolemouth jars (N=1).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A7c	5	1						2		15			23
3A7c	9	1			1			5	1	18			35
Total	14	2	0	0	1	0	0	7	1	33	0	0	58

Links with other wares: Ahmed and Renette 2020: 1xx; Danti 2004: Geruz Ware; Priestman 2005: GRAF.G; GRAF.Y; GRAF.B;

Parallels and Dating: 11th and 12th centuries and lasts until the 16th century

Photographs:

Black on Blue Glazed Earthenware (2A7d, 3A7d)

Description: The most common underglaze painting in this assemblage is black paint under a blue or turquoise glaze. This is also known Raqqa Ware, or Silhouette Ware which grew out of an earlier tradition of painting under a lead or alkaline glaze (Lane 1947, Jenkins 1983:17). Raqqa ware tends to have black painted designs whereas Silhouette ware has black backgrounds with incised decoration carved through the paint (Jenkins-Medina 2006; Lane 1947; Tonghini 1998; Watson 2004). Over the top of this paint was laid an opaque glaze of ivory or deep turquoise (Lane 1947). The designs usually contained geometric, vegetal, calligraphic, or figural motifs. Across Western Asia, this ware has been found dating to the 12th – 14th centuries (Ettinghausen 1936, Gibson et al. 1998; Miglus et al 2013, Nováček et al 2008, Rante 2015, Raymond and Paillet 1995, Safar 1947, Sarre 1925, Tonghini 1998, Watson 2004).

Fabrics: The fabric is a buff color (2.5Y 8/2 Pale Yellow; 5YR 7/6 Reddish Yellow; 5YR 8/2 Pinkish White; 7.5YR 5/4 Brown; 7.5YR 7/4 Pink; 10YR 6/3 Pale Brown) and a red color (2.5YR 3/1 Dusky Red; 2.5YR 5/6 Red; 2.5YR 8/3 Pink; 5YR 6/6 Reddish Yellow; 5YR 7/4 Pink; 7.5YR 5/6 Red).

This ware has sand sized or smaller inclusions (Fine) (N=8) and grit sized or larger inclusions (Coarse (N=1). The ware is wheelmade (N=9).

The surface has been smoothed, and sometimes a white slip is applied. A design in black has been added, and the vessel has been glazed in blue or turquoise. Alternatively, the vessel was painted in black, a design was carved exposing the white slip or clay, and then the vessel was glazed in blue or turquoise.

Fabric Codes: BL/B.br.3.2.2.2.S.g; BL/B.r.3.2.2.2.S.g

Forms: The forms of this ware are bases (N=2) and deep bowls (N=3).

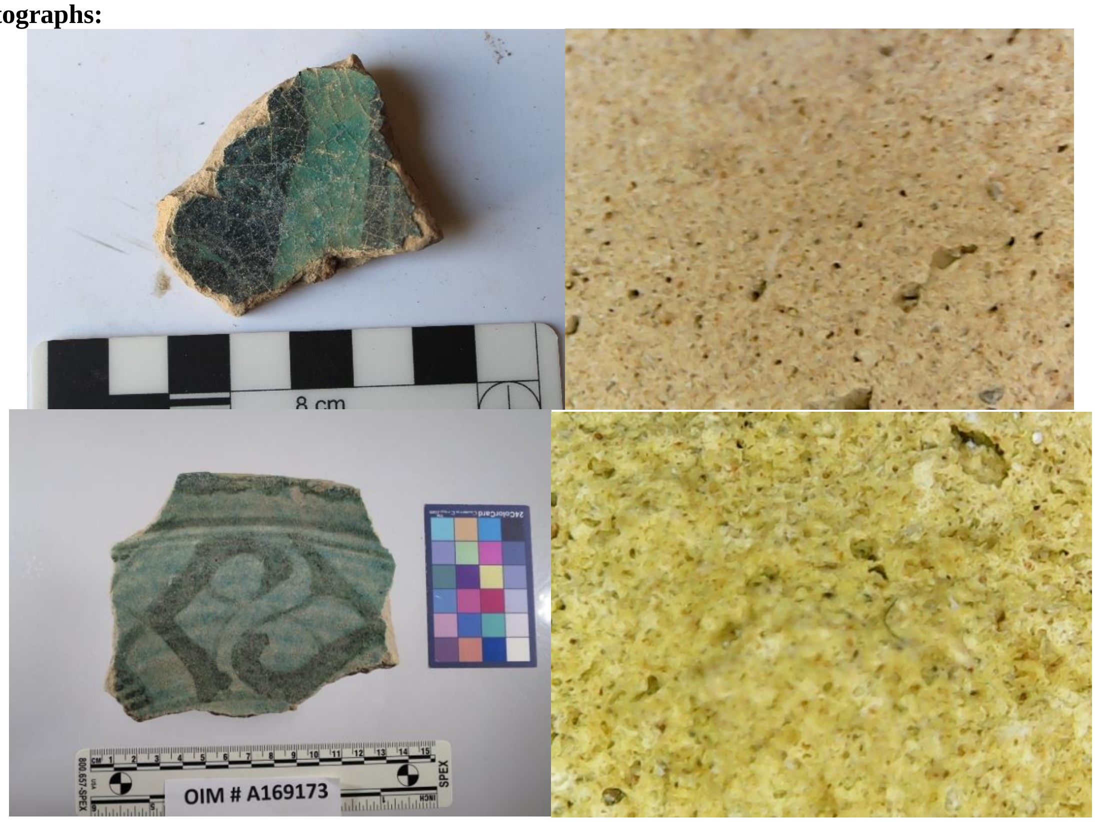
Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A7d	2							5					7
2B7d												1	1
3A7d										1			1
Total	2	0	0	0	0	0	0	5	0	1	0	1	9

Links with other wares: Ahmed and Renette 2020: 1xx; Priestman 2005: UGP.G1, UGP.F2, UPG.C2, UPG.BW; Novacek et al. 2008: EC422.

Parallels and Dating: 12th – 14th centuries

Photographs:



Blue on White Glazed Earthenware (2A7e, 3A7e)

Description: Blue on white ware has been suggested to be an imitation of Chinese ceramics, and dates to the 13th – 15th centuries (Lane 1957). Blue paint on a white body under a clear glaze has been attested in the 13th century, and according to Fehérvári, with the arrival of Chinese porcelains in the 14th centuries, the technique became very popular (Fehérvári 1998:50). The blue color is from the addition of cobalt (Mia et al. 2020; Matin and Pollard 2016).

Fabrics: The fabric is a buff color (2.5Y 8/2 Pale Yellow; 5YR 7/6 Reddish Yellow; 5YR 8/2 Pinkish White; 7.5YR 5/4 Brown; 7.5YR 7/4 Pink; 10YR 6/3 Pale Brown) and a red color (2.5YR 3/1 Dusky Red; 2.5YR 5/6 Red; 2.5YR 8/3 Pink; 5YR 6/6 Reddish Yellow; 5YR 7/4 Pink; 7.5YR 5/6 Red).

This ware has sand sized or smaller inclusions (Fine) (N=3), grit sized or larger inclusions (Coarse (N=1), and vegetal inclusions (N=1). The ware is wheelmade (N=5).

The surface has been smoothed, and sometimes a white slip is applied. Blue paint is added in designs of geometric or vegetal motifs and is coated by a transparent glaze.

Fabric Codes: BL/W.br.3.2.2.2.S.g; BL/W.r.3.2.2.2.S.g

Forms: The forms of this ware are bases (N=2) and deep bowls (N=1).

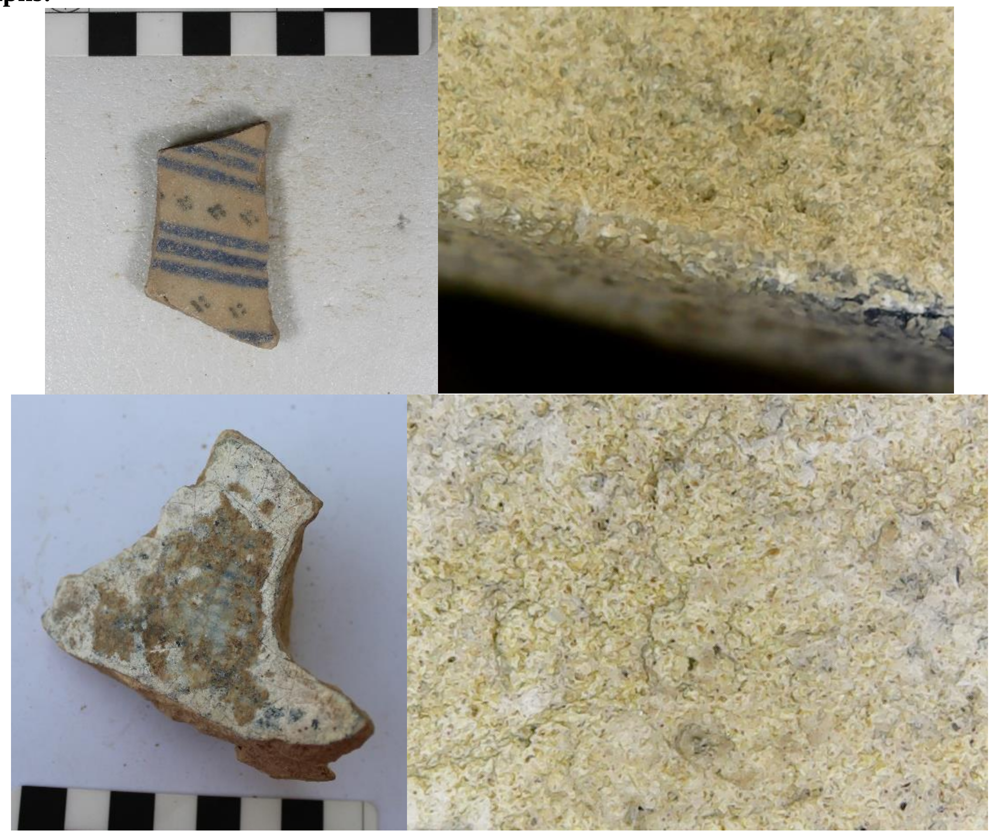
Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A7e		1						2					3
2B7e												1	1
2C7e												1	1
Total	0	1	0	0	0	0	0	2	0	0	0	2	5

Links with other wares: Ahmed and Renette 2020: 1xx; Priestman 2005: UGP.G1, UGP.F2, UPG.C2, UPG.BW; Novacek et al. 2008: EC422.

Parallels and Dating: 13^{th} – 15^{th} centuries

Photographs:



Sultanabad Glazed Earthenware (2A7g, 3A7g)

Description: Sultanabad ware is known for its blue and black painting under a clear glaze and date from the 13^{th} – 14^{th} centuries (Adams 1965, Safar 1945, Féhérvári 2000, Lane 1957). These wares are named as such due to their prevalence at the site of Sultanabad, and their links with the Ilkhanate (Lane 1957, Watson 2004). The decorations are usually divided into panels, mimicking earlier wares and possibly textile production (Watson

2004). These panels are then filled with inscriptions, palmettes, and dotted or hatched fields (Morgan 2004). The decoration of most pieces is vegetal, with stylized vine leaves and bunches of grapes (Morgan 2004).

Fabrics: The fabric is a buff color (2.5Y 8/2 Pale Yellow; 5YR 7/6 Reddish Yellow; 5YR 8/2 Pinkish White; 7.5YR 5/4 Brown; 7.5YR 7/4 Pink; 10YR 6/3 Pale Brown) and a red color (2.5YR 3/1 Dusky Red; 2.5YR 5/6 Red; 2.5YR 8/3 Pink; 5YR 6/6 Reddish Yellow; 5YR 7/4 Pink; 7.5YR 5/6 Red).

This ware has sand sized or smaller inclusions (Fine) (N=14). The ware is wheelmade (N=14).

The surface has been smoothed, and sometimes a white slip is applied. Paint in black and blue has been applied under a clear glaze.

Fabric Codes: B/BL/W.br.3.2.2.2.S.g; B/BL/W.r.3.2.2.2.S.g

Forms: The forms of this ware are bases (N=5) and deep bowls (N=4).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A7g								14					14
Total	0	0	0	0	0	0	0	14	0	0	0	0	14

Links with other wares:

Parallels and Dating: from the 13th – 14th centuries

Photographs:

Opaque Glazed Earthenware (2A7j1, 3A7j1)

Description: Opaque glazed ware, also known as porcelain imitation ware, was created to imitate porcelain. Islamic potters were able to create the whiteness of porcelain, but not the translucent aspects of true Chinese porcelain (Mason and Tite 1994; Priestman 2011; Watson 2004). This ware has a thick opacified glaze that covers the entire interior and exterior surfaces, except for the foot where the vessels were stacked in firing (Priestman 2011). Potters made deep incisions in the walls of the vessels, sometimes piercing them and they were then covered in a transparent glaze, which gave the stonepaste ware a translucent quality (Jenkins 1983). Designs carved into the sides of the vessels were usually vegetal or arabesque, mimicking designs painted and incised on other types of wares. In Iraq, this ware was developed in Basra during the 9th century, imitating the Chinese porcelains received in the courts of the Abbasid Caliphate (Mason and Keall 1991; Watson 2004). Opaque glazed ware is dated to the 12th–14th centuries (Jenkins 1983; Priestman 2011; Rante 2015).

Fabrics: The fabric is a buff color (2.5Y 8/2 Pale Yellow; 5YR 7/6 Reddish Yellow; 5YR 8/2 Pinkish White; 7.5YR 5/4 Brown; 7.5YR 7/4 Pink; 10YR 6/3 Pale Brown) and a red color (2.5YR 3/1 Dusky Red; 2.5YR 5/6 Red; 2.5YR 8/3 Pink; 5YR 6/6 Reddish Yellow; 5YR 7/4 Pink; 7.5YR 5/6 Red).

This ware has sand sized or smaller inclusions (Fine) (N=5). The ware is wheelmade (N=5).

The surface has been smoothed, and sometimes a white slip is applied. Blue and black pigments have been added to the glaze, and is allowed to run down the sides, or is kept in a pattern. This is covered in an opaque white glaze.

Fabric Codes: B/BL/W.br.2.2.2.2.S.g; B/BL/W.r.2.2.2.2.S.g

Forms: The forms of this ware are bases (N=1) and deep bowls (N=1).

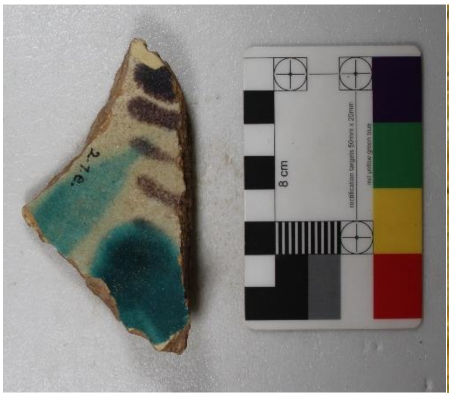
Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A7j1								3					3
3A7j1								2					2
Total	0	0	0	0	0	0	0	5	0	0	0	0	5

Links with other wares: Priestman 2011: OPAQ.TBS

Parallels and Dating: 8th-10th Century

Photographs:



Brown under Clear Glazed Earthenware (2A7k)

Description: This category has been termed the Brown under Clear Glaze, but I could not find any parallels, in both the glazing technique or decoration. It could be related to the slip painted wares identified at Nishapur (Wilkinson 1973), or possibly a lustre glazing (see below).

Fabrics: The fabric is a buff color (2.5Y 8/2 Pale Yellow; 5YR 7/6 Reddish Yellow; 5YR 8/2 Pinkish White; 7.5YR 5/4 Brown; 7.5YR 7/4 Pink; 10YR 6/3 Pale Brown) and a red color (2.5YR 3/1 Dusky Red; 2.5YR 5/6 Red; 2.5YR 8/3 Pink; 5YR 6/6 Reddish Yellow; 5YR 7/4 Pink; 7.5YR 5/6 Red).

This ware has sand sized or smaller inclusions (Fine) (N=3). The ware is wheelmade (N=3).

The surface has been smoothed, and sometimes a white slip is applied. A brown slip has been added, covered by a transparent glaze.

Fabric Codes: BR.br.2.2.2.2.S.g; BR.r.2.2.2.2.S.g

Forms: The forms of this ware are deep bowls (N=2).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A7k			1					2					3
Total	0	0	1	0	0	0	0	2	0	0	0	0	3

Links with other wares:

Parallels and Dating: Unknown

Photographs:

Moulded Earthenware (2A8, 2B8, 2C8, 3A8, 5A8)

Description: Moulded wares are created by pushing a section of clay into a mould to create an intricate design, either a full mould of a vessel (for bowls) or a partial mould (for jars), which is then joined with other sections. Moulded wares have been manufactured from the 8th – 13th centuries and have been found across Western Asia (Henderson et al. 2005: 139 – 141, McPhillips and Walmsley 2007: 2007, Milwright 2003: 92, Mulder 2014: 147, Nováček et al. 2008, Scanlon 1966: 140, Wilkinson 1973). Mulder (2004: 153–155) divides the moulded wares into four categories, jugs with one handle called 'Mosul Jugs' or 'cruches de Mossoul' as identified by Riis and Poulsen 1957, a canteen with flattened sides called 'pilgrim flasks' (for discussion of these types of forms see the smoothed section above), lamps, and spheroconical vessels.

Fabrics: The fabric is a buff color (2.5Y 8/2 Pale Yellow; 5YR 7/6 Reddish Yellow; 5YR 8/2 Pinkish White; 7.5YR 5/4 Brown; 7.5YR 7/4 Pink; 10YR 6/3 Pale Brown), red color (2.5YR 3/1 Dusky Red; 2.5YR 5/6 Red; 2.5YR 8/3 Pink; 5YR 6/6 Reddish Yellow; 5YR 7/4 Pink; 7.5YR 5/6 Red), and greenish color (Gley 1 8/5GY Light Greenish Gray; 5Y 5/4 Olive).

This ware has sand sized or smaller inclusions (Fine) (N=30) grit sized or larger inclusions (Coarse (N=1), and vegetal inclusions (N=1). The ware is mouldmade (N=32).

This ware is moulded with relief decoration in vegetal, animal, and geometric designs.

Fabric Codes: W.w.3.1.1.1.S.m; W.w.2.2.2.2.S.s; BR.br.1.2.1.1.N.m; BR.br.3.2.2.2.S.m; BR.br.2.2.2.2.S.m; BR.br.3.3.3.2.S/R.m; BR.br.2.3.3.3.S/C.m; GR.br.3.3.2.2.S.m; GR.gr.3.3.3.3.S.m; Gr.gr.2.3.3.3.S.m

Forms: The forms of this ware are spheroconical vessels (N=6), the rest are probably from long neck jars or jugs, but only the shoulders/body sherds remain.

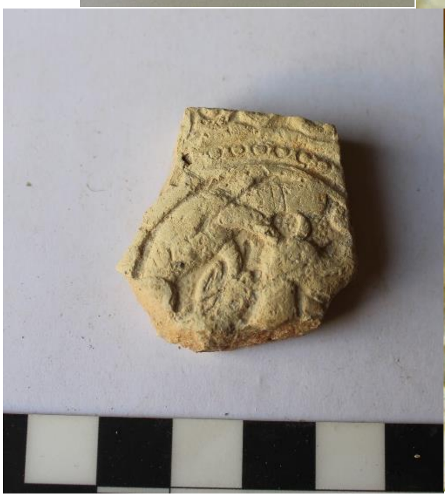
Distribution:

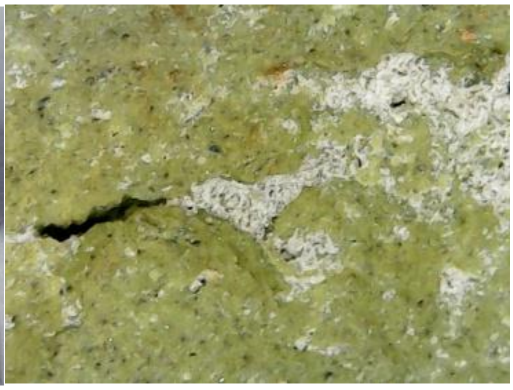
	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A8	9	3	3	3		1	1		1	1			22
2B8	1												1
2C8												1	1
3A8										1			1
5A8								1		5		1	7
Total	10	3	3	3	0	1	1	1	1	7	0	2	32

Links with other wares: Ahmed and Renette 2020: 1xx; Novacek et al. 2008: EC206; Priestman 2005: MEW.CC; MEW.C; MEW.BR

Parallels and Dating: the 8th – 13th centuries

Photographs:





Rope Appliqué Earthenware (2A10a, 2B10a, 2C10a)

Description: Rope appliqué is a decoration type that is normally applied to the shoulders of medium to large jars. As shown below, this appliqué can be very thin and of low relief, to very wide and of high relief. There is also variation in the type of impressions, from oval finger impressions to small slit like incisions. This type of decoration existed for millennia, and as such no date has been proposed for this decoration type.

Fabrics: The fabric is a buff color (2.5Y 8/2 Pale Yellow, 5YR 7/6 Reddish Yellow, 5YR 8/2 Pinkish White, 7.5YR 5/4 Brown, 7.5YR 7/4 Pink, 10YR 6/3 Pale Brown).

This ware has sand sized or smaller inclusions (Fine) (N=6), grit sized or larger inclusions (Coarse) (N=5), and vegetal inclusions (N=10). The ware is handmade (N=5), coilmade (N=4), and wheelmade (N=12).

The surface has been smoothed and ropes of clay have been added either around the rims or around the shoulders of the vessels, possibly to strengthen them.

Fabric Codes: W.w.3.1.1.1.S.m; W.w.2.2.2.2.S.s; BR.br.1.2.1.1.N.m; BR.br.3.2.2.2.S.m; BR.br.2.2.2.2.S.m; BR.br.2.3.2.2.R.a; BR.br.2.3.4.4.R.a; BR.br.2.3.3.3.R.a; BR.br.2.3.3.3.S/R.a; BR.br.2.3.3.4.R.a; BR.br.3.3.2.2.R/C.k/b; BR.br.3.3.3.3.R/C.k/b; BR.br.2.2.2.2.S/C.k/b;

Forms: The forms of this ware are deep bowls (N=3), basins (N=1), no neck jars (N=1), short neck jars (N=3), and long neck jars (N=2).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A10a	5		1										6
2B10a		1		1								3	5
2C10a	2	4										7	13
Total	7	5	1	1	0	0	0	0	0	0	0	10	24

Links with other wares: Ahmed and Renette 2020:1xx; Novacek et al. 2008: EC206; Priestman 2005: FIG, FIG.LV, GRIT, GRIT.LV, GROG, GROG.LV, ORG.S, ORG.I, ORG.H

Parallels and Dating: None

Photographs:

Barbotine Appliqué Earthenware (2A10b, 2B10b, 2C10b)

Description: Barbotine appliqué experienced a revival in the 12th-13th centuries, with more decoration and finer pieces of clay being added to the surface of vessels (Sarre and Mittwoch 1905). Most of these barbotine decorated pieces belong to large water jars called *habb* (Watson 2004; Reitlinger 1951; Riis and Poulsen 1957). Reitlinger dates these vessels to the Zangid period (1170-1220) and states these were made in Northern Iraq and Syria. A large vessel was made, usually by coiling, and the exterior was decorated with the application of smaller pieces of clay, or large slabs and handles also barbitone decorated were added to the vessel. The decoration on these pieces ranges from vegetal and geometric motifs to animal and figural motifs.

Fabrics: The fabric is a buff color (2.5Y 8/2 Pale Yellow, 5YR 7/6 Reddish Yellow, 5YR 8/2 Pinkish White, 7.5YR 5/4 Brown, 7.5YR 7/4 Pink, 10YR 6/3 Pale Brown,).

This ware has sand sized or smaller inclusions (Fine) (N=19), grit sized or larger inclusions (Coarse) (N=2), and vegetal inclusions (N=2). The ware is handmade (N=2), coilmade (N=7), and wheelmade (N=14).

Surface has been smoothed and added pieces of clay have been attached in a geometric, vegetal, or figural pattern. These have been emphasized by incising of the surface and appliqué pieces.

Fabric Codes: BR.br.2.2.2.2.S.a; BR.br.2.3.3.3.S.a; BR.br.2.2.2.2.S.a/i

Forms: The forms of this ware are long neck jars (N=2). The rest are probably from large water pithoi also known as *habb*.

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
2A10b	7						1			10		1	19
2B10b	1	1											2
2C10b	1	1											2
Total	9	2	0	0	0	0	1	0	0	10	0	1	23

Links with other wares: None

Parallels and Dating: the 12th – 14th centuries

Photographs:

Monochrome Glazed Stonepaste Ware (7A7a)

Description: Much like the earthenware ceramics, monochrome glazing is the most common technique of decoration for stonepaste wares. The glazing tends to be in turquoise, green, or blue. Because of the ubiquity of this type of glazing, the production centers and chronological dates are hard to assign (Watson 2006). Most monochrome glazed stonepaste ware has been dated to the 12th–14th centuries (Ettinghausen 1936; Jenkins-Madina 2006; Nováček et al 2008; Rante 2015; Tonghini 1998; Watson 2004).
Fabrics: The fabric is a yellow/white color (5Y 8/2 pale yellow; 10YR 8/3 very pale brown; 10YR 5/1 grey).

This ware no inclusions (N=3). The ware is moulded (N=1) and wheelmade (N=2).

The surface has been smoothed, and sometimes a white slip is applied. A glaze has been added, with blue, green, or turquoise colorants. The glaze has been applied on the exterior and interior of the vessels, usually the same color on both surfaces.

Fabric Codes: BL.w.3.1.1.1.S.g; BL.w.2.2.2.2.S.g; TU.w.3.1.1.1.N.g; GR.w.3.1.1.1.N.g; B/BL.w.3.1.1.1.N.g; W.w.3.1.1.1.N.g; BL/W.w.3.1.1.1.N.g;

Forms: None were identified

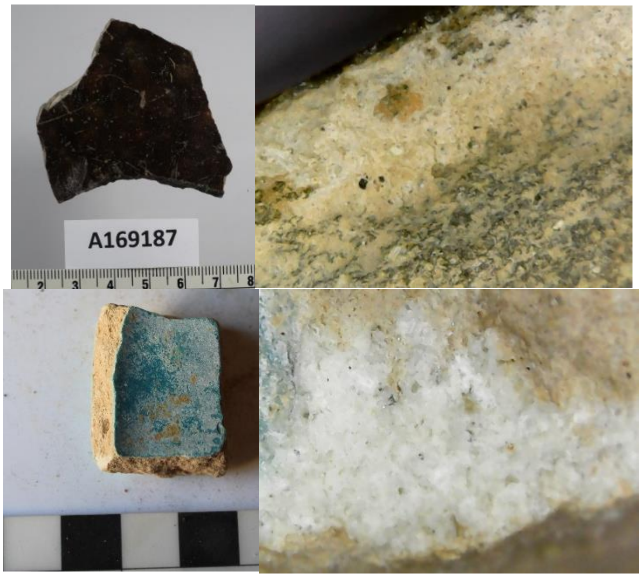
Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
7A7a		1						1		1			3
Total	0	1	0	0	0	0	0	1	0	1	0	0	3

Links with other wares: Priestman 2005: FRIT.T, FIRT.B, FRIT.P, FRIT.W, FRIT.G;

Parallels and Dating: Most monochrome glazed stonepaste ware has been dated to the 12th–14th centuries (Ettinghausen 1936; Jenkins-Madina 2006; Nováček et al 2008; Rante 2015; Tonghini 1998; Watson 2004).

Photographs:



Black on Blue Glazed Stonepaste Ware (7A7d)

Description: Underglaze painted ware was decorated in the same manner as the earthenwares (see above). In Syria, this ware is known as Raqqa ware, and is used as tableware (Jenkins-Madina 2006; Tonghini 1998). In Iran this ware is known as silhouette ware and was made into drinking vessels and bowls with decorations ranging from straight bands to animals (Danti 2004; Jenkins 1983; Watson 2004). Underglaze painted stonepaste ware has been dated to the 13th – 14th centuries (Danti 2004; Jenkins 1983; Jenkins-Madina 2006; Nováček et al 2008; Watson 2004).

Fabrics: The fabric is a yellow/white color (5Y 8/2 pale yellow; 10YR 8/3 very pale brown; 10YR 5/1 grey).

This ware has no inclusions (N=14). The ware is moulded (N=14).

Smoothed surface usually with a white slip. Painting in black or blue under a blue or clear glaze.

Fabric Codes: BR.w.3.1.1.1.S.i/g; B/bl.w.3.2.2.2.S.p/g; BL/b.w.3.1.1.1.S/N.p/g

Forms: The forms of this ware are deep bowls (N=3).

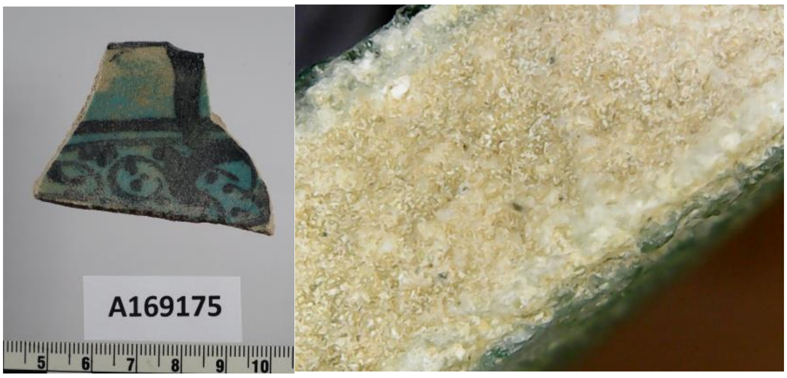
Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
7A7d								3	11				14
Total	0	0	0	0	0	0	0	3	11	0	0	0	14

Links with other wares: Novacek et al. 2008: EC422; Priestman 2005: FIRT.BW, FIRT.TB, FIRT.TBU

Parallels and Dating: Underglaze painted stonepaste ware has been dated to the 13th – 14th centuries (Danti 2004; Jenkins 1983; Jenkins-Madina 2006; Nováček et al 2008; Watson 2004).

Photographs:



Blue on White Glazed Stonepaste Ware (7A7e)

Description: Blue on white ware has been suggested to be an imitation of Chinese ceramics, and dates to the 13th – 15th centuries (Lane 1957). Blue paint on a white body under a clear glaze has been attested in the 13th century, and according to Fehérvári, with the arrival of Chinese porcelains in the 14th centuries, the technique became very popular (Fehérvári 1998:50). The blue color is from the addition of cobalt (Mia et al. 2020; Matin and Pollard 2016).

Fabrics: The fabric is a yellow/white color (5Y 8/2 pale yellow; 10YR 8/3 very pale brown; 10YR 5/1 grey).

This ware no inclusions (N=4). The ware is wheelmade (N=4).

The surface has been smoothed, and sometimes a white slip is applied. Blue paint has been added, usually in a vegetal design. The ware is glazed, usually in white or clear.

Fabric Codes: BL/W.w.3.1.1.1.S.g

Forms: The forms of this ware are bases (N=1), shallow bowls (N=1), and deep bowls (N=2).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
7A7e												4	4
Total	0	0	0	0	0	0	0	0	0	0	0	4	4

Links with other wares: None

Parallels and Dating: 13th – 15th centuries

Photographs: None

Lustre Glazed Stonepaste Ware (7A7f)

Description: Lustre ware is a decoration technique of adding a gold-leaf paint or a copper paint resembling gold on top of a glazed vessel. Lustre wares are reportedly manufactured at Kashan who may have had a monopoly on the production, but lustre tiles were being manufactured at Qum and Mashhad (Watson 2006). This type of ware dates from the mid-12th to mid-14th century. The production decreases with the Mongol invasions, but lustre on tiles remains until the 15th century CE (Watson 2006).

Fabrics: The fabric is a yellow/white color (5Y 8/2 pale yellow; 10YR 8/3 very pale brown; 10YR 5/1 grey).

This ware no inclusions (N=2). The ware is wheelmade (N=2).

The surface has been smoothed, and sometimes a white slip is applied. The ware is glazed, usually in white or clear, and gold paint has been added on top of the glaze.

Fabric Codes: GO/W.w.3.1.1.1.S.g

Forms: The forms of this ware are deep bowls (N=1).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
7A7f									1		1		2
Total	0	0	0	0	0	0	0	0	1	0	1	0	2

Links with other wares: Novacek et al. 2008: 420; Priestman 2005: FRIT.L

Parallels and Dating: This type of ware dates from the mid-12th to mid-14th century. The production decreases with the Mongol invasions, but lustre on tiles remains until the 15th century CE (Watson 2006). Danti dates this to the earlier 13th century.

Photographs:

Sultanabad Glazed Stonepaste Ware (7A7f)

Description: Sultanabad ware is known for its blue and black painting under a clear glaze and date from the 13th – 14th centuries (Adams 1965, Safar 1945, Féhérvári 2000, Lane 1957). These wares are named as such due to their prevalence at the site of Sultanabad, and their links with the Ilkhanate (Lane 1957, Watson 2004). The decorations are usually divided into panels, mimicking earlier wares and possibly textile production (Watson 2004). These panels are then filled with inscriptions, palmettes, and dotted or hatched fields (Morgan 2004). The decoration of most pieces is vegetal, with stylized vine leaves and bunches of grapes (Morgan 2004).

Fabrics: The fabric is a yellow/white color (5Y 8/2 pale yellow; 10YR 8/3 very pale brown; 10YR 5/1 grey).

This ware no inclusions (N=2). The ware is wheelmade (N=2).

The surface has been smoothed, and sometimes a white slip is applied. The ware is glazed, usually in white or clear, and gold paint has been added on top of the glaze.

Fabric Codes: B/BL/W.w.3.1.1.1.S.g

Forms: The forms of this ware are deep bowls (N=1).

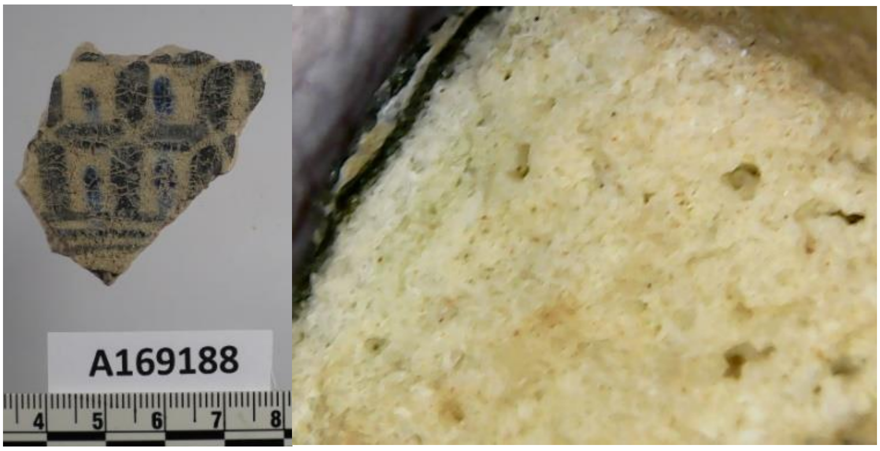
Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
7A7g								2					2
Total	0	0	0	0	0	0	0	2	0	0	0	0	2

Links with other wares: None

Parallels and Dating: the 13th – 14th centuries

Photographs:



Lajvardina Glazed Stonepaste Ware (7A7h)

Description: Lajvardina ware is a decoration technique where the stonepaste body is glazed in dark blue and has red, white, black, and gold-leaf designs painted on top. This ware is reportedly manufactured at Kashan who may have held a monopoly on the production (Allan 1973; Watson 2006). Lajvardina grew out of the earlier Mina'i wares and varies in decoration with more abstract and geometric designs rather than the figural designs of the earlier ware. This type of ware dates from the late 12^{th} to mid-14^{th} century CE (Allan 1971; Golombek 1996:126; Grube 1976; Komaroff and Carboni 2002; Luschey-Schmeisser 2000: 381-82; Naumann and Naumann 1976; Watson 2006).

Fabrics: The fabric is a yellow/white color (5Y 8/2 pale yellow; 10YR 8/3 very pale brown; 10YR 5/1 grey).

This ware has no inclusions (N=15). The ware is wheelmade (N=15).

The surface has been smoothed, glazed in dark blue, and has red, white, black, and gold-leaf designs painted on top.

Fabric Codes: BL/Go/R/W.w.3.1.1.1.S.g

Forms: The forms of this ware are deep bowls (N=1).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
7A7h									14				14
Total	0	0	0	0	0	0	0	0	14	0	0	0	14

Links with other wares: None

Parallels and Dating: This type of ware dates from the late 12^{th} to mid-14^{th} century CE (Watson 2006).

Photographs:


Celadon Imitation Glazed Ware (7A7f)

Description: This ware has a frit body with a thick, opaque, well-fitted, light green glaze which imitates Celadon. The body seems to be grooved to better imitate the white strips present in celadon (Morgan 1991; Priestman 2005; Kennet 2004).

Fabrics: The fabric is a yellow/white color (5Y 8/2 pale yellow; 10YR 8/3 very pale brown; 10YR 5/1 grey).

This ware has no inclusions (N=2). The ware is wheelmade (N=2).

The surface has been smoothed, and a white slip is applied. A glaze of green or light green glaze resembling celadone glaze is added.

Fabric Codes: GR/W.w.3.1.1.1.S.g

Forms: A deep bowl is recorded (N=1).
Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
7A7i								1		1			2
Total	0	0	0	0	0	0	0	1	0	1	0	0	2

Links with other wares: Priestman 2005: FRIT.G

Parallels and Dating: These ceramics have been recorded from the 14th-20th centuries.

Photographs:


Opaque Glazed Stonepaste Ware (7A7j)

Description: Opaque glazed ware, also known as porcelain imitation ware, was created to imitate porcelain. Islamic potters were able to create the whiteness of porcelain, but not the translucent aspects of true Chinese porcelain (Mason and Tite 1994; Priestman 2011; Watson 2004). This ware has a thick opacified glaze that covers the entire interior and exterior surfaces, except for the foot where the vessels were stacked in firing (Priestman 2011). Potters made deep incisions in the walls of the vessels, sometimes piercing them and they were then covered in a transparent glaze, which gave the stonepaste ware a translucent quality (Jenkins 1983). Designs carved into the sides of the vessels were usually vegetal or arabesque, mimicking designs painted and incised on other types of wares. In Iraq, this ware was developed in Basra during the 9th century, imitating the Chinese porcelains received in the courts of the Abbasid Caliphate (Mason and Keall 1991; Watson 2004). Opaque glazed ware is dated to the 12th–14th centuries (Jenkins 1983; Priestman 2011; Rante 2015).

Fabrics: The fabric is a yellow/white color (5Y 8/2 pale yellow; 10YR 8/3 very pale brown; 10YR 5/1 grey).

This ware has no inclusions (N=1). The ware is wheelmade (N=1).

The surface has been smoothed, and sometimes a white slip is applied. An opaque whitish glaze has been applied to the vessel.

Fabric Codes: W.w.3.1.1.1.S.g

Forms: The forms of this ware are bases (N=1).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
7A7j												1	1
Total	0	0	0	0	0	0	0	0	0	0	0	1	1

Links with other wares: Priestman 2011: OPAQ.W1, OPAQ.W2; Priestman 2005: FRIT.W; Novacek et al. 2008: EC504

Parallels and Dating: Opaque glazed ware is dated to the 12th–14th centuries (Jenkins 1983; Priestman 2011; Rante 2015).

Photographs: None

Celadon Glazed Porcelain (8A7a)

Description: The ware has a white glaze with a thin blue line on the interior at the carination mark, with an olive-green glaze on the exterior. The celadon color matches that of the Yaozhu potters who adopted the style of the Yue celadon, with its olive-green coloring. The celadon glazing reached its height during the Song Dynasty (960-1279) (Gompertz 1980).

Fabrics: The fabric is a yellow/white color (10YR 8/2 very pale brown).

This ware has no inclusions (N=1). The ware is wheelmade (N=1).

The surface has been smoothed, and sometimes a white slip is applied. The ware is glazed, with a green color on the exterior. The interior has a blue painted line and a clear glaze.

Fabric Codes: GR.w.3.1.1.1.N.g

Forms: The forms of this ware are bases (N=1).

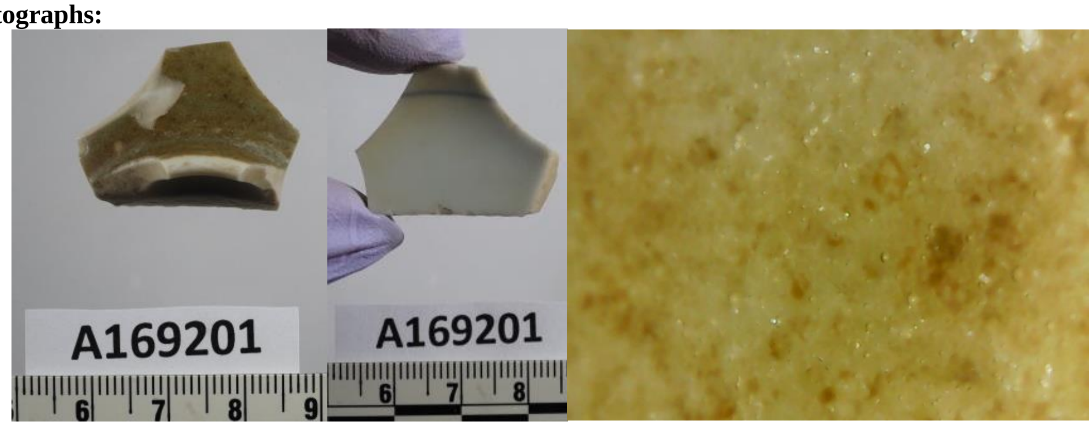
Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
8A7a								1					1
Total	0	0	0	0	0	0	0	1	0	0	0	0	1

Links with other wares: Priestman 2005: WWJ.1-4

Parallels and Dating: The celadon glazing reached its height during the Song Dynasty (960-1279) (Gompertz 1980). However, this vessel with its blue and white on the interior strongly resembles porcelain from Jingdezhen, made in 1751 part of the Nanking Cargo (Howard 1997: 29). The earlier celadons do not seem to have a blue and white component on the interior

Photographs:



Blue on White Glazed Porcelain (8A7b)

Description: Blue on white porcelain was made in China in the 8th century and exported to Western Asia until the 16th century. The height of the export/import was during the Song and Yuan Dynasties (960 – 1368) but was lessened under the Ming (1368 – 1644) (Kessler 2012).

Fabrics: The fabric is a yellow/white color (10YR 8/3 very pale brown).

This ware has no inclusions (N=1). The ware is wheelmade (N=1).

The surface has been smoothed, and sometimes a white slip is applied. The ware is painted with a blue paint, and glazed with a clear glaze.

Fabric Codes: BL/W.w.3.1.1.1.N.g

Forms: The forms of this ware are bases (N=1).

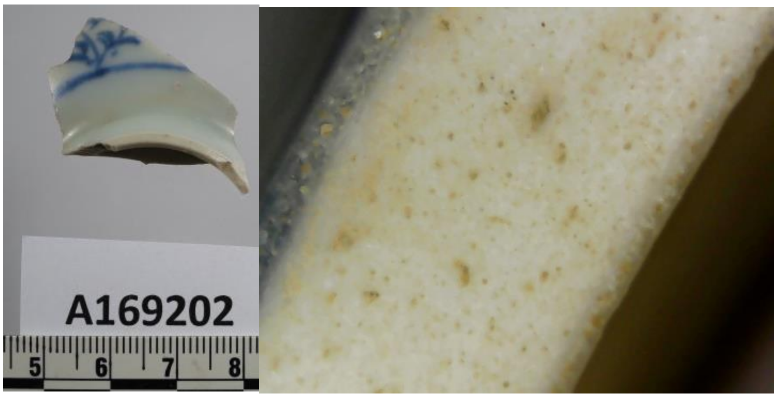
Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
8A7b								1					1
Total	0	0	0	0	0	0	0	1	0	0	0	0	1

Links with other wares: Priestman 2005: CBW.1-45

Parallels and Dating: The height of the export/import was during the Song and Yuan Dynasties (960 – 1368) (Kessler 2012). This ware is very common in terms of motif and form, and as such a date is hard to attribute. It could be anywhere from the 11th-19th century.

Photographs: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Appendix 3: Form Appendix

Bases

- 101 Flat Base Straight Sides
- 102 Flat Base Everted Sides
- 104 Protruded Concave Base
- 105 Protruded Cut Base
- 106 Protruded Wedged Base
- 108 Protruded Incised Base
- 109 Short Ring Base
- 110 Tall Ring Base
- 111 Edge Ring Base
- 112 Dimple Ring Base
- 113 Globular Base

Trays

- 201 Vertical Tray with Straight Rim
- 203 Short Tray with Triangular Rim

Shallow Bowl

- 301 Shallow Curved Bowl with Rounded Rim
- 302 Shallow Straight Bowl with Straight Rim
- 303 Shallow Curved Bowl with Tapered Rim
- 304 Shallow Curved Bowl with Dimple Rim
- 305 Shallow Curved Bowl with Squared Rim
- 306 Shallow Curved Bowl with Ledged Rim

Deep Bowl

- 307 Deep Curved Bowl with Tapered Rim
- 308 Deep Curved Bowl with Vertical Squared Rim
- 310 Deep Curved Bowl with Beveled Rim
- 312 Deep Straight Bowl with Rounded Rim
- 313 Deep Straight Bowl with Diamond Rim
- 314 Deep Straight Bowl with Tapered Rim
- 315 Deep Straight Bowl with Squared Rim
- 316 Deep Straight Bowl with Squared Rim and Handle
- 319 Deep Curved Bowl with Vertical Rim
- 320 Deep Curved Bowl with Vertical Incised Rim
- 322 Deep Straight Bowl with Folded Rim
- 324 Deep Curved Bowl with Short Ledged Rim
- 325 Deep Curved Bowl with Long Ledged Rim
- 326 Deep Curved Bowl with Everted Squared Rim
- 327 Deep Curved Bowl with Everted Triangular Rim
- 328 Deep Curved Bowl with Squared Rim
- 329 Deep Curved Bowl with Squared Incised Rim
- 330 Deep Curved Bowl with Diamond Rim
- 332 Deep Vertical Bowl with Diamond Rim
- 333 Deep Vertical Bowl with Everted Rounded Rim
- 334 Deep Low Carinated Bowl with Straight Rim
- 335 Deep Low Carinated Curved Bowl with Straight Rim
- 336 Deep Low Carinated Bowl with Long Straight Rim
- 337 Deep Low Carinated Bowl with Rounded Rim
- 338 Deep Middle Carinated Bowl with Hammer Head Rim
- 339 Deep Middle Carinated Bowl with Ledged Rim
- 340 Deep Middle Carinated Bowl with Everted Hammer Head Rim
- 342 Deep High Carinated Bowl with Everted Triangular Rim

Beaker

- 343 Globular Beaker with Straight Rim

Basin
- 344 Vertical Basin with Straight Rim
- 345 Vertical Basin with Dimpled Rim
- 346 Vertical Basin with Squared Rim

No Neck Jar
- 401 No Neck Jar with Straight Rim and Handle
- 402 No Neck Jar with Everted Squared Rim
- 404 No Neck Jar with Everted Ledged Rim
- 407 No Neck Jar with Rounded Rim
- 408 No Neck Jar with Everted Triangular Rim

Short Neck Jar
- 409 Short Neck Jar with Everted Rounded Rim
- 411 Short Neck Jar with Squared Carination and Straight Rim
- 415 Short Neck Jar with Triangular Rim and Handle
- 416 Short Neck Globular Jar with Everted Rounded Rim and Handle
- 417 Short Neck Globular Jar with Everted Rounded Rim
- 421 Short Neck Jar with Vertical Rounded Rim
- 422 Short Neck Jar with Everted Squared Rim
- 423 Short Neck Jar with Everted Prominent Rounded Rim
- 424 Short Neck Jar with Everted Diamond Rim
- 425 Short Neck Jar with Triangular Rim
- 428 Short Neck Jar with Dimpled Rim

Long Neck Jars
- 430 Long Straight Neck Jar with Everted Squared Rim
- 431 Long Neck Jar with Straight Squared Rim
- 432 Long Neck Jar with Straight Sharp Everted Rounded Rim
- 433 Long Straight Neck Jar with Everted Rounded Rim
- 434 Long Straight Neck Jar with Everted Triangular Rim
- 435 Long Straight Neck Jar with Everted Squared Rim
- 436 Long Straight Neck Jar with Squared Rim
- 437 Long Straight Neck Jar with Rounded Rim and Carination
- 438 Long Straight Neck Jar with Everted Folded Rim
- 440 Long Straight Neck Jar with Incurved Folded Rim
- 441 Long Straight Neck Jar with Folded Rim
- 442 Long Straight Neck Jar with Complex Rim
- 443 Long Curved Neck Jar with Rounded Rim
- 444 Long Straight Neck Jar with Rounded Rim
- 445 Long Everted Neck Jar with Rounded Rim
- 447 Long Straight Neck Jar with Rounded Rim and Ledge
- 448 Long Straight Neck Jar with Triangular Rim
- 449 Long Straight Neck Jar with Rounded Rim and Handle

Holemouth Jar
- 453 Holemouth Jar with Folded Rim
- 455 Holemouth Jar with Everted Rounded Rim
- 456 Holemouth Jar with Rolled Grooved Rim
- 458 Holemouth Jar with Triangular Rim
- 459 Holemouth Jar with Complex Rim

Other Vessels
- 501 Spheroconical Vessels
- 503 Nargileh
- 504 Lamp
- 505 Pilgrim Flask
- 507 Lid
- Handle
- Spout

Bases (101-113)

Description: Bases are the bottom portion of vessels. Two main types of bases, flat and ringed are present in this sample. These have been further subdivided based on the angle of the sides, shape of the base, and height of the ring. They have a minimum diameter of 4cm, an average diameter of 9.25cm, and a maximum diameter of 38cm. The majority of bases are under 12cm. However, no bases have been determined to have a chronological significance.

Form Codes: 101 Flat Base Straight Sides; 102 Flat Base Everted Sides; 104 Protruded Concave Base; 105 Protruded Cut Base; 106 Protruded Wedged Base; 108 Protruded Incised Base; 109 Short Ring Base; 110 Tall Ring Base; 111 Edge Ring Base; 112 Dimple Ring Base; 113 Globular Base

Fabrics: This ware has fine (n=177), coarse (N=22), vegetal (N=20), stonepaste (N=2), and porcelain (N=2) fabrics. These are slipped (N=5), burnished (N=6), smoothed (N=135), single incised (N=1), comb incised (N=3), monochrome glazed (N=44), polychrome glazed (N=4), sgraffiato glazed (N=11), black and blue glazed (N=2), blue on white glazed (N=4), Sultanabad glazed (N=5), celadon glazed (N=1), opaque glazed (N=1) and Opaque Splash Glazed (N=1).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
101	10	5	3	5	3	5	2					3	36
102	4	2		3			1		1			1	12
103	1												1
104	3						1			2	1	3	10
105	28	10	3	8		4		1		5		5	64
106	1			1				1				1	4
108										2			2
109	22	15	6	1	5		4	6		4			63
110	2	2						5				3	12
111	4		1	1		1				2			9
112	4	1		3		1							9
113	1												1
Total	80	35	13	22	8	11	8	13	1	15	1	16	223

Parallels and Dating: No exact date has been established for this material.

Plates: 1: 1-35, 2:1-20

Trays (201-203)

Description: Trays have a flat base and short sides. The bases were too small (less than 20% of the rim remaining) to measure diameter, or the bases were not round. These trays are all handmade.

Form Codes: 201 Vertical Tray with Straight Rim, 203 Short Tray with Triangular Rim

Fabrics: This ware has coarse (N=1), vegetal (N=4), fabrics. These are smoothed (N=4), single incised (N=1).
Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
201		2	1	1									4
203												1	1
Total	0	2	1	1	0	0	0	0	0	0	0	1	5

Parallels and Dating: No exact date has been established for this material.

Plates: 2:21-24

Shallow Bowl (301-306)

Description: Shallow bowls are open forms that have an angle of less than 20 degrees. The rims range from a minimum of 11cm to 36cm with an average of 21cm. Two types of bowls are present, those with curved sides and those with straight sides. Various rims are present, but none of the sides or rims have a chronological difference based on shape. These vessels are handmade (N=2) and wheelmade (N=14).

Form Codes: 301 Shallow Curved Bowl with Rounded Rim; 302 Shallow Straight Bowl with Straight Rim. 303 Shallow Curved Bowl with Tapered Rim; 304 Shallow Curved Bowl with Dimple Rim; 305 Shallow Curved Bowl with Squared Rim; 306 Shallow Curved Bowl with Ledged Rim

Fabrics: This ware has fine (N=8), vegetal (N=7), and stonepaste (N=1) fabrics. These are smoothed (N=9), stamped (N=1), monochrome glazed (N=1), sgraffiato glazed (N=3), and blue on white glazed (N=1).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
301	1			1									2
302		2		1									3
303	1									1		1	3
304	3		1										4
305			1										1
306	1	1	1										3
Total	6	3	3	2	0	0	0	0	0	1	0	1	16

Parallels and Dating: No exact date has been established for this material.

Plates: 2:25-38

Deep Bowl (307-342)

Description: Deep bowls are open forms that have an angle of more than 20 degrees. Two main types are present, curved sides and straight sides. Various rim types are present ranging from incurved rims to everted rims in a variety of shapes. The minimum diameter is 6cm, the maximum is 53, with an average diameter of 25cm. A few pieces may have a chronological marker, namely the carinated bowls with hammer head rims and carinated bowls with ledged rims. These forms, especially when made in stonepaste date to the 12^{th} – 14^{th} centuries (Danti 2004; Matson 1997a; 1997b; 1997c; 1997d). These bowls are handmade (N=24), coilmade (N=5), moulded (N=2), and wheelmade (N=77).

Form Codes: 307 Deep Curved Bowl with Tapered Rim; 308 Deep Curved Bowl with Vertical Squared Rim; 310 Deep Curved Bowl with Beveled Rim; 312 Deep Straight Bowl with Rounded Rim; 313 Deep Straight Bowl with Diamond Rim; 314 Deep Straight Bowl with Tapered Rim; 315 Deep Straight Bowl with Squared Rim; 316 Deep Straight Bowl with Squared Rim and Handle; 319 Deep Curved Bowl with Vertical Rim; 320 Deep Curved Bowl with Vertical Incised Rim; 322 Deep Straight Bowl with Folded Rim; 324 Deep Curved Bowl with Short Ledged Rim; 325 Deep Curved Bowl with Long Ledged Rim; 326 Deep Curved Bowl with Everted Squared Rim; 327 Deep Curved Bowl with Everted Triangular Rim; 328 Deep Curved Bowl with Squared Rim; 329 Deep Curved Bowl with Squared Incised Rim; 330 Deep Curved Bowl with Diamond Rim; 332 Deep Vertical Bowl with Diamond Rim; 333 Deep Vertical Bowl with Everted Rounded Rim; 334 Deep Low Carinated Bowl with Straight Rim; 335 Deep Low Carinated Curved Bowl with Straight Rim; 336 Deep Low Carinated Bowl with Long Straight Rim; 337 Deep Low Carinated Bowl with Rounded Rim; 338 Deep Middle Carinated Bowl with Hammer Head Rim; 339 Deep Middle Carinated Bowl with Ledged Rim; 340 Deep Middle Carinated Bowl with Everted Hammer Head Rim; 342 Deep High Carinated Bowl with Everted Triangular Rim

Fabrics: This ware has fine (N=60), coarse (N=20), vegetal (N=19), and stonepaste (N=9) fabrics. These are burnished (N=1), smoothed (N=34), single incised (N=9), comb incised (N=5), grooved (N=1), painted (N=1), monochrome glazed (N=18), polychrome glazed (N=1), sgraffiato glazed (N=14), black and blue glazed (N=6), blue on white glazed (N=3), lustre glazed (N=1), sultanabad glazed (N=5), lajvardina glazed (N=1), celadon glazed (N=1), opaque splash glazed (N=1), brown on white glazed (N=2), and rope appliqué (N=4).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
307	1					1		3		5	1		11
308						1							1
309	1												1
310						1							1
312	6	4	1		1			1	1				14
313												1	1
314	4							5		4		3	16
315		3						2					5
316		1											1
319	3												3
320						1		1					2
322								4					4
324			1					3					4
325										1			1
326								2		1		2	5
327			1					4				3	8
328	1											1	2
329								1					1
330		2						1				3	6
332												2	2
333			1									1	2
334								1		1			2
335				2									2
336		1								1			2
337	1									1			2
338								1	3				4
339									1				1
340												1	1
341	1												1
342			1										1
Total	18	11	5	2	1	4	0	29	5	14	1	17	107

Parallels and Dating: No exact date has been established for this material.

Plates: 2:39-47, 3:1-33, 4:1-28, 5:1-17, 6:1-17

Basin (344-346)

Description: These forms are open vessels with flat bases and straight sides. Various rim shapes are present. They range in size from 24cm to 42cm, however, much like trays, some of these are not round, and establishing a diameter is difficult. These forms are handmade (N=9), coilmade (N=2) and wheelmade (N=6).

Form Codes: 344 Vertical Basin with Straight Rim; 345 Vertical Basin with Dimpled Rim; 346 Vertical Basin with Squared Rim

Fabrics: This ware has fine (n=2), coarse (N=3), and vegetal (N=12 fabrics. These are smoothed (N=10), single incised (N=1), comb incised (N=1), grooved (N=1), and rope appliqué (N=2).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
344	2	2		2	2								8
345	3	1											4
346	1											2	3
350		2											2
Total	6	5	0	2	2	0	0	0	0	0	0	2	17

Parallels and Dating: No exact date has been established for this material.

Plates: 6:19-32

No Neck Jar (401-408)

Description: No neck jars are closed forms that have little to no necks. These have various types of rims from vertical ones to everted ones. Diameters range from 18cm at minimum to a max of 48cm with an average of 28cm. These jars are handmade (N=1), coilmade (N=2), and wheelmade (N=13). None of these forms are chronologically significant.

Form Codes: 401 No Neck Jar with Straight Rim and Handle; 402 No Neck Jar with Everted Squared Rim; 404 No Neck Jar with Everted Ledged Rim; 407 No Neck Jar with Rounded Rim; 408 No Neck Jar with Everted Triangular Rim

Fabrics: This ware has fine (N=7), coarse (N=4), and vegetal (N=2) fabrics. These are slipped (N=2), burnished (N=1), smoothed (N=6), single incised (N=1), painted (N=1), and rope incised (N=2).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
401		1						1					2
402												2	2
404	1			1								2	4
407	1	1										1	3
408					1							1	2
Total	2	2	0	1	1	0	0	1	0	0	0	6	13

Parallels and Dating: No exact date has been established for this material.

Plates: 7:1-13

Short Neck Jar (409-428)

Description: Short neck jars are a closed form that has a neck ranging from 1-5cm in height. The necks themselves can be straight or everted, and rims can also then be straight or everted. Rim forms vary. The diameters range from a minimum of 10cm to a maximum of 25cm with an average of 17cm. These vessels are handmade (N=6), coilmade (N=2), and wheelmade (N=14). None of these are chronologically significant.

Form Codes: 409 Short Neck Jar with Everted Rounded Rim; 411 Short Neck Jar with Squared Carination and Straight Rim; 415 Short Neck Jar with Triangular Rim and Handle; 416 Short Neck Globular Jar with Everted Rounded Rim and Handle; 417 Short Neck Globular Jar with Everted Rounded Rim; 421 Short Neck Jar with Vertical Rounded Rim; 422 Short Neck Jar with Everted Squared Rim; 423 Short Neck Jar with Everted Prominent Rounded Rim; 424 Short Neck Jar with Everted Diamond Rim; 425 Short Neck Jar with Triangular Rim; 428 Short Neck Jar with Dimpled Rim

Fabrics: This ware has fine (N=5), coarse (N=9), and vegetal (N=8). These are slipped (N=2), smoothed (N=9), single incised (N=1), comb incised (N=1), stamped (N=3), monochrome glazed (N=1), and rope appliqué (N=3).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
409								2					2
411	1												1
415										1			1
416		1						2					3
417	1									1			2
421												3	3
422												1	1
423								1				4	5
424												1	1
425												1	1
428	2												2
Total	4	1	0	0	0	0	0	5	0	2	0	10	22

Parallels and Dating: No exact date has been established for this material.

Plates: 7:14-26, 8:1-8

Long Neck Jars (430-449)

Description: Long neck jars are closed forms with necks longer than 5cm tall. These can be straight/vertical or everted. The rims are of various shapes, and are incurved, straight, and everted. The diameters range from a minimum of 4cm to a maximum of 27cm with an average of 11cm. These vessels are handmade (N=10), coilmade (N=9), and wheelthrown (N=57). None of these forms are chronologically significant.

Form Codes: 430 Long Straight Neck Jar with Everted Squared Rim; 431 Long Neck Jar with Straight Squared Rim; 432 Long Neck Jar with Straight Sharp Everted Rounded Rim; 433 Long Straight Neck Jar with Everted Rounded Rim; 434 Long Straight Neck Jar with Everted Triangular Rim; 435 Long Straight Neck Jar with Everted Squared Rim; 436 Long Straight Neck Jar with Squared Rim; 437 Long Straight Neck Jar with Rounded Rim and Carination; 438 Long Straight Neck Jar with Everted Folded Rim; 440 Long Straight Neck Jar with Incurved Folded Rim; 441 Long Straight Neck Jar with Folded Rim; 442 Long Straight Neck Jar with Complex Rim; 443 Long Curved Neck Jar with Rounded Rim; 444 Long Straight Neck Jar with Rounded Rim; 445 Long Everted Neck Jar with Rounded Rim; 447 Long Straight Neck Jar with Rounded Rim and Ledge; 448 Long Straight Neck Jar with Triangular Rim; 449 Long Straight Neck Jar with Rounded Rim and Handle

Fabrics: This ware has fine (N=61), coarse (N=12), and vegetal (N=4). These are burnished (N=2), smoothed (N=54), single incised (N=2), comb incised (N=3), comb incised/impressed (N=1), stamped (N=2), grooved (N=1), inlaid (N=2), monochrome glazed (N=5), sgraffiato glazed (N=1), rope appliqué (N=2), and barbitone appliqué (N=2

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
430												1	1
431	1	1											2
432										2			2
433	2							2					4
434	8											2	10
435										1			1
436									1	1		2	4
437												1	1
438		1							1				2
440	2		1	2						1			6
441	4	2	3	2									11
442	1							1					2
443	1				1			1					3
444	3	1						1					5
445					1			1		1			3
447	3		1	1									5
448	5					1							6
449	2	1						4	1	1			9
Total	32	6	5	5	2	1	0	10	3	7	0	6	77

Parallels and Dating: No exact date has been established for this material.

Plates: 8:9-37, 9:1-43

Holemouth Jar (453-459)

Description: Holemouth jars are a closed vessel with no neck and an incurved rim. The rims vary in shape, and diameters range from a minimum of 8cm to a maximum of 51cm with an average of 25cm. These vessels are handmade (N=6) and wheelmade (N=5). None of these forms are chronologically significant.

Form Codes: 453 Holemouth Jar with Folded Rim; 455 Holemouth Jar with Everted Rounded Rim; 456 Holemouth Jar with Rolled Grooved Rim; 458 Holemouth Jar with Triangular Rim; 459 Holemouth Jar with Complex Rim

Fabrics: This ware has fine (N=2), coarse (N=5), and vegetal (N=4) fabrics. These are smoothed (N=4), single incised (N=4), comb incised (N=1), monochrome glazed (N=1), and sgraffiato glazed (N=1).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
453	1							1					2
455	1							1		1			3
456								1					1
458								1				3	4
459												1	1
Total	2	0	0	0	0	0	0	4	0	1	0	4	11

Parallels and Dating: No exact date has been established for this material.

Plates: 9:44-49, 10:1-5

Spheroconical Vessels (501)

Description: Spheroconical vessels have roughly the same shape with a rounded/ovoid body, thick walls (ca. 1 cm thick), and a narrow/restricted neck. These were left undecorated, decorated with incised motifs, names, or parts of poems, stamped with roundels, moulded with raised bumps, glazed, or have a combination of decorations. These vessels have been found from Egypt to Afghanistan, from Russia to southern Africa all dating from the 10th – 14th centuries. There has been much debate over the function of these vessels, due to the sporadic publication of the vessels, the publishing of the archaeological reports in various languages (English, French, German, Russian, Arabic, and Persian), and various connotations drawn from art historical, archaeological, and textual sources. These vessels have been attributed to hand grenades (Sauvaget 1949; Lenz 1912; Post 1929; Pradines 2017; Seyrig 1959), mercury transport (Dzhanpoladian 1958; Vysotskii 1908), perfume transport (Schlumberger 1986; Barnard et al. 2016), fire starters (Hildburgh 1951; Whitcomb 2016) and containers for carbonated drinks (Arman et al. 2020; Ghouchani and Adle 1992). Due to these various lines of evidence, I believe these vessels were used for the transport or storage of various liquids, either for drinking, medicine, or perfumes. Savage-Smith (1997) has created an extensive typology with ten categories of sphero-conical vessels, seven of which are clay based, the remainder are glass, each linked with possible functions. More than likely these vessels had various uses, or as Savage-Smith shows, the function varied by the form and manufacture of the vessel.

Form Codes: 501 Spheroconical Vessel

Fabrics: This ware has fine (N=6) fabrics. These are moulded (N=6).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
501								1		4		1	6
Total	0	0	0	0	0	0	0	1	0	4	0	1	6

Parallels and Dating: 9th – 14th century

Plates: 10: 6-12

Nargileh (503)

Description: Three pieces fall into this category, which is defined by its use as a vessel for smoking (*hooka, nafas, nargileh, galyan, qalyan)*. This type of nargileh became popular in the Indian subcontinent in the 15th century, where it was used to smoke a variety of items including cannabis, hashish, and opium (Qasim et al 2019). In the 16th century, the Portuguese introduced tobacco to Persia, and these types of water pipes became one of the main ways to consume it. The dates of the first use of this type of vessel are unknown, but they are recorded in 1588 (by Abu'l-Fath Gilani, a Persian physician at the Mughal court; Elgood 1970:41-110) and in 1535 (by Ahli Sirazi in Persia; Semsar 1971).

Form Codes: 503 Nargileh

Fabrics: This ware has coarse (N=3) fabrics. These are smoothed (N=3).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
503	1	2											3
Total	1	2	0	0	0	0	0	0	0	0	0	0	3

Parallels and Dating: 14th-18th century

Plates: 10:13-15

Lamp (504)

Description: Three lamps were identified, based on their forms and presence of burning on the surface (Plate 10:17-18). These lamps do not appear to have spouts, and were probably used to hold the oil, the portion holding the wick is lost (Kublak 1970). One lamp is from Nippur (OI A169215), the other from Hasanlu (UPM 93-4-146).

Form Codes: 504 Lamp

Fabrics: This ware has fine (N=3) fabrics. These are burnished (N=1) and monochrome glazed (N=2), polychrome glazed (N=4), sgraffiato glazed (N=11), black and blue glazed (N=2), blue on white glazed (N=4), Sultanabad glazed (N=5), celadon glazed (N=1), opaque glazed (N=1) and Opaque Splash Glazed (N=1).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
504	1							1	1				3
Total	1	0	0	0	0	0	0	1	1	0	0	0	3

Parallels and Dating: No exact date has been established for this material.

Plates: 10:17-18

Pilgrim Flask (505)

Description: Pilgrim flasks are so named due to their association with Christian pilgrims to the Middle East (Anderson 2004). However, this shape has been found across the world in various forms of media from leather to metal, glass, and ceramics. These objects were created to hold liquids, with their small necks allowing for the stopping of the opening, handles for their ability to be tied to belts or saddles (Watson 2004:122), and their size which allows for individual transport.

Form Codes: 505 Pilgrim Flask

Fabrics: This ware has fine (n=1), and coarse (N=1) fabrics. These are burnished (N=1) and smoothed (N=1).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
505	1								1				2
Total	1	0	0	0	0	0	0	0	1	0	0	0	2

Parallels and Dating: 6th-18th century

Plates: 10:26

Lid (507)

Description: Most lids have a knob in the center of a flat or curved base, but the one from Firuzabad (Plate 10:24) is a larger triangular lid with holes through it. These lids could be used for covering food while cooking to prevent evaporation, or for storage, to keep insects and animals out of what was being stored.

Form Codes: 507 Lid

Fabrics: This ware has fine (n=6), coarse (N=1), and vegetal (N=1) fabrics. These are smoothed (N=8).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
507	1	3	1					1		1		1	8
Total	1	3	1	0	0	0	0	1	0	1	0	1	8

Parallels and Dating: No exact date has been established for this material.

Plates: 10:19-25

Handle

Description: Handles are made in a variety of ways from making straps that were attached to the vessel to coils that are attached. Most of the forms are not chronologically significant. The few that are chronically dated to the Islamic period (turban handles, thumb stops) are not present in this assemblage.

Form Codes: Handle

Fabrics: This ware has fine (N=93), coarse (N=27), vegetal (N=6), and stonepaste (N=1) fabrics. These are slipped (N=2), burnished (N=1), smoothed (N=110), single incised (N=1), comb incised (N=1), grooved (N=7), monochrome glazed (N=2), and black and blue glazed (N=2).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
Handle	63	18	14	8	2	3	9	3	1	1		5	127
Total	63	18	14	8	2	3	9	3	1	1	0	5	127

Parallels and Dating: No exact date has been established for this material.

Plates:

Spout

Description: Spouts are normally handmade, and it looks like they may be moulded around a central rod to form the center hole. None of these are chronologically significant.

Form Codes: Spout

Fabrics: This ware has fine (n=14), and coarse (N=2) fabrics. These are smoothed (N=15) and monochrome glazed (N=1).

Distribution:

	155	217	276	381	453	519	535	Nippur	Hasanlu	Rayy	Chal Tarkhan	Firuzabad	Total
Spout	7		2	2	1	3		1					16
Total	7	0	2	2	1	3	0	1	0	0	0	0	16

Parallels and Dating: No exact date has been established for this material.

Plates:

Appendix 4: Plates

Plate 1

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	155.1.572.8	Site 155	103	2A7a	Wheelmade	Serving	CO55	8	18.1	9	64.4			
2	155.7.578.27	Site 155	104	2A7c	Wheelmade	Serving	CO55	5	21.9	10.5	59.5			
3	155.3.574.18	Site 155	109	2A7a	Wheelmade	Serving	CO55	7	31.9	12	84.6			
4	155.8.579.19	Site 155	109	3A7a	Wheelmade	Serving	CO55	5	19.2	8.8	56.5			
5	155.4.575.15	Site 155	109	3A7a	Wheelmade	Serving	CO55		20.6	8.6	47.3			
6	155.7.578.47	Site 155	109	3A7c	Wheelmade	Serving	CO55	6	45.9	7.4	62.7			
7	155.10.581.18	Site 155	110	3A7a	Wheelmade	Serving	CO55	6	27.7	9.2	66.3			
8	155.10.581.14	Site 155	110	2A7a	Wheelmade	Serving	CO55		27	8.1	72.5			
9	155.10.581.17	Site 155	111	2A7d	Wheelmade	Serving	CO55	10	23.4	8.2	64.9		12th-13th	Watson 2004: 334-337
10	155.7.578.31	Site 155	111	3A7b	Wheelmade	Serving	CO55	8	22.6	9.8	83.5			
11	155.2.573.31	Site 155	112	2A4	Wheelmade	Serving	CO49		29.1	7.1	50.1			
12	155.3.574.13	Site 155	112	2A4	Wheelmade	Serving	CO49		27.3	5.2	52.7			
13	155.3.574.7	Site 155	301	2C4	Handmade	Food Processing	CO24	11	51.2	17.4	55.9			
14	155.3.574.11	Site 155	303	2A4	Wheelmade	Serving	CO49	16	46.4	12.5	45			
15	155.7.578.19	Site 155	304	3A7c	Wheelmade	Serving	CO55	21	38.9	7.8	66.2			
16	155.7.578.20	Site 155	304	2A7a	Wheelmade	Serving	CO55	36	43.1	9.1	55			
17	155.7.578.17	Site 155	304	3A7c	Wheelmade	Serving	CO55	21	35	9.4	43.9			
18	155.11.582.18	Site 155	306	2A5c	Wheelmade	Serving	CO50		51.8	16.2	51.7			
19	155.4.575.13	Site 155	307	3A7a	Wheelmade	Serving	CO55	13	33.8	8.5	51.4			
20	155.4.575.6	Site 155	309	6B4	Wheelmade	Cooking	CO13	16	45	10.8	67.7			
21	155.7.578.8	Site 155	312	2A4	Wheelmade	Serving	CO35	24	51.7	9.7	53.2			
22	155.9.580.19	Site 155	312	2A4	Coilmade	Serving	CO38	36	42.1	9.6	48.9			

Plate 1

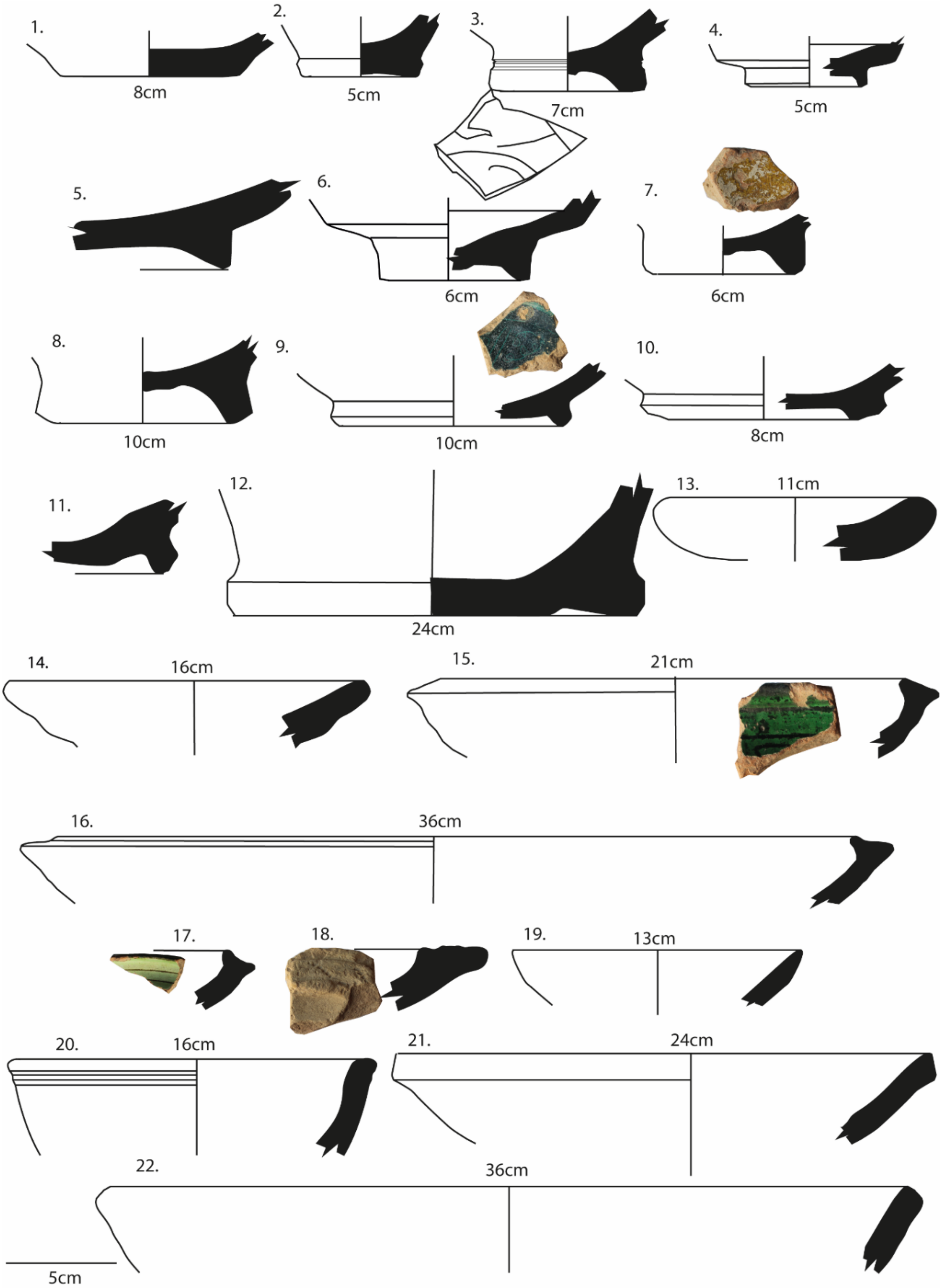

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Plate 2

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	155.8.579.43	Site 155	312	2A5b	Coilmade	Serving	CO39	30	65.5	11.8	64.9			
2	155.10.581.40	Site 155	312	2A5b	Wheelmade	Serving	CO50	26	28.5	8.7	42.3			
3	155.8.579.37	Site 155	312	2A5b	Coilmade	Serving	CO39	22	71.7	16.7	50.9			
4	155.7.578.18	Site 155	312	3A7c	Wheelmade	Serving	CO55		35.1	9.3	45.6			
5	155.9.580.21	Site 155	314	2A5b	Wheelmade	Serving	CO50	20	31.9	7.2	45.2			
6	155.6.577.6	Site 155	314	2B4	Wheelmade	Serving	CO62		28.6	14.2	47.6			
7	155.10.581.38	Site 155	314	2C4	Handmade	Serving	CO66		26.5	9.5	37.8			
8	155.4.575.12	Site 155	314	2A7a	Wheelmade	Serving	CO55	36	35	10.4	51.4			
9	155.2.573.86	Site 155	319	3A7c	Wheelmade	Serving	CO55		44.4	8.5	24.2			
10	155.7.578.16	Site 155	319	3A7a	Wheelmade	Serving	CO55	12	43.4	8.2	41			
11	155.10.581.29	Site 155	319	2A5f	Wheelmade	Serving	CO51		40.9	6.2	44.1			
12	155.3.574.10	Site 155	337	2A7a	Wheelmade	Serving	CO55	16	33.2	8	48.4			
13	155.4.575.38	Site 155	341	2A4	Wheelmade	Serving	CO49		45.3	8.6	85.2			
14	155.10.581.34	Site 155	341	2A2	Wheelmade	Serving	CO45	20	44.4	8.7	72.4			
15	155.9.580.18	Site 155	344	3B5f	Wheelmade	Food Processing	CO23		32.1	10.7	46.2			
16	155.7.578.11	Site 155	344	2C4	Wheelmade	Food Processing	CO29		63.1	7.9	58.3			
17	155.4.575.9	Site 155	344	2A5b	Handmade	Food Processing	CO17	42	81.2	22.4	74			
18	155.11.582.19	Site 155	345	2C5a	Coilmade	Food Processing	CO28		51.1	28.1	65.8			
19	155.4.575.10	Site 155	345	2A5b	Coilmade	Food Processing	CO18		58.6	19.6	94.2			
20	155.4.575.8	Site 155	345	2A5b	Handmade	Food Processing	CO17		69.3	25.8	59.6			

Plate 2

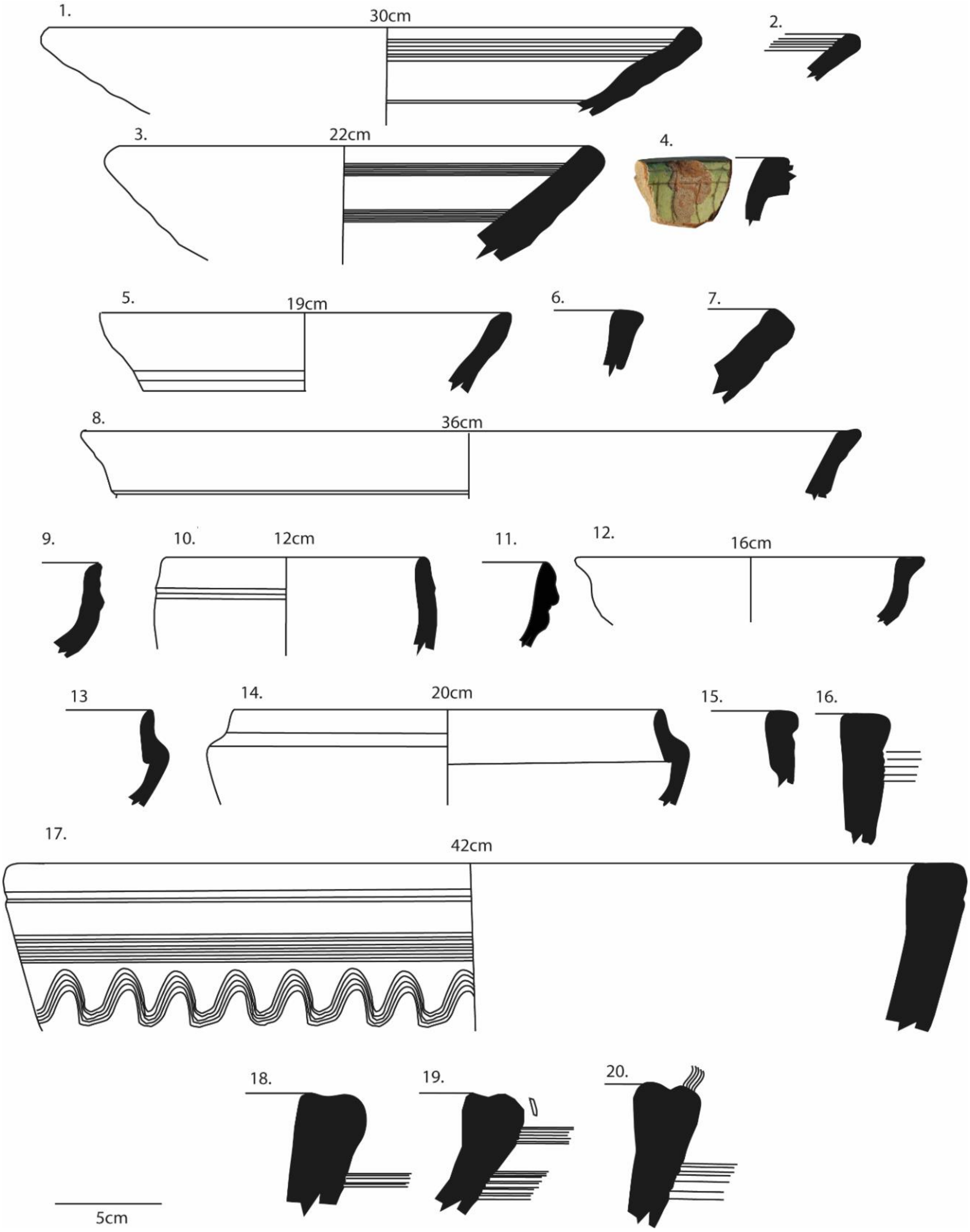

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Plate 3

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	155.10.581.35	Site 155	346	3C4	Handmade	Food Processing	CO24	24	96.4	26.6	85.3			
2	155.2.573.19	Site 155	404	2A4	Wheelmade	Dry Storage	CO91		28.5	7.2	41.1			
3	155.10.581.39	Site 155	407	3B3	Wheelmade	Dry Storage	CO109		26.9	10.8	40.6			
4	155.9.580.22	Site 155	428	2A4	Wheelmade	Liquid Storage	CO91	20	53.3	13.9	95.3			
5	155.9.580.15	Site 155	428	3B4	Wheelmade	Liquid Storage	CO113	12	38.2	7.3	62.9		11th-14th	Tonghini 1998: 19k; 19l, 25k
6	155.10.581.33	Site 155	431	2C5a	Coilmade	Liquid Storage	CO126		52.3	13.7	64			
7	155.9.580.20	Site 155	433	3B4	Wheelmade	Liquid Storage	CO113		58.5	9.7	69.8			
8	155.2.573.22	Site 155	433	6B3	Wheelmade	Liquid Storage	CO10	22	21.2	9.3	64.5			
9	155.10.581.32	Site 155	434	2A10a	Wheelmade	Liquid Storage	CO91		30.8	8.1	38.7			
10	155.5.576.14	Site 155	434	2A4	Wheelmade	Liquid Storage	CO91		36.1	9.1	34.1		11th-14th	Tonghini 1998: 39d
11	155.6.577.5	Site 155	434	2A4	Wheelmade	Liquid Storage	CO91	9	47.5	8.4	50.6			
12	155.2.573.21	Site 155	434	2A4	Wheelmade	Liquid Storage	CO91	18	49.3	15.4	63.8			
13	155.2.573.17	Site 155	434	2A4	Wheelmade	Liquid Storage	CO91	17	51.1	8.9	85.2			
14	155.3.574.6	Site 155	434	2A4	Wheelmade	Liquid Storage	CO91	11	59.1	7.7	66.9			
15	155.7.578.12	Site 155	434	2A5b	Coilmade	Liquid Storage	CO78		65.3	20.6	69.8			
16	155.10.581.41	Site 155	434	2B10a	Coilmade	Liquid Storage	CO107	27	57.9	14.8	66			
17	155.8.579.26	Site 155	440	2A4	Wheelmade	Liquid Storage	CO91	11	22.4	10.4	51			
18	155.4.575.11	Site 155	440	2A5a	Handmade	Liquid Storage	CO72	8	82.1	19.2	92.1			
19	155.10.581.37	Site 155	441	2A3	Wheelmade	Liquid Storage	CO86	10	34	9.3	48.6			
20	155.7.578.15	Site 155	441	2A4	Wheelmade	Liquid Storage	CO91	10	33.6	9.7	48			
21	155.9.580.14	Site 155	441	2A4	Wheelmade	Liquid Storage	CO91	8	36.6	7.3	45.6			
22	155.8.579.6	Site 155	441	3A4	Wheelmade	Liquid Storage	CO91		48.4	9.1	43.7			
23	155.4.575.7	Site 155	442	2A4	Wheelmade	Liquid Storage	CO91	11	38	8.5	48.5			

Plate 3

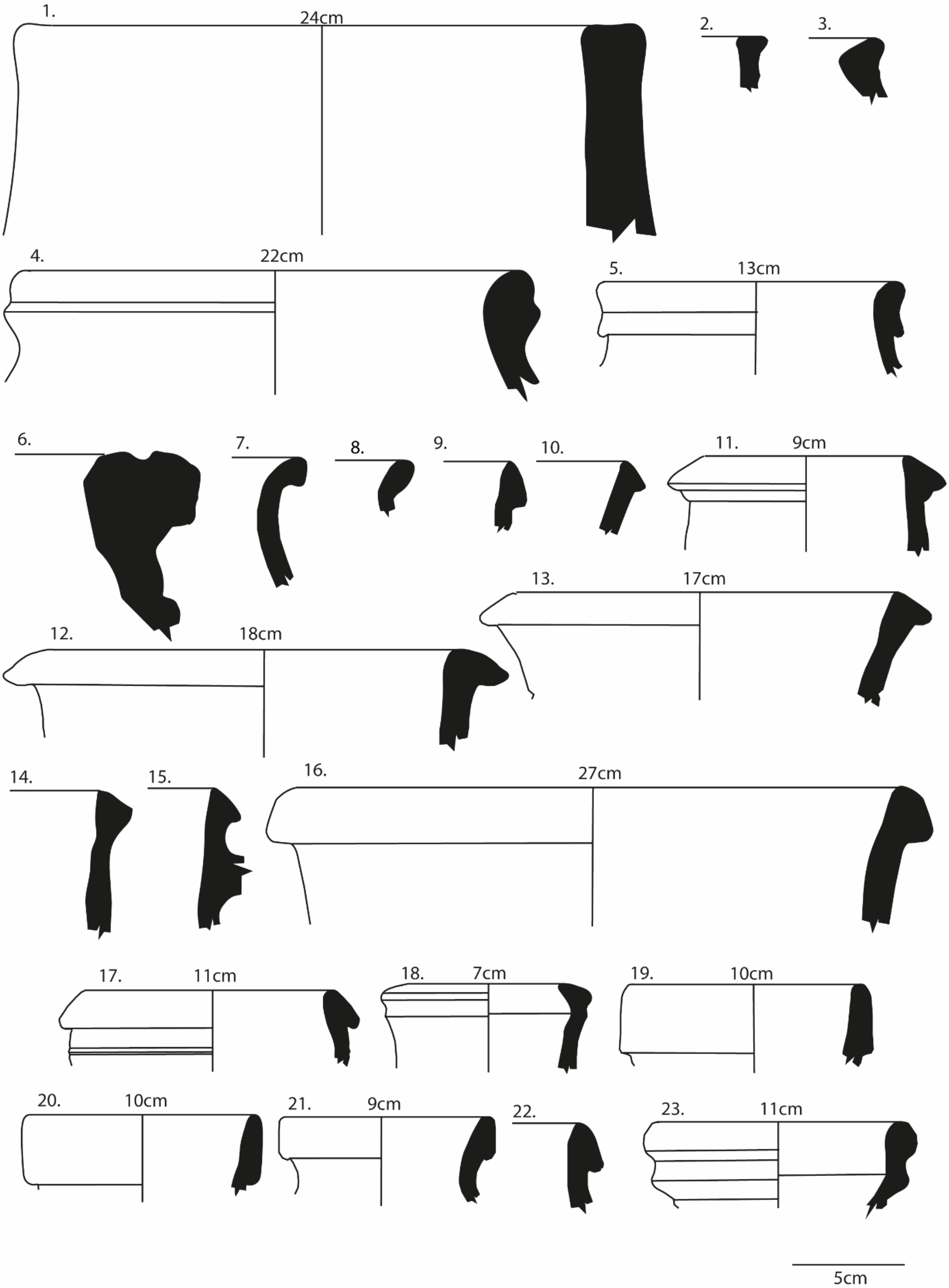

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Plate 4

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	155.5.576.9	Site 155	443	3A4	Wheelmade	Liquid Storage	CO91	4	34.7	6.6	37.1			
2	155.9.580.17	Site 155	444	2A4	Handmade	Liquid Storage	CO71	9	37.6	10.5	48.9			
3	155.8.579.16	Site 155	444	2A5f	Wheelmade	Liquid Storage	CO96	6	22.6	4.2	32.7			
4	155.3.574.12	Site 155	444	3A7a	Wheelmade	Liquid Storage	CO99		35.9	7.9	35.8			
5	155.8.579.38	Site 155	447	2A4	Wheelmade	Liquid Storage	CO91	9	25.9	13.5	45.8		11th-14th	Tonghini 1998: Fig 19d
6	155.2.573.38	Site 155	447	2A4	Wheelmade	Liquid Storage	CO91	13	40.9	8.8	63.3		11th-14th	Tonghini 1998: Fig 19d
7	155.3.574.9	Site 155	447	2A4	Wheelmade	Liquid Storage	CO91	12	33.3	7.5	36.3		11th-14th	Tonghini 1998: Fig 19d
8	155.11.582.23	Site 155	448	2A10a	Wheelmade	Liquid Storage	CO100		30.1	8.9	30.6			
9	155.4.575.5	Site 155	448	2A4	Wheelmade	Liquid Storage	CO91	14	26.1	6.2	67.5			
10	155.4.575.39	Site 155	448	3A7a	Wheelmade	Liquid Storage	CO99		37.5	9	52.8			
11	155.11.582.20	Site 155	448	2A4	Wheelmade	Liquid Storage	CO91	13	52.5	11	32.4			
12	155.2.573.18	Site 155	448	3A7a	Wheelmade	Liquid Storage	CO99	17	36.6	10.3	41.6			
13	155.7.578.13	Site 155	449	2A10b	Wheelmade	Liquid Storage	CO100	19	86.5	12.9	37.4			
14	155.4.575.3	Site 155	449	2A4	Handmade	Liquid Storage	CO71	6	29.4	5.4	40.8			
15	155.10.581.31	Site 155	453	2A4	Wheelmade	Storage	CO91	15	35.8	14.1	58.1			
16	155.3.574.8	Site 155	455	3C4	Handmade	Storage	CO121		32.1	10.3	49.9			
17	155.3.574.15	Site 155	503	2B4	Wheelmade	Other	CO138	4	30.6	4.9	68.7			
18	155.7.578.48	Site 155	504	2A7a	Wheelmade	Other	CO142	3	39.6	6.2	71.3			
19	155.9.580.36	Site 155	505	2A4	Wheelmade	Liquid Storage	CO91		50.4	6.7	37.8		10th-15th	Watson 2004: 122
20	155.9.580.7	Site 155	507	2A4	Wheelmade	Other	CO144	4	33.4	10.2	44.7		10th-12th	Wilkinson 1973: no. 47
21	155.2.573.1	Site 155	Spout	2A4	Handmade	Other	CO154		96.2	12.5	36.7			
22	155.8.579.24	Site 155	Handle	2A10b	Handmade	Storage	CO73		134.9	28.6	60.6			
23	155.4.575.26	Site 155		2A10a	Coilmade	Storage	CO83		51.8	21.2	50.5			
24	155.8.579.9	Site 155		2A10a	Wheelmade	Storage	CO100		60.4	19.9	83.5			
25	155.7.578.40	Site 155		2A10b	Wheelmade	Liquid Storage	CO100		75.4	16.6	75.1			

Plate 4

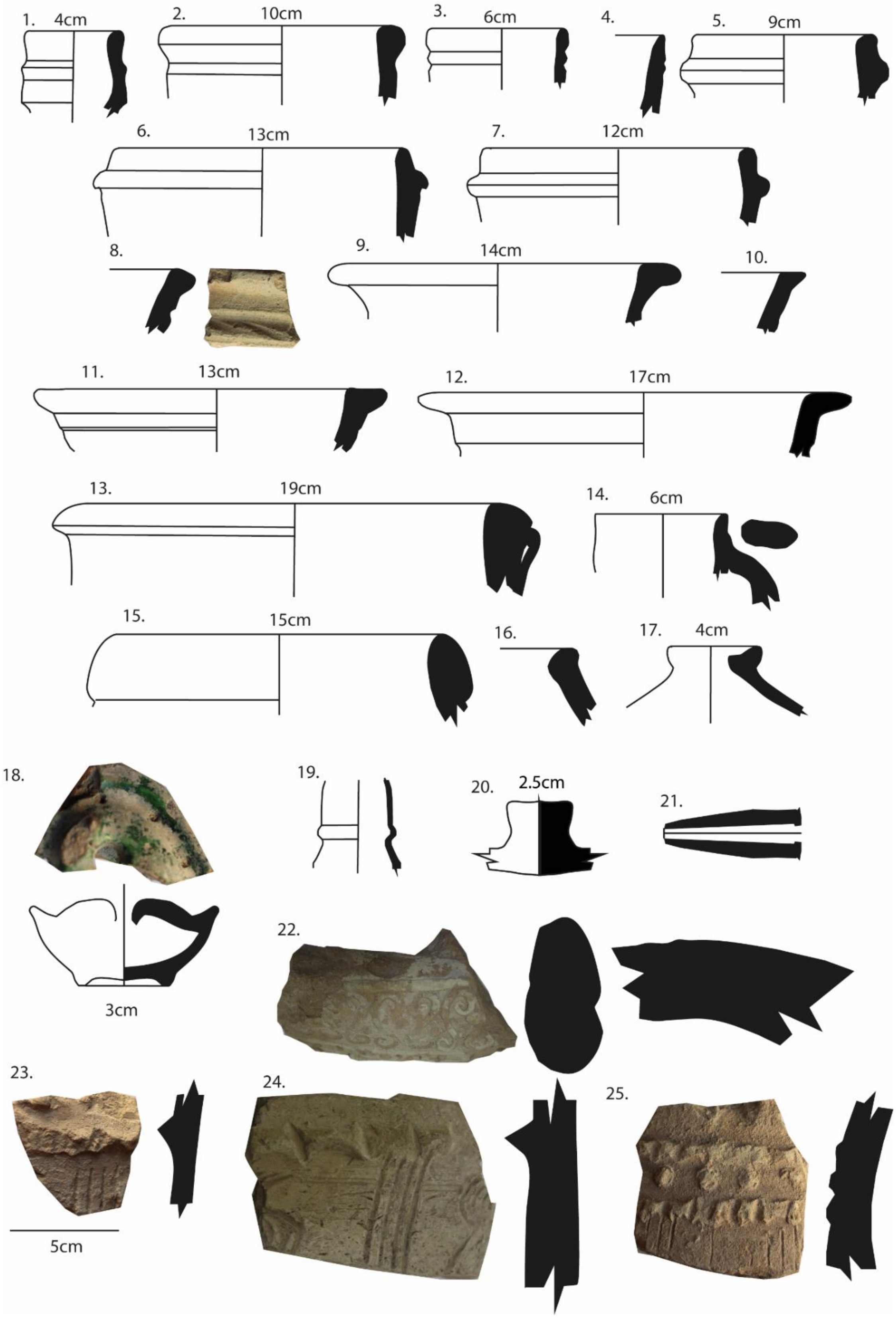

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Plate 5

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	155.9.580.23	Site 155		2C10a	Handmade	Dry Storage	CO124		61.2	30	69.6			
2	155.2.573.67	Site 155		2A10b	Wheelmade	Storage	CO100		44.7	8.3	27.8			
3	155.8.579.20	Site 155		2A10b	Wheelmade	Liquid Storage	CO100		74.2	14.1	76.9	CA200238		
4	155.8.579.32	Site 155		2A10b	Wheelmade	Liquid Storage	CO100		50.7	14.8	52.6			
5	155.10.581.27	Site 155		2C10b	Coilmade	Liquid Storage	CO129		53.4	97.7	18.4			
6	155.3.574.24	Site 155		2A5a	Coilmade	Storage	CO78		40.3	13.7	55.8			
7	155.4.575.33	Site 155		2A5a	Coilmade	Storage	CO78		67.8	14.5	42.4			
8	155.2.573.61	Site 155		2A5a	Coilmade	Storage	CO78		67.3	14.7	68.9			
9	155.1.572.15	Site 155		2A5b	Coilmade	Storage	CO78		70.7	12.4	59.2			
10	155.11.582.30	Site 155		2A5b	Coilmade	Storage	CO78		97.3	23.9	92.7			
11	155.2.573.57	Site 155		2A5b	Coilmade	Storage	CO78		58.9	13.7	59.7			
12	155.8.579.15	Site 155		2A5b	Coilmade	Storage	CO78		69.4	18.1	67.1			
13	155.8.579.27	Site 155		2A5b	Coilmade	Storage	CO78		71.5	10.5	65.7			
14	155.10.581.21	Site 155		2B5b	Coilmade	Storage	CO104		70.4	19.4	66.3			
15	155.4.575.27	Site 155		3A5b	Coilmade	Storage	CO78		43.1	10.4	50.5			
16	155.8.579.35	Site 155		3B5b	Coilmade	Storage	CO104		54.1	14	50.9	CA200240		

Plate 5

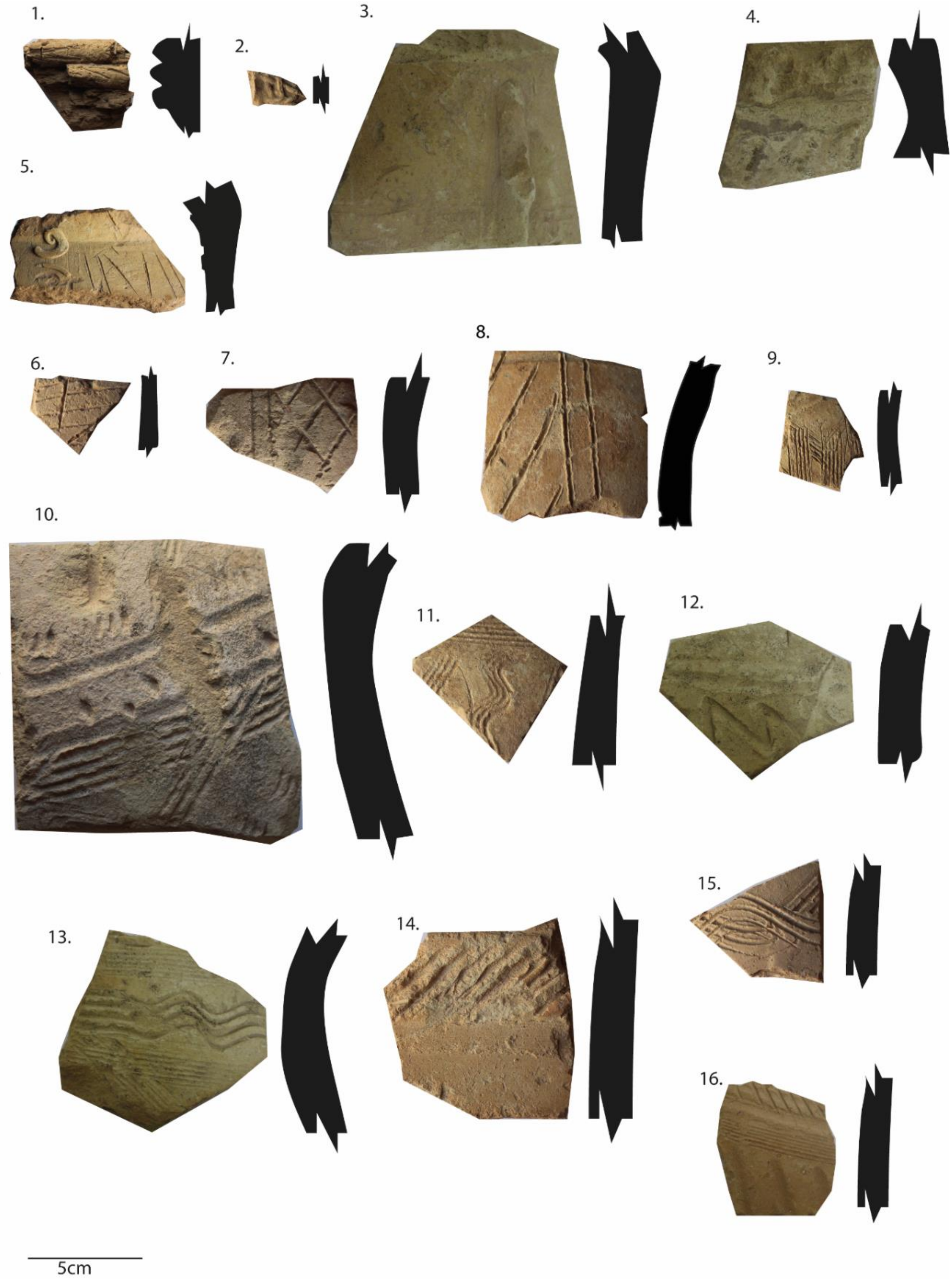

Plate 6

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	155.3.574.23	Site 155		2A5c	Coilmade	Storage	CO78		42.6	14.1	43			
2	155.4.575.34	Site 155		2A5c	Coilmade	Storage	CO78		77.5	21.3	77.9			
3	155.9.580.31	Site 155		2A5c	Wheelmade	Storage	CO95		52.1	7.4	49.6			
4	155.2.573.71	Site 155		2A5e	Wheelmade	Storage	CO97		30.7	13.6	54.8			
5	155.8.579.17	Site 155		2A5e	Wheelmade	Storage	CO97		35.7	13.9	44.2			
6	155.10.581.26	Site 155		2C5e	Coilmade	Storage	CO128		86.7	14.7	91.3			
7	155.5.576.3	Site 155		2C5e	Wheelmade	Storage	CO133		58.1	14.6	34.4			
8	155.10.581.25	Site 155		2C5e	Coilmade	Storage	CO128		54.2	12.5	71.6			
9	155.2.573.83	Site 155		2A7c	Wheelmade	Serving	CO55		24.5	7.5	24.6			
10	155.8.579.44	Site 155		2A7c	Wheelmade	Serving	CO55		47.3	9.9	56.4			
11	155.4.575.40	Site 155		3A7c	Wheelmade	Serving	CO55		55.5	8.9	29.4			
12	155.2.573.75	Site 155		3A7c	Wheelmade	Serving	CO55		70.3	17.8	36.8			
13	155.10.581.20	Site 155		2A5d	Wheelmade	Serving	CO55		45	7.8	46.9	CA200234	12th-13th	Watson 2004: 334-337
14	155.2.573.70	Site 155		2A8	Moulded	Serving	CO44		39.2	7.4	56.3			
15	155.4.575.47	Site 155		2A8	Moulded	Serving	CO44		19	5.9	21.5		12th-13th	Mulder 2014: Fig. 19
16	155.4.575.46	Site 155		2A8	Moulded	Serving	CO44		55.5	7.9	37.1		12th-13th	Mulder 2014: Fig. 19
17	155.2.573.66	Site 155		2A8	Moulded	Serving	CO44		43.3	10.2	64.8		12th-13th	Mulder 2014: Fig. 19
18	155.2.573.68	Site 155		2A8	Moulded	Serving	CO44		53.7	10.5	92.6		12th-13th	Mulder 2014: Fig. 19
19	155.1.572.18	Site 155		2A8	Wheelmade	Serving	CO44		43.3	7.2	39		12th-13th	Mulder 2014: Fig. 19
20	155.8.579.2	Site 155		2A8	Moulded	Serving	CO44		38.6	8.7	51.1		12th-13th	Mulder 2014: Fig. 19
21	155.10.581.23	Site 155		2A8	Moulded	Serving	CO44		23.5	5.6	69.8		12th-13th	Mulder 2014: Fig. 19
22	155.10.581.24	Site 155		2A8	Moulded	Serving	CO44		30.6	5.9	25.1		12th-13th	Mulder 2014: Fig. 19

Plate 6

Plate 7

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	217.5.1008.21	Site 217	101	2B4	Wheelmade	Serving	CO62		23.2	7.5	61.2			
2	217.3.1006.33	Site 217	101	2C4	Coilmade	Storage	CO27		54.6	12.4	73.6			
3	217.3.1006.40	Site 217	105	2A4	Wheelmade	Serving	CO49		27.6	12.6	45.3			
4	217.5.1008.27	Site 217	109	2A4	Coilmade	Serving	CO38		34.3	10.4	54.7			
5	217.5.1008.28	Site 217	109	3A7a	Wheelmade	Serving	CO55	8	37.2	13	116.2	CA200270		
6	217.3.1006.42	Site 217	109	2A4	Coilmade	Serving	CO38		70..4	12.1	69.2			
7	217.3.1006.44	Site 217	201	3C4	Handmade	Food Processing	CO24		50.7	18	18.3			
8	217.3.1006.36	Site 217	201	3C4	Handmade	Food Processing	CO24		68.7	19.7	120.1			
9	217.3.1006.35	Site 217	201	2C4	Handmade	Food Processing	CO24		77.3	25.7	101.4			
10	217.5.1008.8	Site 217	201	2C4	Handmade	Food Processing	CO24		57.7	18.4	90.5			
11	217.3.1006.14	Site 217	312	2C4	Coilmade	Serving	CO65		74.2	14.8	75.1			
12	217.4.1007.5	Site 217	312	2B4	Handmade	Serving	CO57		57.8	19.9	67			
13	217.3.1006.16	Site 217	306	3C5e	Wheelmade	Serving	CO52	16	60.8	9.9	67.9	CA200255		
14	217.5.1008.9	Site 217	312	3C4	Handmade	Serving	CO34		80.7	20.3	127.7			
15	217.3.1006.17	Site 217	312	2B10a	Handmade	Serving	CO59		89.5	24.8	72.3			
16	217.5.1008.11	Site 217	350	2C10a	Handmade	Food Processing	CO26		89.9	29.5	96.5			
17	217.5.1008.14	Site 217	315	3B4	Wheelmade	Serving	CO12	21	47.7	9.4	70.2	CA200268	11th-14th	Tonghini 1994: Fig. 104d
18	217.3.1006.11	Site 217	315	2A7a	Wheelmade	Serving	CO55	16	39.4	10.8	41			
19	217.2.1005.7	Site 217	315	3A7a	Wheelmade	Serving	CO55	26	33.1	9.1	54.1	CA200250		
20	217.3.1006.30	Site 217	316	2C10a	Handmade	Food Processing	CO26	40	54.6	15.4	60.9			

Plate 7

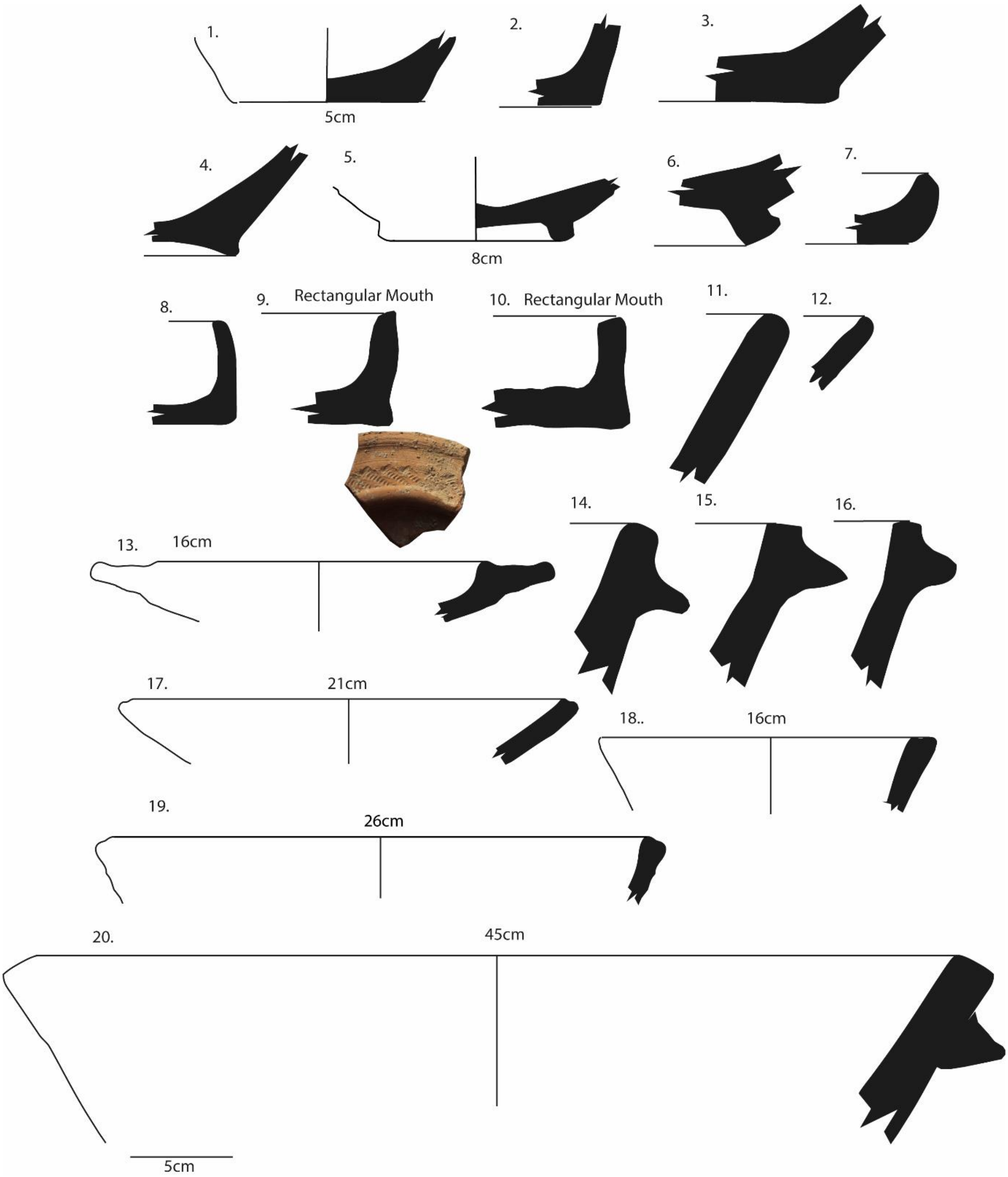

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Plate 8

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	217.2.1005.8	Site 217	330	2A7a	Wheelmade	Food Processing	CO55	15	38.7	7.1	43	CA200251		
2	217.3.1006.25	Site 217	330	2C4	Handmade	Food Processing	CO24		93	24.7	80.3	CA200256		
3	217.2.1005.9	Site 217	344	3C4	Handmade	Food Processing	CO24		37.6	14.2	60.2	CA200252		
4	217.3.1006.12	Site 217	344	2C4	Wheelmade	Food Processing	CO29		23.2	13.6	39.6			
5	217.1.1004.3	Site 217	345	2B4	Handmade	Food Processing	CO20		50.7	16.7	43.6			
6	217.5.1008.13	Site 217	336	2A7a	Wheelmade	Serving	CO55	24	94.3	8.9	71.9			
7	217.4.1007.6	Site 217	401	2C10a	Handmade	Dry Storage	CO124		74.6	24.3	64.3			
8	217.3.1006.27	Site 217	401	2B10b	Coilmade	Liquid Storage	CO107		61.7	12.1	64.8			
9	217.3.1006.2	Site 217	416	2A7a	Wheelmade	Liquid Storage	CO99	10	54.2	8.7	45.1			
10	217.5.1008.18	Site 217	407	3A4	Wheelmade	Dry Storage	CO91	19	35.2	6.1	55.5			
11	217.3.1006.18	Site 217	431	2C4	Handmade	Liquid Storage	CO121	14	53.5	20.7	47.3			
12	217.5.1008.10	Site 217	438	5A5b	Wheelmade	Liquid Storage	CO95	8	74.9	9.4	46.5	CA200267		
13	217.1.1004.2	Site 217	441	2A4	Wheelmade	Liquid Storage	CO90	11	42	9	76.9	CA200246		
14	217.5.1008.7	Site 217	441	2A4	Coilmade	Liquid Storage	CO77	8	47.5	11.9	37.4			
15	217.3.1006.28	Site 217	444	2A4	Wheelmade	Liquid Storage	CO91	10	30.1	5.4	20.6			
16	217.5.1008.6	Site 217	449	2A7a	Coilmade	Liquid Storage	CO82	8	57.4	9.7	85.9			

Plate 8

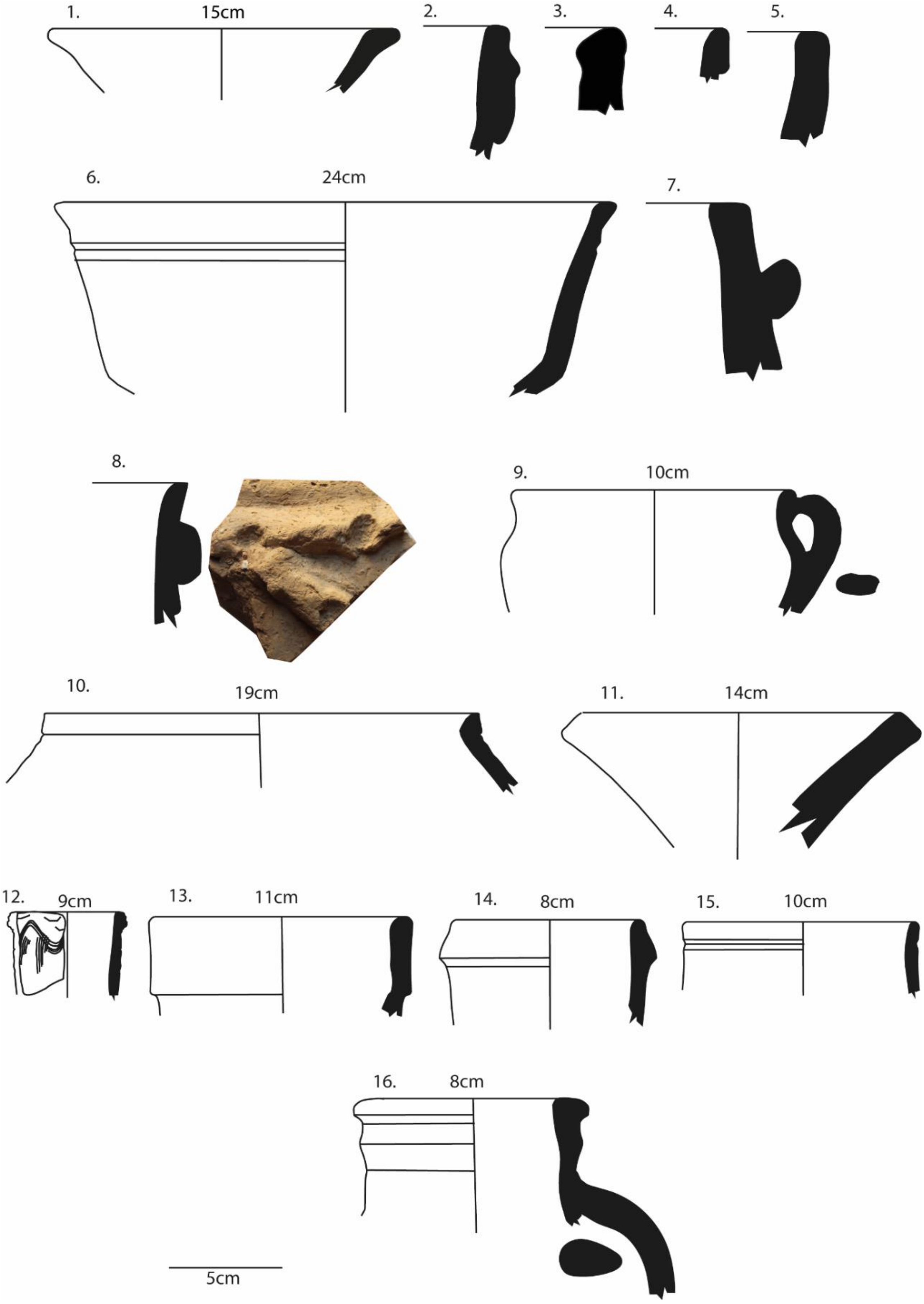
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Plate 9

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	217.6.1009.3	Site 217	503	2B4	Wheelmade	Other	CO138		128.2	9.7	101.9	CA200276		
2	217.5.1008.40	Site 217	503	2B4	Handmade	Other	CO137		49	8.9	116.1	CA200272		
3	217.4.1007.7	Site 217	507	2C4	Handmade	Other	CO146	11	78.4	14.2	96.4			
4	217.5.1008.4	Site 217	507	2A4	Wheelmade	Lid	CO144	2	43	9.5	32.4		9th-11th	Wilkinson 1973: no. 47
5	217.5.1008.20	Site 217	507	2A4	Wheelmade	Lid	CO144	9	67.7	9	44.3		9th-11th	Wilkinson 1973: no. 47
6	217.3.1006.69	Site 217		7A7a	Wheelmade	Serving	CO69		22.2	11.3	30	CA200264		
7	217.3.1006.55	Site 217		2B5c	Coilmade	Storage	CO104		91.3	15.5	101.3	CA200260		
8	217.3.1006.58	Site 217		2A5b	Wheelmade	Storage	CO95		22.5	9.6	28.4			
9	217.2.1005.19	Site 217		2B5b	Wheelmade	Storage	CO117		50.2	11.7	42.5			
10	217.2.1005.24	Site 217		2B5b	Coilmade	Storage	CO104		61	16.6	93.1			
11	217.5.1008.37	Site 217		2A5b	Coilmade	Storage	CO78		87.6	12.7	45.9			
12	217.5.1008.41	Site 217		2B5b	Coilmade	Storage	CO104		111.3	15.4	184.2			
13	217.3.1006.71	Site 217		2A8	Coilmade	Serving	CO41		61.4	11.9	26.7		11th-13th	Mulder 2015
14	217.5.1008.46	Site 217		2A8	Moulded	Serving	CO44		41.5	10.6	45.6	CA200275	11th-13th	Mulder 2015
15	217.5.1008.47	Site 217		2A8	Moulded	Serving	CO44		41.6	4.5	63.6		11th-13th	Mulder 2015
16	217.3.1006.73	Site 217		2A7c	Wheelmade	Serving	CO55		38.2	7.9	37.9	CA200265	11th-13th	Fehervari 2000: 84
17	217.4.1007.11	Site 217	110	2A7e	Wheelmade	Serving	CO55		56.5	11.7	75.2		10th-12th	Northedge 1996
18	217.5.1008.45	Site 217		2A5e	Coilmade	Storage	CO80		133.5	13.9	68.7	CA200274		
19	217.4.1007.12	Site 217		2C10b	Handmade	Liquid Storage	CO124		91.8	23.5	116.5			

Plate 9

Plate 10

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	276.2.1242.35	Site 276	201	3B5a	Handmade	Food Processing	CO21		23.5	14	34.4			
2	276.2.1242.13	Site 276	305	2C4	Handmade	Food Processing	CO24		95.5	23.2	68.2			
3	276.3.1243.9	Site 276	304	2A4	Wheelmade	Serving	CO49		41.8	8.8	38.2			
4	276.2.1242.21	Site 276	306	2C4	Handmade	Serving	CO66		31.4	16.4	70.4	CA200322		
5	276.2.1242.17	Site 276	324	3A7a	Wheelmade	Serving	CO55		46.7	10.7	34	CA200321		
6	276.2.1242.11	Site 276	342	3C4	Handmade	Food Processing	CO24	16	53.2	16.2	55.7			
7	276.2.1242.10	Site 276	327	3B4	Wheelmade	Food Processing	CO22	40	82.7	12.1	70.3			
8	276.2.1242.7	Site 276	333	2A7k	Wheelmade	Serving	CO55		33.4	8.5	45.8	CA200318	11th -13th	
9	276.3.1243.8	Site 276	312	2A10a	Wheelmade	Serving	CO56		34.2	9.9	39.3			
10	276.2.1242.16	Site 276	441	2A4	Wheelmade	Liquid Storage	CO91	24	30	5.5	40.8			
11	276.2.1242.18	Site 276	440	2A4	Wheelmade	Liquid Storage	CO91	10	58.2	10.4	25.7			
12	276.2.1242.15	Site 276	441	2A4	Wheelmade	Liquid Storage	CO91	11	47.9	9.8	26.1			
13	276.2.1242.41	Site 276	441	2A4	Wheelmade	Liquid Storage	CO91		32.3	8.6	32.1			
14	276.2.1242.19	Site 276	447	2A4	Wheelmade	Liquid Storage	CO91	10	31.4	9.4	53.1		11th-14th	Tonghini 1998: Fig 19d
15	276.2.1242.37	Site 276	507	24A	Wheelmade	Other	CO144	2	35.5	9.5	43.5		11th-14th	Wilkinson 1973: no. 47
16	276.2.1242.45	Site 276		2A8	Moulded	Serving	CO44		24.1	7.2	33.9			
17	276.2.1242.43	Site 276		2C5e	Coil Built	Storage	CO128		115.2	15.1	69.9			
18	276.2.1242.46	Site 276		2A8	Moulded	Serving	CO44		35.3	7.6	64.8			
19	276.2.1242.47	Site 276		2A8	Moulded	Serving	CO44		38.1	7.4	30.3		12th-15th	Mulder 2004: 170

Plate 10

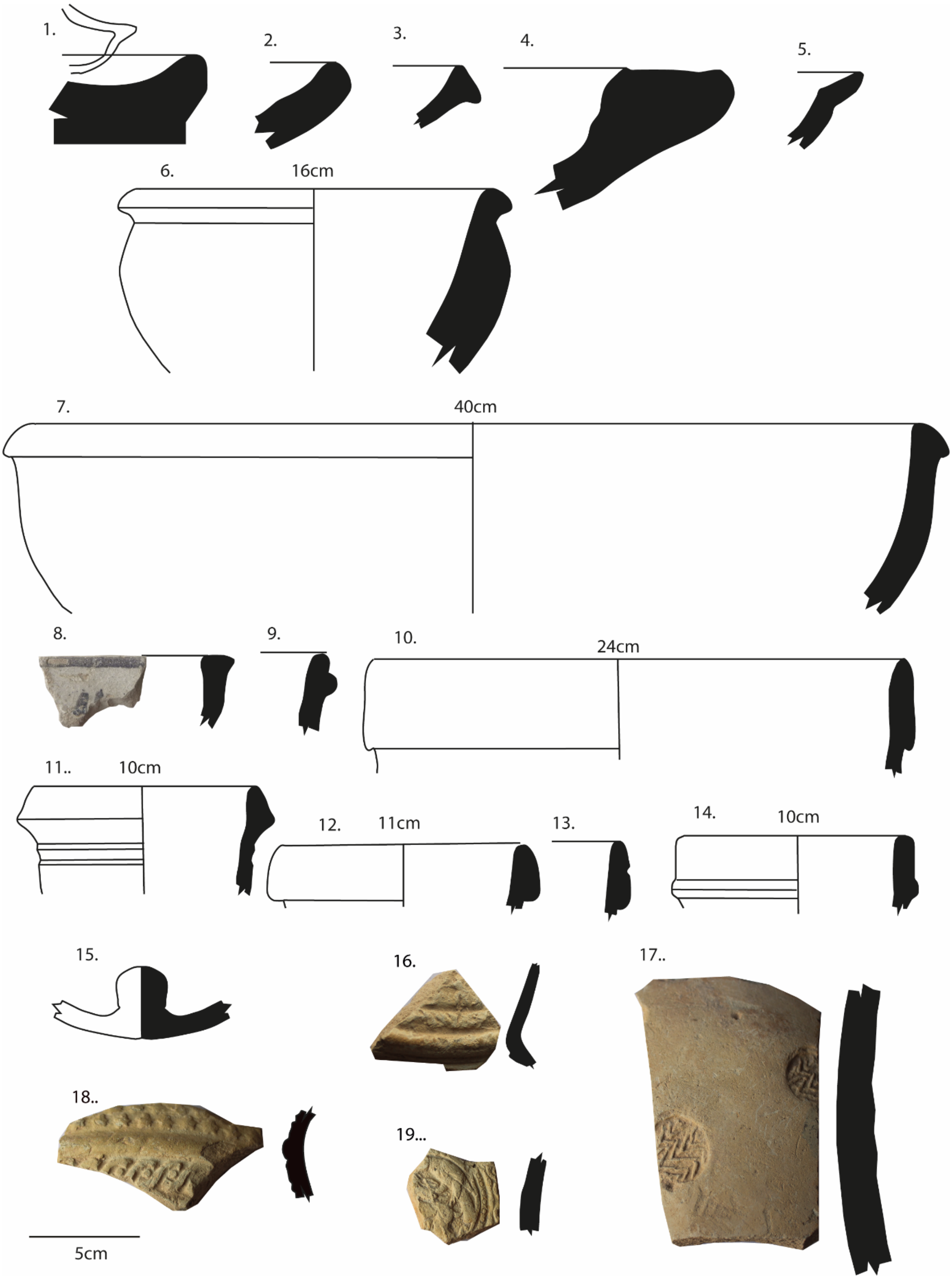
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Plate 11

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	381.1.1553.17	Site 381	302	2A4	Wheelmade	Serving	CO49	20	25.8	7.8	42.2			
2	381.2.1554.3	Site 381	301	2C4	Wheelmade	Food Processing	CO29	18	56.7	15.5	58.6			
3	381.2.1554.7	Site 381	335	2C4	Handmade	Food Processing	CO24		82.9	12.4	74.5			
4	381.2.1554.5	Site 381	335	2C4	Handmade	Food Processing	CO24	19	64.9	18.6	62.8			
5	381.1.1553.13	Site 381	344	2C4	Handmade	Food Processing	CO24		86.7	23.4	75.2			
6	381.1.1553.11	Site 381	344	3C4	Handmade	Food Processing	CO24		94.5	28.7	64			
7	381.1.1553.9	Site 381	404	2A4	Wheelmade	Dry Storage	CO91	21	37.9	11.3	41.9			
8	381.3.1555.17	Site 381	440	2A4	Wheelmade	Liquid Storage	CO91	9	41	8.1	49.4			
9	381.2.1554.2	Site 381	441	2A4	Wheelmade	Liquid Storage	CO91	10	34.6	6.4	55.1			
10	381.3.1555.10	Site 381	441	2A4	Wheelmade	Liquid Storage	CO91	10	29.4	12.9	36.2			
11	381.2.1554.4	Site 381	447	2A4	Wheelmade	Liquid Storage	CO91	6	69.2	7.6	60.5		11th-14th	Tonghini 1998: Fig 19d
12	381.1.1553.8	Site 381	440	2A4	Wheelmade	Liquid Storage	CO89	8	46.7	6.8	67.6	CA200290		
13	381.1.1553.32	Site 381		2A5b	Coilmade	Storage	CO78		42.9	13.5	71.7			
14	381.3.1555.32	Site 381		2B5c	Coilmade	Storage	CO104		49.7	14.4	43.4			
15	381.2.1554.18	Site 381		2A8	Moulded	Serving	CO44		77.3	10.5	108		12th-13th	Mulder 2015: 161
16	381.3.1555.36	Site 381		2A8	Moulded	Serving	CO44		28.1	8.8	44.6	CA200284	12th-13th	Mulder 2015: 161
17	381.3.1555.37	Site 381		2A8	Moulded	Serving	CO44		36.1	8.8	25.1		12th-13th	Mulder 2015: 161
18	381.3.1555.4	Site 381		2A8	Moulded	Serving	CO61		33.4	6.3	51.3	CA200277	12th-13th	Mulder 2015: 161

Plate 11

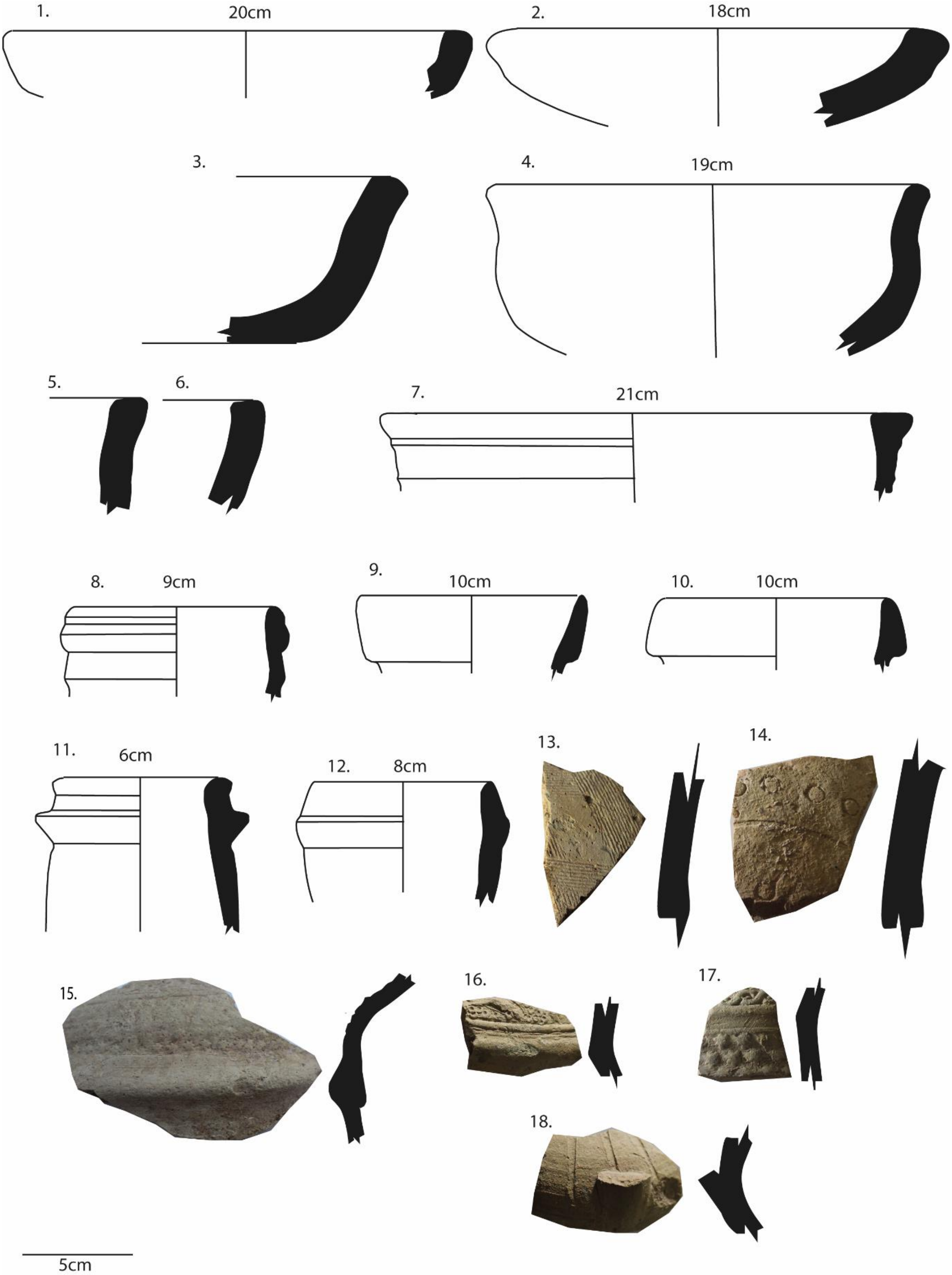

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Plate 12

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	453.1.1632.10	Site 453	101	3C4	Wheelmade	Storage	CO131		114.2	22.7	193.7			
2	453.1.1632.7	Site 453	109	3A7c	Wheelmade	Serving	CO55		30.2	9.7	67.8			
3	453.4.1635.6	Site 453	101	3B4	Wheelmade	Storage	CO113	6	99.1	25.5	111.4			
4	453.3.1634.4	Site 453	109	2A4	Wheelmade	Serving	CO49		45.3	7.7	52.6			
5	453.1.1632.4	Site 453	312	6B3	Wheelmade	Cooking	CO10		25	14.7	49.2			
6	453.1.1632.8	Site 453	408	2A4	Wheelmade	Dry Storage	CO91		32.2	10.8	28.9			
7	453.1.1632.5	Site 453	344	2C4	Wheelmade	Food Processing	CO29		109.9	23.6	105.6			
8	453.1.1632.6	Site 453	344	2C4	Wheelmade	Food Processing	CO29		141.3	31.2	168.5			
9	453.4.1635.3	Site 453	443	3B4	Wheelmade	Liquid Storage	CO113	6	41.1	9.3	34.5			
10	453.4.1635.2	Site 453	445	2A4	Wheelmade	Liquid Storage	CO91	8	39.2	9.1	37.9			
11	453.2.1633.1	Site 453	504	2A7a	Handmade	Other	CO155		45.9	8.2	35.9			
12	453.2.1633.8	Site 453		2A5b	Wheelmade	Storage	CO95		30.5	8.7	48.1			
13	453.1.1632.12	Site 453		5A5a	Wheelmade	Storage	CO95		79.7	15.6	46.9			

Plate 12

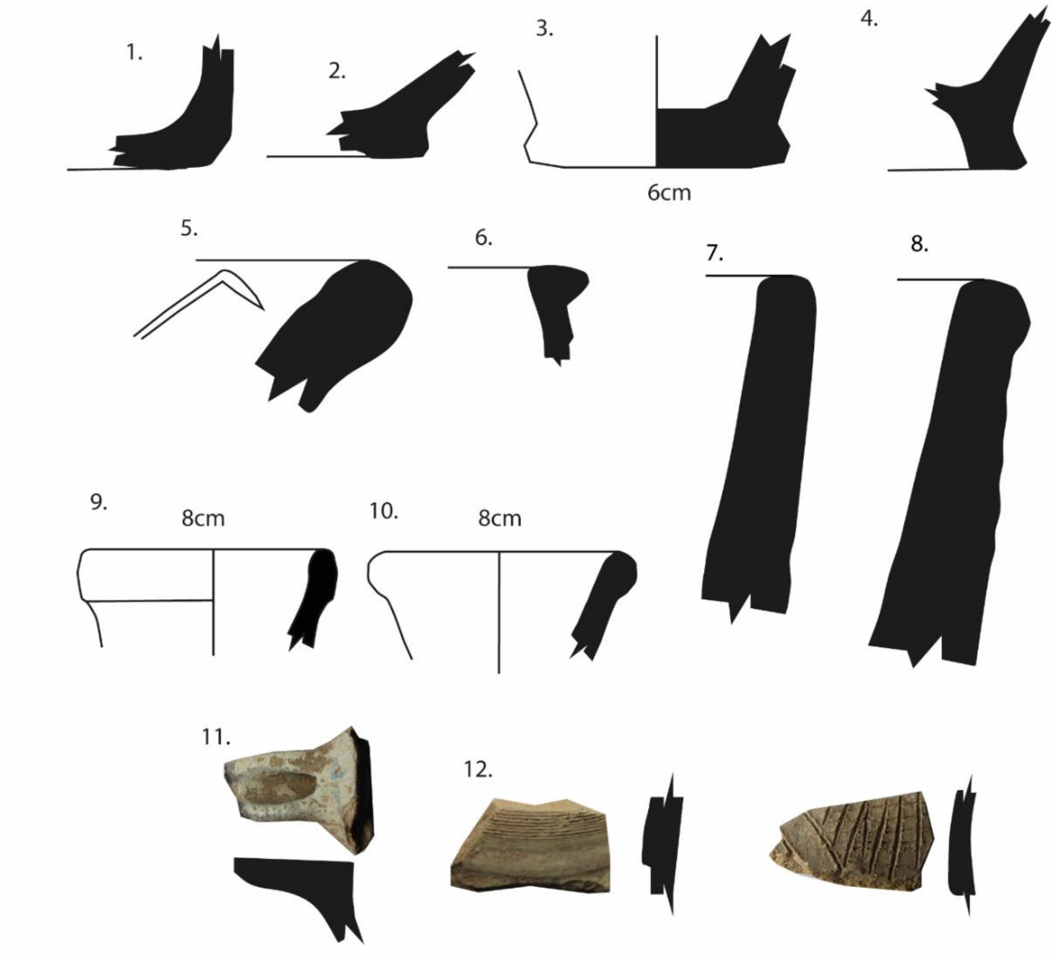

Plate 13

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	519.2.1916.20	Site 519	101	2A4	Wheelmade	Storage	CO91	9	51.9	9	150.2			
2	519.1.1915.3	Site 519	105	2B4	Wheelmade	Storage	CO113	6	30.8	11.7	83.3			
3	519.2.1916.13	Site 519	111	2A7a	Wheelmade	Serving	CO55		24.4	5.8	48.8	CA200298		
4	519.2.1916.10	Site 519		3A4	Wheelmade	Storage	CO91		40.7	9.9	32.3	CA200297		
5	519.2.1916.7	Site 519	308	3A7a	Wheelmade	Serving	CO55		40.7	7.8	39.6	CA200295		
6	519.2.1916.8	Site 519	310	3A4	Wheelmade	Serving	CO49	23	40.7	7.8	39.6			
7	519.1.1915.1	Site 519	320	2A5a	Wheelmade	Serving	CO50	17	41.8	9.7	72.3			
8	519.2.1916.9	Site 519	448	2A4	Wheelmade	Liquid Storage	CO89	6	36.6	3.8	60.1	CA200296		
9	519.2.1916.21	Site 519		2A8	Moulded	Serving	CO44		43.8	6.9	41.5		13th-14th	Mulder 2015: 174
10	519.2.1916.6	Site 519		2A4	Wheelmade	Serving	CO49		26.7	8.1	39			
11	519.2.1916.1	Site 519	Handle	2B4	Handmade	Other	CO152		54.1	9.3	91.8			
12	519.3.1917.1	Site 519	Spout	2A4	Handmade	Other	CO154		86.1	6.8	33.6			
13	535.1.1953.12	Site 535	104	2A4	Coilmade	Serving	CO36		47.8	9.5	86.3	CA200304		
14	535.2.1954.6	Site 535		2A10b	Wheelmade	Liquid Storage	CO100		34.8	7.1	31.1			
15	535.2.1954.7	Site 535		2A5f	Wheelmade	Serving	CO51		36	8.3	30.8			
16	535.1.1953.24	Site 535		2A8	Moulded	Serving	CO44		33.3	8.1	42.2			
17	535.1.1953.7	Site 535		6B4	Wheelmade	Cooking	CO15		43.9	10.9	41.1	CA200302	12th-13th	Mulder 2015: 161

Plate 13

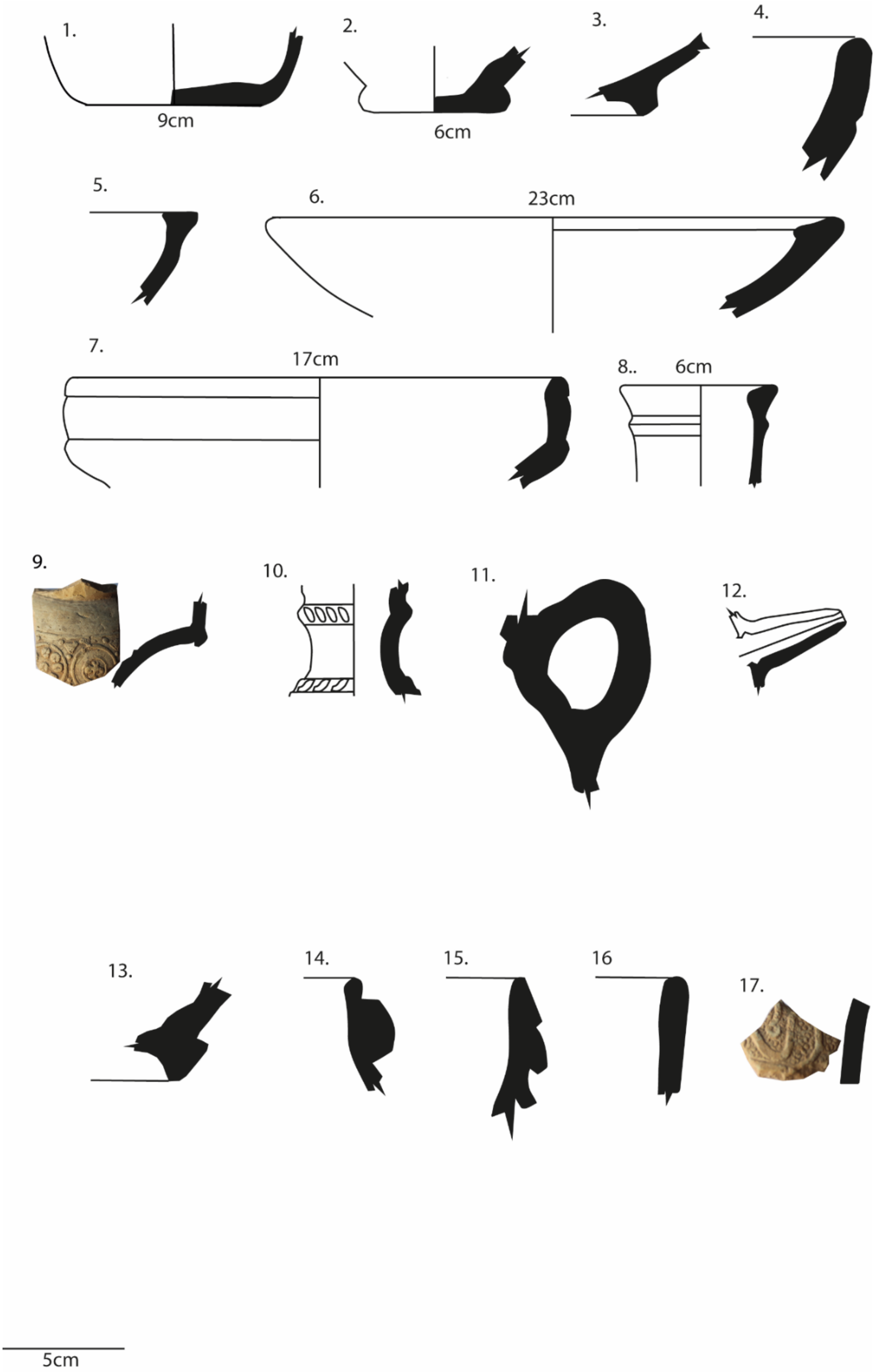

Plate 14

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	A169213	Nippur	105	2A7b	Wheelmade	Serving	CO55	6	14.9	7	61.9			
2	A169212	Nippur	106	2A7b	Wheelmade	Serving	CO55		13.1	7.8	93.1		11th-13th	Jenkins 1983: 6: no. 4
3	A169214	Nippur	109	3A7c	Wheelmade	Serving	CO55	8	18.7	6.4	54.7	CA200729		
4	A169198	Nippur	109	2A7j1	Wheelmade	Serving	CO55		57.5	7.2	110.4			
5	A169199	Nippur	109	2A7d	Wheelmade	Serving	CO55	8	20.9	6.2	98.8		12th-14th	Safar 1945
6	Gibson et al. 1998: Fig. 21.2	Nippur	109	2A7g	Wheelmade	Serving	CO55	12					12th-14th	Safar 1945: Fig 18, no. 50, 60
7	A163160	Nippur	109	3A7c	Wheelmade	Serving	CO55	12	34.7	7.6	107			
8	Gibson et al. 1998: Fig. 21.4	Nippur	110	2A7g	Wheelmade	Serving	CO55	7					12th-14th	Safar 1945: Fig. 20, No. 107
9	Gibson et al. 1998: Fig. 21.5	Nippur	110	2A7g	Wheelmade	Serving	CO55	7					12th-14th	Lane 1971: Fig. 10, 12a; Riis and Poulsen 1957: Fig 663, 698-700; 704-7, 709
10	A169202	Nippur	110	8A7b	Wheelmade	Serving	CO70	4	19.5	2.9	25.9		11th-19th	Kessler 2012
11	A169201	Nippur	110	8A7a	Wheelmade	Serving	CO70	4	16.7	2.7	28.5		17th ?	Howard 1997: 29, cat. 19
12	Gibson et al. 1998: Fig. 21.1	Nippur	110	2A7g	Wheelmade	Serving	CO55	8					12th-14th	Safar 1945: Fig 17, No. 47; Adams 1965:134
13	A169200	Nippur	109	2A7g	Wheelmade	Serving	CO55	4	29	8.1	38			

Plate 14

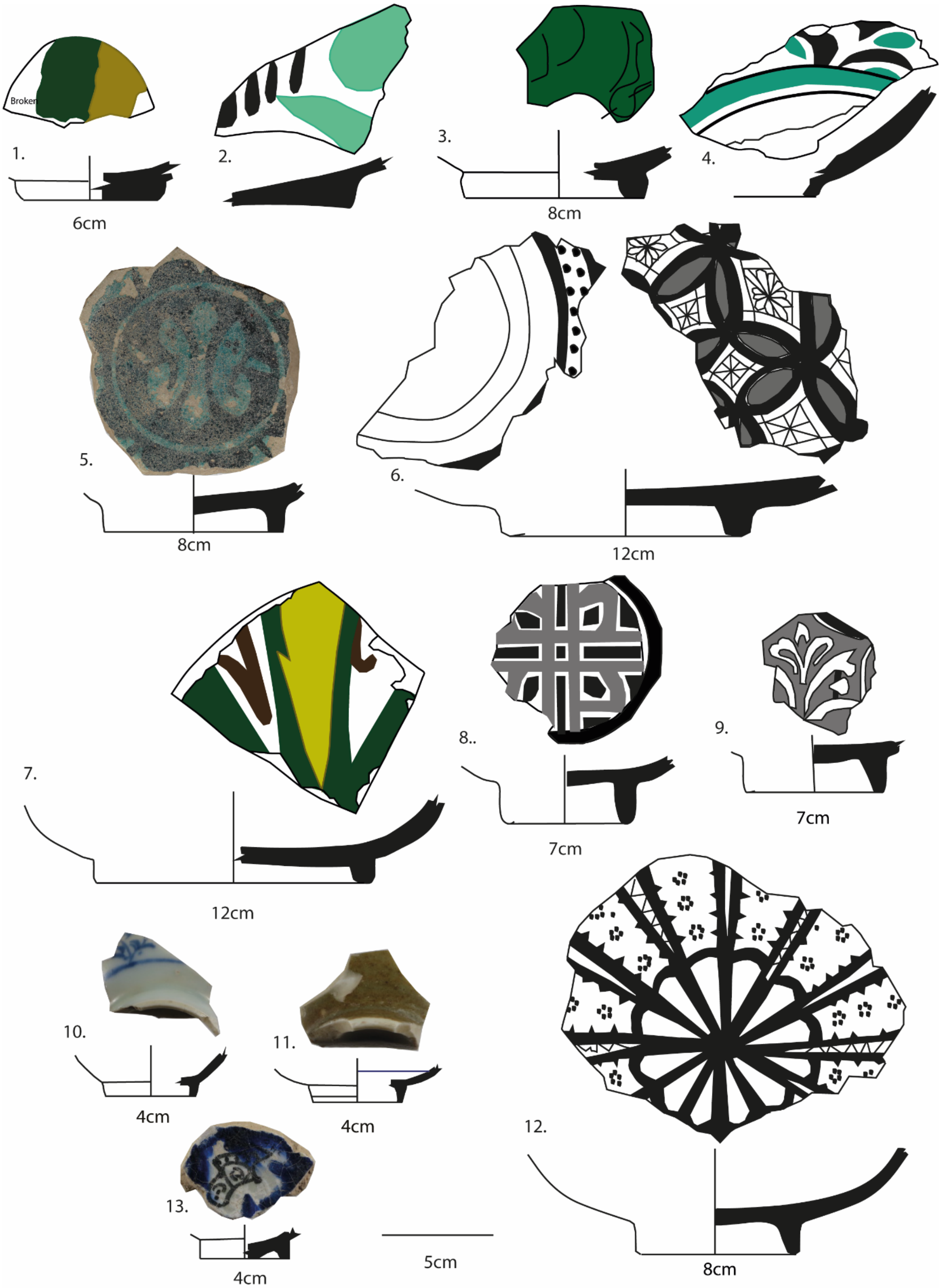

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Plate 15

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	Gibson et al. 1998: Fig. 17.1	Nippur	307	2B4	Wheelmade	Food Processing	CO57	14						
2	A163159	Nippur	307	2A7c	Wheelmade	Serving	CO55	24	79.3	6.6	69.5			
3	Gibson et al. 1998: Fig. 17:7	Nippur	307	3A4	Handmade	Food Processing	CO35	22						
4	A169176	Nippur	312	2A7b	Wheelmade	Serving	CO55	30-35	39.5	7.2	42.3			
5	Gibson et al. 1998: Fig. 17.2	Nippur	315	3B5a	Handmade	Food Processing	CO58	13						
6	A169179	Nippur	314	7A7g	Wheelmade	Serving	CO69	18	21.7	4.6	33.5			
7	A169178	Nippur	314	2A7g	Wheelmade	Serving	CO55	20	35	5.7	42.7		13th-14th	Fehervari 2000: no.286
8	A169177	Nippur	314	2A7k	Wheelmade	Serving	CO55	20	41.4	5.9	57.9			
9	Gibson et al. 1998: Fig. 20.3	Nippur	314	2A7g	Wheelmade	Serving	CO55	25					12th-14th	Adams 1965: 134
10	Gibson et al. 1998: Fig. 20.4	Nippur	314	2A7g	Wheelmade	Serving	CO55	25					12th-14th	Safar 1945: Fig. 19: No. 67
11	A169175	Nippur	319	7A7d	Wheelmade	Serving	CO69	10	38.2	3.7	53.5			

Plate 15

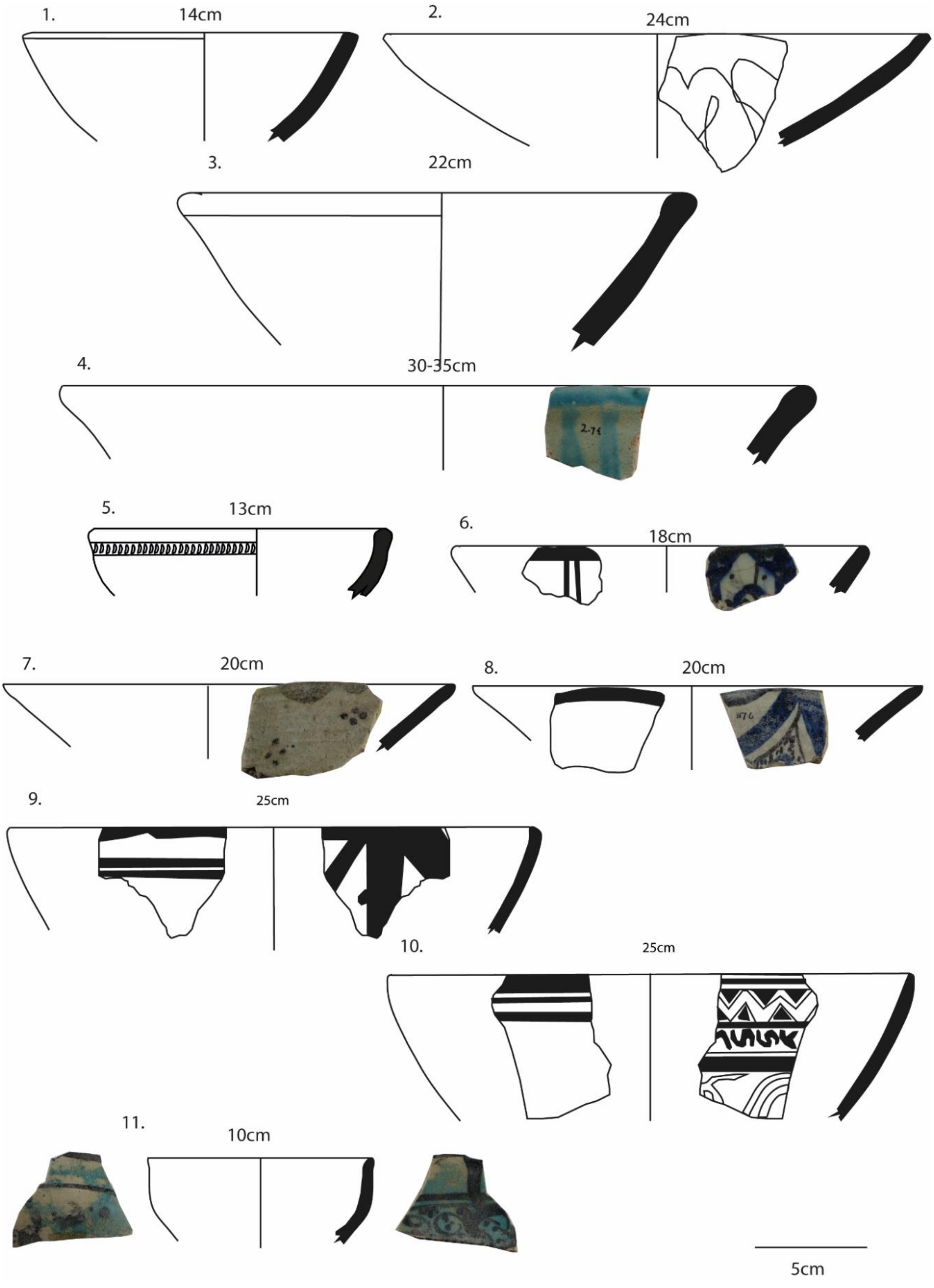
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Plate 16

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	Gibson et al. 1998: Fig. 18:1	Nippur	315	2B4	Handmade	Serving	CO57	36					13th-14th	Whitcomb and Johnson 1979: Plate 424
2	A169173	Nippur	320	2A7d	Wheelmade	Serving	CO55	40	106.1	12.2	125.2			
3	Gbison et al. 1998: Fig. 17.9	Nippur	322	2B5a	Handmade	Food Processing	CO21	26						
4	Gibson et al. 1998: Fig. 18.4	Nippur	322	2C4	Handmade	Food Processing	CO24	32						
5	Gibson et al. 1998: Fig. 20.1	Nippur	322	2A7a	Wheelmade	Food Processing	CO55	40						
6	Gibson et al. 1998: Fig. 20.2	Nippur	322	2A7a	Wheelmade	Food Processing	CO55	44						
7	Gibson et al. 1998: Fig. 20.6	Nippur	324	7A7i	Moulded	Serving	CO55	34					12th-14th	Safar 1945: Fig. 20, No. 98; Lane 1971: Fig. 86B

Plate 16

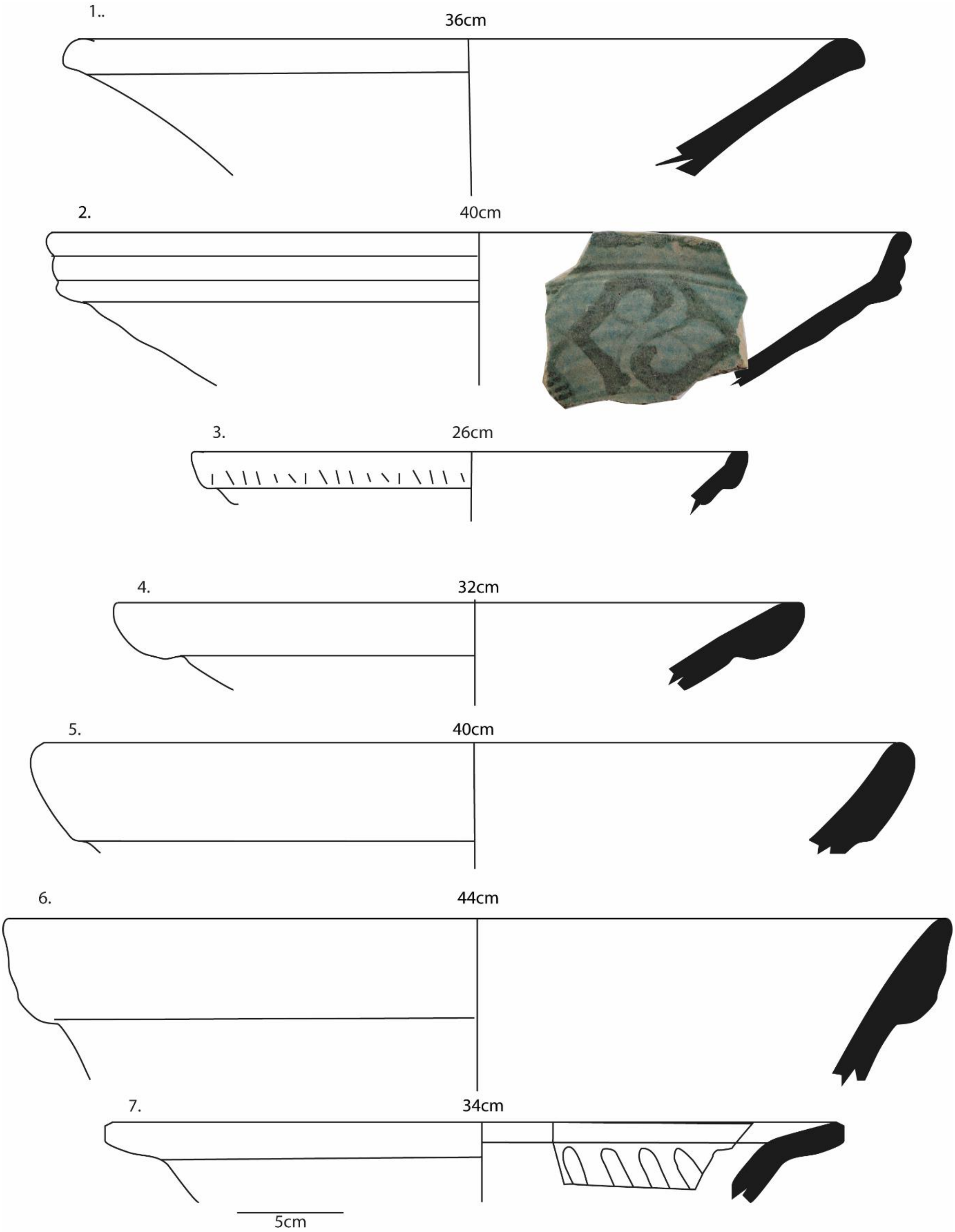


Plate 17

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	A169203	Nippur	324	2A7j1	Wheelmade	Serving	CO55	28	94.5	7.8	106.2			
2	Gibson et al. 1998: Fig. 20.5	Nippur	324	2A7d	Wheelmade	Serving	CO55	32					12th-14th	Safar 1945: Fig. 20: No. 99; Adams 1965: 134
3	Gibson et al. 1998: Fig. 17.3	Nippur	326	2B4	Handmade	Food Processing	CO20	10						
4	Gibson et al. 1998: Fig. 17.10	Nippur	326	2B5a	Handmade	Food Processing	CO21	38						
5	Gibson et al. 1998: Fig. 17.6	Nippur	327	2B4	Handmade	Food Processing	CO20	20						
6	Gibson et al. 1998: Fig. 17.5	Nippur	327	2B4	Handmade	Food Processing	CO20	16						
7	Gibson et al. 1998: Fig. 17.4	Nippur	327	2B5a	Handmade	Food Processing	CO21	26						
8	Gibson et al. 1998: Fig. 17.8	Nippur	327	2B4	Handmade	Food Processing	CO20	24						
9	Gibson et al. 1998: Fig. 18.2	Nippur	330	2B4	Handmade	Food Processing	CO20	40					12th-14th	Iraq Government 1940: Pl. 17: no. 5, 8-9, 19

Plate 17

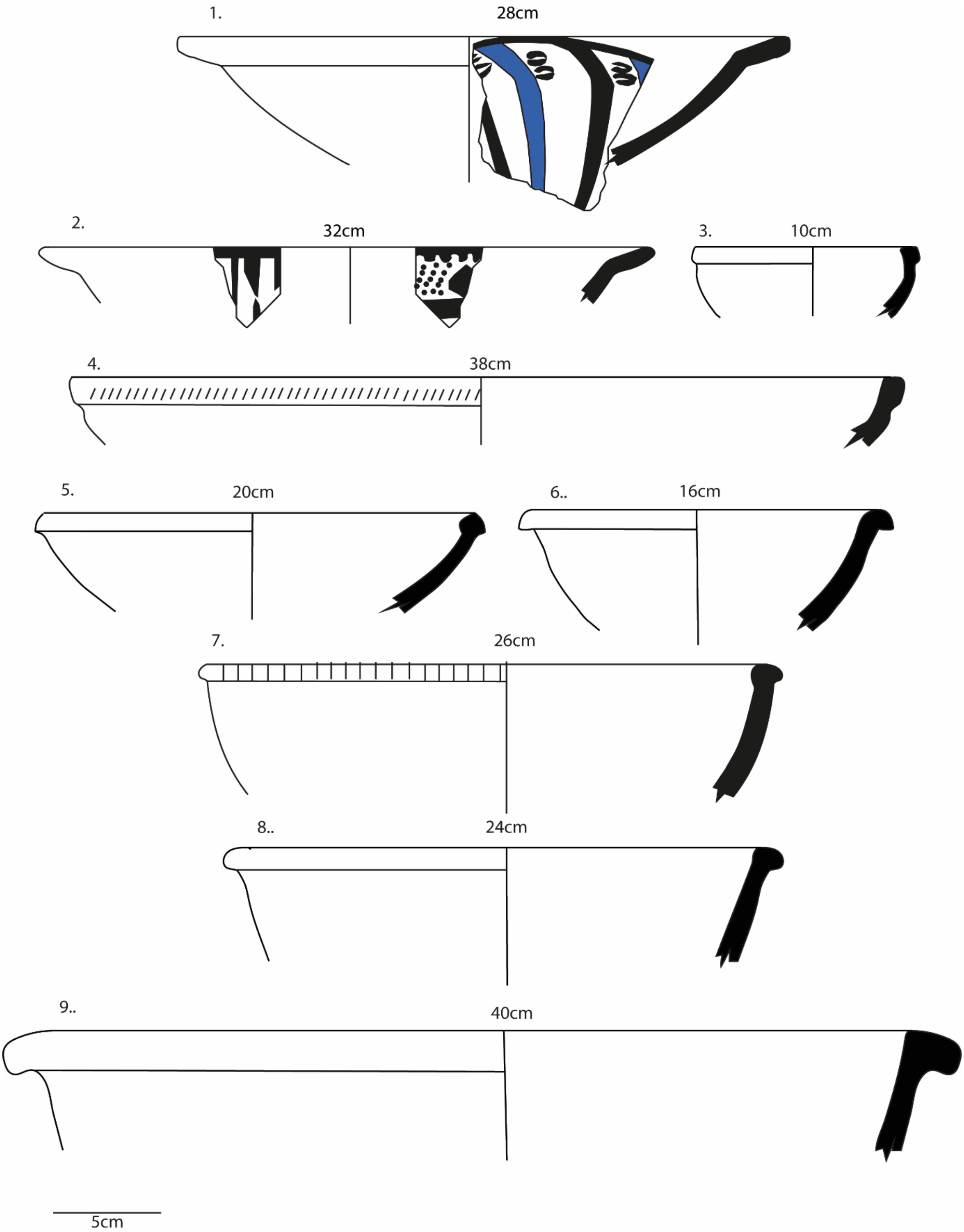


Plate 18

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	Gibson et al. 1998: Fig. 18.3	Nippur	329	2B4	Handmade	Food Processing	CO100	38					13th-14th	Whitcomb and Johnson 1982: Pl. 43g
2	A169174	Nippur	334	7A7d	Wheelmade	Serving	CO69	20	45.9	4.8	45.6			
3	Gibson et al. 1998: Fig. 20.7	Nippur	338	2A7g	Wheelmade	Serving	CO55	20					12th-14th	Lane 1971: Fig. 4; Hobson 1932: Fig. 68
4	A163163	Nippur	401	6B2	Wheelmade	Cooking	CO9	23	73.1	6.6	83.2	CA200724		
5	Gibson et al. 1998: Fig. 18.5	Nippur	409	6B4	Handmade	Cooking	CO6	16					13th-14th	Whitcomb and Johnson 1982: Pl. 46I, L, N, P
6	Gibson et al. 1998: Fig. 18.6	Nippur	409	6B5e	Handmade	Cooking	CO7	18					13th-14th	Whitcomb and Johnson 1982: Pl. 46I, L, N, P
7	A169227	Nippur	416	6B4	Handmade	Cooking	CO6	12	136.9	9.4	139.2	CA200733		
8	Gibson et al. 1998: Fig. 18.7	Nippur	416	6B4	Handmade	Cooking	CO6	14						

Plate 18

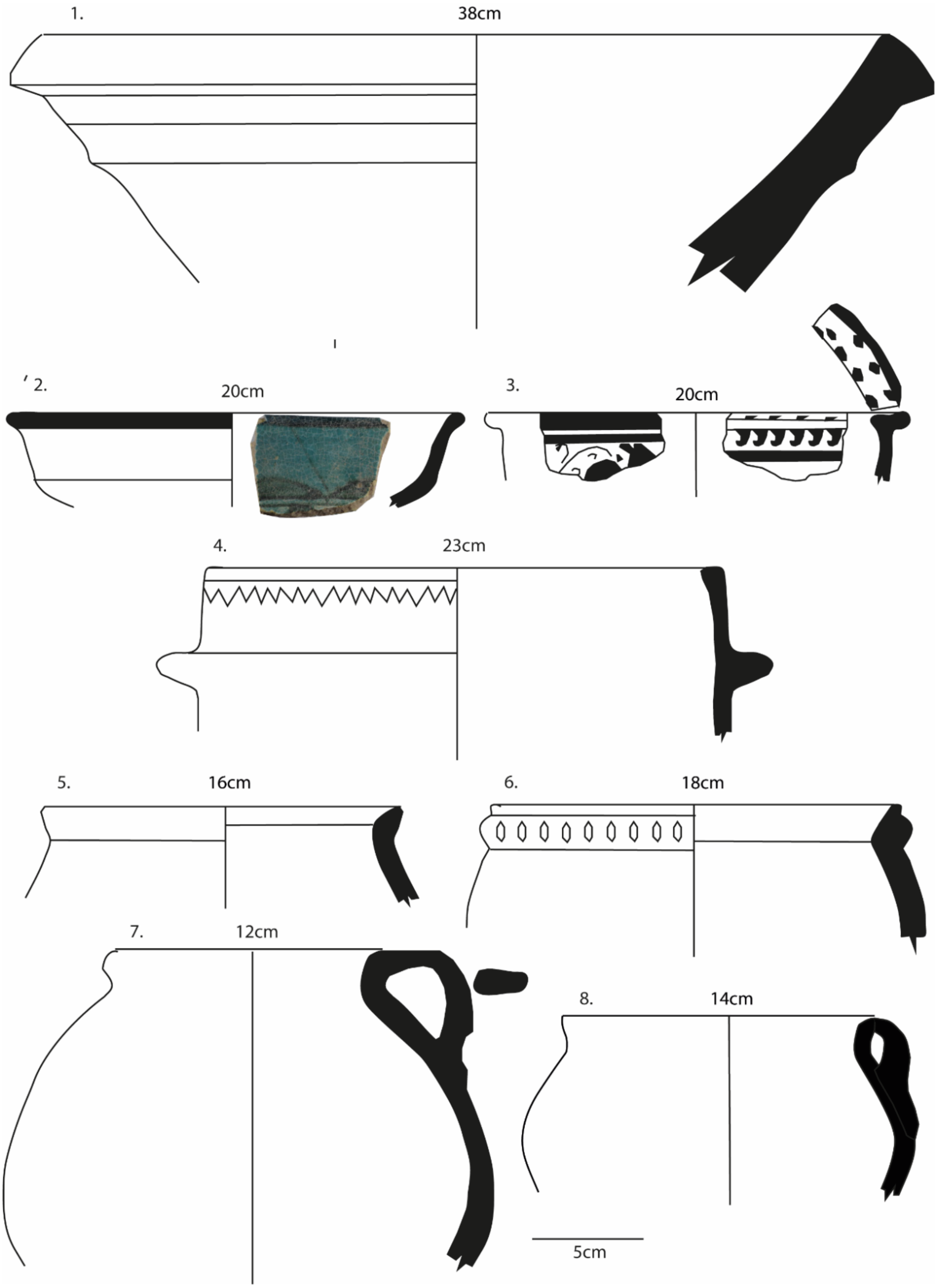
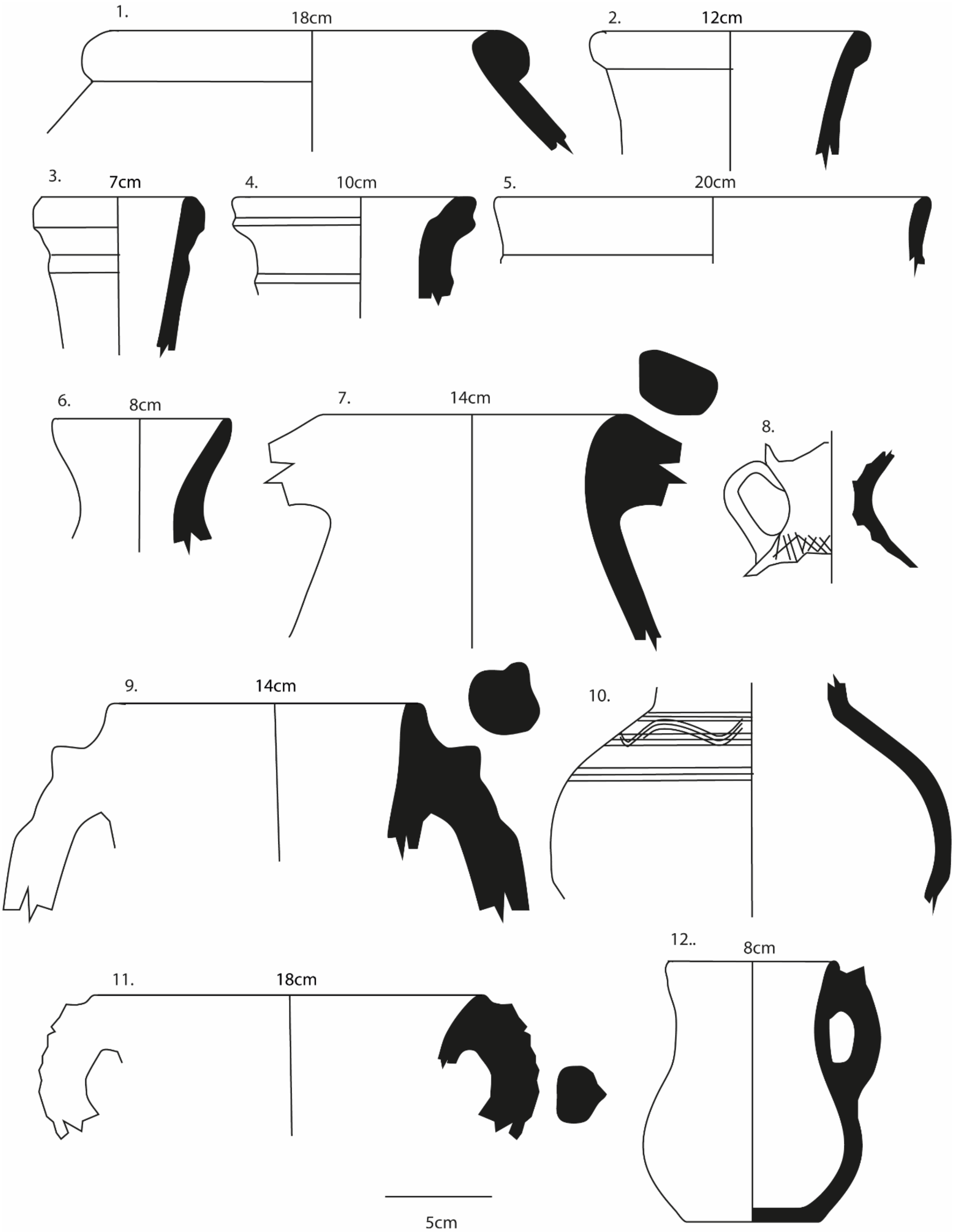


Plate 19

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	A169230	Nippur	423	2B4	Wheelmade	Dry Storage	CO113	18	62.6	10.8	105.6			
2	Gibson et al. 1998: Fig. 19.2	Nippur	433	2B4	Handmade	Liquid Storage	CO101	12						
3	Gibson et al. 1998: Fig. 19.3	Nippur	433	2A4	Wheelmade	Liquid Storage	CO91	7					12th-14th	Safar 1945: Fig. 16 no. 27; Tonghini 1998: 22a
4	A169231	Nippur	442	3B4	Wheelmade	Liquid Storage	CO111	10	48.6	16	77.7	CA200735		
5	A169181	Nippur	444	2A7a	Wheelmade	Liquid Storage	CO99	20	32.3	6.9	39.9			
6	Gibson et al. 1998: Fig. 19.1	Nippur	445	2B4	Handmade	Liquid Storage	CO101	8						
7	Gibson et al. 1998: Fig. 19.4	Nippur	449	2B4	Handmade	Liquid Storage	CO101	14						
8	Gibson et al. 1998: Fig. 22.4	Nippur		2B5a	Wheelmade	Storage	CO117						12th-14th	Safar 1945: Fig. 15. no. 14
9	Gibson et al. 1998: Fig. 19.5	Nippur	449	2B4	Handmade	Liquid Storage	CO101	14						
10	Gibson et al. 1998: Fig. 22.3	Nippur		2A5b	Wheelmade	Storage	CO95						10th-11th	Rosen-Ayalon 1974: 151 and Pl. 94A
11	Gibson et al. 1998: Fig. 19.6	Nippur	449	2B4	Handmade	Liquid Storage	CO101	18						
12	Gibson et al. 1998: Fig. 22.8	Nippur	449	2C4	Handmade	Liquid Storage	CO121	8						

Plate 19



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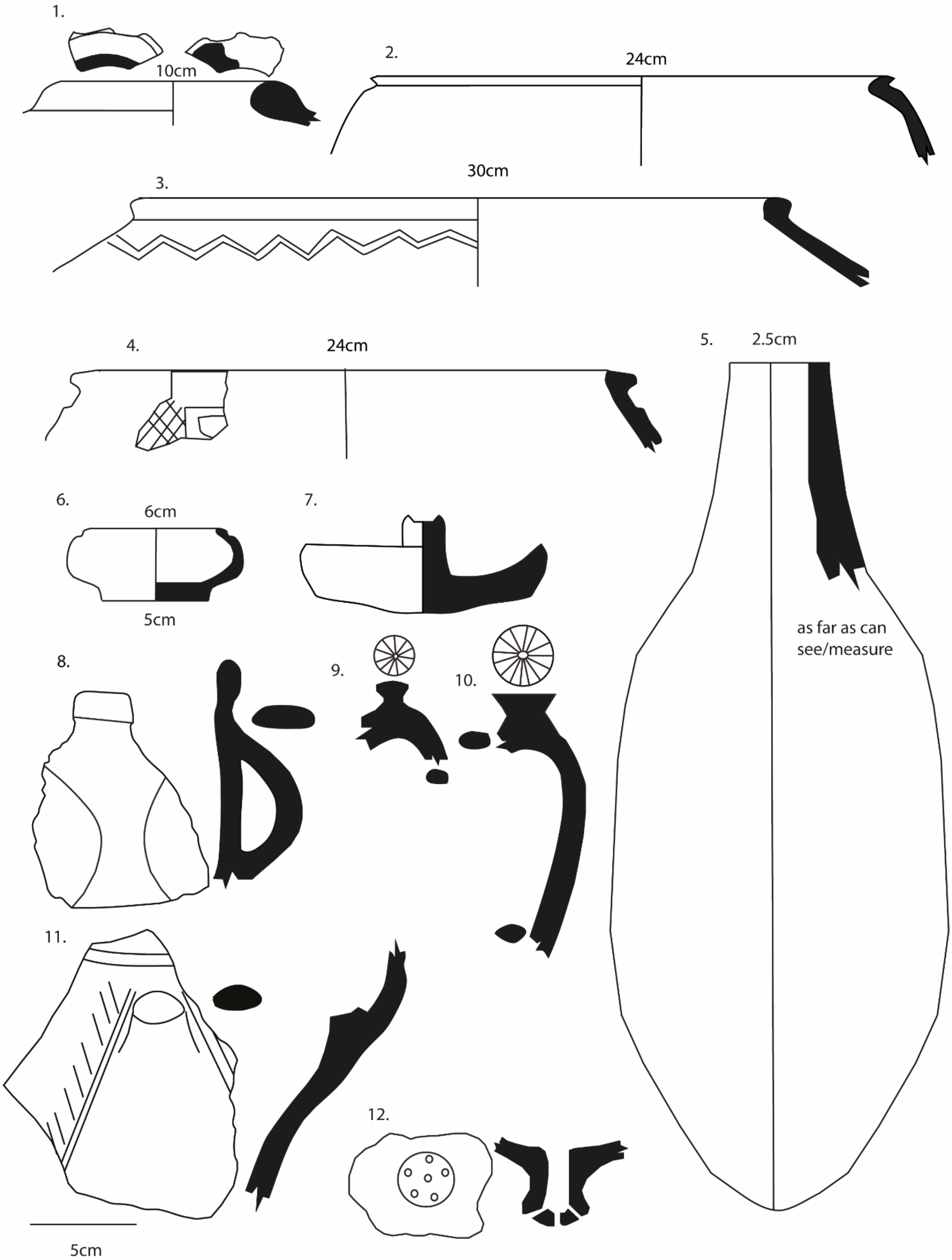
18cm
12..
8cm
5cm

Plate 20

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	A169232	Nippur	453	2B7a	Wheelmade	Storage	CO118	10	30.7	12.3	85.9	CA200736		
2	Gibson et al. 1998: Fig. 19.8	Nippur	455	2B4	Handmade	Storage	CO101	24					13th-14th	Whitcomb and Johnson 1982: Pl. 44 H, K; Pl. 44 L-Q
3	Gibson et al. 1998: Fig. 19.10	Nippur	456	2B5a	Handmade	Storage	CO102	30						
4	Gibson et al. 1998: Fig. 19.9	Nippur	458	2B5a	Handmade	Storage	CO102	24						
5	A169238	Nippur	444	2A4	Wheelmade	Liquid Storage	CO77	2.5	204.8	4.9	76.7			
6	A169215	Nippur	504	2A7a	Wheelmade	Other	CO141	5	26.6	5.3	68.7			
7	Gibson et al. 1998: Fig. 22:10	Nippur	507	2A4	Handmade	Other	CO143						12th-14th	Wilkinson 1973: no. 47; Safar 1945: Fig. 15, No. 16
8	A169228	Nippur		6B4	Wheelmade	Cooking	CO11		101.3	8.9	81	CA200734		
9	A169236	Nippur	Handle	2A4	Handmade	Other	CO148		41.9	10.6	26.5			
10	A169235	Nippur	Handle	2A4	Handmade	Other	CO148		122.1	18.2	32.4			
11	A169229	Nippur		2A5a	Wheelmade	Storage	CO95		126.4	8.1	107.2			
12	A169237	Nippur	Spout	2A4	Handmade	Other	CO154		58.8	9	46.6			

Plate 20


1.
10cm
2.
24cm
3.
30cm
4.
24cm
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2.5cm
6.
6cm
5cm
7.
as far as can
see/measure
8.
9.
10.
11.
12.
5cm

Plate 21

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	A169233	Nippur	501	5A8	Moulded	Liquid Storage/ Transport	CO84		35	8.6	52.8		10th-14th	Ettinghausen 1965
2	A169217	Nippur		2B5a	Wheelmade	Storage	CO117		47.4	13.2	39.8			
3	Gibson et al. 1998: Fig. 22.7	Nippur		2C5a	Handmade	Storage	CO122						10th-11th	Rosen-Ayalon 1974: Figs 34-6
4	Gibson et al. 1998: Fig. 22.5	Nippur		2B5c	Coilmade	Storage	CO104						12th-14th	Safer 1945: Fig. 15 no. 14
5	A169234	Nippur		5A5a	Wheelmade	Storage	CO95		29	5.7	35.7		12th-14th	Safer 1945: Fig. 15 no. 14
6	Gibson et al. 1998: Fig. 22.6	Nippur		2C5c	Wheelmade	Storage	CO132						12th-14th	Riis and Poulsen 1957: Figs. 943-4
7	A169219	Nippur		2B5e	Coilmade	Storage	CO105		48.4	13.7	93	CO200730		
8	A163162	Nippur		2A5e	Handmade	Storage	CO80		61.6	7	56.3			
9	A163161	Nippur		2C5e	Coilmade	Storage	CO80		80	14.5	118.7	CA200723		
10	A169225	Nippur		2A5e	Coilmade	Storage	CO80		134.8	9.3	82.9			
11	A169216	Nippur		2A5e	Coilmade	Storage	CO97		57.4	13.2	29.7			
12	Gibson et al. 1998: Fig.	Nippur		2A5e	Wheelmade	Storage	CO97						12th-14th	Riis and Poulson 1957: Fig. 855
13	A169223	Nippur		2A5e	Coilmade	Storage	CO80		77.3	11.1	96.7			
14	A169220	Nippur		2A5e	Handmade	Storage	CO80		75.2	10.1	65.7			
15	A169222	Nippur		2A5e	Coilmade	Storage	CO80		69.3	8.4	77.5	CA200731		
16	A169224	Nippur		2C5e	Handmade	Storage	CO123		78.4	11.8	129			
17	A169226	Nippur		2B5e	Coilmade	Storage	CO80		154.3	11.7	137.6	CA200732		

Plate 21

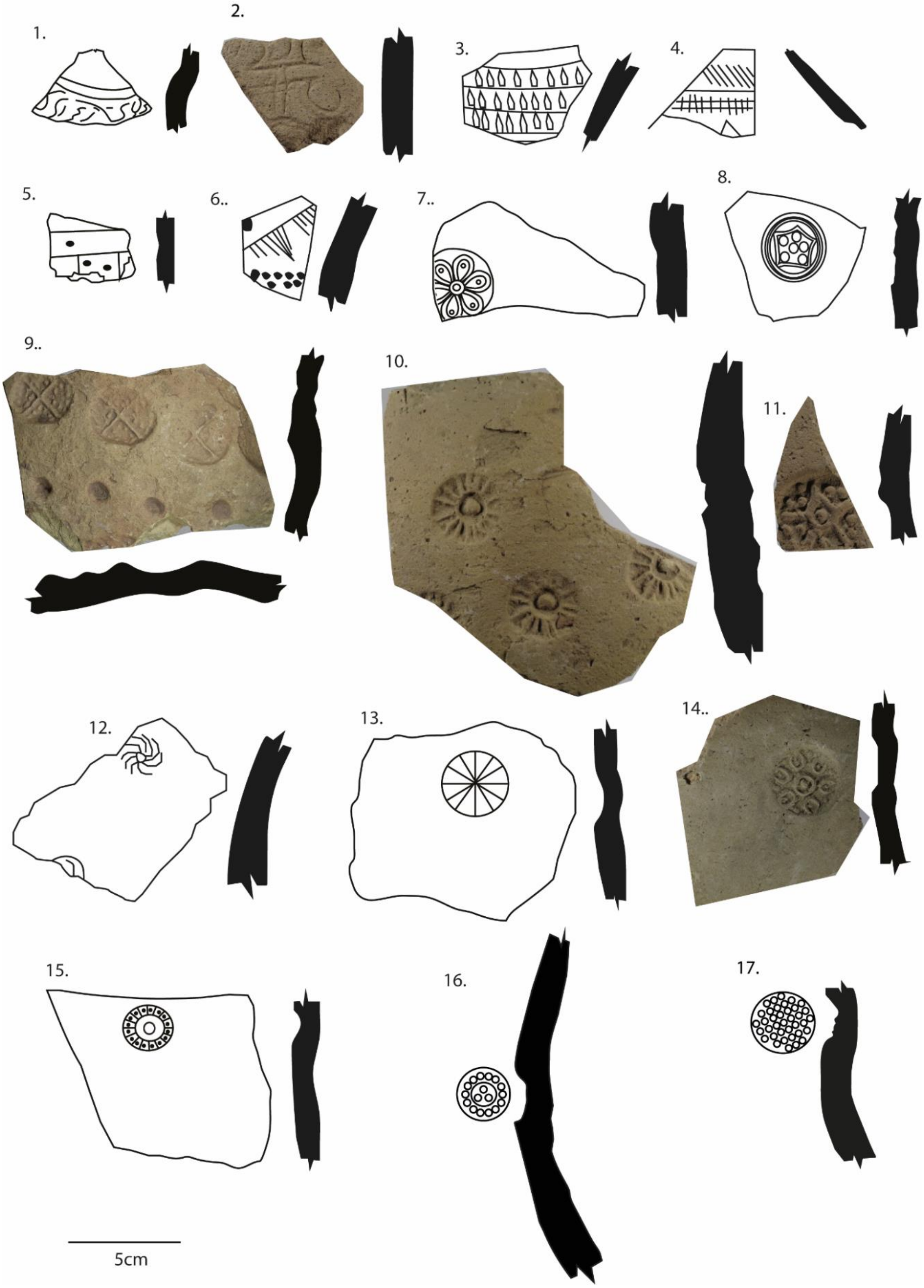

Plate 22

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	A169187	Nippur		7A7a	Wheelmade	Serving	CO69		45.4	6.6	49.5			
2	A169207	Nippur		2A7a	Wheelmade	Serving	CO55		35	6.3	30.9	CA200727	13th-15th	Watson 2004: 454
3	A169206	Nippur		2A7a	Wheelmade	Serving	CO55		39.4	7.4	39.5	CA200726	13th-15th	Watson 2004: 454
4	A169191A	Nippur		2A7b	Wheelmade	Serving	CO55		54.6	7.6	48.2			
5	A169195	Nippur		3A7b	Wheelmade	Serving	CO55		63.1	8.5	19.1			
6	A169208	Nippur		2A7c	Wheelmade	Serving	CO55		44.6	7.5	36.2		10th-11th	Whitehouse 1979: 39
7	A169205	Nippur		3A7c	Wheelmade	Serving	CO55		64.8	5.7	39.3		10th-11th	Whitehouse 1979: 39
8	Gibson et al. 1998: Fig. 22.2	Nippur		2A7a	Wheelmade	Serving	CO55						12th-14th	Adams 1965:134
9	A169211	Nippur		3A7c	Wheelmade	Serving	CO55		56.3	4.9	42		10th-11th	Whitehouse 1979: 39
10	A169210	Nippur		3A7c	Wheelmade	Serving	CO55		51.4	7.9	59.8	CA200728		
11	A169197	Nippur		7A7d	Wheelmade	Serving	CO69		21.1	3.2	16.4			
12	A169194	Nippur		2A7d	Wheelmade	Serving	CO55		38.2	6.2	50.7			
13	A169184	Nippur		2A7d	Wheelmade	Serving	CO55		73.1	7.7	55.6	CA200725		
14	A169192	Nippur		2A7e	Wheelmade	Serving	CO55		24.3	4.6	42		15th	ROM 909.42.7
15	Gibson et al. 1998: Fig. 22.1	Nippur		2A7e	Wheelmade	Serving	CO55						12th-14th	Safar 1945: Fig. 20, no. 97; Lane 1971: Fig. 19A, 14-15
16	A169188	Nippur		7A7g	Wheelmade	Serving	CO55		46	4.5	32.5			
17	A169185	Nippur		2A7g	Wheelmade	Serving	CO55		69.4	8	36.2			
18	A169189	Nippur		2A7g	Wheelmade	Serving	CO55		33.1	8.8	31.1			
19	Gibson et al. 1998: Fig. 21.6	Nippur		2A7g	Wheelmade	Serving	CO55						12th-14th	Safar 1945: Fig. 19 no. 63
20	Gibson et al. 1998: Fig. 21.3	Nippur		2A7g	Wheelmade	Serving	CO55						12th-14th	Adams 1965:134; Rosen-Ayalon 1974: 151; Pl. 94A
21	A169190	Nippur		3A7j1	Wheelmade	Serving	CO55		32.4	6.3	24			
22	A169204	Nippur		2A7j1	Wheelmade	Serving	CO55		59.2	11	40.5			
23	A169186	Nippur		2A7j1	Wheelmade	Serving	CO55		65.8	12.8	61.8			
24	A169183	Nippur		3A7j1	Wheelmade	Serving	CO55		74.5	7.9	74.4			
25	A169193	Nippur		2A7k	Wheelmade	Serving	CO55		23.9	5.1	19.8		13th-14th	Féhérvári 2000: No. 286, CER1767TSR
26	A169182	Nippur		2A7k	Wheelmade	Serving	CO55		72	11.3	68.5			

Plate 22

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16.
17.
18.
Clear
Glaze
White Slip
19.
20.
21.
22.
23.
24.
25.
26.
5cm

Plate 23

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	93-4-150	Hasanlu	102	2B4	Handmade	Storage	CO101	4	117.7	9.7	90.9			
2	63-5-2058	Hasanlu	312	3A7a	Wheelmade	Serving	CO55	30	64.9	7.6	123.9	CA200368		
3	63-5-2038.1	Hasanlu	338	7A7d	Moulded	Serving	CO69	16	68.2	3	106.1		13th-14th	Danti 2004:42; Lane 1947: 45-46, Fig. 86, 91; Grube 1976: 189, no. 136; Kiani 1978: 63, no. 115).
4	63-5-113.14	Hasanlu	338	7A7h	Wheelmade	Serving	CO69	12	25.2	4.6	49		13th-14th	Danti 2004; Color Plate C-D
5	93-4-143	Hasanlu	338	7A7f	Wheelmade	Serving	CO69	24	27.5	6.1	75.6		12th-13th	Danti 2004: 42; Watson 1985; 108-9 Fig. 87)
6	63-5-2057	Hasanlu	339	3A7c	Wheelmade	Serving	CO55	23	81.7	6.6	183		12th-13th	Danti 2004: 36; Aslanov et al. 1997: 402; Pl. 10; Féhérvári 2000: no. 84, CER536TSR
7	93-4-152	Hasanlu	436	3B4	Wheelmade	Liquid Storage	CO111	c. 14	84	7	84.8	CA200365		
8	63-5-2063	Hasanlu	438	2A4	Wheelmade	Liquid Storage	CO91	13	55	4.6	74.2			
9	60-20-331	Hasanlu	449	2A5c	Wheelmade	Liquid Storage	CO95	5	58.1	3.5	48.3		11-14th	
10	93-4-148	Hasanlu	505	3B3	Wheelmade	Liquid Storage	CO109	5	101.8	6.5	167.5		12th	Los Angeles County Museum of Art (M.2002.1.140)
11	93-4-146	Hasanlu	504	3A3	Wheelmade	Other	CO141	12	45.1	7	132.6			

Plate 23

1.
4cm
2.
30cm
3.
16cm
4.
12cm
5.
6.
23cm
7.
Wavy Rim
ca. 14
8.
13cm
Filter
9.
5cm
Filter
10.
5cm
11.
12cm
6cm
5cm

Plate 24

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	93-4-153.1	Hasanlu		3B4	Wheelmade	Serving	CO62		20.8	5.3	42.6			
2	93-4-151	Hasanlu		3B4	Wheelmade	Storage	CO113		61.4	7.1	132.3			
3	63-5-2067	Hasanlu		2A5b	Wheelmade	Serving	CO50		58.4	6	50.5			
4	63-5-2066	Hasanlu		3A5b	Wheelmade	Storage	CO14		75.2	5.1	96.3			
5	93-4-147	Hasanlu		3B5b	Wheelmade	Cooking	CO14		75.2	5.4	37	CA200364		
6	63-5-2050	Hasanlu		2A5c	Wheelmade	Serving	CO50		100.8	5.4	65.1		11th-12th	Watson Ab.1
7	93-4-145.6	Hasanlu		2A5c	Wheelmade	Serving	CO50		32.3	4.9	52.3		11th-12th	Watson Ab.1
8	93-4-145.1	Hasanlu		2A5c	Wheelmade	Serving	CO50		24.1	5.1	14.3		11th-12th	Watson Ab.1
9	93-4-145.7	Hasanlu		2A5c	Wheelmade	Serving	CO50		24.5	5.6	15.6		11th-12th	Watson Ab.1
10	93-4-145.2	Hasanlu		2A5c	Wheelmade	Serving	CO50		22.1	6.6	35.2		11th-12th	Watson Ab.1
11	93-4-145.5	Hasanlu		2A5c	Wheelmade	Serving	CO50		10.8	5.2	25.3		11th-12th	Watson Ab.1
12	93-4-145.3	Hasanlu		2A5c	Wheelmade	Serving	CO50		15.7	4.9	37.1		11th-12th	Watson Ab.1
13	93-4-145.4	Hasanlu		2A5c	Wheelmade	Serving	CO50		9.8	4.6	20.4		11th-12th	Watson Ab.1
14	60-20-328.2	Hasanlu		2A5c	Wheelmade	Serving	CO50		35.1	4.4	24.8			
15	61-5-920	Hasanlu		2A8	Moulded	Serving	CO44		22.5	3.2	41.7			
16	63-5-2061	Hasanlu		2A6	Wheelmade	Serving	CO54		32.8	6.2	36.4			
17	61-5-919	Hasanlu		3B7a	Coilmade	Storage	CO106		94.9	12.8	86.7	CA200368		
18	63-5-2047	Hasanlu		2A7a	Wheelmade	Serving	CO55		18.4	6.1	37.3			
19	63-5-2059	Hasanlu		3A7a	Wheelmade	Serving	CO55		50.6	7.3	37.7			
20	63-5-2062.2	Hasanlu		2A7a	Wheelmade	Serving	CO55		27	7.7	42			
21	63-5-2038.2	Hasanlu		7A7d	Moulded	Serving	CO55		44.1	3.2	85.1			
22	63-5-2038.3	Hasanlu		7A7d	Moulded	Serving	CO55		33.8	3.5	27.9			
23	63-5-113.15	Hasanlu		7A7h	Wheelmade	Serving	CO55		40.9	7.3	34.3		13th-14th	Danti 2004; Color Plate C-D
24	63-5-113.1	Hasanlu		7A7h	Wheelmade	Serving	CO55		53.9	6.9	81.3		13th-14th	Danti 2004; Color Plate C-D
25	63-5-113.13	Hasanlu		7A7h	Wheelmade	Serving	CO55		22.4	6	11.9		13th-14th	Danti 2004; Color Plate C-D
26	63-5-113.2	Hasanlu		7A7h	Wheelmade	Serving	CO55		29.3	7.4	17.1		13th-14th	Danti 2004; Color Plate C-D
27	63-5-113.3	Hasanlu		7A7h	Wheelmade	Serving	CO55		22.1	11.1	15.8		13th-14th	Danti 2004; Color Plate C-D
28	63-5-113.12	Hasanlu		7A7h	Wheelmade	Serving	CO55		24.5	7.2	20		13th-14th	Danti 2004; Color Plate C-D
29	63-5-113.11	Hasanlu		7A7h	Wheelmade	Serving	CO55		31.8	8	19.8		13th-14th	Danti 2004; Color Plate C-D
30	63-5-113.10	Hasanlu		7A7h	Wheelmade	Serving	CO55		19.7	9.3	19.6		13th-14th	Danti 2004; Color Plate C-D
31	63-5-113.9	Hasanlu		7A7h	Wheelmade	Serving	CO55		49.2	8.4	31.9		13th-14th	Danti 2004; Color Plate C-D
32	63-5-113.7	Hasanlu		7A7h	Wheelmade	Serving	CO55		56.1	9.5	40.6		13th-14th	Danti 2004; Color Plate C-D
33	63-5-113.8	Hasanlu		7A7h	Wheelmade	Serving	CO55		71.2	8.7	17.3		13th-14th	Danti 2004; Color Plate C-D

Plate 24

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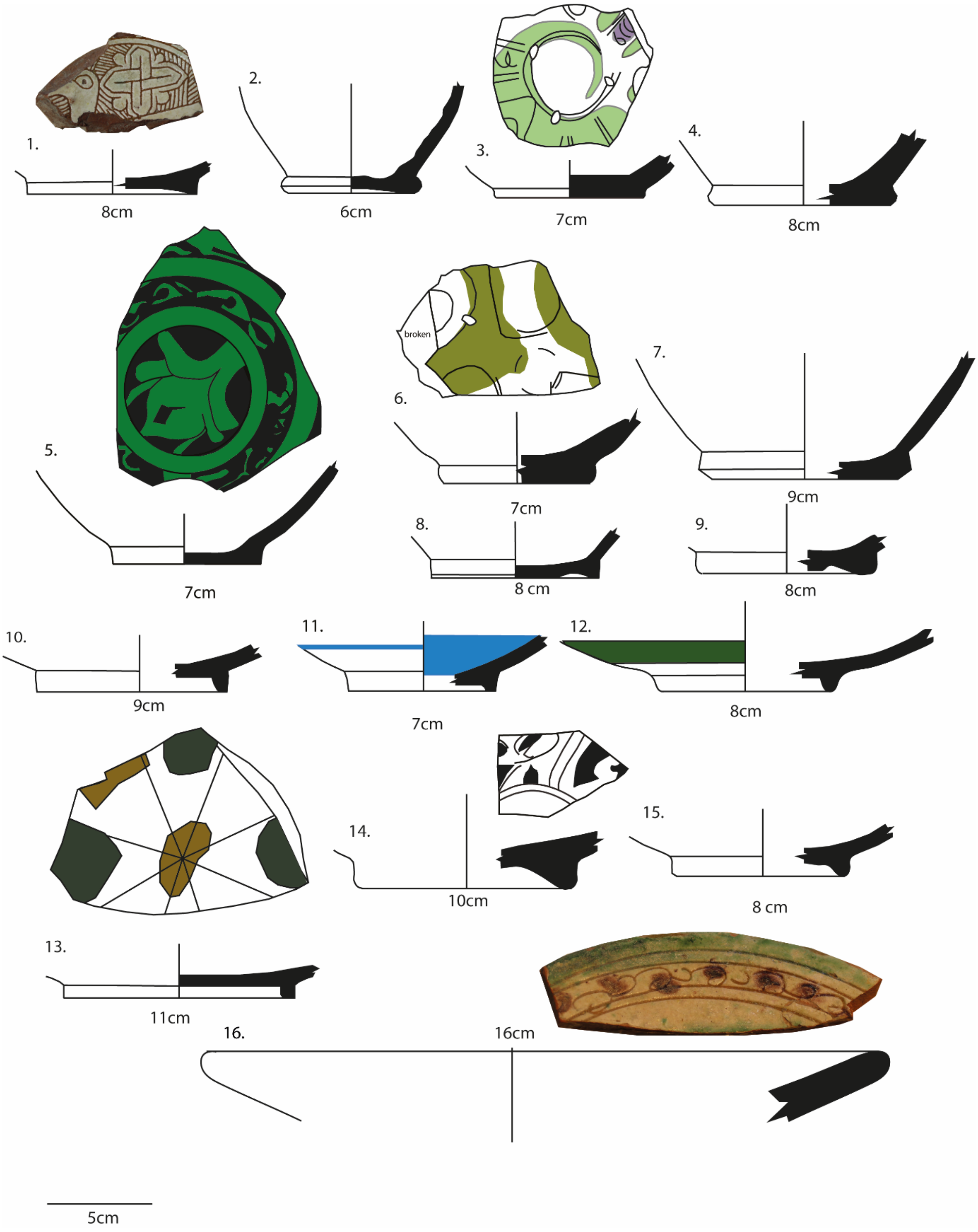
33.
5cm

Plate 25

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	35-7-236	Rayy	104	2A7c	Wheelmade	Serving	CO55	8	14.8	9	74.7		11th-12th	Watson 2004: 258
2	35-7-994	Rayy	104	2A4	Wheelmade	Serving	CO47	6	56.7	4.7	97.8	CA200338		
3	35-7-1002	Rayy	105	2A7c	Wheelmade	Serving	CO55	7	18.6	8.6	77.5			
4	37-38-209	Rayy	105	2A7a	Wheelmade	Serving	CO55	8	34	13.5	35.3			
5	37-11-34	Rayy	105	3A7c	Wheelmade	Serving	CO55	7	52	6.9	117.8			
6	35-7-259	Rayy	105	2A7c	Wheelmade	Serving	CO55	7	27.3	13	102.4			
7	35-7-1015	Rayy	105	3A4	Wheelmade	Storage	CO87	9	63.2	4.5	126.4	CA200326		
8	35-7-989	Rayy	108	2A4	Wheelmade	Serving	CO49	8	20.3	4.8	80.1			
9	37-38-211	Rayy	108	3A7a	Wheelmade	Serving	CO55	8	15.3	5.7	66.5			
10	37-38-199	Rayy	109	2A7a	Wheelmade	Serving	CO55	9	19.1	8.1	73.4			
11	35-7-1014	Rayy	109	2A7a	Wheelmade	Serving	CO55	7	20.3	5.7	56.3	CA200325		
12	37-38-201	Rayy	109	3A7a	Wheelmade	Serving	CO55	8	37.6	4.8	77.2			
13	35-7-200	Rayy	109	2A7c	Wheelmade	Serving	CO55	11	22.7	10.6	124.5			
14	35-7-143	Rayy	111	3A7c	Wheelmade	Serving	CO55	10	22.9	8.8	61.4			
15	37-38-203	Rayy	111	2A7a	Wheelmade	Serving	CO55	8	18.3	6.8	65.5			
16	37-38-192	Rayy	303	3A7c	Wheelmade	Serving	CO55	16	33.2	5	100.5			

Plate 25



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15.
8 cm
16.
16cm
5cm

Plate 26

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	35-7-997	Rayy	307	3A7c	Wheelmade	Serving	CO55	15	44.2	4.7	59			
2	35-7-203	Rayy	307	3A7c	Wheelmade	Serving	CO55	c. 15	47.7	6.2	50.2		13th-14th	Watson 2004: 411; 2004: 264; Fitzwilliam Museum C.18.3-1948; C.4.1.-1919; C.4.21-1919
3	35-7-465	Rayy	307	2A7c	Wheelmade	Serving	CO55	10	41.3	4.3	46.4			
4	35-7-419	Rayy	307	2A7c	Wheelmade	Serving	CO55	20	24.2	4.9	44.8			
5	35-7-996	Rayy	307	3A7c	Wheelmade	Serving	CO55	20	54.4	5.2	63.7			
6	35-7-115	Rayy	314	3A7c	Wheelmade	Serving	CO55	26	106.6	10.7	244.2			
7	35-7-1001	Rayy	314	2A7c	Wheelmade	Serving	CO55	20	71.8	6.7	70.6			
8	35-7-1000	Rayy	314	3A7c	Wheelmade	Serving	CO55	18	44.2	3.7	75.6			
9	35-7-356	Rayy	314	3A7c	Wheelmade	Serving	CO55	14	49.5	5.4	60.6		10th-12th	Watson 2004: 256-257; Detroit Institute of Arts (A.C.E. 1925: 32: no.6
10	37-38-207	Rayy	325	2A7a	Wheelmade	Serving	CO55	16	21.7	7.6	94.4			
11	37-38-194	Rayy	325	2A4	Wheelmade	Serving	CO48	11	42.4	5.7	68.1	CA200345		
12	35-7-983	Rayy	326	2A4	Wheelmade	Food Processing	CO33	30	54.2	7.8	129.8	CA200332		
13	35-7-981	Rayy	334	3A7c	Wheelmade	Serving	CO33	28	65.9	6.9	113.7	CA200330		

Plate 26

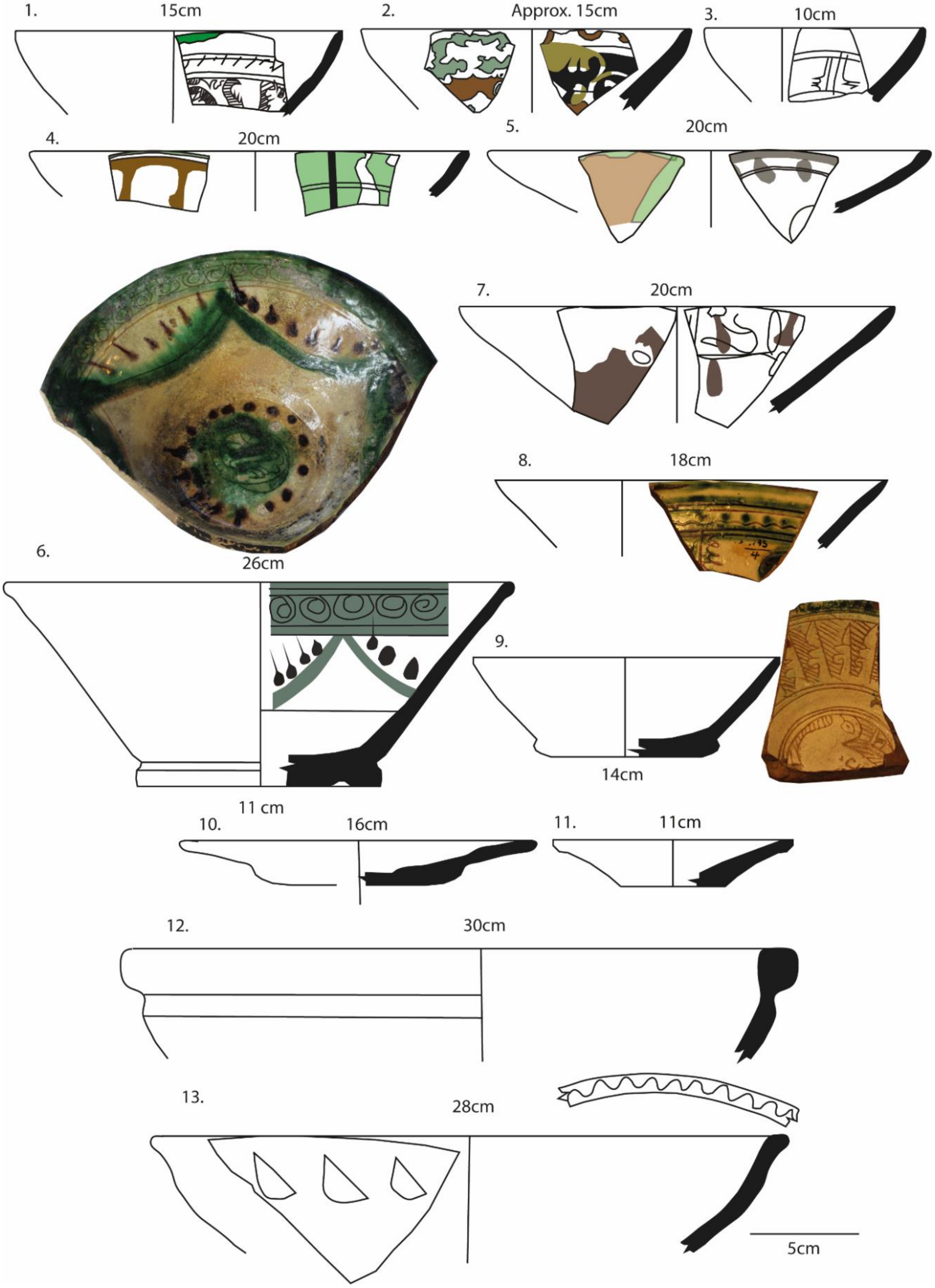
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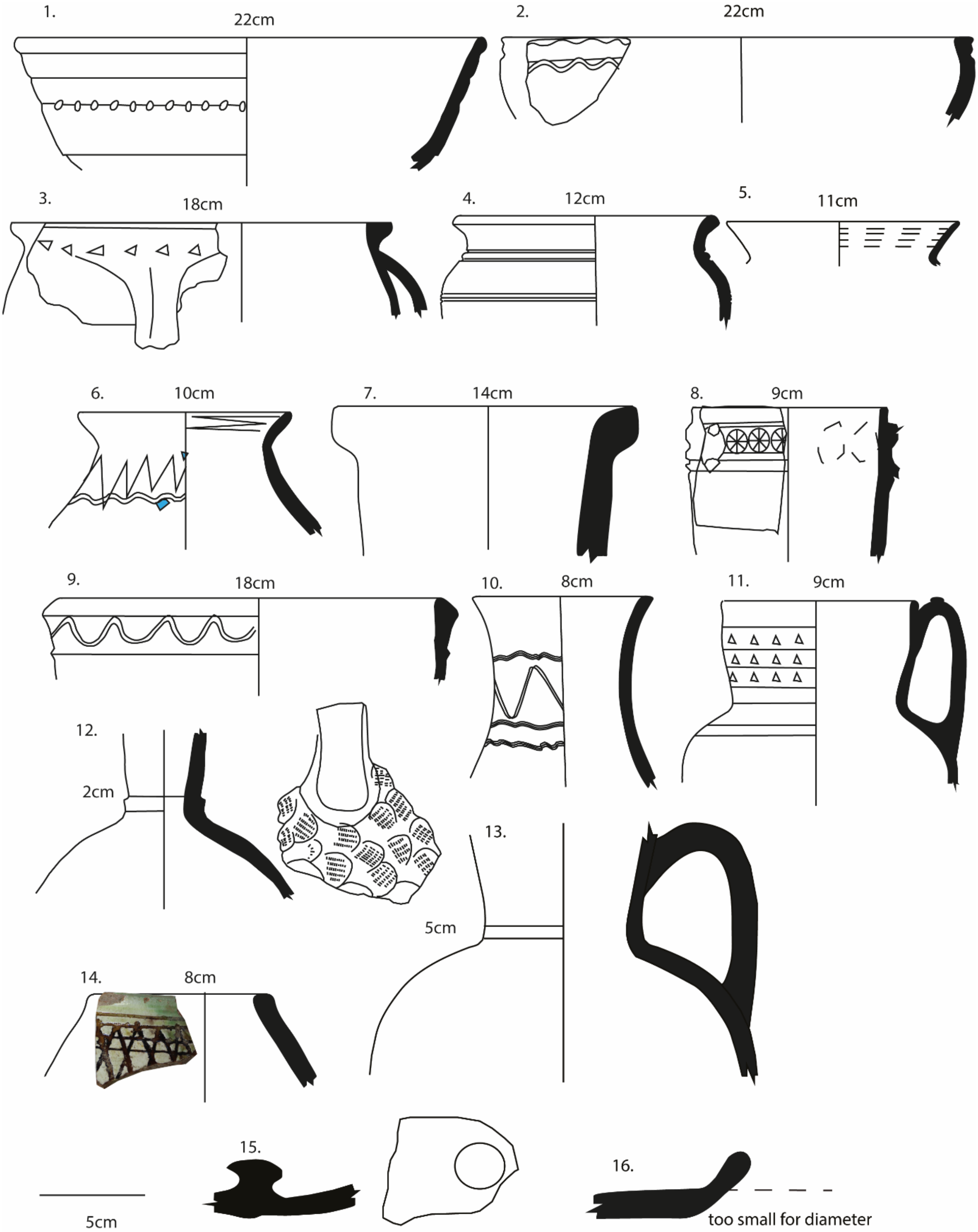
Plate 27

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	37-38-188	Rayy	336	2A7a	Wheelmade	Serving	CO55	22	65.3	5.4	84.8			
2	35-7-987	Rayy	337	3A7a	Moulded	Serving	CO43	22	40.8	6.4	48			
3	37-11-1304	Rayy	415	6B5	Wheelmade	Cooking	CO16	18	44.2	3	91.7	CA200339		
4	35-7-985	Rayy	417	3A5b	Coilmade	Liquid Storage	CO132	12	50.4	5.9	58.5	CA200334		
5	37-38-189	Rayy	432	2A4	Wheelmade	Liquid Storage	CO90	11	26	3.1	83.6	CA200343		
6	35-7-1012	Rayy	432	2A5g	Wheelmade	Serving	CO63	10	58.4	7.1	86.8	CA200324	11th-12th	Tonghini 1998: pl. 70-72; Rante and Collinet 2013: Fig. 107
7	35-7-984	Rayy	435	3A4	Wheelmade	Liquid Storage	CO87	14	72.7	8.9	82.6	CA200333		
8	35-7-990	Rayy	436	2A5e	Coilmade	Liquid Storage	CO97	9	70.9	6.2	49.5			
9	37-38-187	Rayy	440	2A7c	Wheelmade	Liquid Storage	CO99	18	37.4	7	81.8	CA200342		
10	37-11-1305	Rayy	445	3A5b	Wheelmade	Liquid Storage	CO115	8	88.5	4.7	82.6	CA200340		
11	37-38-214	Rayy	449	2A5e	Wheelmade	Liquid Storage	CO53	9	82.3	4.5	81.7	CA200351		
12	35-7-1009	Rayy		2A5c	Wheelmade	Serving	CO50		83.1	3.9	76			Féhérvári 2000; no. 254, CER1365TSR
13	37-38-197	Rayy	445	2A4	Wheelmade	Serving	CO47	6	126.4	9.2	121	CA200347		
14	35-7-198	Rayy	455	2A7c	Wheelmade	Liquid Storage	CO99	8	47.9	7.9	47.1		12th - 13th	Watson 2004: 263
15	37-38-212	Rayy	507	2A4	Wheelmade	Other	CO144		25	8.6	44.5			Wilkinson 1973: no. 47
16	37-38-205	Rayy		2A7a	Wheelmade	Other	CO140		11.9	4.7	28.5			

Plate 27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16.
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Plate 28

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	35-7-704	Rayy	501	5A8	Moulded	Liquid Storage/ Transport	CO84		69.5	7	40.3			
2	35-7-686	Rayy	501	5A8	Moulded	Liquid Storage/ Transport	CO84		36.5	15.8	76.9		11th-13th	UPM 37-11-657 (Rayy)
3	35-7-819	Rayy	501	5A8	Moulded	Liquid Storage/ Transport	CO84		44	7.1	93.6			
4	37-11-1103	Rayy	501	5A8	Moulded	Liquid Storage/ Transport	CO84		90.4	10.6	92.3		11th-13th	UPM 37-11-658 (Rayy)
5	35-7-817	Rayy	501	5A8	Moulded	Liquid Storage/ Transport	CO84		111	17.3	82.3			
6	35-7-1008	Rayy		2A10b	Wheelmade	Serving	CO56		68.4	3.8	59.9		11th-12th	Baxter 1989: Figure 15
7	37-38-198	Rayy		2A4	Wheelmade	Storage	CO88		51.7	4.4	108.4	CA200348		
8	37-11-1303	Rayy		2A5a	Wheelmade	Storage	CO95		66.1	4.1	59.4			
9	35-7-1006	Rayy		2A5a	Wheelmade	Serving	CO50		36.2	8.9	66.5			
10	35-7-982	Rayy		3A5a	Wheelmade	Storage	CO82		46.5	8.3	47.3	CA200331		
11	35-7-1010	Rayy		2A5a	Wheelmade	Storage	CO95		50.8	3.4	69.3			
12	37-38-213	Rayy		2A5a	Wheelmade	Serving	CO93		96.4	9.5	108.5	CA200350		
13	35-7-1007	Rayy		2A5e	Coilmade	Storage	CO80		76.1	8.7	74.9	CA200323	8th	Watson Aa.2
14	35-7-1016	Rayy		2B5g	Wheelmade	Storage	CO98		94.5	6.3	85	CA200327		Tonghini 1998: pl. 70-72; Rante and Collinet 2013: Fig. 107

Plate 28

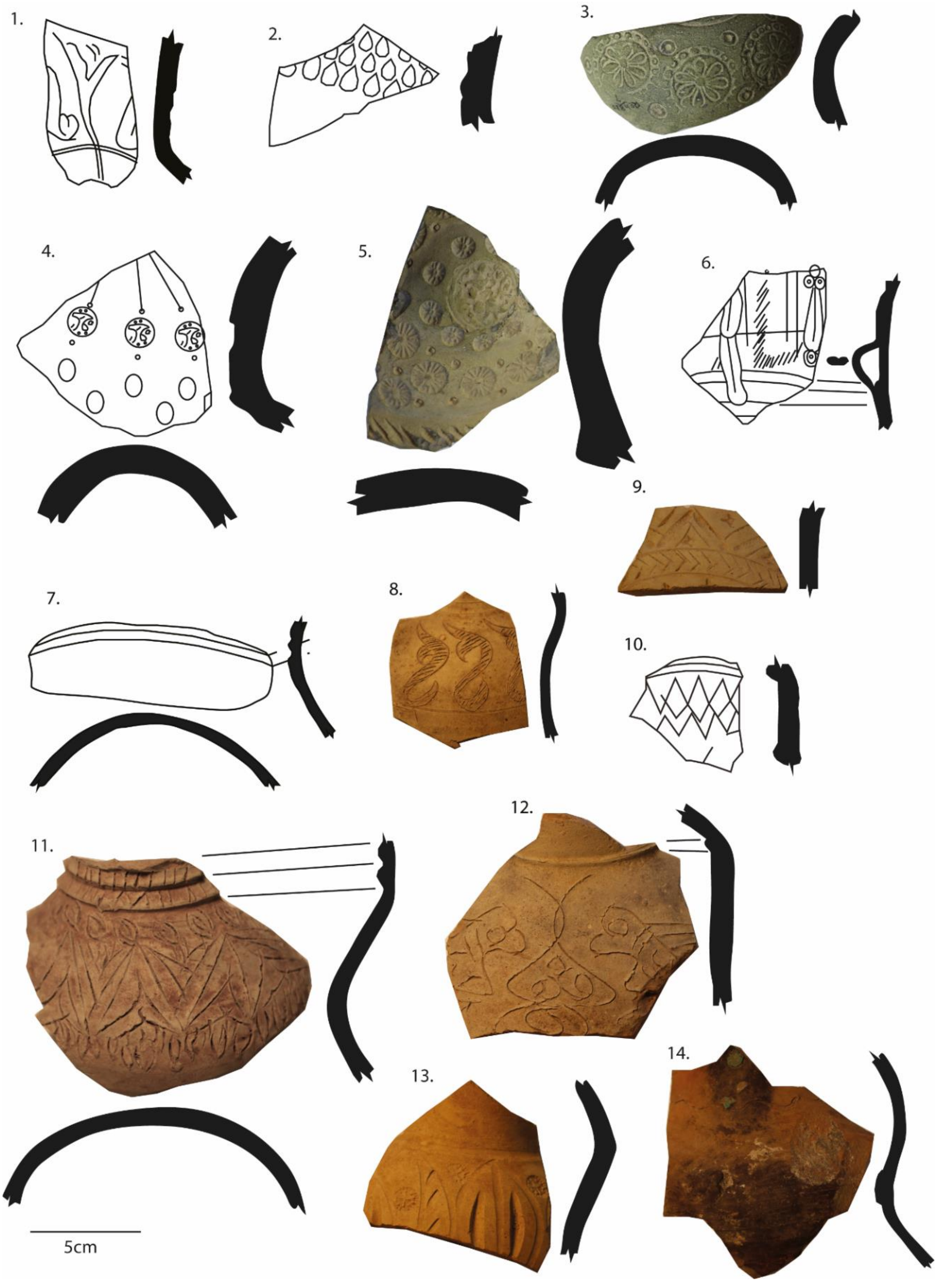

Plate 29

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	37-11-1112	Rayy		2B5e	Coilmade	Storage	CO105		284.5	20.4	419.3			
2	35-7-993	Rayy		2A4	Wheelmade	Storage	CO90		44.3	4.4	36	CA200337		
3	35-7-992	Rayy		2A5e	Wheelmade	Serving	CO53		26.7	3.6	41.8			
4	35-7-991	Rayy		2A5e	Wheelmade	Storage	CO97		36.8	5	62.8			
5	37-11-168	Rayy		2A8	Moulded	Serving	CO44		85.6	8.1	166.6	CA200341		
6	35-7-1003	Rayy		2A10b	Wheelmade	Serving	CO56		48.7	6.9	52.1		8th-9th; 12th-13th	Watson Aa.3
7	35-7-680	Rayy		2A10b	Wheelmade	Serving	CO56		41.4	6.2	53.7		8th-9th; 12th-13th	Watson Aa.3
8	35-7-1011	Rayy		2A10b	Wheelmade	Serving	CO56		47	4.9	60.9		8th-9th; 12th-13th	Watson Aa.3
9	37-38-190.2	Rayy		2A10b	Coilmade	Serving	CO42		35	4.2	45		8th-9th; 12th-13th	Watson Aa.3
10	37-38-196	Rayy		2A10b	Coilmade	Serving	CO42		72.5	7.7	112.3		8th-9th; 12th-13th	Watson Aa.3
11	37-38-190.1	Rayy		2A10b	Coilmade	Serving	CO42		39.3	5.3	117.5		8th-9th; 12th-13th	Watson Aa.3
12	35-7-1004	Rayy		2A10b	Wheelmade	Storage	CO100		87.9	5.5	67.1		8th-9th; 12th-13th	Watson Aa.3
13	35-7-1005	Rayy		2A10b	Wheelmade	Serving	CO56		63.1	5.9	86.4		8th-9th; 12th-13th	Watson Aa.3

Plate 29

Plate 30

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	37-38-200	Rayy		2A7a	Wheelmade	Storage	CO99		62.3	5.7	73.4	CA200349		
2	35-7-194	Rayy		3A7a	Wheelmade	Serving	CO55		65.5	8.1	44.2	CA200328		
3	37-38-206	Rayy		2A7a	Coilmade	Serving	CO40		61.3	4.7	53.1			
4	37-38-208	Rayy		2A10b	Coilmade	Liquid Storage	CO83		77.2	6.3	134.8		8th-10th	Watson Ba.4
5	35-7-1013	Rayy		3A7a	Wheelmade	Serving	CO55		38.9	8.6	79			
6	35-7-988	Rayy		3A7c	Wheelmade	Serving	CO64		59.9	7.4	45	CA200335		
7	37-38-210	Rayy		3A8	Moulded	Storage	CO55		50.3	8.1	49.1			
8	35-7-998	Rayy		3A7c	Wheelmade	Serving	CO55		51.4	7.2	82.5			
9	37-38-204	Rayy		7A7a	Moulded	Serving	CO69		26.4	7.6	33.9			
10	37-38-193	Rayy		2A7c	Wheelmade	Serving	CO55		18	4.8	41.5			
11	35-7-211	Rayy		3A7c	Wheelmade	Serving	CO55		31.5	6.9	42.1			
12	35-7-999	Rayy		2A7c	Wheelmade	Serving	CO55		61.1	7.2	42.6		12th-13th	Fehérvári 2000: no.83; CER1743TSR
13	35-7-295	Rayy		3A7c	Wheelmade	Serving	CO55		32.4	10.3	80.5			
14	37-38-191	Rayy		2A7c	Wheelmade	Serving	CO55		51.6	4.9	65.2	CA200344		
15	35-7-255	Rayy		2A7c	Wheelmade	Serving	CO64		83.4	8.6	72.5	CA200329		
16	35-7-169	Rayy		3A7c	Wheelmade	Serving	CO55		42.4	4.1	66.6			
17	35-7-354	Rayy		2A7c	Wheelmade	Serving	CO55		31.6	5.5	31.9			
18	35-7-995	Rayy		3A7c	Wheelmade	Serving	CO55		62.1	5	27.4			
19	37-11-733	Rayy		2A7c	Wheelmade	Serving	CO55		63.6	5.8	48.2			
20	37-11-855	Rayy		2A7c	Wheelmade	Serving	CO55		69.8	7.1	48.5			
21	37-38-202	Rayy	Handle	3A7e3	Moulded	Serving	CO37		22.5	4.7	18.4			
22	37-11-777	Rayy		7A7i	Wheelmade	Serving	CO69		57.8	5.5	43		15th-17th	Jenkins 1983: 28; no. 31; Sarre 1925: Tafel XXIII

Plate 30

Plate 31

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	37-33-41	Chal Tarkhan	104	2A5b	Wheelmade	Serving	CO95	11	175.3	5.3	172.2			
2	37-33-64	Chal Tarkhan	307	2A7a	Wheelmade	Serving	CO55	18	56.3	7.1	95.2	CA200374		
3	37-33-58	Chal Tarkhan	436	2A7a	Wheelmade	Serving	CO55	14	63.9	5.9	65.2	CA200372		
4	37-33-59	Chal Tarkhan		2A5b	Wheelmade	Serving	CO50	14	87.6	4	102.4	CA200373		
5	37-33-62	Chal Tarkhan		2A5a	Wheelmade	Serving	CO50		64.2	5.7	109.3			
6	37-33-4	Chal Tarkhan		7A7f	Wheelmade	Serving	CO69		64.8	5.6	67.5		13th-14th	
7	37-33-49	Chal Tarkhan		2A4	Wheelmade	Storage	CO91		40.9	8.7	66.5			

Plate 31

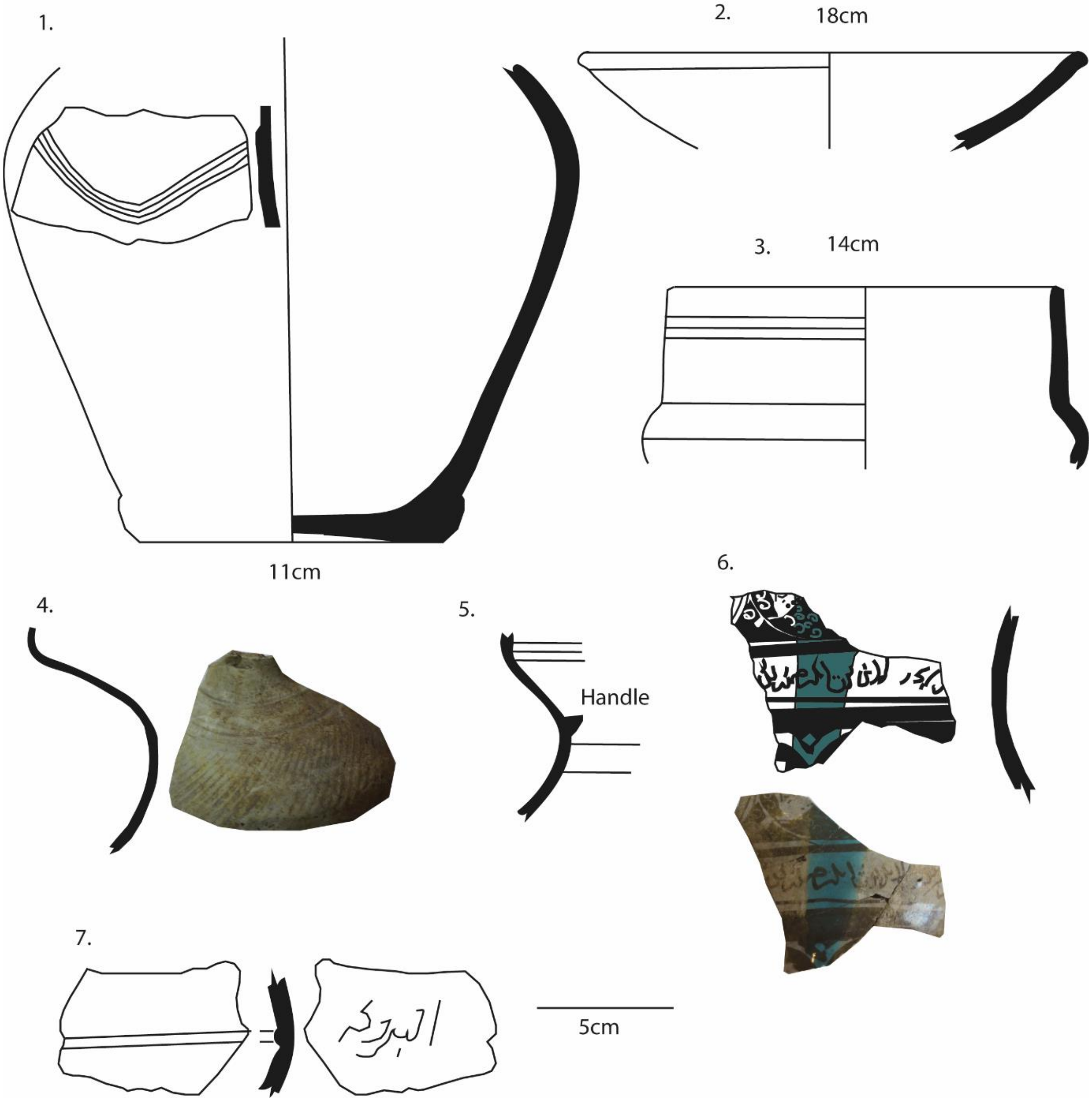

Plate 32

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	70-7-211	Firuzabad	101	3C4	Wheelmade	Storage	CO131	38	59.2	27.4	170.1			
2	70-7-171	Firuzabad	101	2C4	Coilmade	Storage	CO76	c. 27	76.4	20.4	157.4	CA200358		
3	Ingraham 1975 Plate VII:4				Wheelmade	Storage	CO55	28						
4	70-7-195	Firuzabad	102	2B4	Coilmade	Storage	CO103	22	116.5	17.9	238.5	CA200359		
5	70-7-197	Firuzabad	101	3A4	Wheelmade	Storage	CO91	10	88	11.4	134.4			
6	70-7-200	Firuzabad	105	2A4	Wheelmade	Storage	CO91	4	28.5	6.2	71.2			
7	Ingraham 1975: Plate VII: 3	Firuzabad	104	7A7j	Wheelmade	Serving	CO69	6						
8	Ingraham 1975: Plate V:54	Firuzabad	104	2C4	Wheelmade	Storage	CO66	10						
9	70-7-199	Firuzabad	104	2A4	Wheelmade	Serving	CO91	7	38.8	8.9	93.8			
10	70-7-199A	Firuzabad	105	2A4	Wheelmade	Storage	CO91	12	79.8	19.7	151.5			
11	70-7-191	Firuzabad	105	2C4	Handmade	Storage	CO121	25	98.4	21.7	240.6			
12	70-7-210	Firuzabad	106	4A4	Wheelmade	Storage	CO90	12	75.1	11.1	70.2			
13	70-7-199B	Firuzabad	105	2A4	Wheelmade	Storage	CO91	11	108	8.5	108.9			
14	70-7-198	Firuzabad	105	3A2	Coilmade	Storage	CO74	12	51	9.1	101.1			
15	Ingraham 1975: Plate VII: 6	Firuzabad	110	2B7e	Wheelmade	Serving	CO64	6						
16	Ingraham 1975: Plate VII:2	Firuzabad	110	7A7e	Wheelmade	Serving	CO69	6						
17	70-7-201	Firuzabad	110	2A4	Wheelmade	Serving	CO49	7	44.9	8.9	110.1			
18	70-7-189	Firuzabad	203	5C4	Wheelmade	Other	CO140	c.50	78.4	149.7	12.5		9th-11th	Rante and Collinet 2013: Fig.106
19	Ingraham 1975: Plate VII:1	Firuzabad	303	7A7e	Wheelmade	Serving	CO69	38						
20	70-7-180	Firuzabad	313	2C5a	Coilmade	Food Processing	CO28	38	136	14.5	169.8			
21	Ingraham 1975: Plate VII: 8	Firuzabad	314	7A7e	Wheelmade	Serving	CO69	24						
22	Ingraham 1975: Plate VII: 9	Firuzabad	314	7A7e	Wheelmade	Serving	CO9	24						
23	Ingraham 1975: Plate VII: 7	Firuzabad	314	2B7d	Wheelmade	Serving	CO64	26						
24	70-7-157	Firuzabad	326	3A4	Wheelmade	Food Processing	CO19	38	98.4	12.2	148.3			
25	70-7-165	Firuzabad	327	2C5a	Wheelmade	Food Processing	CO30	45	92.7	16.7	123.3			

Plate 32

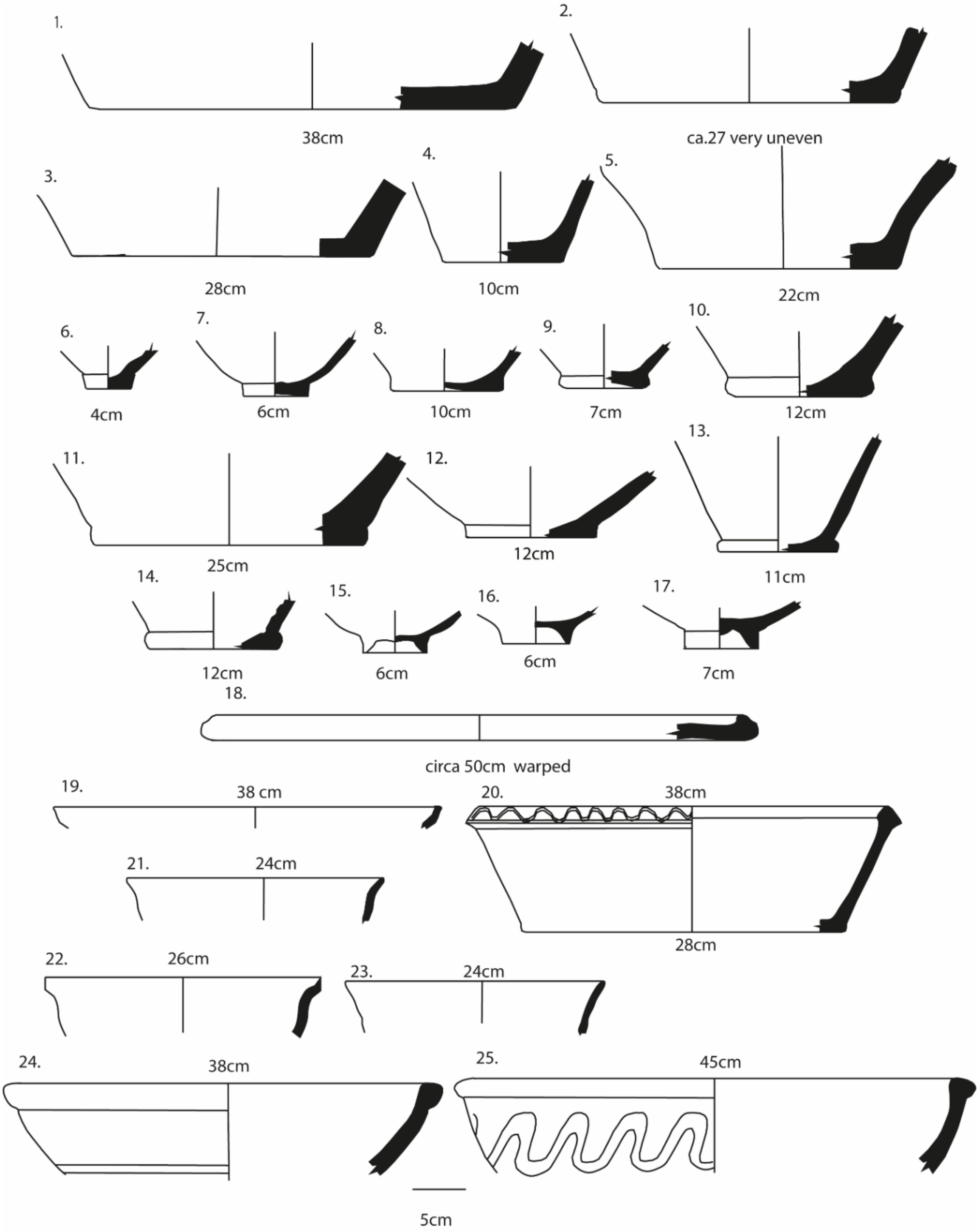

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Plate 33

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	Ingraham 1975: Plate I: 4	Firuzabad	327	3C4	Wheelmade	Storage	CO65	28						
2	Ingraham 1975: Plate VII:5	Firuzabad	330	2C7e	Wheelmade	Serving	CO67	32						
3	70-7-161	Firuzabad	330	2C4	Wheelmade	Food Processing	CO29	32	85.8	16.5	163.2			
4	70-7-167	Firuzabad	327	2C5a	Wheelmade	Food Processing	CO30	47	68.3	12	171.1			
5	70-7-162	Firuzabad	328	2C4	Wheelmade	Food Processing	CO29	45	76.6	18.2	107.4			
6	Ingraham 1975: Plate I: 5	Firuzabad	330	3C4	Wheelmade	Serving	CO65	32						
7	70-7-175	Firuzabad	330	2C4	Wheelmade	Food Processing	CO29	53	91.6	12.8	152.5		11th-12th	Rante and Collinet 2013: Fig. 88: 3
8	70-7-181	Firuzabad	332	2A4	Wheelmade	Food Processing	CO19	40	58.7	18.4	114.6			
9	70-7-185	Firuzabad	332	2C10a	Handmade	Food Processing	CO31	49	90.8	12.7	81			
10	70-7-170	Firuzabad	344	2C4	Handmade	Food Processing	CO32		55.9	22.4	142.5	CA200355		
11	Ingraham 1975: Plate III: 26	Firuzabad	333	2C5a	Wheelmade	Food Processing	CO30	44						
12	70-7-205	Firuzabad	340	2A6	Wheelmade	Serving	CO54	40	65.4	12.8	150.8			
13	70-7-186	Firuzabad	346	2B10a	Wheelmade	Food Processing	CO31	42	92.3	20.5	137.8			
14	70-7-187	Firuzabad	346	3C5a	Handmade	Food Processing	CO25	40	136	35.2	152.5			

Plate 33

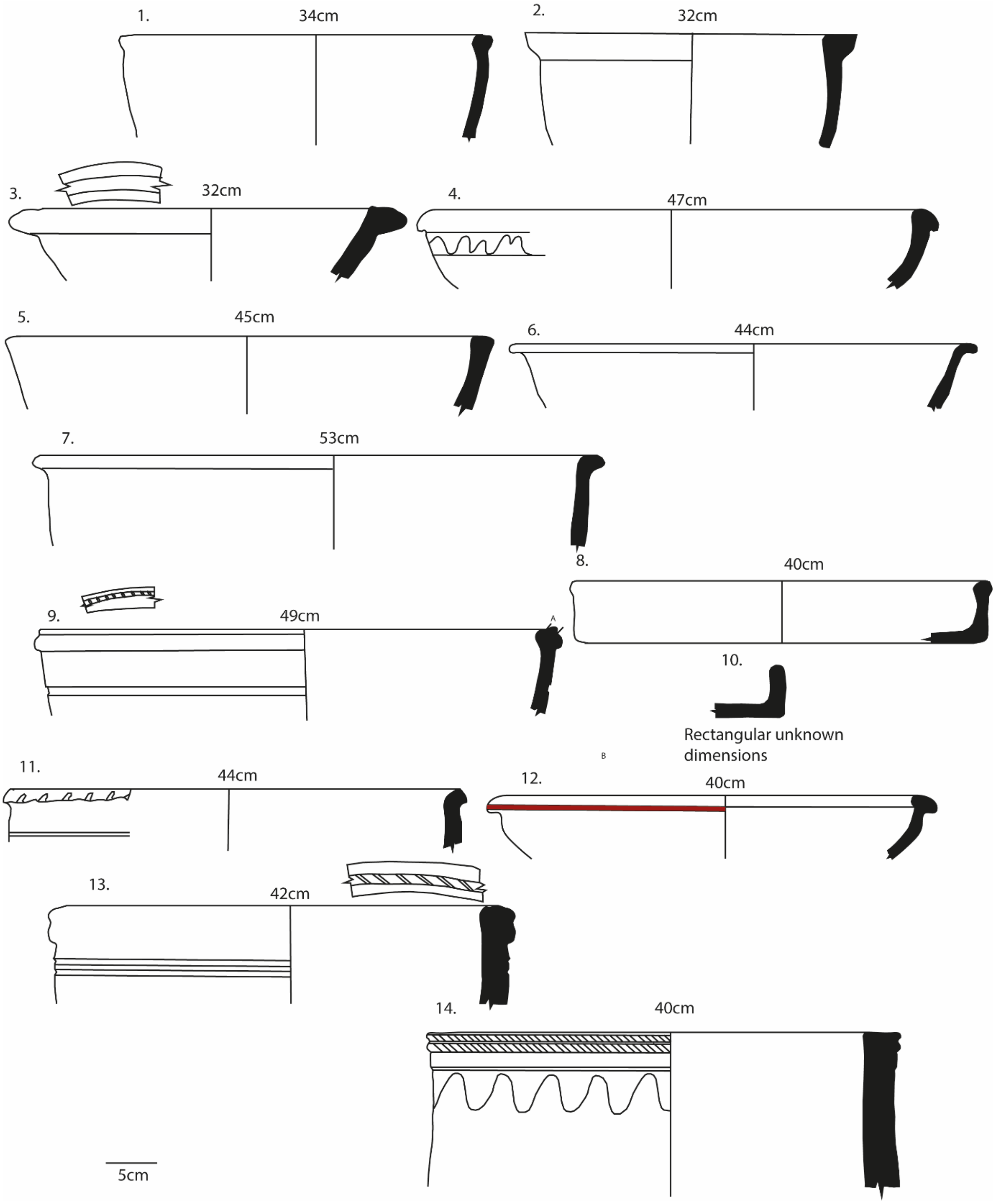
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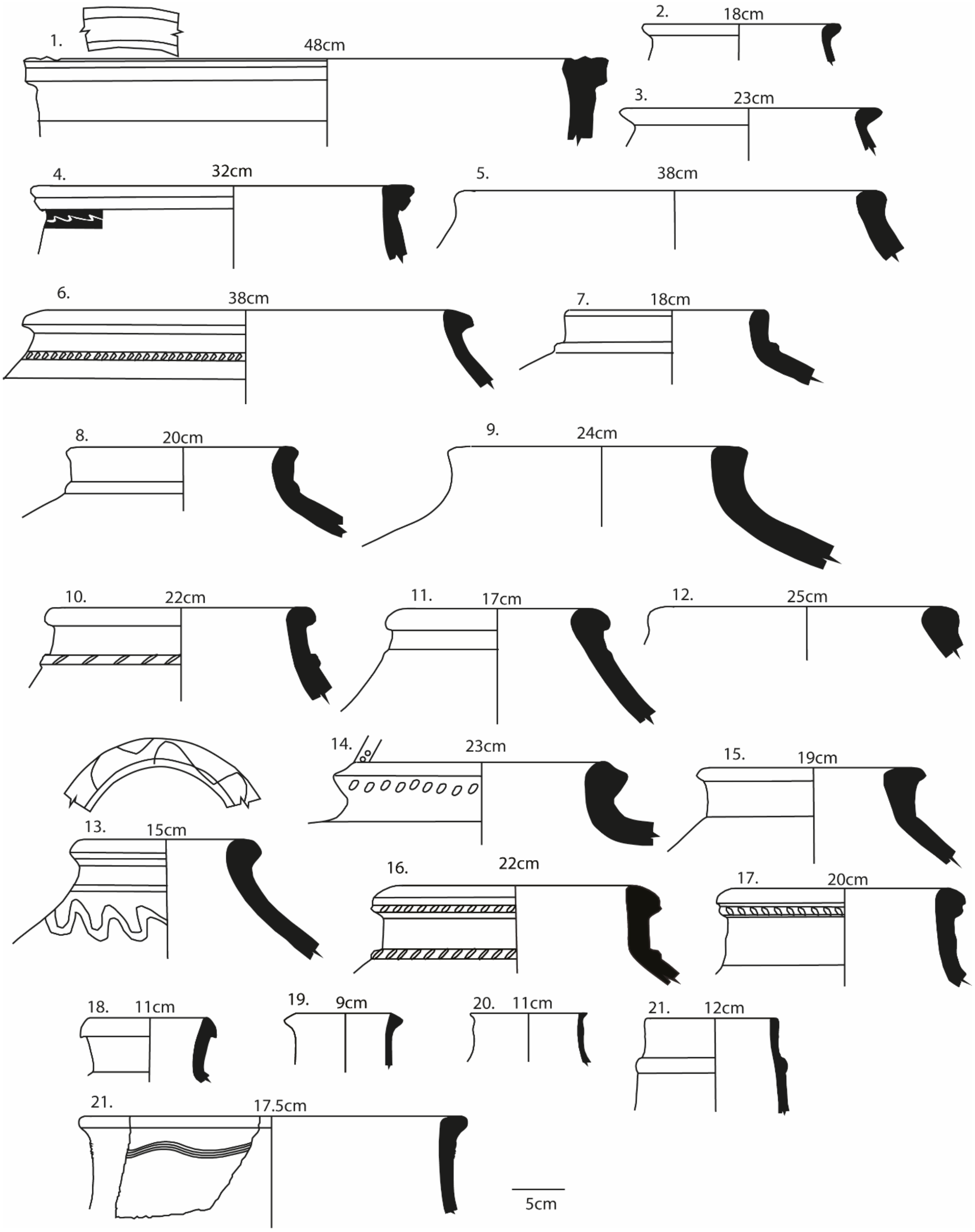
Plate 34

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	70-7-174	Firuzabad	402	2C5a	Wheelmade	Dry Storage	CO132	48	83.2	22.2	143.8			
2	Ingraham 1975: Plate IV:36	Firuzabad	404	2C4	Wheelmade	Dry Storage	CO91	18						
3	70-7-207	Firuzabad	404	6B4	Wheelmade	Cooking	CO4	23	36.8	7.5	90.6	CA200361		
4	70-7-176	Firuzabad	402	2A6	Coilmade	Dry Storage	CO81	32	65.6	15.7	98.1			
5	70-7-164B	Firuzabad	407	3A2	Coilmade	Dry Storage	CO74	38	69.3	17.3	108.2			
6	70-7-179	Firuzabad	408	2B10a	Wheelmade	Dry Storage	CO134	38	101.3	11.2	98.9			
7	70-7-164A	Firuzabad	421	2C10a	Wheelmade	Dry Straoge	CO134	18	90	17.7	134.5			
8	Ingraham 1975: Plate III:21	Firuzabad	421	2C4	Wheelmade	Dry Storage	CO131	20						
9	70-7-159	Firuzabad	421	3C4	Wheelmade	Dry Storage	CO121	24	154.3	21.7	172.9			
10	70-7-172	Firuzabad	422	2C10a	Wheelmade	Dry Storage	CO134	22	85.8	19.7	87.8			
11	70-7-156	Firuzabad	423	3C2	Coilmade	Dry Storage	CO125	17	152.2	20.6	145.6			
12	70-7-160	Firuzabad	423	3C4	Handmade	Dry Storage	CO121	25	52.6	20.5	80.7	CA200353		
13	70-7-194	Firuzabad	423	2B5a	Coilmade	Dry Storage	CO104	15	139.3	17.9	212.1			
14	70-7-184	Firuzabad	424	2C5e	Handmade	Dry Storage	CO122	23	82.3	19.2	240.9		11th-12th	Rante and Collinet 2013: Fig. 97: no. 16
15	70-7-196	Firuzabad	425	3B2	Wheelmade	Dry Storage	CO108	19	105.3	15.4	151.7	CA200359		
16	70-7-177	Firuzabad	423	2C10a	Wheelmade	Dry Storage	CO135	22	92.8	17.7	128	CA200357		
17	70-7-169	Firuzabad	430	2C10a	Coilmade	Dry Storage	CO135	20	93.7	17.4	145.6	CA200354		
18	70-7-202	Firuzabad	434	3A2	Wheelmade	Liquid Storage	CO85	11	62.5	7.4	146.3			
19	70-7-203B	Firuzabad	434	2A4	Wheelmade	Liquid Storage	CO91	9	45.1	5	61.9	CA200360	9-11th	Rante and Collette 2006: Fig. 90:3
20	Ingraham 1975: Plate IV:31	Firuzabad	436	2C4	Wheelmade	Liquid Storage	CO91	11						
21	70-7-206	Firuzabad	437	2A4	Coilmade	Liquid Storage	CO77	12	144.9	9.9	117.3		11th-12th	Rante Collette 2006: Fig. 87:49
22	70-7-209	Firuzabad	436	4A4	Wheelmade	Liquid Storage	CO90	12	43.1	4.4	44.8	CA200362		Rante and Collette 2006: Fig. 90:4

Plate 34



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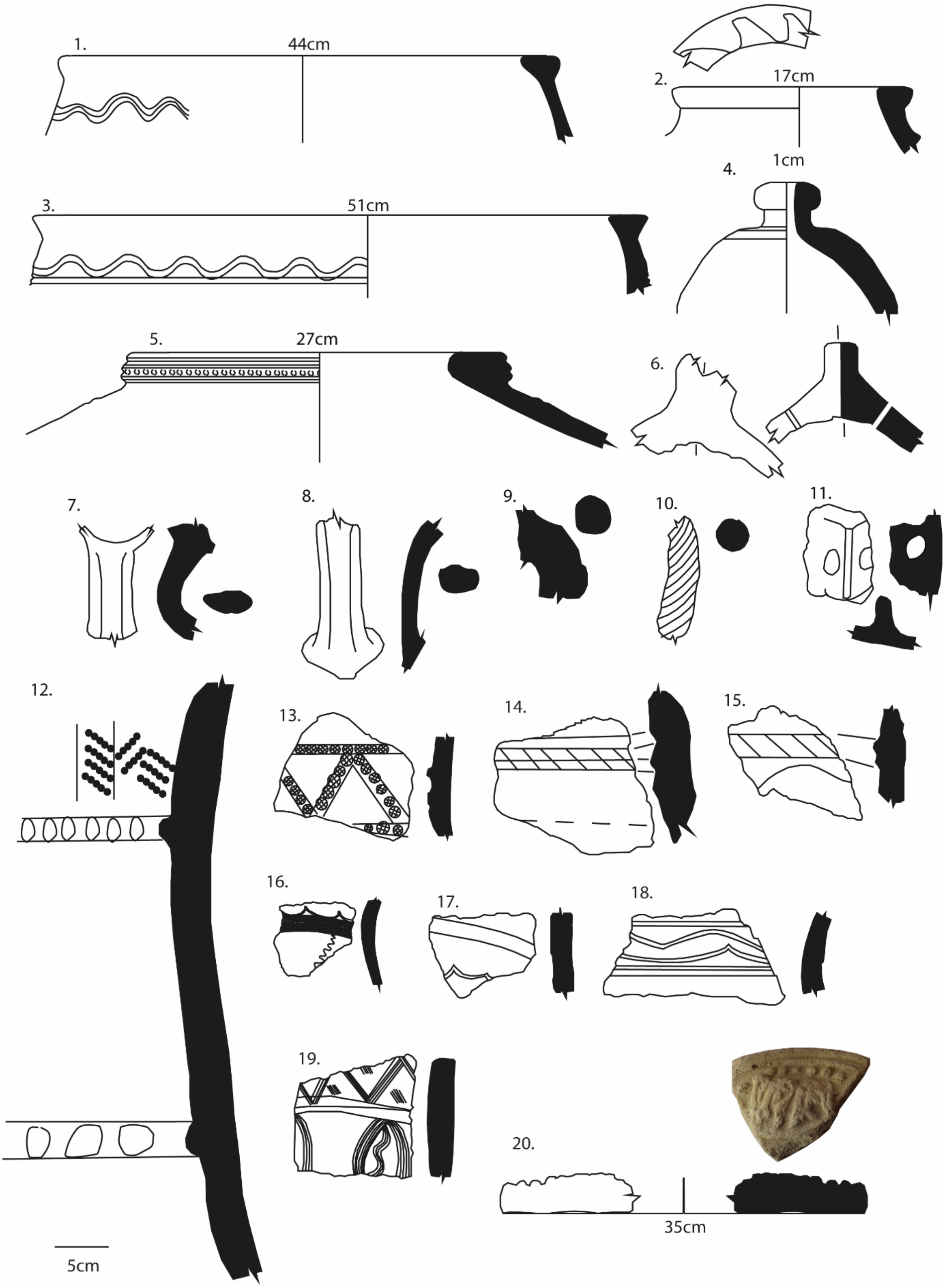
5cm

Plate 35

Plate Number	Sherd Number	Site Name	Form Code	Ware Code	Technique	Function	CO	Diameter (cm)	Height (mm)	Thickness (mm)	Width (mm)	Scientific Testing?	Date	Comparanda
1	Ingraham 1975: Plate III:27	Firuzabad	458	3C5b	Wheelmade	Storage	CO132	44						
2	70-7-155	Firuzabad	458	3B5a	Wheelmade	Storage	CO117	17	61	17.1	133.2			
3	70-7-158	Firuzabad	458	3C5a	Wheelmade	Storage	CO132	51	78.9	12.4	125.2	CA200352		
4	70-7-208	Firuzabad	501	5A8	Moulded	Liquid Storage/ Transport	CO84	1	72.9	12.1	86.3		11th-13th	Wilkinson 1973: 353 no. 111
5	70-7-183	Firuzabad	459	2C4	Handmade	Storage	CO121	27	152.3	18	176.4		8th-11th	Rante and Collette Like Fig. 80:4
6	70-7-178	Firuzabad	507	3B4	Moulded	Other	CO145		142.8	19.7	159.7		10th-12th	Wilkinson 1973: no. 47
7	70-7-213	Firuzabad	Handle	2A4	Handmade	Other	CO148		98.8	20.9	68			
8	70-7-215	Firuzabad	Handle	2A4	Handmade	Other	CO148		144.9	20.6	71.8			
9	70-7-214	Firuzabad	Handle	2C4	Handmade	Other	CO153		96.2	34.5	72.5			
10	70-7-217	Firuzabad	Handle	2A4	Handmade	Other	CO148		104.9	30.1	29.8			
11	70-7-216	Firuzabad	Handle	2A4	Handmade	Other	CO148		84.3	13	59.8			
12	70-7-192	Firuzabad		2C10a	Coilmade	Dry Storage	CO129		290.1	201.8	18.1			
13	70-7-193	Firuzabad		2A10b	Wheelmade	Liquid Storage	CO100		90.9	12.7	125.1			
14	70-7-166	Firuzabad		2C10a	Coilmade	Dry Storage	CO129		131.4	39	151.2			
15	70-7-173	Firuzabad		2B10a	Wheelmade	Storage	CO129		86.8	23.3	99.3			
16	70-7-204	Firuzabad		2B5c	Coilmade	Storage	CO104		138.4	20.9	140.9		9th-11th	Wilkinson 1973: 64
17	70-7-182	Firuzabad		2A5a	Wheelmade	Storage	CO95		72.7	17.8	99.8			
18	70-7-168	Firuzabad		2C5a	Coilmade	Storage	CO127		73.9	17.3	162.2			
19	70-7-163	Firuzabad		3A5b	Coilmade	Storage	CO78		108.7	17.6	105.8			
20	70-7-190	Firuzabad	508	2C8	Moulded	Architectural	CO139	35	127	21.3	148.5			

Plate 35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5cm

Appendix 5: Function

This flowchart (albeit broken into various lines) is used to determine the function of the material. Starting with a sherd, first one determines the form, then the ware type, then tempering used, then surface treatment and any other factors to arrive at the function. For example: a slipped untempered earthenware flat base would have a serving function.

Form	Flat Base								
Ware Type	Earthenware								
Tempering	Untempered			Mineral Tempered		Vegetal Tempered			
Surface Treatment	Slipped	Smoothed	Glazed	Smoothed	Comb Incised	Slipped	Smoothed		Single Incised
Other							Thin <1cm	Thick >1cm	
Function	Serving	Storage	Storage	Storage	Storage	Storage	Storage	Food Processing	Storage

Form	Protruded Base										
Ware Type	Earthenware										Stonepaste
Tempering	Untempered						Mineral Tempered		Vegetal Tempered		Untempered
Surface Treatment	Slipped	Burnished	Smoothed		Comb Incised	Glazed	Slipped	Smoothed	Smoothed		Glazed
Other			Coilmade/ Handmade	Wheelmade					Coilmade/ Handmade	Wheelmade	
Function	Storage	Storage	Storage	Serving	Storage	Serving	Dry Storage	Storage	Storage	Serving	Serving

Form	Short Ring Base					Tall Ring Base					Edge Ring Base	
Ware Type	Earthenware					Earthenware			Stonepaste	Porcelain	Earthenware	
Tempering	Untempered			Mineral Tempered	Vegetal Tempered	Untempered		Mineral Tempered	Untempered	Untempered	Untempered	
Surface Treatment	Slipped	Smoothed	Glazed	Smoothed	Smoothed	Smoothed	Glazed	Smoothed	Glazed	Glazed	Smoothed	Glazed
Other												
Function	Serving	Serving	Serving	Serving	Serving	Serving	Serving	Serving	Serving	Serving	Serving	Serving

Form	Dimple Base			Globular Base	Tray		Basin					
Ware Type	Earthenware			Earthenware	Earthenware		Earthenware					
Tempering	Untempered		Mineral Tempered	Mineral Tempered	Mineral Tempered	Vegetal Tempered	Untempered	Mineral Tempered	Vegetal Tempered			
Surface Treatment	Smoothed		Smoothed	Burnished	Single Incised	Smoothed	Comb Incised	Smoothed	Smoothed	Single Incised	Comb Incised	Rope Applique
Other	Thin <1mm	Thick >1mm										
Function	Serving	Storage	Storage	Cooking	Food Processing	Food Processing	Food Processing	Food Processing	Food Processing	Food Processing	Food Processing	Food Processing

Form	Shallow Bowl					
Ware Type	Earthenware					Stonepaste
Tempering	Untempered			Vegetal Tempered		Untempered
Surface Treatment	Smoothed	Incised/ Impressed	Glazed	Smoothed		Glazed
Other				Curved	Straight	
Function	Serving	Serving	Serving	Food Processing	Serving	Serving

Form	Deep Bowl																			
Ware Type	Earthenware																			Stonepaste
Tempering	Untempered							Mineral Tempered						Vegetal Tempered						Untempered
Surface Treatment	Smoothed	Single Incised	Comb Incised		Painted	Glazed	Rope Applique	Burnished	Smoothed		Single Incised		Rope Applique	Smoothed			Single Incised	Glazed	Rope Applique	Glazed
Other			Vertical	Curved					Vertical	Curved	Vertical	Curved		Curved	Straight	Carinated				
Function	Serving	Food Processing	Food Processing	Serving	Serving	Serving	Serving	Cooking	Serving	Food Processing	Serving	Food Processing	Serving	Food Processing	Serving	Food Processing	Food Processing	Serving	Food Processing	Serving

Form	No Neck Jar								
Ware Type	Earthenware								
Tempering	Untempered			Mineral Tempered				Vegetal Tempered	
Surface Treatment	Slipped	Smoothed	Painted	Slipped	Burnished	Smoothed	Rope Applique	Single Incised	Rope Applique
Other									
Function	Dry Storage	Dry Storage	Dry Storage	Cooking	Cooking	Cooking	Storage	Storage	Dry Storage

Form	Short Neck Jar										
Ware Type	Earthenware										
Tempering	Untempered				Mineral Tempered				Vegetal Tempered		
Surface Treatment	Slipped	Smoothed	Comb Incised	Glazed	Slipped	Smoothed		Comb Incised	Slipped	Smoothed	Rope Applique
Other						Globular	Vertical				
Function	Serving	Liquid Storage	Liquid Storage	Storage	Dry Storage	Cooking	Dry Storage	Dry Storage	Dry Storage	Dry Storage	Dry Storage

Form	Long Neck Jar												
Ware Type	Earthenware												
Tempering	Untempered								Mineral Tempered		Vegetal Tempered		
Surface Treatment	Slipped	Burnished	Smoothed	Single Incised	Comb Incised	Glazed	Smoothed	Barbotine	Burnished	Smoothed	Smoothed	Single Incised	Rope Applique
Other													
Function	Liquid Storage	Liquid Storage	Liquid Storage	Liquid Storage	Liquid Storage	Liquid Storage	Storage	Liquid Storage	Cooking	Liquid Storage	Liquid Storage	Liquid Storage	Dry Storage

Form	Holemouth Jar								Spheroconical	Nargileh	
Ware Type	Eartheware								Earthenware	Earthenware	
Tempering	Untempered		Mineral Tempered			Vegetal Tempered			Untempered	Untempered	Mineral Tempered
Surface Treatment	Glazed	Slipped	Smoothed	Single Incised	Glazed	Smoothed	Single Incised	Comb Incised	Moulded	Smoothed	Smoothed
Other											
Function	Liquid Storage	Cooking	Storage	Storage	Storage	Storage	Storage	Storage	Liquid Storage	Nargileh	Nargelieh

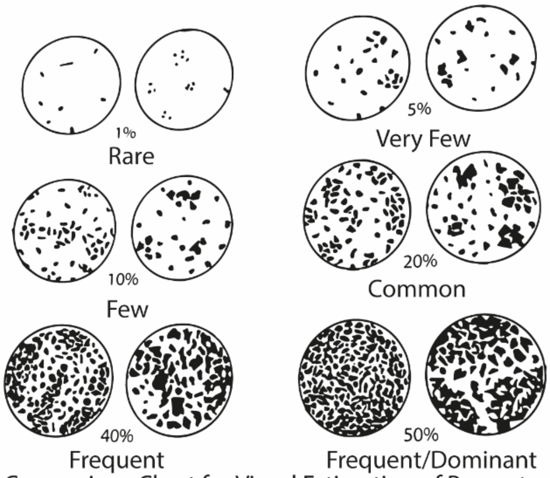
Form	Lamp		Pilgrim Flask		Lid			Spout	Tile		
Ware Type	Earthenware		Earthenware		Earthenware			Earthenware	Earthenware		
Tempering	Untempered		Untempered	Mineral Tempered	Untempered	Mineral Tempered	Vegetal Tempered	Untempered	Untempered	Vegetal Tempered	
Surface Treatment	Burnished	Glazed	Smoothed	Burnished	Smoothed	Smoothed	Smoothed	Glazed	Glazed	Smoothed	Moulded
Other											
Function	Lamp	Lamp	Liquid Storage	Liquid Storage	Lid	Lid	Lid	Liquid Storage	Architectural	Architectural	Plaque

Form	Handle													
Ware Type	Earthenware													Stonepaste
Tempering	Untempered							Mineral Tempered			Vegetal Tempered			Untempered
Surface Treatment	Slipped	Smoothed			Single Incised	Comb Incised	Glazed	Burnished	Smoothed		Smoothed	Rope Applique	Barbotine	Glazed
Other			Thin <1cm	Burned						Burned				
Function	Other	Other	Serving	Cooking	Storage	Storage	Other	Cooking	Other	Cooking	Other	Other	Liquid Storage	Serving

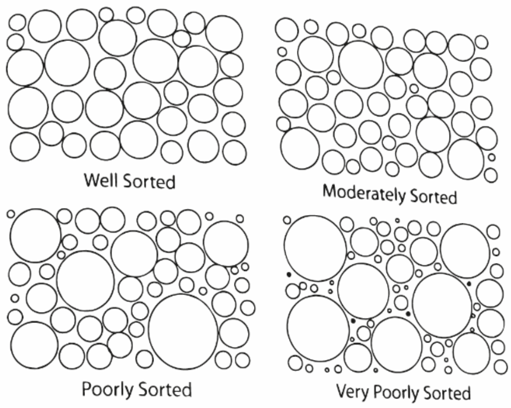
Form	Body															
Ware Type	Earthenware															
Tempering	Untempered															
Surface Treatment	Slipped		Smoothed	Single Incised	Comb Incised			Incised/Impressed		Painted	Glazed		Moulded	Rope Applique	Barbotine	
Other	Burned	Eroded Glaze			Coilmade/ Handmade	Wheelmade	Burned	Coilmade/ Handmade	Wheelmade		Coilmade/ Handmade	Wheelmade			Thin <1cm	Thick >1cm
Function	Cooking	Storage	Storage	Storage	Storage	Serving	Cooking	Storage	Serving	Serving	Storage	Serving	Serving	Storage	Serving	Liquid Storage

Form	Body															
Ware Type	Earthenware															Stonepaste
Tempering	Mineral Tempered												Vegetal Tempered			Untempered
Surface Treatment	Slipped	Burnished	Smoothed		Single Incised	Comb Incised		Incised/ Impressed	Glazed	Moulded	Rope Applique	Barbotine	Single Incised	Comb Incised	Barbotine	Glazed
Other			Coilmade/ Handmade	Wheelmade			Burned									
Function	Storage	Cooking	Storage	Serving	Storage	Storage	Cooking	Storage	Storage	Storage	Storage	Liquid Storage	Storage	Storage	Liquid Storage	Serving

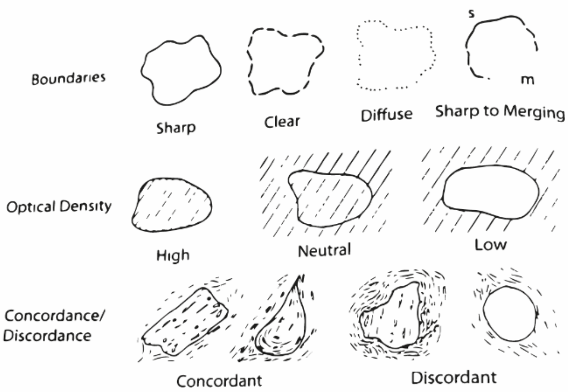
Appendix 6: Petrography Terminology



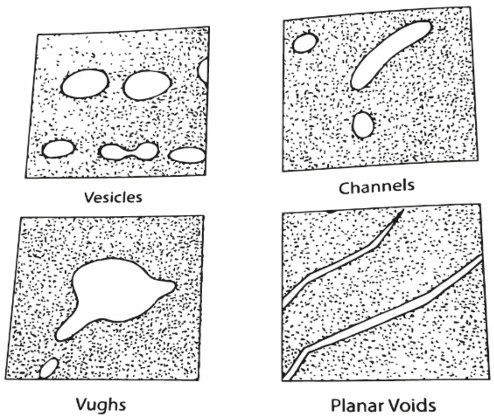
Comparison Chart for Visual Estimation of Percentage Area (Quinn 2013: Fig.4.9)



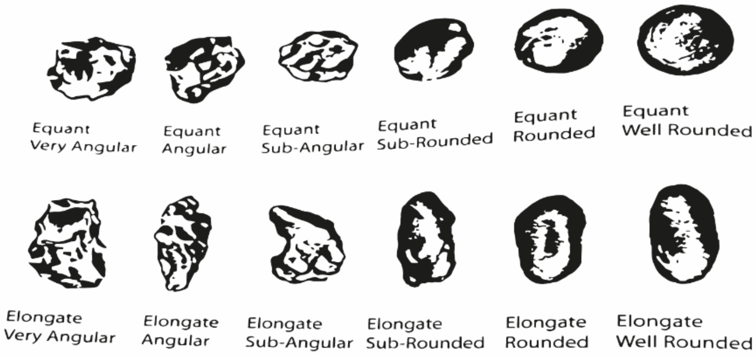
Comparison Chart for Estimating the Degree of Sorting (Quinn 2013: Fig. 4.15)



Selected Terminology for the Characterization of Agrillaceous Inclusions (Quinn 2013: Fig. 4.19 after Whitbread 1986: Table 1).



Terminology for the Description of Void Shape (Quinn 2013: Fig. 4.25)



Categories for the Description of Shape and Roundness/Angularity (Quinn 2013: Fig. 4.11)

Appendix 7: Petrofabric Descriptions

EPAS

EPAS Fabric E.1a: Fine Fabric

16 samples: CA200246, CA200261, CA200275. CA200281, CA200283, CA200284, CA200287, CA200290, CA200292, CA200293, CA200294, CA200299, CA200304, CA200313, CA200316, CA200319

Microstructure: Common to rare microvughs, few to rare mesovughs, and rare mesoelongated voids. The distribution of the inclusions is open in the coarse and fine fraction. Both the voids and inclusions are weakly to strongly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is yellowish brown to brown in PPL (x40) and brown in XPL (x40).

Inclusions: C:F:$V_{.0625mm}$ =ca. 5:90:5. The inclusions are well sorted with an overall unimodal grain size distribution. <2.30mm, mode 0.10mm, a-r.

Inclusions
Fine Fraction

Few to Rare	**Monocrystalline Quartz**
	Opaque

Coarse Fraction

Rare	**Monocrystalline Quartz** equant to elongated, sa-sr, <0.45mm, mode 0.10mm
	Chert equant to elongated, sa-sr, some very weathered <0.80mm, mode 0.20mm.
	Opaque equant to elongated, sr-r, <0.85mm, mode 0.15mm.
	Micritic Limestone equant, sr-r, reaction rim <2.30mm, mode 0.25mm
	Muscovite equant to elongated, a-sa, clear ppl, (290, 299, 316, 319) <0.35mm, mode 0.10mm.
Very Rare	**Orthoclase** equant, sa-sr, one cleavage, (304) <0.35mm, mode 0.20mm.
	Quartzite equant to elongated, sa-sr, (275, 287, 294) <0.45mm, mode 0.25mm.

Concentration Features: TCF equant to elongated, sr-r, red clay nodes <0.30mm, mode 0.10mmTCF equant to elongated, sr-r, Brownish red (CA200261, CA200275, CA200290) <1.75mm, mode 0.65mm, KCF Sparry calcite in voids, post depositional

Comments: CA200261 and CA200293 have comb incising grooves on its edge. CA200275 has a darker matrix along edge, more inclusions along edge, covered by sparry calcite (Post dep). CA200294 has very dark matrix along one edge, slip? CA200316 has a cloudy greenish glaze, no slip.

EPAS Fabric E.1b: Quartz Rich Fine Fabric

17 samples: CA200234, CA200237, CA200247, CA200249, CA200251, CA200260, CA200263, CA200269, CA200271, CA200285, CA200295, CA200296, CA200300, CA200301, CA200308, CA200309, CA200318

Microstructure: Common to rare microvughs, few to rare mesovughs, and rare mesoelongated voids. The distribution of the inclusions is open in coarse fraction and single to double in the fine fraction. Both the voids and inclusions are weakly to strongly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is yellowish brown to brown in PPL (x40) and brown in XPL (x40).

Inclusions: C:F:V$_{.0625mm}$ =ca. 5:90:5. The inclusions are moderately sorted with an overall unimodal grain size distribution. <1.45mm, mode 0.10mm, a-r.

Inclusions
Fine Fraction

Common to Few	**Monocrystalline Quartz** **Opaque**

Coarse Fraction

Few to Very Rare	**Monocrystalline Quartz** equant to elongated, sa-sr, <0.45mm, mode 0.10mm **Chert** equant to elongated, sa-sr, some very weathered <0.80mm, mode 0.20mm. **Opaque** equant to elongated, sr-r, <0.85mm, mode 0.15mm. **Micritic Limestone** equant, sr-r, reaction rim <1.45mm, mode 0.25mm **Muscovite** equant to elongated, a-sa, clear ppl, (237, 249, 251, 263) <0.35mm, mode 0.10mm. **Quartzite** equant to elongated, sa-sr, (234, 247, 295) <0.45mm, mode 0.25mm.
Rare to Very Rare	**Bioclast Shell** Elongated to equant, a-sa, (318) <0.35mm, mode 0.10mm. **Radiolarian Chert** equant to elongated, sa-sr, (247, 260) <1.15mm, mode 0.15mm. **Polycrystalline Quartz** equant to elongated, sa-sr, (308, 318) <0.45mm, mode 0.25mm.

Concentration Features: TCF equant to elongated, sr-r, red clay nodes <0.30mm, mode 0.10mm, TCF equant to elongated, sr-r, orange in ppl and xpl (CA200263) <0.60mm, mode 0.30mm, TCF equant to elongated, sr-r, Brownish red (CA200308) <1.75mm, mode 0.65mm, TCF elongated, sr-r, gray (CA200251) <0.25mm, mode 0.20mm, KCF Sparry calcite in voids, post depositional

Comments: CA200260 has lighter wavy spots in matrix, possibly burned out shell fragments that have been re-filled by matrix? CA200234 has clear glaze on both edges. One edge has dark brown/black opaque layer. Paint? Quartz rich Slip under paint, not under glaze. CA200295 has clear glaze with epidote inclusions, no slip, CA200300 has cloudy glaze with sparite inclusions, no slip. CA200318 has a thick quartz/calcite slip, a brown/black opaque layer, paint? With a clear glaze. Paint one side, but glaze/slip both. CA200247 comb incising on one edge, sparry calcite along edges.

EPAS Fabric E.2a: Fine Biotite Rich Fabric

11 samples: CA200235, CA200238, CA200242, CA200245, CA200258, CA200280, CA200298, CA200305, CA200306, CA200314, CA200315

Microstructure: Few microvughs, few mesovughs rare mesoelongated voids. The distribution of the inclusions is open in the coarse and fine fraction. Both the voids and inclusions are weakly to strongly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is red in PPL (x40) and red in XPL (x40).

Inclusions: C:F:V$_{.0625mm}$ =ca. 5:90:5. The inclusions are well sorted with an overall unimodal grain size distribution. <1.05mm, mode 0.10mm, a-r.

Inclusions
Fine Fraction

Rare **Monocrystalline Quartz**
Opaque
Biotite

Coarse Fraction

Few **Monocrystalline Quartz** equant to elongated, sa-sr, <0.45mm, mode 0.10mm.
Opaque equant to elongated, sr-r, <0.35mm, mode 0.10mm.

Rare **Micritic Limestone** equant to elongated, sr-r, <1.05mm, mode 0.25mm.
Chert equant to elongated, sa-sr, <0.40mm, mode 0.25mm.
Muscovite elongated to equant, a-sa, clear ppl, (235, 245, 258, 280, 305) <0.20mm, mode 0.10mm.
Radiolarian Chert equant to elongated, sa-sr, (258) <0.30mm, mode 0.15mm.

Very Rare **Biotite** elongated to equant, a-sa, brown pleochroism (280, 314) <0.15mm, mode 0.05mm.
Sedimentary Rock Fragment equant to elongated, sa-sr, quartz and mudstone with biotite laths (238), <0.40mm, mode 0.25mm.

Concentration Features: TCF equant to elongated, sr-r, red clay node (315), <1.45m, mode 0.15mm, KCF Sparry Calcite in voids, post depositional

Comments: CA200235, CA200245, CA200306, are slightly thick. CA200306 lighter along one edge, greenish brown ppl, light brown xpl, possible slip? CA200242 has a quartz rich slip with greenish/clear glaze on both edges. CA200245 has a quartz slip with clear glaze along edge. CA200280 has a cloudy glaze, no slip.

EPAS Fabric E.2b: Fine Biotite and Quartz Rich Fabric

9 samples: CA200236, CA200241, CA200243, CA200250, CA200254, CA200255, CA200265, CA200270, CA200321

Microstructure: Few microvughs, few mesovughs rare mesoelongated voids. The distribution of the inclusions is open in coarse fraction and single to double in the fine fraction. Both the voids and inclusions are weakly to strongly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is red in PPL (x40) and red in XPL (x40).

Inclusions: C:F:$V_{.0625mm}$ =ca. 5:90:5. The inclusions are moderately sorted with an overall unimodal grain size distribution. <1.15mm, mode 0.10mm, a-r.

Inclusions
Fine Fraction

Common **Monocrystalline Quartz**
Opaque
Biotite

Few **Muscovite**

Coarse Fraction

Few **Monocrystalline Quartz** equant to elongated, sa-sr, <0.50mm, mode 0.15mm.
Opaque equant to elongated, sr-r, <0.30mm, mode 0.15mm.
Micritic Limestone equant to elongated, sr-r, <1.15mm, mode 0.25mm.

	Chert equant to elongated, sa-sr, <0.50mm, mode 0.20mm.
Rare	**Muscovite** elongated to equant, a-sa, clear ppl, (250) <0.25mm, mode 0.10mm.
	Biotite elongated to equant, a-sa, brown pleochroism (241, 250,) <0.35mm, mode 0.05mm.
Very Rare	**Bioclast Shell** elongated, sa, (241) <0.25mm, mode 0.10mm

Concentration Features: TCF equant to elongated, sr-r, red clay node (241, 250, 255), <1.45m, mode 0.15mm, KCF Sparry Calcite in voids, post depositional

Comments: CA200270 darker streaks-clay mixing? CA200250 has a quartz rich slip with yellowish/clear glaze. One side has quartz slip, glaze, and a brown/black opaque darker layer, possibly paint on top of glaze? CA200241 has a quartz rich slip with greenish/clear glaze. CA200248 has a quartz slip with clear glaze.

EPAS Fabric E.3a: Tempered Quartz Rich Fabric

8 samples: CA200248, CA200253, CA200274, CA200282, CA200291, CA200303, CA200307, CA200317

Microstructure: Few microvughs, few mesovughs, and rare mesoelongated voids. The distribution of the inclusions is single to double in the coarse fraction and double to open in the fine fraction. Both the voids and inclusions are random to weakly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is yellowish brown in PPL (x40) and greenish brown in XPL (x40).

Inclusions: $C:F:V_{.0625mm}$ =ca. 15:70:5. The inclusions are moderately to poorly sorted with an overall bimodal grain size distribution. <1.35mm, mode 0.40mm, a-r.

Inclusions
Fine Fraction

Common	**Monocrystalline Quartz**
	Opaque
	Micrite
Few	**Biotite**
	Shell

Coarse Fraction

Frequent to Few	**Chert** equant to elongated sa-sr, <1.15mm, mode 0.20mm.
	Micritic Limestone equant to elongated, sr-r, one with shell relicts, some burned out, <1.05mm, mode 0.40mm.
	Monocrystalline Quartz equant to elongated, sa-sr, <0.60mm, mode 0.20mm.
	Quartzite equant to elongated, sa-sr, weakly sutured, <0.70mm, mode 0.25mm.
Common to Rare	**Metamorphic Rock (Hornfel?)** equant to elongated, sa-sr, crystals of quartz and rounded opaques, laths of biotite, Not foliated (274, 303, 312) <1.15mm, mode 0.40mm.
Few to Very Rare	**Biotite Schist** equant to elongated, elongated, quartz and biotite, weakly foliated (248, 291, 303, 317) <0.70mm, mode 0.40mm.
	Siltstone equant to elongated, sa, clasts of quartz in dark matrix (248, 291, 303, 307) <1.35mm, mode 0.40mm.
	Mudstone equant, sr-r, greyish to reddish in ppl and xpl, doesn't go extinct (248, 282, 291, 303, 317) < 0.85mm, mode 0.35mm.
	Opaque equant to elongated, sr-r, <0.65mm, mode 0.30mm.

Polycrystalline Quartz equant to elongated, sa-sr, probably part of quartzite, but only 2-3 quartz grains. Weakly sutured. Undulous extinction. (317) <0.60mm, mode 0.25mm.
Radiolarian Chert equant to elongated, sa-r, (248, 282) <0.40mm, mode 0.20mm.

Rare — **Serpentinite** equant to elongated, sr-r, red in ppl and xpl, (248, 274, 291) <0.40mm, mode 0.20mm.

Very Rare — **Bivalve Shell** elongated, a-sa, (248, 282, 303) <0.35mm, mode 0.20mm.
Plagioclase equant to elongated, sa-sr, Carlsbad twinning (303, 307) <0.30mm, mode 0.25mm.
Calcite equant, a-sa, (248) <0.40mm, mode 0.15mm.
Epidote equant, a, zoned high bifringence (248) <0.25mm, mode 0.10mm.
Orthoclase equant, sa-sr, one cleavage, (274, 307, 317) <0.45mm, mode 0.20mm.
Muscovite equant, sa-a, one clevage, high bifringence, (291) <0.75mm, mode 0.40mm
Biotite elongated to equant, a-sa, brown pleochroism, (248) <0.30mm, mode 0.20mm.

Concentration Features: TCF equant, sr-r, red clay node (248, 253) <0.65mm, mode 0.20mm. TCF, equant to elongated, sa-sr, orange diffuse (248, 291, 307) <0.70mm, mode 0.15mm. KCF, sparry calcite in voids, post depositional,

Comments: CA200307 has one incised groove. CA200253 is possibly comb incised?

EPAS Fabric E.3b: Tempered Biotite Rich Fabric

6 samples: CA200240, CA200268, CA200276, CA200277, CA200279, CA200297

Microstructure: Few microvughs, few mesoelongated voids, and few mesovughs. The distribution of the inclusions is single to double in the coarse and double to open in the fine fraction. Both the voids and inclusions are random to weakly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is reddish brown in PPL (x40) and in XPL (x40).

Inclusions: $C:F:V_{.0625mm}$ =ca. 25:70:5. The inclusions are poorly sorted with an overall bimodal grain size distribution. <2.55mm, mode 0.30mm, sa-r.

Inclusions
Fine Fraction
Common — **Monocrystalline Quartz**
Few — **Shell**
Biotite
Calcite
Muscovite

Coarse Fraction
Frequent to Few — **Micritic Limestone** equant to elongated, sr-r, <0.85mm, mode 0.55mm.
Monocrystalline Quartz equant to elongated, a-sa, <0.70mm, mode 0.25mm.
Chert equant to elongated, sa-sr, <1.15mm, mode 0.30mm.
Quartzite equant to elongated, sa-sr, weakly sutured, <0.75mm, mode 0.30mm.

Common to Rare	**Metamorphic Rock Fragment (Hornfel?)** Equant to elongated, sa-sr, crystals of quartz and rounded opaques, laths of biotite, (276, 277, 297) <1.15mm, mode 0.40mm.
Few	**Polycrystalline Quartz** equant to elongated, sa-sr, probably part of quartzite, but only 2-3 quartz grains. Weakly sutured. Undulous extinction. (276, 277) <0.60mm, mode 0.25mm.
	Calcite equant, sa, high bifringence, one clevage present (276) <0.35mm, mode 0.15mm
Few to Rare	**Serpentinite** equant to elongated, sr-r, red in ppl and xpl, (240, 297) <0.45mm, mode 0.25mm
	Biotite Schist equant to elongated, elongated, quartz and biotite, weakly foliated (268, 276, 297) <0.80mm, mode 0.45mm.
	Plagioclase equant to elongated, sa-sr, Carlsbad twinning (240, 276, 277) <0.35mm, mode 0.25mm
	Radiolarian Chert equant to elongated, sa-r, (276, 297) <0.40mm, mode 0.20mm.
	Opaque equant to elongated, sr-r, <0.30mm, mode 0.10mm.
Rare	**Amphibolite** equant to elongated, sa-sr, multiple crystals of amphibole, weakly foliated. Some weathered. (268, 276) <0.60mm, mode 0.20mm.
	Mudstone equant, sr-r, greyish to reddish in ppl and xpl, doesn't go extinct (268, 276) <1.05mm, mode 0.50mm.
	Metamorphic Rock Fragment (Gneiss?) equant, sa-a, quartz grains, poorly sorted, weakly foliated (268, 276) <0.75mm, mode 0.20mm.
Very Rare	**Bivalve Shell** elongated, a-sa, (268, 276, 297) <0.35mm, mode 0.30mm.
	Orthoclase equant to elongated, sa, one cleavage, (268) <0.90mm, mode 0.35mm.
	Sparry Calcite equant, a-sa, (276) <0.40mm, mode 0.15mm.

Concentration Features: TCF equant, sr-r, red clay node (240, 276, 297, 311), <0.45mm, mode 0.20mm. KCF sparry calcite in voids, post depositional (276, 279, 311)

Comments: CA200279 has a quartz rich slip and clear glaze.

EPAS Fabric E.3c: Tempered Heterogenous Colored Fabric

3 samples: CA200244, CA200267, CA200272

Microstructure: Few microvughs and rare mesovughs. The distribution of the inclusions is single to double in coarse fraction and double to open in fine fraction. Both the voids and inclusions are randomly oriented to the edge.

Groundmass: Heterogenous based on color. The fabric is optically inactive. It is brown to reddish brown in PPL (40x) and dark brown to reddish brown in XPL (40x).

Inclusions: C:F:$V_{.0625mm}$ =ca 25:70:5. The inclusions are poorly sorted with an overall bimodal grain size distribution. <1.35mm, mode 0.35mm, sa-r.

Inclusions
Fine Fraction

Few	**Micritic Limestone**
	Shell
	Monocrystalline Quartz
Rare	**Opaque**
	Plagioclase

Coarse Fraction

Common to Few	**Micritic Limestone** equant, sr-r, <1.35mm, mode 0.60mm.
	Bivalve Shell elongated, a-sa, <0.70mm, mode 0.50mm.
	Monocrystalline Quartz equant to elongated, sa-sr, <0.60mm, mode 0.40mm.
Few	**Quartzite** equant to elongated, sa-sr, weakly sutured, <0.55mm, mode 0.25mm.
Few to Rare	**Chert** equant to elongated, sa-sr, <1.05mm, mode 0.35mm.
	Opaque equant to elongated, sr-r, <0.40mm, mode 0.10mm.
Rare	**Biotite Schist?** equant to elongated, elongated, quartz and biotite, weakly foliated, (267) <0.70mm, mode 0.40mm.
Very Rare	**Plagioclase** equant, sa-sr, Carlsbad twinning, (267) <0.30mm, mode 0.10mm.
	Radiolarian Chert equant to elongated, sa-sr, (267) <1.20mm, mode 0.55mm.

Concentration Features: KCF, sparry calcite in voids, post depositional.

Comments: All pieces have micritic limestone beginning to burn out with darker reaction rims and breaking up of mineral.

EPAS Fabric E.4: Schist Tempered Fabric

2 samples: CA200257, CA200262

Microstructure: Frequent shrinkage cracks, few mesovughs. The distribution of the inclusions is single in the coarse fraction and in the fine fraction. Both the voids and inclusions are weakly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is red to brown in PPL (40x) and red to reddish brown in XPL (40x)

Inclusions: C:F:V$_{.0625mm}$ =ca 55:35:10. The inclusions are poorly sorted with an overall bimodal grain size distribution. <2.40mm, mode 0.40mm, a-r.

Inclusions
Fine Fraction

Common	**Biotite**
	Monocrystalline Quartz
	Calcite
Rare	**Orthoclase**
	Plagioclase
	Muscovite

Coarse Fraction

Common to Few	**Biotite Schist** equant to elongated, sa-sr, biotite, some quartz, Foliated, <2.10mm, mode 0.55mm.
	Chert equant to elongated, sa-sr, <1.80mm, mode 0.55mm.
	Quartzite equant to elongated, sa-sr (257), <0.80mm, mode 0.45mm.
	Sillimanite Schist? equant to elongated, sa-sr, sillimanite and biotite, weakly foliated, altering to clay <2.40mm, mode 0.40mm.
	Amphibolite? Equant to elongated, sa-sr, bladed hornblends, biotite, few quartz and calcite grains, some altering to chlorite, some have epidote grains. <1.55mm, mode 0.50mm.
	Dolomitic Limestone? Equant to elongated, sa-sr, dolomite crystals in calcite matrix. <1.10mm, mode 0.35mm.

Few	**Monocrystalline Quartz** equant to elongated, sa-sr, <0.20mm, mode 0.10mm.
	Muscovite elongated to equant, a-sa, clear ppl, <0.25mm, mode 0.06mm.
	Opaque equant to elongated, sr-r, <0.15mm, mode 0.06mm.
Rare	**Orthoclase** equant, sa-sr, one cleavage <0.20mm, mode 0.15mm
	Plagioclase equant, sa-sr, Carlsbad twinning, <0.15mm, mode 0.10mm.

Concentration Features: KCF Sparry calcite in voids, post depositional.

Comments: None

EPAS Fabric E.5a: Vegetal Tempered Fabric

4 samples: CA200239, CA200252, CA200289, CA200310

Microstructure: Common mesoelongated voids and frequent mesovughs. The distribution of the inclusions is double in the coarse fraction and double to open in the fine fraction. Both the voids and inclusions are weakly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is brown to reddish brown in PPL (40x) and brown to reddish brown in XPL (40x)

Inclusions: $C:F:V_{.0625mm}$ =ca 10:75:15. The inclusions are moderately sorted with an overall bimodal grain size distribution. <3.10mm, mode 0.15mm, a-r.

Inclusions
Fine Fraction

Few	**Monocrystalline Quartz**
	Opaque
Rare	**Shell**
	Muscovite

Coarse Fraction

Few	**Monocrystalline Quartz** equant to elongated, sa-sr, <0.45mm, mode 0.30mm.
	Opaque equant to elongated, sr-r, <0.25mm, mode 0.15mm.
	Micritic Limestone equant, sr-r, reaction rim, <3.10mm, mode 0.28mm.
Rare	**Quartzite** equant to elongated, sa-sr, (239, 289) <0.55mm, mode 0.10mm.
	Chert equant to elongated, sa-sr, <0.60mm, mode 0.28mm.
Very Rare	**Muscovite** elongated to equant, a-sa, clear ppl (252) <0.14mm, mode 0.08mm.
	Calcite? equant, sa, cloudy in ppl, no cleavage, in xpl crossing lines of brighter birefringence (239) <0.70mm, mode 0.70mm.
	Plagioclase equant, sa, Carlsbad twinning, <0.25mm, mode 0.15mm
	Epidote equant, sa, zoned bifringence, high, (252) <0.20mm, mode 0.10mm.

Concentration Features: TCF equant to elongated, sr-r, red clay pellets, (239, 252, 310) <0.70mm, mode 0.10mm. KCF, sparry calcite in voids, post depositional

Comments: None

EPAS Fabric E.5b: Vegetal Tempered Oxidized Fabric

4 samples: CA200256, CA200286, CA200302, CA200322

Microstructure: Common mesoelongated voids, few macroelongated voids, few mesovughs. The distribution of the inclusions is open in coarse fraction and fine fraction. Both the voids and inclusions strongly oriented to the edge.

Groundmass: Heterogenous based on color. The fabric is optically inactive. It is reddish brown to dark brown in PPL (40x) and brown to dark brown in XPL (40x).

Inclusions: $C:F:V_{.0625mm}$ =ca 5:75:20. The inclusions are moderately sorted with an overall unimodal grain size distribution. <4.65mm, mode 0.10mm, a-r.

Inclusions	
Fine Fraction	
Few	**Monocrystalline Quartz**
	Opaque
	Micritic Limestone
Rare	**Shell**
	Muscovite
Coarse Fraction	
Common to Few	**Monocrystalline Quartz** equant to elongated, sa-sr, <0.35mm, mode 0.10mm.
	Micritic Limestone equant, sr-r, <4.65mm, mode 0.20mm.
Few to Rare	**Chert** equant to elongated, sa-sr, <0.90mm, mode 0.30mm.
	Opaque equant to elongated, sr-r, <0.60mm, mode 0.06mm.
	Sparry Calcite equant, sr, crystals of calcite in an euhedral form (302), <0.80mm, mode 0.30mm.
Very Rare	**Bivalve Shell** elongated, a-sa, (256, 302) <1.70mm, mode 0.20mm.
	Muscovite elongated to equant, a-sa, clear ppl, <0.25mm, mode 0.06mm.
	Epidote equant, sa, zoned bifringence, high, (302) <0.35mm, mode 0.10mm.

Concentration Features: TCF, equant, sr-r, red clay pellets (256, 286, 302) <0.40mm, mode 0.08mm.
KCF, sparry calcite in voids, post depositional

Comments: None

EPAS Fabric E.5c: Vegetal and Mineral Tempered Fabric

3 samples: CA200259, CA200311, CA200312

Microstructure: Common mesoelongated voids and frequent mesovughs. The distribution of the inclusions is single to double in the coarse fraction and double in the fine fraction. Both the voids and inclusions are weakly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is brown to reddish brown in PPL (40x) and brown to reddish brown in XPL (40x)

Inclusions: $C:F:V_{.0625mm}$ =ca 15:70:15. The inclusions are moderately sorted with an overall bimodal grain size distribution. <3.10mm, mode 0.15mm, a-r.

Inclusions	
Fine Fraction	
Few	**Monocrystalline Quartz**
	Opaque
Rare	**Shell**
	Muscovite

Coarse Fraction

Common	**Micritic Limestone** equant, sr-r, reaction rim, <3.00mm, mode 0.20mm.
	Monocrystalline Quartz equant to elongated, sa-sr, <0.45mm, mode 0.30mm.
Few	**Chert** equant to elongated, sa-sr, <1.05mm, mode 0.28mm.
	Biotite Schist equant to elongated, elongated, quartz and biotite, weakly foliated (311, 312) <0.85mm, mode 0.40mm.
	Sparry Calcite equant, sr, crystals of calcite in an euhedral form (259, 312), <0.80mm, mode 0.30mm.
	Opaque equant to elongated, sr-r, <0.25mm, mode 0.15mm.
Rare	**Quartzite** equant to elongated, sa-sr, <0.55mm, mode 0.10mm.
	Radiolarian Chert equant to elongated, sa-r, (311, 312) <0.40mm, mode 0.20mm.
	Mudstone equant, sr-r, greyish to reddish in ppl and xpl, doesn’t go extinct (311, 312) < 0.85mm, mode 0.35mm.
Very Rare	**Serpentinite** equant to elongated, sr-r, red in ppl and xpl, (312) <0.40mm, mode 0.20mm.
	Plagioclase equant, sa, Carlsbad twinning, (259) <0.25mm, mode 0.15mm
	Bivalve Shell elongated, sa-sr, (259) <0.34mm, mode 0.10mm.
	Epidote equant, sa, zoned bifringence, high, (259)

Concentration Features: TCF equant to elongated, sr-r, red clay pellets, <0.70mm, mode 0.10mm. TCF equant to elongated, sr-r, difuse boundaries, black (259), <1.40mm, mode 0.80mm. KCF, sparry calcite in voids, post depositional

Comments: None

EPAS Fabric E.6: Quartzite Tempered Quartz Rich Fabric

1 sample: CA200288

Microstructure: Few microvughs and few mesovughs. The distribution of the inclusions is single to double in the coarse fraction and fine fraction. Both the voids and inclusions strongly oriented to the edge.

Groundmass: Heterogeneous based on color. The fabric is optically inactive. It is yellowish brown in PPL (40x) and brown in XPL (40x)

Inclusions: C:F:V$_{.0625mm}$ =ca.20:75:5. The inclusions are poorly sorted with an overall bimodal grain size distribution. <2.10mm, mode 0.20mm, a-r.

Inclusions
Fine Fraction

Common	**Monocrystalline Quartz**
	Opaque
Few	**Shell**
	Plagioclase

Coarse Fraction

Common	**Quartzite** equant to elongated, sa-sr, weakly sutured, <0.75mm, mode 0.45mm.
Few	**Opaque** equant to elongated, sa-sr, <0.55mm, mode 0.15mm.
	Monocrystalline Quartz equant to elongated, a-sr, <0.15mm, mode 0.06mm.
	Chert equant to elongated, sa-sr <0.35mm, mode 0.15mm.
Rare	**Micritic Limestone** equant to elongated, sr-r, <2.10mm, mode 0.50mm.
Very Rare	**Bivalve Shell** Elongated, a-sa, <0.55mm, mode 0.10mm.

Orthoclase, equant to elongated, sa-sr, one cleavage, <0.35mm, mode 0.30mm.
Felsic Igneous Rock, Rhyolite? Equant, sr, red in ppl and xpl with very fine lines through, <0.40mm, mode 0.35mm.
Plagioclase equant, sa, Carlsbad twinning <0.30mm, mode 0.10mm.
Schist? equant to elongated, sa-sr, quartz and biotite, weakly foliated <0.60mm, mode 0.35mm.

Concentration Features: TCF equant to elongated, sr-r, red clay node, <0.60mm, mode 0.10mm.
KCF, sparry calcite in voids, post depositional

Comments: Very thick

EPAS Fabric E.7: Quartzite Tempered Biotite Rich Fabric

1 sample: CA200278

Microstructure: Common shrinkage cracks, few mesoelongated voids, few mesovughs. The distribution of the inclusions is single in the coarse fraction and double to open in the fine fraction. Both the voids and inclusions are strongly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is red in PPL (x40) and XPL (x40).

Inclusions: C:F:V$_{.0625mm}$ =ca.35:58:7. The inclusions are poorly sorted with an overall bimodal grain size distribution. <1.10mm, mode 0.20mm, sa-r.

Inclusions
Fine Fraction

Common	**Monocrystalline Quartz**
	Biotite
	Opaque
Few	**Shell**
	Muscovite

Coarse Fraction

Common	**Quartzite** equant to elongated, sa-sr, weakly sutured <0.55mm, mode 0.25mm.
	Chert equant to elongated, sa-sr, <0.70mm, mode 0.25mm.
	Monocrystalline Quartz equant to elongated, a-sr, <0.70mm, mode 0.10mm.
Few	**Biotite Schist?** elongated to equant, sa-sr, quartz and biotite, weakly foliated, <0.55mm, mode 0.35mm.
	Plagioclase equant to elongated, sa-sr, Carlsbad and albite twinning, <0.45mm, mode 0.10mm.
	Micritic Limestone equant to elongated, sr-r, reaction rim <0.55mm, mode 0.40mm.
Rare	**Opaque** equant to elongated, sr-r, <0.40mm, mode 0.15mm.
	Granite? Equant to elongated, sa-sr, equant phenocrysts of quartz, plagioclase, and laths of biotite, <0.60mm, mode 0.45mm.
	Bivalve Shell elongated, sa-sr, <0.30mm, mode 0.15mm.
Very Rare	**Basalt?** Equant to elongated, sa-sr, laths of plagioclase in a dark matrix, very weathered, <1.10mm, mode 0.45mm.
	Serpentinite equant to elongated, sr-r, red in ppl and xpl,<0.50mm, mode 0.25mm.
	Felsic Igneous Rock, Rhyolite? Equant to elongated, sr-r, dark red in ppl and xpl with thin laths, <0.40mm, mode 0.20mm.
	Radiolarian Chert equant to elongated, sa-sr, <0.60mm, mode 0.40mm.

Concentration Features: TCF equant, sr-r, red clay node, <0.55mm, mode 0.20mm. KCF sparry calcite in voids, post depositional

Comments: None

EPAS Fabric E.8: Quartz Tempered Fabric

1 sample: CA200320

Microstructure: Common microvughs and few mesovughs. The distribution of the inclusions is double in the coarse fraction and single to double in the fine fraction. Both the voids and inclusions are weakly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is reddish brown in PPL (40x) and red in XPL (40x)

Inclusions: C:F:$V_{.0625mm}$ =ca.15:80:5. The inclusions are poorly sorted with an overall bimodal grain size distribution9. <0.55mm, mode 0.10mm, a-sr.

Inclusions
Fine Fraction

Common	**Monocrystalline Quartz**
	Opaques

Coarse Fraction

Common	**Monocrystalline Quartz** equant to elongated, sa-sr, <0.40mm, mode 0.10mm.
	Quartzite equant to elongated, sa-sr, weakly sutured, <0.55mm, mode 0.30mm.
	Chert equant to elongated, sa-sr, <0.40mm, mode 0.25mm.
Few	**Opaques** equant to elongated, sr-r, <0.15mm, mode 0.10mm.

Concentration Features: TCF, equant to elongated, sr-r, reddish clay nodes <0.40mm, mode 0.10mm, KCF, sparry calcite in voids, post depositional

Comments: None

EPAS Fabric E.9: Stonepaste

1 sample: CA200264

Microstructure: Few mesovughs, few microvughs. The distribution of the inclusions is single in coarse fraction and fine fraction. Both the voids and inclusions randomly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is black n in PPL (40x) and in XPL (40x).

Inclusions: C:F:$V_{.0625mm}$ =ca 75:20:5. The inclusions are well sorted with an overall unimodal grain size distribution. <0.64mm, mode 0.10mm, a-r.

Inclusions
Fine Fraction

Frequent	**Monocrystalline Quartz**
Few	**Opaque**

Coarse Fraction

Frequent	**Monocrystalline Quartz** equant to elongated, a-sa, <0.32mm, mode 0.12mm.

Few **Opaque** equant, sr-r, <0.16mm, mode 0.10mm.
Very Rare **Quartzite** equant to elongated, sa-sr, <0.64mm, mode 0.28mm.
Chert equant to elongated, sa-sr, <0.20mm, mode 0.10mm.

Concentration Features: None

Comments: Glazed between 0.32 and 0.14mm thick.

Nippur

Nippur Fabric N.1a: Fine Fabric

5 samples: CA200723, CA200725, CA200726, CA200727, CA200730

Microstructure: Dense with rare mesovughs. The distribution of the inclusions is open spaced in both coarse and fine fraction. Both the voids and inclusions are weakly aligned with the edge, this is more pronounced in CA200726.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is yellowish brown in PPL (x40) and brown in XPL (x40).

Inclusions: C:F:$V_{.0625mm}$ =ca. 5:92:3. The inclusions are well sorted with an overall unimodal grain size distribution. <0.26mm, mode 0.073mm, a-r

Inclusions
Fine Fraction
Few **Monocrystalline Quartz**
Rare **Opaques**

Coarse Fraction
Very Rare **Monocrystalline Quartz** equant, a-sr, straight extinction, <0.15mm, mode 0.063mm.
Opaques equant to elongated, sr-r, dark black with slightly reddish tint in ppl (x40). <0.14mm, mode 0.076mm.
Chert equant, sa-sr, <0.26mm, mode 0.13mm.

Concentration Features: TCF, equant to elongated, sr-r, reddish clay nodes (723, 725, 730) <0.50mm, mode 0.08mm.

Comments: CA200723 has very wavy edge, with post depositional sparry calcite along it. CA200725 has a wollastonite rich slip under a clear glaze. CA200726, CA200727 has a bluish to clear glaze in ppl with glaucophane (Purple pleochroism) inclusions. One side has been corrugated, leaving many ridges/divots, which have been glazed over. There is a thin quartz rich slip on the one side.

Nippur Fabric N.1b: Fine Quartz Rich Fabric

2 samples: CA200731, CA200732

Microstructure: Rare mesovughs. In CA200732 some of the mesovughs are elongated. The distribution of the inclusions is open spaced in the coarse fraction and single to double spaced in the fine fraction. Both the voids and inclusions are randomly to weakly oriented.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is yellowish brown to brown in PPL (x40) and brown to brown with green tints in XPL (x40).

Inclusions: $C:F:V_{.0625mm}$ =ca. 5:94:1. The inclusions are well sorted with an overall unimodal grain size distribution. <1.40mm, mode 0.10mm, a-r

Inclusions
Fine Fraction

Frequent	**Opaques**
Common	**Monocrystalline Quartz**
Rare	**Muscovite**
	Bioclast Shell
	Pyroxene
Coarse Fraction	
Frequent	**Monocrystalline Quartz** equant to elongated, a-sr, straight to undulose extinction <0.35mm, mode 0.09mm.
	Opaques equant to elongated, sr-r, dark black with slightly reddish tint, <0.15mm, mode 0.15mm.
Few	**Quartzite** equant, sa-sr, weakly sutured, Very weathered. <0.34mm, mode 0.14mm.
	Muscovite elongated, sa, high birefringence, <0.25mm. mode 0.11 mm.
Rare	**Chert** equant, a-sa, <0.25mm, mode 0.09mm.
	Plagioclase elongated, a, Carlsbad twinning, <0.25mm, mode 0.12mm.
	Bioclast Shell elongated, a, <1.40mm, mode 1.10mm.
Very Rare	**Epidote** equant, a-sa, zoned extinction, <0.15mm, mode 0.15mm.

Concentration Features: Acf: Reddish node with streaks, strong to diffuse edges, equant to elongated, <0.75mm, mode 0.65mm. Kcf: large clusters of sparry calcite, equant sa-sr, possible post firing deposition, completely filling voids. <0.5mm, mode 0.27mm.

Comments: Slightly thick, making quartz more yellowish.

Nippur Fabric N.2: Fine Biotite and Quartz Rich Fabric

2 samples: CA200728, CA200729

Microstructure: Dense with rare to few mesovughs. The distribution of the inclusions is double to open spaced in the coarse fraction and single to double spaced in the fine fraction. Both the voids and inclusions are weakly aligned with the edges.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is reddish brown in both PPL (x40) and XPL (x40).

Inclusions: $C:F:V_{.0625mm}$ =ca. 5:92:3. The inclusions are moderately sorted with an overall unimodal grain size distribution. <0.35mm, mode 0.10mm, a-sr.

Inclusions
Fine Fraction

Common	**Monocrystalline Quartz**
	Bioclast Shell
	Biotite
Few	**Serpentinite**
	Muscovite
Rare	**Opaques**

Coarse Fraction

Frequent	**Monocrystalline Quartz** equant, a-sa, <0.26mm, mode 0.08mm.
Few	**Quartzite** equant, sa-sr, weakly sutured, <0.30mm, mode 0.17mm.
	Muscovite elongated, a-sa, clear in ppl <0.16mm, mode 0.08mm.

Serpentinite elongated, sr. Reddish, no pleochroism, no cleavage in PPL (x40), reddish brown-black in XPL (x40), doesn't go extinct. <0.19mm, mode 0.10mm.

Rare **Opaques** equant to elongated, sr-r, dark black with slightly reddish tint in ppl (x40). <0.15mm, mode 0.08mm.

Biotite elongated, sa, brown in ppl, <0.35mm, mode 0.06mm.

Chert equant, a-sa, <0.28mm, mode 0.16mm.

Bivalve Shell elongated, a-sa, clear in PPL (x40), high bifringence in XPL (x40). Bioclast in calcite possibly bivalve? <0.26mm, mode 0.18mm

Very Rare **Epidote** equant, sa-sr, zoned extinction, <0.08mm, mode 0.08mm.

Concentration Features: Kcf: large clusters of sparry calcite, equant sa-sr, possible post firing deposition, completely filling voids. <0.35mm, mode 0.25mm.

Comments: A bit thick, quartz is slightly yellowish. CA200729 has a quartz rich slip on one edge.

Nippur Fabric N.3: Igneous Rock Tempered Quartz Fabric

3 samples: CA200733, CA200734, CA200736

Microstructure: Rare mesovughs and frequent shrinkage cracks. The distribution of the inclusions is single to double in the coarse fraction and single in the fine fraction. Both the voids and inclusions are weakly aligned in the elongated minerals and shrinkage cracks.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is brown in PPL (x40) and brown to reddish brown in XPL (x40).

Inclusions: $C:F:V_{.0625mm}$ =ca. 20:78:2 to 15:83:2. The inclusions are moderately with an overall bimodal grain size distribution. <0.45mm, mode 0.12mm, a-sr.

Inclusions

Fine Fraction

Common to Few **Monocrystalline Quartz**

Plagioclase

Few **Olivine**

Serpentinite

Ood Shell

Bioclast Shell

Calcite

Biotite

Muscovite

Rare **Opaques**

Hornblende

Coarse Fraction

Frequent **Monocrystalline Quartz** equant, a-sa, straight to undulous extinction, <0.23mm, mode 0.12mm.

Common **Plagioclase** equant, sa, Carlsbad twinning, <0.18mm, mode 0.12mm.

Olivine Equant, sa slightly yellowish in ppl (x40), high bifringence in xpl (x40), one cleavage present, <0.28mm, mode 0.14mm.

Calcite equant, sa, pastel birefringence, one cleavage, <0.26mm, mode 0.16mm.

Serpentinite elongated-equant, a-r, red in ppl, reddish-black xpl, <0.45mm, mode 0.25mm

Common to Rare	**Ood Shell** equant, r, darker rings on exterior and sometimes darker in the middle, brown in ppl and xpl, Concentric structures <0.45mm, mode 0.10mm.
Few	**Mudstone** equant, sr, no extinction, <0.16mm, mode 0.12mm.
	Opaques equant, sr-r, <0.18mm, mode 0.06mm.
	Bioclast Shell elongated, a-sa, possibly bivalve?, <0.28mm, 0.14mm.
	Chert equant to elongated, sa-sr, <0.32mm, mode 0.18mm.
	Quartzite equant to elongated, sa-sr, sutures are poorly formed, undulous extinction, <0.20mm, mode 0.16mm.
	Hornblende elongated, sa, green in ppl, two cleavages, <0.32mm, mode 0.16mm.
Very Rare	**Basalt** equant, sr, very weathered, plagioclase, olivine, opaque (733) <0.30mm, mode 0.30mm.
	Biotite elongated, sa, brown in ppl (728), <0.22mm, mode 0.08mm.
	Granite elongated to equant, sa-sr, quartz with small pieces of biotite, <0.38mm, mode 0.38mm.
	Muscovite elongated, sa, clear in PPL, <0.44mm, mode 0.18mm.

Concentration Features: TCF, equant, sr-r, brown strong edges no inclusions

Comments: 733 very thick, CA200728 is finer than the rest of the assemblage, with less and smaller inclusions. However, the rest of the fabric is the same so grouped together.

Nippur Fabric N.4: Quartz Tempered Fabric

1 sample: CA200724

Microstructure: Dense with rare mesovughs and frequent shrinkage cracks. The distribution of the inclusions is single to double in both the coarse and fine fraction. Both the voids and inclusions are weakly aligned with the edges, there are a few relict coils.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is reddish brown in PPL (x40) and red XPL (x40).

Inclusions: C:F:$V_{.0625mm}$ =ca. 30:65:5. The inclusions are poorly sorted with an overall bimodal grain size distribution, <0.64mm, mode 0.12mm, sa-r.

Inclusions
Fine Fraction

Rare	**Monocrystalline Quartz**
Very Rare	**Opaque**

Coarse Fraction

Frequent	**Monocrystalline Quartz** equant, sa-r, straight to undulose extinction, <0.38mm, mode <0.12mm
Very Rare	**Mudstone** equant, sr-r. very fine texture, sometimes including clasts of quartz, <0.64mm, mode <0.25mm.
	Chert elongated, sr-r, fine texture, sometimes including clasts of quartz, <0.10mm, mode 0.10mm.

Concentration Features: None

Comments: There are relict coils present towards the bottom of the sample, very small coils. Three across in the sample.

Nippur Fabric N.5: Dolerite Tempered Fabric

1 sample: CA200735

Microstructure: Dense with rare microvughs and few shrinkage cracks. The distribution of the inclusions is single to double in the coarse fraction and open in the fine fraction. Both the voids and inclusions are randomly aligned.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is brown in both PPL (x40) and XPL (x40).

Inclusions: $C:F:V_{.0625mm}$ =ca. 35:60:5. The inclusions are poorly sorted with an overall bimodal grain size distribution. <1.85mm, mode 0.35mm, a-sr.

Inclusions
Fine Fraction

Rare	**Monocrystalline Quartz**
	Plagioclase
	Serpentinite
Very Rare	**Opaques**

Coarse Fraction

Frequent	**Olivine Dolerite** equant to elongated, sa-sr, laths of plagioclase, olivine, pyroxene, serpentinite (weathered olivine), opaques, <1.85mm, mode 1.10mm.
Few	**Chert** equant, some are radiolarian, sa-sr, <0.55mm, mode 0.28mm.
	Monocrystalline Quartz equant, sa-sr, <0.35mm, mode 0.19mm
	Serpentinite equant-elongated, weathered olivine sa-sr, <1.15mm, mode 0.38mm.
Rare	**Olivine** equant, sa, well defined edges, high bifringence. <0.22mm, mode 0.12mm.
	Plagioclase equant, a, twinning <0.45mm, mode 0.15mm.
	Mudstone equant, sa-sr. very fine texture, some have clasts of quartz, <0.65mm, mode 0.35mm.
Very Rare	**Quartzite** equant, sa-sr, poorly sutured, undulous extinction, <0.45mm, mode 0.32mm.

Concentration Features: None

Comments: Slightly thick, Quartz is yellowish.

Hasanlu

Hasanlu Fabric H.1: Schist Tempered Biotite Rich Fabric

4 samples: CA200364, CA200365, CA200366, CA200368

Microstructure: Common mesovughs with few shrinkage cracks and few mesoelongated voids, in sample CA200366. The distribution of the inclusions is single to open in the coarse fraction and double in the fine fraction. The voids and inclusions are weakly to strongly oriented to the edges.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is reddish brown to brown with red tints in PPL (x40) and red to reddish brown in XPL (x40).

Inclusions: $C:F:V_{.0625mm}$ = ca. 20:75:5. The inclusions are poorly sorted with an overall bimodal grain size distribution. <0.84mm, mode 0.18mm, a-sr.

Inclusions
Fine Fraction

Frequent	**Monocrystalline Quartz**
Common	**Opaques**
	Chert
Few	**Serpentinite**
	Biotite
	Plagioclase

Coarse Fraction

Frequent	**Monocrystalline Quartz** equant to elongated, a-sa, straight to undulous extinction, <0.72mm, mode 0.10mm.
Frequent to Rare	**Serpentinite** equant to elongated, sa-sr, red in ppl and xpl <0.60mm, mode 0.30mm.
	Hornblende elongated, sa-sr, greenish/gray pleochroism in ppl, two cleavages, <0.26mm, mode 0.12mm.
Common	**Quartzite** equant, sr, Quartz grains, weakly sutured, some have a weak foliation, <0.24mm, mode 0.16mm.
Common to Rare	**Opaques** equant-elongated, a-r, slightly reddish, <0.30mm, mode 0.15mm.
	Micritic Limestone equant, sr, <0.44mm, mode 0.24mm.
	Chert equant to elongated, sa-sr, <0.42mm, mode 0.22mm.
	Quartz Schist? Equant to elongated, sa-sr, quartz clasts, sometimes with small pieces of biotite, some have plagioclase with Carlsbad twinning, weakly foliated, <0.84mm, mode 0.18mm.
Few	**Biotite** elongated, sa, strong brown pleochroism in ppl, single cleavage <0.46mm, mode 0.22mm.
	Biotite Schist? elongated, sa, strong brown pleochroism in ppl, foliated, multiple pieces of biotite, sometimes a quartz clast present, <0.46mm, mode 0.12mm.
Few to Rare	**Basalt** equant, sr, laths of feldspar in a dark matrix, <0.34mm, mode 0.16mm.
Very Rare	**Plagioclase** equant, sa, Carlsbad twinning, <0.10mm, mode 0.10mm.
	Muscovite elongated, sa, clear in ppl, one cleavage, <0.18mm, mode 0.18mm.

Concentration Features: TCF equant to elongated, sr-r, well defined boundaries, reddish in ppl reddish brown in xpl <0.25mm, mode 0.20mm.

Comments: CA200368 has a quartz rich slip and a clear to bluish glaze. Both sides glazed. CA200366 has a clear glaze with no slip.

Hasanlu Fabric H.2: Fine Quartz Rich Fabric

1 sample: CA200363

Microstructure: Dense with few microvughs and rare microelongated voids. The distribution of the inclusions is open in both coarse and fine fraction. Both the voids and inclusions are randomly oriented to the edges.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is greenish brown in PPL (x40) and brown with greenish tints in XPL (x40).

Inclusions: C:F:V$_{.0625mm}$ =ca. 10:86:4. The inclusions are moderately sorted with an overall unimodal grain size distribution, <0.32mm, mode 0.06mm, a-sr.

Inclusions
Fine Fraction

Few	**Monocrystalline Quartz**
Very Rare	**Opaque**

Coarse Fraction

Few	**Monocrystalline Quartz** equant to elongated, a-sa, straight to undulous extinction, <0.16mm, mode 0.06mm.
Rare	**Chert** equant, sr, <0.32mm, mode 0.08mm.
Very Rare	**Quartzite** equant, sr, very weathered, weak sutures <0.18mm, mode 0.14mm.
	Plagioclase Equant, sa-sr, Carlsbad twinning, <0.22mm, mode 0.16mm.

Concentration Features: TCF equant, sr-r, Red to reddish black, iron rich clay pellets, <0.18mm, mode 0.10mm.

Comments: None

Hasanlu Fabric H.3 Fine Biotite Rich Fabric

1 sample: CA200369

Microstructure: Dense with few microelongated voids. The distribution of the inclusions is open in both coarse and fine fraction. Both the voids and inclusions are strongly oriented perpendicular to the edges.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is reddish brown in PPL (x40) and red in XPL (x40).

Inclusions: C:F:V$_{.0625mm}$ =ca. 15:81:4. The inclusions are moderately sorted with an overall unimodal grain size distribution. <0.35mm, mode 0.12mm, a-sr.

Inclusions
Fine Fraction

Few	**Monocrystalline Quartz**
	Biotite
Very Rare	**Chert**

Coarse Fraction

Common	**Monocrystalline Quartz** equant to elongated, a-sa, straight to undulous extinction <0.12mm, mode 0.06mm.
	Biotite elongated, sa, strong brown pleochroism in ppl, <0.10mm, mode 0.06mm
Rare	**Chert** equant, sr**,** <0.14mm, mode 0.12mm.
	Biotite Schist equant, sr, Quartz in a biotite matrix, very weathered. <0.28mm, mode 0.18mm.
	Opaque, equant, sa-sr, <0.35mm, mode 0.2mm.
Very Rare	**Micritic Limestone** equant, sr-r, <0.09mm, mode 0.09mm.
	Serpentinite equant to elongated, sr, red in ppl and xpl, doesn't go extinct, <0.12mm, mode 0.12mm.

Concentration Features: None

Comments: None

Hasanlu Fabric H.4: Stonepaste

1 sample: CA200367

Microstructure: No voids. The distribution of the inclusions is single in the coarse and fine fraction. Both the voids and inclusions are randomly oriented.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is clear in PPL (x40) and greyish in XPL (x40).

Inclusions: C:F:V$_{.0625mm}$ =ca. 20:80:0. The inclusions are well sorted with an overall unimodal grain size distribution. <0.46mm, mode 0.14mm, a-sa.

Inclusions
Fine Fraction

Frequent	**Monocrystalline Quartz**

Coarse Fraction

Frequent	**Monocrystalline Quartz** equant to elongated, a-sa, straight extinction <0.46mm, mode 0.14mm
Very Rare	**Calcite** equant, sa, high birefringence, <0.12mm, mode 0.12mm.

Concentration Features: None

Comments: None

Rayy
Rayy Fabric R.1: Fine Quartz Rich Fabric

10 samples: CA200336, CA200337, CA200338, CA200342, CA200344, CA200345, CA200346, CA200349, CA200372, CA200373

Microstructure: Common to few mesovughs and rare microvughs. The distribution of the inclusions is open in the coarse fraction and single to double in the fine fraction. Both the voids and inclusions are weakly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is yellowish brown in PPL (x40) and brown in XPL (x40).

Inclusions: C:F:V$_{.0625mm}$ =ca. 5:90:5. The inclusions are well sorted with an overall unimodal grain size distribution. <0.62mm, mode 0.06mm, a-sr.

Inclusions
Fine Fraction

Common	**Monocrystalline Quartz**
Few	**Opaques**
Rare	**Serpentinite**
	Plagioclase

Coarse Fraction

Frequent	**Monocrystalline Quartz** equant, sa-sr, straight to undulous extinction, <0.18mm, mode 0.06mm.
Common to Very Rare	**Opaques** elongated to equant, sr-r, slight red edges <0.22mm, mode 0.06mm.
	Chert equant to elongated, sr, (337, 338, 344, 345, 373), <0.28mm, mode 0.12mm.
Few to Very Rare	**Muscovite** elongated to equant, a-sa, clear ppl (336, 337, 345), <0.16mm, mode 0.08mm.

	Plagioclase equant, a-sa, Carlsbad twinning <0.16mm, mode 0.06mm.
	Biotite elongated, a-sa, brown pleochroism ppl, <0.14mm, mode 0.06mm.
Rare to Very Rare	**Quartzite** equant to elongated, sa-sr, some slightly weathered, (338, 345, 373), <0.62mm, mode 0.16mm.
Very Rare	**Biotite schist?** elongated, sa-sr, quartz with biotite weakly foliated, (336, 337), <0.26mm, mode 0.16mm.
	Serpentinite elongated, r, red in ppl and xpl, (338), <0.16mm, mode 0.16mm.

Concentration Features: TCF equant, r, red clay nodes, strong boundaries <0.14mm, mode 0.06mm.

Comments: CA200349 clear glaze with no slip, glaze has quartz fragments in it. CA200372 has a clear glaze over a wollastonite slip. Both edges. CA200344 has a clear glaze over a quartz rich slip. both sides.

Rayy Fabric R.2a: Fine Biotite Rich Fabric

6 samples: CA200325, CA200326, CA200327, CA200331, CA200347, CA200350

Microstructure: Few microvughs, mesovughs, and rare mesoelongated vughs, and macrovughs. The distribution of the inclusions is double to open in the coarse fraction and fine fraction. Both the voids and inclusions are randomly to strongly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is reddish brown to brown with red tints in PPL (x40) and red to brown in XPL (x40).

Inclusions: $C{:}F{:}V_{.0625mm}$ =ca. 5:90:5. The inclusions are well sorted with an overall unimodal grain size distribution. <0.62mm, mode 0.10mm, a-r.

Inclusions
Fine Fraction

Few	**Biotite**
	Monocrystalline Quartz
	Opaque
Rare	**Muscovite**

Coarse Fraction

Common to Few	**Monocrystalline Quartz** equant, sa-sr, straight to undulous extinction, <0.35mm, mode 0.10mm.
	Biotite elongated to equant, a-sa, brown pleochroism ppl, <0.25mm, mode 0.10mm.
Few to Rare	**Opaques** elongated to equant, sr-r, slight red edges, <0.50mm, mode 0.08mm.
	Chert equant to elongated, sa-sr, some are very weathered, (325, 326, 331, 347, 350), <0.40mm, mode 0.20mm.
	Plagioclase equant, a-sa, Carlsbad twinning, (325, 327, 331), <0.35mm, mode 0.10mm.
Very Rare	**Mudstone** equant, r, gray in ppl and xpl, (326, 350), <0.62mm, mode 0.15mm.
	Quartzite equant, sr, weakly sutured, (325, 327), <0.25mm, mode 0.10mm.
	Serpentinite equant, sr-r, red in ppl and xpl, (327), <0.10mm, mode 0.10mm.
	Igneous Rock Fragment (Basalt?) equant, sr, crystals of quartz, laths of plagioclase and biotite, opaques in a darker matrix, <0.45mm, mode 0.20mm.
	Micritic Limestone equant, sa, (331, 347) <0.50mm, mode 0.35mm.

	Fine Grained Igneous Rock (Trachyte?) equant, sa, laths of quartz and biotite, <0.25mm, mode 0.10mm

Concentration Features: TCF equant, r, red clay nodes, strong boundaries, (331, 350), <0.35mm. mode 0.14mm. TCF elongated to equant, r, diffuse boundaries, orange (326), <0.45mm, mode 0.15mm. KCF sparry calcite in voids (327, 347, 331).

Comments: Slightly heterogenous grouping especially in terms of voids/orientation. However, clay source and inclusions are relatively homogenous so grouped together. CA200325 has a blue/clear glaze with some opaques and a quartz rich slip.

Rayy Fabric R.2b: Fine Biotite and Quartz Rich Fabric

6 samples: CA200328, CA200330, CA200343, CA200348, CA200351, CA200374

Microstructure: Few microvughs, rare mesoelongated vughs. The distribution of the inclusions is double to open in the coarse fraction and single to double in the fine fraction. Both the voids and inclusions are random to strongly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is reddish brown to brown with red tints in PPL (x40) and red to brown in XPL (x40).

Inclusions: $C:F:V_{.0625mm}$ =ca. 5:90:5. The inclusions are well sorted with an overall unimodal grain size distribution. <0.70mm, mode 0.15mm, a-r.

Inclusions
Fine Fraction

Common	**Monocrystalline Quartz**
	Biotite
Few	**Opaque**
Rare	**Muscovite**

Coarse Fraction

Common	**Monocrystalline Quartz** equant, sa-sr, straight to undulous extinction, <0.35mm, mode 0.10mm.
Few	**Biotite** elongated to equant, a-sa, brown pleochroism ppl, <0.25mm, mode 0.10mm.
	Opaques elongated to equant, sr-r, slight red edges, <0.50mm, mode 0.08mm.
Few to Rare	**Chert** equant to elongated, sa-sr, some are very weathered <0.40mm, mode 0.20mm.
	Plagioclase equant, a-sa, Carlsbad twinning, (328, 330, 348, 374), <0.35mm, mode 0.10mm.
Rare	**Muscovite** elongated to equant, a-sa, clear ppl, (328, 350, 351, 374), <0.25mm, mode 0.15mm.
Very Rare	**Polycrystalline Quartz** elongated, sa-sr, two to three grains of quartz, weakly sutured, possibly from quartzite (328, 330, 343), <0.55mm, mode 0.20mm.
	Metamorphic Rock (Amphibolite?) equant to elongated, sa-sr, laths of hornblende/amphibole, weakly foliated (348, 351) <0.65mm, mode 0.30mm.
	Mudstone equant, r, gray in ppl and xpl, (328, 330, 348), <0.70mm, mode 0.20mm.
	Serpentinite equant, sr-r, red in ppl and xpl, (328, 348, 351), <0.20mm, mode 0.10mm.

Hornblende elongated, sa, one clevage, brown/green pleochroism, high bifringence (328, 348, 351)**,** <0.35mm, mode 0.10mm.
Fine grained Igneous Rock (Trachyte?) equant, sa, laths of quartz and biotite, (330, 348, 351) <0.30mm, mode 0.10mm
Zircon equant, a, high relief, high bifringence (328, 348, 351), <0.15mm, mode 0.08mm.
Quartzite equant, sr, weakly sutured, (328, 343, 351), <0.25mm, mode 0.10mm.
Calcite equant, a-sa, pastel bifringence (351), <0.25mm, mode 0.10mm.
Igneous Rock Fragment (Basalt?) equant, sr, crystals of quartz, laths of plagioclase and biotite, opaques in a darker matrix, (330, 351) <0.45mm, mode 0.20mm.
Igneous Rock Fragment equant, a-sa, quartz crystals with biotite laths inside. <0.30mm, mode 0.25mm.

Concentration Features: TCF equant, sr-r, red in ppl and xpl, (328, 348, 351, 374). KCF sparry calcite in all voids.

Comments: CA200330 as a greenish clear glaze on top of a quartz rich slip.

Rayy Fabric R.3: Sedimentary Quartz Fabric

2 samples: CA200323, CA200341

Microstructure: Common microvughs and few mesovughs. The distribution of the inclusions is double in the coarse fraction and double to open in the fine fraction. Both the voids and inclusions weakly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is yellowish brown in PPL (x40) and brown in XPL (x40).

Inclusions: C:F:V$_{.0625mm}$ =ca. 15:80:5. The inclusions are well sorted with an overall unimodal grain size distribution. <0.85mm, mode 0.15mm, a-sr.

Inclusions
Fine Fraction
Common **Monocrystalline Quartz**
Few **Biotite**
Rare **Serpentinite**
Plagioclase

Coarse Fraction
Common to Few
Monocrystalline Quartz equant, sa-sr, straight to undulous extinction, <0.45mm, mode 0.15mm.
Micritic Limestone equant to elongated, sa-sr, burning out leaving darker rims/sparry calcite rims <0.55mm, mode 0.20mm

Few
Biotite equant to elongated, a-sa, strong brown pleochroism ppl <0.20mm, mode 0.08mm.
Opaques elongated to equant, sr-r, slight red edges, <0.25mm, mode 0.10mm.
Plagioclase equant, a-sa, Carlsbad twinning, <0.20mm, mode 0.15mm.

Few to Rare
Quartzite equant to elongated, sa-sr, weakly sutured, <0.28mm, mode 0.22mm.
Chert equant, sa-sr, very weathered in some fragments, <0.85mm, mode 0.30mm

Rare	**Felsic Igneous Rock Fragment, Basalt?** Equant to elongated, sa-sr, Laths of feldspar, igneous, opaque red/brown matrix, very weathered, <0.34mm, mode 0.22mm.
	Hornblende elongated, sa, one clevage, brown/green pleochroism, high bifringence <0.35mm, mode 0.10mm.
	Fine grained Igneous Rock (Trachyte?) equant, sa, laths of quartz and biotite (323) <0.55mm, mode 0.25mm
	Fine grained Igneous Rock (Rhyolite?) equant, sa, laths of quartz and biotite in a reddish matrix (323) <0.50mm, mode 0.20mm.
Very Rare	**Biotite Schist** equant, sa-sr, quartz, biotite, weakly foliated <0.55mm, mode 0.30mm.
	Mudstone elongated, sr-r, sometimes with quartz phenocrysts, (323) <0.55mm, mode 0.22mm.
	Calcite equant, a-sa, pastel bifringence (341) <0.35mm, mode 0.15mm.

Concentration Features: TCF, equant, r, reddish clay nodes <0.14mm, mode 0.06mm. KCF sparry calcite in voids

Comments: None

Rayy Fabric R.4: Quartz Tempered Fabric

2 samples: CA200340, CA200370

Microstructure: Few mesoelongated voids, and mesovughs, and rare megavughs. The distribution of the inclusions is double in the coarse fraction and single to double in the fine fraction. Both the voids and inclusions are strongly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is greenish brown with red tints in PPL (x40) and XPL (x40).

Inclusions: $C:F:V_{.0625mm}$ =ca. 20:75:5. The inclusions are moderately sorted with an overall bimodal grain size distribution. <0.74mm, mode 0.14mm, a-sr.

Inclusions
Fine Fraction

Frequent	**Monocrystalline Quartz**
Common	**Biotite**
Few	**Opaque**
	Orthoclase
Rare	**Serpentinite**
	Plagioclase

Coarse Fraction

Frequent to Common	**Monocrystalline Quartz** elongated, sa-r, straight to undulous extinction, <0.70mm, mode 0.14mm.
Common to Few	**Biotite** elongated, a-sa, brown pleochroism ppl, <0.18mm, mode 0.10mm.
Few	**Opaques** equant, r, slightly reddish edges, <0.35mm, mode 0.10mm.
	Orthoclase equant, a-sa, cloudy in ppl, 1 cleavage <0.16mm, mode 0.12mm.
Few to Rare	**Mudstone** equant to elongated, sr-r, sometimes slightly greyish, sometimes with rare phenocrysts of quartz, <2.10mm, mode 2.10mm.
	Chert equant to elongated, sr, <1.35mm, mode 0.28mm.
	Plagioclase equant, a-sa, Carlsbad Twinning <0.30mm, mode 0.10mm.
	Micritic Limestone equant to elongated, sa-sr, burning out leaving darker rims/sparry calcite rims <0.48mm, mode 0.24mm.

Rare **Hornblende** elongated, sa, one clevage, brown/green pleochroism, high bifringence <0.35mm, mode 0.10mm.
Calcite equant, a-sa, pastel bifringence (340) <0.32mm, mode 0.15mm.
Serpentinite equant to elongated, sr-r, reddish in ppl and xpl, <0.10mm, mode 0.06mm.
Quartzite equant to elongated, sr, weak to strong sutures <1.05mm, mode 0.24mm.

Concentration Features: TCF equant, sr-r, reddish clay nodes, <0.94mm, mode 0.40mm.

Comments: None

Rayy Fabric R.5a: Tempered Biotite Rich Fabric

3 samples: CA200324, CA200333, CA200334, CA200371

Microstructure: Few mesovughs, rare mesoelongated voids. The distribution of the inclusions is double in the coarse fraction and single to double in the fine fraction. Both the voids and inclusions are weakly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is reddish brown in PPL (x40) and reddish brown in XPL (x40).

Inclusions: C:F:$V_{.0625mm}$ =ca. 20:77:3. The inclusions are poorly sorted with an overall bimodal grain size distribution. <1.60mm, mode 0.20mm, a-sr.

Inclusions
Fine Fraction
Common **Monocrystalline Quartz**
Opaque
Few **Biotite**
Orthoclase
Rare **Muscovite**
Plagioclase
Epidote

Coarse Fraction
Common to Few **Monocrystalline Quartz** equant, sa-sr, <0.26mm, mode 0.14mm.
Few **Mudstone** equant to elongated, sr-r, sometimes slightly greyish, sometimes with rare phenocrysts of quartz, <0.45mm, mode 0.20mm.
Opaque equant to elongated, sr-r, reddish tinted along edges, <0.30mm, mode 0.20mm.
Plagioclase equant to elongated, sa-sr, Carlsbad twinning, <0.36mm, mode 0.16mm.
Biotite elongated, a-sa, brown pleochroism ppl, <0.20mm, mode 0.10mm.
Few to Rare **Serpentinite** equant to elongated, sr-r, red in ppl and xpl, <0.25mm, mode 0.20mm.
Basalt equant to elongated, sa-sr, thick plagioclase laths, quartz, opaque, muscovite, biotite, sometimes very weathered, <0.55mm, mode 0.28mm.
Trachyte equant, sa-sr, thin plagioclase laths, opaques, biotite, sometimes very weathered, only a few pieces of plagioclase or quartz in a reddish-brown matrix, (324) <0.35mm, mode 0.20mm.
Orthoclase equant, sa-sr, one cleavage, cloudy ppl, <0.64mm, mode 0.14mm.
Chert equant to elongated, sa-sr, <0.55mm, mode 0.32mm.

Rare	**Calcite** equant, a-sa, one clevage, low birefringence, <0.48mm, mode 0.10mm.
	Muscovite elongated to equant, a-sa, clear ppl, (328, 350, 351, 374), <0.25mm, mode 0.15mm.
	Micritic Limestone equant to elongated, sa-sr, burning out leaving darker rims/sparry calcite rims <1.60mm, mode 0.42mm.
	Fine Grained Metamorphic Rock (Biotite Schist?) equant to elongated, sa-sr, foliated, biotite, muscovite, rare quartz <0.55mm, mode 0.25mm.
	Quartzite equant to elongated, sr, weak to strong sutures (334), <1.05mm, mode 0.24mm.
	Dolomitic Limestone equant, sa, individual crystals of dolomite seen <0.30mm, mode 0.15mm.
Very Rare	**Epidote** equant, sa-sr, zoned extinction, high birefringence, (334) <0.15mm, mode 0.10mm.
	Hornblende elongated, sa, one clevage, brown/green pleochroism, high bifringence (333) <0.25mm, mode 0.15mm

Concentration Features: TCF equant to elongated, sr-r, reddish clay nodes, (333, 334), <0.45mm, mode 0.12mm. KCF sparry calcite in voids

Comments: None

Rayy Fabric R.5b: Tempered Biotite and Quartz Rich Fabric

2 samples: CA200329, CA200335

Microstructure: Few mesovughs, and microvughs, rare macrovughs, and mesoelongated voids. The distribution of the inclusions is double in the coarse fraction and single to double in the fine fraction. Both the voids and inclusions are weakly oriented to the edge.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is reddish brown in PPL (x40) and reddish brown in XPL (x40).

Inclusions: C:F:V$_{.0625mm}$ =ca. 25:70:5. The inclusions are poorly sorted with an overall bimodal grain size distribution. <1.05mm, mode 0.10mm, a-sr.

Inclusions
Fine Fraction

Common	**Monocrystalline Quartz**
	Opaque
Few	**Biotite**
	Orthoclase
Rare	**Muscovite**
	Plagioclase
	Epidote

Coarse Fraction

Common to Few	**Monocrystalline Quartz** equant, sa-sr, <0.35mm, mode 0.14mm.
	Biotite elongated to equant, a-sa, brown pleochroism in ppl, <0.18mm, mode 0.10mm.
Few	**Opaque** equant to elongated, sr-r, reddish tinted along edges, <0.35mm, mode 0.10mm.
	Chert equant to elongated, sa-sr, <0.85mm, mode 0.25mm

Few to Rare **Plagioclase** equant to elongated, sa-sr, Carlsbad twinning (329), <1.05mm, mode 0.10mm.

Rare **Muscovite** elongated, sa, clear ppl, high bifringence (335) <0.15mm, mode 0.08mm.
Basalt equant to elongated, sa-sr, thick plagioclase laths, quartz, opaque, muscovite, biotite, sometimes very weathered, <0.66mm, mode 0.28mm.
Quartzite equant to elongated, sr, weakly sutured, <0.34mm, mode 0.14mm.
Mudstone equant to elongated, sr-r, sometimes slightly greyish, sometimes with rare phenocrysts of quartz, (335) <0.45mm, mode 0.20mm.
Micritic Limestone equant to elongated, sa-sr, burning out leaving darker rims/sparry calcite rims <0.55mm, mode 0.25mm.

Very Rare **Hornblende** elongated, sa, one clevage, brown/green pleochroism, high bifringence <0.25mm, mode 0.15mm.
Fine Grained Metamorphic Rock (Biotite Schist?) equant to elongated, sa-sr, foliated, biotite, muscovite, rare quartz (335) <0.50mm, mode 0.15mm.
Trachyte equant, sa-sr, thin plagioclase laths, opaques, biotite, sometimes very weathered, only a few pieces of plagioclase or quartz in a reddish-brown matrix, <0.30mm, mode 0.15mm
Epidote equant, sa-sr, zoned extinction, high birefringence, (335) <0.35mm, mode 0.04mm.

Concentration Features: TCF equant to elongated, sr-r, reddish clay nodes, <0.94mm, mode 0.20mm.
KCF sparry calcite in voids

Comments: Glazed both sides.

Rayy Fabric R.6: Vegetal Tempered Quartz Rich Fabric

1 sample: CA200332

Microstructure: Common mesoelongated voids. The distribution of the inclusions is single to double in the coarse and the fine fraction. Both the voids and inclusions are strongly oriented to the edge.

Groundmass: Heterogenous based on color. The fabric is optically inactive. It is grey to black in the core, and reddish brown along the edges in PPL (x40) and black in the core and brown along the edges in XPL (x40).

Inclusions: C:F:V$_{.0625mm}$ =ca. 10:80:10. The inclusions are moderately sorted with an overall unimodal grain size distribution. <1.70mm, mode 0.12mm, a-sr.

Inclusions
Fine Fraction

Common **Monocrystalline Quartz**
Few **Opaques**
Rare **Serpentinite**
Plagioclase

Coarse Fraction

Frequent **Monocrystalline Quartz** elongated to equant, a-sr, <0.24mm, mode 0.06mm.
Common **Mudstone** elongated to equant, sa-sr, coarser to finer throughout the sample, <1.70mm, mode 0.84mm.
Few **Felsic Igneous Rock fragment** equant, sr, Quartz/feldspar and epidote in red/brown matrix, very weathered <0.60mm, mode 0.46mm.
Rare **Epidote** equant, a-sa, zoned extinction, <0.14mm, mode 0.10mm.
Quartzite equant to elongated, sa-sr, <0.64mm, mode 0.16mm.

Very Rare **Chert** equant to elongated, sa-sr, <0.62mm, mode 0.62mm.
Plagioclase equant, a-sa, Carlsbad twining, weathered, <0.18mm, mode 0.10mm.

Concentration Features: None

Comments: Brown edges measure between 0.20mm and 0.85mm.

Rayy Fabric R.7: Vegetal and Sedimentary Tempered Biotite Fabric

1 sample: CA200339

Microstructure: Common mesoelongated voids and few mesovughs,. The distribution of the inclusions is double to open in the coarse fraction and double in the fine fraction. Both the voids and inclusions are weakly oriented perpendicular to the edge.

Groundmass: Homogenous based on color. The fabric is a striated b-fabric. It is orangish red in PPL (x40) and red in XPL (x40).

Inclusions: $C:F:V_{.0625mm}$ =ca. 17:76:7. The inclusions are moderately sorted with an overall bimodal grain size distribution. <1.85mm, mode 0.30mm, a-sr.

Inclusions
Fine Fraction
Common **Monocrystalline Quartz**
Opaque
Few **Serpentinite**
Plagioclase

Coarse Fraction
Common **Monocrystalline Quartz** equant, a-sr, straight extinction <0.65mm, mode 0.06mm.
Opaque equant, sr-r, slightly reddish along edges, <0.20mm, mode 0.10mm.
Few **Mudstone** equant, sr-r, sometimes phenocrysts of quartz in matrix, <1.85mm, mode 1.10mm.
Serpentinite equant to elongated, sr-r, reddish brown in ppl, red in xpl, <2.40mm, mode 2.40mm.
Rare **Biotite Schist?** equant to elongated, sr, quartz, opaque, biotite, weakly foliated, <1.15mm, mode 1.15mm.
Sandstone elongated, sr, individual slightly rounded quartz grains in a darker matrix, <0.40mm, mode 0.30mm.
Plagioclase equant to elongated, sa, Carlsbad twinning, <0.30mm, mode 0.06mm.
Felsic Igneous Rock Fragment equant, sr, very weathered, laths of plagioclase in dark red matrix <0.55mm, mode 0.45mm.
Very Rare **Zircon** equant, a, high relief, clear to greenish ppl, glassy texture, high birefringence, <0.08mm, mode 0.08mm.
Quartzite equant to elongated, sa-sr, <1.60mm, mode 1.60mm.

Concentration Features: None

Comments: None

Firuzabad
Firuzabad Fabric F.1: Fine Fabric

3 samples: CA200356, CA200360, CA200362

Microstructure: Common mesovesicles to few elongated macrovughs and microvesicles. The distribution of the inclusions is open in the coarse fraction and single to double in the fine fraction. Both the voids and inclusions are random to weakly oriented to the edges. There are few relict coils present.

Groundmass: Heterogenous based on color. The fabric is optically inactive. It is greenish brown with red specks in PPL (x40) and greenish to yellowish brown with red specks in XPL (x40).

Inclusions: C:F:$V_{.0625mm}$ =ca. 20:65:15. The inclusions are moderately sorted with an overall bimodal grain size distribution. <1.60mm, mode 0.06mm, a-sr.

Inclusions
Fine Fraction

Frequent	**Monocrystalline Quartz**
Common	**Opaques**
Few	**Biotite**
Very Rare	**Serpentinite**
	Epidote
	Plagioclase
	Muscovite

Coarse Fraction

Frequent	**Monocrystalline Quartz** equant, a-sa, <0.38mm, mode 0.06mm.
Common	**Opaques** equant, sr-r, slightly reddish, <0.16mm, mode 0.06mm.
	Plagioclase elongated, sr, Carlsbad twinning <0.18mm, mode 0.08mm.
Few	**Biotite** elongated a-sa, strong brown pleochroism in ppl, some alteration <0.16mm, mode 0.06mm.
Rare	**Muscovite** elongated, a-sa, clear in ppl, <0.28mm, mode 0.08mm.
	Quartzite equant to elongated, sa-sr, sutures are weakly defined, <0.36mm, mode 0.36mm.
Very Rare	**Serpentinite** elongated, sr, reddish brown in ppl <0.20mm, mode 0.04mm
	Epidote equant, sa, high bifringence, zoned extinction (360), <0.08mm, mode 0.04mm.
	Mudstone elongated, sr, reddish in ppl and xpl, <1.60mm, mode 1.60mm.
	Basalt equant, sr, laths of plagioclase, small pieces of biotite, rare epidote, very weathered, (360) <0.28mm, mode 0.18mm.
	Greywacke equant to elongated, sr, some with larger pieces of quartz, <0.28mm, mode 0.28mm.
	Orthoclase equant, sa, cloudy in ppl, 1 clevage, <0.18mm, mode 0.16mm.

Concentration Features: TCF reddish brown, equant, well defined boundary, <0.08mm, mode 0.04mm. TCF grey, elongated, slightly porous boundaries (360) <0.34mm, mode 0.24mm.

Comments: There are a few larger pieces making the fabric bimodal, but probably not intentionally added.

Firuzabad Fabric F.2a: Igneous Tempered Biotite Rich Fabric

1 sample: CA200359

Microstructure: Common mesovughs, few mesoelongated voids, and rare macrovughs. The distribution of the inclusions is single to open in the coarse fraction and double to open in the fine fraction. Both the voids and inclusions are randomly oriented.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is red in PPL (x40) and red in XPL (x40).

Inclusions: $C:F:V_{.0625mm}$ =ca. 23:72:5. The inclusions are very poorly sorted with an overall bimodal grain size distribution. <2.15mm, mode 0.35mm, sa-sr.

Inclusions
Fine Fraction

Few	**Monocrystalline Quartz**
	Biotite
	Plagioclase
Rare	**Serpentinite**
Very Rare	**Amphibole**

Coarse Fraction

Common	**Monocrystalline Quartz** equant, sa-sr, straight to undulous extinction, <0.12mm, mode 0.04mm.
	Biotite elongated, sa, brown in ppl, <0.10mm, mode 0.08mm.
	Felsic Igneous Rock Fragment, Andesite? elongated, sa-sr, large pieces of plagioclase, hornblende, and a few opaques, very weathered <1.15mm, mode 0.80mm.
	Plagioclase equant to elongated, sa-sr, Carlsbad to albite twinning, <0.18mm, mode 0.06mm.
Few	**Micritic Limestone** equant to elongated, sr-r, <0.34mm, mode 0.18mm.
	Greywacke equant, sa-sr, rounded quartz in darker matrix, <0.55mm, mode 0.30mm.
	Intermediate Igneous Rock Fragment, Trachyte? equant, sr, laths of orthoclase, opaques, fine texture, weathered <0.60mm, mode 0.20mm.
Rare	**Serpentinite** elongated, sr-r, red-reddish brown in ppl and xpl, some have centers of amphibole altering to serpentinite, <0.85mm, mode 0.40mm.
	Conglomerate Rock Fragment equant, sr-r, calcite rich matrix, opaques, muscovite, amphibole, plagioclase, quartz, <1.15mm, mode 0.88mm.
Very Rare	**Siliceous Schist? Granite?** equant, sa-sr, quartz, plagioclase, biotite, weak foliation on one side of fragment, <1.10mm, mode 0.80mm.
	Sandstone elongated, sa-sr, large pieces of quartz, weathered <2.15mm, mode 2.15mm.
	Amphibolite elongated, sa, large phenocrysts of hornblende and orthoclase, <0.85mm, mode 0.35mm.

Concentration Features: None

Comments: None

Firuzabad Fabric F.2b Scoria Tempered Heterogeneous Fabric

1 sample: CA200358

Microstructure: Frequent mesovughs, rare mesoelongated voids. The distribution of the inclusions is open in the coarse fraction and single to double in the fine fraction. Both the voids and inclusions are randomly oriented.

Groundmass: Heterogenous based on color. The fabric is optically inactive. It is greenish brown with reddish spots in PPL (x40) and brown with greenish tints and red spots in XPL (x40).

Inclusions: C:F:V$_{.0625mm}$ =ca. 15:65:20. The inclusions are very poorly sorted with an overall bimodal grain size distribution. <4.40mm, mode 0.70mm, sa-r.

Inclusions
Fine Fraction

Common	**Monocrystalline Quartz**
	Hornblende
	Opaques
Rare	**Serpentinite**
	Plagioclase
	Opaques

Coarse Fraction

Common	**Monocrystalline Quartz** equant, sa-sr, <0.54mm, mode 0.06mm.
Few	**Scoria** elongated to equant, sr-r, plagioclase, 30-40% vesicles, glassy matrix, <1.60mm, mode 0.80mm.
	Mudstone equant to elongated, sr, <1.05mm, mode 0.70mm.
	Serpentinite elongated, sr-r, red to reddish black in ppl and xpl**,** <1.05mm, mode 0.40mm.
	Opaque equant, sr-r, reddish tint along exterior, <0.25mm, mode 0.10mm.
Rare	**Sandstone** equant, a-sa, large quartz on dark matrix, <4.40mm, mode 0.45mm.
	Plagioclase equant, sa, Carlsbad twinning <0.10mm, mode 0.06mm.

Concentration Features: None

Comments: None

Firuzabad Fabric F.2c: Igneous Tempered Heterogeneous Fabric

1 sample: CA200357

Microstructure: Frequent mesovughs and rare mesoelongated voids. The distribution of the inclusions is open in the coarse fraction and single to double in the fine fraction. Both the voids and inclusions are randomly oriented.

Groundmass: Heterogenous based on color. The fabric is optically inactive. It is greenish brown with reddish spots in PPL (x40) and brown with greenish tints and red spots in XPL (x40).

Inclusions: C:F:V$_{.0625mm}$ =ca. 15:65:20. The inclusions are moderately sorted with an overall bimodal grain size distribution. <0.95mm, mode 0.15mm, a-sr.

Inclusions
Fine Fraction

Common	**Monocrystalline Quartz**
	Opaque
Rare	**Serpentinite**
	Plagioclase

Coarse Fraction

Common	**Monocrystalline Quartz** equant, sa-sr, <0.35mm, mode 0.06mm.
	Plagioclase equant, sa, Carlsbad twinning, <0.80mm, mode 0.08mm.
	Opaque equant, sr-r, slightly reddish along edges, <0.45mm, mode 0.15mm.

Few **Hornblende** equant, sa-sr, green in ppl <0.40mm, mode 0.12mm
Chert equant, sa, <0.65mm, mode 0.45mm.
Felsic Igneous Rock Fragment, Andesite? elongated, sa, large pieces of plagioclase, hornblende, and a few opaques, very weathered <0.95mm, mode 0.70mm.
Quartzite equant, sa-sr, sutures almost gone <0.65mm, mode 0.40mm.
Rare **Epidote** equant, a-sa, zoned extinction <0.40mm, mode 0.20mm.

Concentration Features: None

Comments: None

Firuzabad Fabric F.3a: Vegetal and Sedimentary Tempered Fabric

1 sample: CA200353

Microstructure: Common macroelongated vughs, few mesoelongated vughs. The distribution of the inclusions is double to open in the coarse fraction and single to double in the fine fraction. Both the voids and inclusions are weakly oriented to the edge.

Groundmass: Heterogenous based on color. The fabric is optically inactive. It is greenish brown with red spots in PPL (x40) and brown with green tints and red spots in XPL (x40).

Inclusions: C:F:V$_{.0625mm}$ =ca. 15:80:5, The inclusions are poorly sorted with an overall bimodal grain size distribution. <0.95mm, mode 0.08mm, a-sr.

Inclusions
Fine Fraction
Common **Monocrystalline Quartz**
Opaques
Few **Serpentinite**
Plagioclase
Rare **Biotite**
Muscovite
Epidote

Coarse Fraction
Common **Opaques** equant, sr-r, slight reddish-brown tint along edges, <0.15mm, mode 0.06mm.
Monocrystalline Quartz equant to elongated, sa-sr, mainly undulous extinction <0.46mm, mode 0.08mm.
Plagioclase equant to elongated, sa, Carlsbad twinning, <0.18mm, mode 0.08mm.
Micritic Limestone elongated, sr-r, yellowish brown in color, does not go extinct, <0.95mm, mode 0.34mm.
Few **Felsic Igneous Rock Fragment, Andesite?** elongated, sr, large pieces of plagioclase, hornblende, and a few opaques, very weathered <0.22mm, mode 0.16mm.
Biotite elongated, a-sa, brown in ppl, strong pleochroism, <0.10mm, mode 0.06mm.
Calcite equant, a, clear ppl, one cleavage, high birefringence, <0.18mm, mode 0.10mm.
Rare **Serpentinite** elongated to equant, sr-r, reddish brown in ppl and xpl, <0.20mm, mode 0.10mm.
Greywacke equant to elongated, sa-sr, rounded quartz in a darker matrix, fine, <0.46mm, mode 0.30mm.
Polycrystalline Quartz equant, sa-sr, undulous extinction <0.34mm, mode 0.30mm.
Very Rare **Epidote** equant, a-sa, zoned extinction, high birefringence, <0.08mm, mode 0.08mm.

Orthoclase equant, sa-sr, cloudy in ppl, <0.10mm, mode 0.06mm.

Concentration Features: TCF equant, sr-r, slightly grayish ppl, yellowish brown xpl, strong boundaries <0.08mm, mode 0.06mm, KCF sparry calcite in voids

Comments: Some voids ringed with dark material, some filled in with dark material/sparry calcite.

Firuzabad Fabric F.3b: Vegetal and Igneous Tempered Fabric

1 sample: CA200352, CA200354, CA200355

Microstructure: Common macroelongated vughs, few megaelongated vughs. The distribution of the inclusions is open in the coarse and fine fraction. Both the voids and inclusions are weakly oriented to the edges.

Groundmass: Heterogenous based on color. The fabric is optically inactive. It is reddish brown with darker red streaks in PPL (x40) and XPL (x40).

Inclusions: C:F:V$_{.0625mm}$ =ca. 25:60:15. The inclusions are moderately sorted with an overall bimodal grain size distribution. <1.65mm, mode 0.3mm, a-sr.

Inclusions
Fine Fraction

Few	**Monocrystalline Quartz**
	Opaques
	Biotite
Rare	**Serpentinite**
	Plagioclase
	Orthoclase
	Muscovite

Coarse Fraction

Common	**Quartzite** equant, sr, weakly sutured (352, 355) <0.80mm, mode 0.35mm.
Common to Few	**Opaques** equant, sr-r, slight reddish-brown tint along edges, <0.35mm, 0.15mm.
	Monocrystalline Quartz equant, a-sa, straight to undulous extinction, <1.00mm, mode 0.15mm.
	Plagioclase elongated, sr, Carlsbad twinning, <0.55mm, mode 0.20mm.
Few	**Biotite** elongated a-sa, brown pleochroism in ppl, <0.35, mode 0.10mm.
	Micritic Limestone elongated, sa-sr, does not go extinct, <1.6mm, mode 0.35mm.
	Felsic Igneous Rock Fragment, Andesite? elongated, sr, large pieces of plagioclase, hornblende, and a few opaques, very weathered <0.95mm, mode 0.35mm.
Few to Rare	**Serpentinite** elongated to equant, sa-sr, red to reddish brown in ppl and xpl, <0.55mm, mode 0.30mm.
	Orthoclase equant, sa-sr, cloudy ppl, <0.45mm, mode 0.30mm.
Rare	**Muscovite** elongated, sa, clear ppl, one cleavage (352, 354), <0.95mm, mode 0.10mm.
	Greywacke equant to elongated, sa-sr, rounded quartz in a darker matrix, fine, <0.85mm, mode 0.35mm.
	Intermediate Igneous Rock Fragment, Trachyte? equant, sr, laths of orthoclase, opaques, fine texture, from low to highly weathered (354) <1.65mm, mode 1.65mm.

Very rare	**Amphibole, Hornblende?** Equant, sa-sr, 1 cleavage visible, slightly green in ppl, (354, 355), <0.35mm, mode 0.30mm. **Epidote** equant, a-sa, zoned extinction, high birefringence, <0.60mm, mode 0.20mm. **Calcite** equant, a, clear in ppl, one cleavage, high birefringence, (352), <0.40mm, mode 0.20mm.

Concentration Features: KCF Sparry calcite in voids

Comments: Slightly heterogenous grouping based on amount of inclusions and types of inclusions. However grouped together based on igneous and sedimentary nature of inclusions and vegetal tempered.

Firuzabad Fabric F.4: Quartz Rich Fabric

1 sample: CA200361

Microstructure: Dense with few microvughs and very rare elongated voids. The distribution of the inclusions is open in the coarse fraction and single in the fine fraction. Both the voids and inclusions are randomly oriented.

Groundmass: Homogenous based on color. The fabric is optically inactive. It is greyish brown in PPL (x40) and grey in XPL (x40).

Inclusions: C:F:V$_{.0625mm}$ =ca. 10:87:3. The inclusions are well sorted with an overall unimodal grain size distribution. <0.35mm, mode 0.06mm, a-sr.

Inclusions
Fine Fraction

Dominant	**Monocrystalline Quartz**

Coarse Fraction

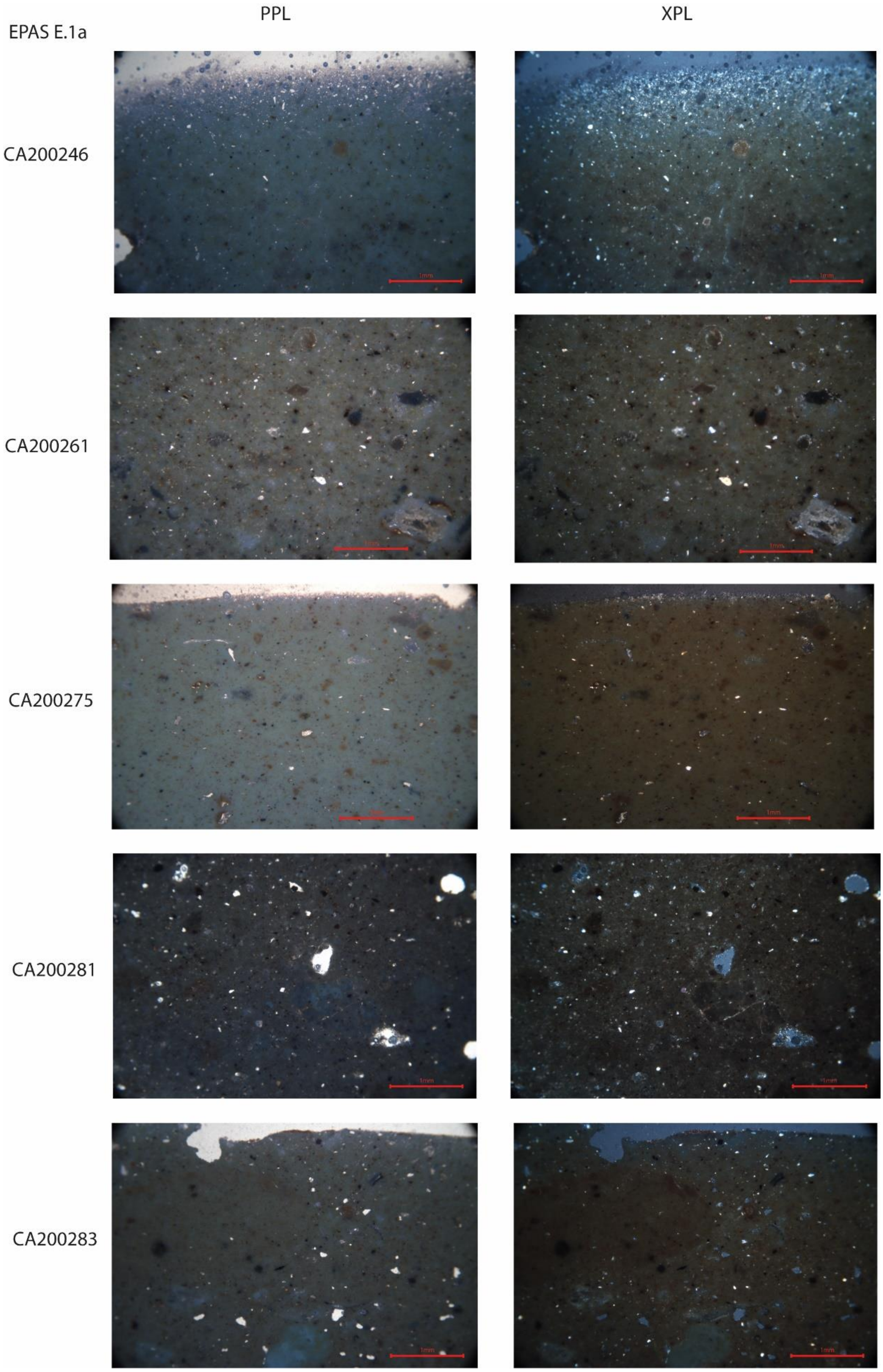
Few	**Monocrystalline Quartz** equant, a-sa, <0.18mm, mode 0.06mm.
	Opaques equant, r, <0.35mm, mode 0.10mm.
Rare	**Chert** elongated, sa <0.08mm, mode 0.04mm.
	Plagioclase elongated, sr, twinning <0.10mm, mode 0.08mm.
Very Rare	**Epidote** equant, sa, clear ppl/high bifringence <0.08mm, mode 0.06mm.

Concentration Features: none

Comments: Very dark band along one edge, slip? Protostonepaste?

Appendix 8: Petrographic Photos all at 40x

EPAS



EPAS E.1a

PPL | XPL

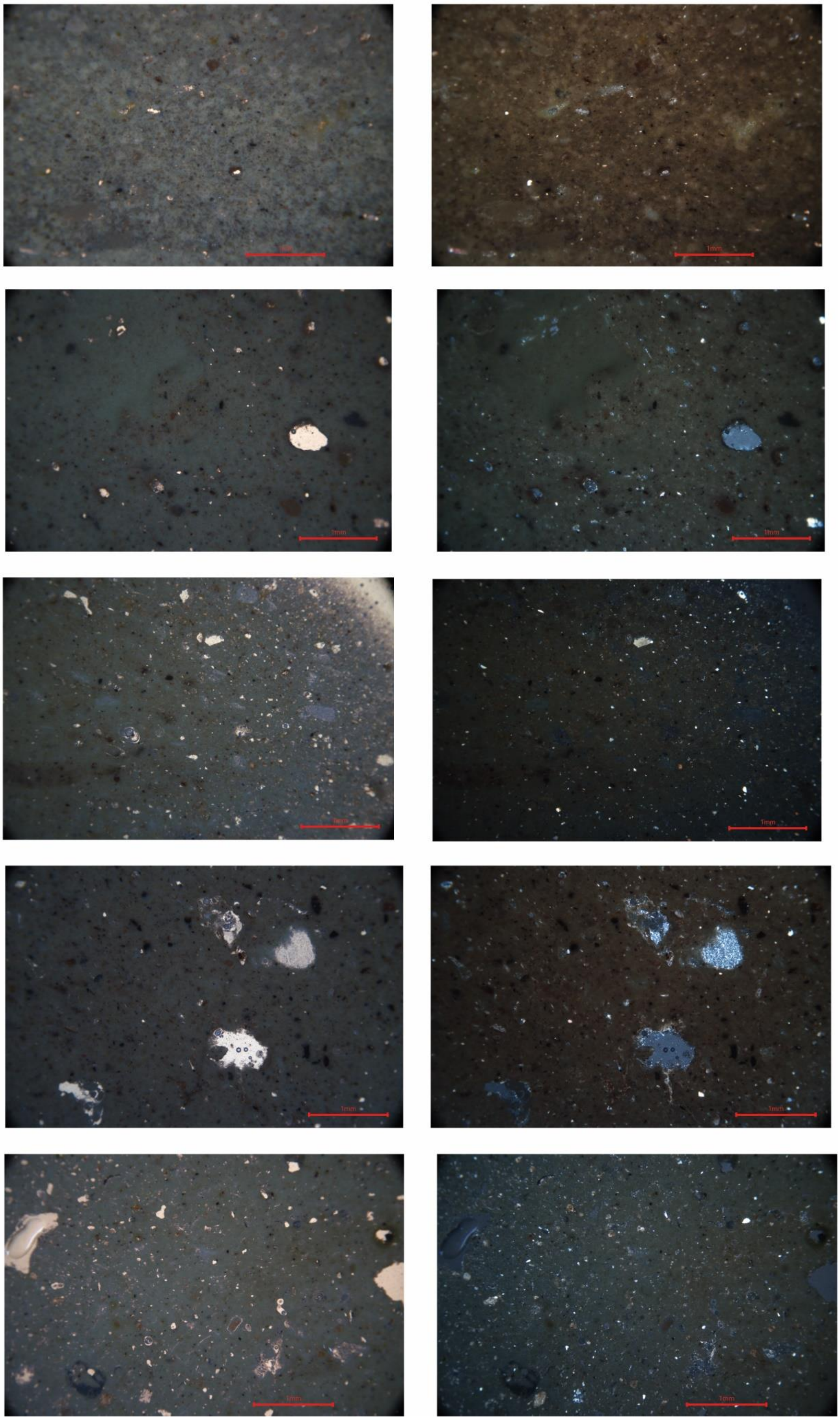
CA200284

CA200287

CA200290

CA200292

CA200293



EPAS E.1a

PPL | XPL

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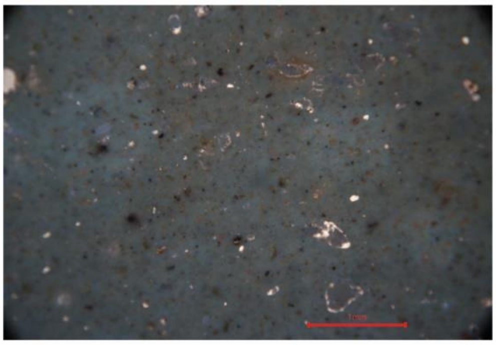

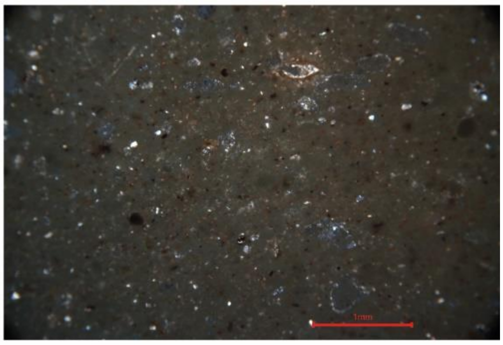

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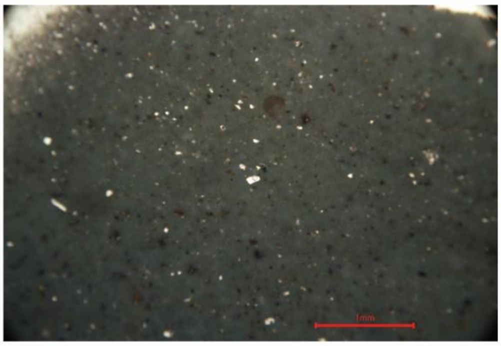

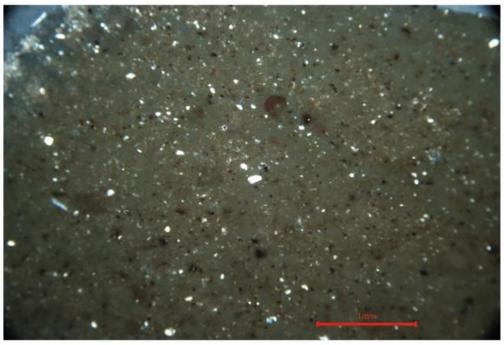

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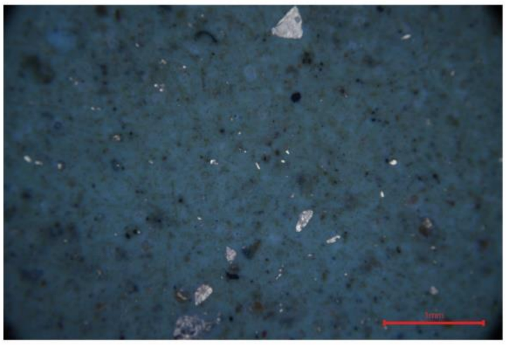

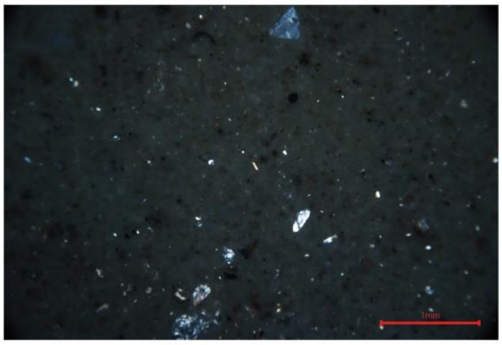

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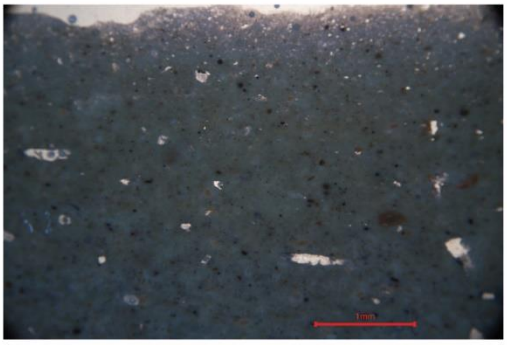

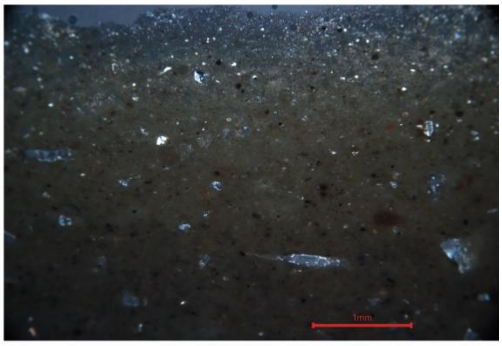

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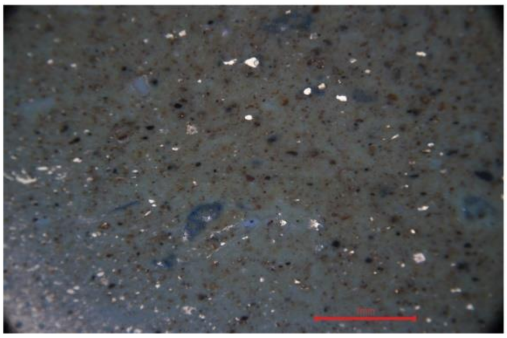
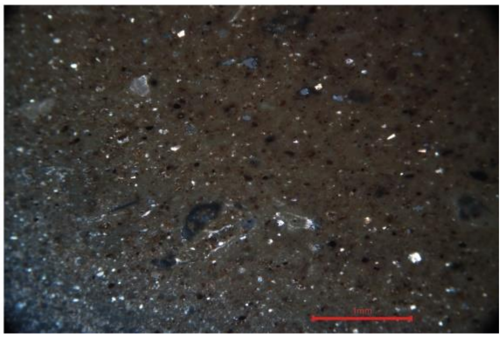




PPL XPL

EPAS E.1a

CA200319

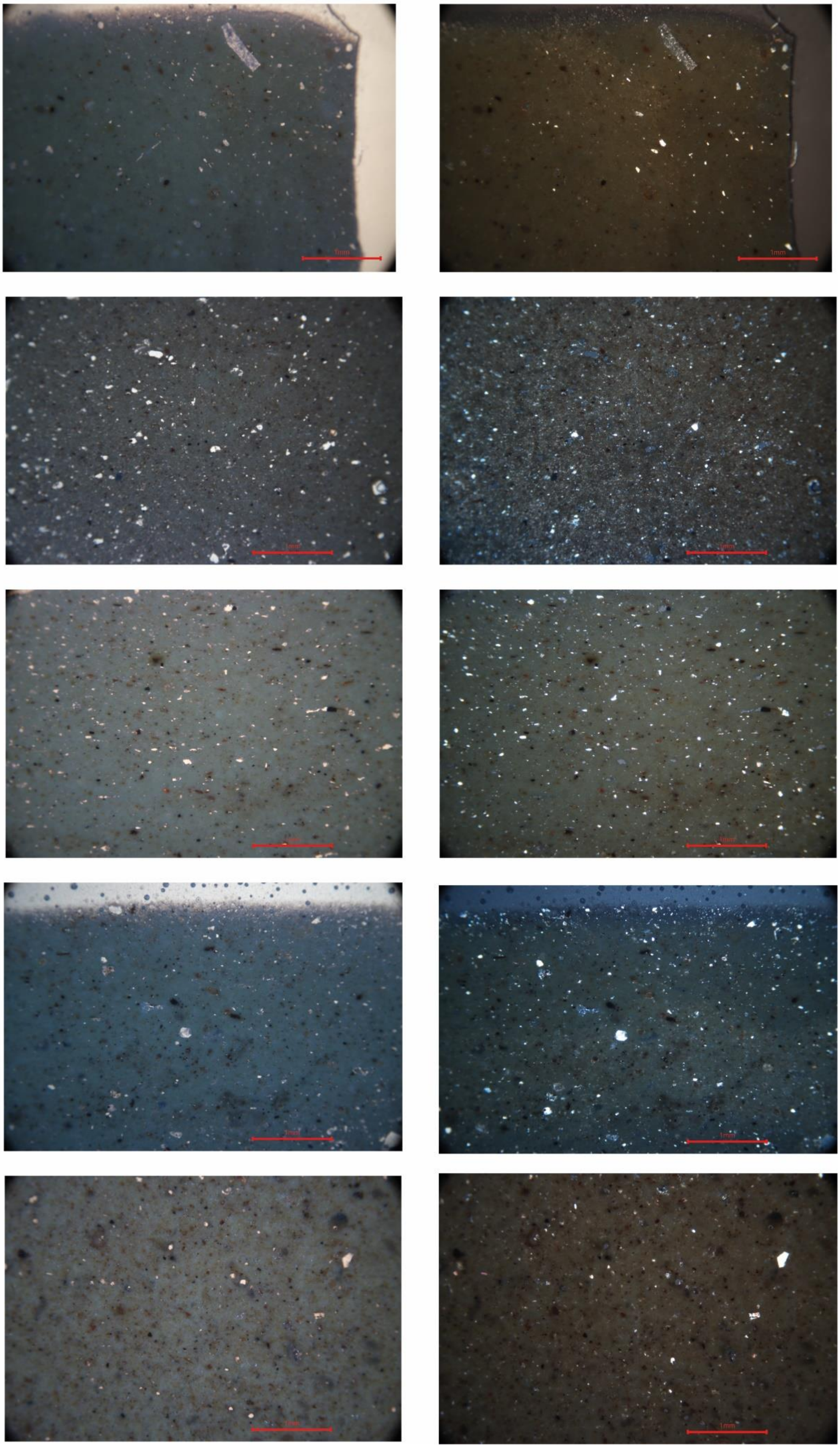
EPAS E.1b

CA200234

CA200237

CA200247

CA200249



EPAS E.1b

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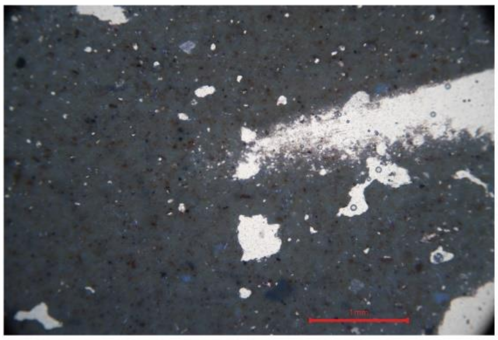
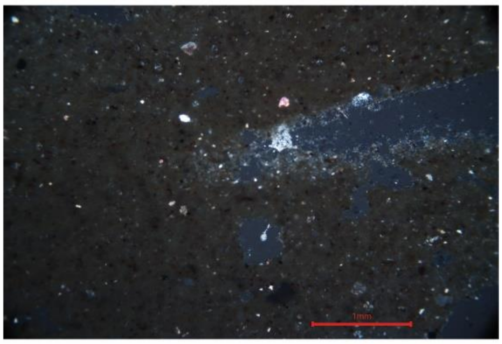
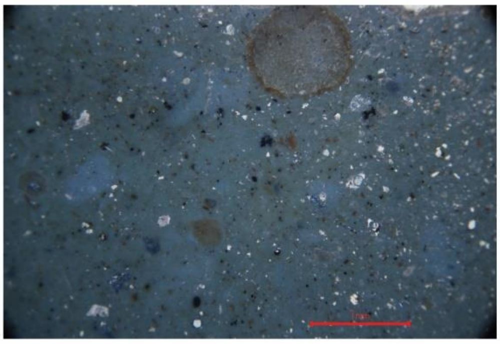
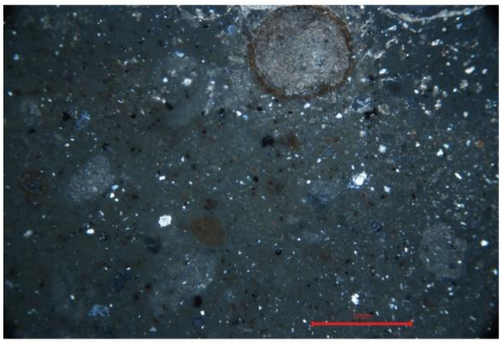
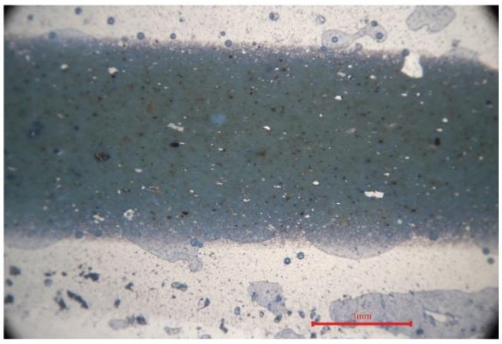
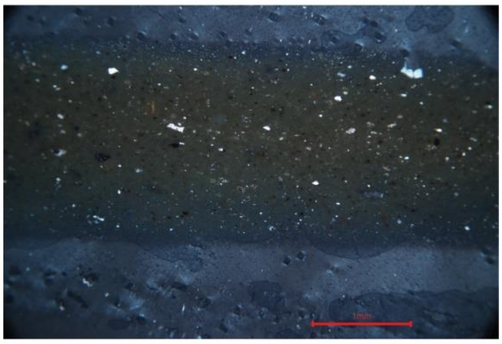
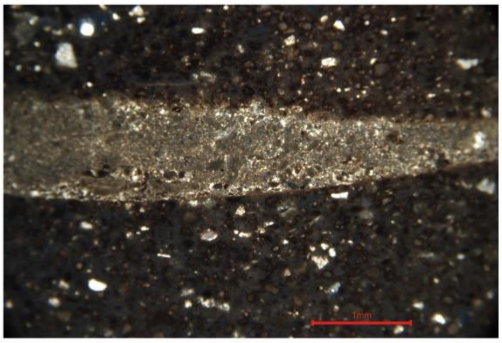
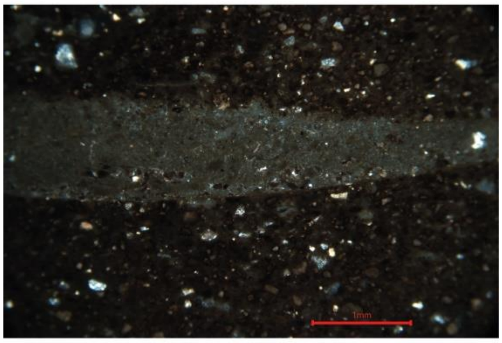
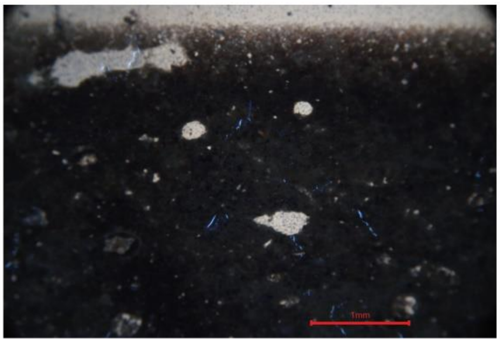
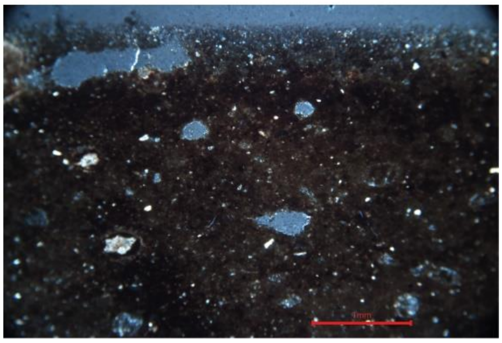
CA200251		
CA200260		
CA200263		
CA200269		
CA200271		

EPAS E.1b

PPL XPL

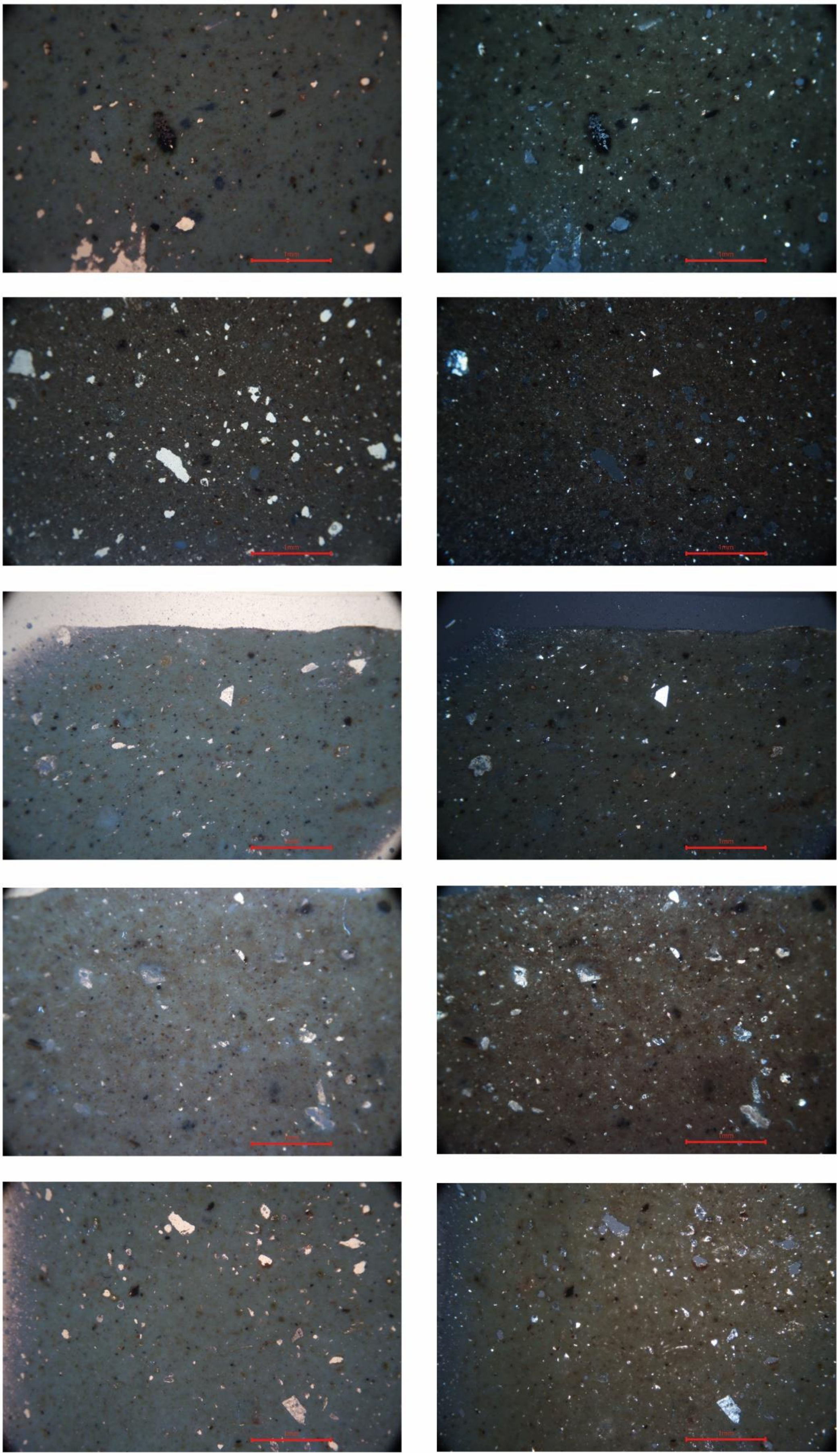
CA200285

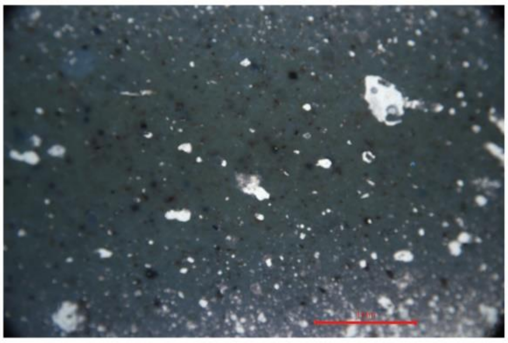
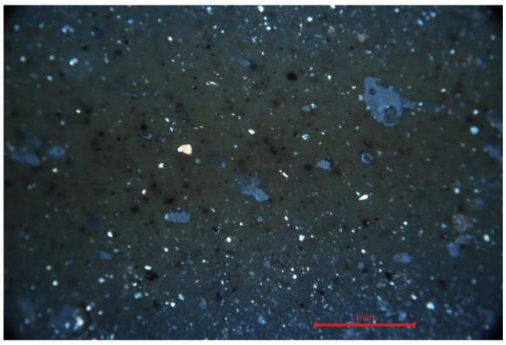
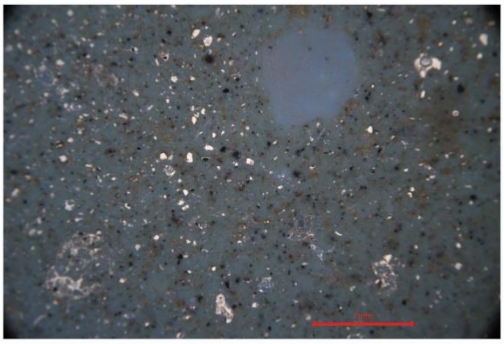
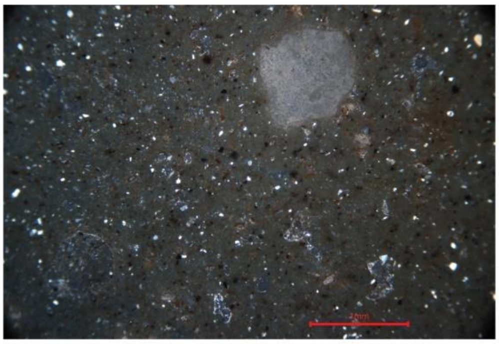
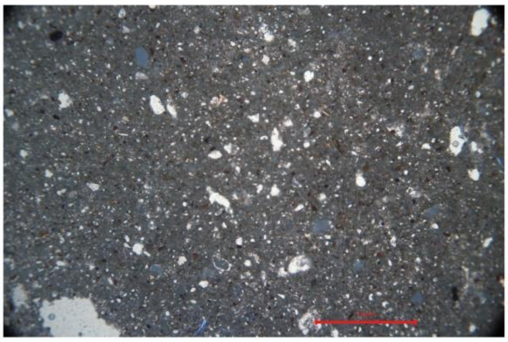
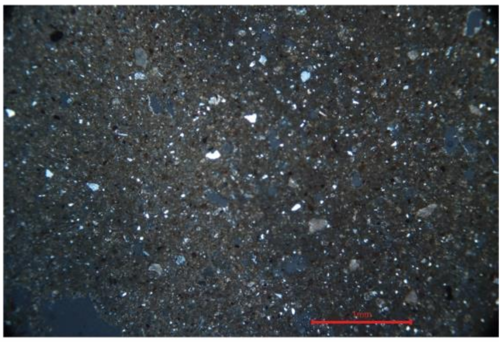
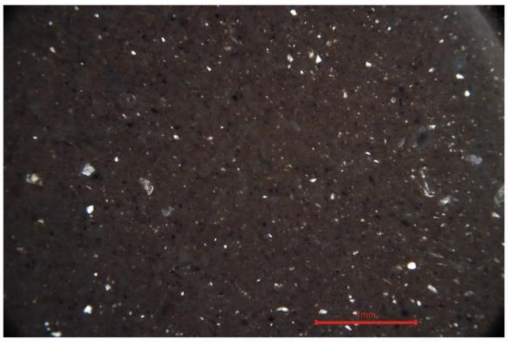
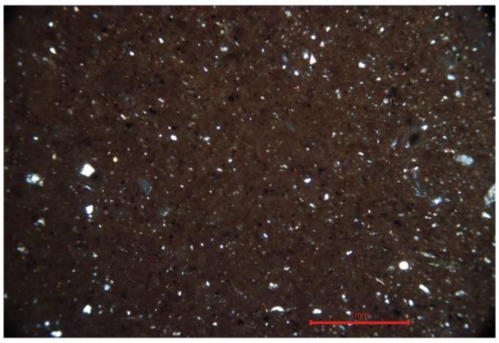
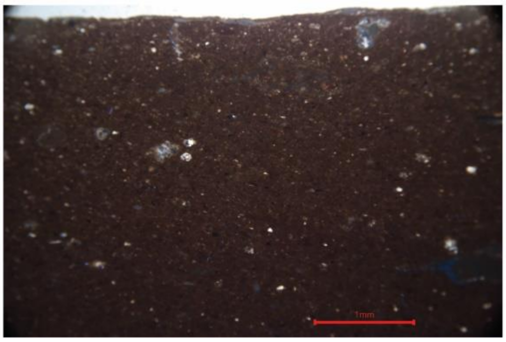
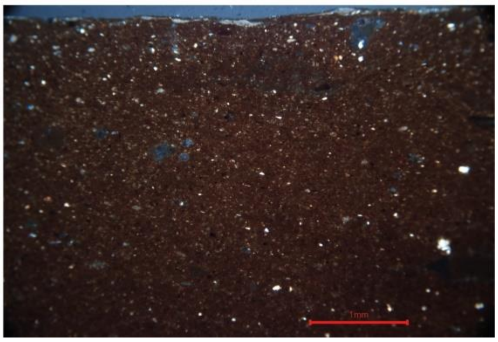
CA200295

CA200296

CA200300

CA200301



	PPL	XPL
EPAS E.1b		
CA200308		
CA200309		
CA200318		
EPAS E.2a		
CA200235		
CA200238		

EPAS E.2a

PPL | XPL

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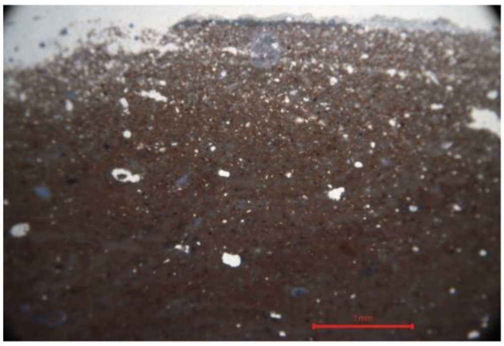
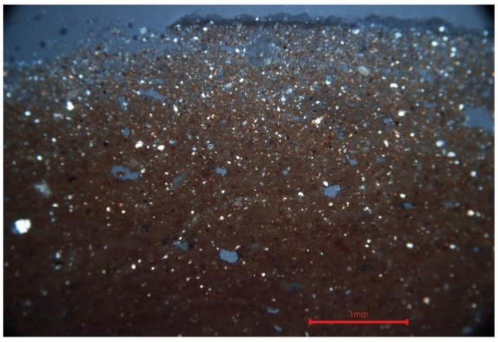

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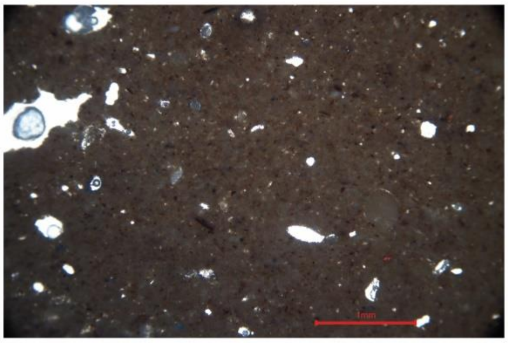
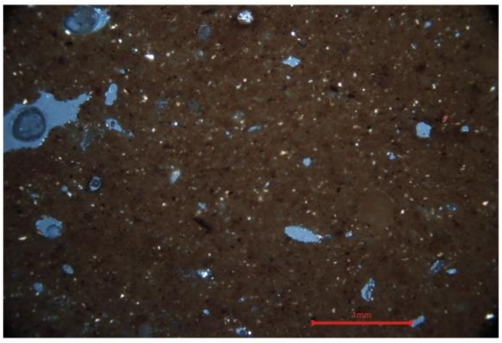

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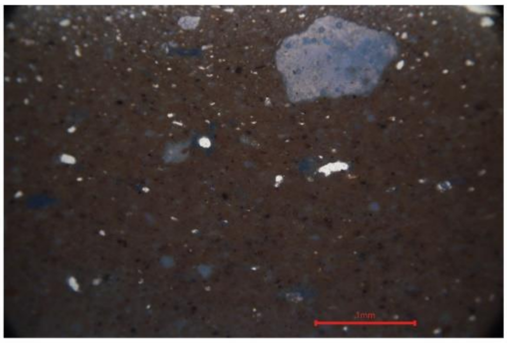
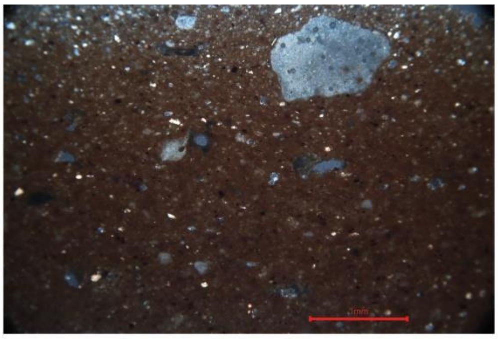

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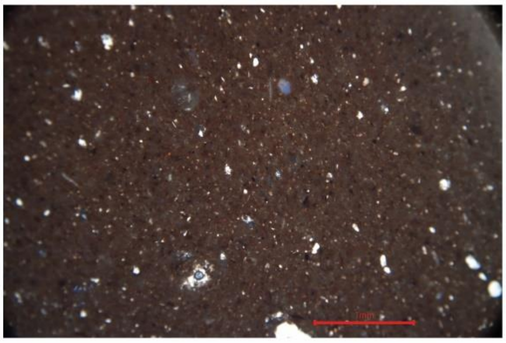
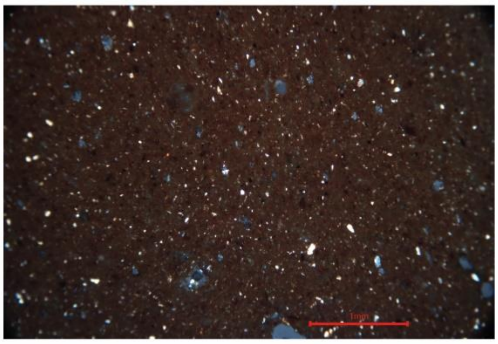

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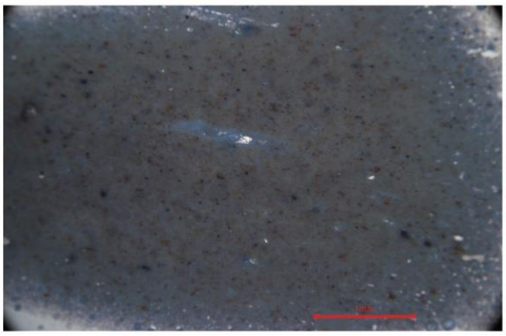
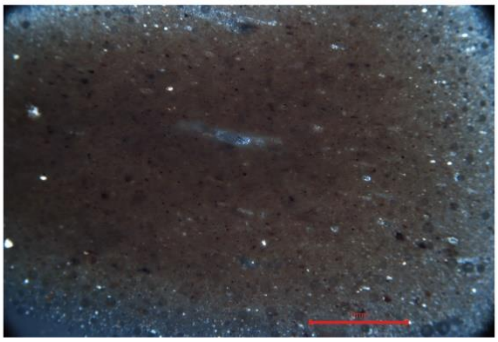
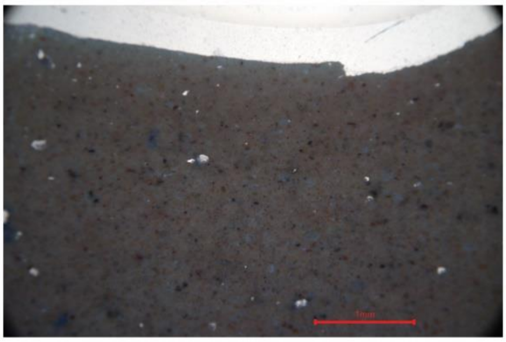
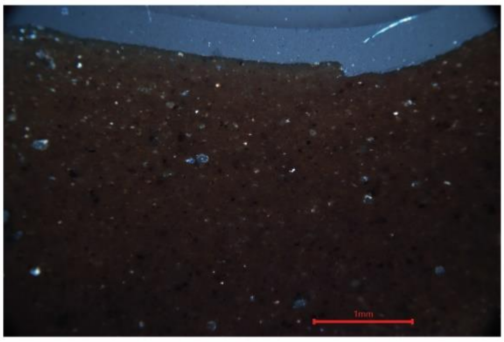



PPL XPL

EPAS E.2a

CA200305





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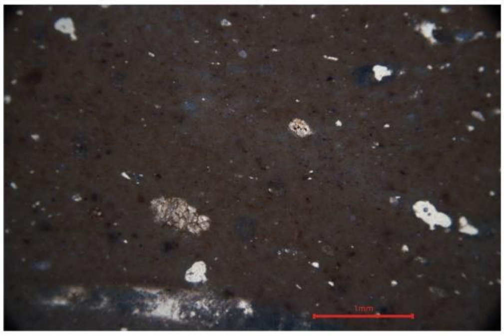

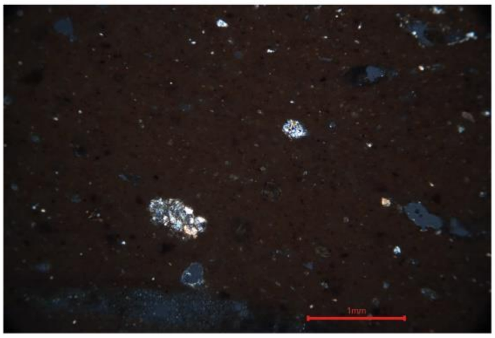

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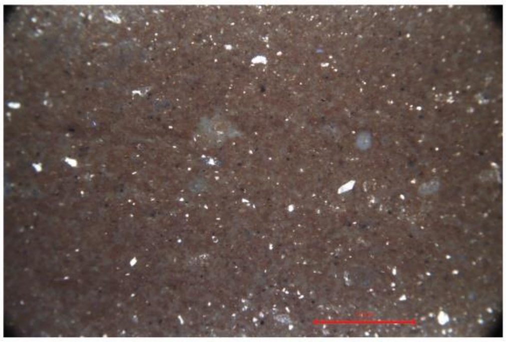

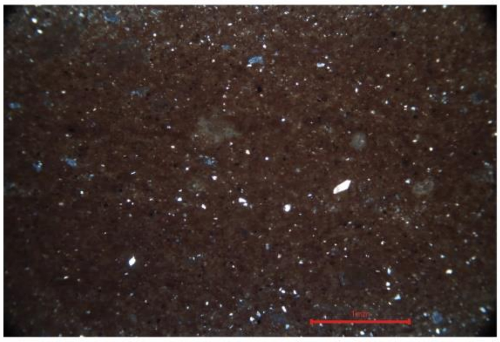

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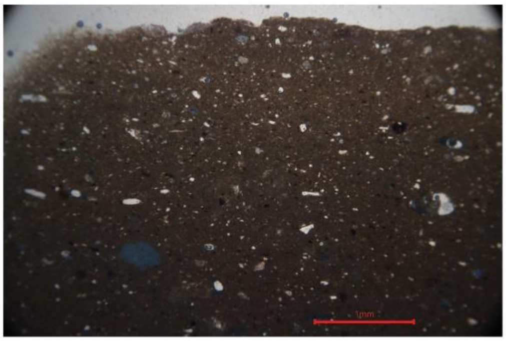

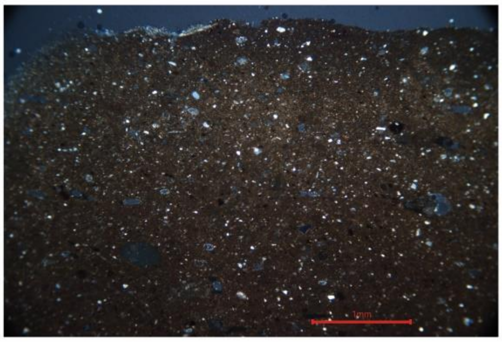

EPAS E.2b

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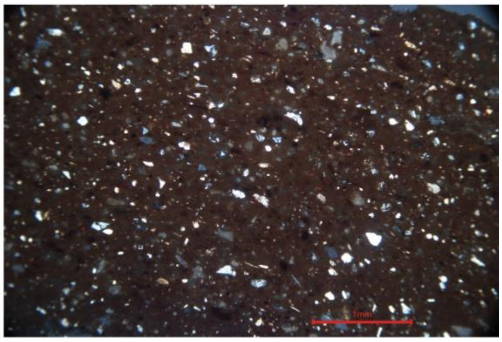
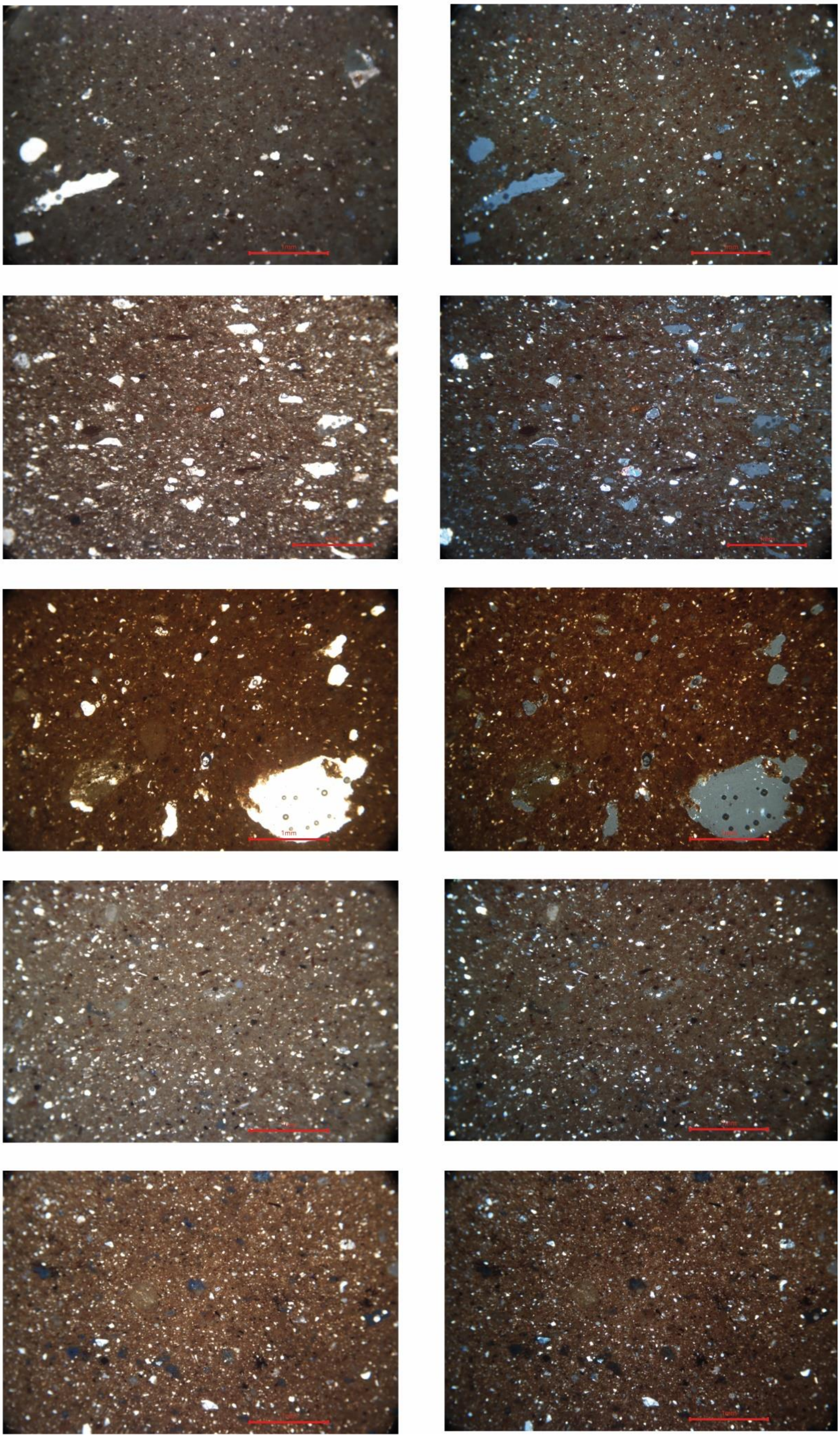


EPAS E.2b

PPL | XPL



CA200241

CA200243

CA200250

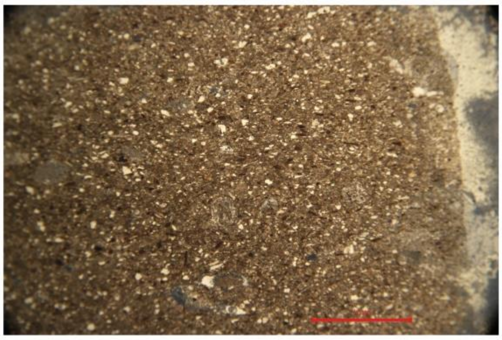
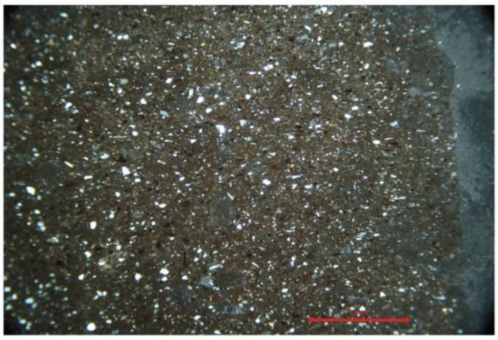
CA200254

CA200255

PPL | XPL

EPAS E.2b

CA200265

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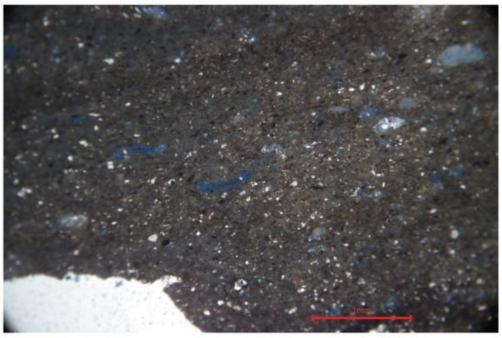
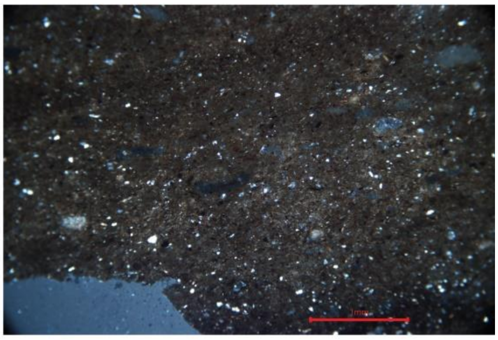

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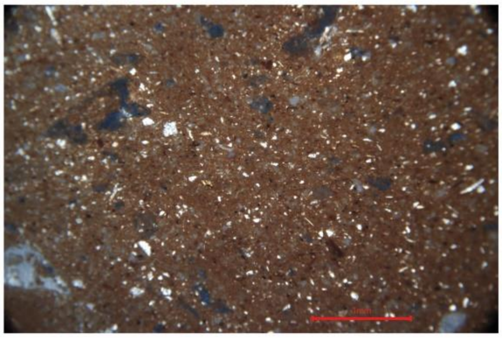
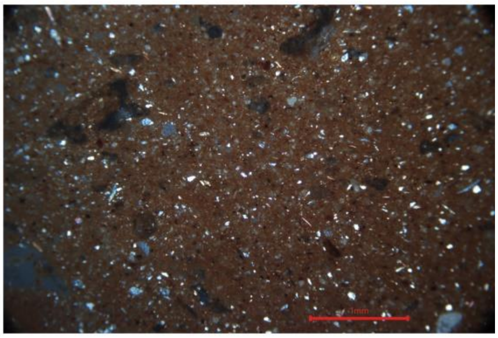

EPAS E.3a

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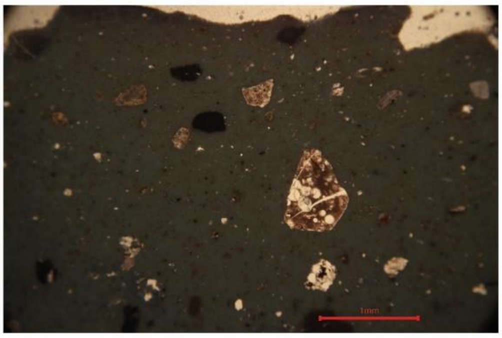
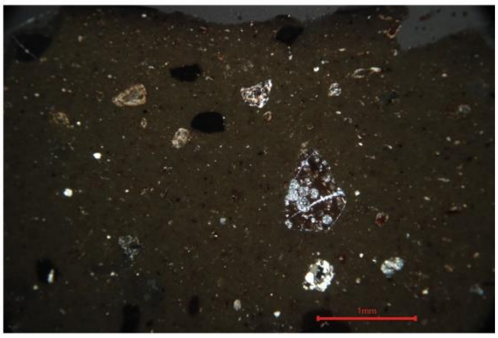

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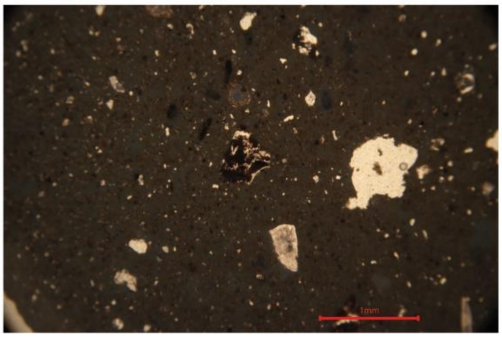
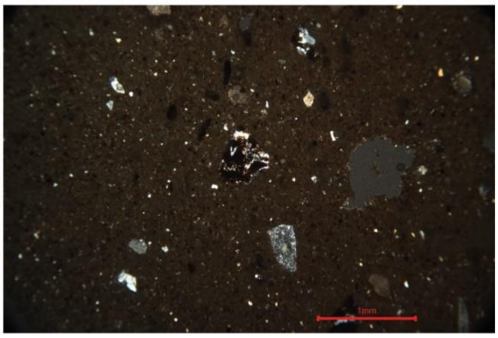
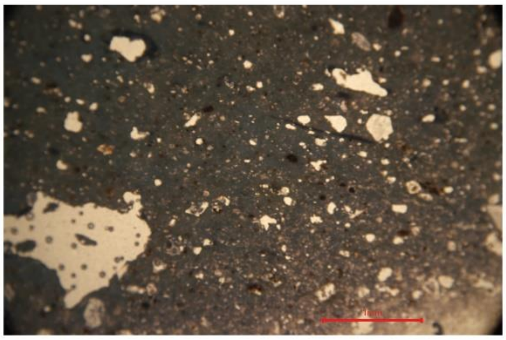
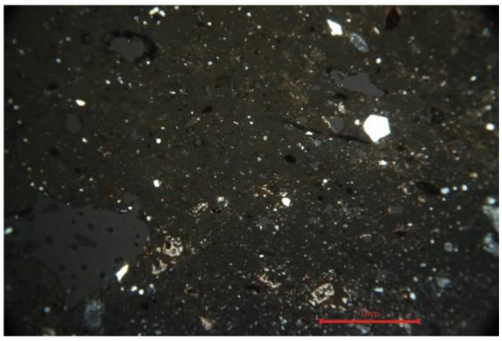



EPAS E.3a

PPL | XPL

CA200274





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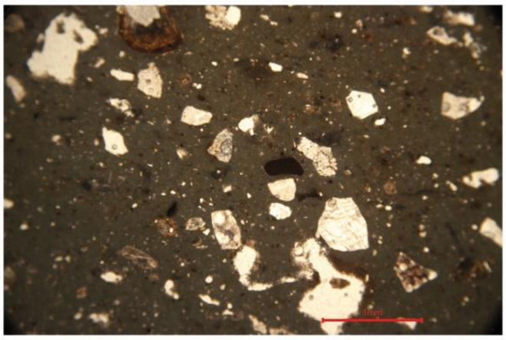

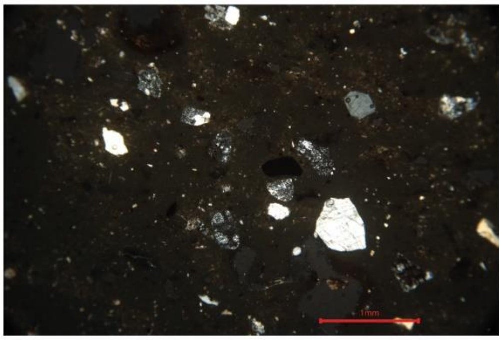

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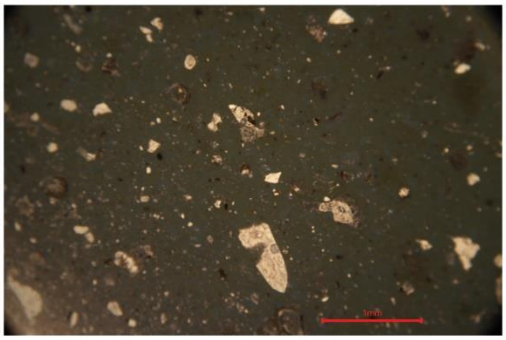

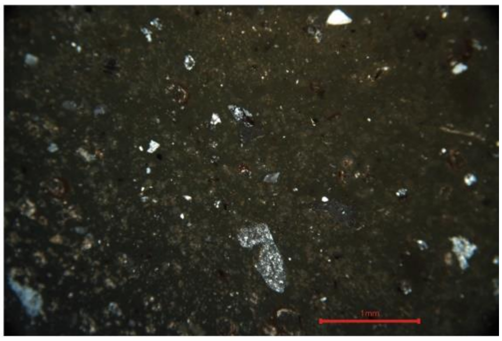

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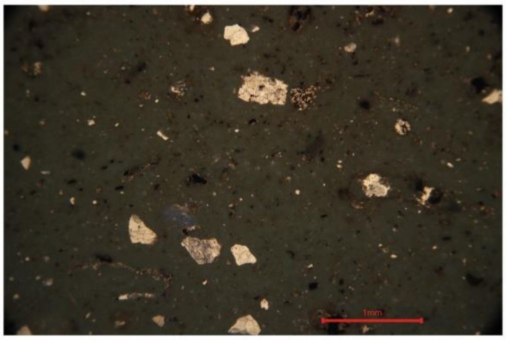

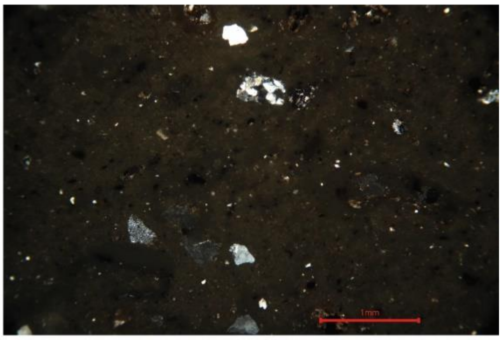

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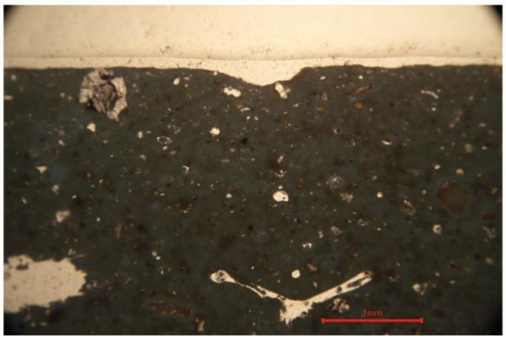
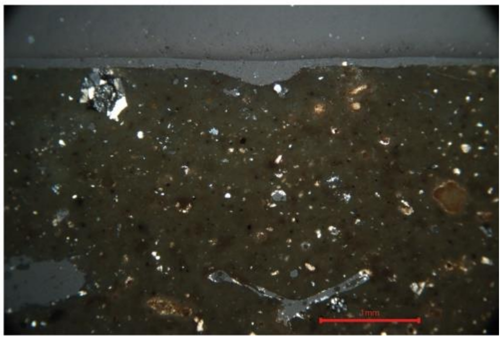
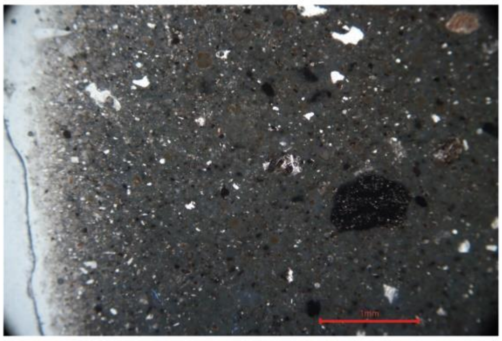
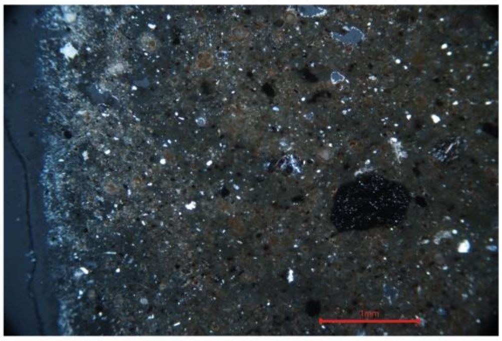




PPL XPL

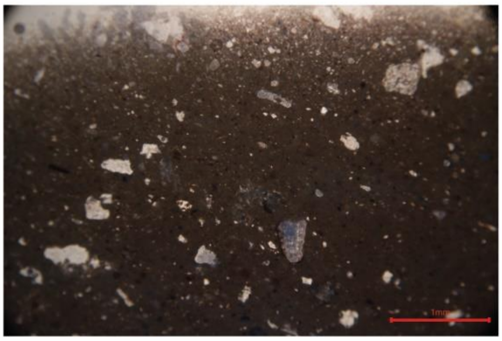
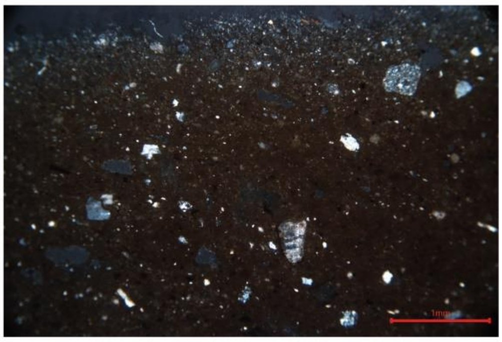
EPAS E.3a

CA200317

EPAS E.3b

CA200240

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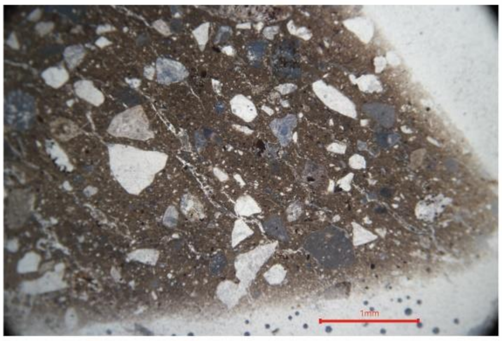
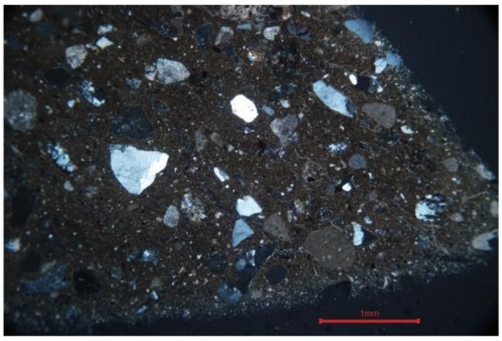

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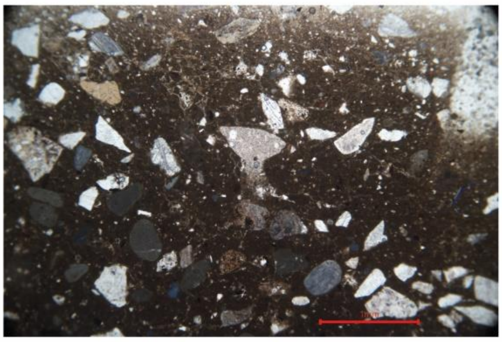
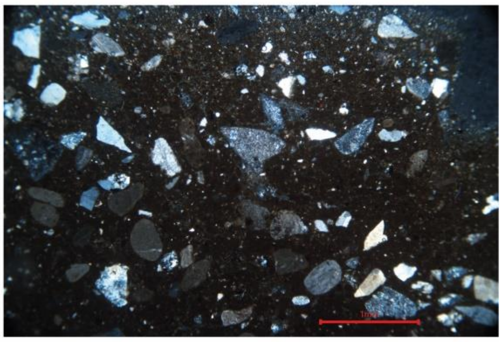
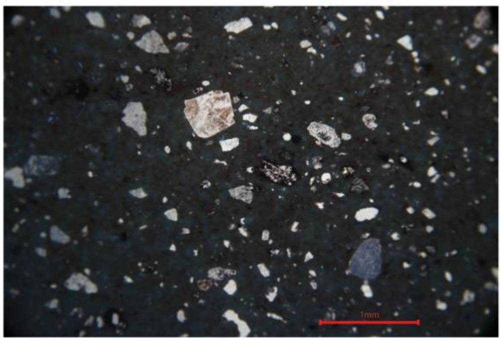
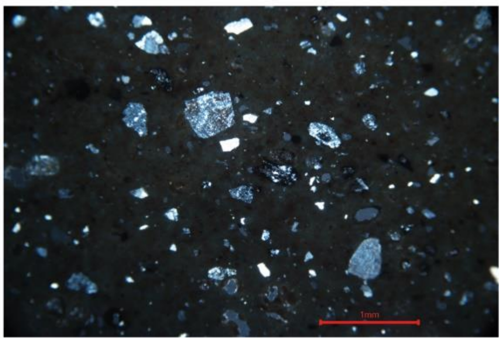



CA200277

PPL XPL

EPAS E.3b

CA200279

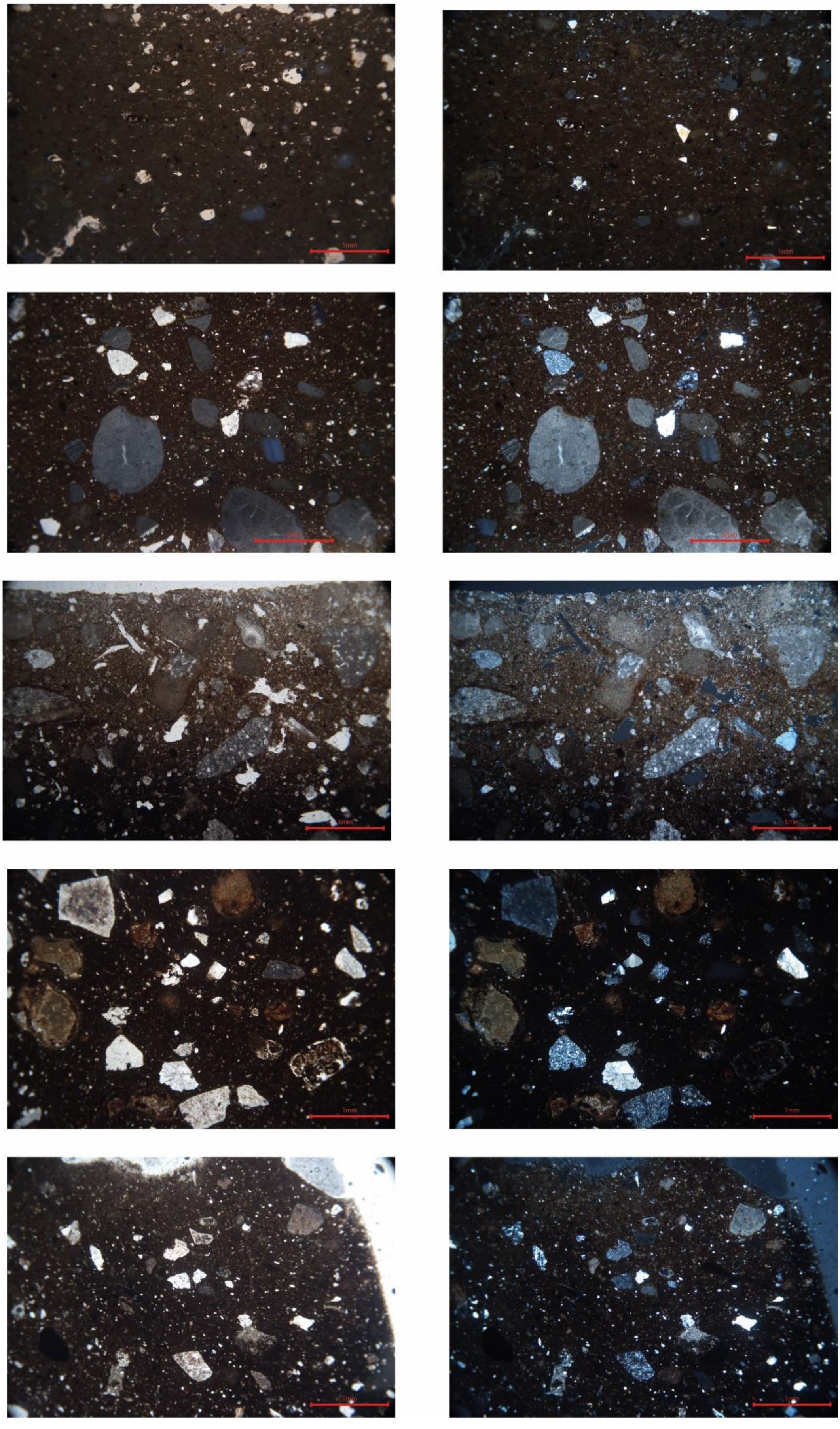
CA200297

EPAS E.3c

CA200244

CA200267

CA200272



PPL XPL

EPAS E.4

CA200257

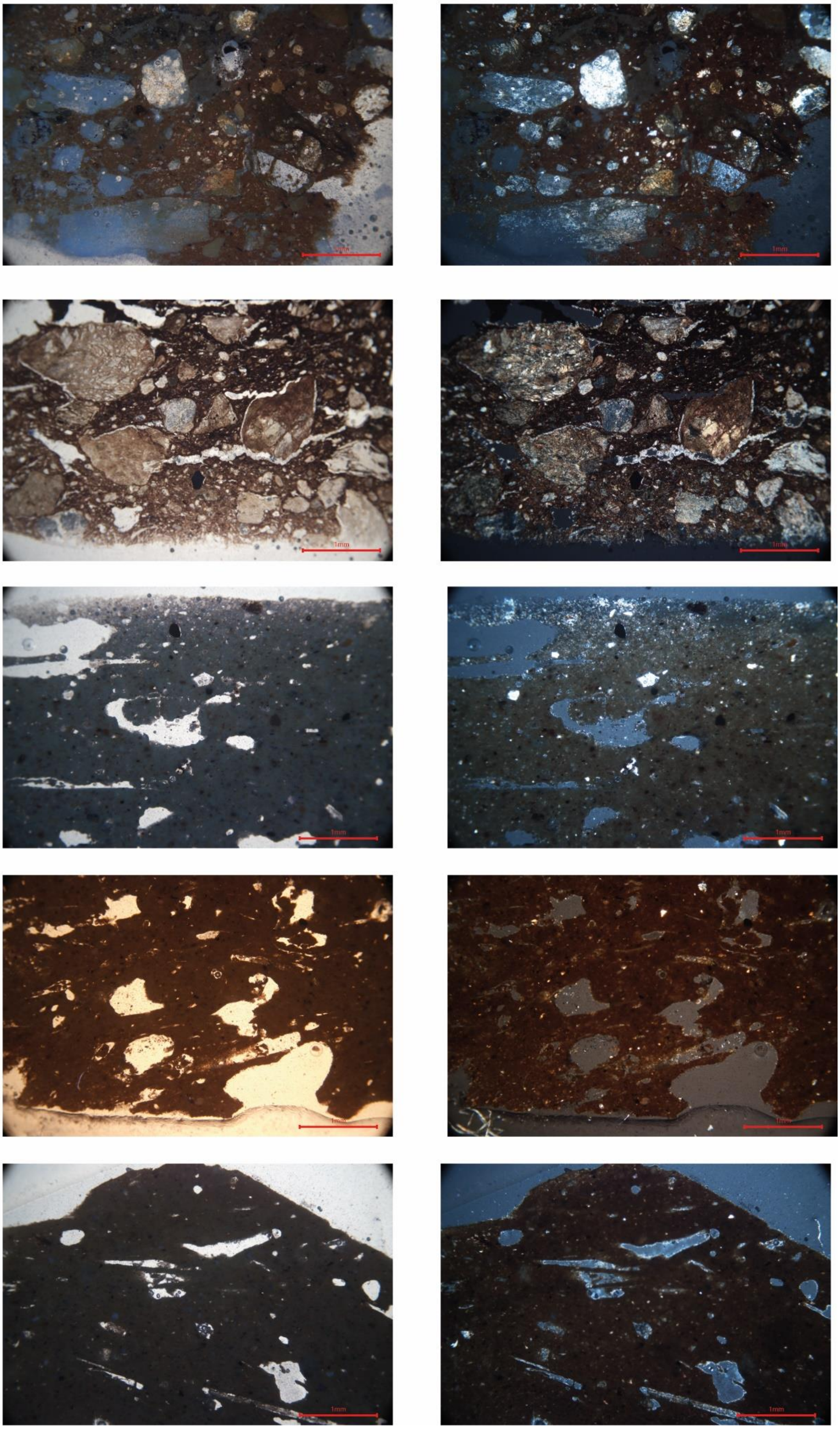
CA200262

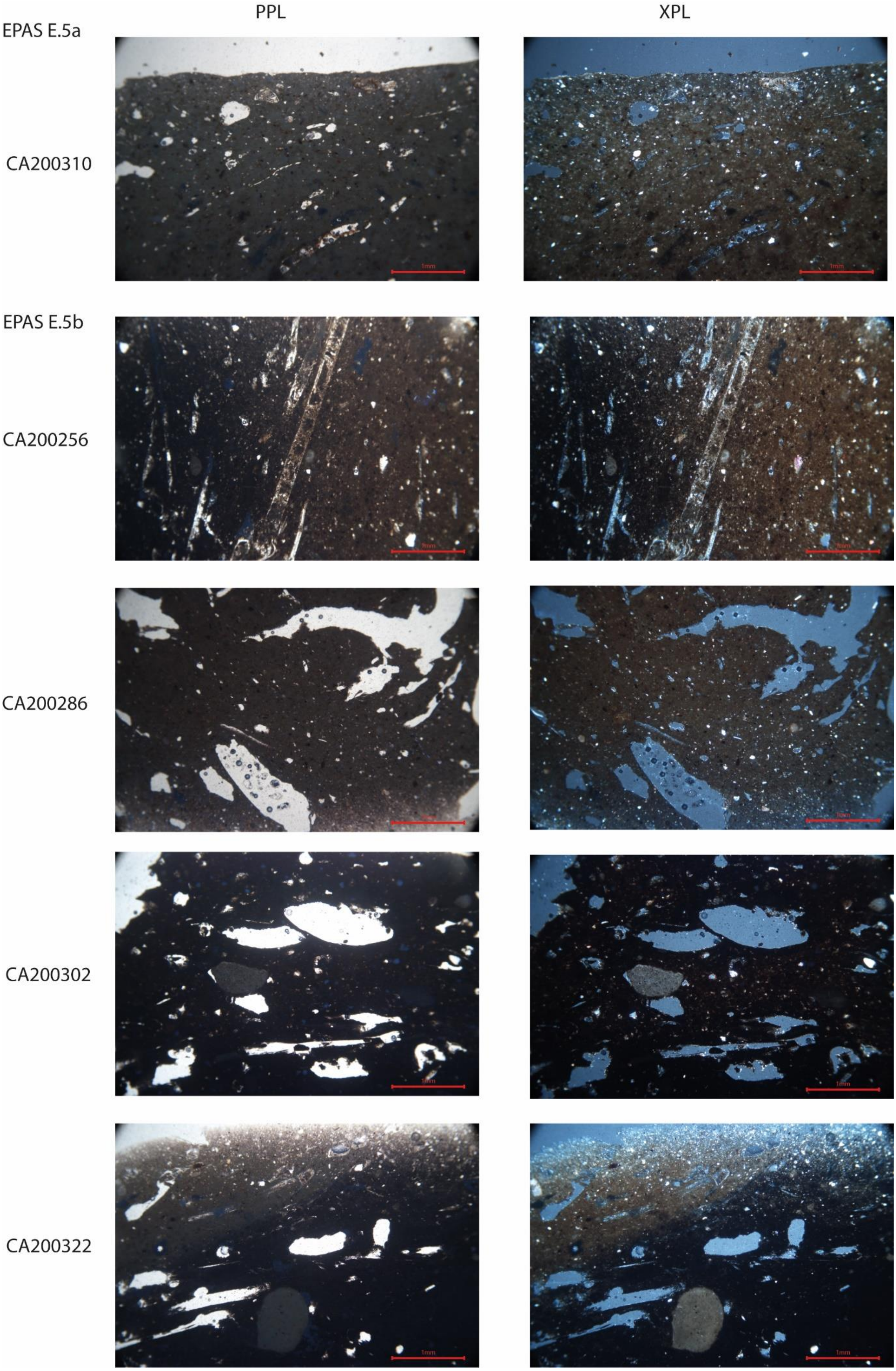
EPAS E.5a

CA200239

CA200252

CA200289




PPL
XPL
EPAS E.5a
CA200310
EPAS E.5b
CA200256
CA200286
CA200302
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PPL XPL

EPAS E.5c

CA200259

CA200311

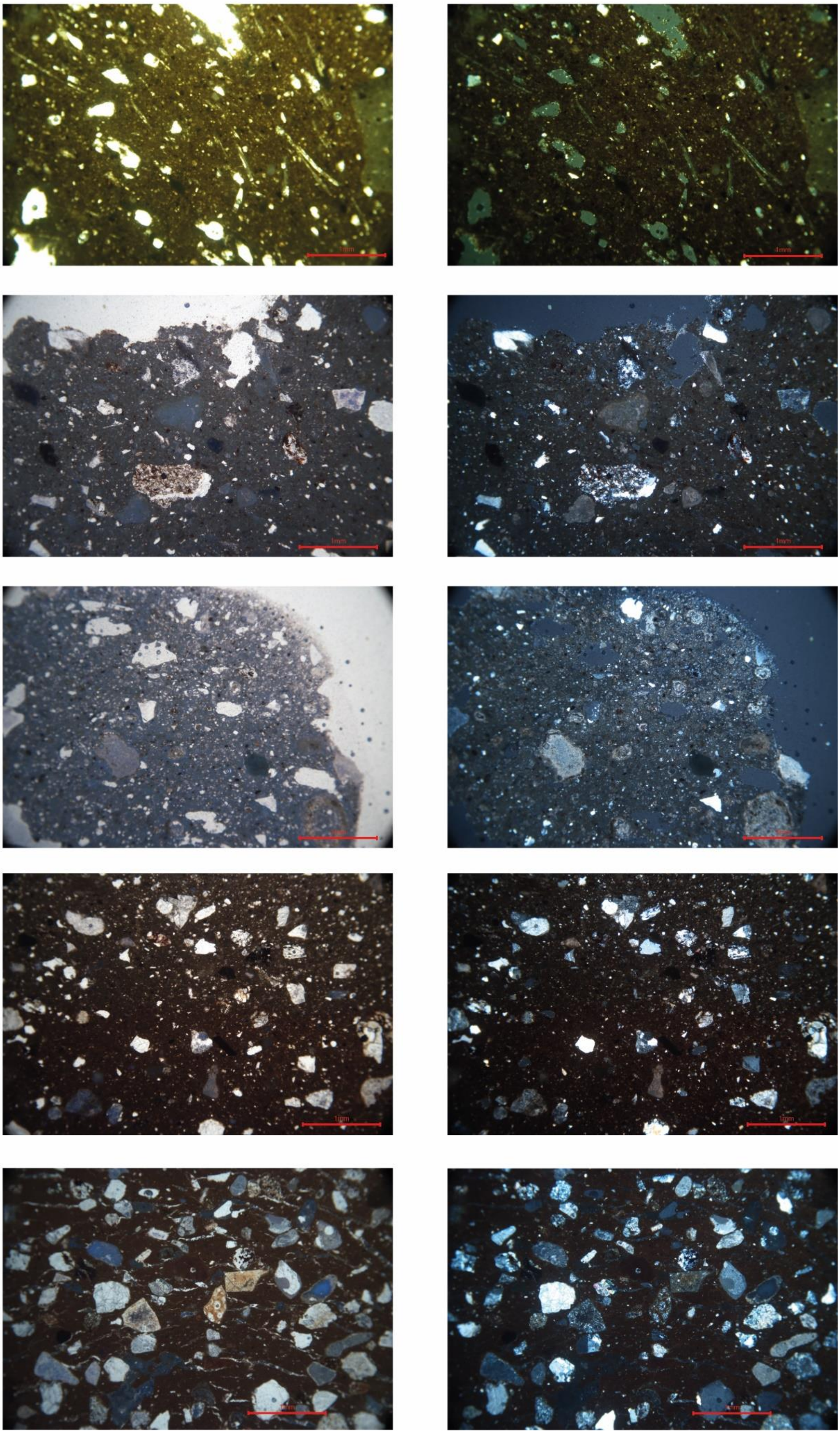
CA200312

EPAS E.6

CA200288

EPAS E.7

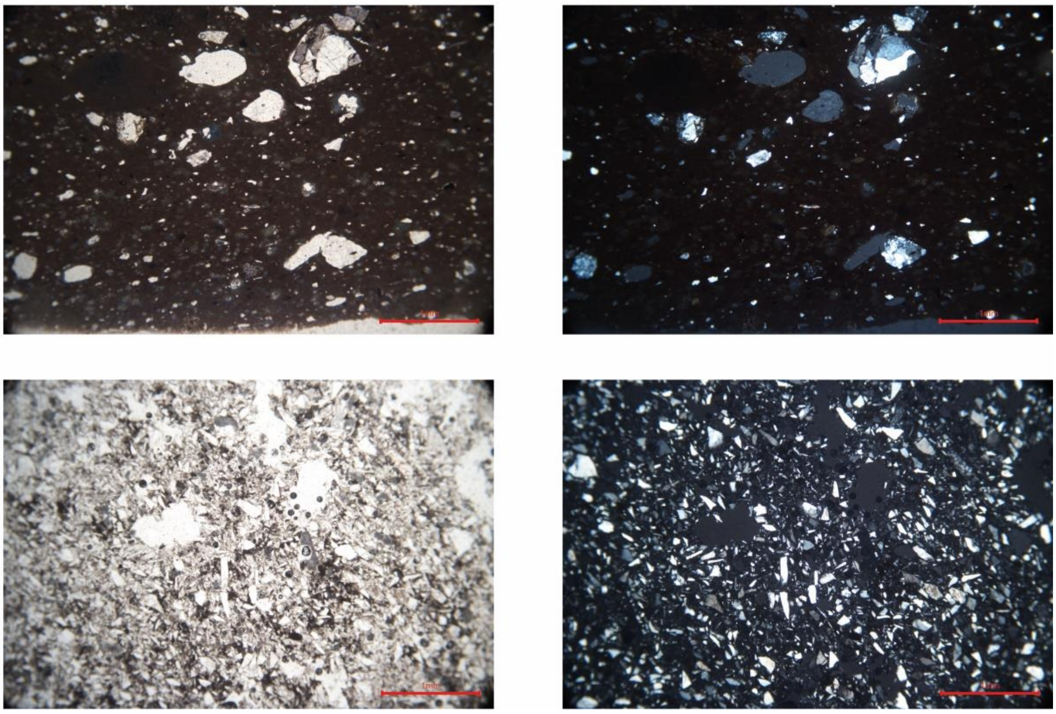
CA200278



PPL XPL

EPAS E.8 CA200320

EPAS E.9 CA200264

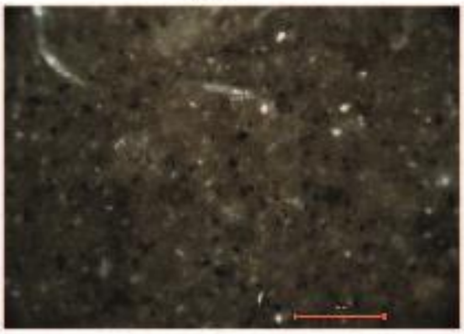


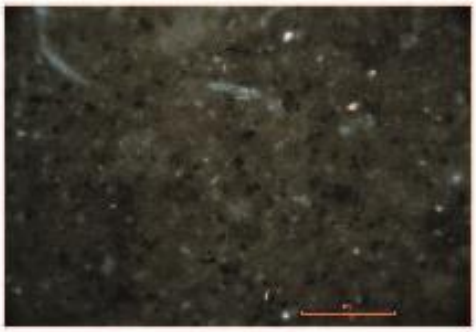
Nippur

Nippur N.1a

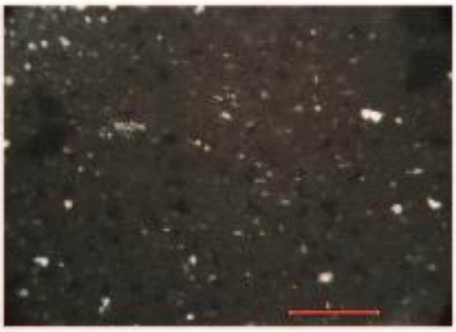
PPL XPL

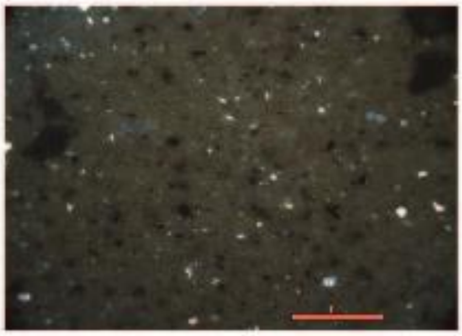
CA200723



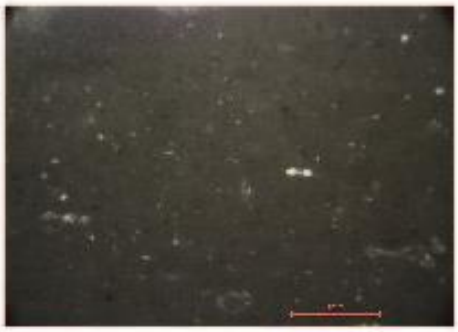


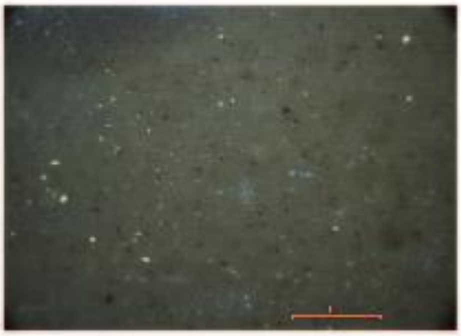
CA200725





CA200726





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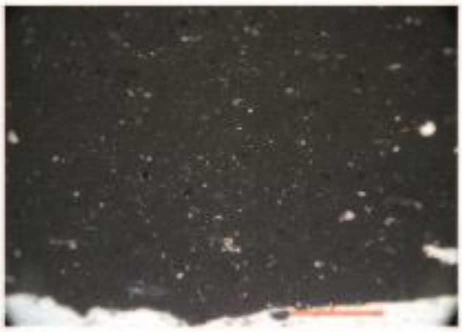
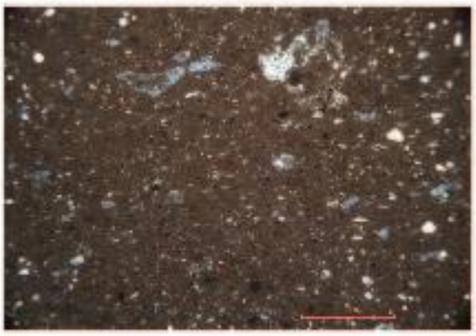
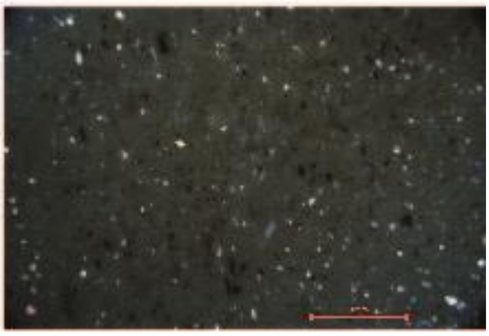


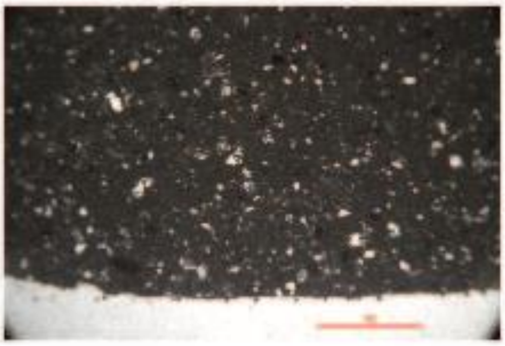
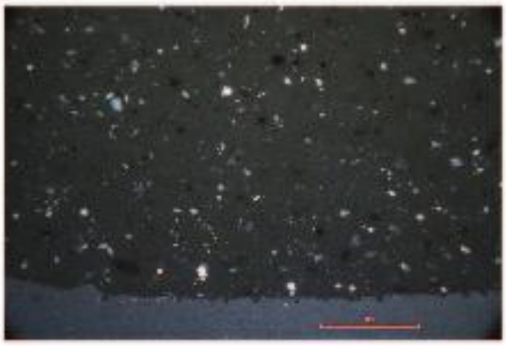
CA200730



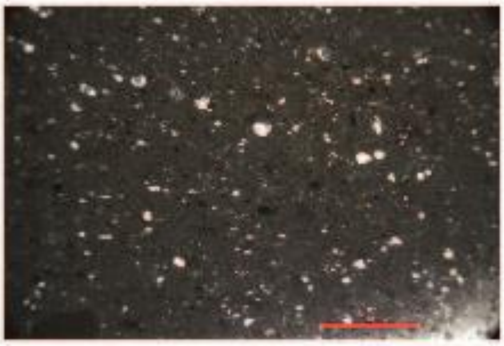
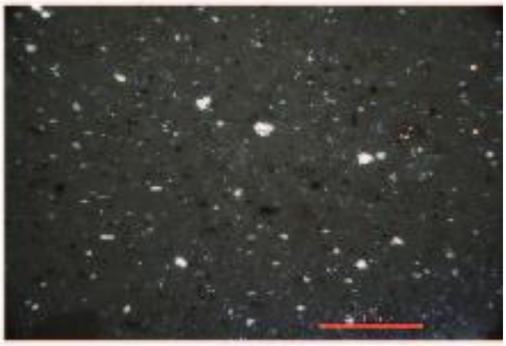


Nippur N.1b PPL XPL

CA200731

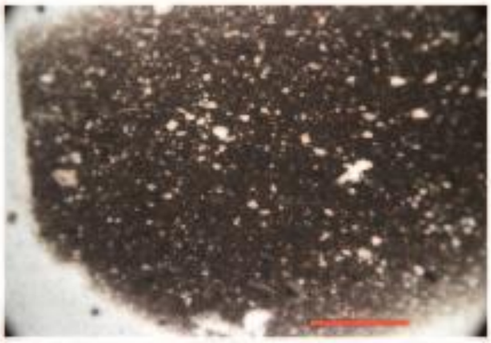
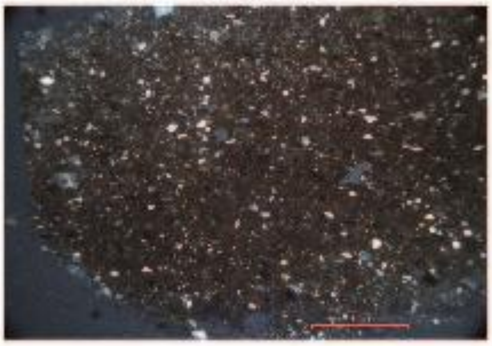



CA200372

Nippur N.2

CA200728

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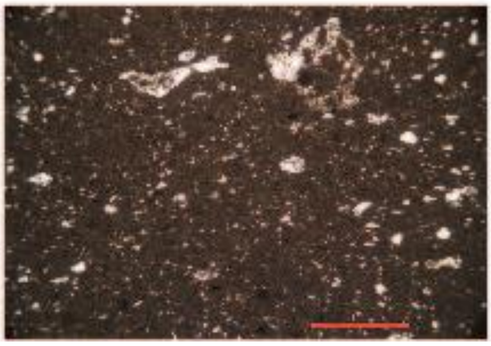
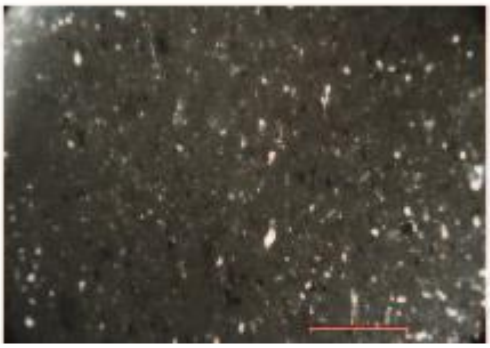
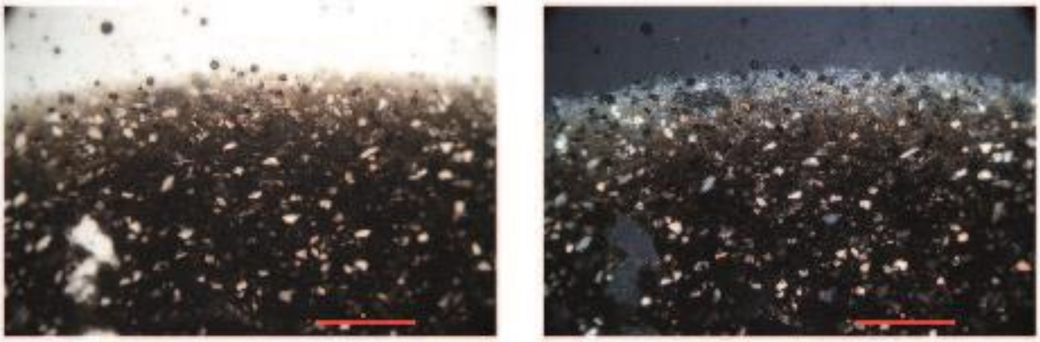



PPL XPL

Nippur N.3

CA200733



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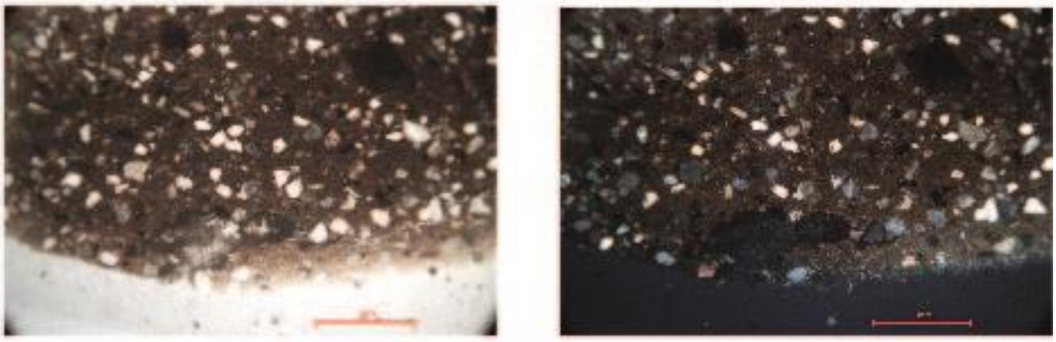

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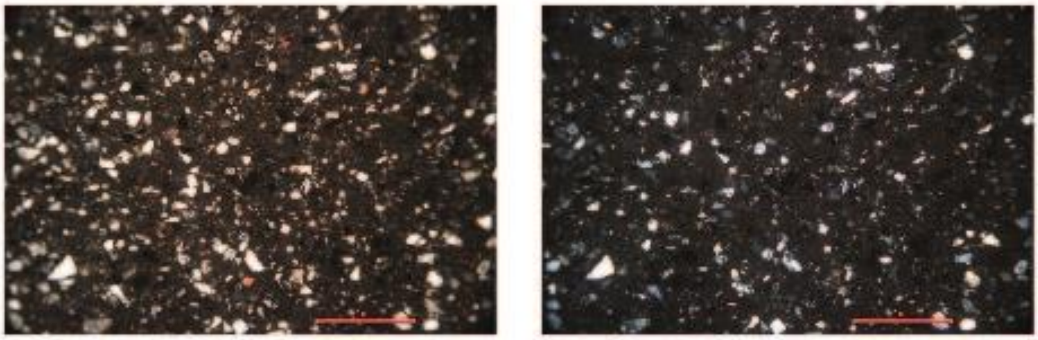
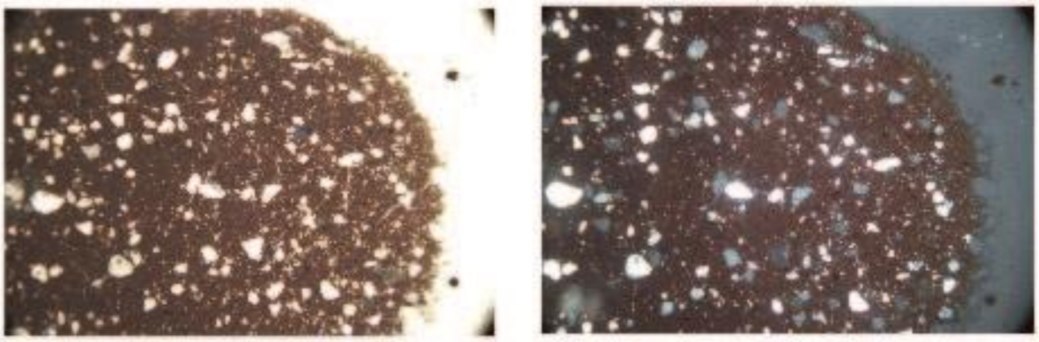


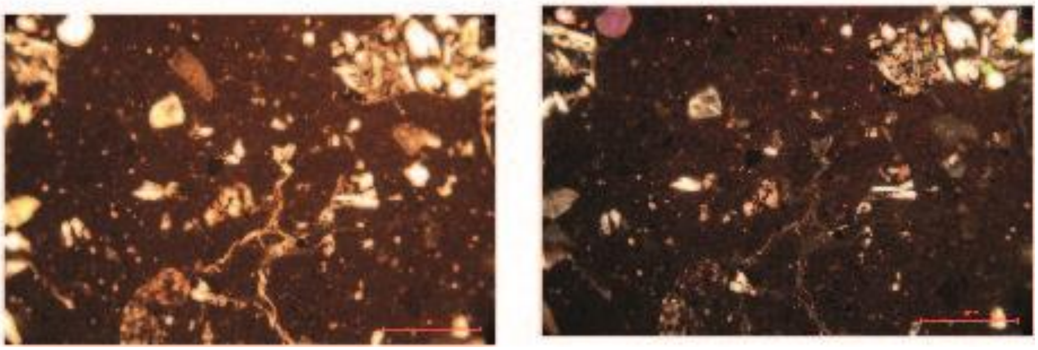
Nippur N.4

CA200724



Nippur N.5

CA200735



Hasanlu

Hasanlu H.1

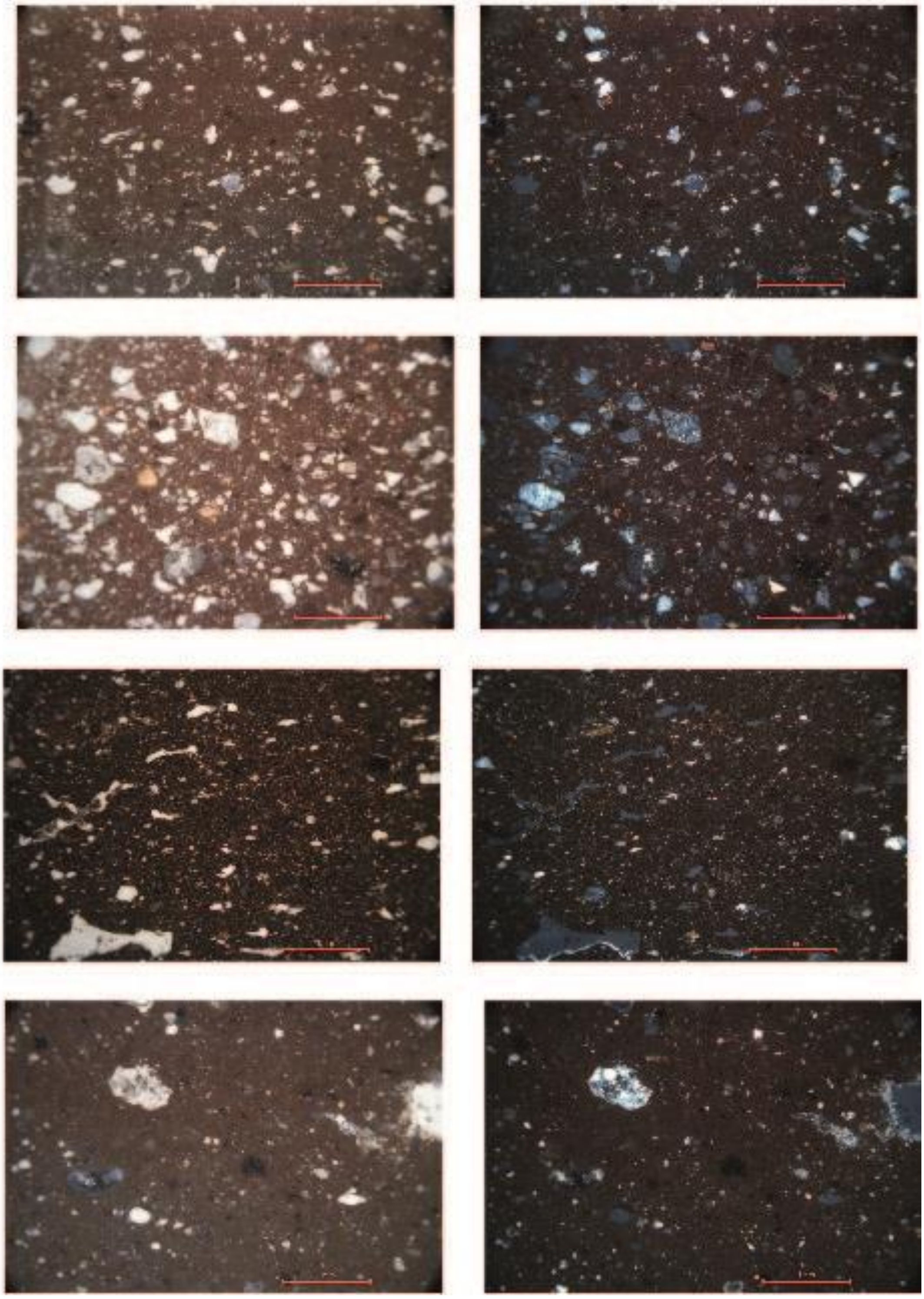
PPL | XPL

CA200364

CA200365

CA200366

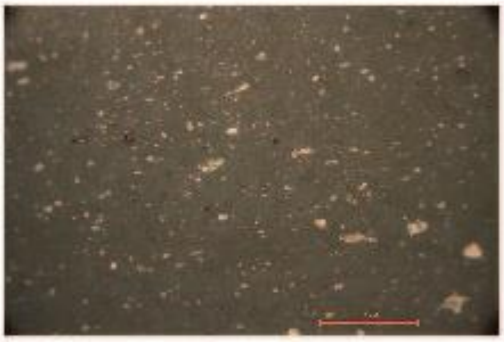
CA200368

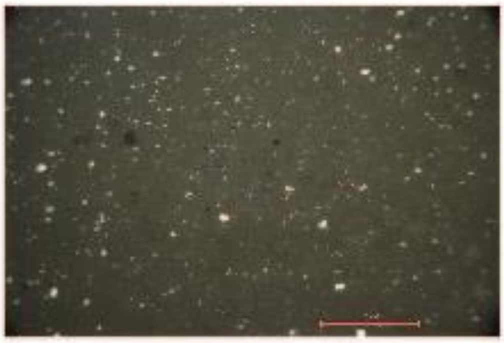


PPL XPL

Hasanlu H.2

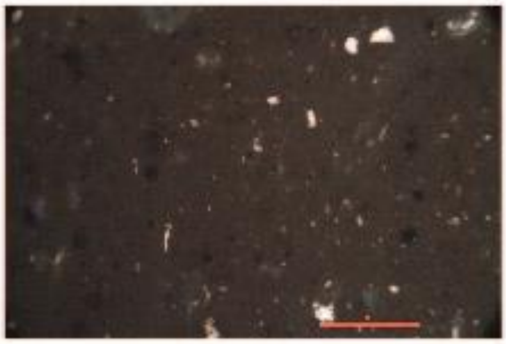
CA200363

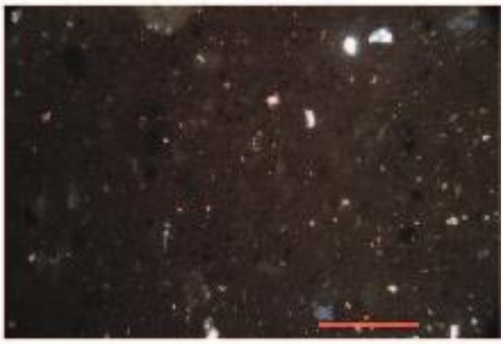




Hasanlu H.3

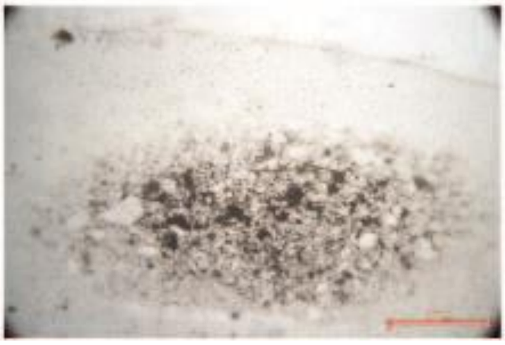
CA200369

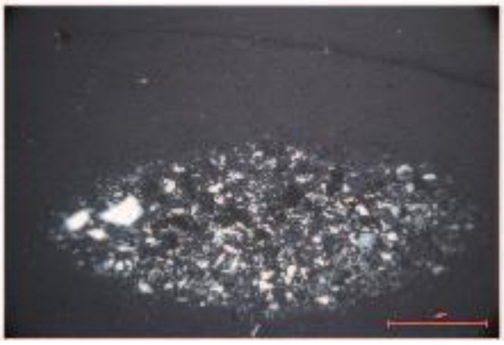




Hasanlu H.4

CA200367





Rayy

Rayy R.1

PPL | XPL

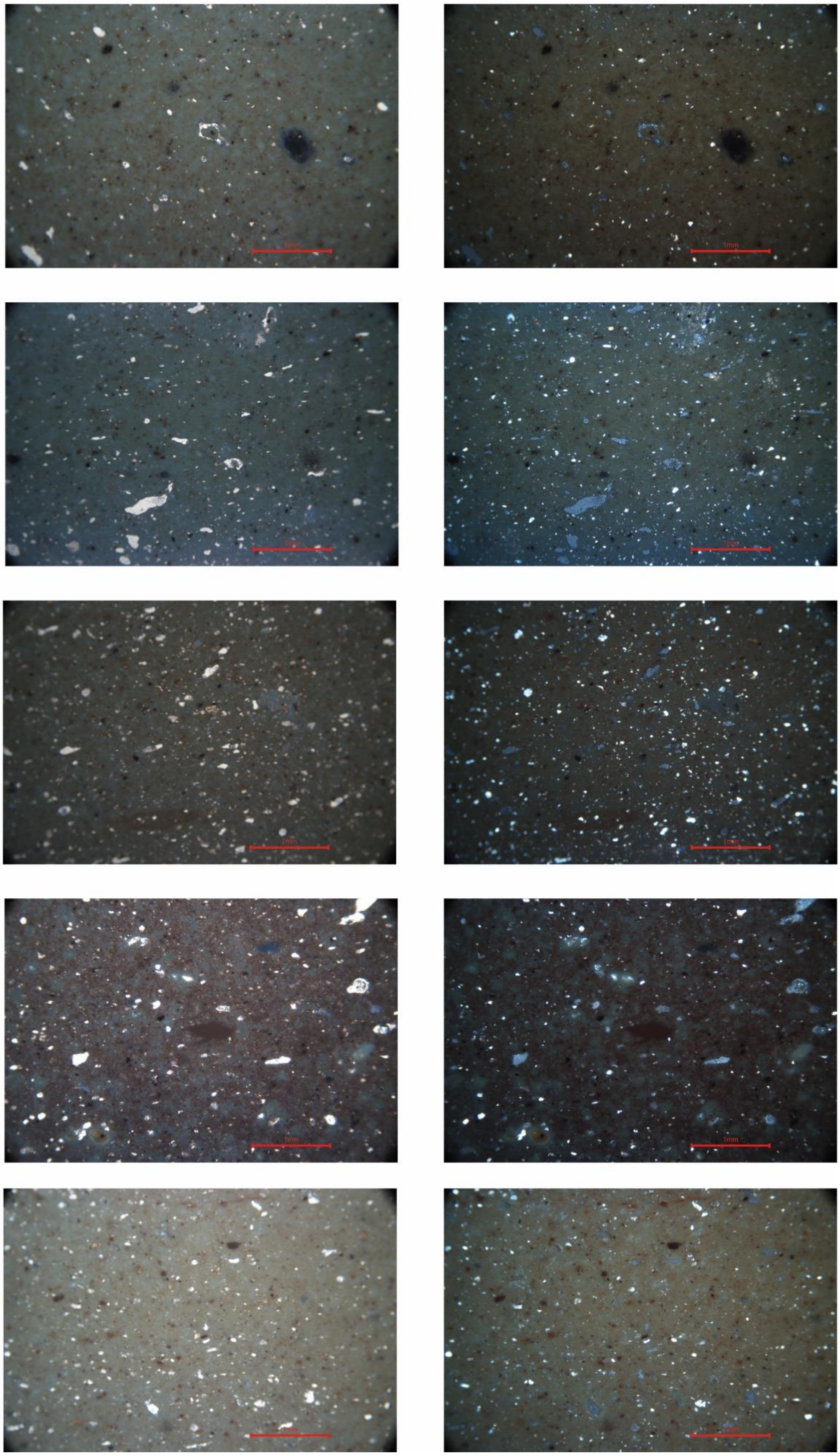
CA200336

CA200337

CA200338

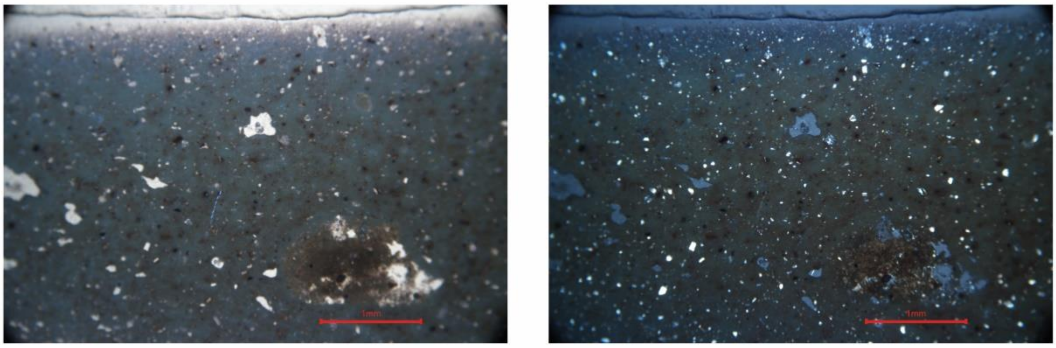
CA200342

CA200344



Rayy R.1 PPL XPL

CA200345



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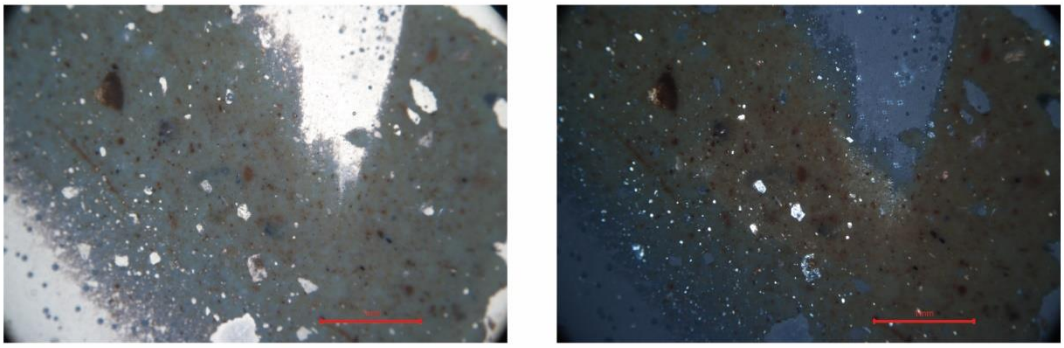

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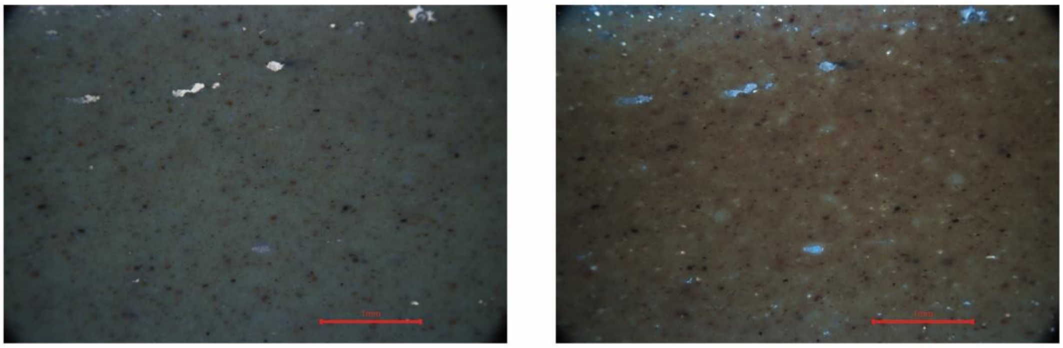

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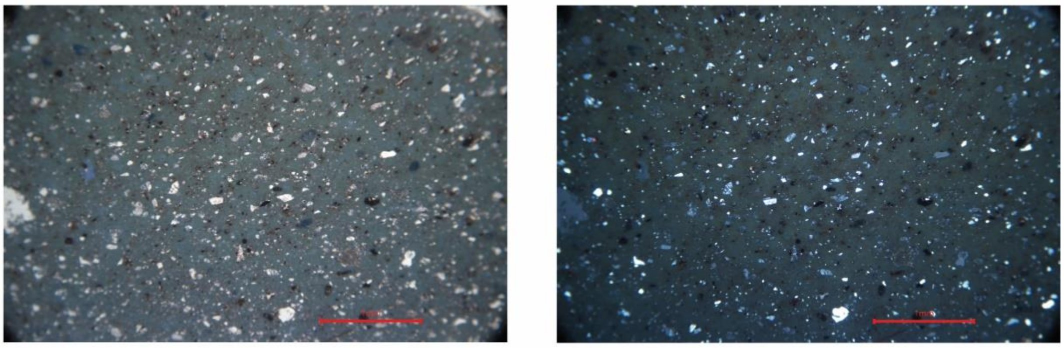

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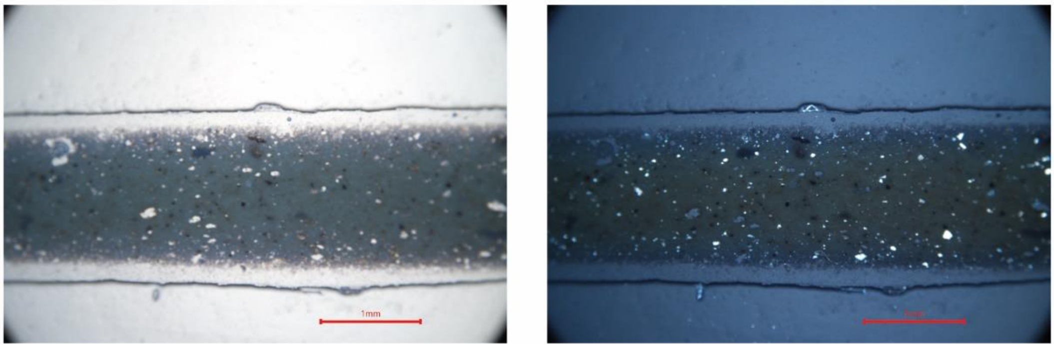
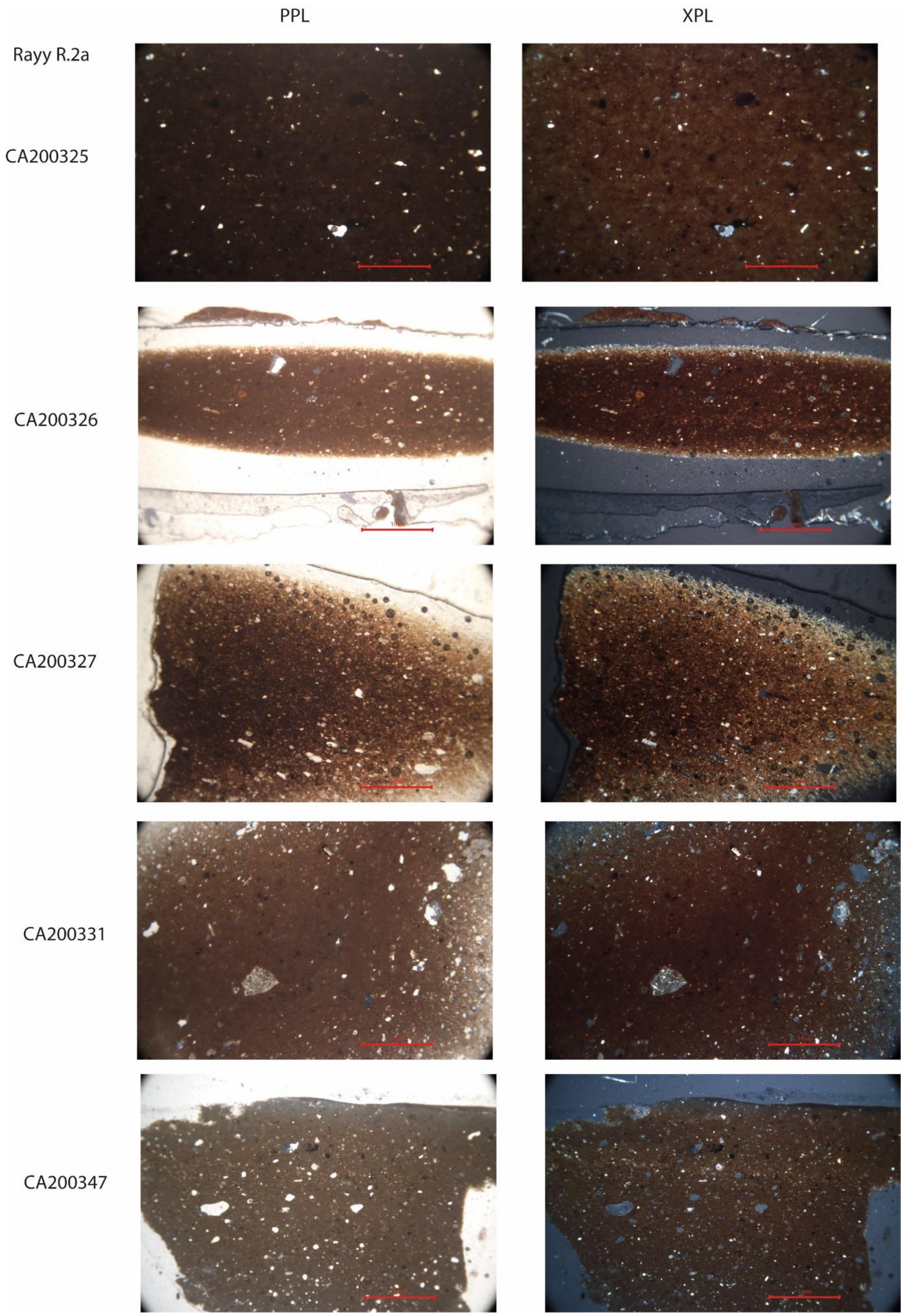
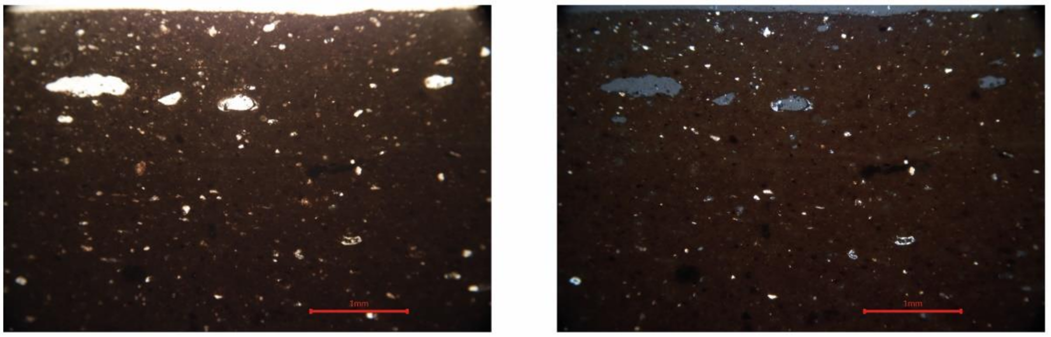




PPL
XPL
Rayy R.2a
CA200325
CA200326
CA200327
CA200331
CA200347

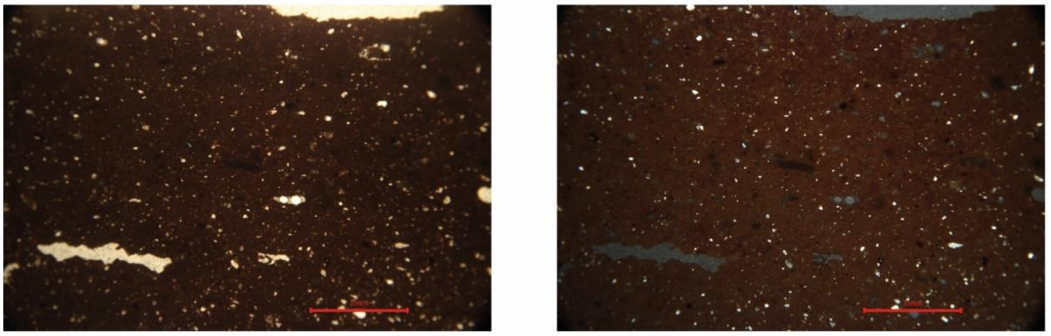
Rayy R.2a PPL XPL

CA200350

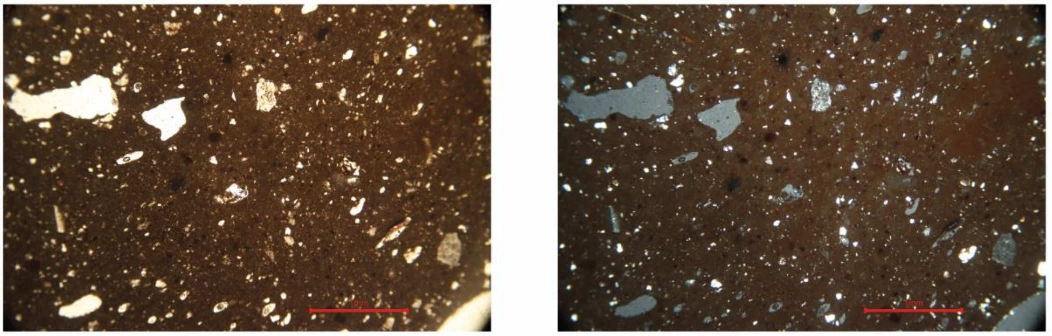


Rayy R.2b

CA200328



CA200330



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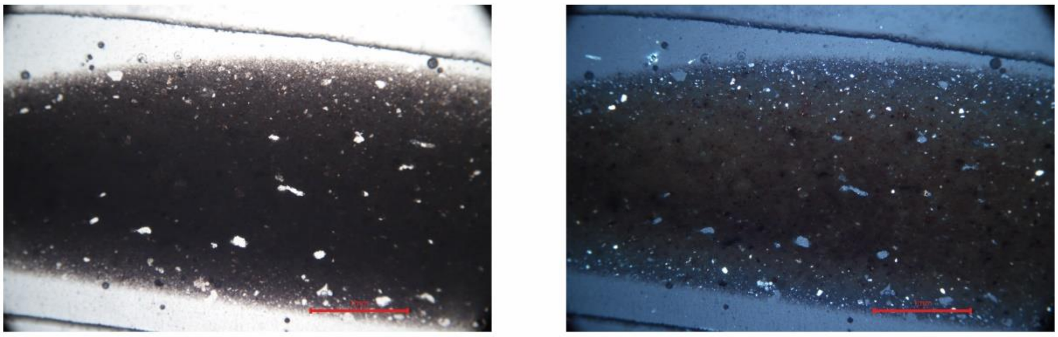

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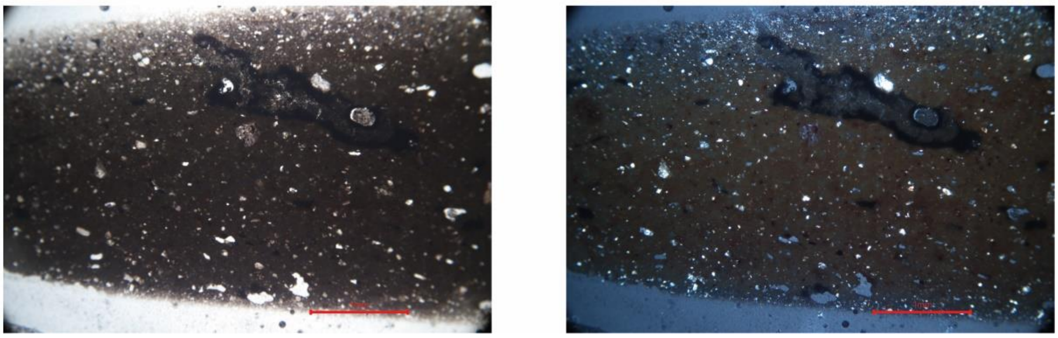
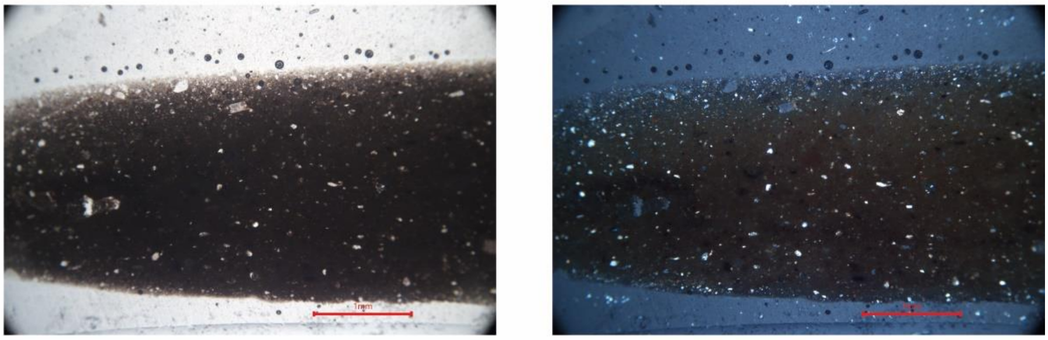


PPL XPL

Rayy R.2b

CA200351



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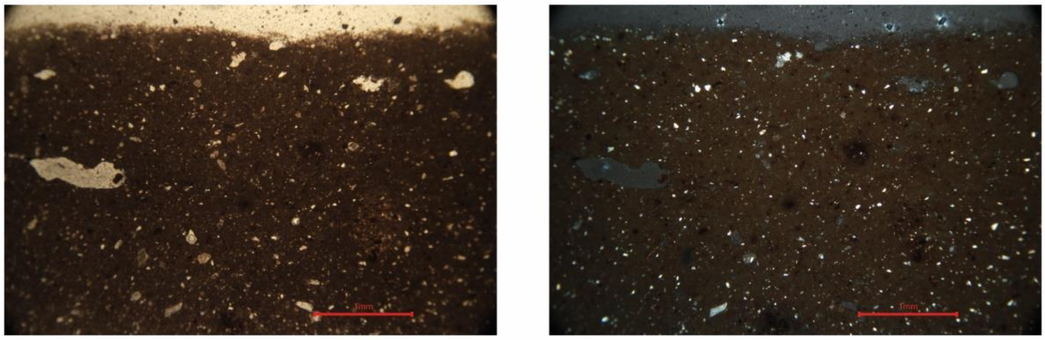
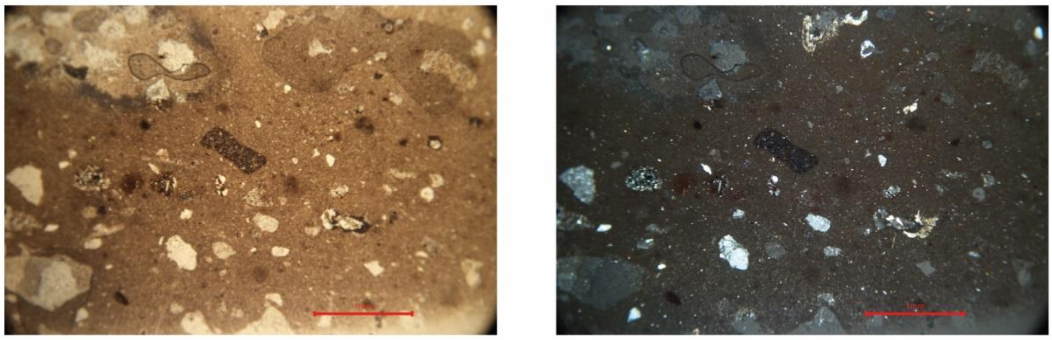


Rayy R.3

CA200323



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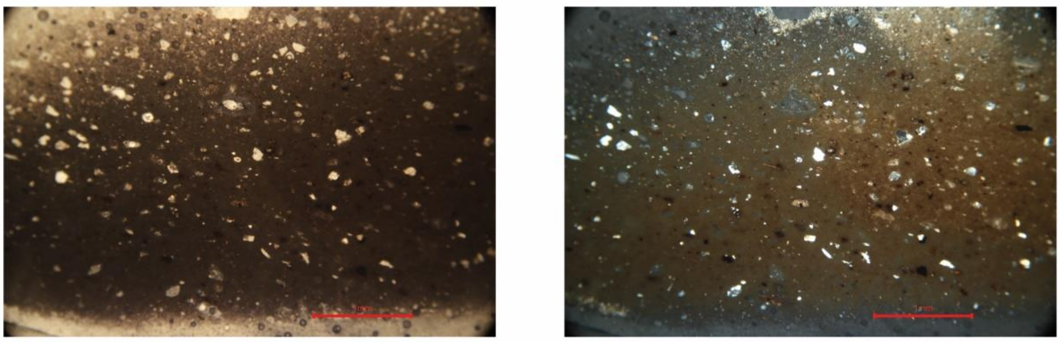
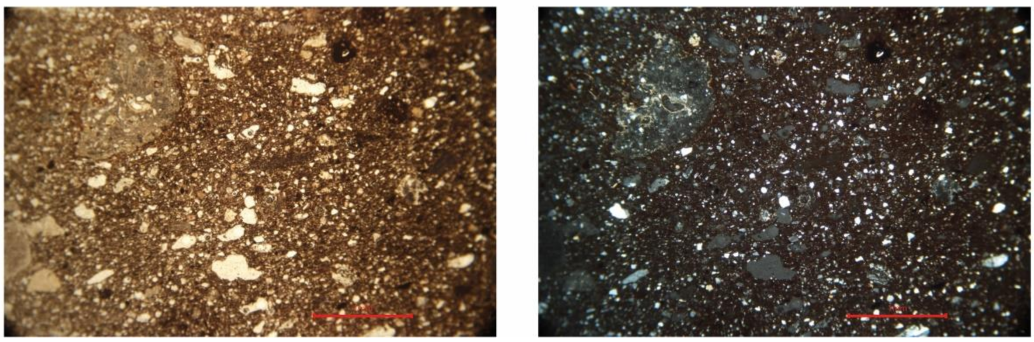
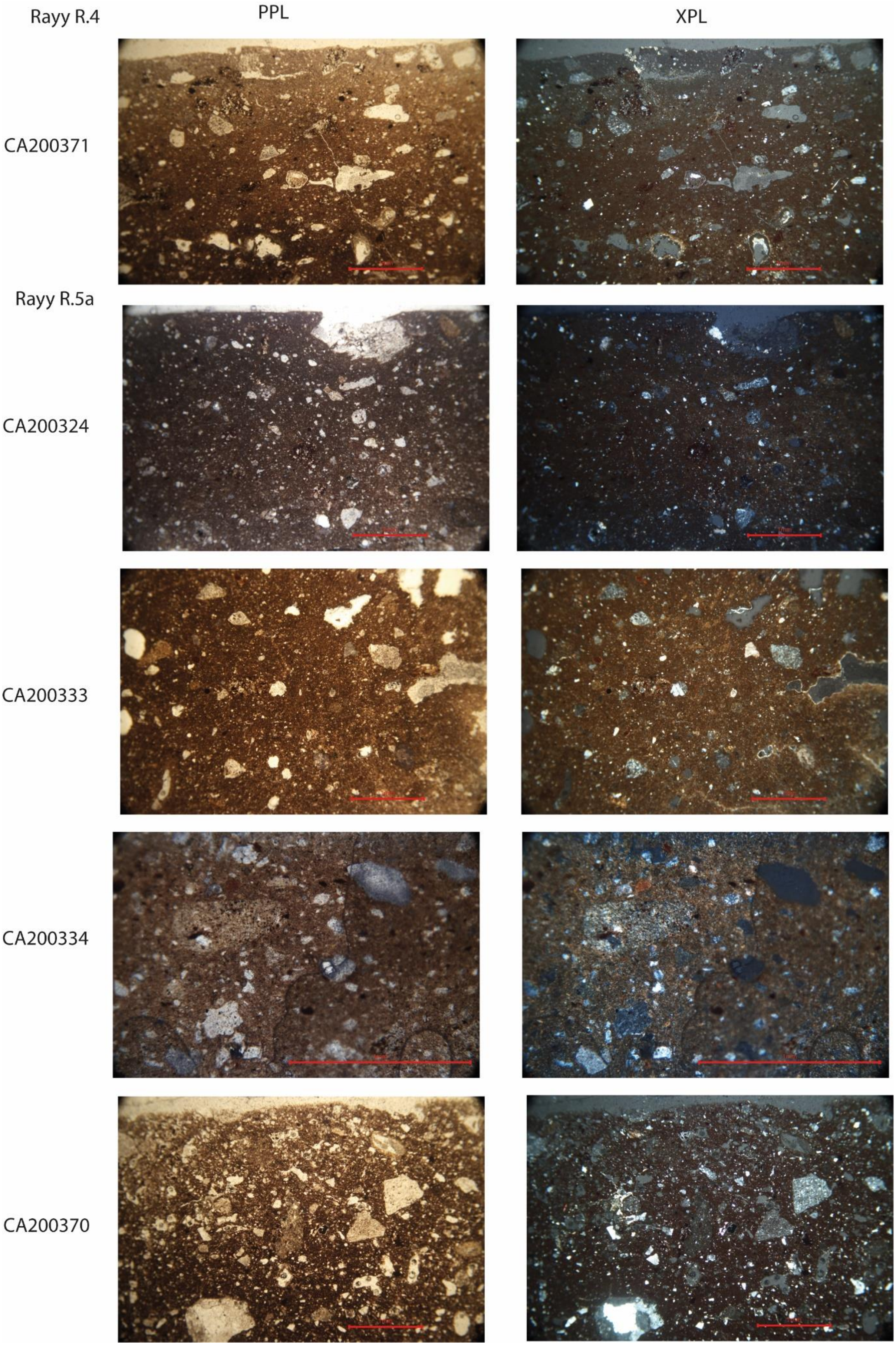
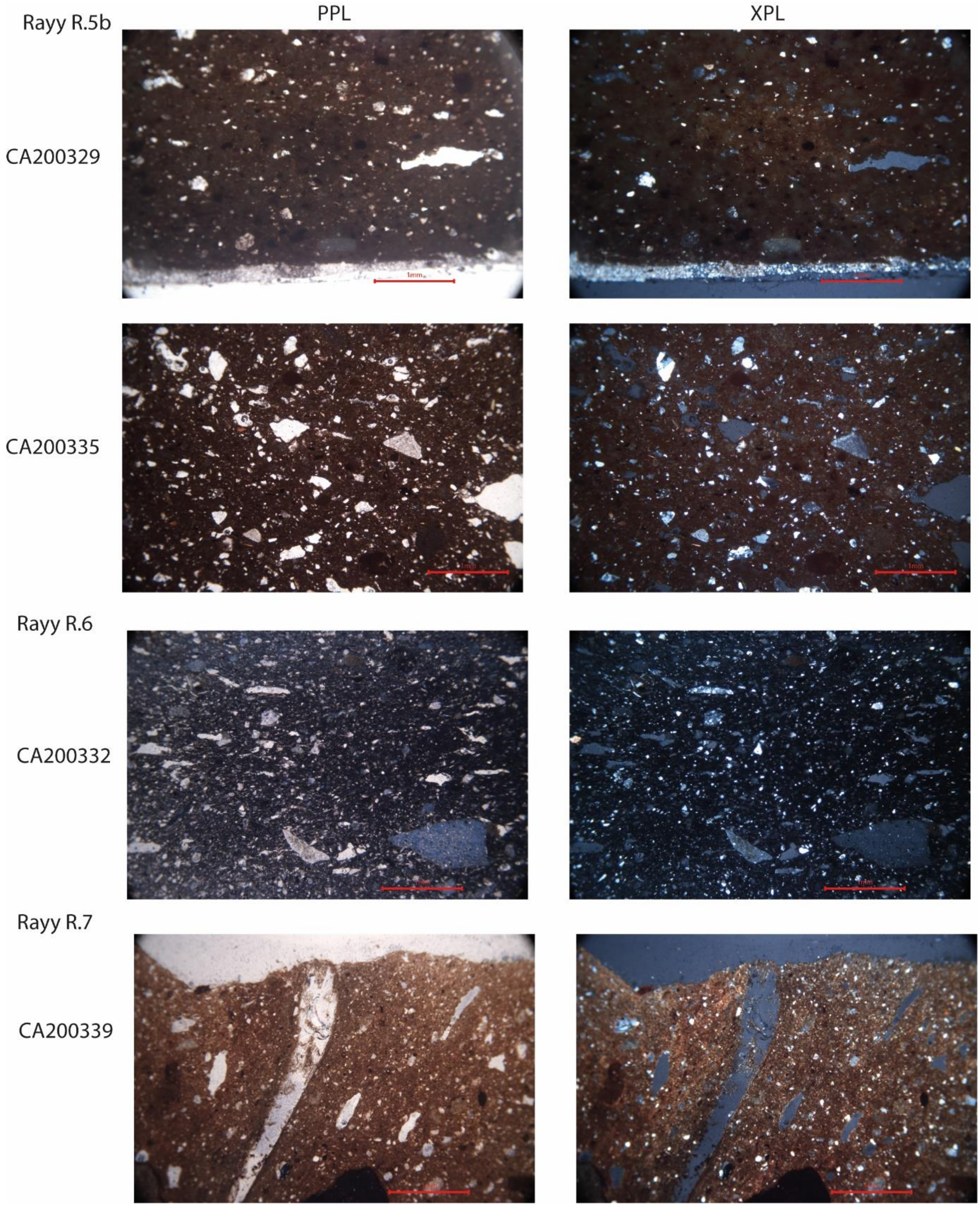


Rayy R.4

CA200340




Rayy R.4
PPL
XPL
CA200371
Rayy R.5a
CA200324
CA200333
CA200334
CA200370



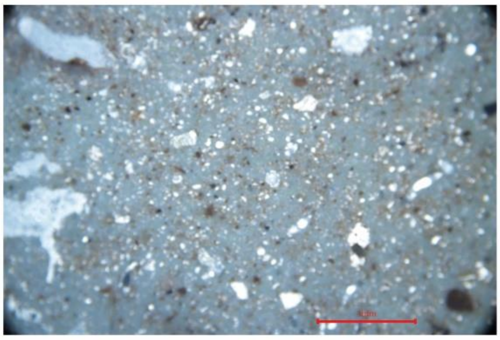
PPL
XPL
Rayy R.5b
CA200329
CA200335
Rayy R.6
CA200332
Rayy R.7
CA200339

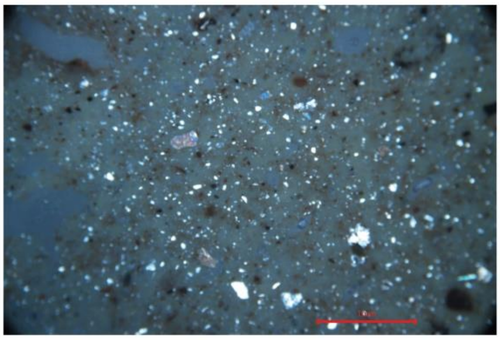
Firuzabad

PPL | XPL

Firuzabad F.1

CA200356





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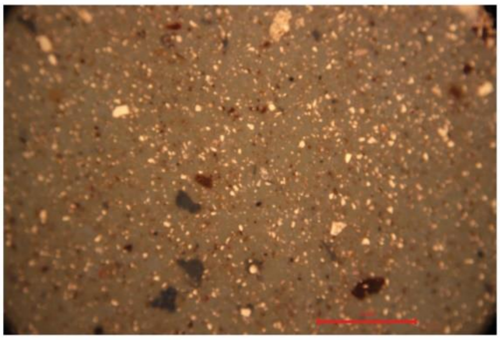

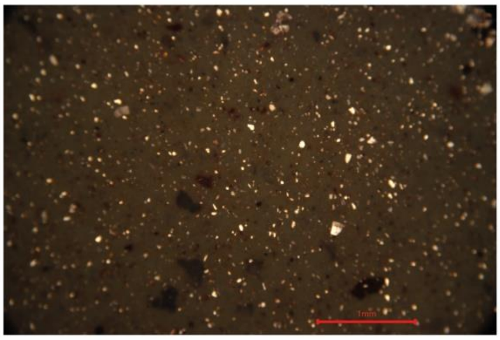

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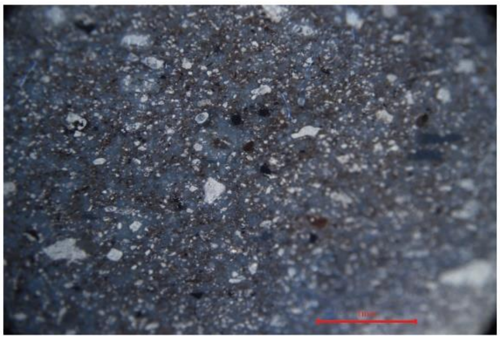
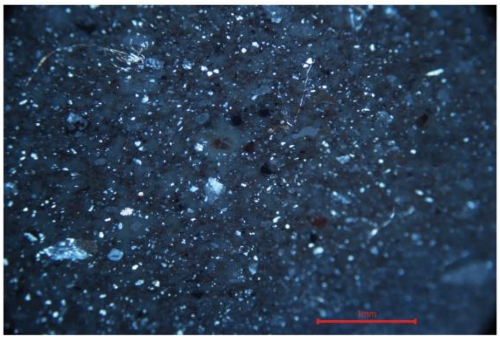
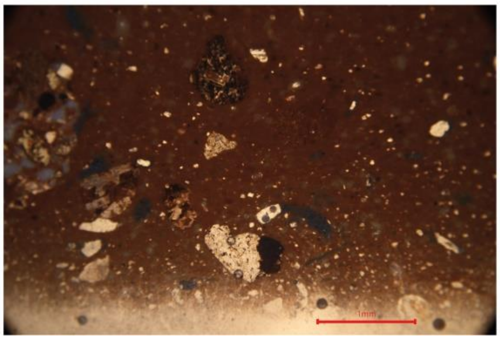
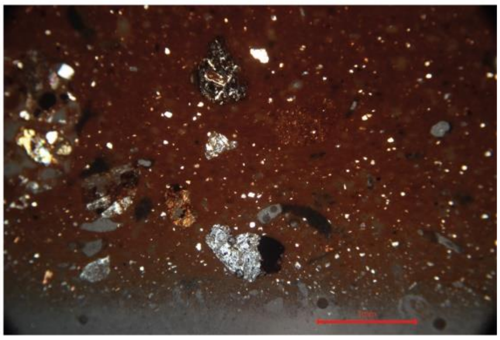




Firuzabad F.2a

CA200359

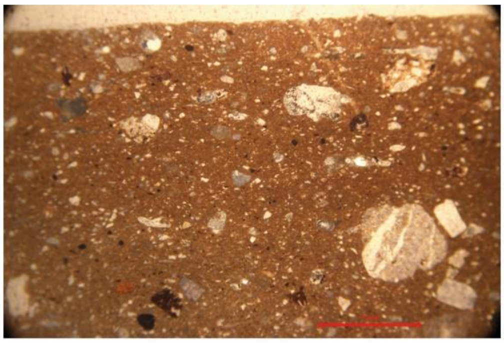


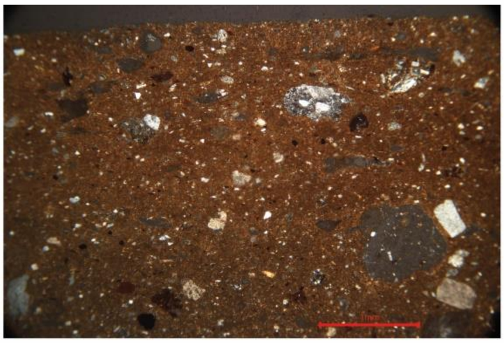


Firuzabad F.3b

PPL | XPL

CA200352





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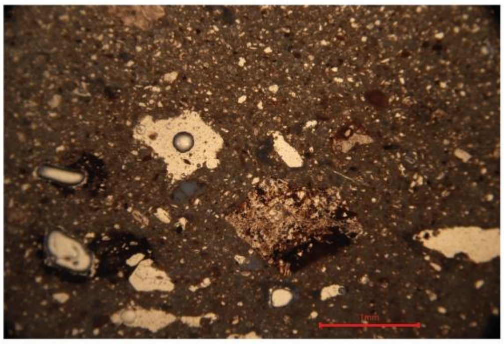

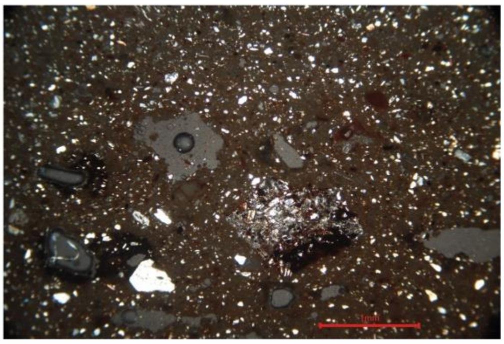

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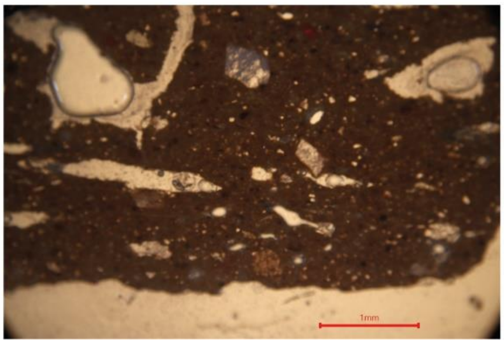

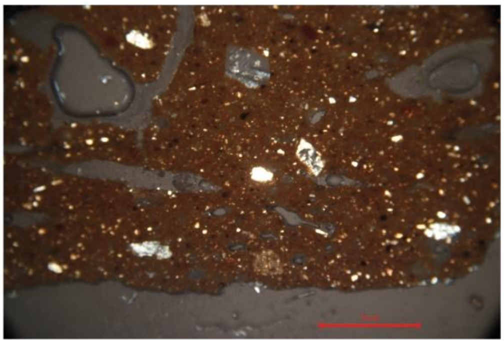

PPL XPL

Firuzabad F.2b

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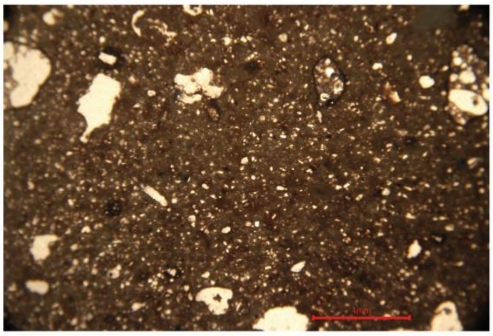

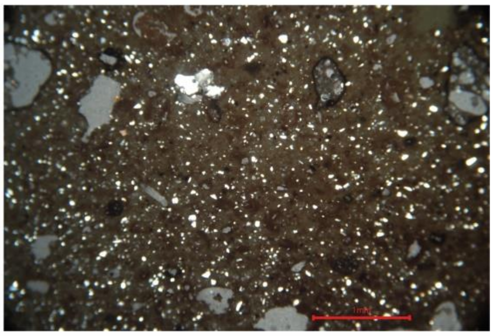

Firuzabad F.2c

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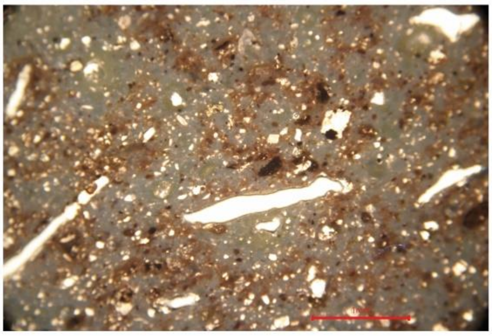

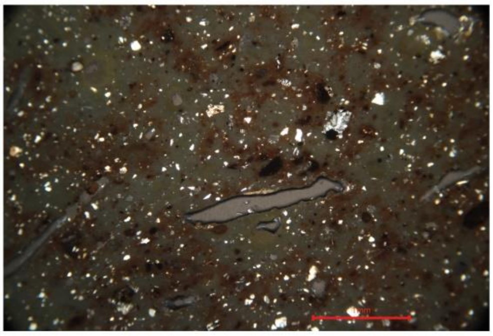

Firuzabad F.3a

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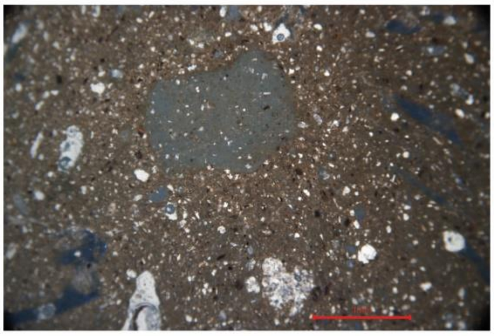

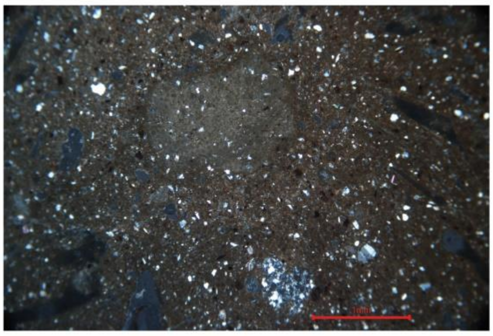

Firuzabad F.4

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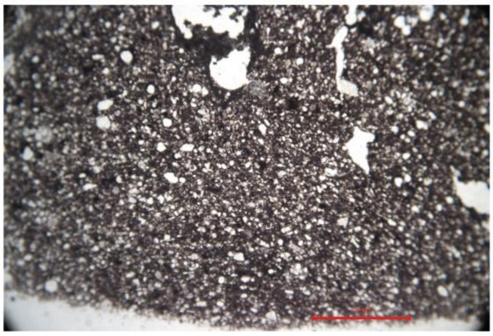
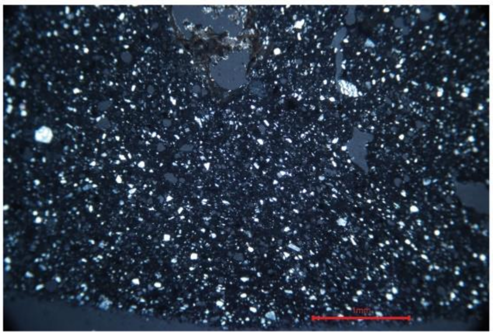




Appendix 9: PXRF Data

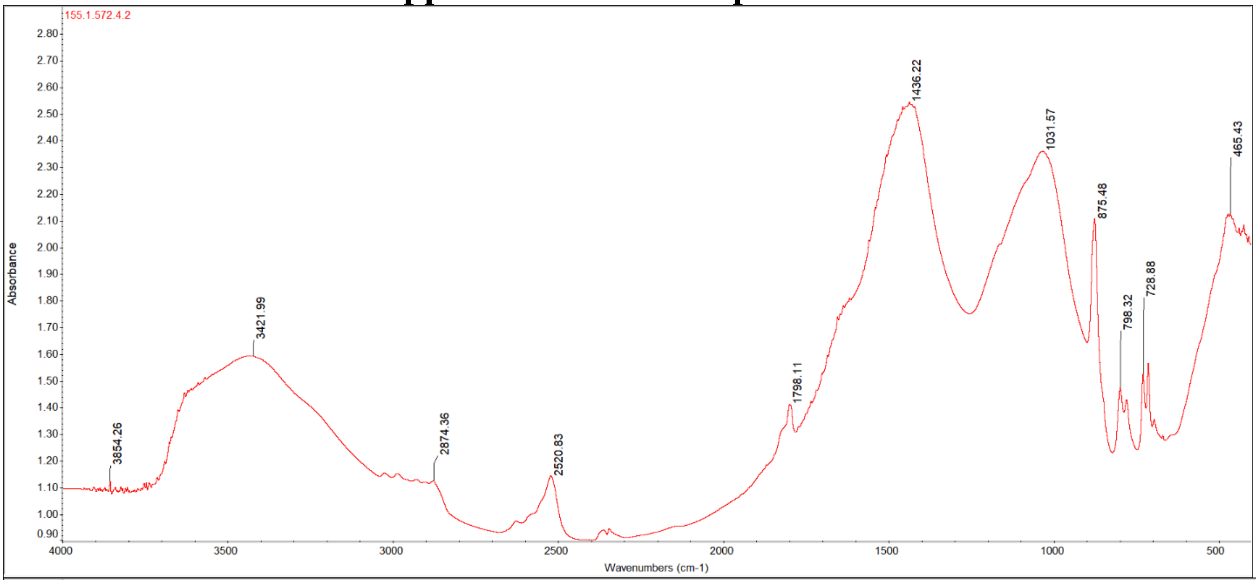
Science Number	Sherd Number	Al2O3 (wt%)	CaO (wt%)	Fe2O3 (wt%)	K2O (wt%)	SiO2 (wt%)	Cr (ppm)	Mn (ppm)	Rb (ppm)	Sr (ppm)	Ti (ppm)	V (ppm)	Zn (ppm)	Zr (ppm)
CA200235	155.11.582.17	14.55	12.85	8.36	1.89	49.88	424	1075	75	305	5083	101	120	158
CA200236	155.11.582.21	13.28	12.33	7.01	1.74	51.10	622	1000	57	346	4406	114	95	130
CA200237	155.11.582.28	12.80	17.93	7.48	1.71	45.39	468	878	77	369	4657	129	102	156
CA200238	155.8.579.20	12.71	12.69	7.21	2.01	45.07	370	902	61	307	4240	129	107	132
CA200239	155.8.579.23	11.15	18.80	5.41	1.65	44.40	280	762	57	521	4110	112	86	147
CA200240	155.8.579.35	11.07	19.31	5.53	1.94	45.96	259	758	61	425	4150	118	89	140
CA200241	155.8.579.44	15.76	15.72	7.77	1.83	53.17	410	1047	65	303	4812	163	118	146
CA200242	155.8.579.47	11.25	15.52	5.88	1.81	43.16	333	733	53	388	3707	99	86	125
CA200243	155.8.579.51	11.14	15.30	6.84	1.51	42.72	413	875	59	343	4502	126	95	141
CA200244	155.1.572.4	9.23	20.63	4.16	1.33	30.57	239	348	28	225	2442	86	59	62
CA200245	155.1.572.5	14.14	14.82	8.07	1.59	48.34	405	1061	64	312	4871	166	115	149
CA200246	217.1.1004.2	10.50	20.10	5.70	2.25	45.18	355	800	62	550	3735	75	107	150
CA200247	217.1.1004.6	10.25	19.35	5.58	2.02	45.52	337	713	74	482	3858	118	112	134
CA200248	217.1.1004.7	10.06	19.01	5.38	1.53	40.89	229	648	53	561	3550	100	84	120
CA200249	217.4.1007.3	10.30	22.22	4.90	1.38	48.85	374	744	49	480	4184	102	145	188
CA200250	217.2.1005.7	13.04	14.76	6.70	1.79	48.44	496	863	53	323	4460	134	92	139
CA200251	217.2.1005.8	9.95	24.11	4.85	1.51	44.67	370	664	45	443	3786	85	73	173
CA200252	217.2.1005.9	9.56	21.38	4.76	1.61	38.24	258	660	48	487	3497	96	71	129
CA200253	217.2.1005.23	9.32	21.43	4.89	1.46	40.88	285	697	47	477	3537	0	77	126
CA200254	217.2.1005.26	11.10	15.03	6.65	2.03	43.23	379	850	64	385	4357	103	94	140
CA200254	217.3.1006.16	9.14	18.98	4.94	1.74	37.14	353	783	47	489	3885	99	71	145
CA200256	217.3.1006.25	8.67	17.78	4.66	1.64	33.66	296	678	48	910	3570	97	70	134
CA200257	217.3.1006.29	15.35	3.88	10.65	0.88	63.64	882	1294	32	112	4909	167	87	96
CA200258	217.3.1006.31	8.76	19.95	4.81	1.90	36.49	323	680	50	519	3645	61	73	137
CA200259	217.3.1006.50	9.12	20.56	4.42	1.64	37.29	288	600	44	571	3334	85	66	135
CA200260	217.3.1006.55	9.56	22.26	5.29	1.83	40.90	317	742	61	575	3655	113	95	138
CA200261	217.3.1006.57	11.24	18.84	5.99	2.60	45.70	360	901	77	582	4305	119	118	165
CA200262	217.3.1006.63	14.37	5.96	9.19	1.27	59.00	1155	1002	32	152	2500	148	77	68
CA200263	217.3.1006.65	16.52	17.85	7.62	2.85	63.04	535	929	66	413	4931	128	119	161
CA200264	217.3.1006.69	6.03	2.36	0.67	1.19	77.35	366	146	10	95	1035	0	44	65
CA200265	217.3.1006.73	14.59	14.46	7.08	1.93	52.07	405	935	55	373	4556	132	91	142
CA200266	217.3.1006.74	9.48	23.49	5.06	1.89	41.10	318	729	54	444	3439	76	93	122
CA200267	217.5.1008.10	9.88	19.57	4.87	1.34	42.83	281	589	47	362	3457	119	74	119
CA200268	217.5.1008.14	8.89	16.19	4.25	1.50	45.90	217	553	41	331	3088	96	66	95
CA200269	217.5.1008.15	10.14	17.25	4.71	1.94	39.63	299	629	44	429	3519	115	80	119
CA200270	217.5.1008.28	13.35	15.25	7.39	2.07	46.50	347	918	68	385	4545	107	106	144
CA200271	217.5.1008.36	9.07	21.79	4.85	1.07	37.52	261	682	34	680	3395	112	76	130
CA200272	217.5.1008.40a	10.70	22.10	4.77	1.70	41.39	423	630	52	422	3638	105	71	128
CA200274	217.5.1008.45	10.40	23.38	5.22	1.28	47.07	406	771	42	518	3682	94	79	131
CA200275	217.5.1008.46	12.78	21.07	5.85	1.76	50.52	438	758	71	456	4012	63	106	143
CA200276	217.6.1009.3	9.52	17.58	5.22	1.61	49.45	391	635	53	325	3682	103	78	113
CA200277	381.3.1555.4	15.27	14.87	6.77	2.46	54.25	368	753	115	635	4287	145	99	136
CA200278	381.3.1555.11	10.67	24.02	4.87	1.61	43.08	341	726	48	433	3632	82	75	134
CA200279	381.3.1555.9	11.90	12.59	5.25	1.82	53.76	324	617	68	323	3118	83	83	100

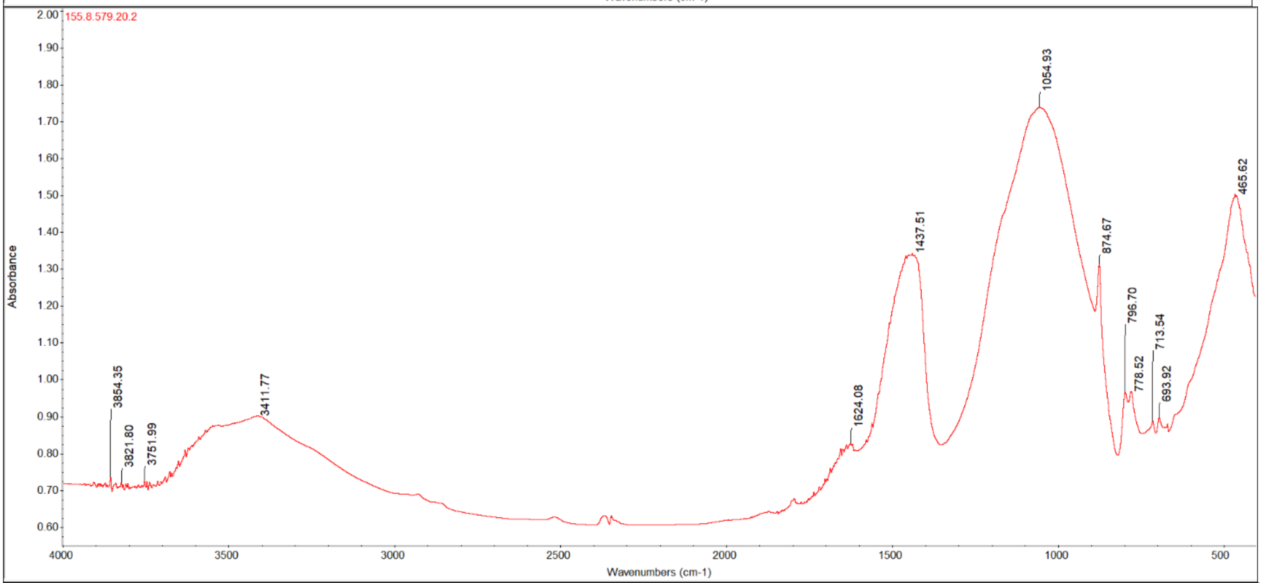
Science Number	Sherd Number	Al2O3 (wt%)	CaO (wt%)	Fe2O3 (wt%)	K2O (wt%)	SiO2 (wt%)	Cr (ppm)	Mn (ppm)	Rb (ppm)	Sr (ppm)	Ti (ppm)	V (ppm)	Zn (ppm)	Zr (ppm)
CA200280	381.3.1555.16	12.61	15.11	7.24	1.76	46.22	455	1014	58	395	4487	121	134	138
CA200281	381.3.1555.19	11.42	20.25	5.81	1.66	46.65	306	663	56	430	4079	108	99	139
CA200282	381.3.1555.20	10.42	19.14	5.35	1.59	44.40	285	650	52	517	3644	100	84	138
CA200283	381.3.1555.24	13.37	18.90	6.27	2.06	53.32	335	897	64	425	4338	107	109	144
CA200284	381.3.1555.36	12.12	22.54	5.66	1.76	49.06	260	802	57	464	3930	62	110	146
CA200285	381.2.1554.8	11.56	22.00	5.58	1.60	47.10	293	753	70	604	3792	89	92	140
CA200286	381.2.1554.6	7.66	21.55	5.06	1.55	30.96	220	659	51	576	3550	81	80	120
CA200287	381.2.1554.12	9.53	22.69	5.33	1.78	39.89	310	688	62	547	3649	96	90	125
CA200288	381.2.1554.14	10.82	14.47	5.40	1.98	44.03	375	773	58	377	4165	106	82	139
CA200289	381.2.1554.15	8.98	22.08	4.63	1.78	35.80	267	624	48	552	3231	62	71	120
CA200290	381.1.1553.8	10.93	19.92	5.82	1.82	43.17	311	722	57	505	3983	124	109	144
CA200291	381.1.1553.21	11.98	19.03	5.97	1.11	48.21	366	794	62	385	3581	102	88	110
CA200292	519.1.1915.2	11.26	22.82	5.65	1.40	43.85	368	789	55	554	3718	84	86	126
CA200293	519.3.1917.2	9.25	18.41	5.90	1.81	43.85	295	747	100	420	3842	111	107	131
CA200294	519.3.1917.5	11.38	22.94	5.84	1.59	45.33	304	806	60	490	3958	138	99	142
CA200295	519.2.1916.7	9.50	22.72	4.78	1.36	38.21	343	753	55	433	3447	0	79	131
CA200296	519.2.1916.9	12.46	22.45	5.82	1.70	47.88	452	782	60	403	4032	93	97	145
CA200297	519.2.1916.10	9.10	22.31	4.53	1.71	37.85	360	603	41	355	3381	36	69	121
CA200298	519.2.1916.13	11.16	22.17	5.41	1.42	42.10	438	926	59	444	3717	80	86	143
CA200299	519.2.1916.18	11.48	18.76	6.13	1.63	45.88	357	791	62	428	4357	125	173	169
CA200300	535.1.1953.5	10.07	23.56	4.86	1.34	43.29	364	709	45	376	3628	92	74	150
CA200301	535.1.1953.6	11.77	22.85	5.71	1.54	47.45	292	815	64	406	3862	106	97	132
CA200302	535.1.1953.7	8.58	22.64	4.69	1.31	36.09	291	630	44	310	3766	123	66	137
CA200303	535.1.1953.10	10.28	19.65	5.77	1.57	44.29	279	794	62	310	3585	82	95	110
CA200304	535.1.1953.12	9.85	21.81	5.46	1.66	43.50	278	722	70	439	4064	117	103	147
CA200305	535.1.1953.13	12.80	22.18	5.86	1.96	50.55	290	809	64	380	4042	92	101	144
CA200306	535.1.1953.18	13.38	17.99	6.20	1.93	51.74	396	881	52	313	3899	99	96	125
CA200307	535.1.1953.21	10.05	22.25	5.45	1.60	43.69	340	775	66	417	3777	104	91	139
CA200308	535.1.1953.23	14.97	19.05	6.81	1.90	56.17	369	921	73	399	4769	119	125	167
CA200309	276.1.1241.3	10.78	20.60	5.42	1.94	44.34	334	822	58	541	4076	97	93	165
CA200310	276.1.1241.4	9.15	21.34	5.20	1.62	39.05	378	700	52	565	4008	57	79	148
CA200311	276.1.1241.7	9.91	22.30	4.45	1.99	46.43	345	621	48	454	3277	86	70	124
CA200312	276.1.1241.9	9.54	21.39	4.64	1.66	42.88	340	652	44	456	3529	98	77	138
CA200313	276.1.1241.11	11.90	18.35	5.96	1.99	49.60	286	852	58	705	3920	92	107	131
CA200314	276.1.1241.12	16.30	12.86	8.33	2.20	53.08	390	1150	76	347	4953	133	131	151
CA200315	276.3.1243.7	11.31	18.24	5.43	2.33	44.50	263	813	58	567	3756	81	88	129
CA200316	276.3.1243.13	10.39	20.18	5.52	1.72	45.40	318	829	51	518	3726	72	89	127
CA200317	276.2.1242.2	8.54	27.79	4.48	1.28	36.13	385	611	46	588	3572	58	75	146
CA200318	276.2.1242.7	9.88	22.02	4.72	1.48	41.55	396	740	48	492	3531	74	74	141
CA200319	276.2.1242.12	14.41	20.29	6.94	1.22	51.70	403	773	50	480	4136	120	112	134
CA200320	276.2.1242.14	17.17	10.48	7.61	2.73	56.19	308	648	113	392	4405	139	117	146
CA200321	276.2.1242.17	12.30	14.01	7.31	1.89	45.52	445	928	60	345	4589	136	107	135
CA200322	276.2.1242.21	11.08	19.87	5.52	1.74	43.06	307	660	58	487	3960	129	86	135
CA200323	35.7.1007	15.53	10.52	5.62	3.16	63.00	170	1181	99	429	3610	127	117	142
CA200324	35.7.1012	17.59	2.16	6.84	3.10	70.90	196	1713	116	250	4424	167	139	168
CA200325	35.7.1014	17.21	11.84	5.97	2.89	65.89	162	971	93	492	3818	113	183	143
CA200326	35.7.1015	5.60	18.20	4.66	1.30	18.98	235	617	79	341	2211	104	109	133
CA200327	35.7.1016	15.16	3.67	6.34	2.48	61.10	428	948	86	532	4312	143	130	179
CA200328	35.7.194	14.62	12.94	5.87	2.94	55.39	165	965	89	484	3712	112	108	134
CA200329	35.7.255	17.00	11.74	6.15	2.84	63.41	156	1185	105	353	4233	96	180	161
CA200330	35.7.981	16.11	8.81	5.80	2.94	63.18	184	997	91	538	3818	117	96	147

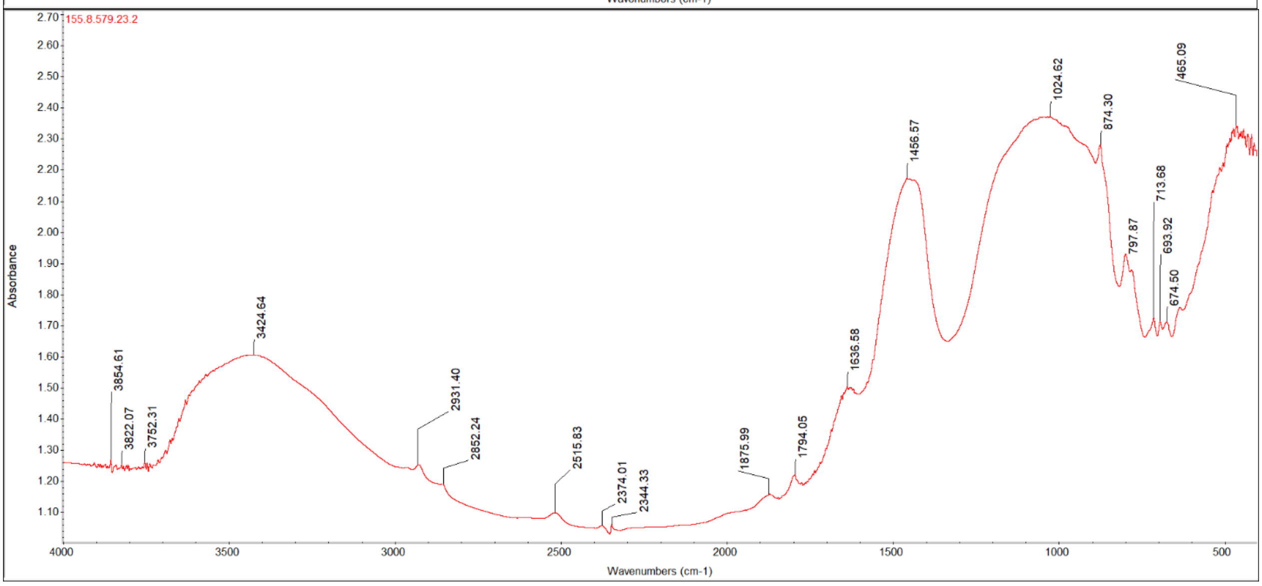
Science Number	Sherd Number	Al2O3 (wt%)	CaO (wt%)	Fe2O3 (wt%)	K2O (wt%)	SiO2 (wt%)	Cr (ppm)	Mn (ppm)	Rb (ppm)	Sr (ppm)	Ti (ppm)	V (ppm)	Zn (ppm)	Zr (ppm)
CA200331	35.7.982	16.06	11.61	5.71	2.72	59.68	119	934	91	633	3657	130	111	145
CA200332	35.7.983	15.20	9.85	5.64	2.86	55.90	119	985	95	624	3956	121	116	148
CA200333	35.7.984	15.83	10.70	6.21	2.89	58.42	188	1377	87	400	3294	133	139	141
CA200334	35.7.985	13.53	7.34	5.25	3.23	51.42	144	759	101	1029	4467	95	143	141
CA200335	35.7.988	14.26	9.17	6.64	3.21	50.95	183	975	93	560	4171	123	116	151
CA200336	35.7.990	16.93	14.79	6.53	2.89	59.56	231	1017	80	496	4245	152	112	153
CA200337	35.7.993	15.77	14.98	6.61	2.66	57.39	192	937	100	552	4143	144	113	154
CA200338	35.7.994	16.28	10.62	6.29	3.06	61.22	151	1325	103	220	3851	137	185	197
CA200339	37.11.1304	8.26	10.26	6.83	1.85	27.06	198	680	101	373	5016	136	94	215
CA200340	37.11.1305	16.35	1.81	5.98	3.09	70.33	135	660	78	838	3442	103	109	122
CA200341	37.11.168	13.29	18.92	4.81	2.19	46.72	216	774	91	616	4048	167	94	152
CA200342	37.38.187	17.13	11.55	5.77	3.20	64.01	226	735	74	699	3046	55	106	137
CA200343	37.38.189	12.79	18.89	4.76	1.60	46.31	196	1003	84	540	3915	155	129	139
CA200344	37.38.191	14.77	15.06	5.99	2.44	55.59	251	1243	79	553	4073	127	171	170
CA200345	37.38.194	16.55	13.13	5.98	2.50	62.53	190	925	83	550	4099	105	88	148
CA200346	37.38.195	15.52	14.38	6.18	2.59	58.20	376	901	95	631	3915	130	142	150
CA200347	37.38.197	14.85	9.15	5.71	2.58	54.21	198	945	97	558	4183	155	126	161
CA200348	37.38.198	15.84	10.97	6.39	2.91	58.08	251	890	75	523	3822	143	122	143
CA200349	37.38.200	16.13	15.11	5.86	2.36	60.41	304	1071	95	456	3936	125	130	143
CA200350	37.38.213	16.86	9.38	6.30	3.78	61.99	239	1037	83	838	3889	101	162	147
CA200351	37.38.214	13.61	11.79	5.57	2.40	52.52	157	1092	94	528	3812	113	110	147
CA200352	70.7.158	13.68	8.67	6.65	2.71	52.67	264	973	71	552	3883	128	103	146
CA200353	70.7.160	11.50	12.98	5.23	2.58	45.74	259	781	64	1068	3198	104	83	131
CA200354	70.7.169	13.38	10.53	5.99	2.41	51.98	246	1426	67	592	3805	146	88	164
CA200355	70.7.170	15.30	11.15	6.08	2.50	56.79	221	885	79	430	3792	151	89	161
CA200356	70.7.171	14.43	12.00	6.35	1.49	52.14	486	809	60	433	4575	135	111	195
CA200357	70.7.177	12.76	11.20	6.06	1.43	50.03	317	751	45	474	3657	125	98	153
CA200358	70.7.195	13.33	10.58	5.67	2.47	54.28	174	466	102	883	4156	114	84	169
CA200359	70.7.196	17.05	8.62	7.68	3.01	62.30	238	961	98	478	4111	145	105	145
CA200360	70.7.203B	14.35	13.04	6.14	1.85	53.88	265	995	48	372	3694	90	82	163
CA200361	70.7.207	17.08	2.65	6.84	2.73	64.84	261	831	105	231	5324	184	107	213
CA200362	70.7.209	17.13	11.96	6.75	1.96	62.19	563	990	69	375	4045	155	104	149
CA200363	93.4.145.8	12.20	12.07	5.89	4.10	44.44	201	765	85	395	4147	129	92	159
CA200364	93.4.147	18.07	3.12	10.71	2.57	64.35	604	959	84	205	7631	201	133	160
CA200365	93.4.152	16.51	3.83	9.30	2.29	59.34	361	970	72	230	6587	169	123	152
CA200366	61.5.919	15.06	7.63	6.72	3.39	50.05	135	741	118	184	4682	116	123	156
CA200367	63.5.2038.9	1.37	5.26	0.92	0.60	14.95	1416	198	17	272	1770	0	159	45
CA200368	63.5.2058	15.19	9.33	6.41	3.18	55.20	149	829	117	257	4703	94	113	172
CA200369	63.5.2060	17.47	9.24	6.49	3.22	59.48	218	738	119	254	4793	117	114	177
CA200370	37.33.43	16.86	8.06	5.74	2.90	66.80	198	1001	97	518	3869	130	128	151
CA200371	37.33.44	18.33	11.16	6.45	2.82	62.93	197	1161	94	525	3727	155	124	143
CA200372	37.33.58	16.51	12.45	5.91	2.84	62.60	347	1277	83	691	4172	129	142	147
CA200373	37.33.59	16.41	14.96	6.66	2.30	59.93	139	1020	85	478	3689	140	97	137
CA200374	37.33.64	13.92	12.47	5.66	2.59	54.54	176	1176	111	346	3906	130	130	151
CA200723	A163161b	10.24	16.45	6.53	1.07	39.30	383	963	23	513	4395	137	97	139
CA200724	A163163b	17.50	1.57	9.07	1.06	67.71	497	890	59	598	3788	113	100	117
CA200725	A169184b	12.66	15.81	7.35	1.51	49.33	358	930	21	601	4200	117	95	126
CA200726	A169206b	10.92	15.28	6.40	1.09	45.55	273	820	44	652	4291	127	73	108
CA200727	A169207b	11.46	15.60	6.52	1.32	48.77	494	879	49	546	4579	122	92	121
CA200728	A169210b	10.85	14.09	6.43	1.61	41.92	338	749	43	482	3937	121	131	116
CA200729	A169214b	12.03	15.87	5.80	1.66	45.95	377	1424	90	113	8606	163	111	350
CA200730	A169219b	12.81	16.53	7.25	0.94	50.17	432	1056	37	612	4835	155	120	134

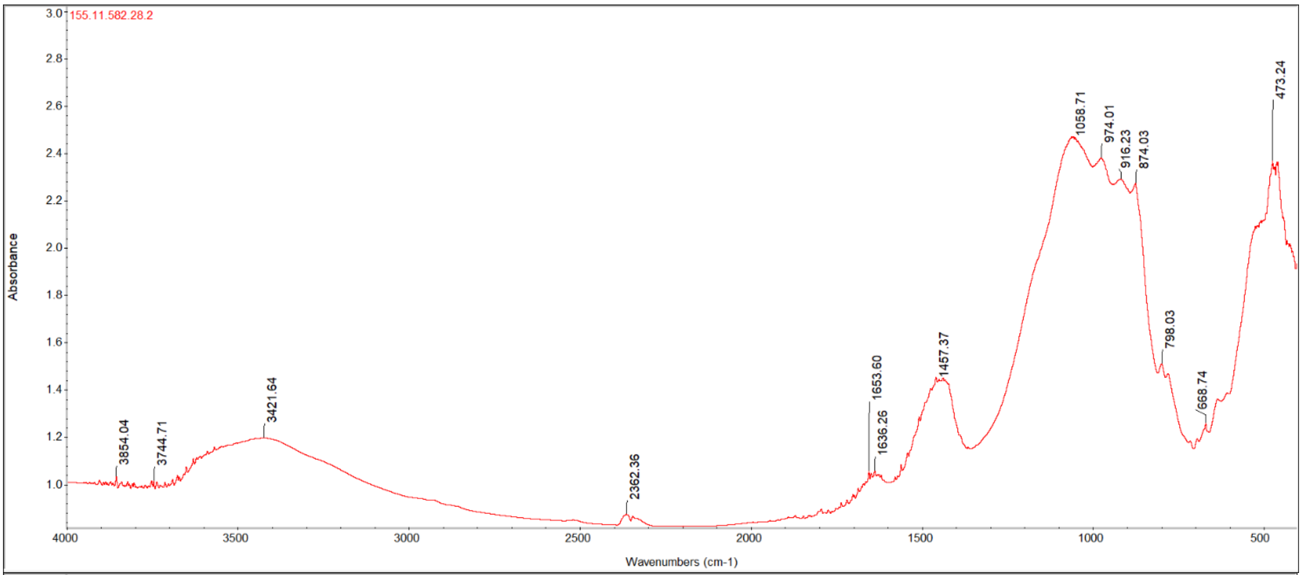
Science Number	Sherd Number	Al2O3 (wt%)	CaO (wt%)	Fe2O3 (wt%)	K2O (wt%)	SiO2 (wt%)	Cr (ppm)	Mn (ppm)	Rb (ppm)	Sr (ppm)	Ti (ppm)	V (ppm)	Zn (ppm)	Zr (ppm)
CA200731	A169222b	10.61	16.35	6.48	1.23	45.18	419	866	35	617	3920	112	94	118
CA200732	A169226b	11.91	16.29	6.98	0.91	46.65	928	735	45	336	4560	135	80	115
CA200733	A169227b	9.02	11.76	6.62	2.04	35.47	541	789	46	330	4725	157	92	136
CA200734	A169228b	11.54	14.08	6.15	2.12	43.30	394	868	58	514	3893	143	120	110
CA200735	A169231b	10.64	12.91	6.63	1.34	45.33	304	812	31	459	3958	132	109	120
CA200736	A169232b	11.48	13.26	6.52	1.66	44.89	356	792	17	550	3933	109	80	121
CA299234	155.10.581.20	10.61	21.89	4.73	1.65	47.42	2576	778	55	447	3300	78	189	138

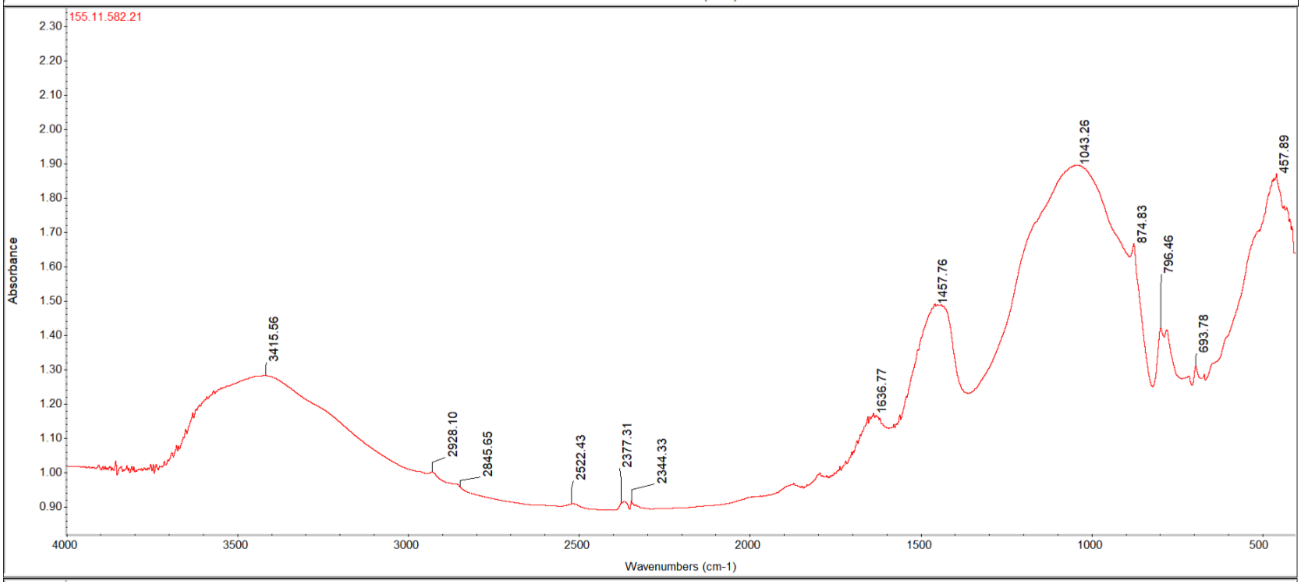
Appendix 10: FT-IR Spectra

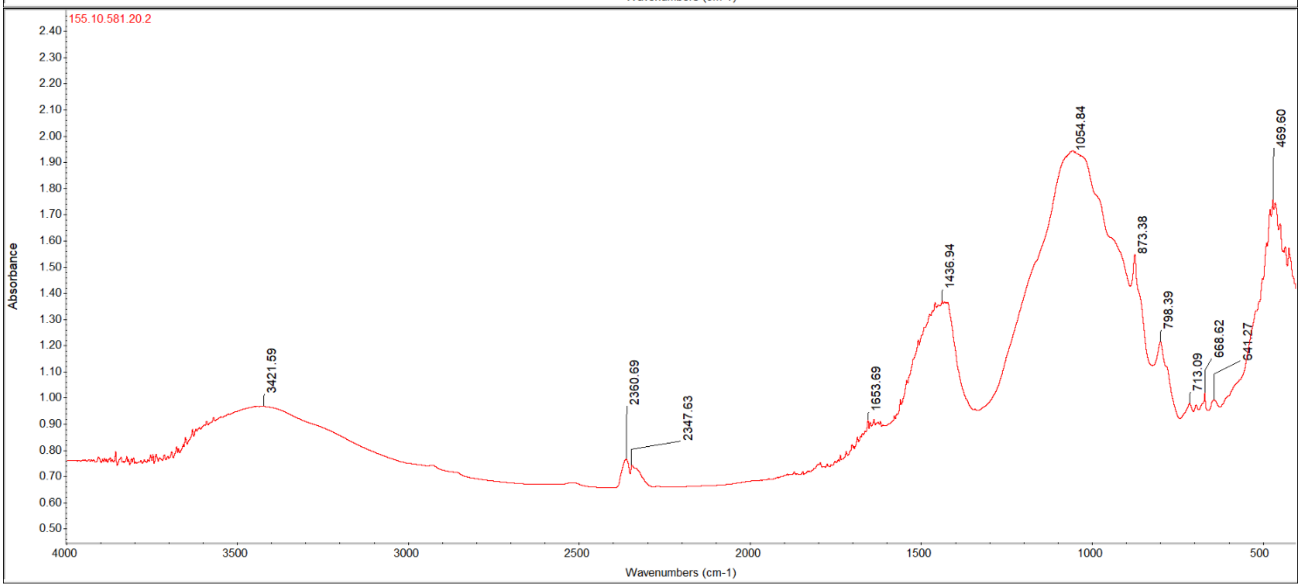


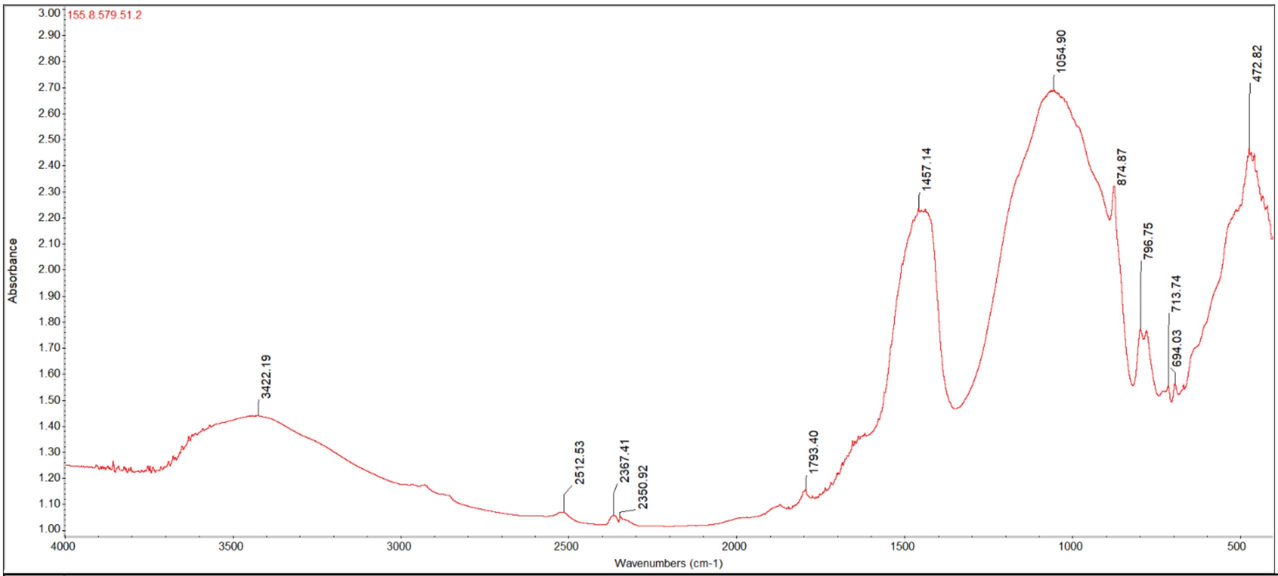





155.11.582.28.2
Absorbance
Wavenumbers (cm-1)
3854.04
3744.71
3421.64
2362.36
1653.60
1636.26
1457.37
1058.71
974.01
916.23
874.03
798.03
668.74
473.24


155.11.582.21
Absorbance
Wavenumbers (cm-1)
3415.56
2928.10
2845.65
2522.43
2377.31
2344.33
1636.77
1457.76
1043.26
874.83
796.46
693.78
457.89


155.10.581.20.2
Absorbance
Wavenumbers (cm-1)
3421.59
2360.69
2347.63
1653.69
1436.94
1054.84
873.38
798.39
713.09
668.62
641.27
469.60


155.8.579.51.2
Absorbance
Wavenumbers (cm-1)
3422.19
2512.53
2367.41
2350.92
1793.40
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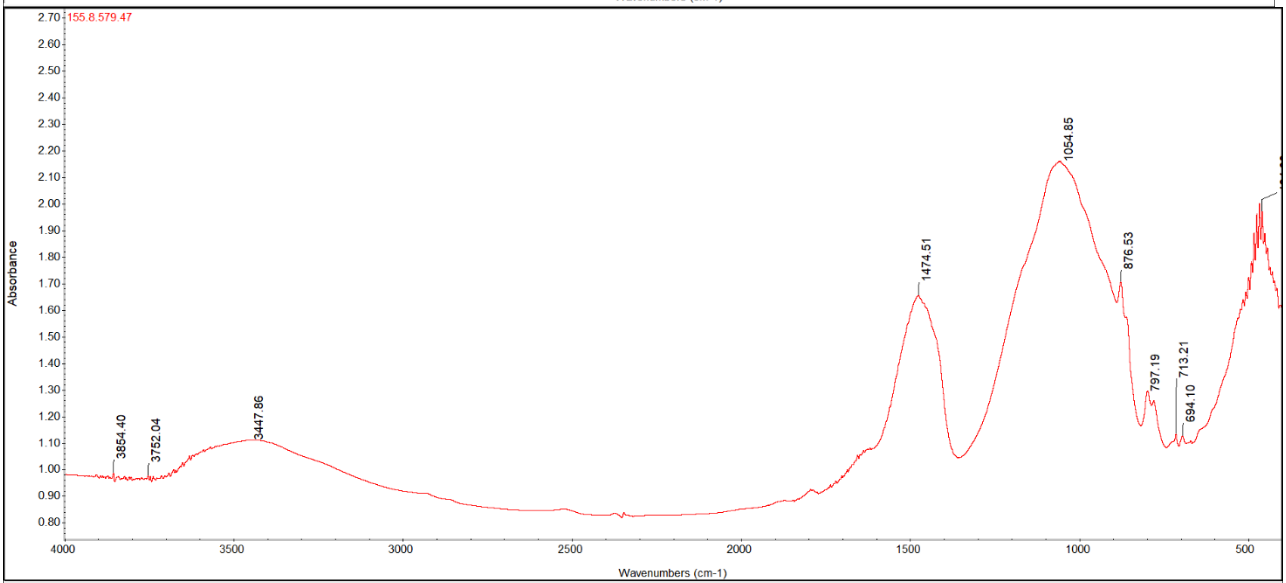
796.75
713.74
694.03
472.82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Absorbance
Wavenumbers (cm-1)
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1474.51
1054.85
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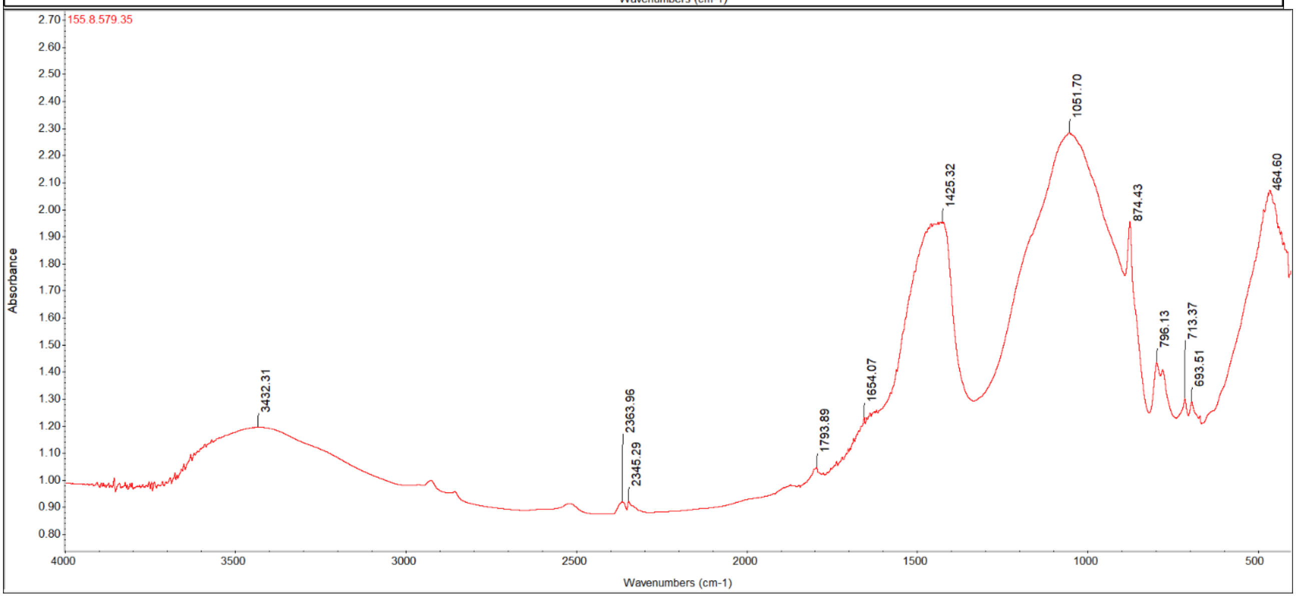
797.19
713.21
694.10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Absorbance
Wavenumbers (cm-1)
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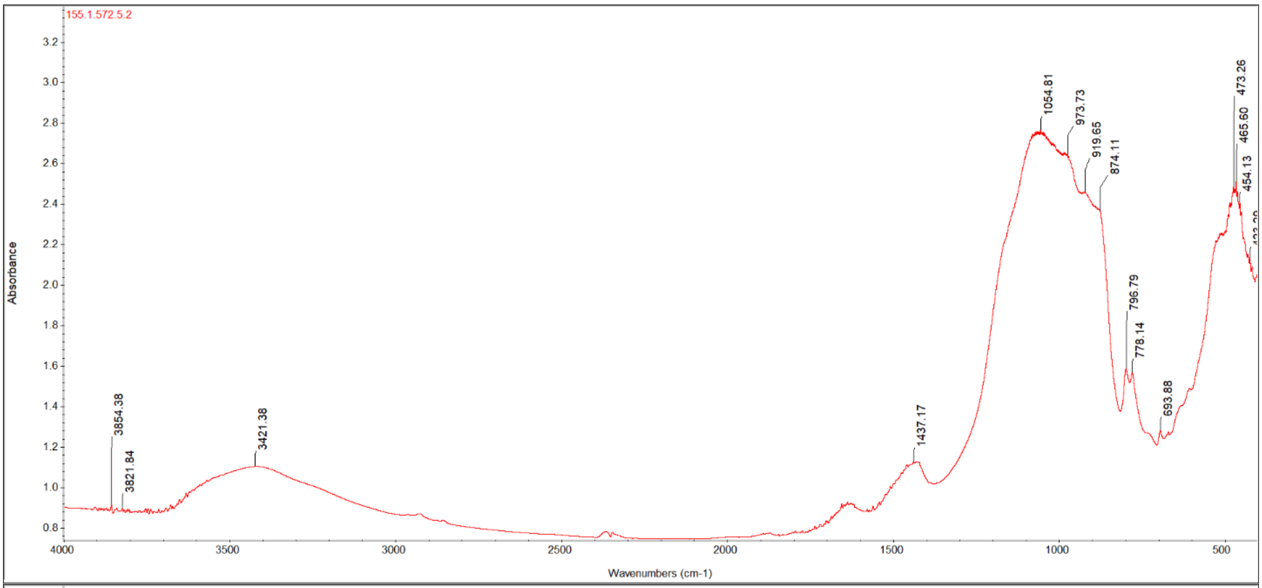
2363.96
2345.29
1793.89
1654.07
1425.32
1051.70
874.43
796.13
713.37
693.51
464.60


155.1.572.5.2
Absorbance
Wavenumbers (cm-1)
3854.38
3821.84
3421.38
1437.17
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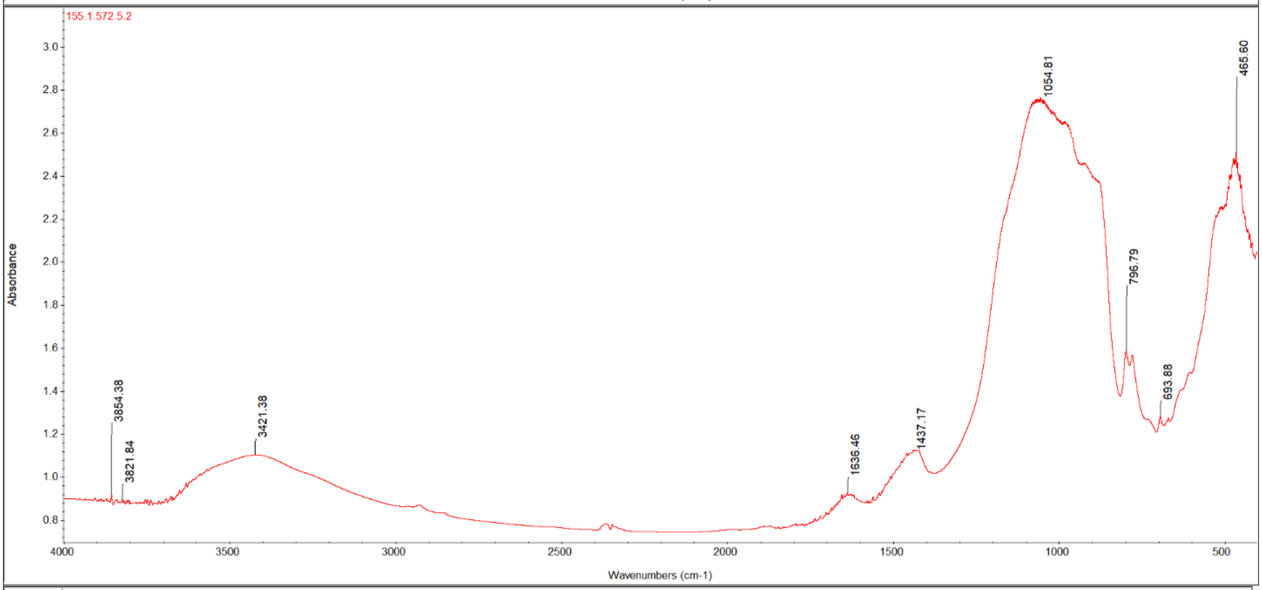
973.73
919.65
874.11
796.79
778.14
693.88
473.26
465.60
454.13


155.1.572.5.2
Absorbance
Wavenumbers (cm-1)
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3821.84
3421.38
1636.46
1437.17
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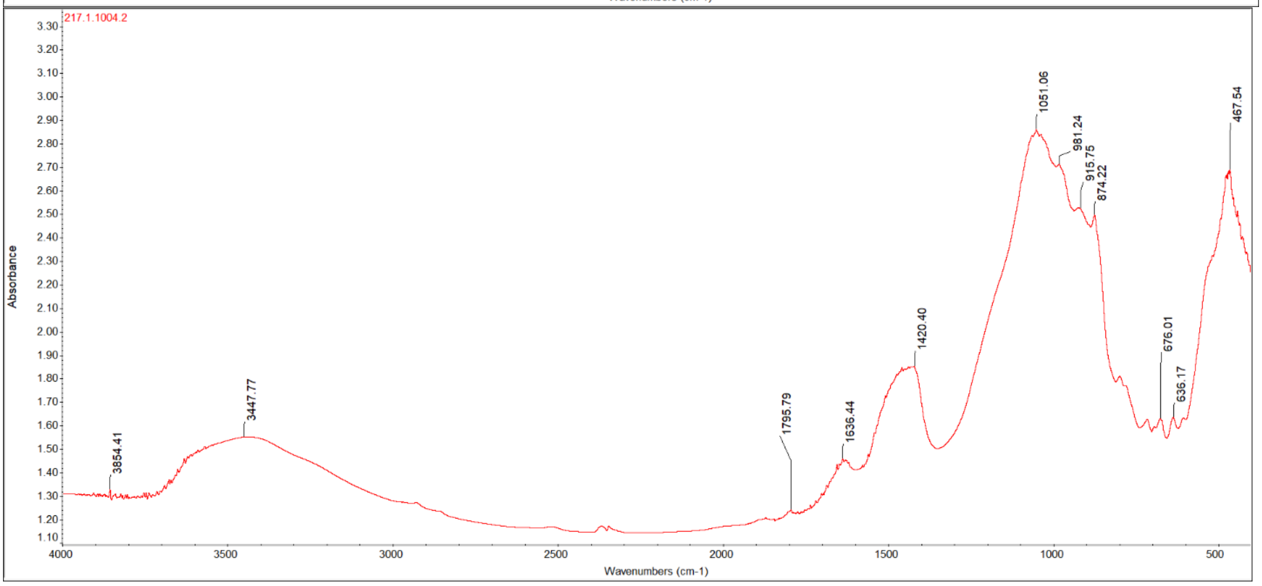
796.79
693.88
465.60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Absorbance
Wavenumbers (cm-1)
3854.41
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1636.44
1420.40
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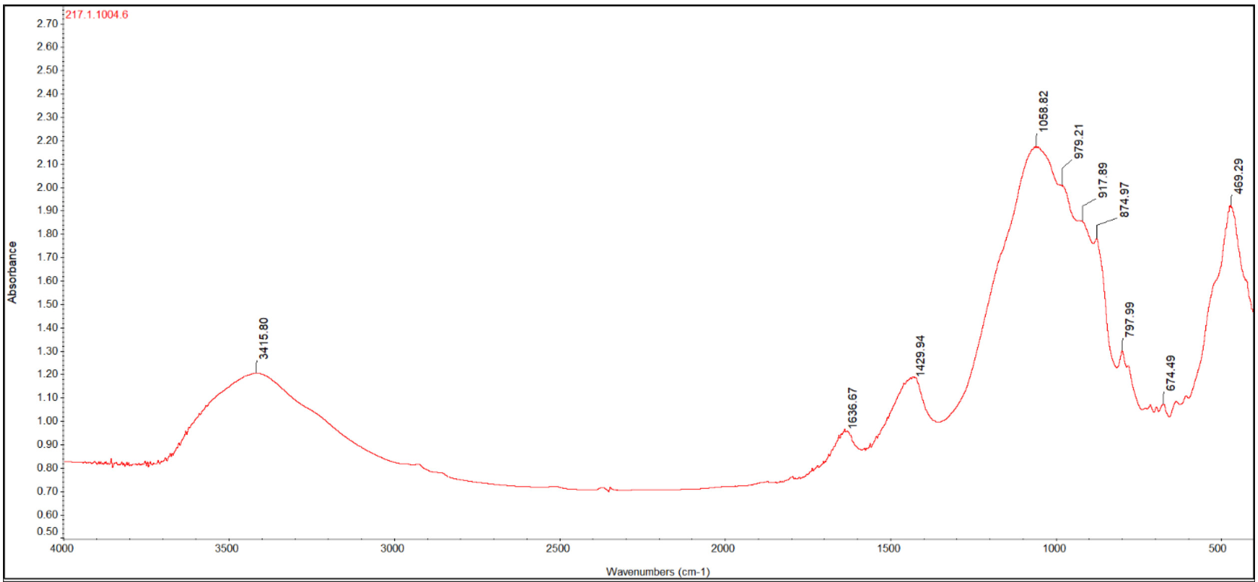
981.24
915.75
874.22
676.01
636.17
467.54


217.1.1004.6
Absorbance
Wavenumbers (cm-1)
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1636.67
1429.94
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979.21
917.89
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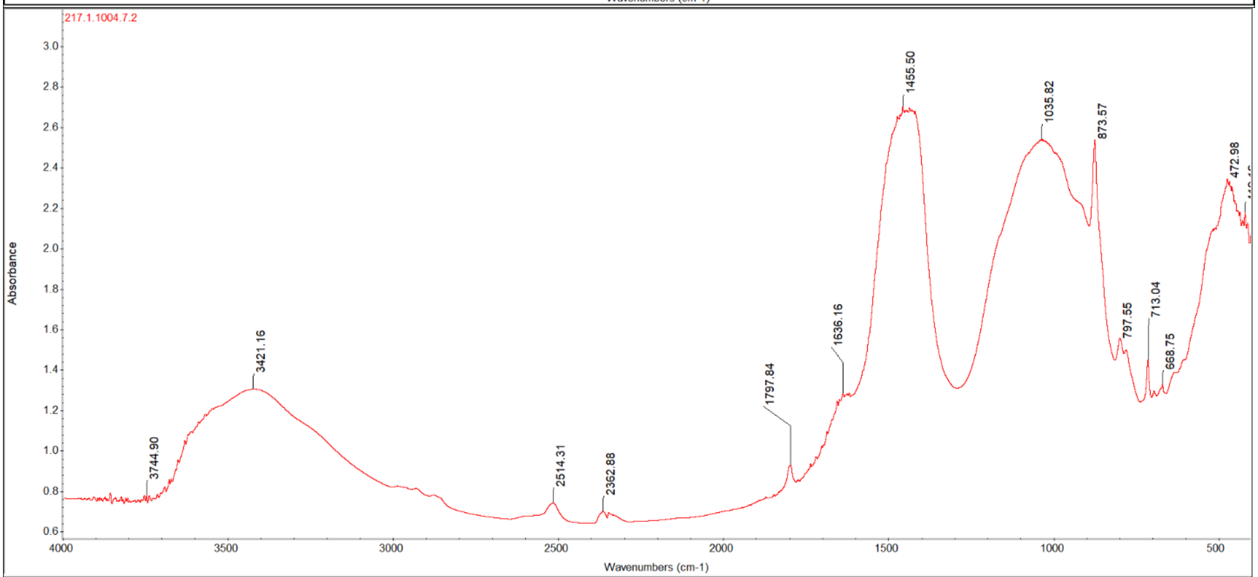
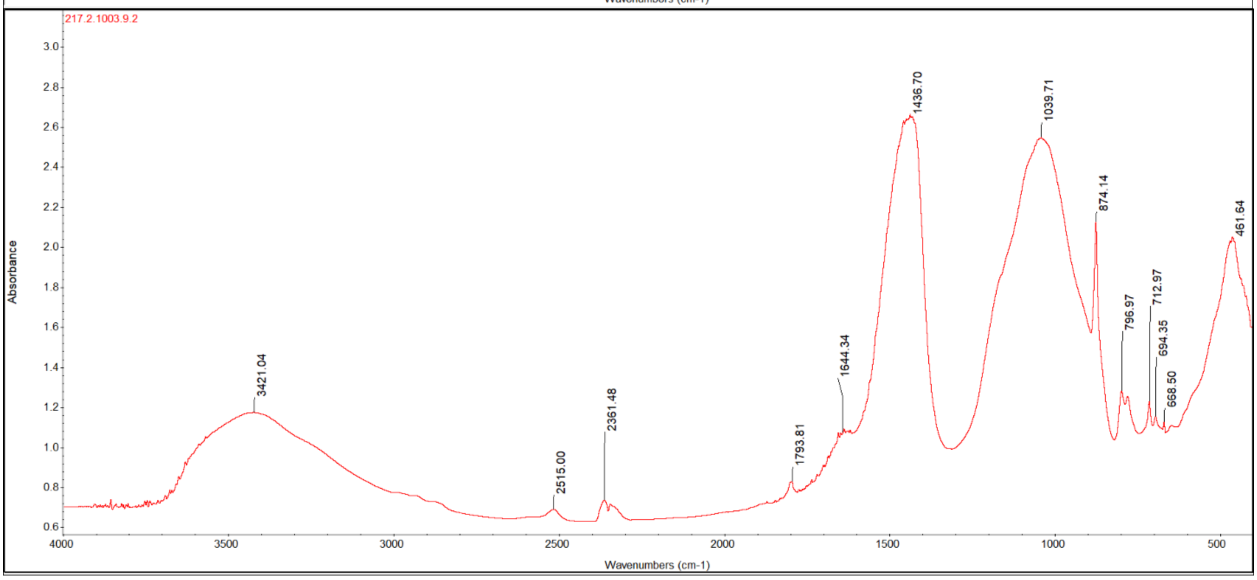
674.49
469.29


217.1.1004.7.2
Absorbance
Wavenumbers (cm-1)
3744.90
3421.16
2514.31
2362.88
1797.84
1636.16
1455.50
1035.82
873.57
797.55
713.04
668.75
472.98


217.2.1003.9.2
Absorbance
Wavenumbers (cm-1)
3421.04
2515.00
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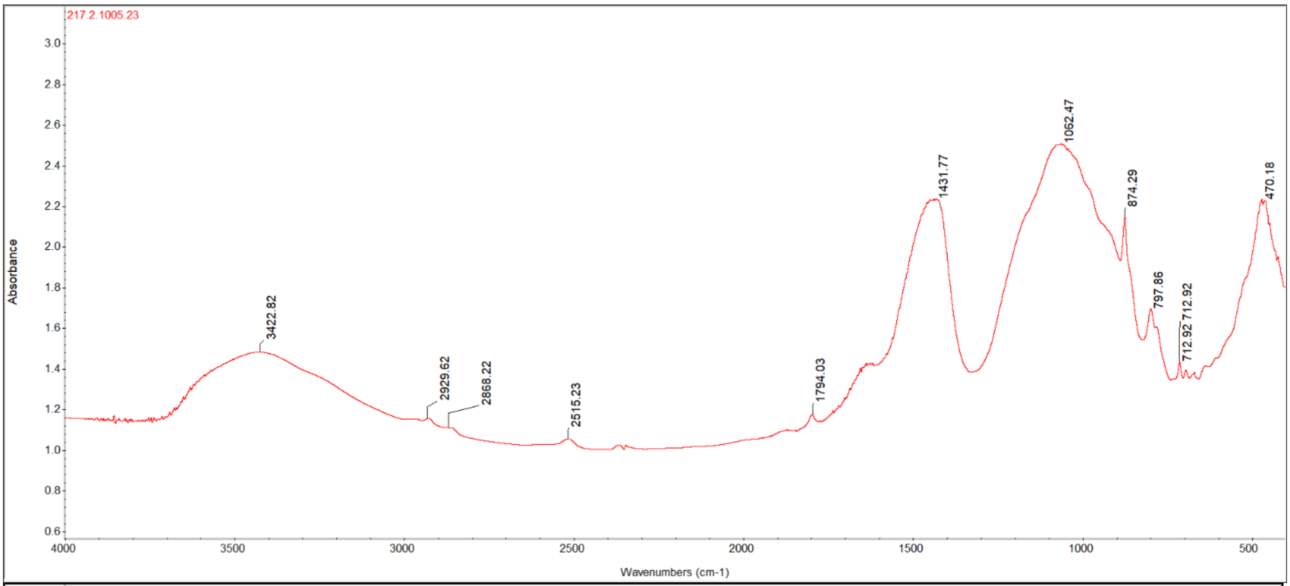
1436.70
1039.71
874.14
796.97
712.97
694.35
668.50
461.64


217.2.1005.23
Absorbance
Wavenumbers (cm-1)
3422.82
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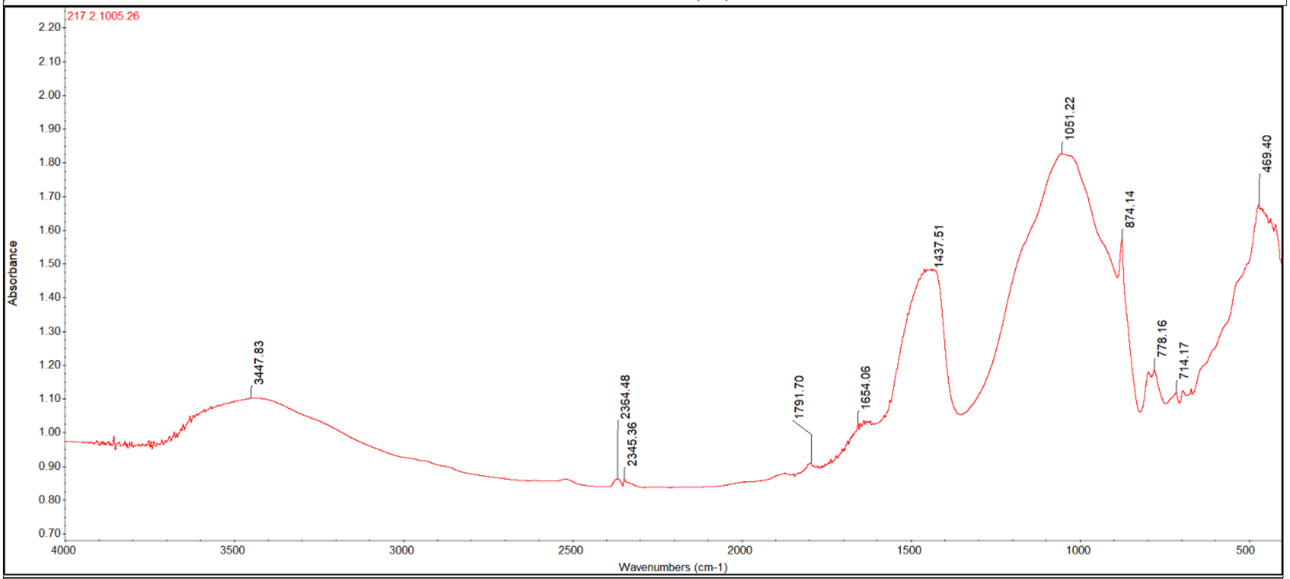
874.29
797.86
712.92
712.92
470.18


217.2.1005.26
Absorbance
Wavenumbers (cm-1)
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1437.51
1051.22
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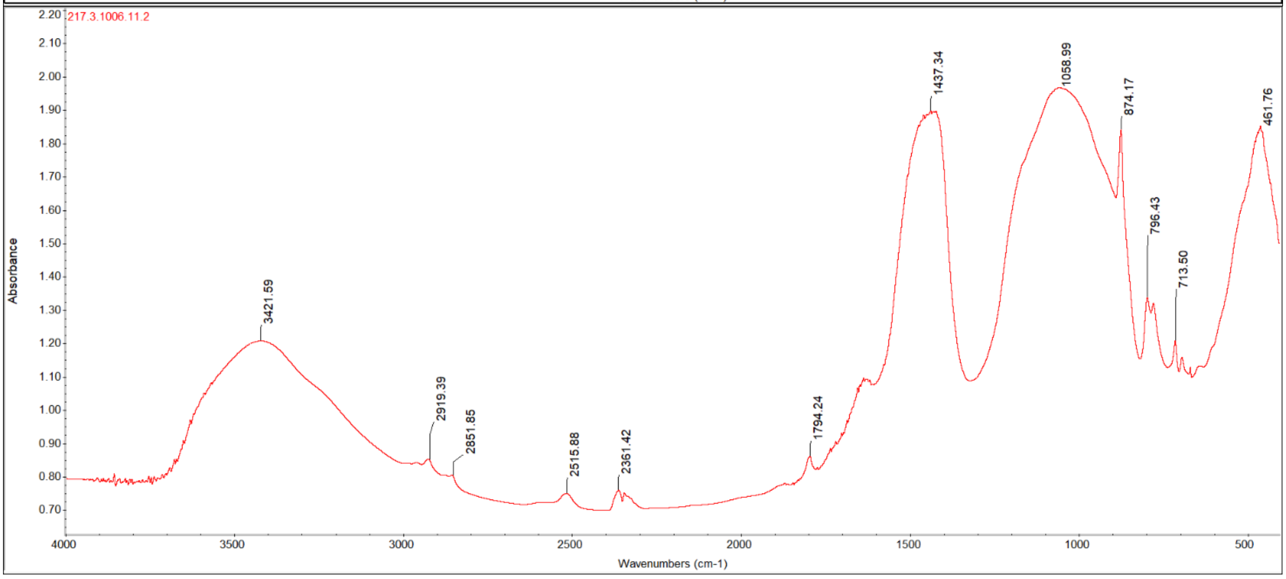
778.16
714.17
469.40


217.3.1006.11.2
Absorbance
Wavenumbers (cm-1)
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2515.88
2361.42
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1437.34
1058.99
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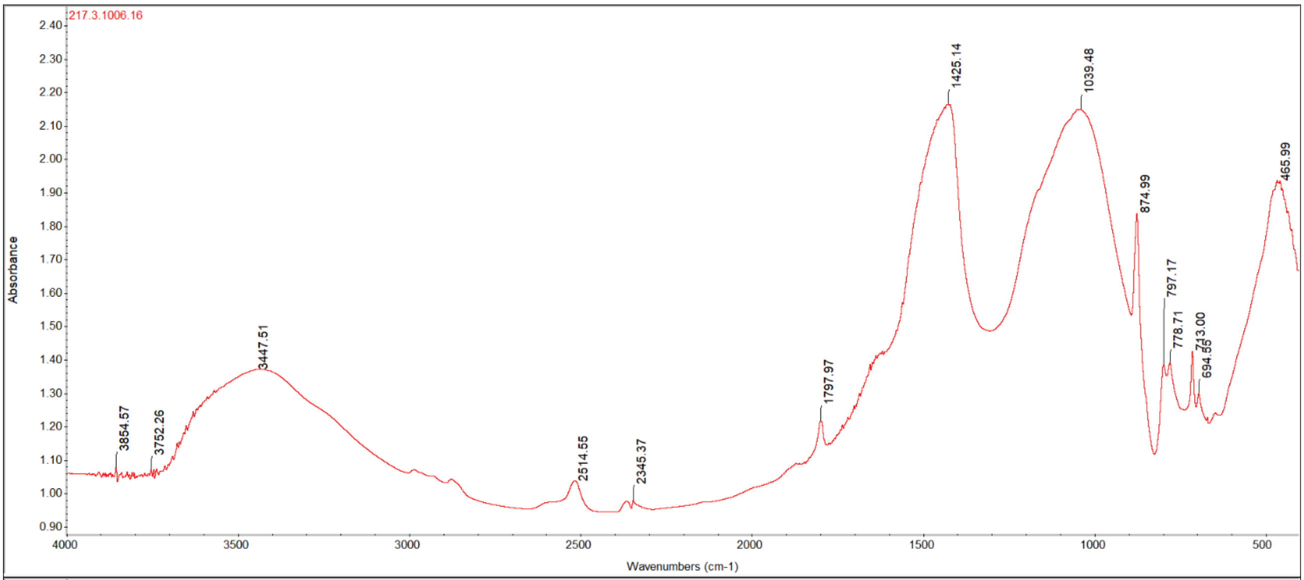
796.43
713.50
461.76


217.3.1006.16
Absorbance
Wavenumbers (cm-1)
3854.57
3752.26
3447.51
2514.55
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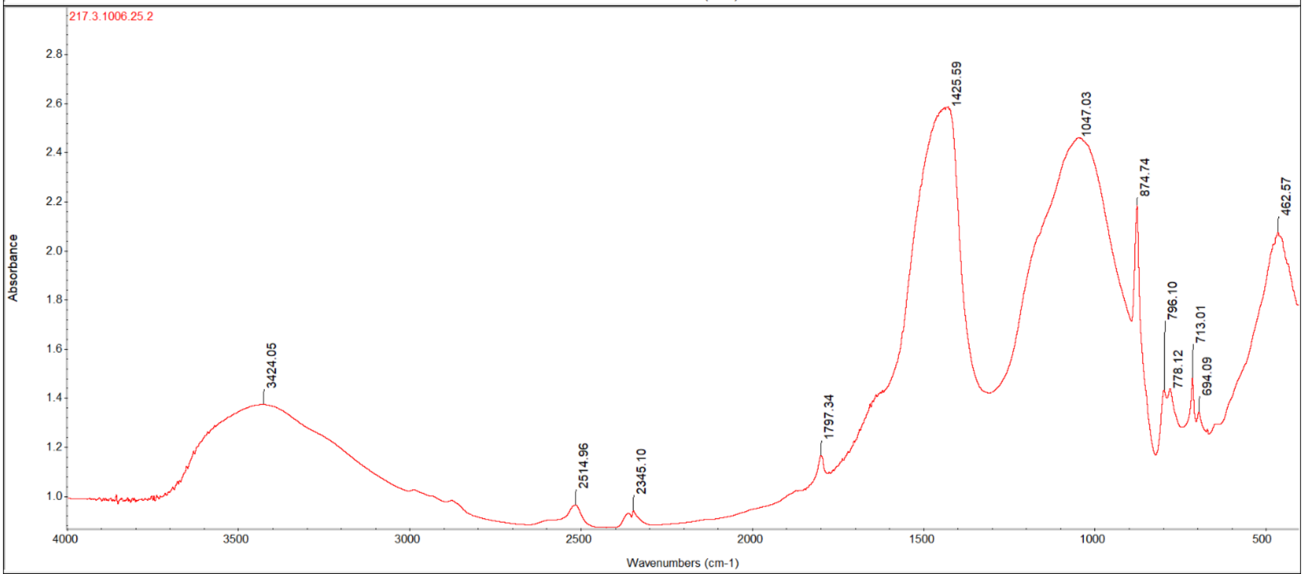
1797.97
1425.14
1039.48
874.99
797.17
778.71
713.00
694.55
465.99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Absorbance
Wavenumbers (cm-1)
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1797.34
1425.59
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874.74
796.10
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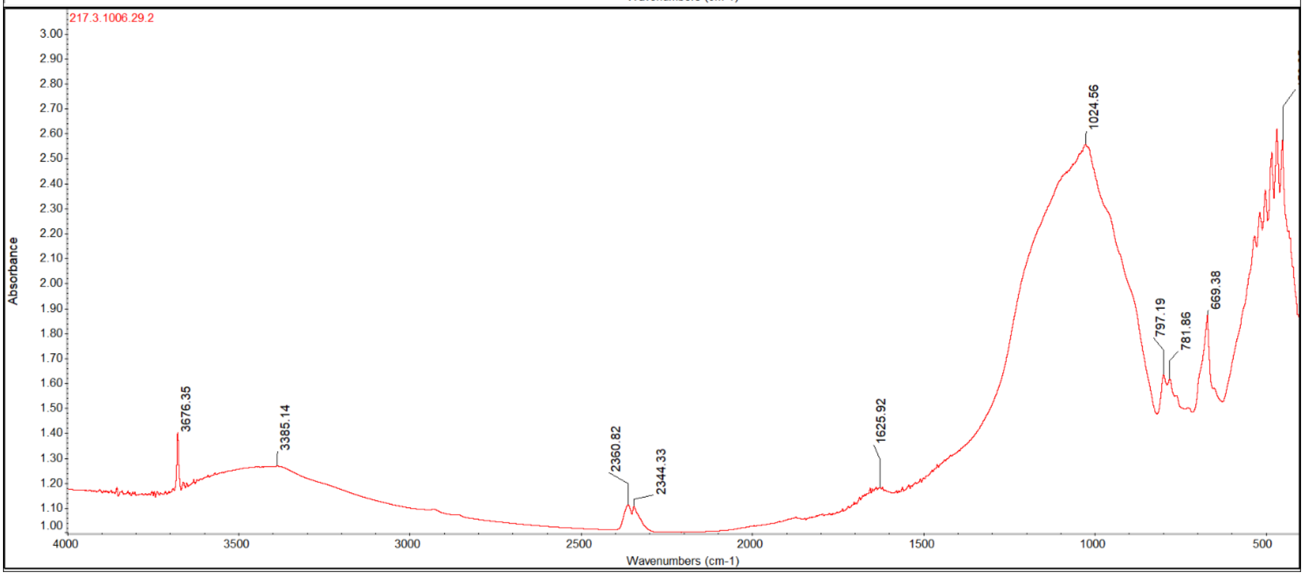
713.01
694.09
462.57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Absorbance
Wavenumbers (cm-1)
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2344.33
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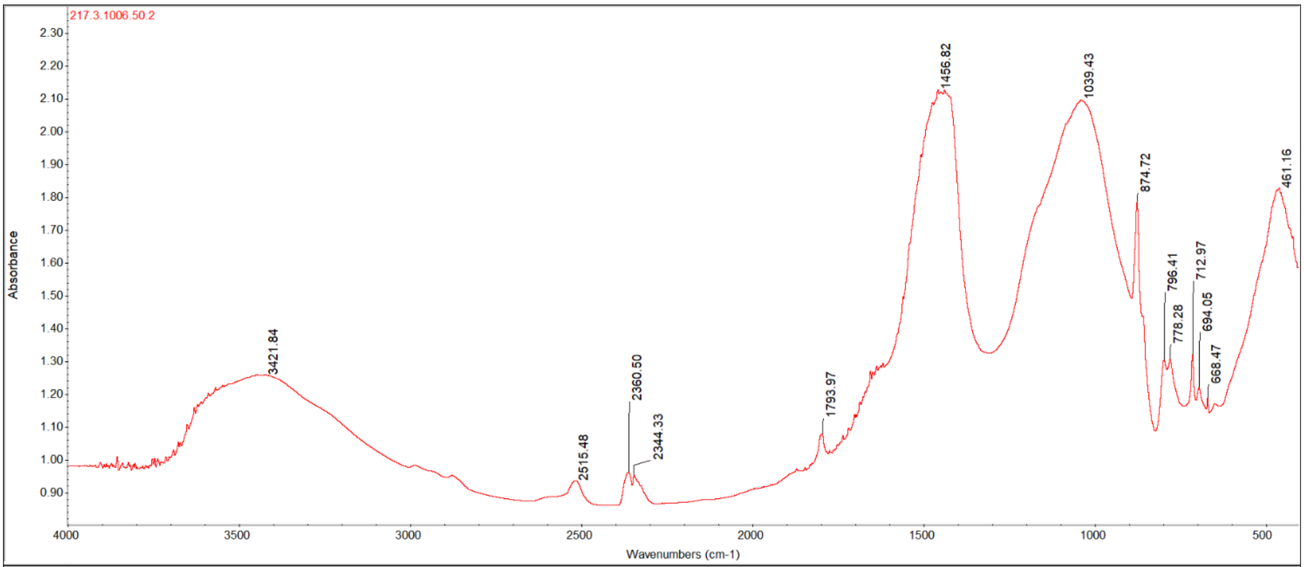
797.19
781.86
669.38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Absorbance
Wavenumbers (cm-1)
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2360.50
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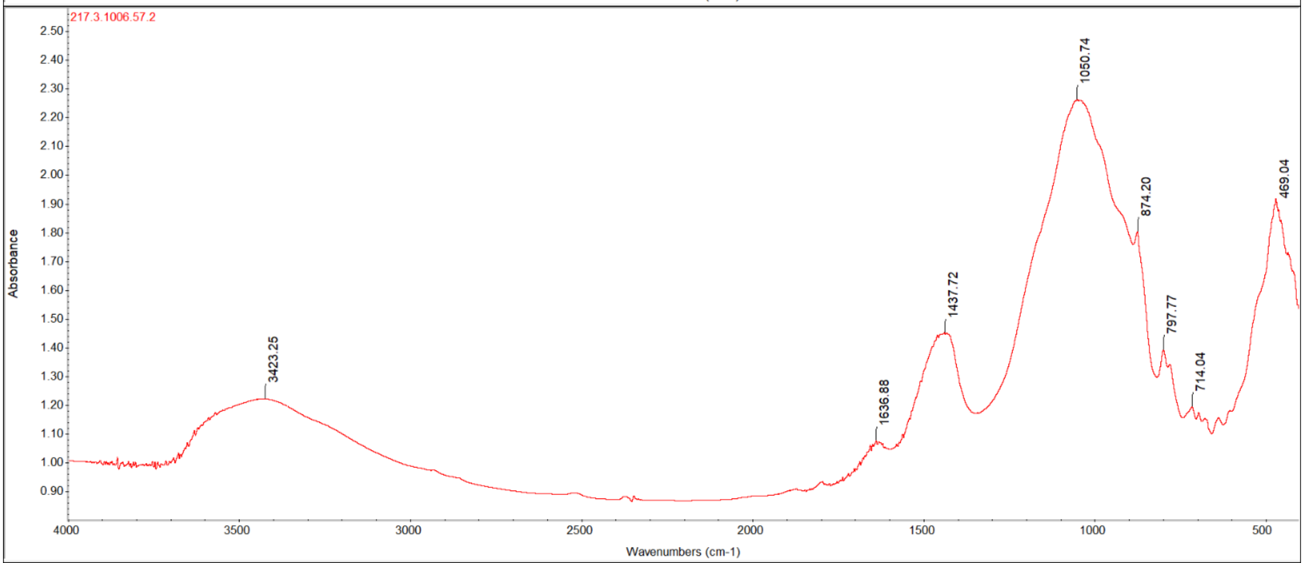
694.05
668.47
461.16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Absorbance
Wavenumbers (cm-1)
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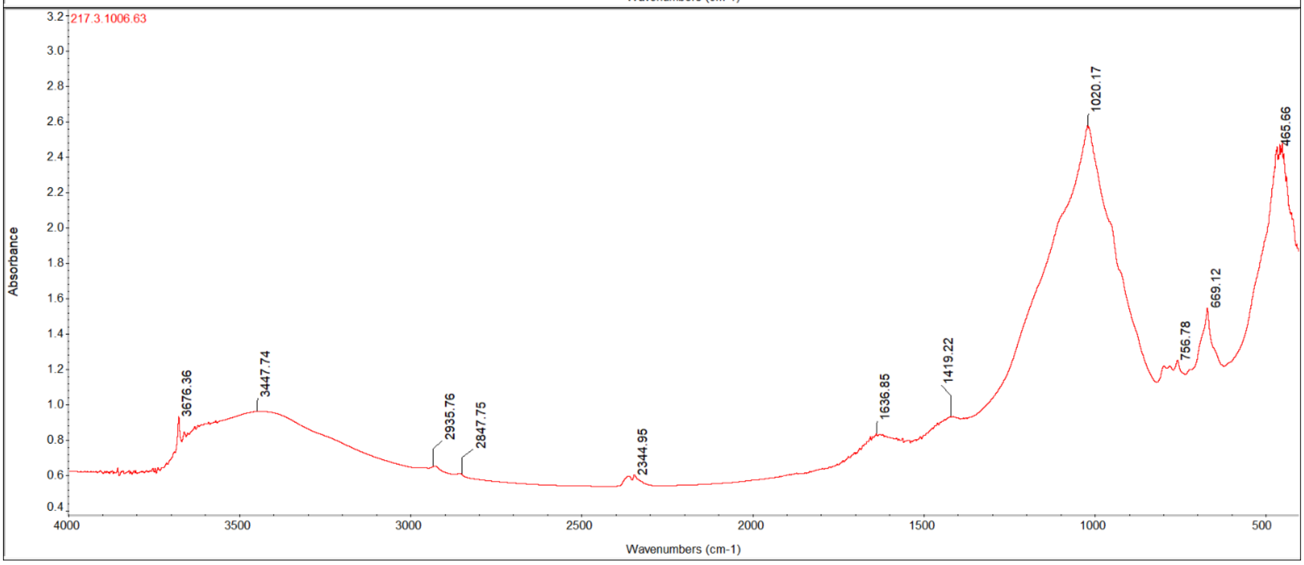
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Absorbance
Wavenumbers (cm-1)
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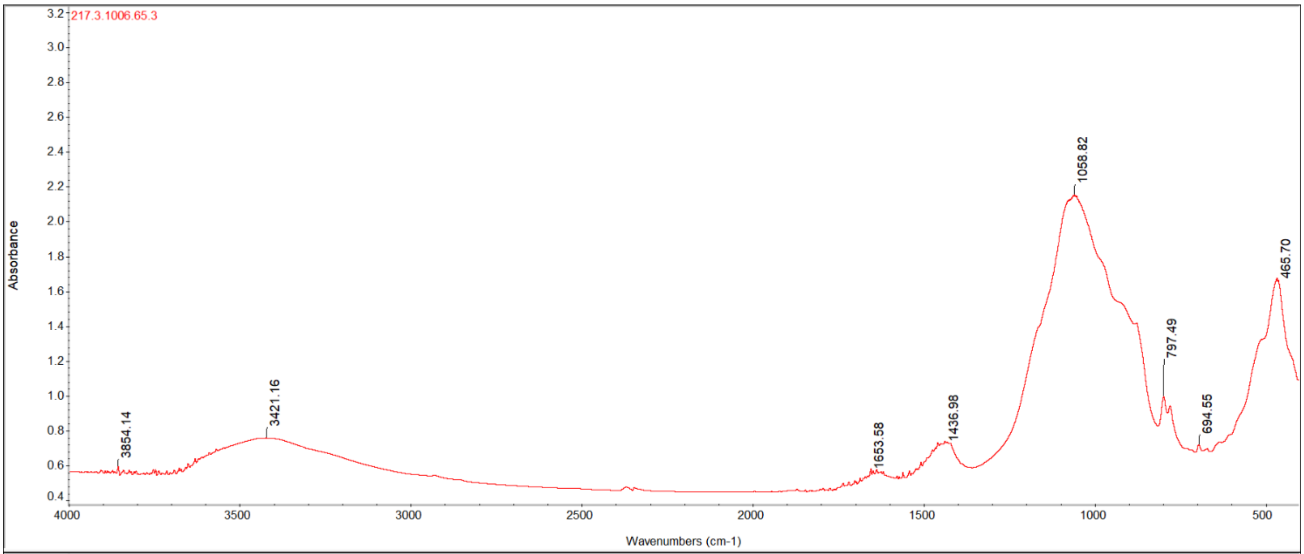
669.12
465.66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Absorbance
Wavenumbers (cm-1)
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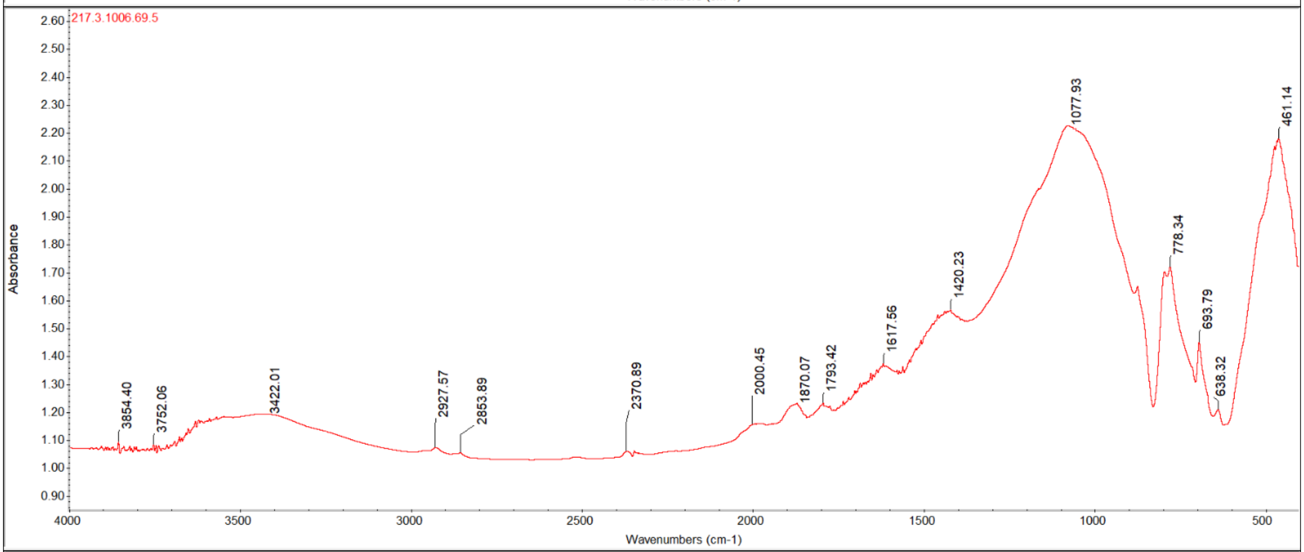
1436.98
1058.82
797.49
694.55
465.70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Wavenumbers (cm-1)
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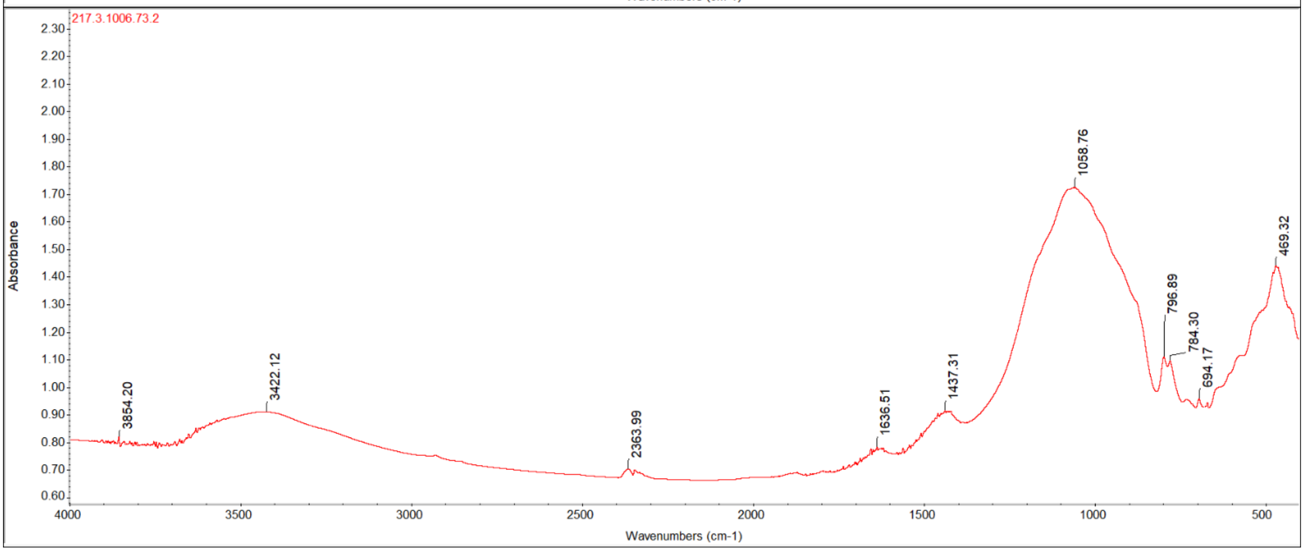
638.32
461.14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Absorbance
Wavenumbers (cm-1)
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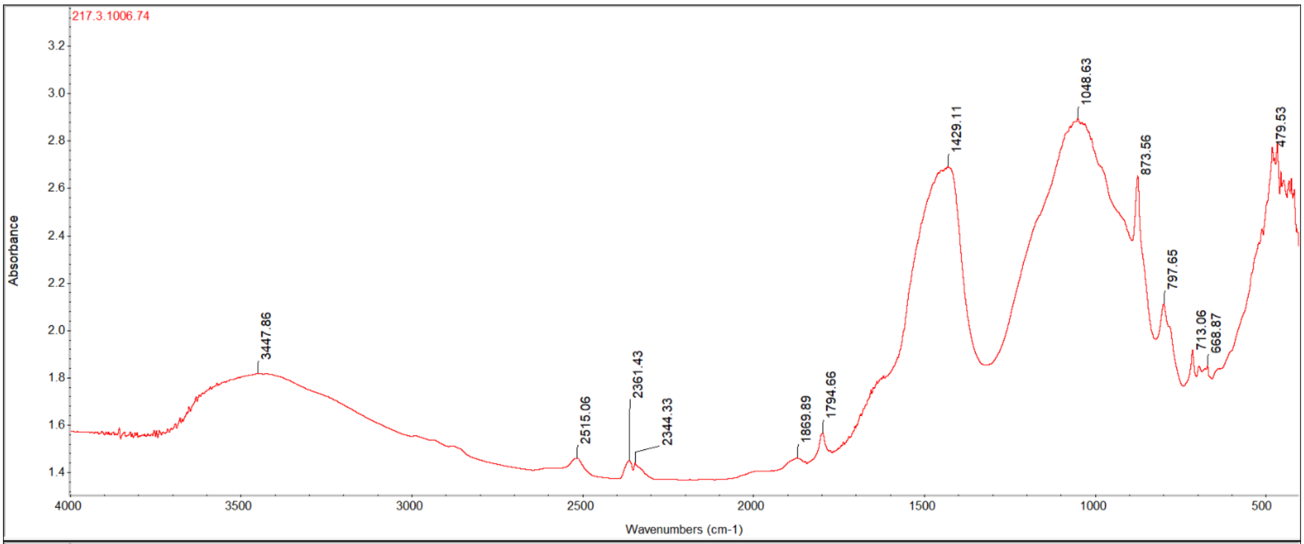
469.32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1.4
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2515.06
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1869.89
1794.66
1429.11
1048.63
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668.87
479.53
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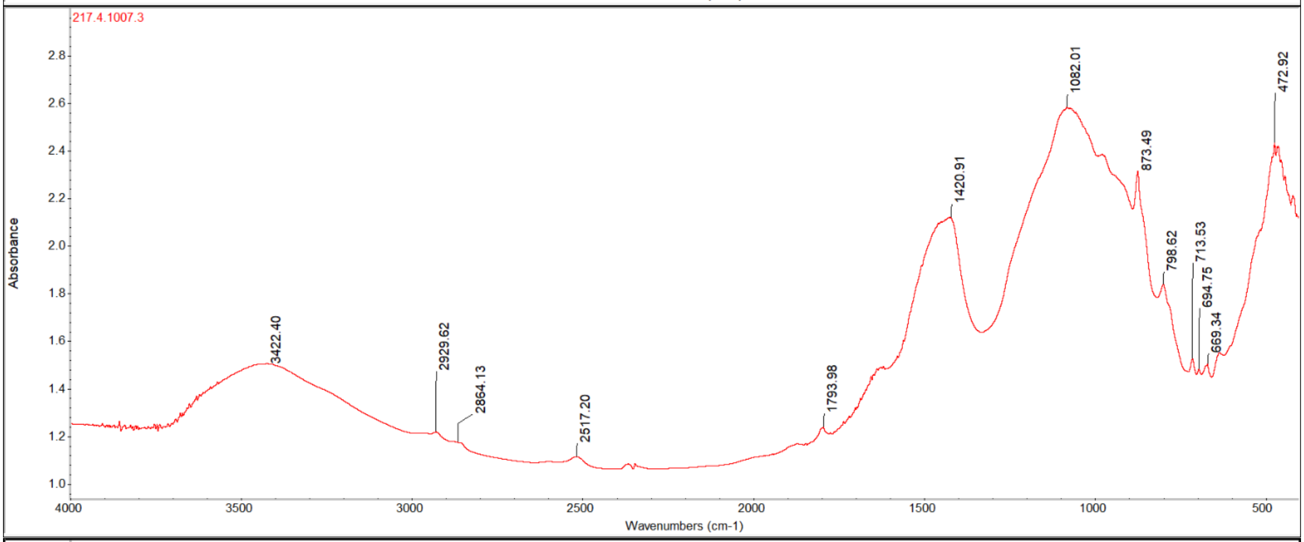
3500
3000
2500
2000
1500
1000
500
Wavenumbers (cm-1)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1.6
1.4
1.2
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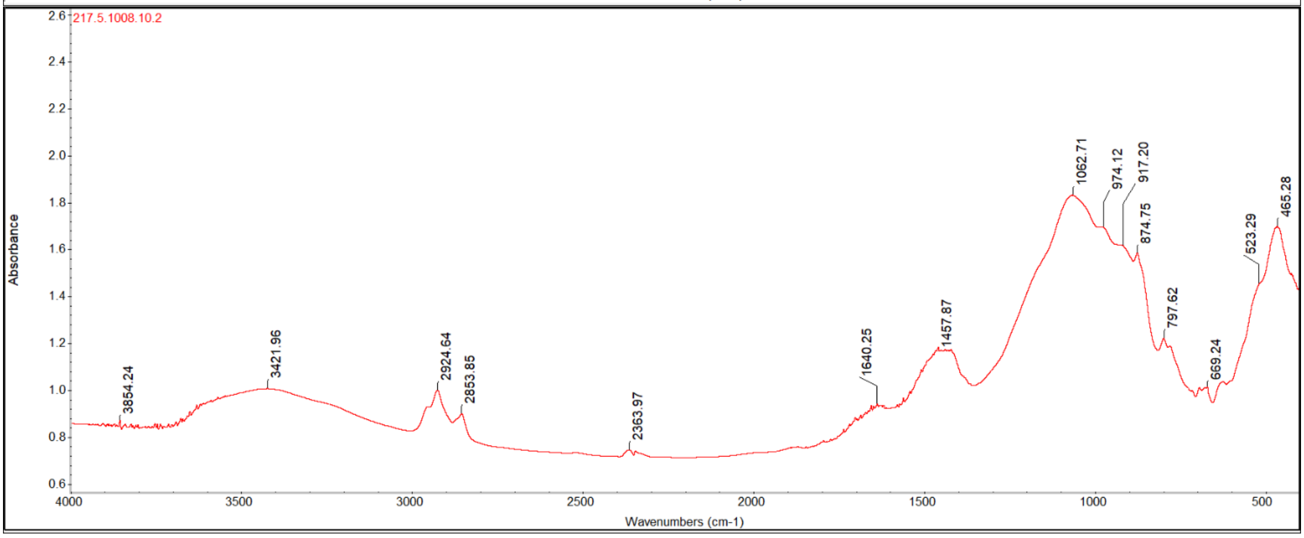
3422.40
2929.62
2864.13
2517.20
1793.98
1420.91
1082.01
873.49
798.62
713.53
694.75
669.34
472.92
4000
3500
3000
2500
2000
1500
1000
500
Wavenumbers (cm-1)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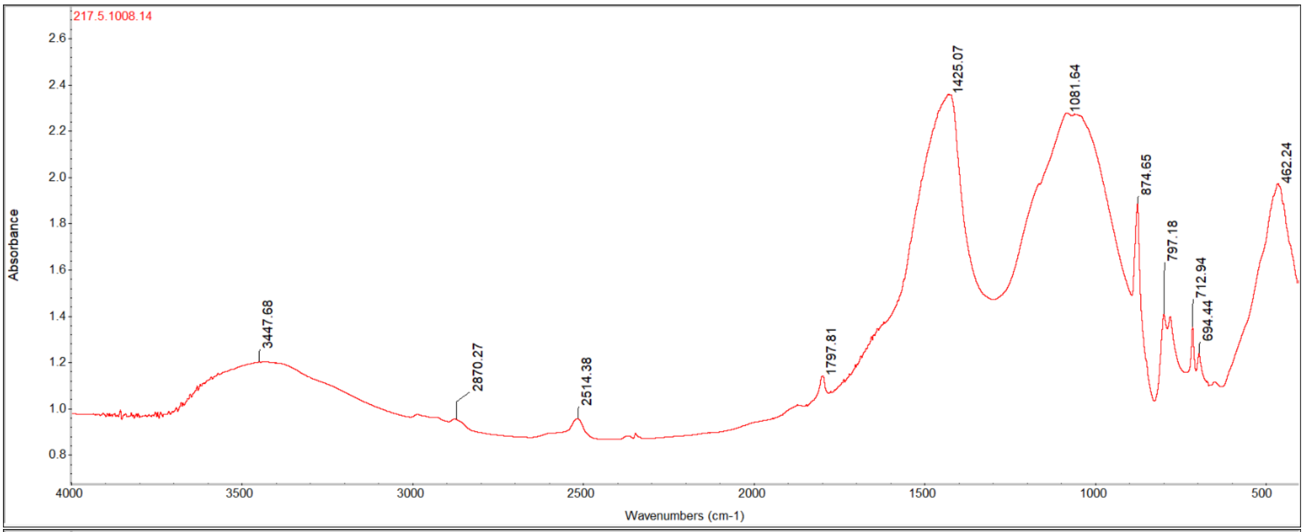
1.8
1.6
1.4
1.2
1.0
0.8
0.6
3854.24
3421.96
2924.64
2853.85
2363.97
1640.25
1457.87
1062.71
974.12
917.20
874.75
797.62
669.24
523.29
465.28
4000
3500
3000
2500
2000
1500
1000
500
Wavenumbers (cm-1)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Absorbance
Wavenumbers (cm-1)
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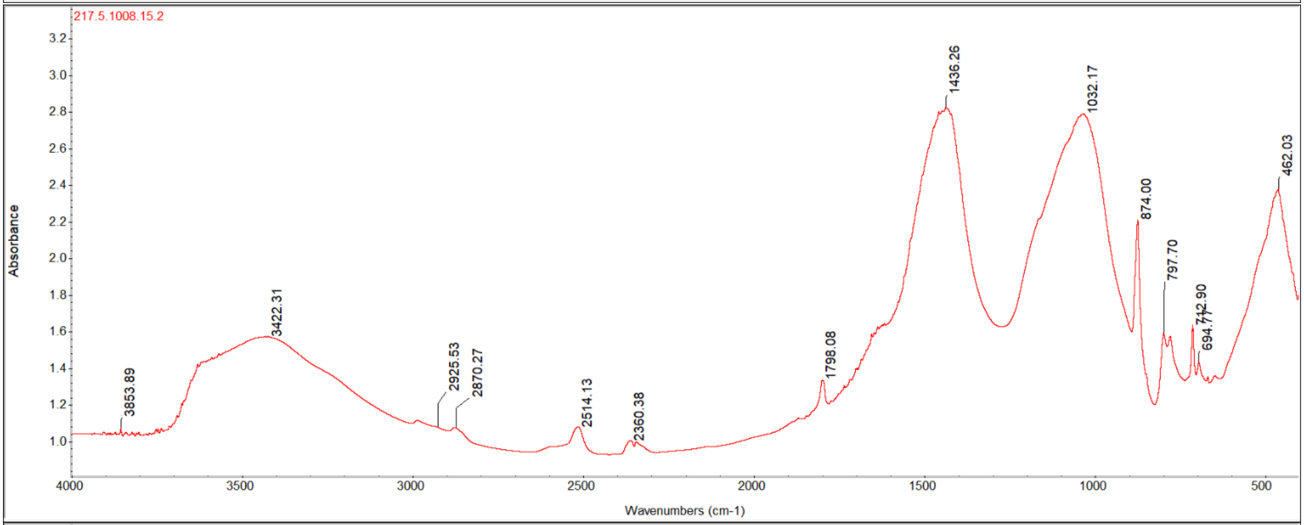
462.24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Absorbance
Wavenumbers (cm-1)
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2925.53
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1798.08
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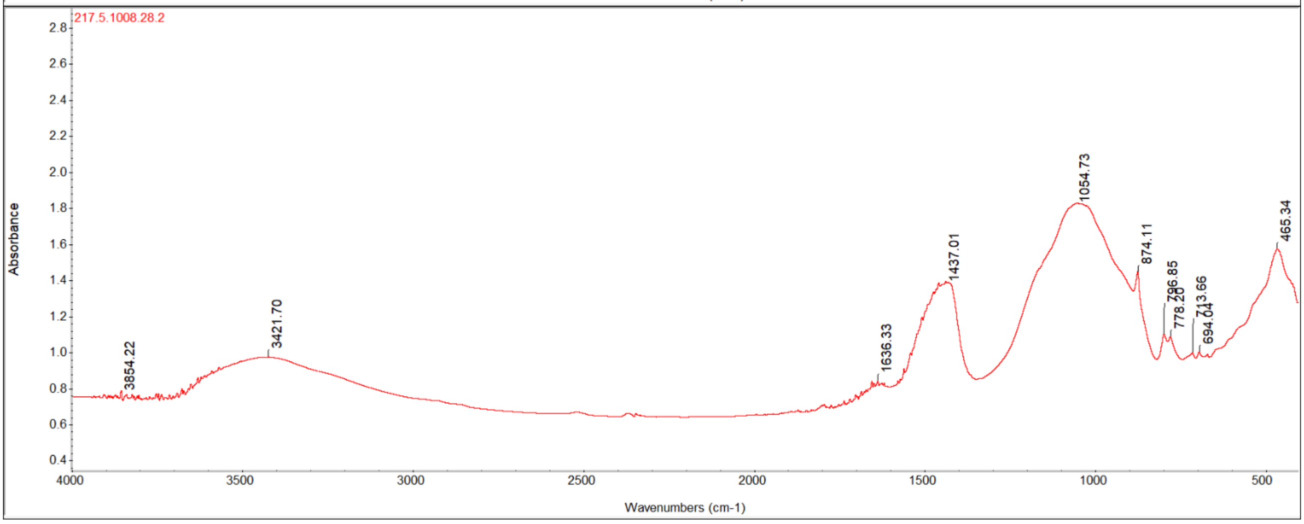
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Absorbance
Wavenumbers (cm-1)
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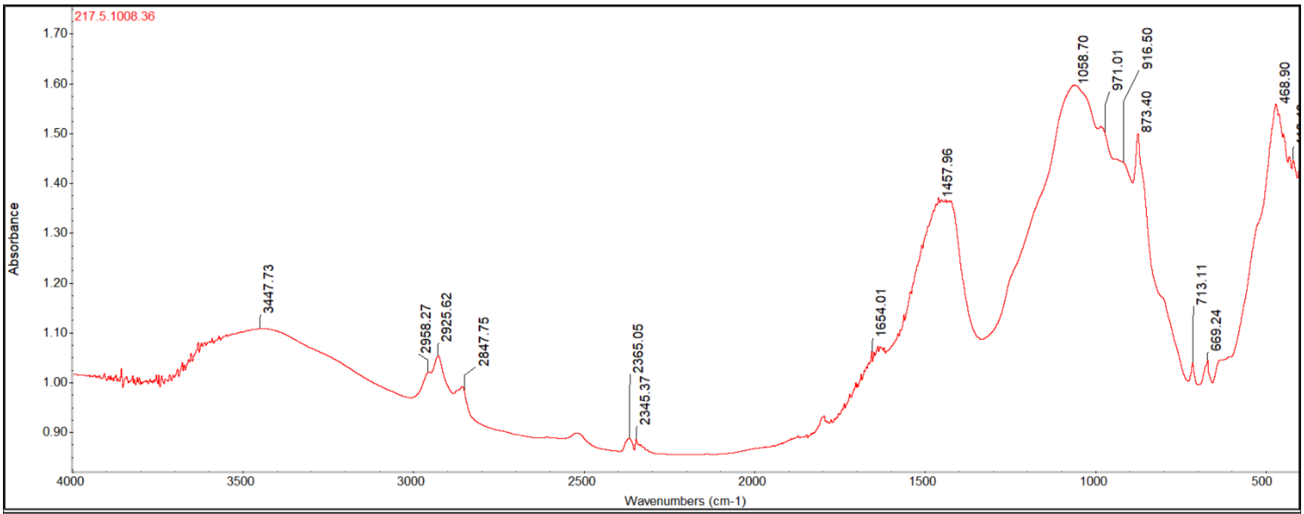
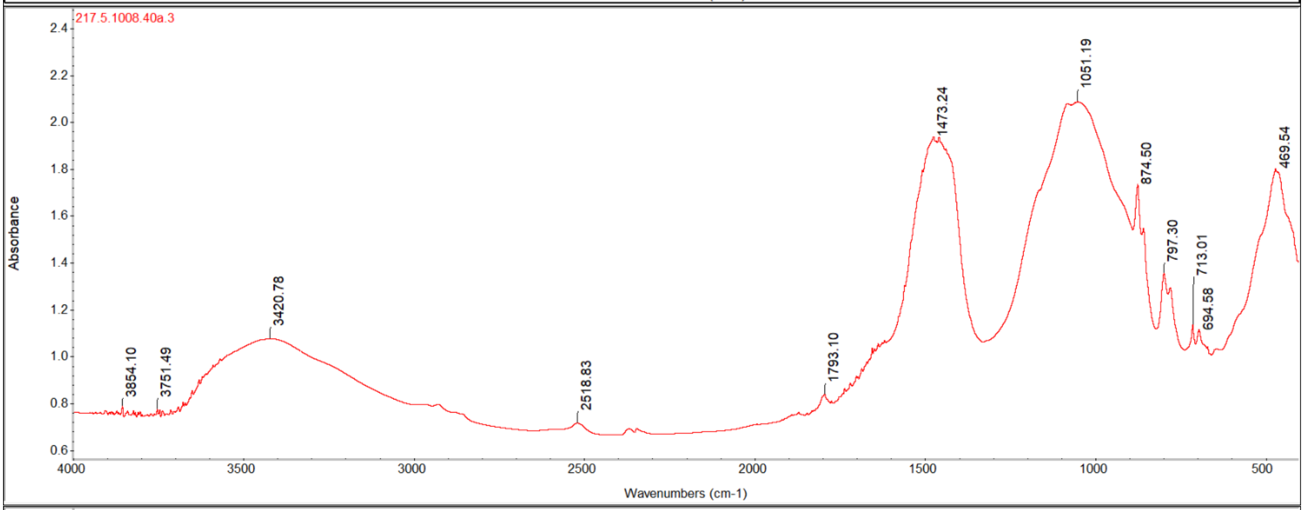
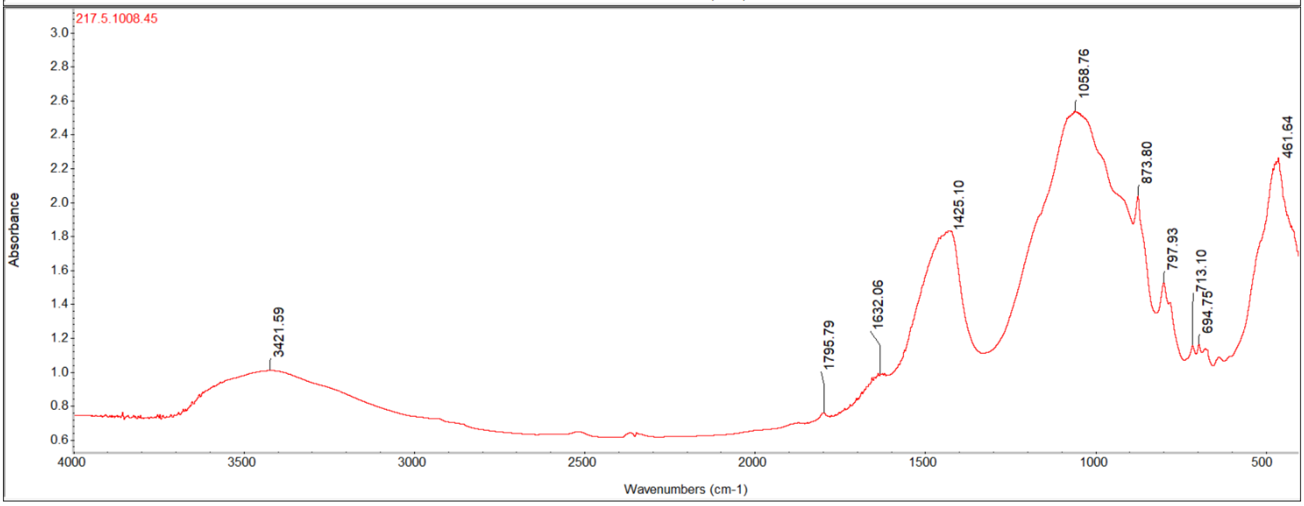
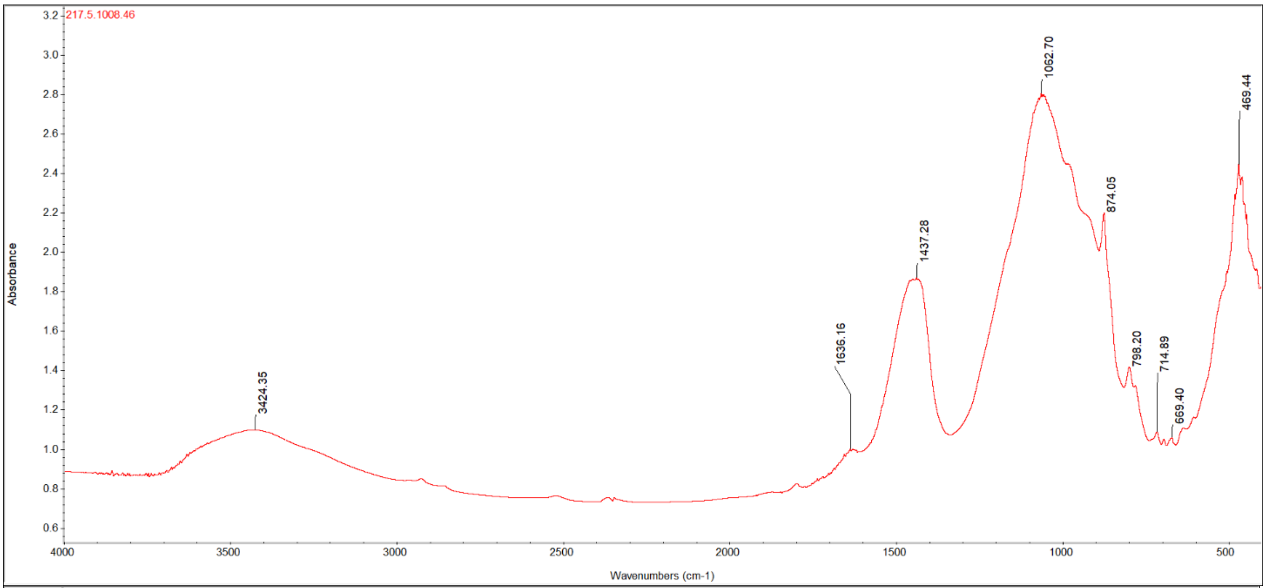
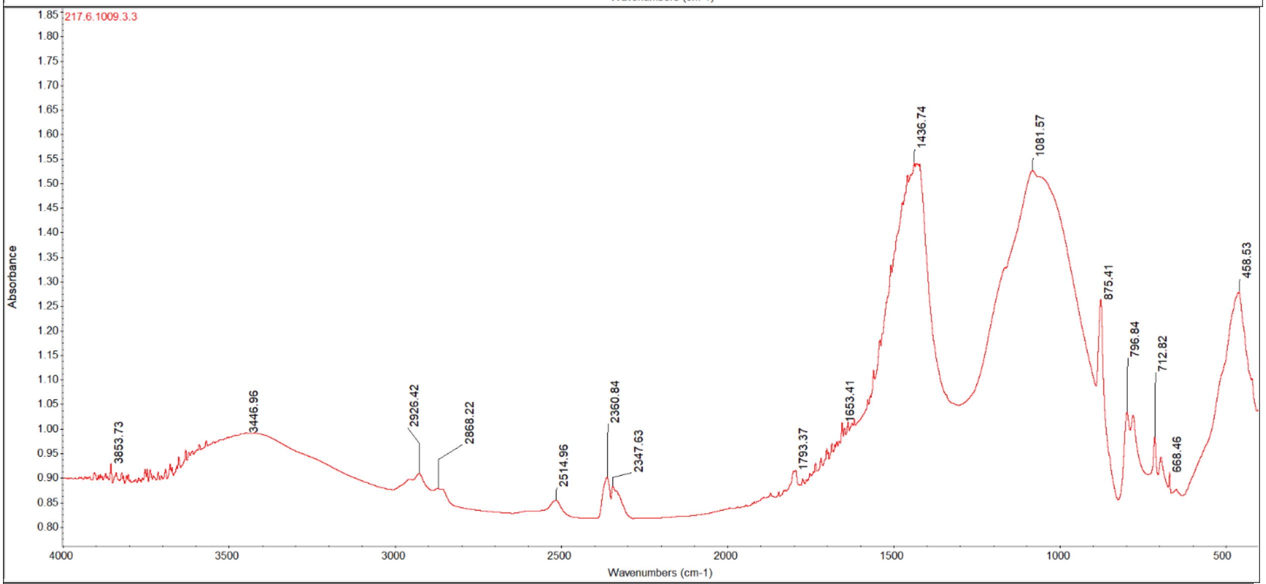
796.85
778.20
713.66
694.04
465.34

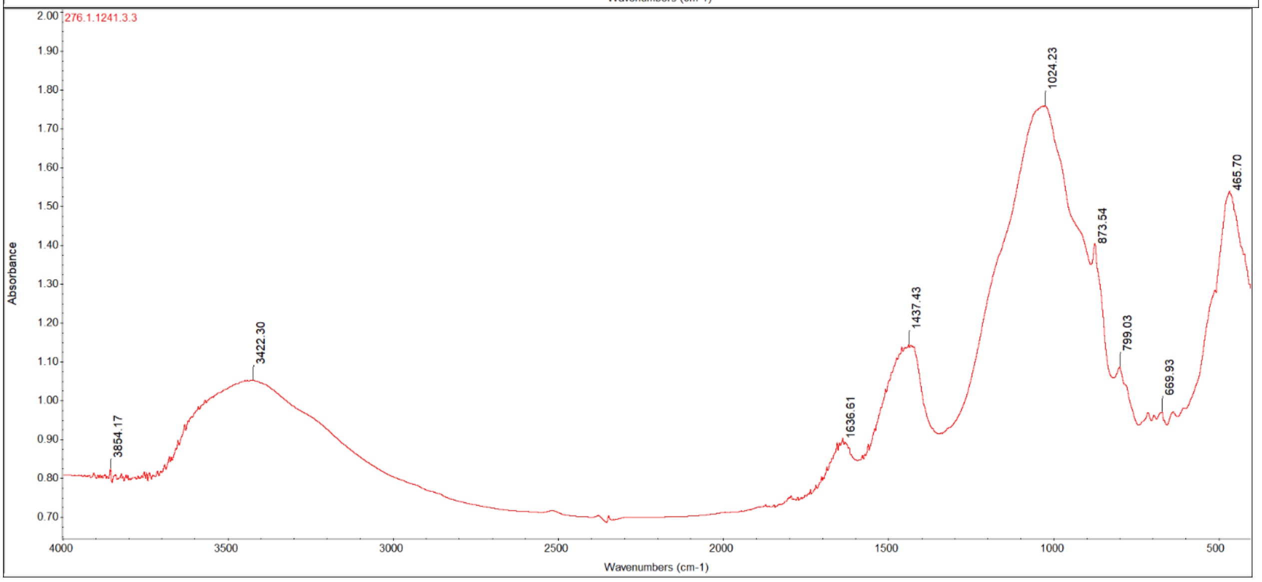

217.5.1008.36
Absorbance
Wavenumbers (cm-1)
3447.73
2958.27
2925.62
2847.75
2365.05
2345.37
1654.01
1457.96
1058.70
971.01
916.50
873.40
713.11
669.24
468.90

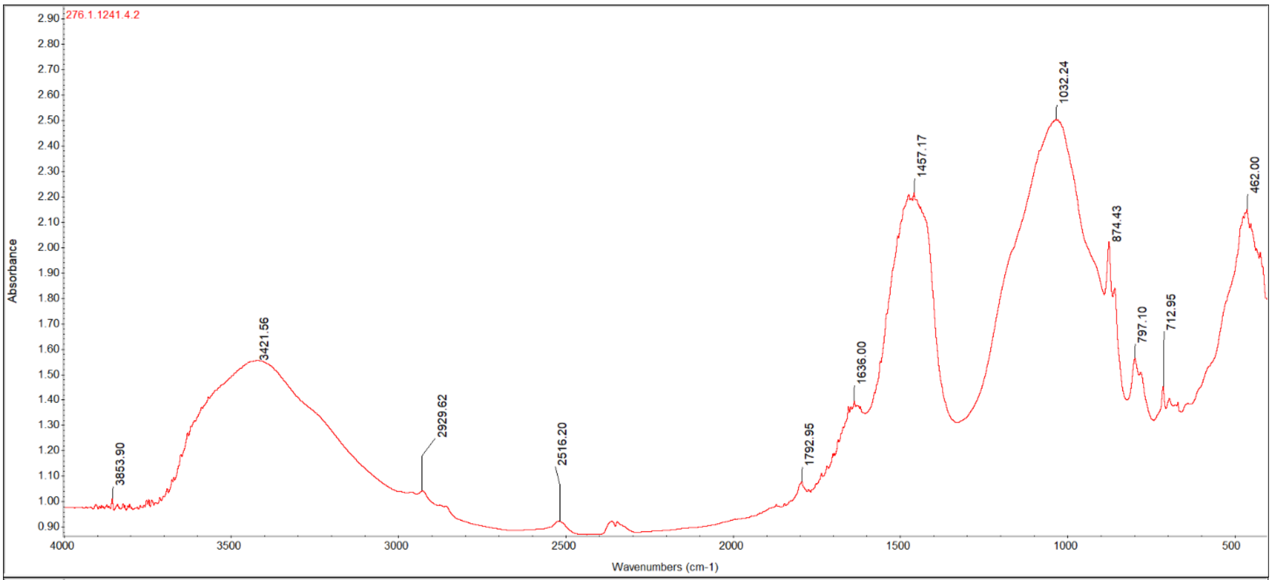

217.5.1008.40a.3
Absorbance
Wavenumbers (cm-1)
3854.10
3751.49
3420.78
2518.83
1793.10
1473.24
1051.19
874.50
797.30
713.01
694.58
469.54

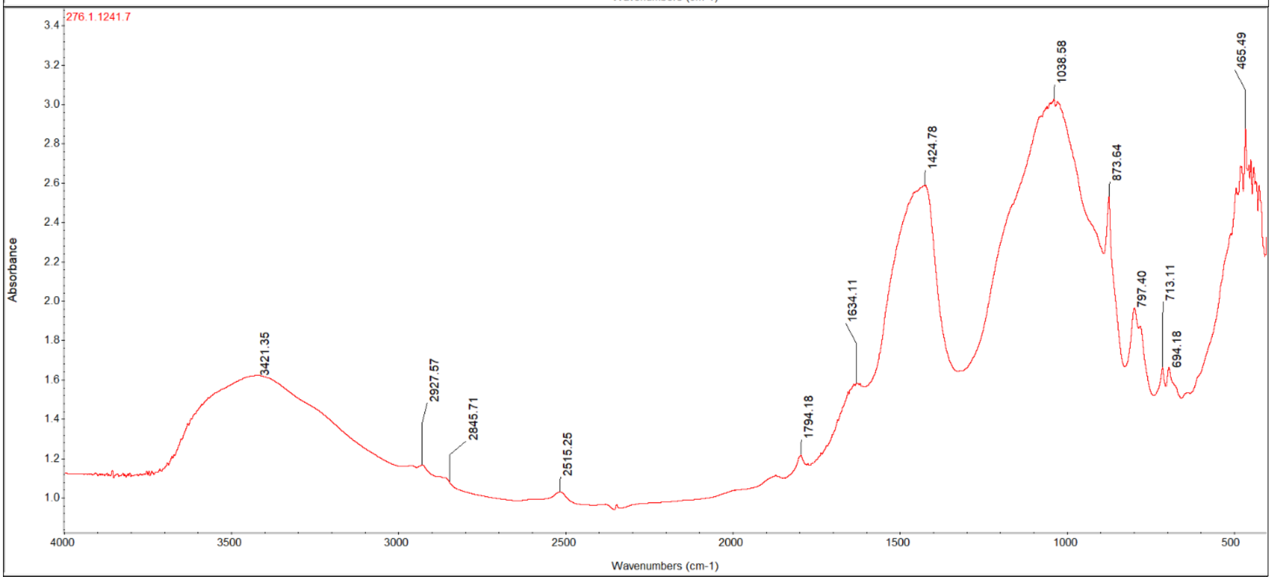

217.5.1008.45
Absorbance
Wavenumbers (cm-1)
3421.59
1795.79
1632.06
1425.10
1058.76
873.80
797.93
713.10
694.75
461.64

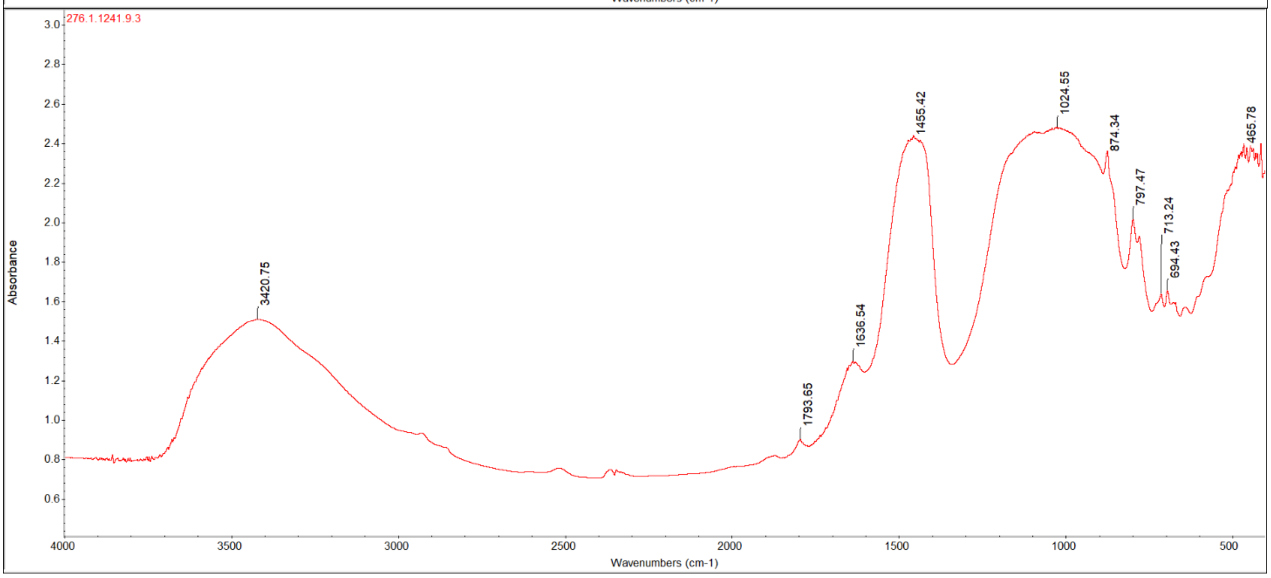

217.5.1008.46
Absorbance
Wavenumbers (cm-1)
3424.35
1636.16
1437.28
1062.70
874.05
798.20
714.89
669.40
469.44

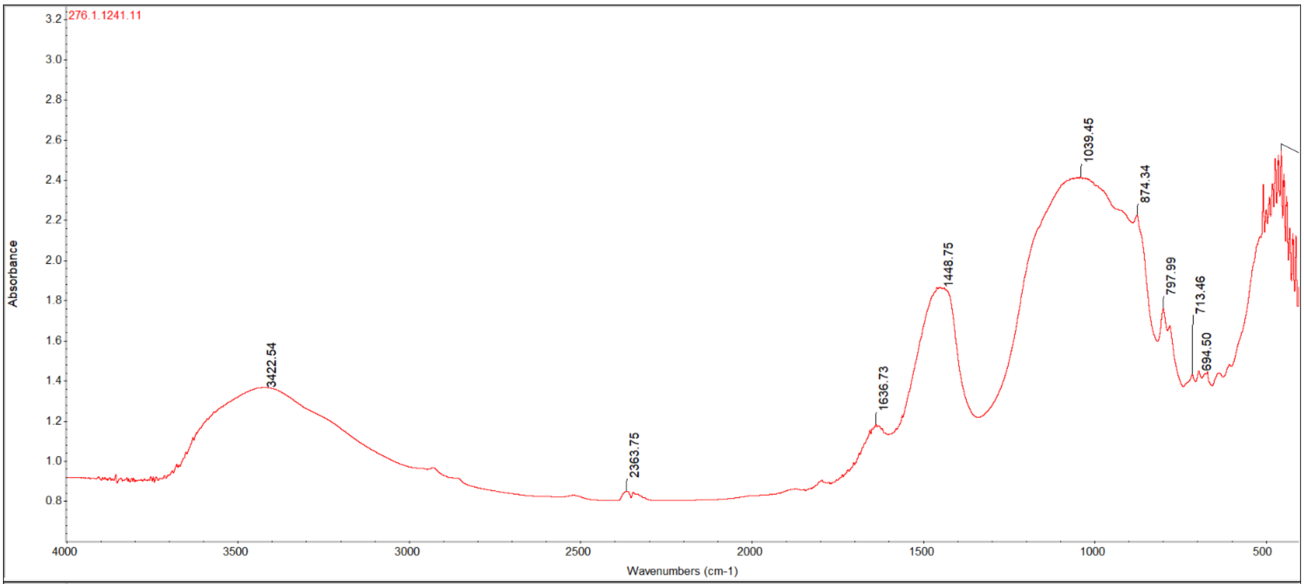

217.6.1009.3.3
Absorbance
Wavenumbers (cm-1)
3853.73
3446.96
2926.42
2868.22
2514.96
2360.84
2347.63
1793.37
1653.41
1436.74
1081.57
875.41
796.84
712.82
668.46
458.53


276.1.1241.3.3
Absorbance
Wavenumbers (cm-1)
3854.17
3422.30
1636.61
1437.43
1024.23
873.54
799.03
669.93
465.70


276.1.1241.4.2
Absorbance
Wavenumbers (cm-1)
3853.90
3421.56
2929.62
2516.20
1792.95
1636.00
1457.17
1032.24
874.43
797.10
712.95
462.00


276.1.1241.7
Absorbance
Wavenumbers (cm-1)
3421.35
2927.57
2845.71
2515.25
1794.18
1634.11
1424.78
1038.58
873.64
797.40
713.11
694.18
465.49


276.1.1241.9.3
Absorbance
Wavenumbers (cm-1)
3420.75
1793.65
1636.54
1455.42
1024.55
874.34
797.47
713.24
694.43
465.78


276.1.1241.11
Absorbance
Wavenumbers (cm-1)
3422.54
2363.75
1636.73
1448.75
1039.45
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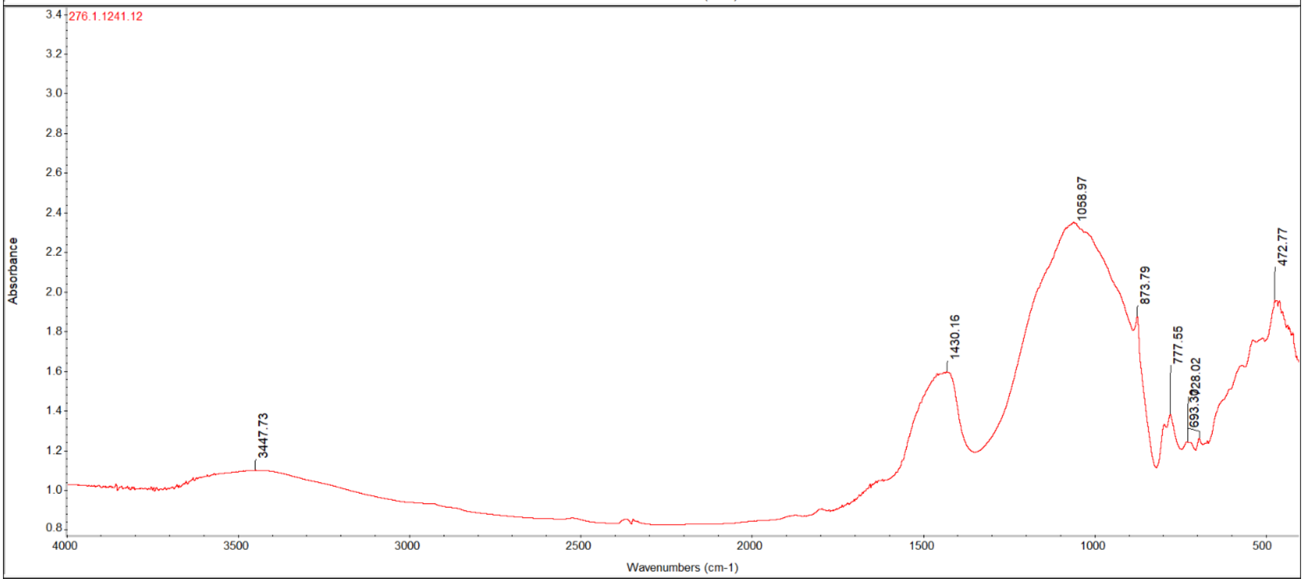
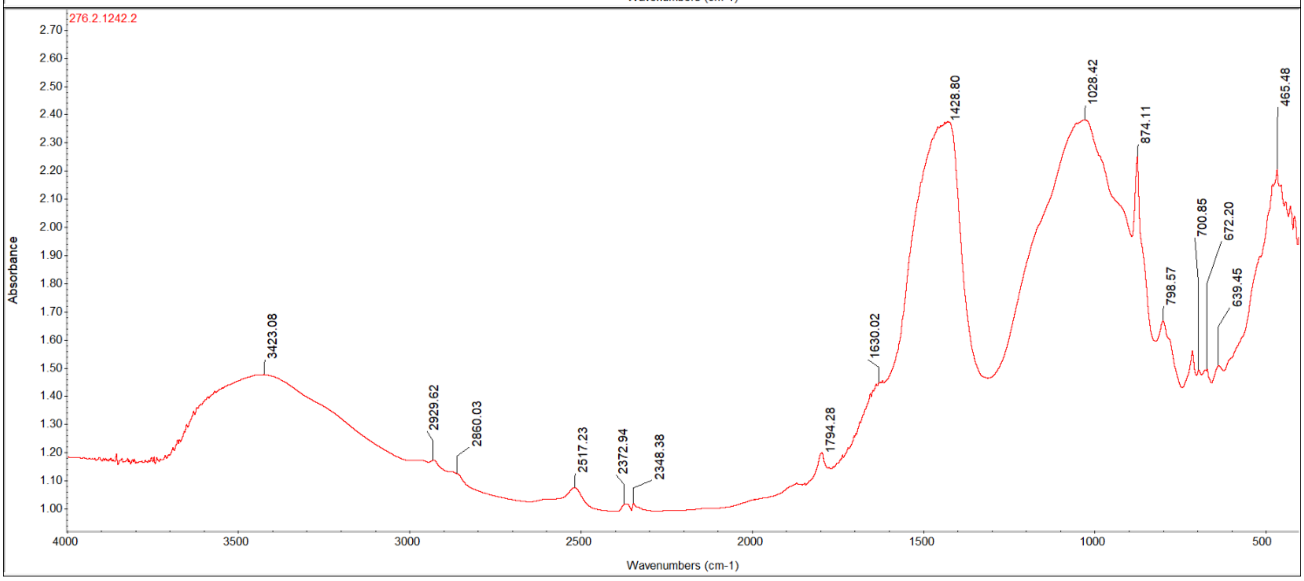
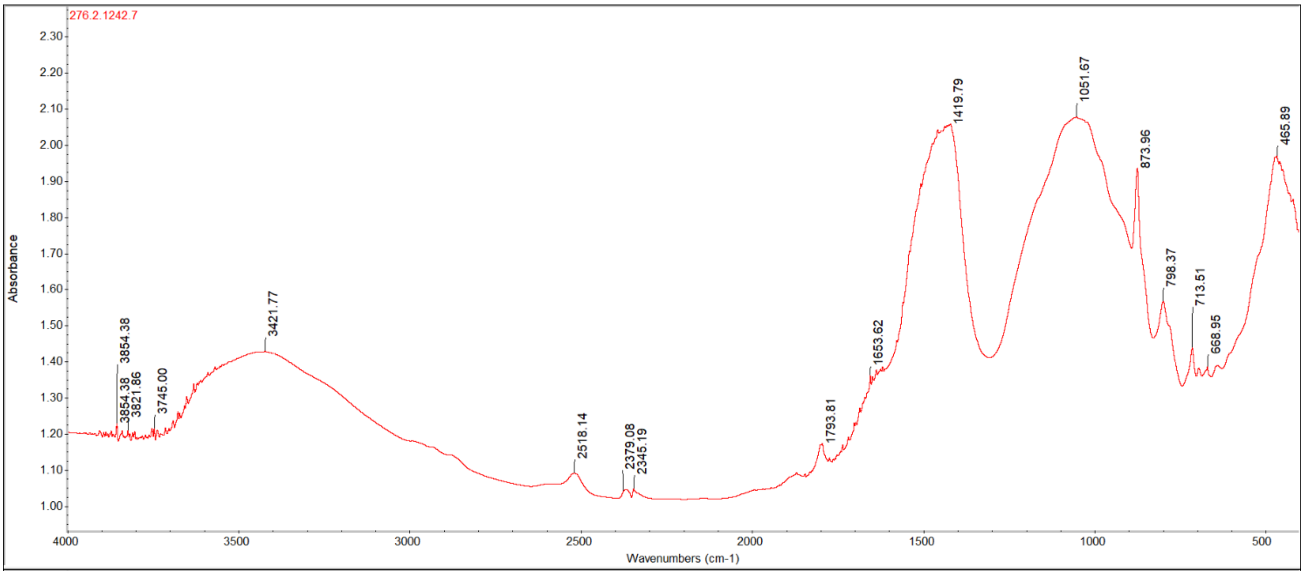
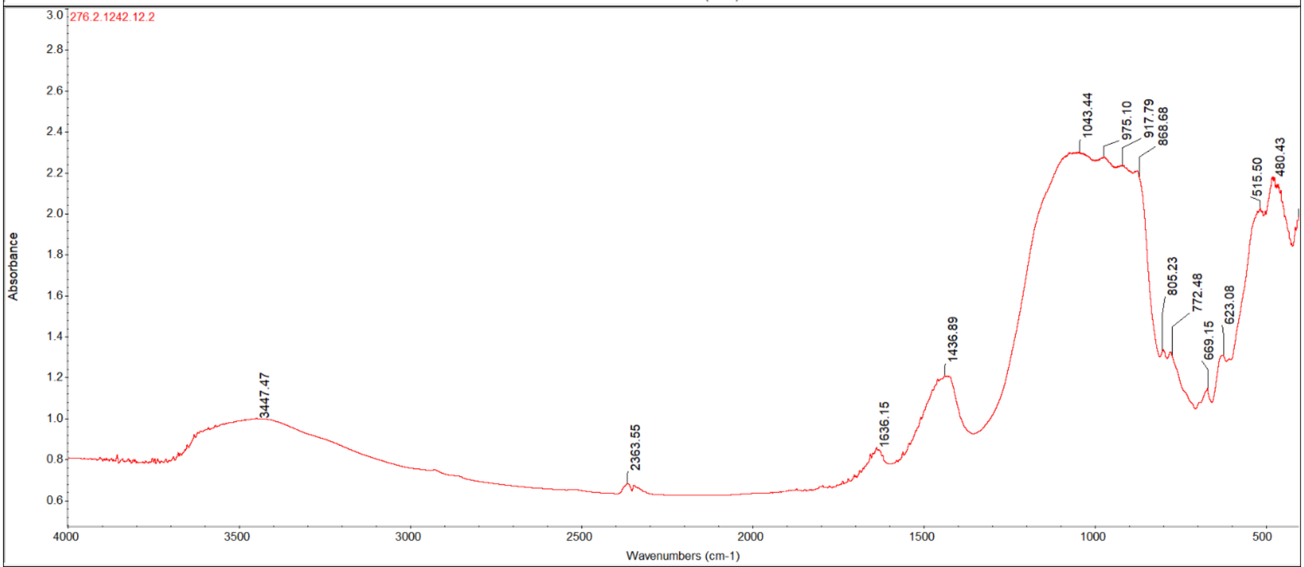
797.99
713.46
694.50


276.1.1241.12
Absorbance
Wavenumbers (cm-1)
3447.73
1430.16
1058.97
873.79
777.55
728.02
693.30
472.77


276.2.1242.2
Absorbance
Wavenumbers (cm-1)
3423.08
2929.62
2860.03
2517.23
2372.94
2348.38
1794.28
1630.02
1428.80
1028.42
874.11
798.57
700.85
672.20
639.45
465.48


276.2.1242.7
Absorbance
Wavenumbers (cm-1)
3854.38
3854.38
3821.86
3745.00
3421.77
2518.14
2379.08
2345.19
1793.81
1653.62
1419.79
1051.67
873.96
798.37
713.51
668.95
465.89


276.2.1242.12.2
Absorbance
Wavenumbers (cm-1)
3447.47
2363.55
1636.15
1436.89
1043.44
975.10
917.79
868.68
805.23
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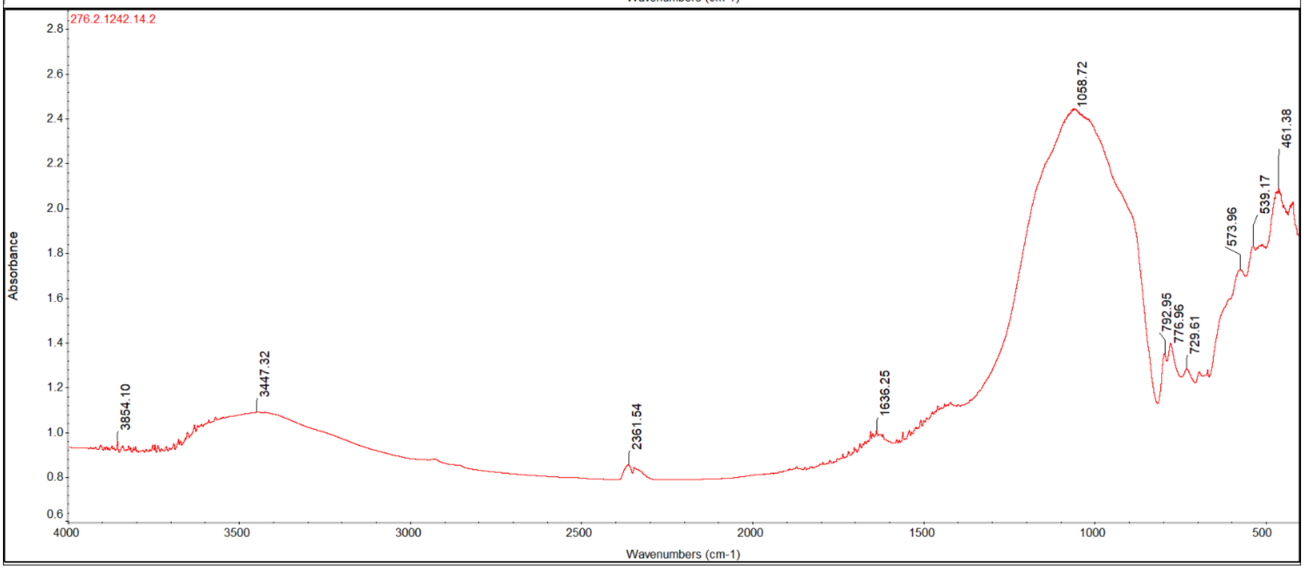
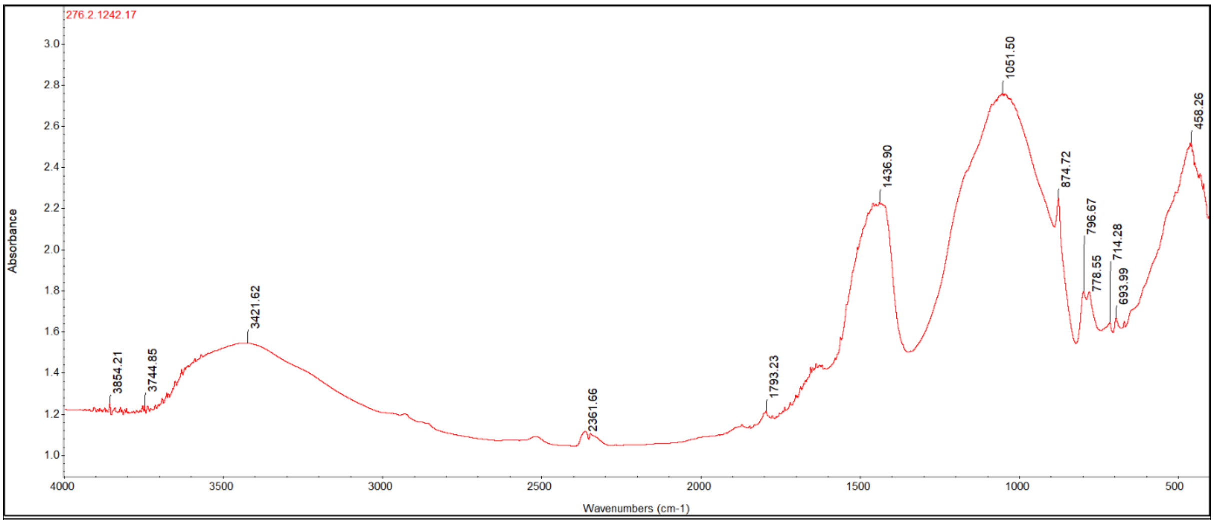
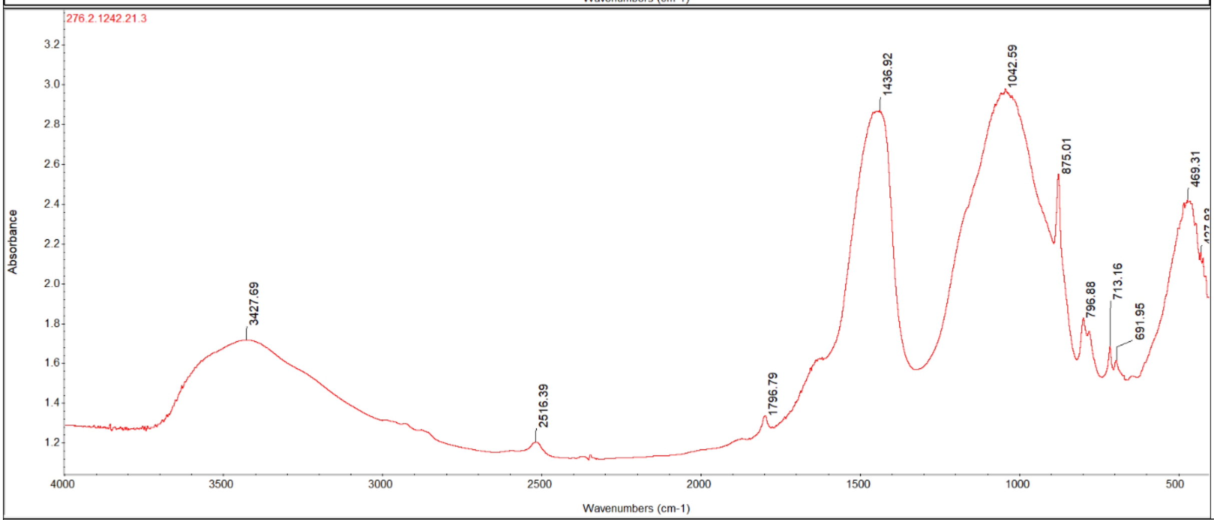
669.15
623.08
515.50
480.43


276.2.1242.14.2
Absorbance
Wavenumbers (cm-1)
3854.10
3447.32
2361.54
1636.25
1058.72
792.95
776.96
729.61
573.96
539.17
461.38


276.2.1242.17
Absorbance
Wavenumbers (cm-1)
3854.21
3744.85
3421.62
2361.66
1793.23
1436.90
1051.50
874.72
796.67
778.55
714.28
693.99
458.26


276.2.1242.21.3
Absorbance
Wavenumbers (cm-1)
3427.69
2516.39
1796.79
1436.92
1042.59
875.01
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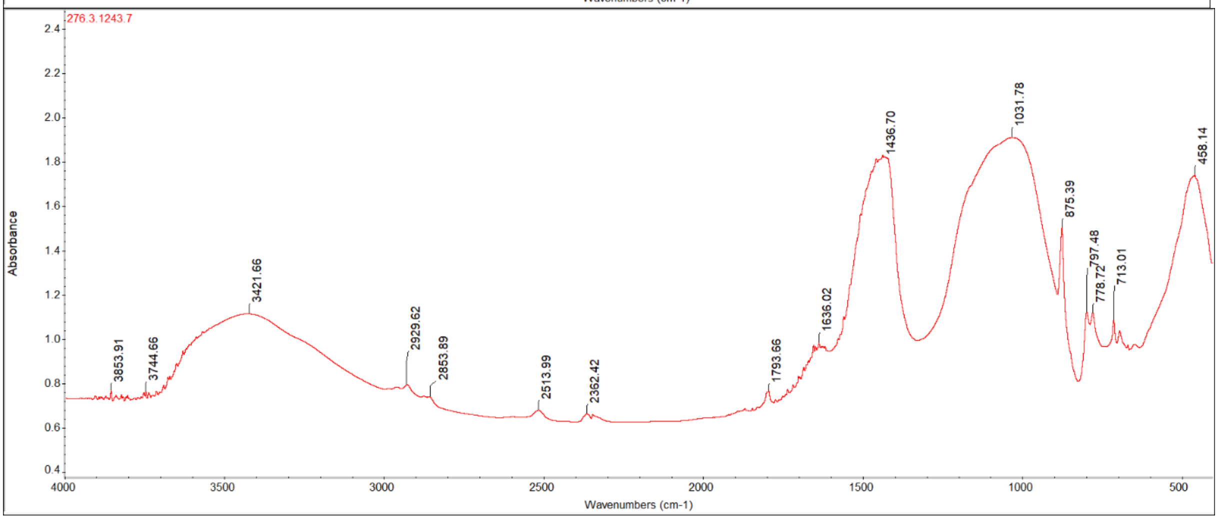
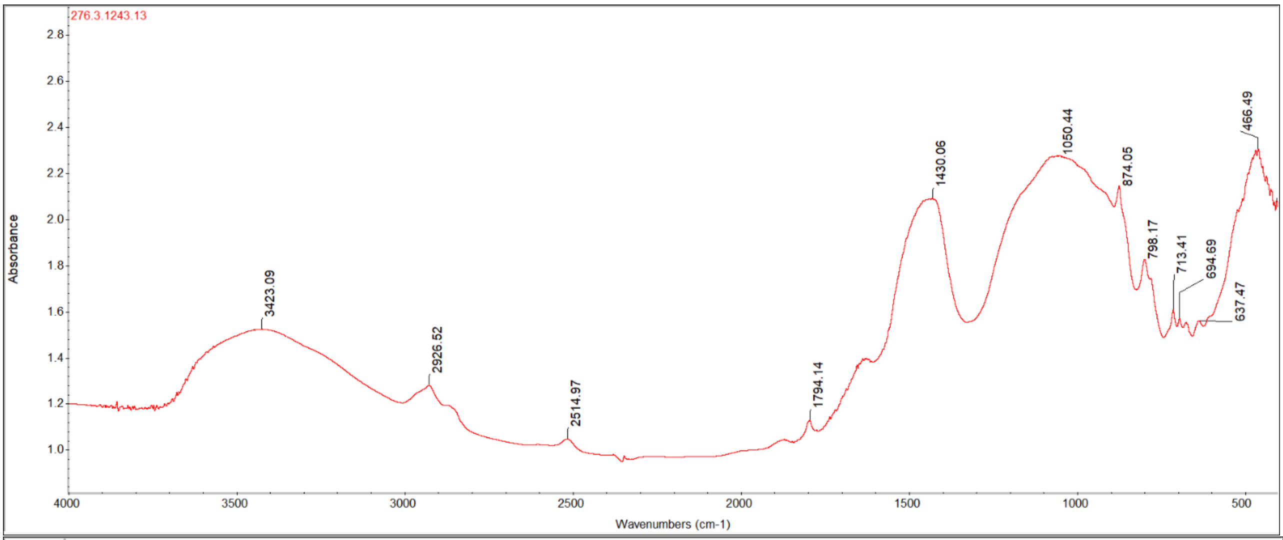
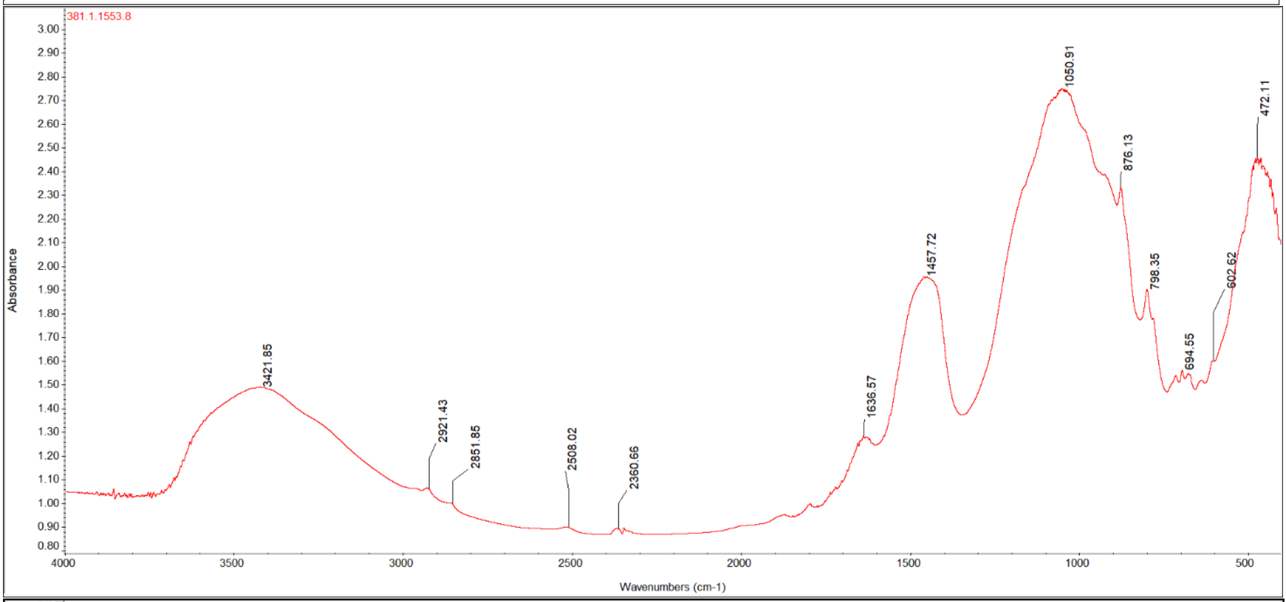
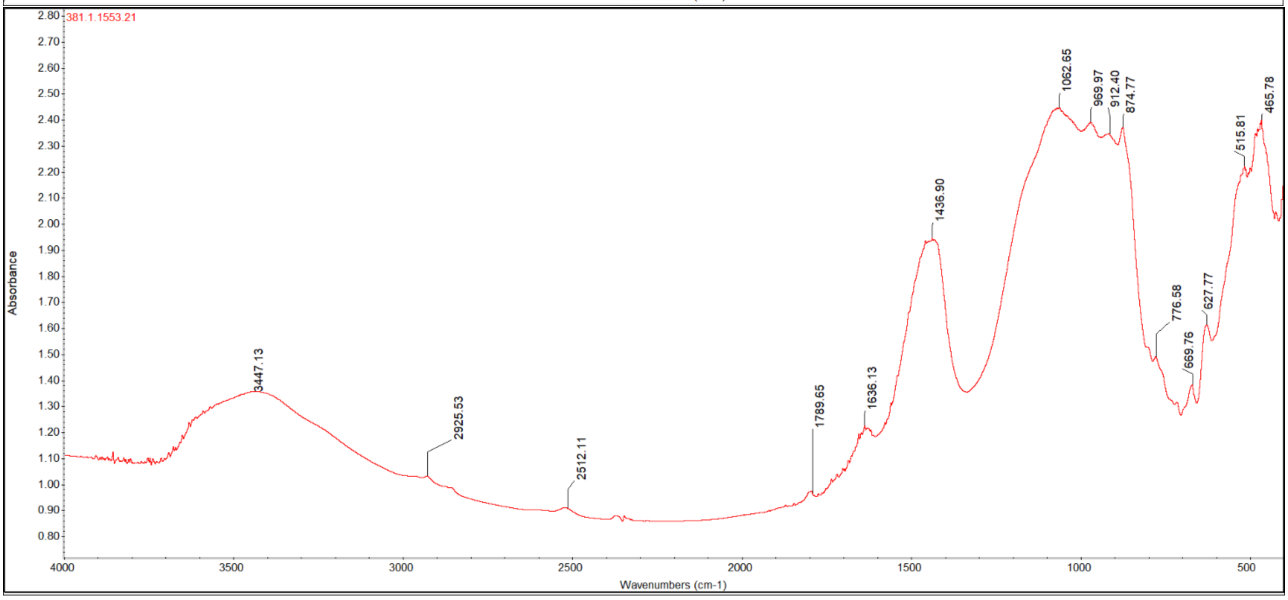
713.16
691.95
469.31


276.3.1243.7
Absorbance
Wavenumbers (cm-1)
3853.91
3744.66
3421.66
2929.62
2853.89
2513.99
2362.42
1793.66
1636.02
1436.70
1031.78
875.39
797.48
778.72
713.01
458.14


276.3.1243.13
Absorbance
Wavenumbers (cm-1)
3423.09
2926.52
2514.97
1794.14
1430.06
1050.44
874.05
798.17
713.41
694.69
637.47
466.49


381.1.1553.8
Absorbance
Wavenumbers (cm-1)
3421.85
2921.43
2851.85
2508.02
2360.66
1636.57
1457.72
1050.91
876.13
798.35
694.55
602.62
472.11


381.1.1553.21
Absorbance
Wavenumbers (cm-1)
3447.13
2925.53
2512.11
1789.65
1636.13
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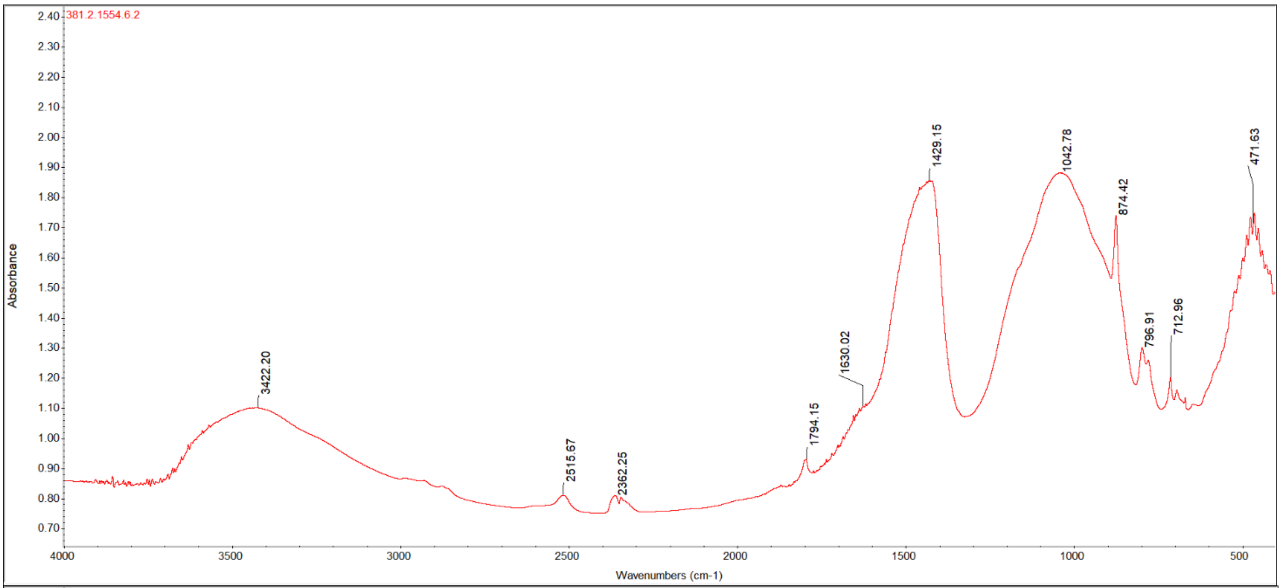
1062.65
969.97
912.40
874.77
776.58
669.76
627.77
515.81
465.78


381.2.1554.6.2
Absorbance
Wavenumbers (cm-1)
3422.20
2515.67
2362.25
1794.15
1630.02
1429.15
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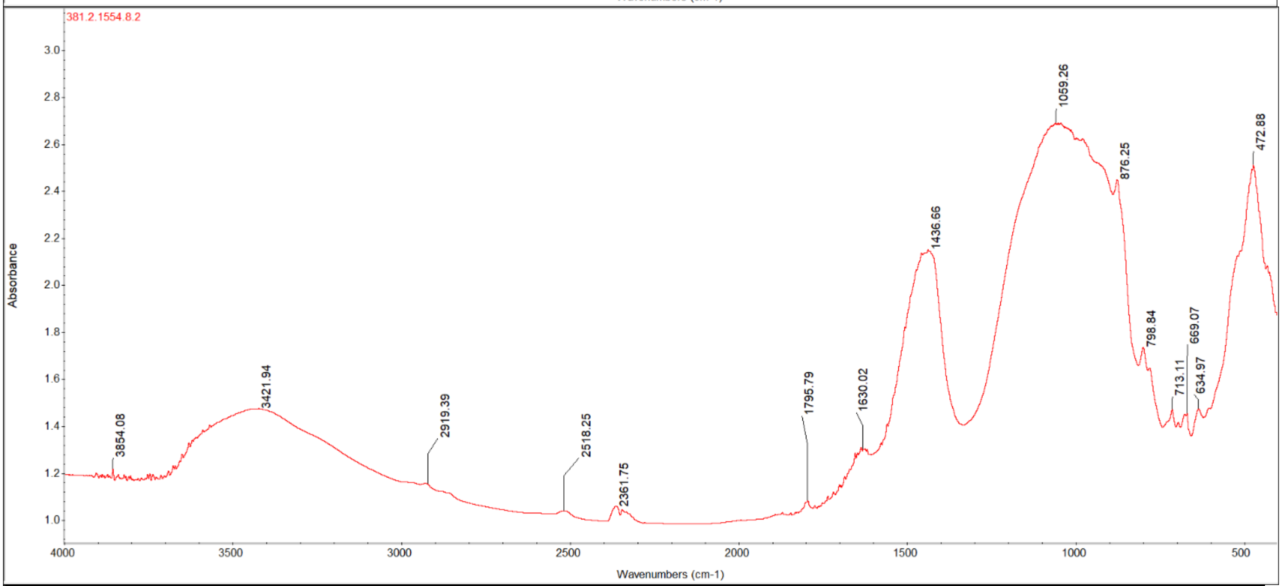
796.91
712.96
471.63


381.2.1554.8.2
Absorbance
Wavenumbers (cm-1)
3854.08
3421.94
2919.39
2518.25
2361.75
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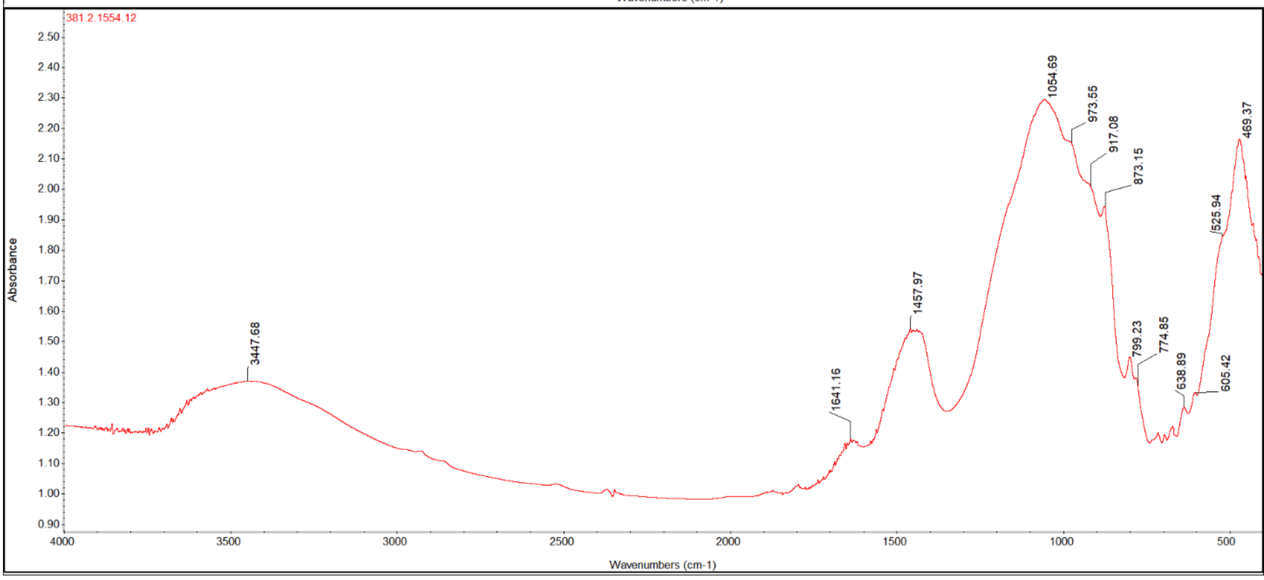
1630.02
1436.66
1059.26
876.25
798.84
713.11
669.07
634.97
472.88


381.2.1554.12
Absorbance
Wavenumbers (cm-1)
3447.68
1641.16
1457.97
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973.55
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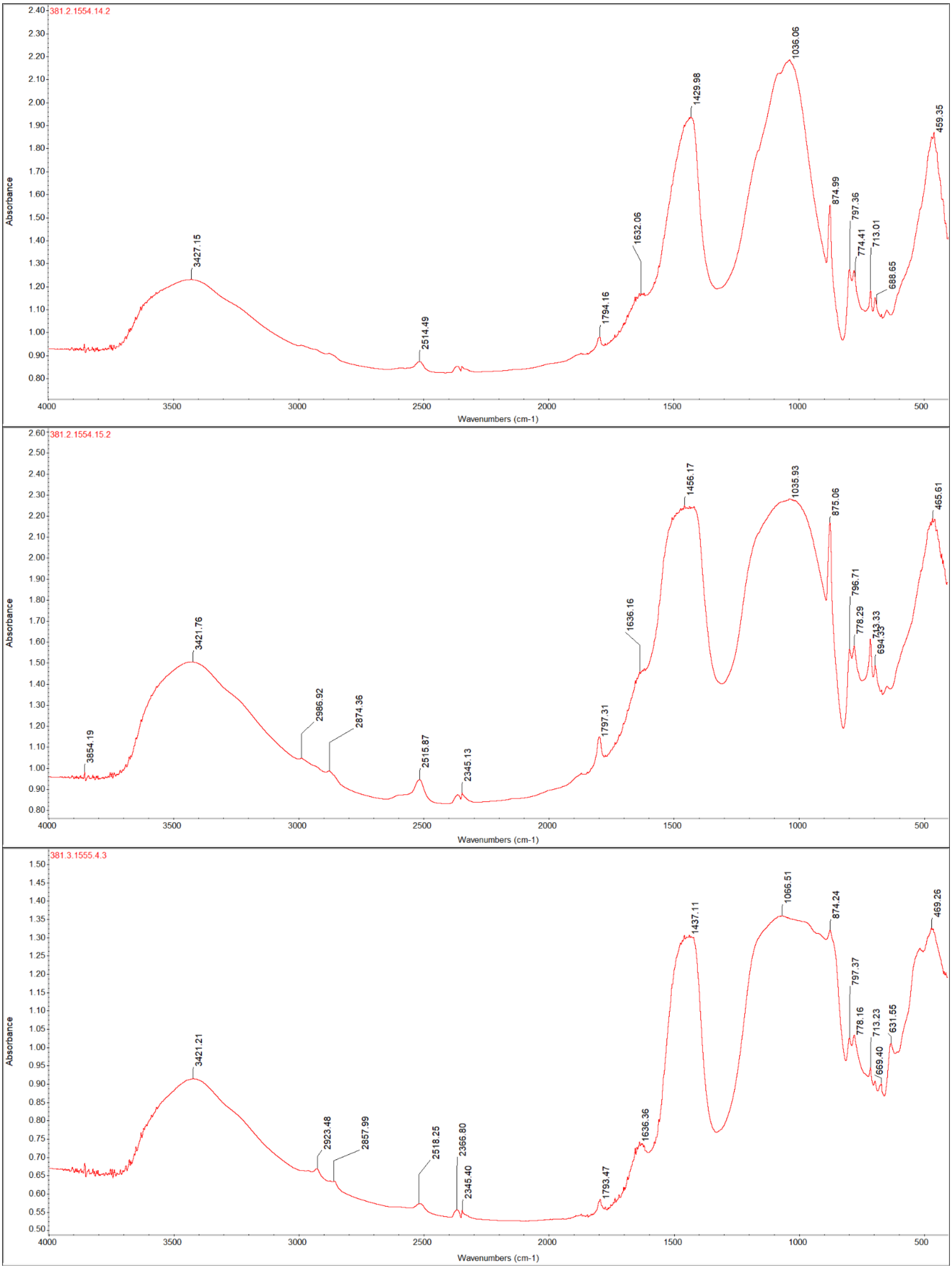
873.15
799.23
774.85
638.89
605.42
525.94
469.37


381.2.1554.14.2
Absorbance
Wavenumbers (cm-1)
3427.15
2514.49
1794.16
1632.06
1429.98
1036.06
874.99
797.36
774.41
713.01
688.65
459.35
381.2.1554.15.2
3854.19
3421.76
2986.92
2874.36
2515.87
2345.13
1797.31
1636.16
1456.17
1035.93
875.06
796.71
778.29
713.33
694.33
465.61
381.3.1555.4.3
3421.21
2923.48
2857.99
2518.25
2366.80
2345.40
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797.37
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713.23
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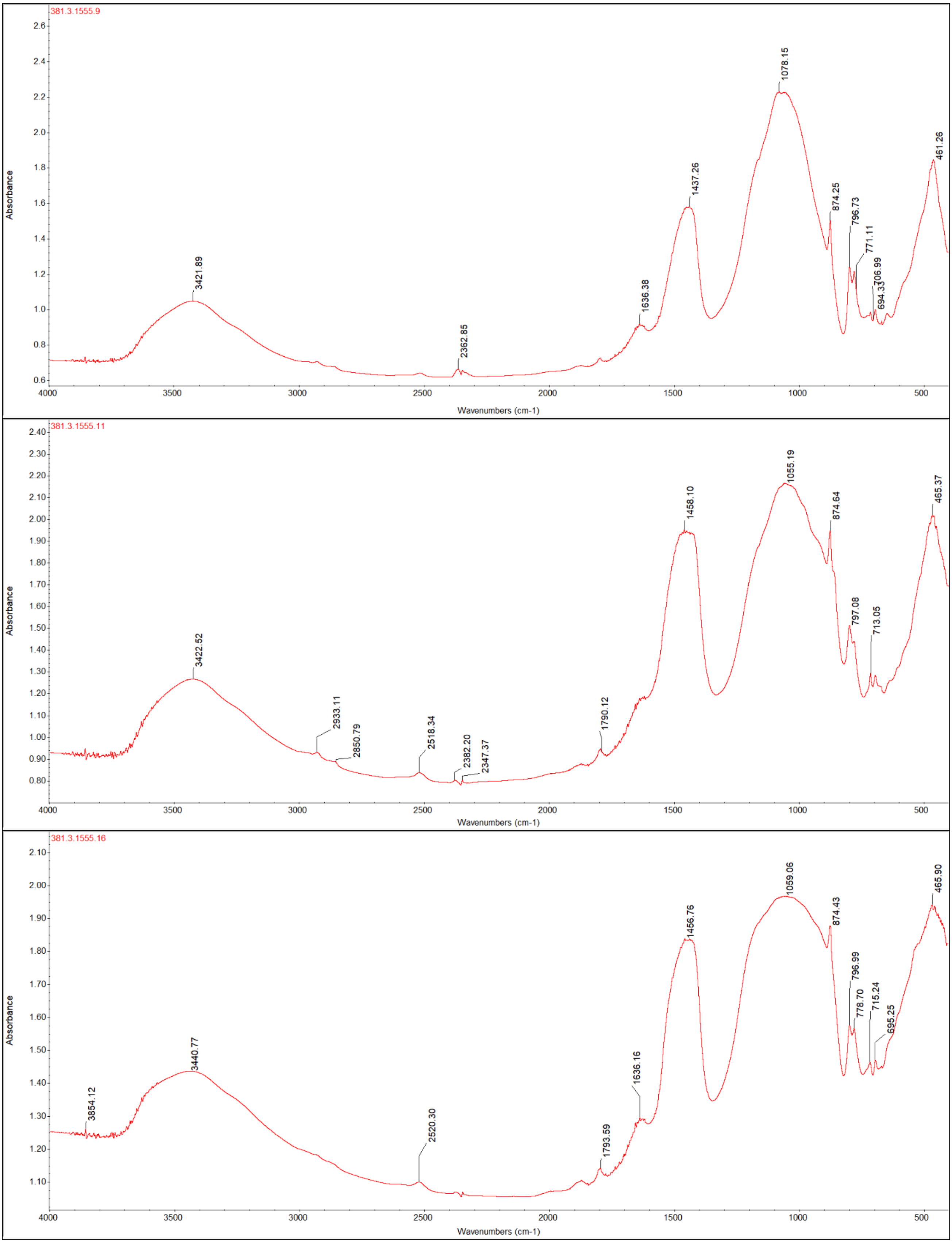
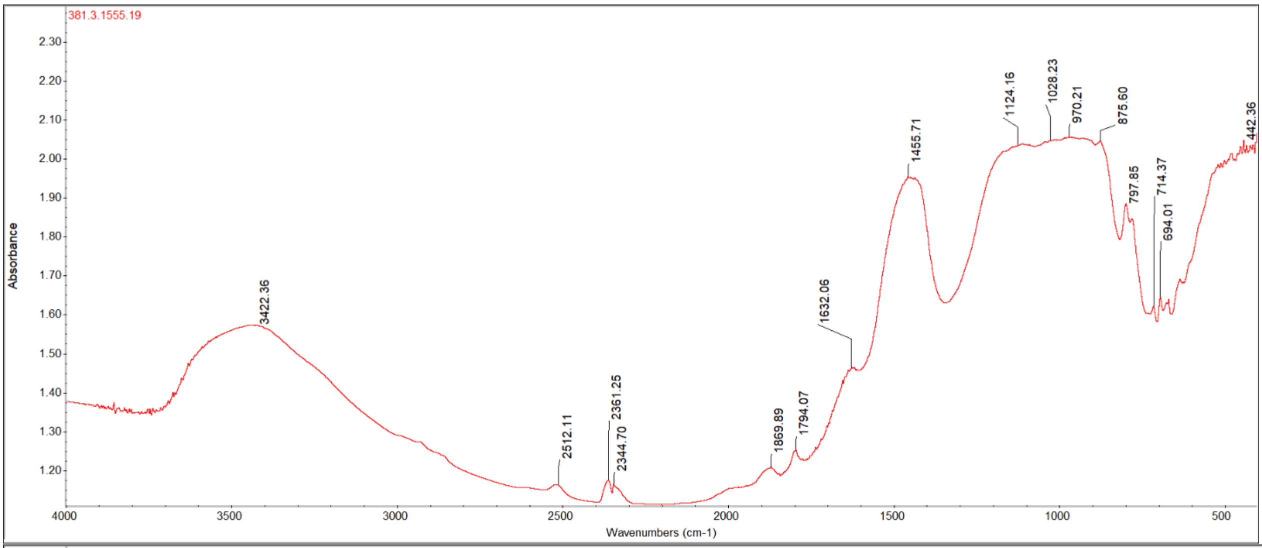
631.55
469.26


381.3.1555.9
Absorbance
Wavenumbers (cm-1)
3421.89
2362.85
1636.38
1437.26
1078.15
874.25
796.73
771.11
706.99
694.33
461.26
381.3.1555.11
Absorbance
Wavenumbers (cm-1)
3422.52
2933.11
2850.79
2518.34
2382.20
2347.37
1790.12
1458.10
1055.19
874.64
797.08
713.05
465.37
381.3.1555.16
Absorbance
Wavenumbers (cm-1)
3854.12
3440.77
2520.30
1793.59
1636.16
1456.76
1059.06
874.43
796.99
778.70
715.24
695.25
465.90


381.3.1555.19
Absorbance
Wavenumbers (cm-1)
3422.36
2512.11
2361.25
2344.70
1869.89
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1455.71
1124.16
1028.23
970.21
875.60
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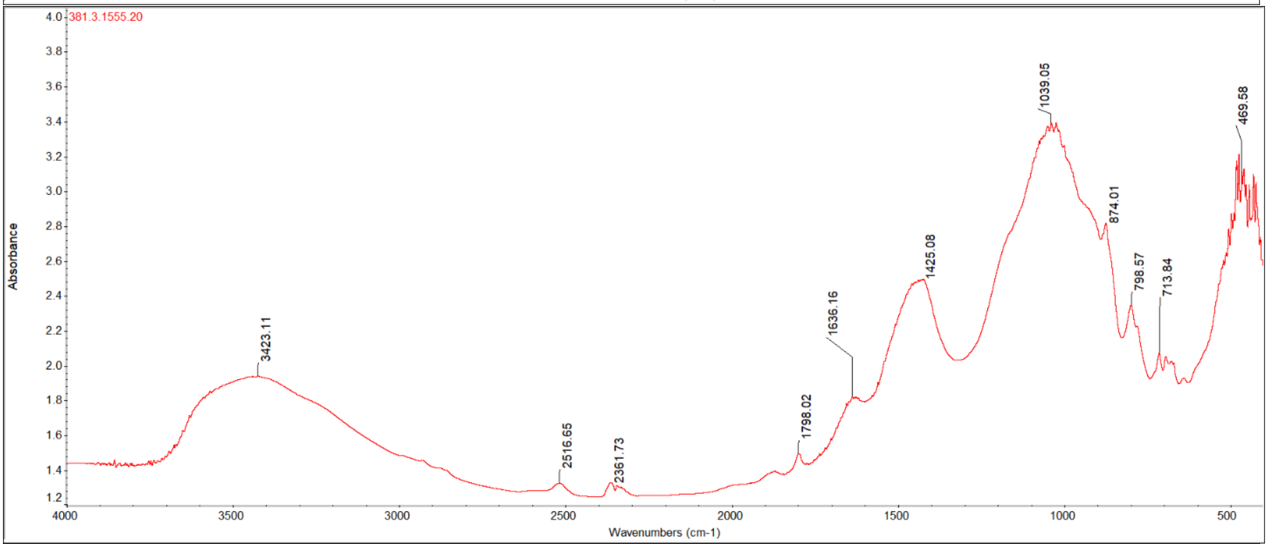
714.37
694.01
442.36


381.3.1555.20
Absorbance
Wavenumbers (cm-1)
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2361.73
1798.02
1636.16
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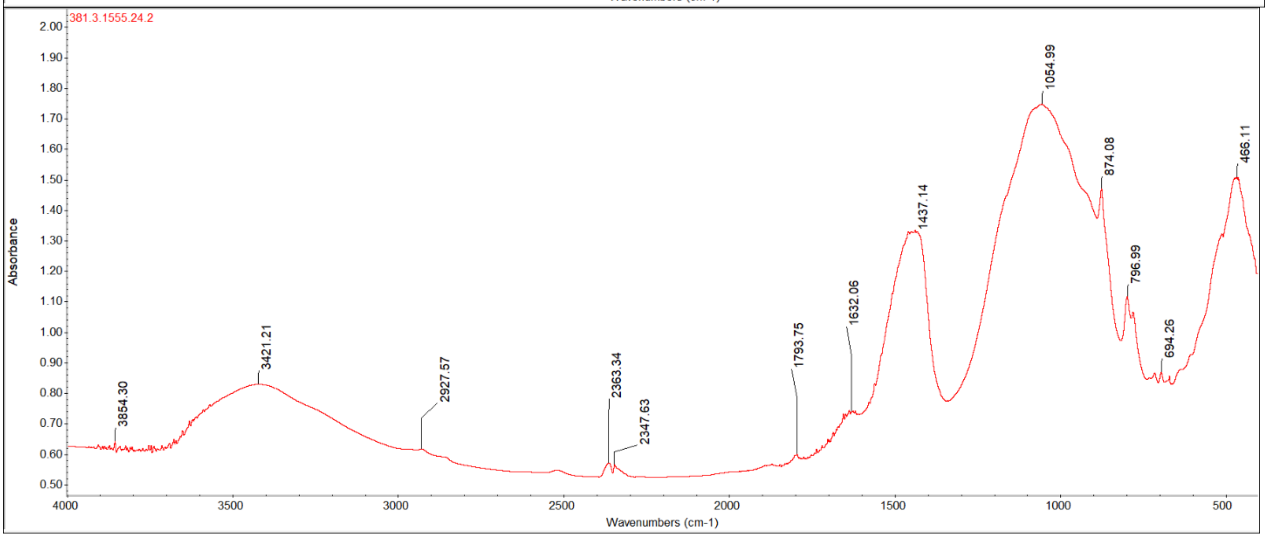
798.57
713.84
469.58


381.3.1555.24.2
Absorbance
Wavenumbers (cm-1)
3854.30
3421.21
2927.57
2363.34
2347.63
1793.75
1632.06
1437.14
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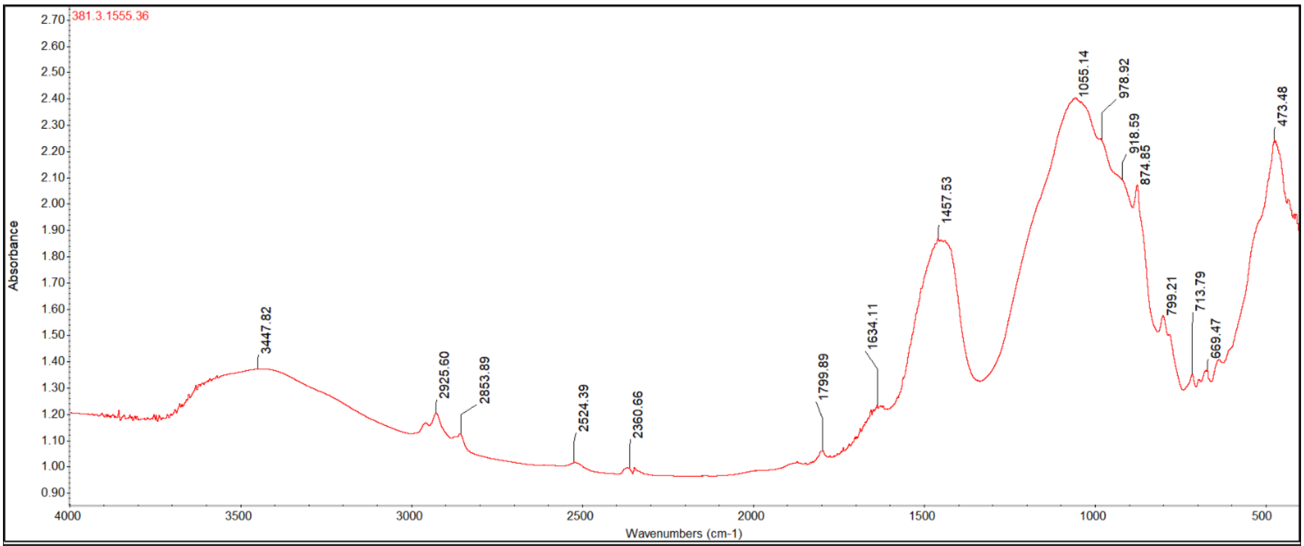
874.08
796.99
694.26
466.11


381.3.1555.36
Absorbance
Wavenumbers (cm-1)
3447.82
2925.60
2853.89
2524.39
2360.66
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1055.14
978.92
918.59
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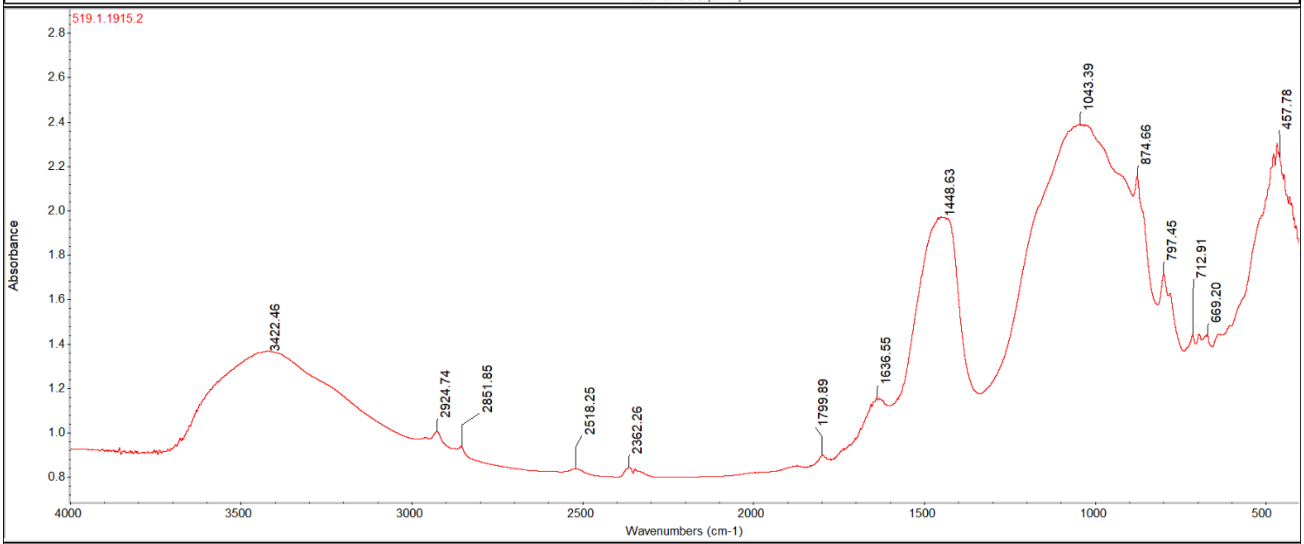
799.21
713.79
669.47
473.48


519.1.1915.2
Absorbance
Wavenumbers (cm-1)
3422.46
2924.74
2851.85
2518.25
2362.26
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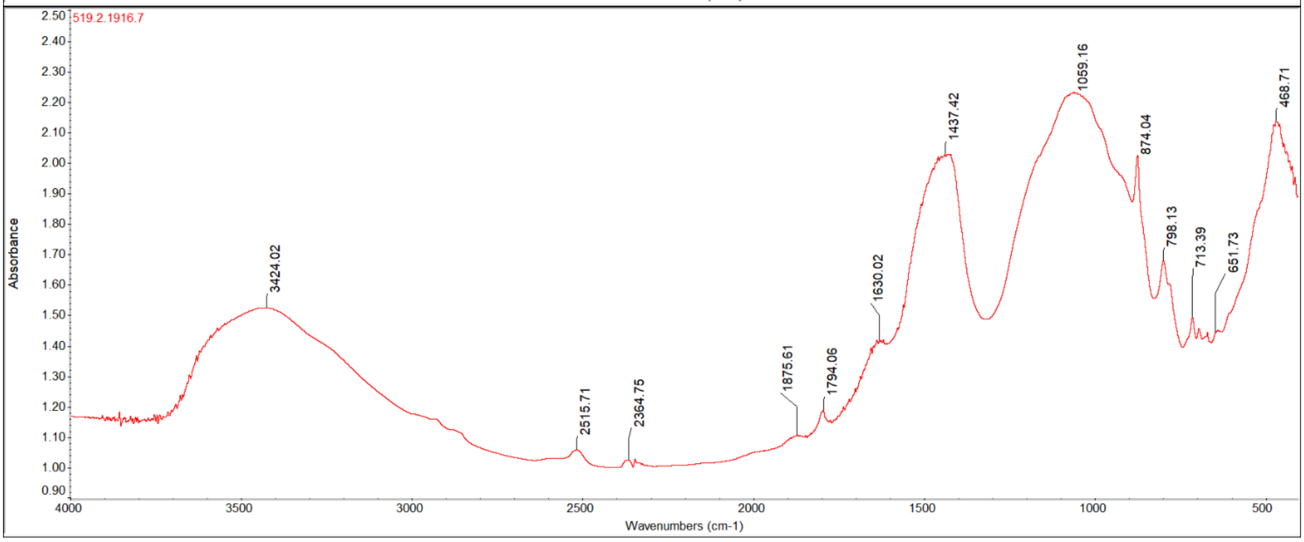
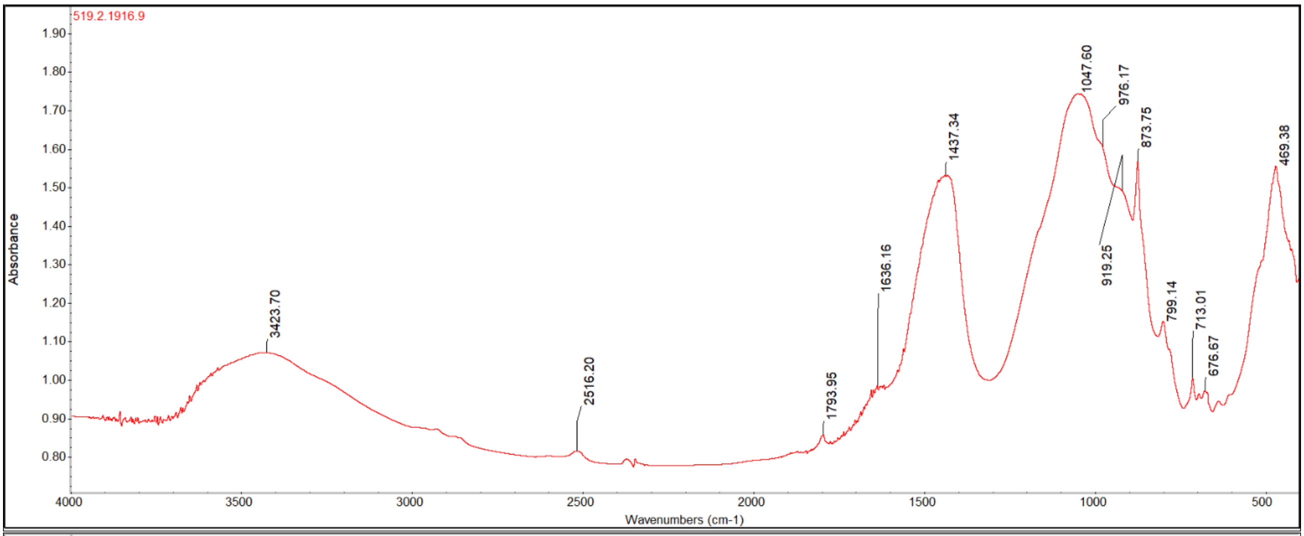
1636.55
1448.63
1043.39
874.66
797.45
712.91
669.20
457.78


519.2.1916.7
Absorbance
Wavenumbers (cm-1)
3424.02
2515.71
2364.75
1875.61
1794.06
1630.02
1437.42
1059.16
874.04
798.13
713.39
651.73
468.71


519.2.1916.9
Absorbance
Wavenumbers (cm-1)
3423.70
2516.20
1793.95
1636.16
1437.34
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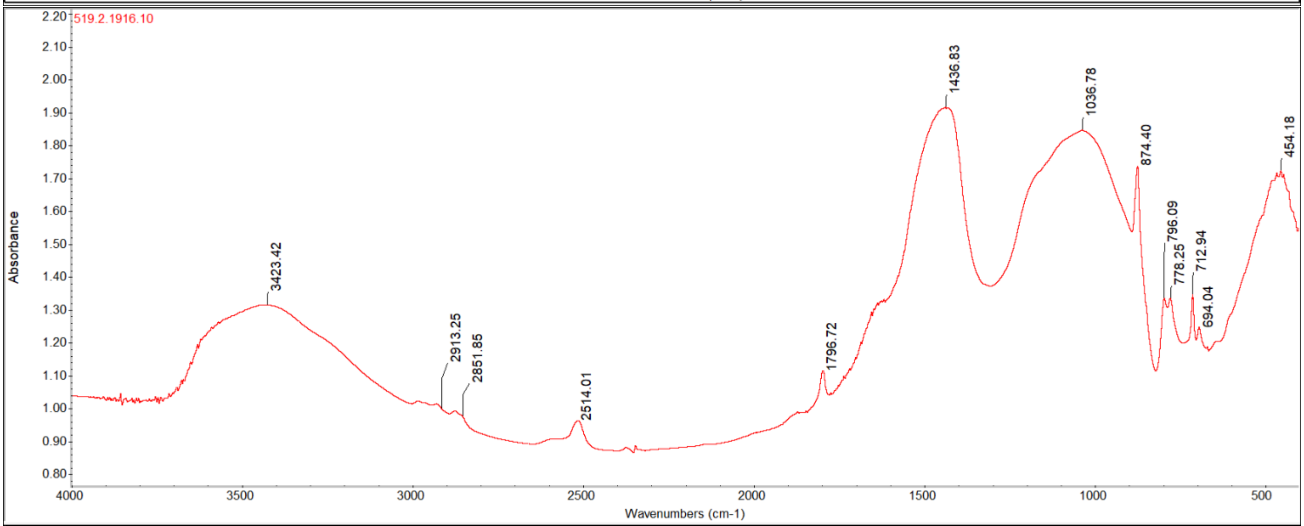
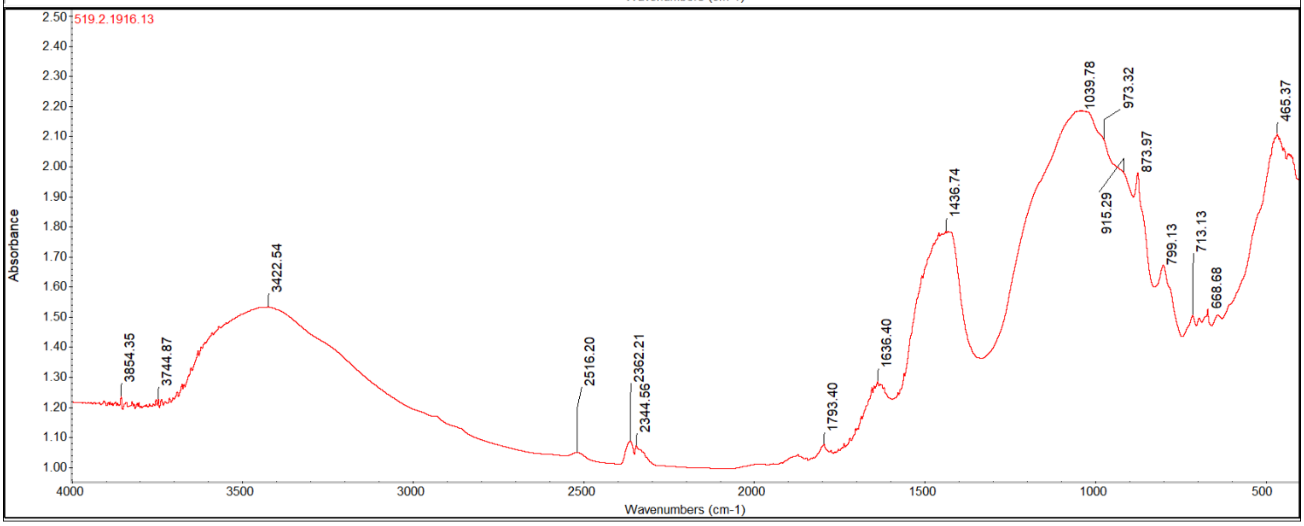
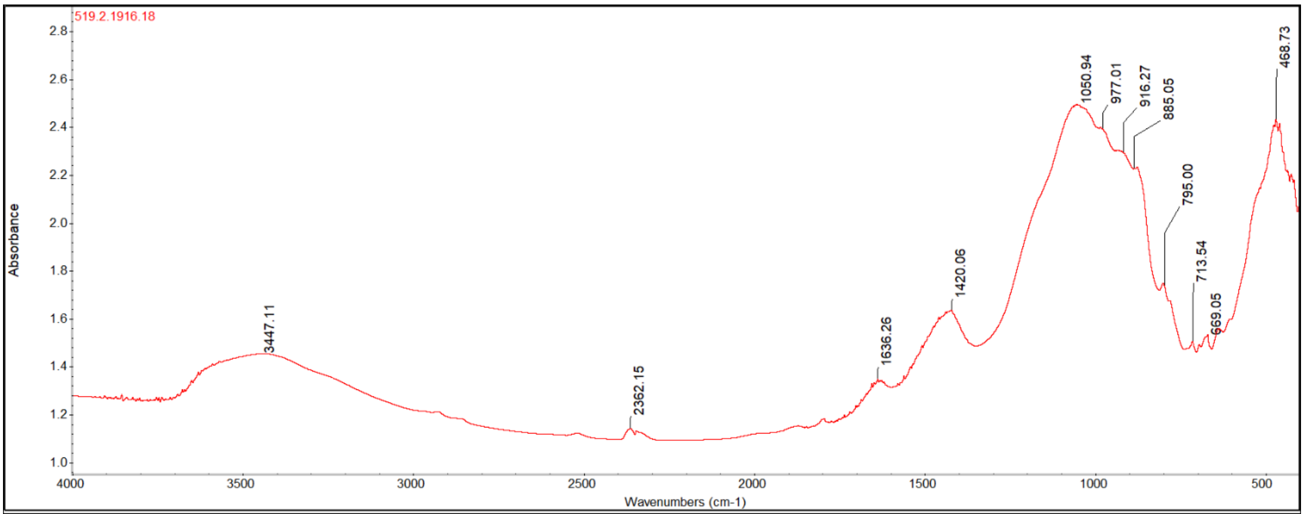
713.01
676.67
469.38


519.2.1916.10
Absorbance
Wavenumbers (cm-1)
3423.42
2913.25
2851.85
2514.01
1796.72
1436.83
1036.78
874.40
796.09
778.25
712.94
694.04
454.18


519.2.1916.13
Absorbance
Wavenumbers (cm-1)
3854.35
3744.87
3422.54
2516.20
2362.21
2344.56
1793.40
1636.40
1436.74
1039.78
973.32
915.29
873.97
799.13
713.13
668.68
465.37


519.2.1916.18
Absorbance
Wavenumbers (cm-1)
3447.11
2362.15
1636.26
1420.06
1050.94
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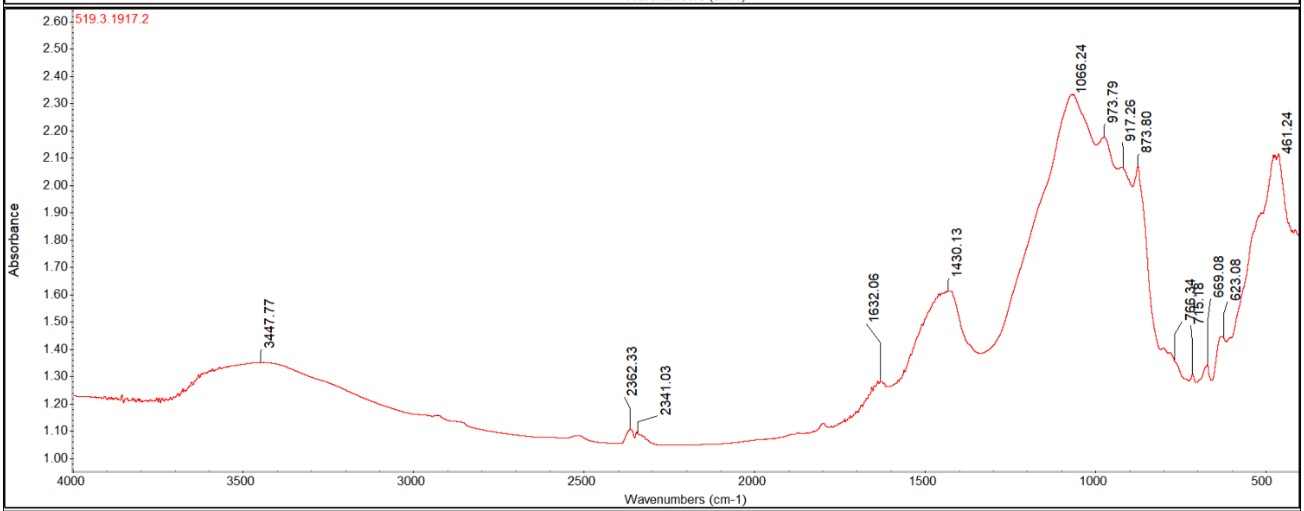
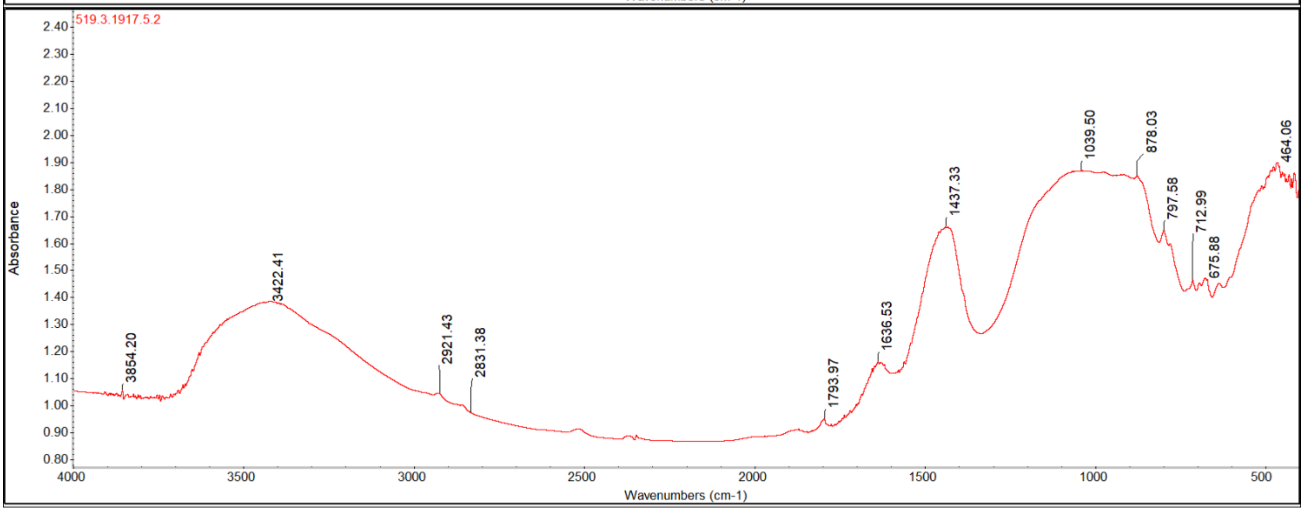
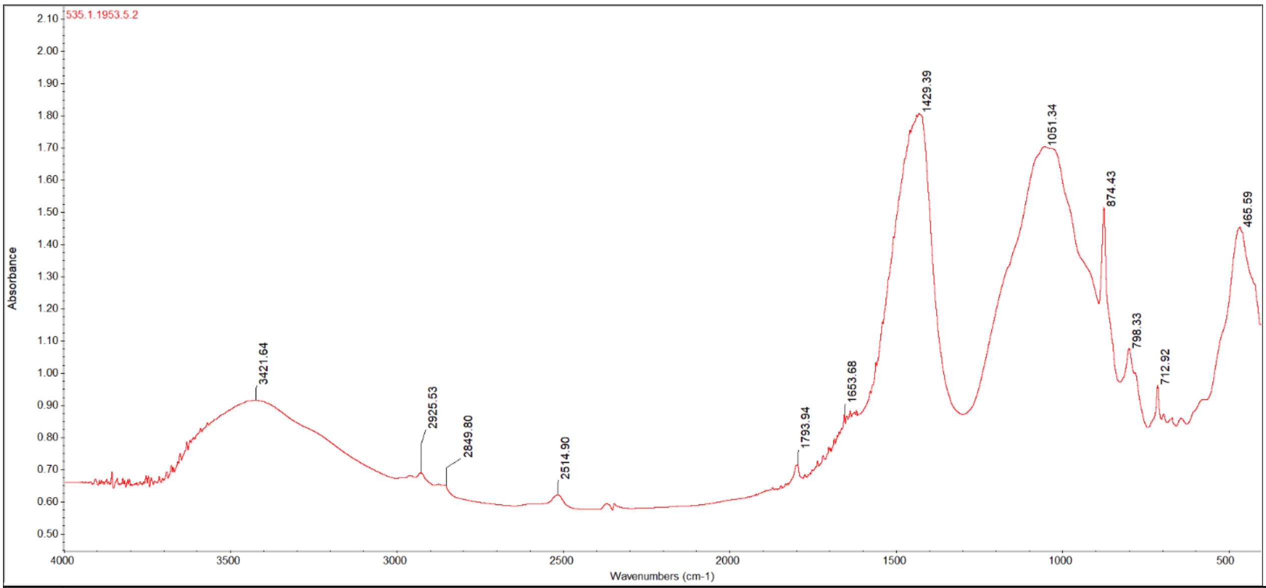
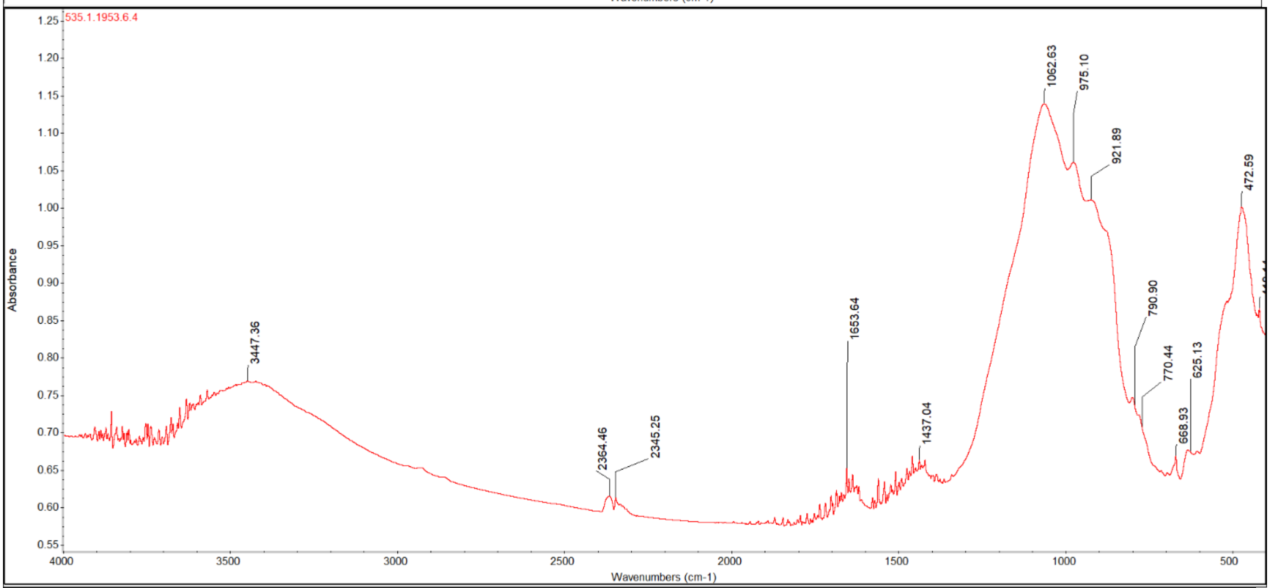
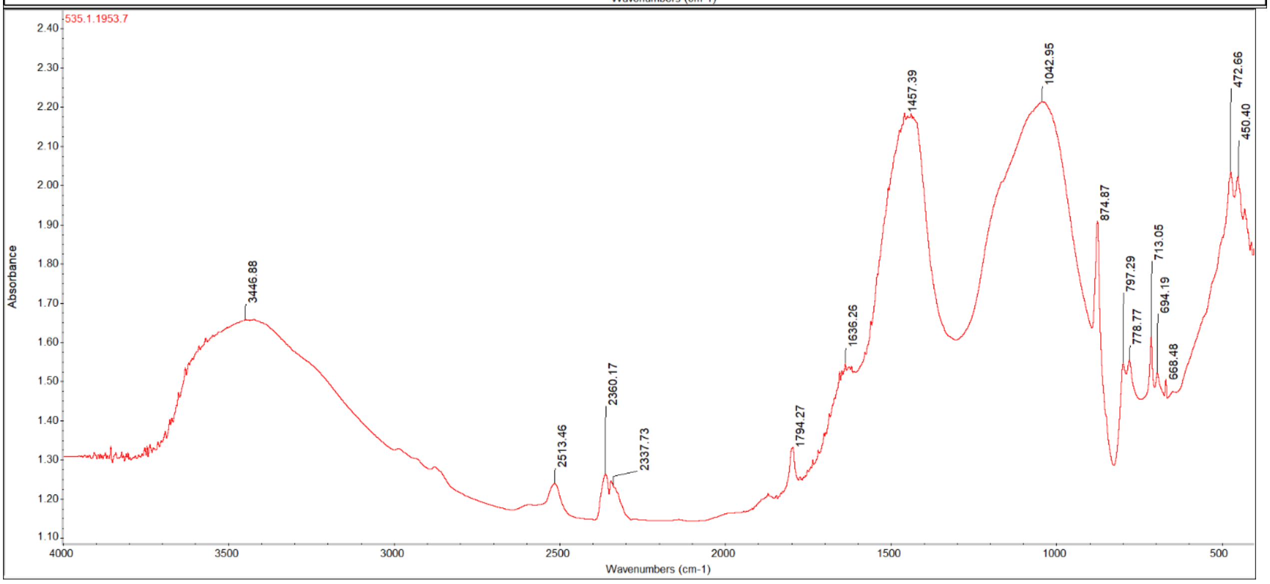
916.27
885.05
795.00
713.54
669.05
468.73

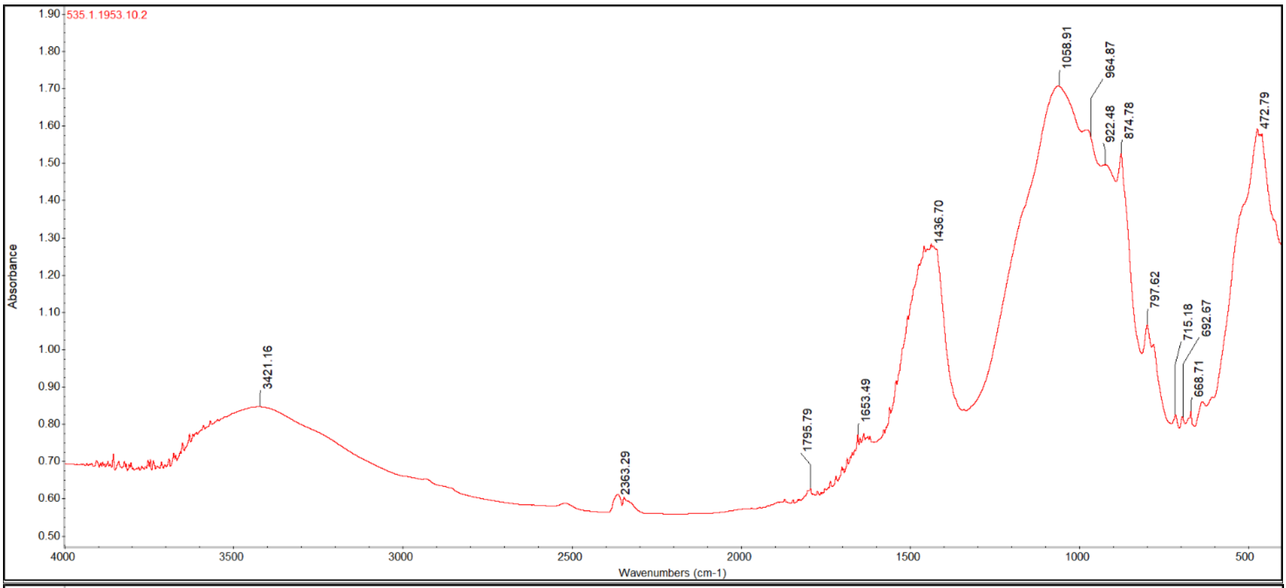

519.3.1917.2
Absorbance
Wavenumbers (cm-1)
3447.77
2362.33
2341.03
1632.06
1430.13
1066.24
973.79
917.26
873.80
669.08
623.08
461.24

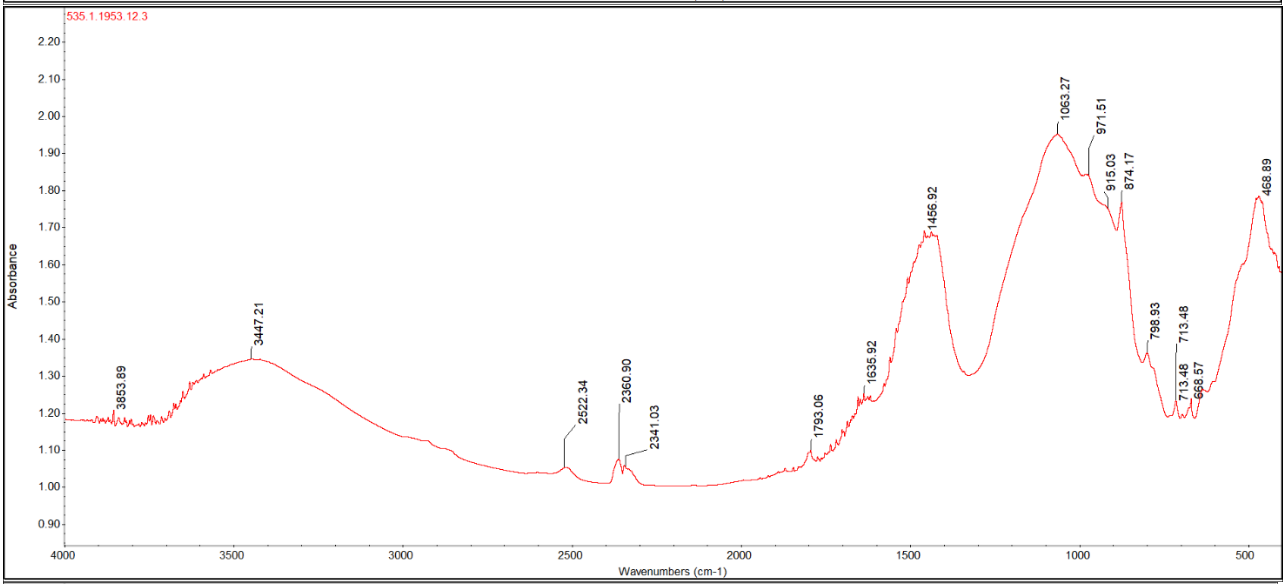

519.3.1917.5.2
Absorbance
Wavenumbers (cm-1)
3854.20
3422.41
2921.43
2831.38
1793.97
1636.53
1437.33
1039.50
878.03
797.58
712.99
675.88
464.06

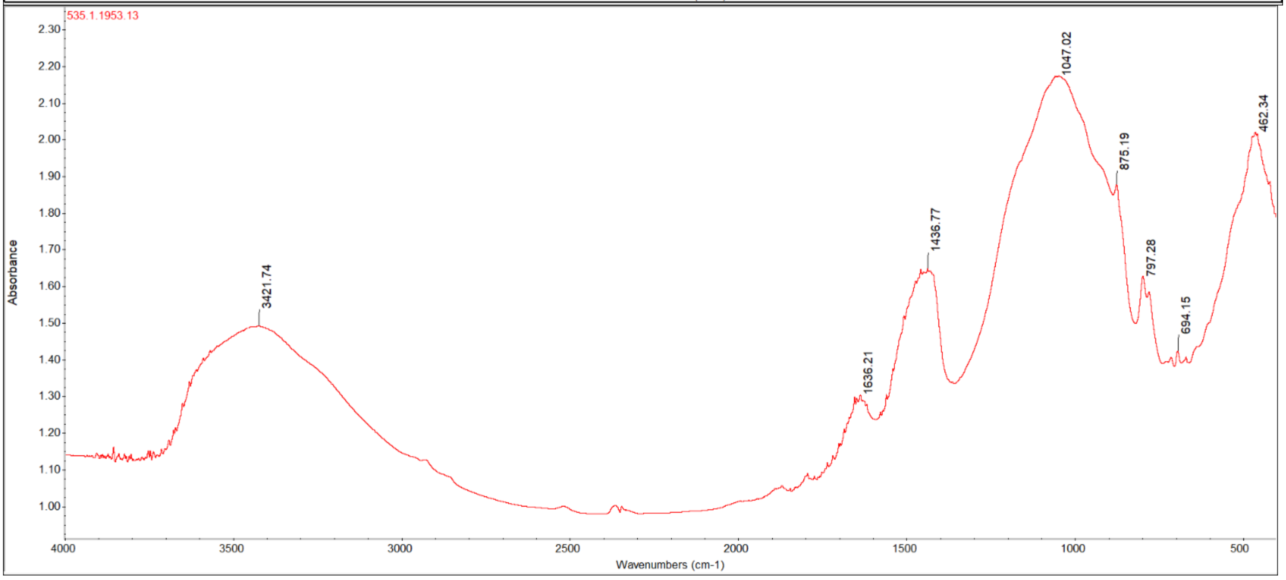

535.1.1953.5.2
Absorbance
Wavenumbers (cm-1)
3421.64
2925.53
2849.80
2514.90
1793.94
1653.68
1429.39
1051.34
874.43
798.33
712.92
465.59

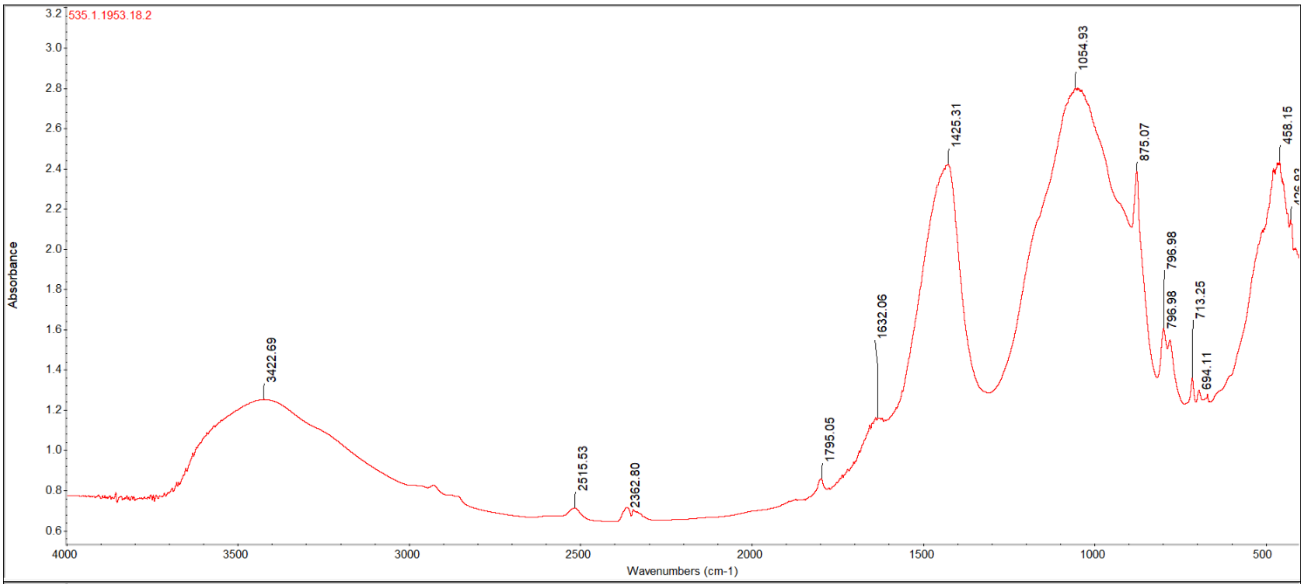

535.1.1953.6.4
Absorbance
Wavenumbers (cm-1)
3447.36
2364.46
2345.25
1653.64
1437.04
1062.63
975.10
921.89
790.90
770.44
668.93
625.13
472.59

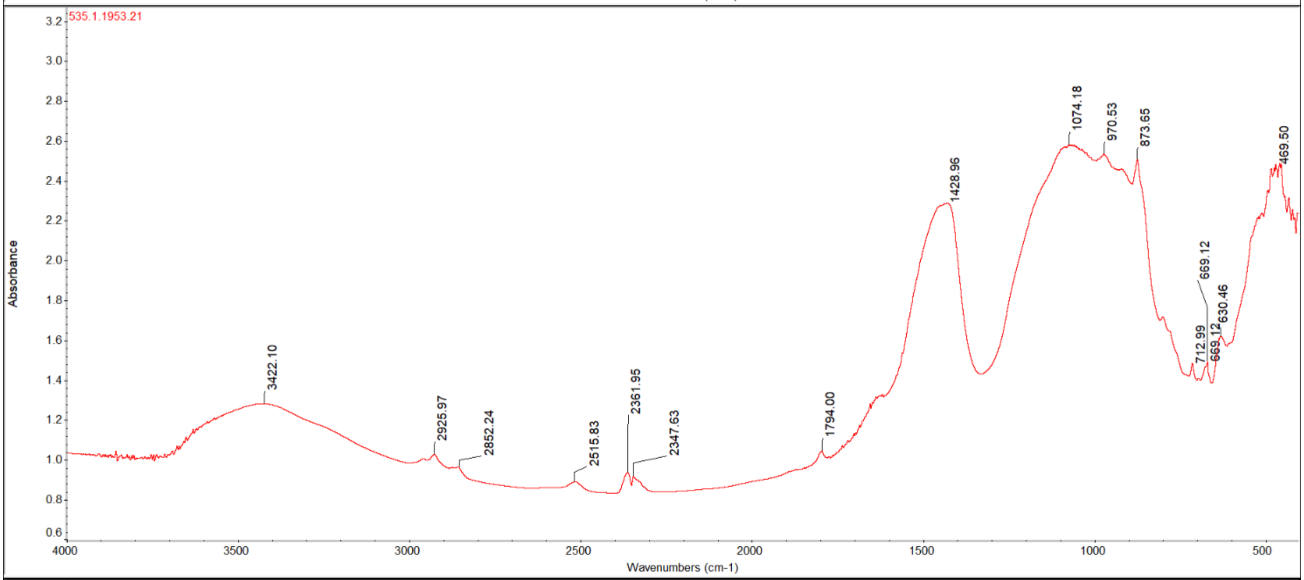

535.1.1953.7
Absorbance
Wavenumbers (cm-1)
3446.88
2513.46
2360.17
2337.73
1794.27
1636.26
1457.39
1042.95
874.87
797.29
778.77
713.05
694.19
668.48
472.66
450.40

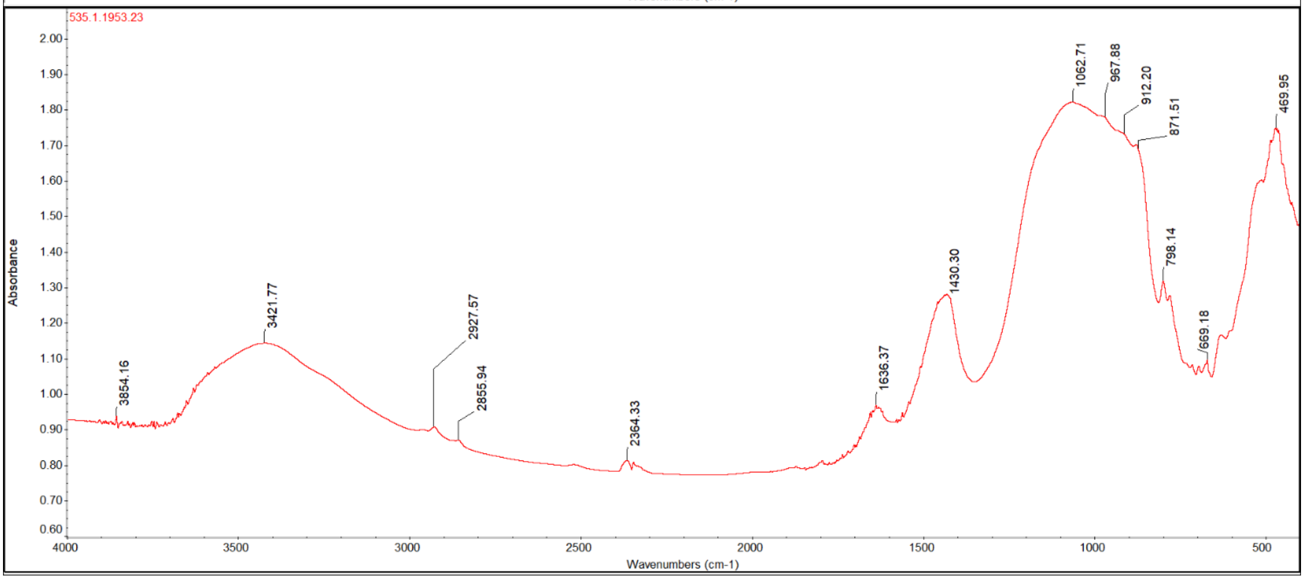

535.1.1953.10.2
Absorbance
Wavenumbers (cm-1)
3421.16
2363.29
1795.79
1653.49
1436.70
1058.91
964.87
922.48
874.78
797.62
715.18
692.67
668.71
472.79

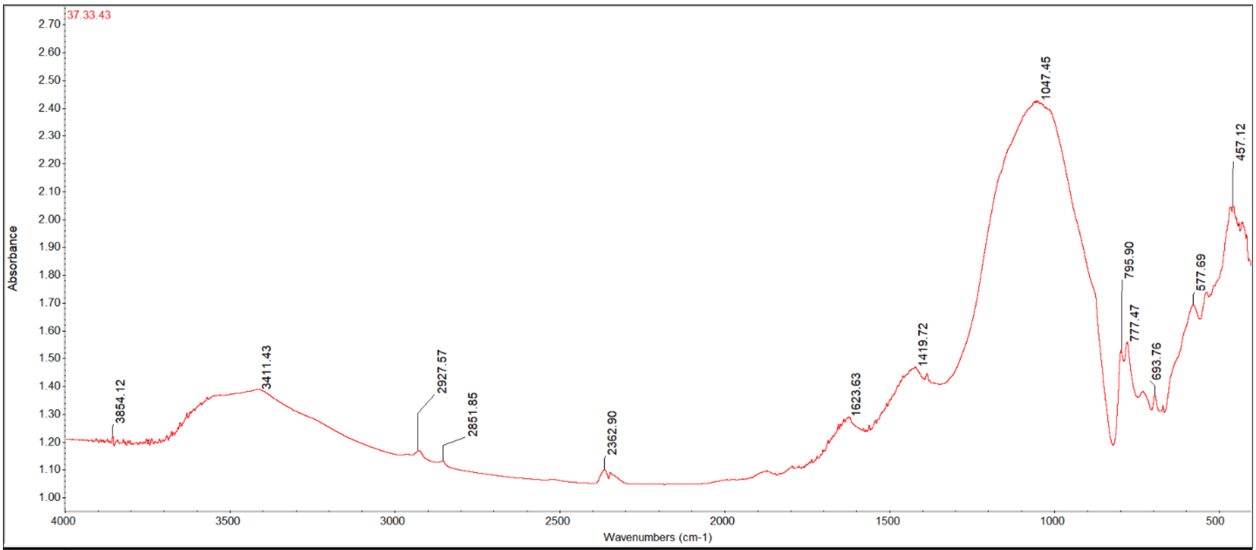

535.1.1953.12.3
Absorbance
Wavenumbers (cm-1)
3853.89
3447.21
2522.34
2360.90
2341.03
1793.06
1635.92
1456.92
1063.27
971.51
915.03
874.17
798.93
713.48
713.48
668.57
468.89

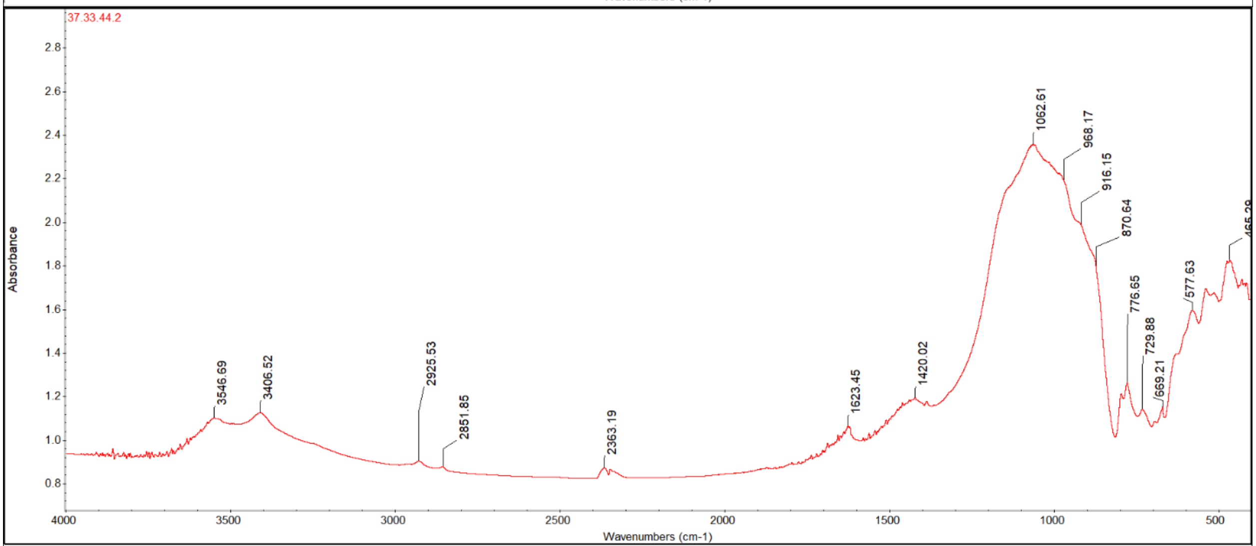

535.1.1953.13
Absorbance
Wavenumbers (cm-1)
3421.74
1636.21
1436.77
1047.02
875.19
797.28
694.15
462.34

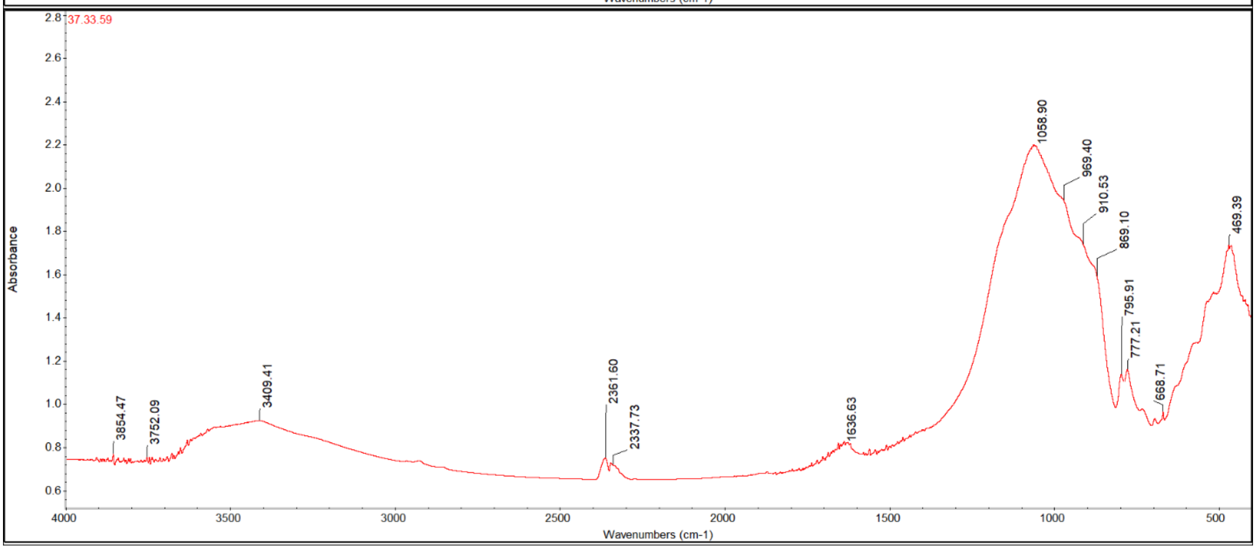

535.1.1953.18.2
Absorbance
Wavenumbers (cm-1)
3422.69
2515.53
2362.80
1795.05
1632.06
1425.31
1054.93
875.07
796.98
796.98
713.25
694.11
458.15


535.1.1953.21
Absorbance
Wavenumbers (cm-1)
3422.10
2925.97
2852.24
2515.83
2361.95
2347.63
1794.00
1428.96
1074.18
970.53
873.65
669.12
630.46
712.99
669.12
469.50


535.1.1953.23
Absorbance
Wavenumbers (cm-1)
3854.16
3421.77
2927.57
2855.94
2364.33
1636.37
1430.30
1062.71
967.88
912.20
871.51
798.14
669.18
469.95


37.33.43
Absorbance
Wavenumbers (cm-1)
2.70
2.60
2.50
2.40
2.30
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
4000
3500
3000
2500
2000
1500
1000
500
3854.12
3411.43
2927.57
2851.85
2362.90
1623.63
1419.72
1047.45
795.90
777.47
693.76
577.69
457.12


37.33.44.2
Absorbance
Wavenumbers (cm-1)
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
4000
3500
3000
2500
2000
1500
1000
500
3546.69
3406.52
2925.53
2851.85
2363.19
1623.45
1420.02
1062.61
968.17
916.15
870.64
776.65
729.88
669.21
577.63


37.33.59
Absorbance
Wavenumbers (cm-1)
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
4000
3500
3000
2500
2000
1500
1000
500
3854.47
3752.09
3409.41
2361.60
2337.73
1636.63
1058.90
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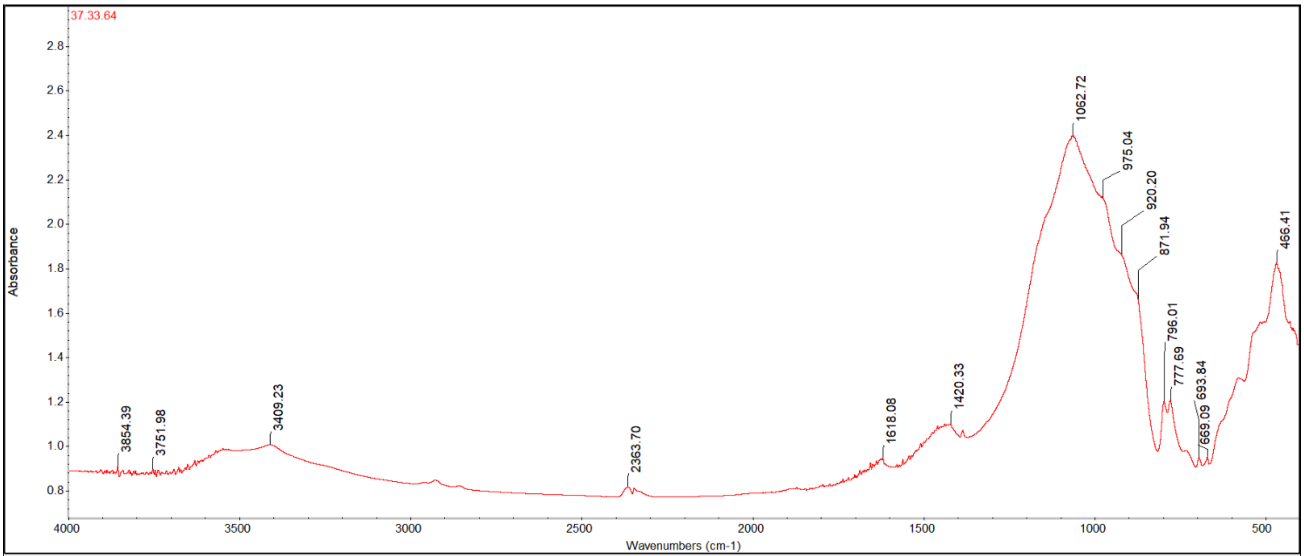
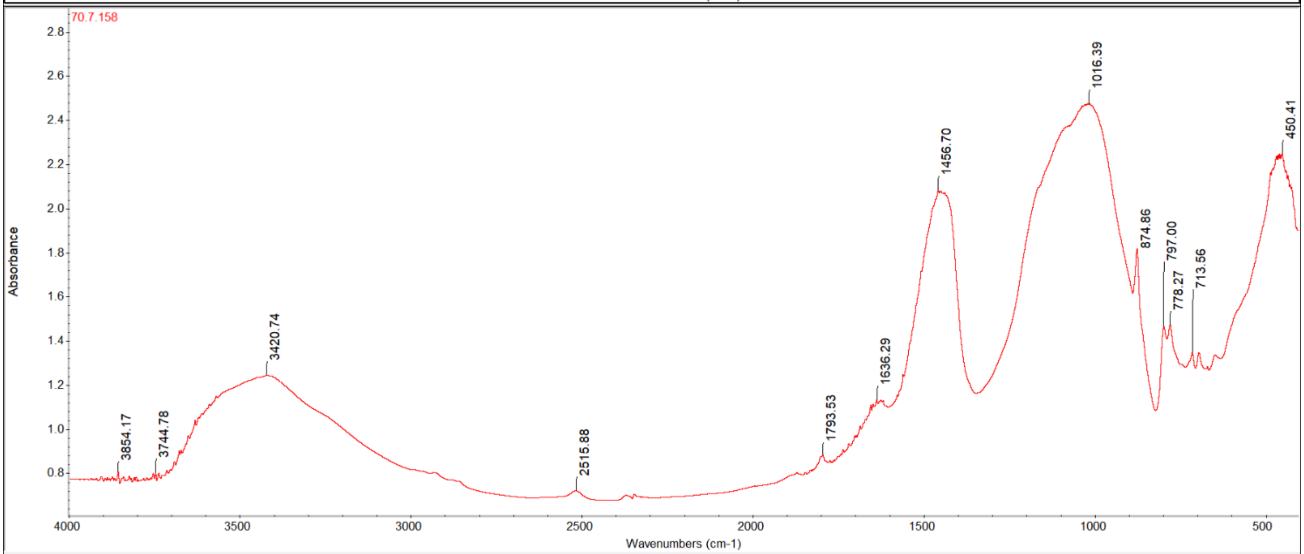
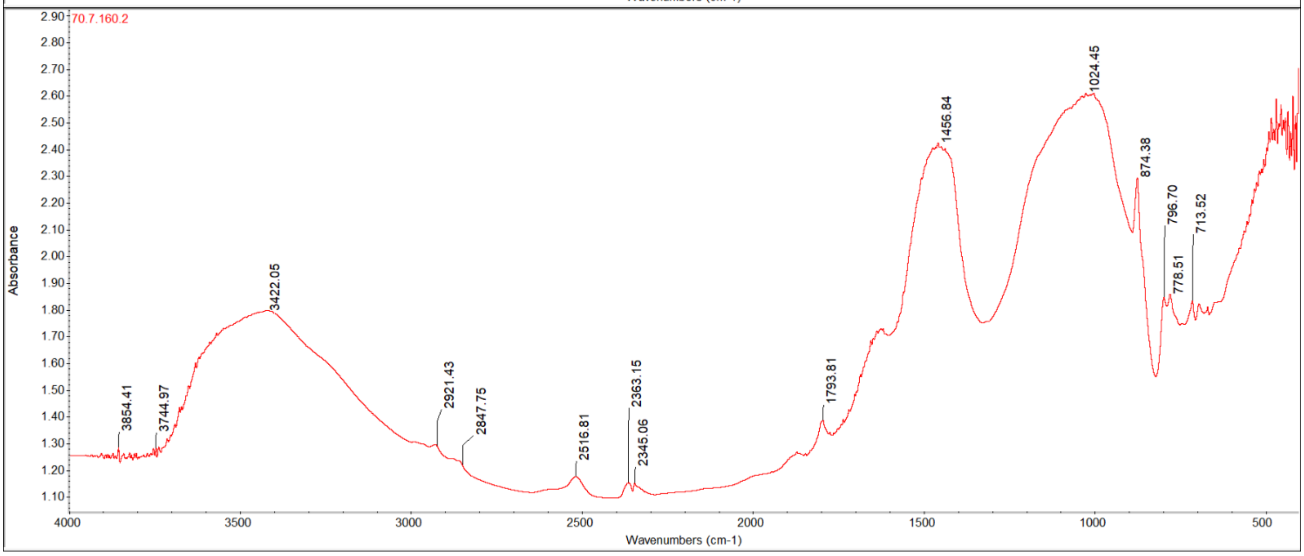
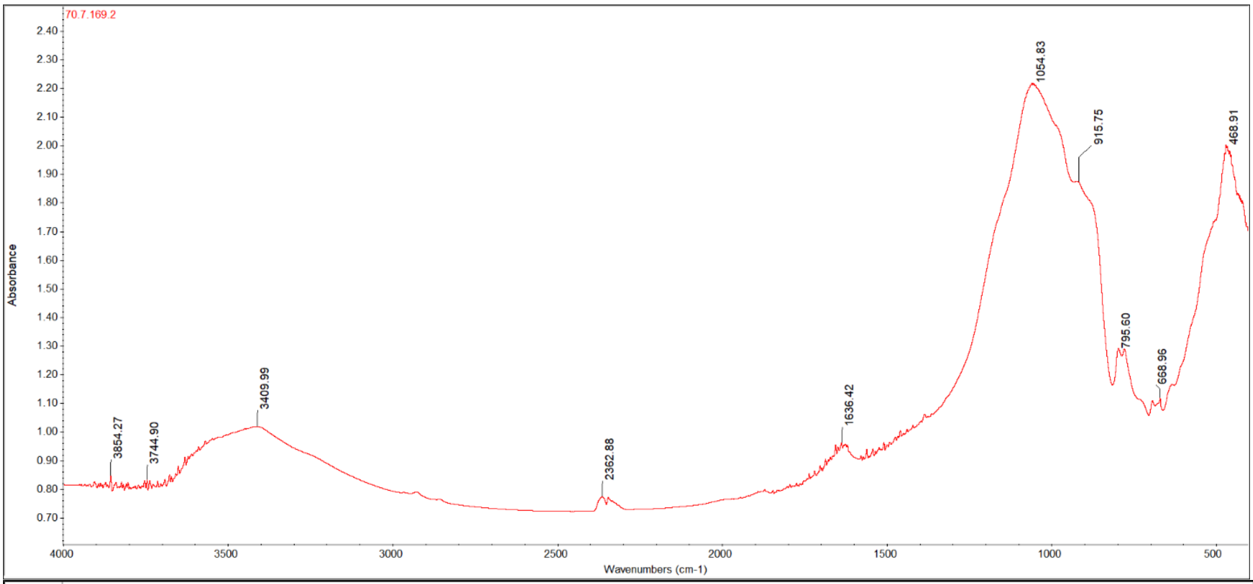
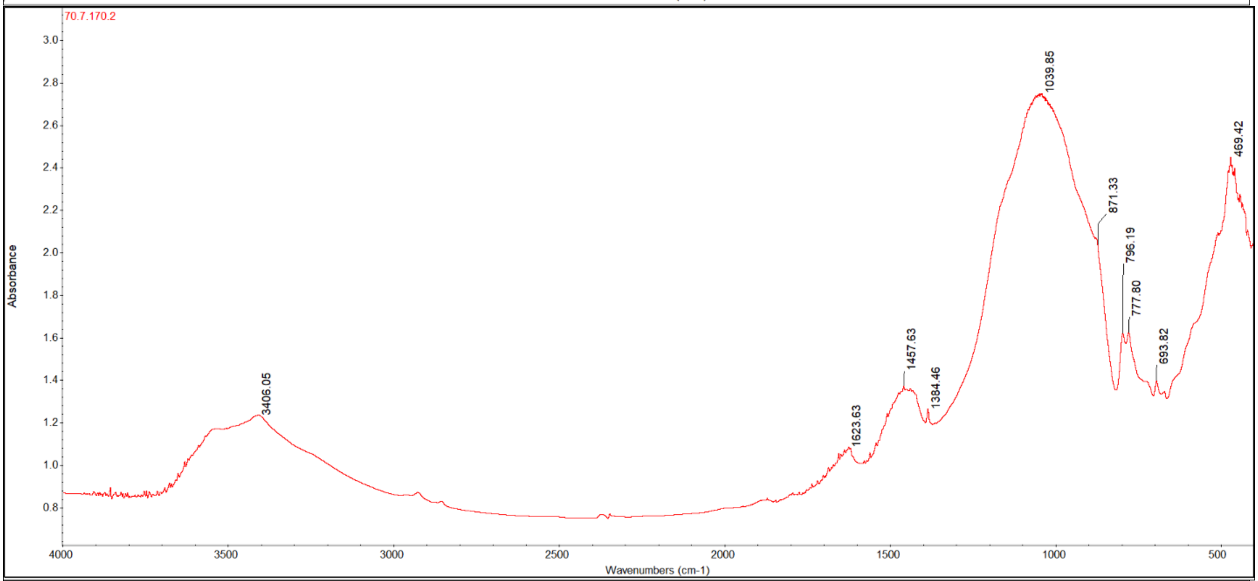
777.21
668.71
469.39

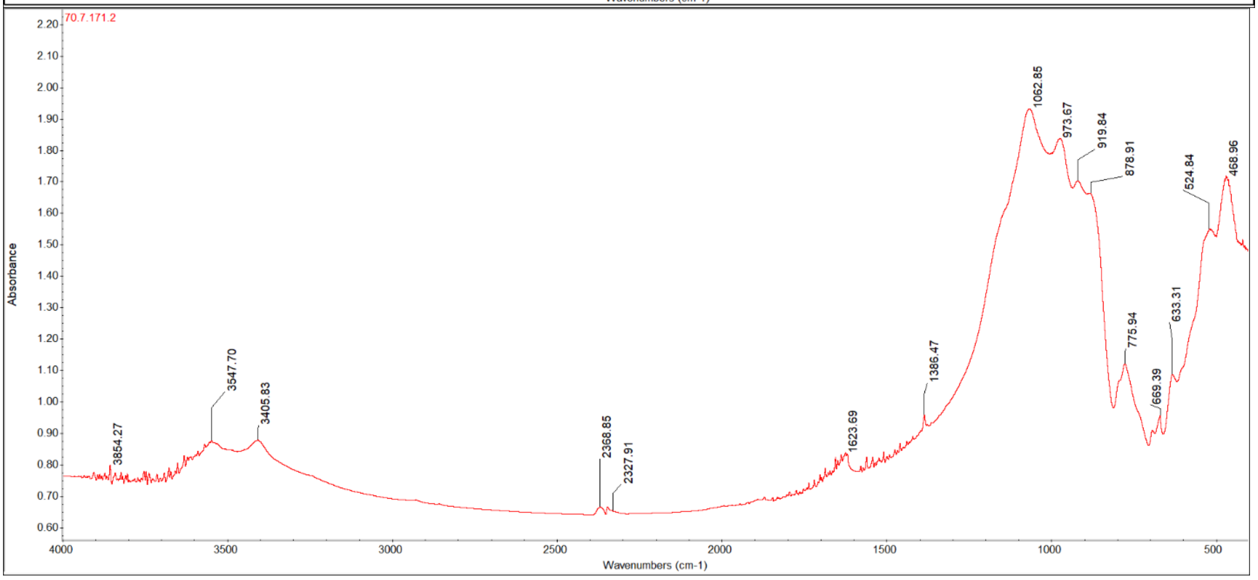

37.33.64
Absorbance
Wavenumbers (cm-1)
3854.39
3751.98
3409.23
2363.70
1618.08
1420.33
1062.72
975.04
920.20
871.94
796.01
777.69
693.84
669.09
466.41

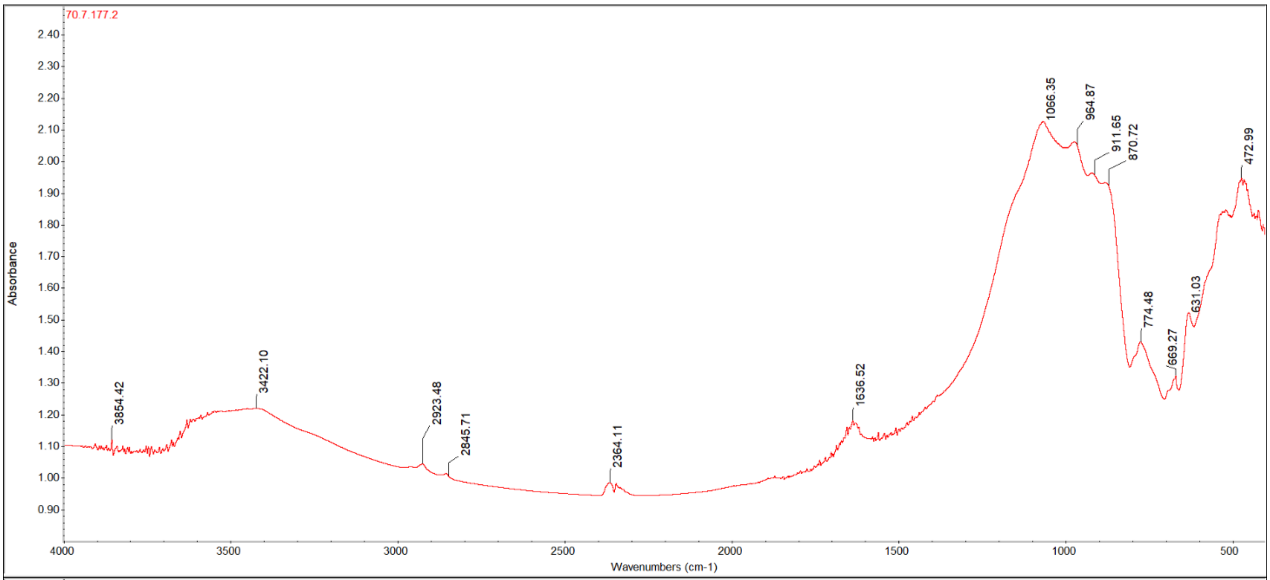

70.7.158
Absorbance
Wavenumbers (cm-1)
3854.17
3744.78
3420.74
2515.88
1793.53
1636.29
1456.70
1016.39
874.86
797.00
778.27
713.56
450.41

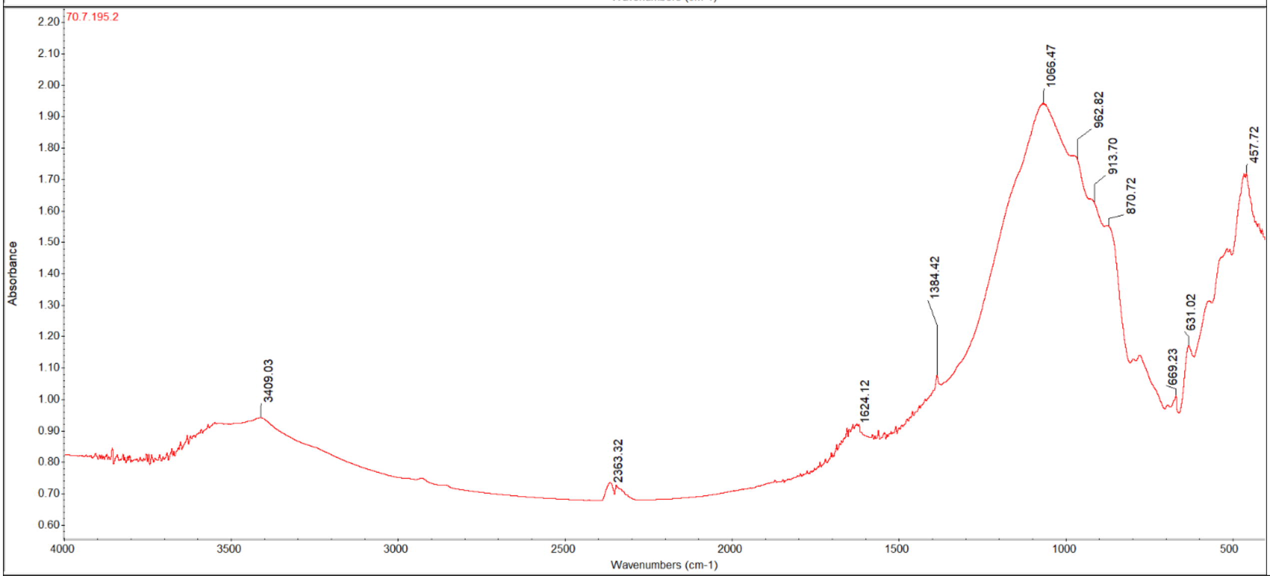

70.7.160.2
Absorbance
Wavenumbers (cm-1)
3854.41
3744.97
3422.05
2921.43
2847.75
2516.81
2363.15
2345.06
1793.81
1456.84
1024.45
874.38
796.70
778.51
713.52

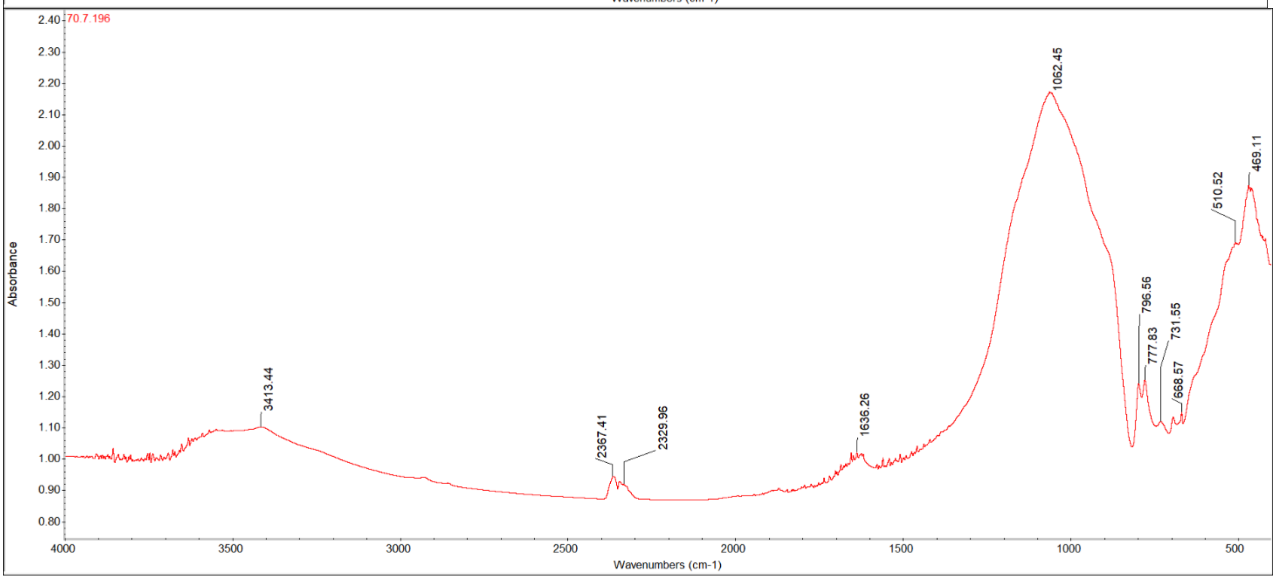

70.7.169.2
Absorbance
Wavenumbers (cm-1)
1054.83
915.75
468.91
795.60
668.96
3409.99
1636.42
3854.27
3744.90
2362.88

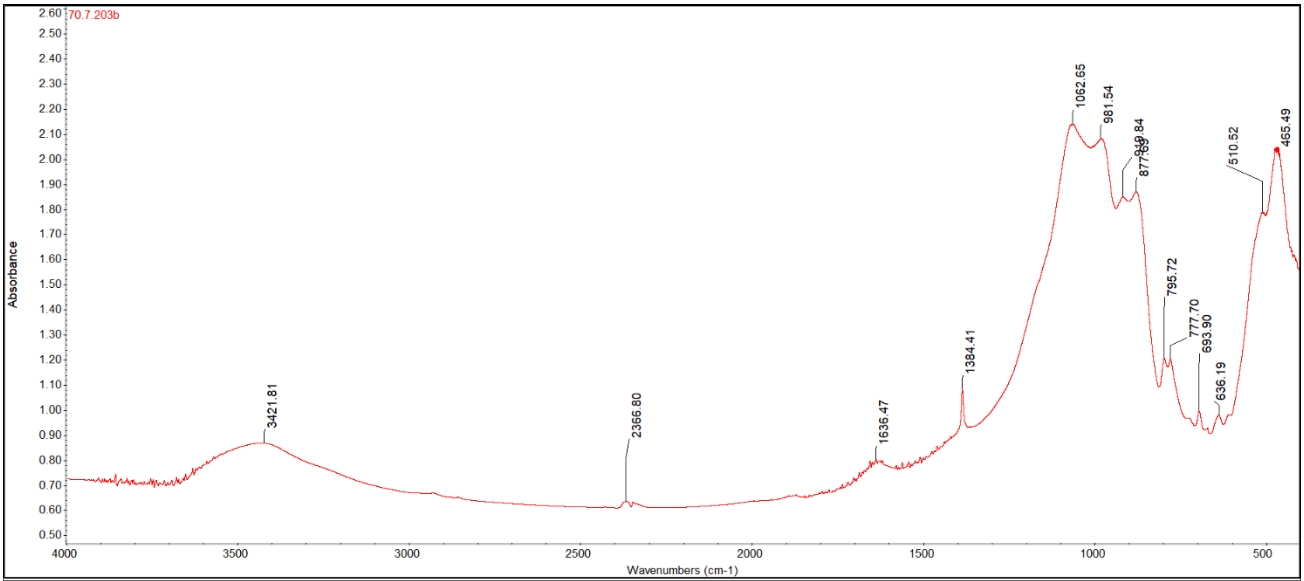

70.7.170.2
Absorbance
Wavenumbers (cm-1)
1039.85
469.42
871.33
796.19
777.80
693.82
1457.63
1384.46
3406.05
1623.63

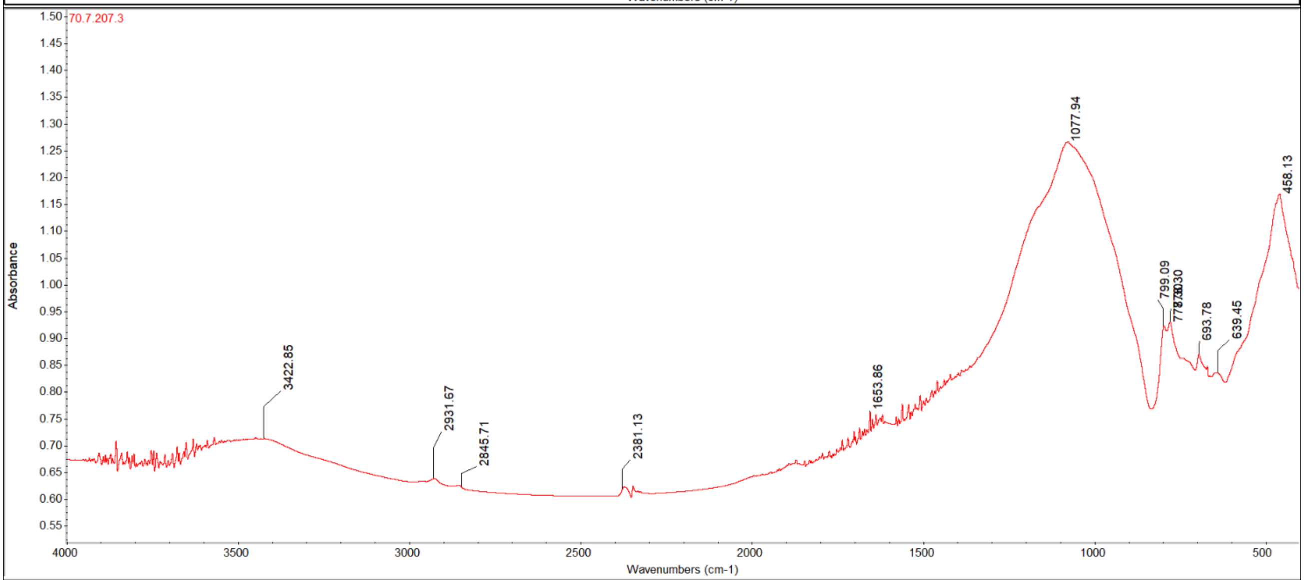

70.7.171.2
Absorbance
Wavenumbers (cm-1)
1062.85
973.67
919.84
878.91
524.84
468.96
633.31
775.94
669.39
1386.47
3547.70
3405.83
1623.69
3854.27
2368.85
2327.91


70.7.177.2
Absorbance
Wavenumbers (cm-1)
3854.42
3422.10
2923.48
2845.71
2364.11
1636.52
1066.35
964.87
911.65
870.72
774.48
669.27
631.03
472.99


70.7.195.2
Absorbance
Wavenumbers (cm-1)
3409.03
2363.32
1624.12
1384.42
1066.47
962.82
913.70
870.72
669.23
631.02
457.72


70.7.196
Absorbance
Wavenumbers (cm-1)
3413.44
2367.41
2329.96
1635.26
1062.45
796.56
777.83
731.55
668.57
510.52
469.11


70.7.203b
Absorbance
Wavenumbers (cm-1)
3421.81
2366.80
1636.47
1384.41
1062.65
981.54
795.72
777.70
693.90
636.19
510.52
465.49


70.7.207.3
Absorbance
Wavenumbers (cm-1)
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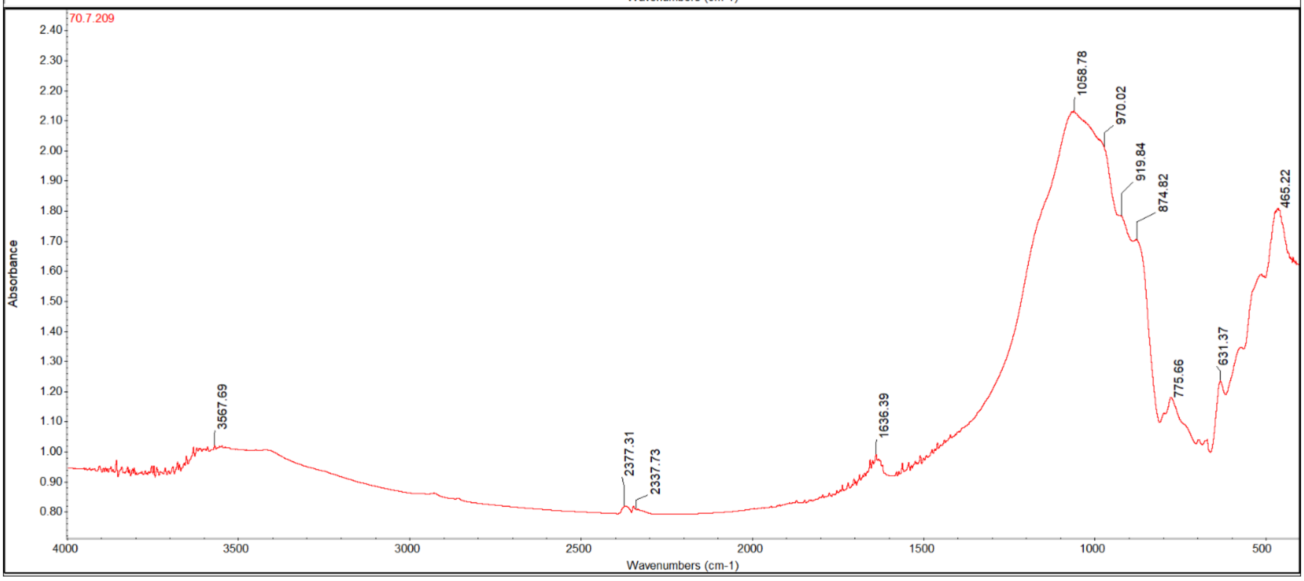
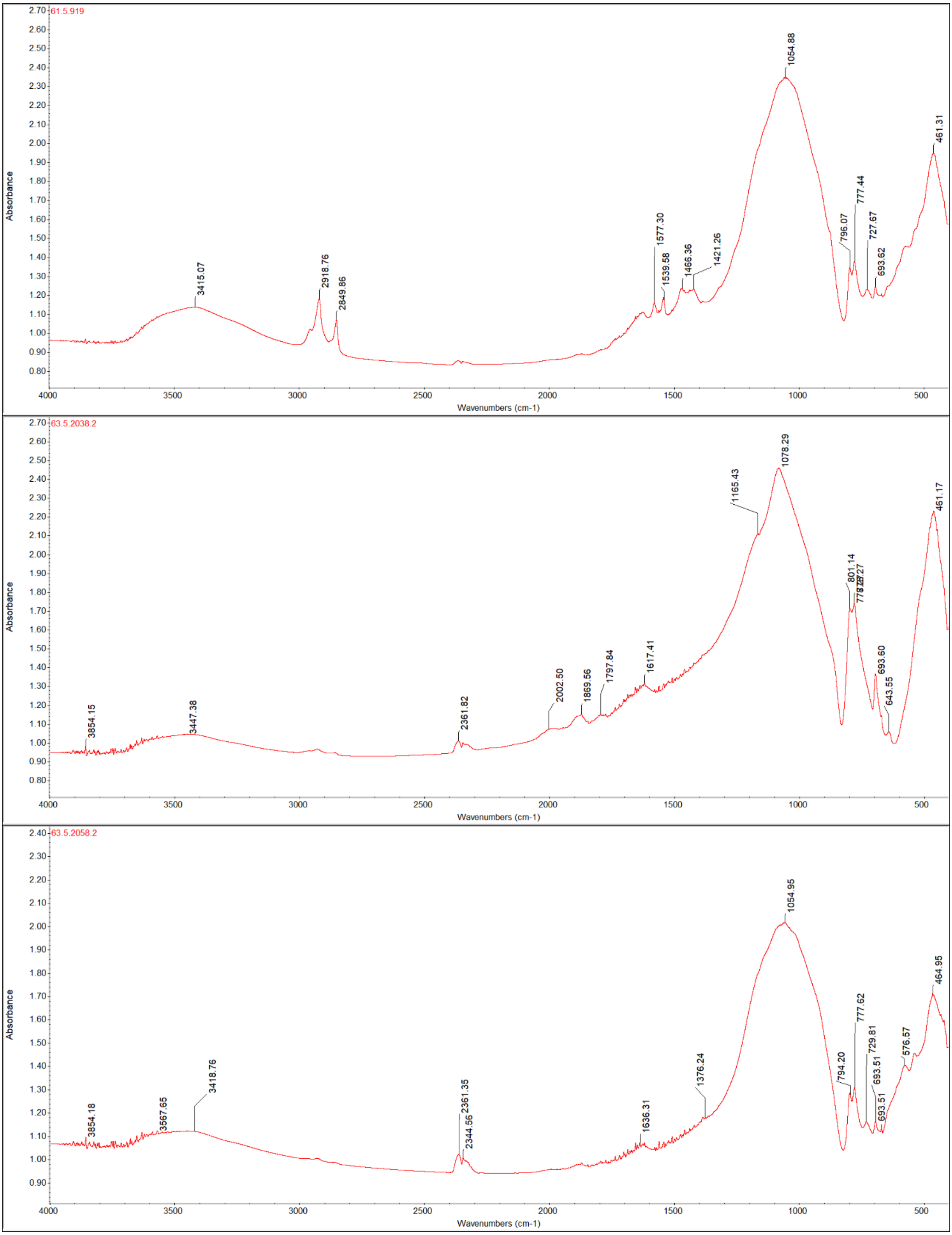
2931.67
2845.71
2381.13
1653.86
1077.94
799.09
693.78
639.45
458.13


70.7.209
Absorbance
Wavenumbers (cm-1)
3567.69
2377.31
2337.73
1636.39
1058.78
970.02
919.84
874.82
775.66
631.37
465.22


61.5.919
63.5.2038.2
63.5.2058.2
Absorbance
Wavenumbers (cm-1)
1054.88
461.31
777.44
796.07
727.67
693.62
1577.30
1539.58
1466.36
1421.26
3415.07
2918.76
2849.86
1078.29
1165.43
461.17
801.14
693.60
643.55
1617.41
1797.84
1869.56
2002.50
2361.82
3447.38
3854.15
1054.95
464.95
777.62
729.81
794.20
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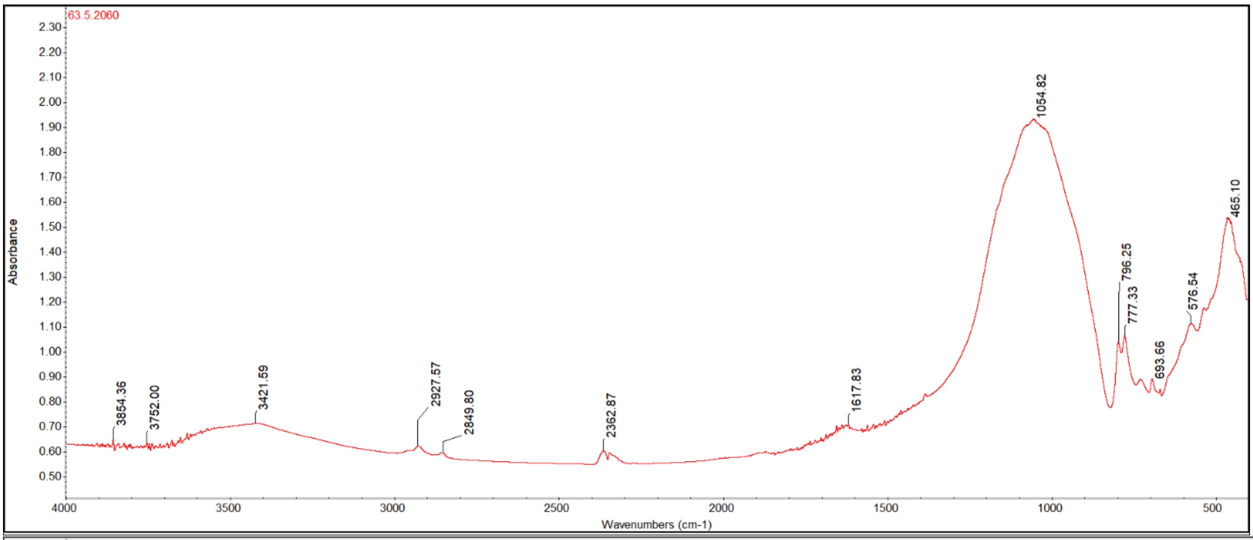
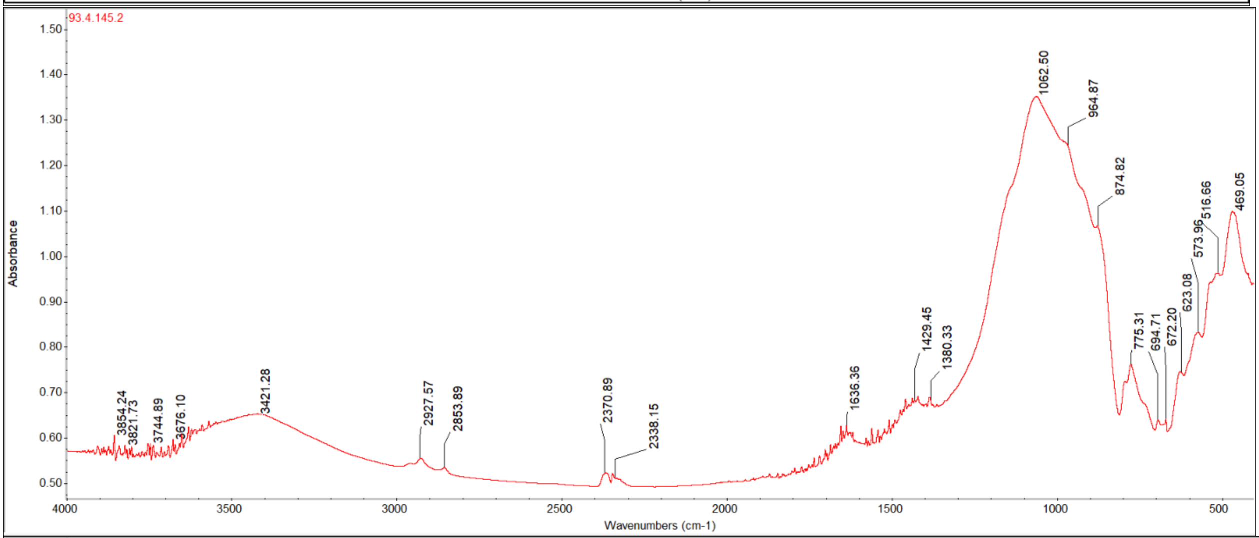
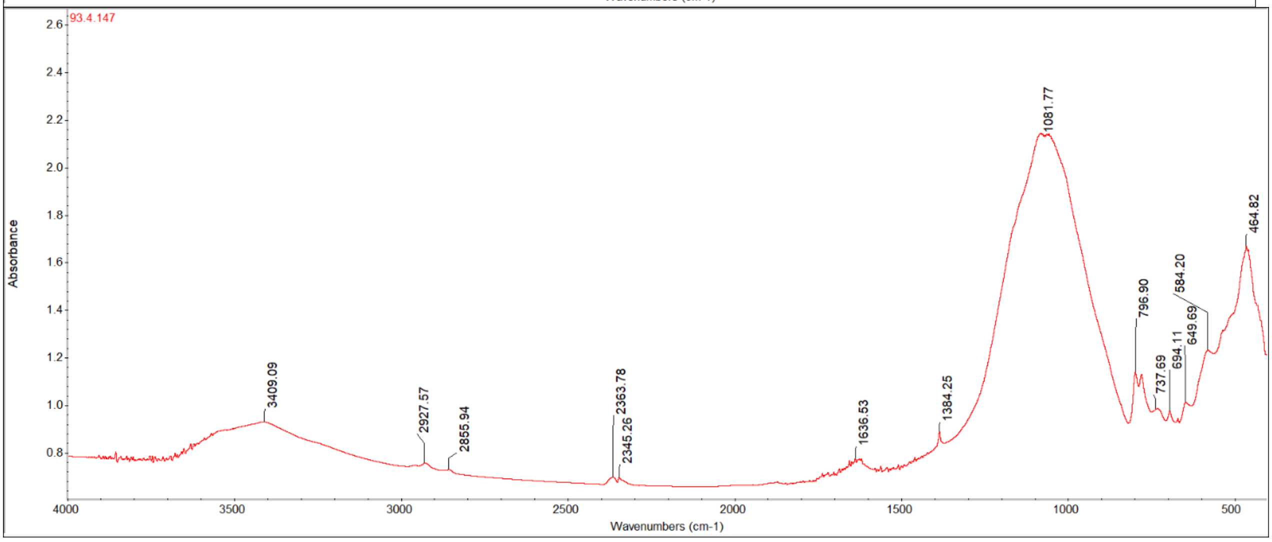
576.57
1376.24
1636.31
2361.35
2344.56
3418.76
3567.65
3854.18


63.5.2060
Absorbance
Wavenumbers (cm-1)
3854.36
3752.00
3421.59
2927.57
2849.80
2362.87
1617.83
1054.82
796.25
777.33
693.66
576.54
465.10


93.4.145.2
Absorbance
Wavenumbers (cm-1)
3854.24
3821.73
3744.89
3676.10
3421.28
2927.57
2853.89
2370.89
2338.15
1636.36
1429.45
1380.33
1062.50
964.87
874.82
775.31
694.71
672.20
623.08
573.96
516.66
469.05


93.4.147
Absorbance
Wavenumbers (cm-1)
3409.09
2927.57
2855.94
2363.78
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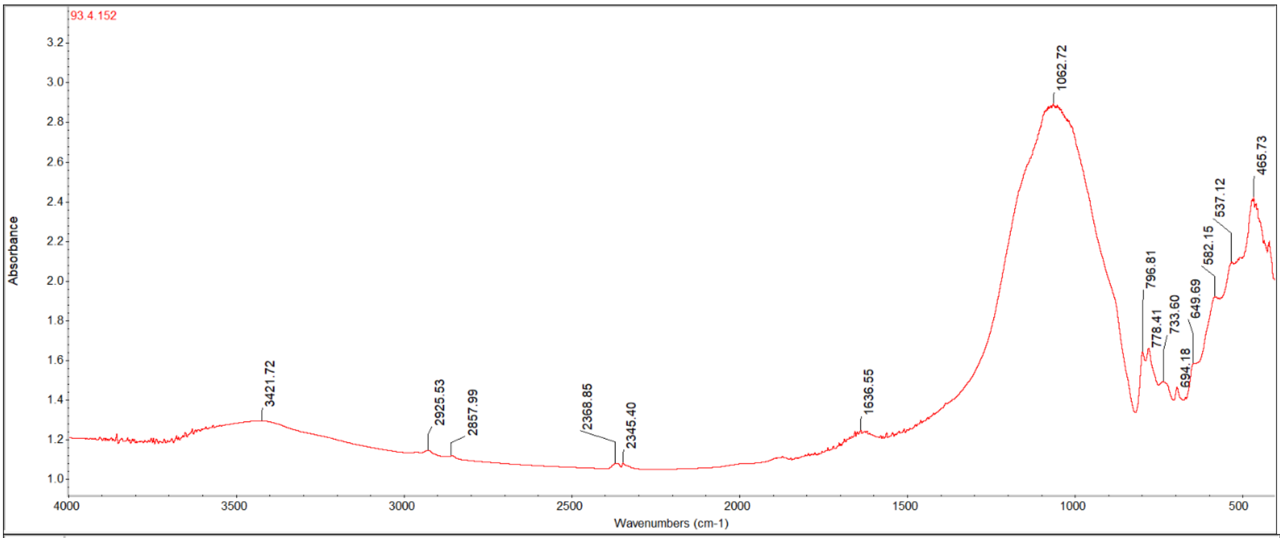
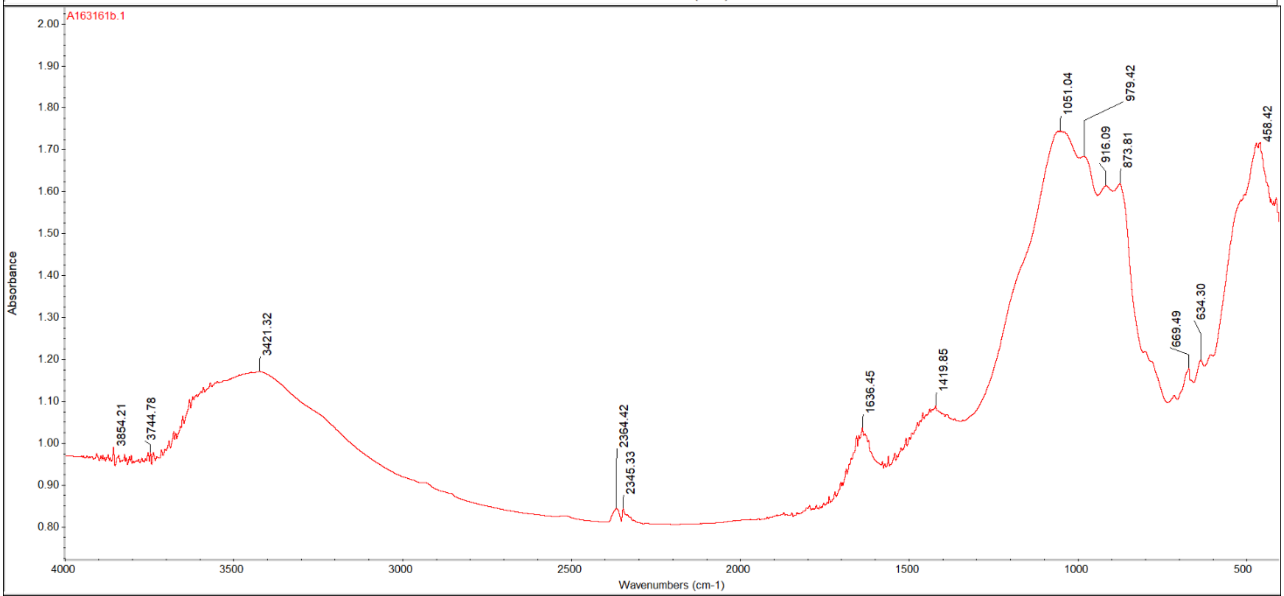
1636.53
1384.25
1081.77
796.90
737.69
694.11
649.69
584.20
464.82


93.4.152
Absorbance
Wavenumbers (cm-1)
3421.72
2925.53
2857.99
2368.85
2345.40
1636.55
1062.72
796.81
778.41
733.60
694.18
649.69
582.15
537.12
465.73


A163161b.1
Absorbance
Wavenumbers (cm-1)
3854.21
3744.78
3421.32
2364.42
2345.33
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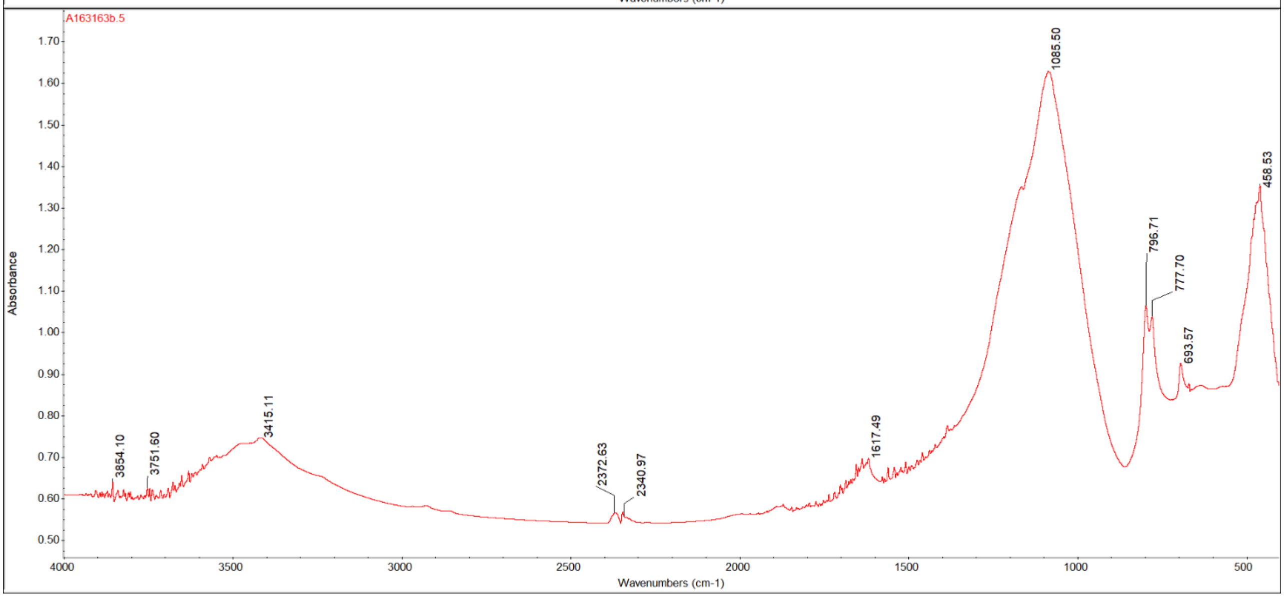
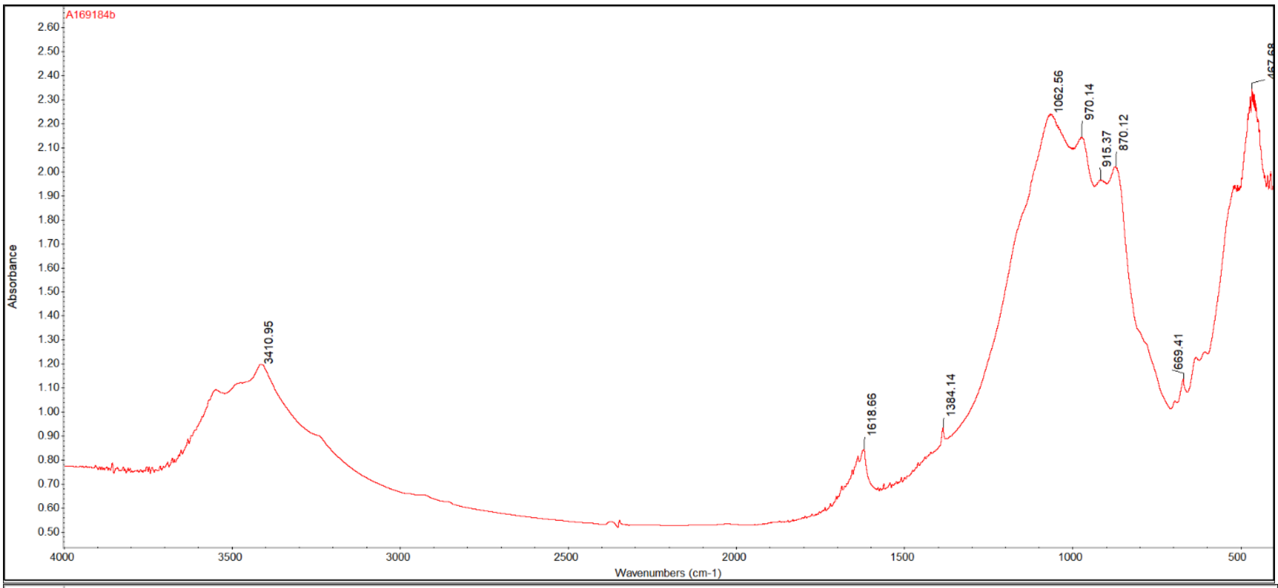
1419.85
1051.04
979.42
916.09
873.81
669.49
634.30
458.42


A163163b.5
Absorbance
Wavenumbers (cm-1)
3854.10
3751.60
3415.11
2372.63
2340.97
1617.49
1085.50
796.71
777.70
693.57
458.53


A169184b
Absorbance
Wavenumbers (cm-1)
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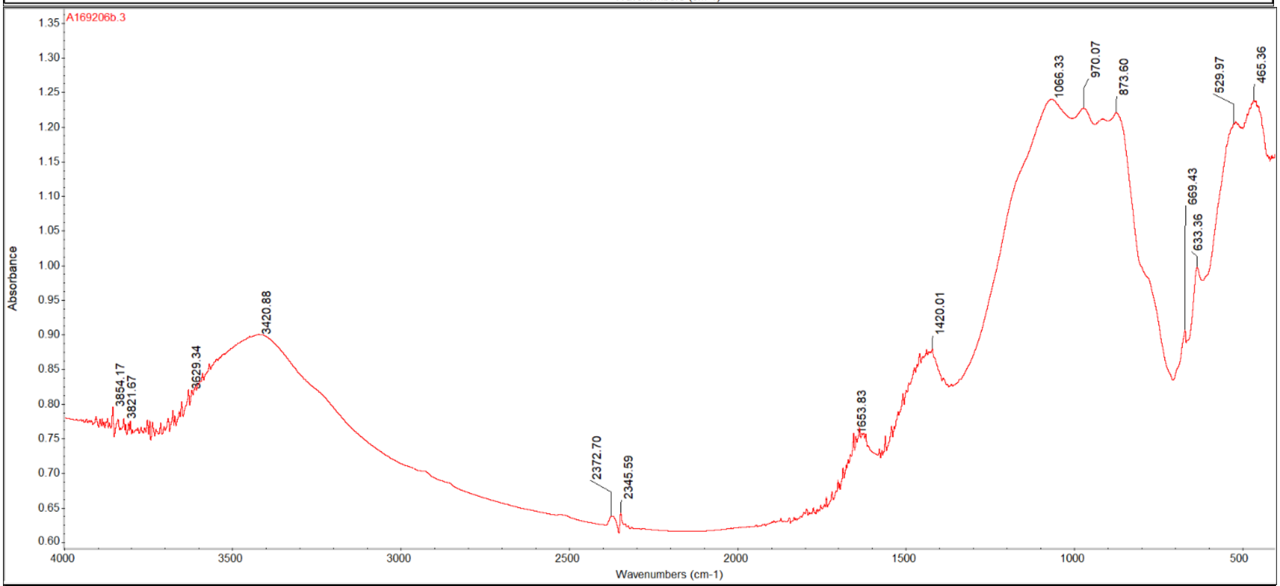
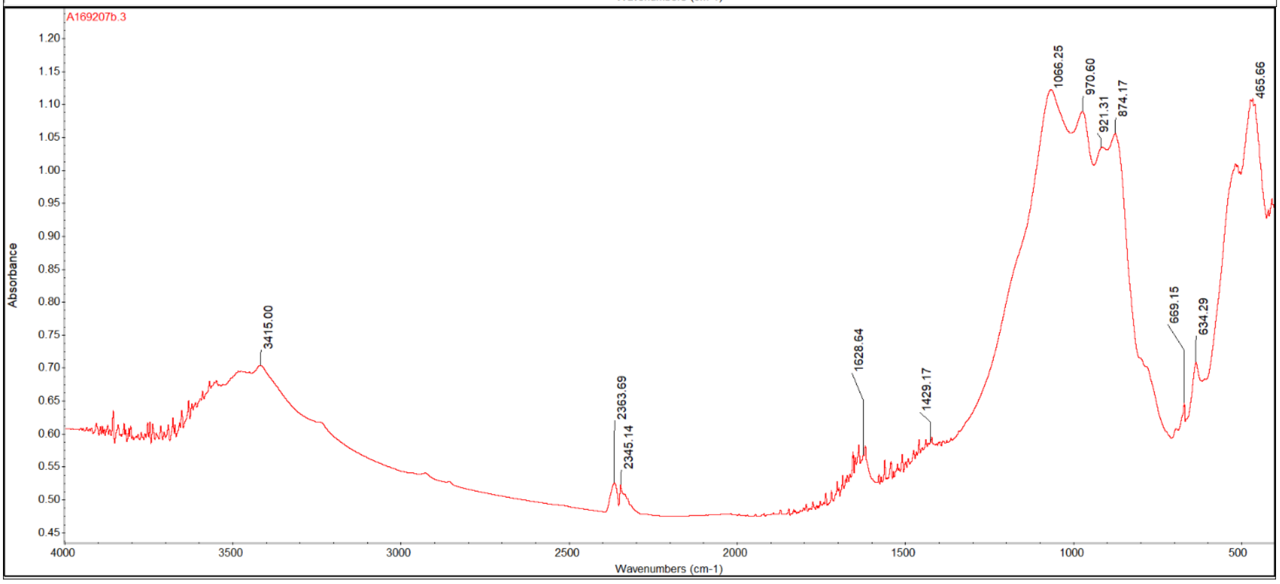
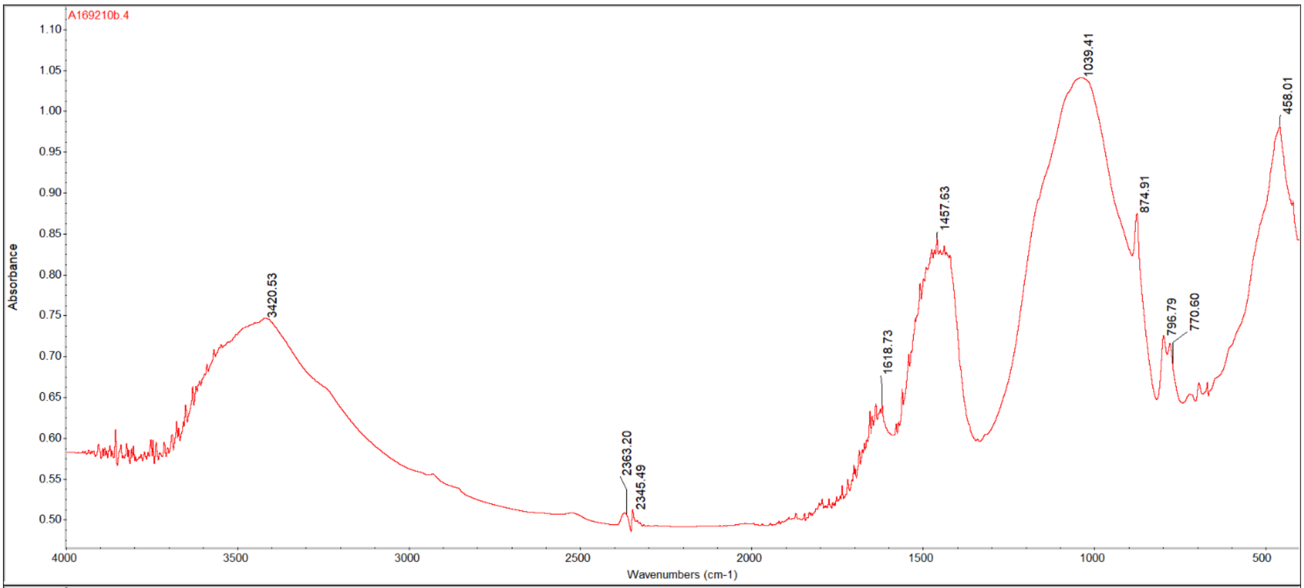
1618.66
1384.14
1062.56
970.14
915.37
870.12
669.41


A169206b.3
Absorbance
Wavenumbers (cm-1)
3854.17
3821.67
3629.34
3420.88
2372.70
2345.59
1653.83
1420.01
1066.33
970.07
873.60
669.43
633.36
529.97
465.36


A169207b.3
Absorbance
Wavenumbers (cm-1)
3415.00
2363.69
2345.14
1628.64
1429.17
1066.25
970.60
921.31
874.17
669.15
634.29
465.66


A169210b.4
Absorbance
Wavenumbers (cm-1)
3420.53
2363.20
2345.49
1618.73
1457.63
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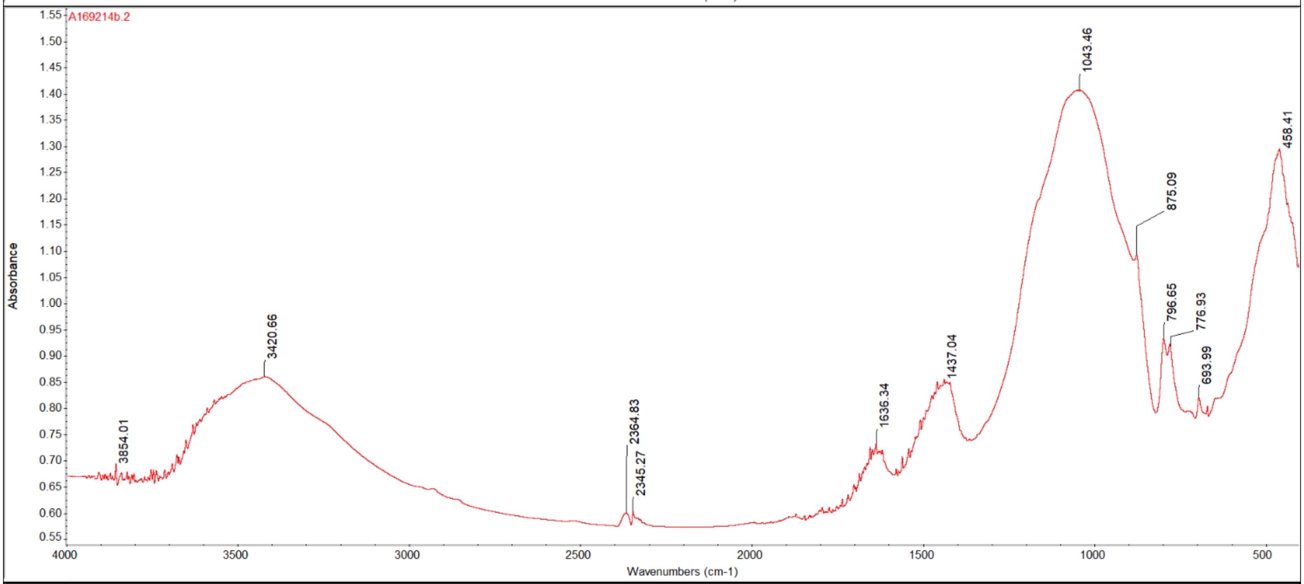
796.79
770.60
458.01


A169214b.2
Absorbance
Wavenumbers (cm-1)
3854.01
3420.66
2364.83
2345.27
1636.34
1437.04
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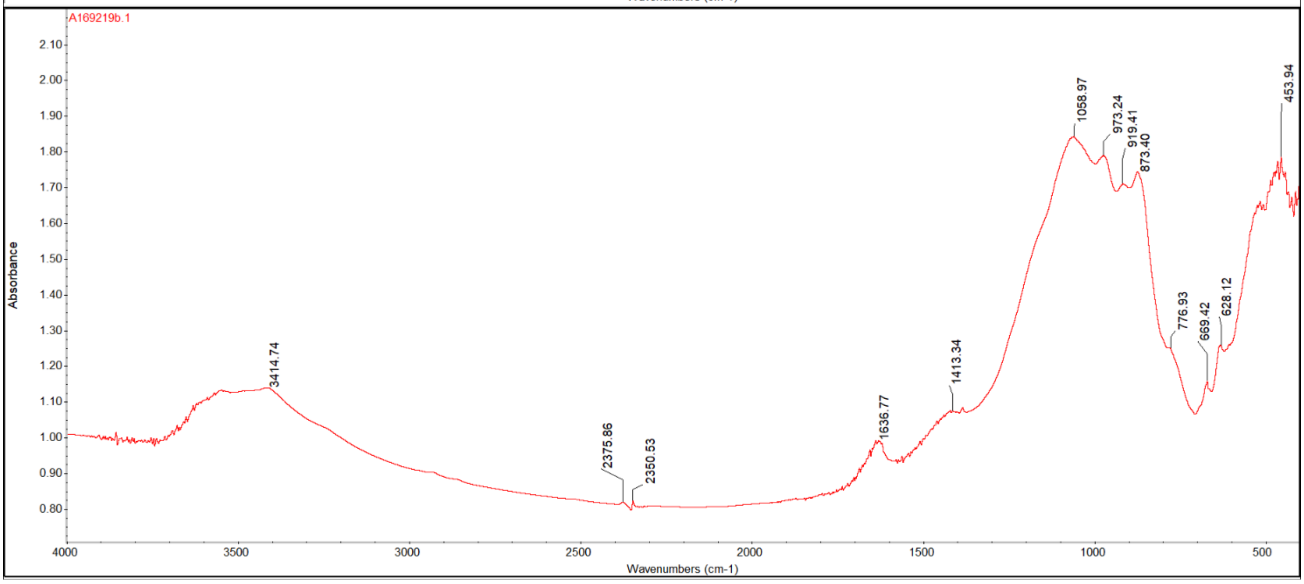
776.93
693.99
458.41


A169219b.1
Absorbance
Wavenumbers (cm-1)
3414.74
2375.86
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1413.34
1058.97
973.24
919.41
873.40
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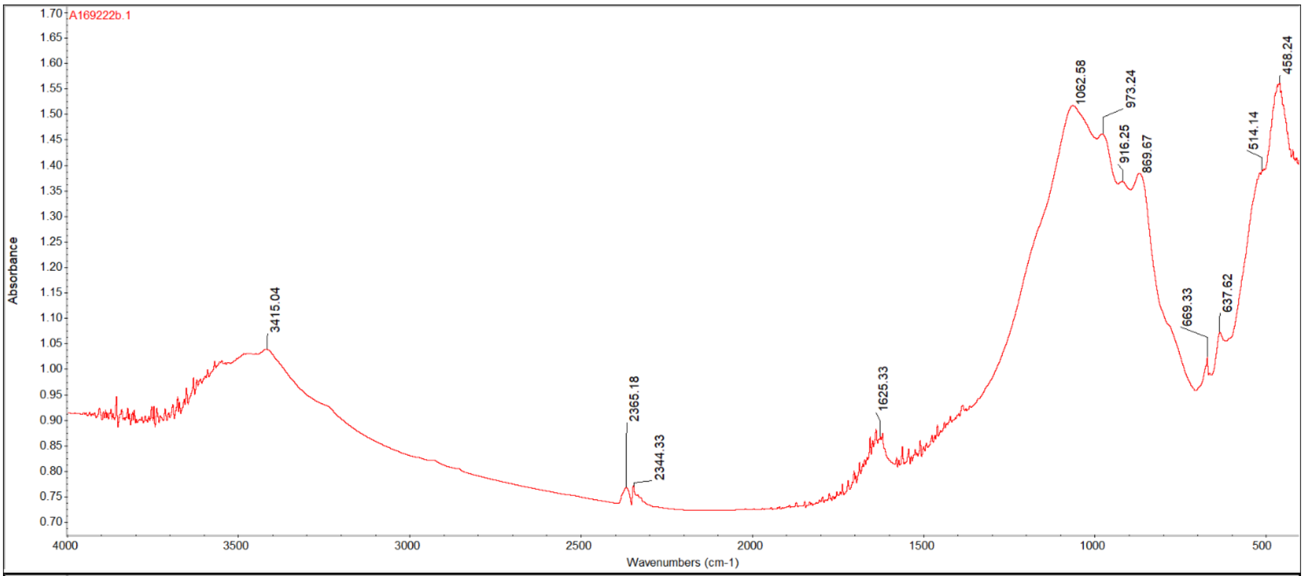
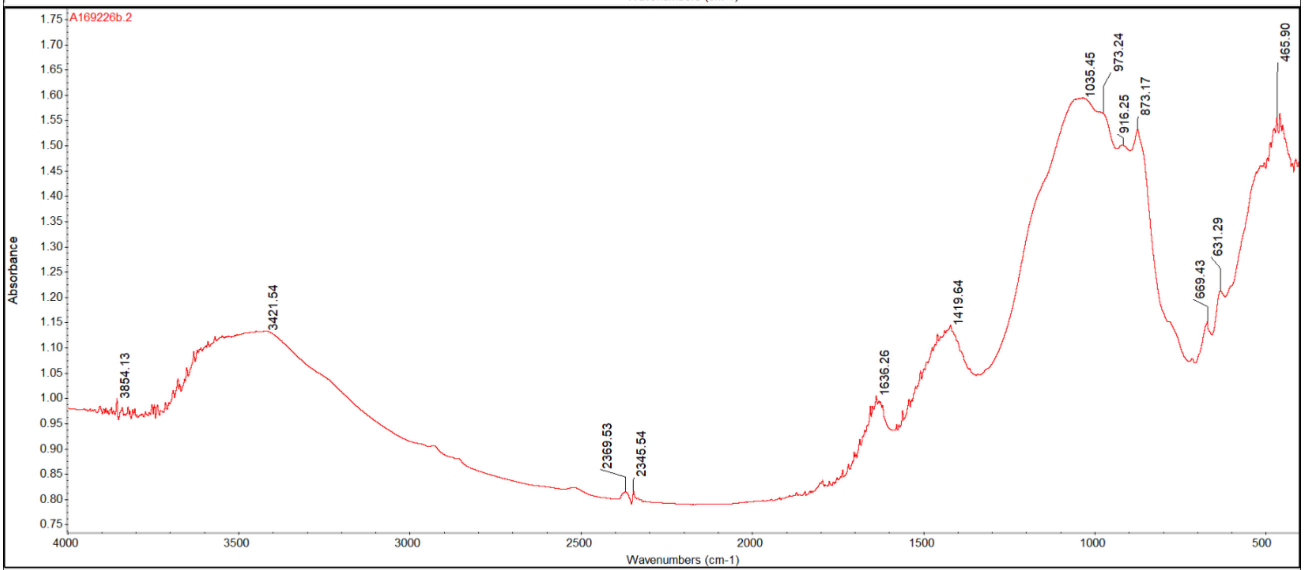
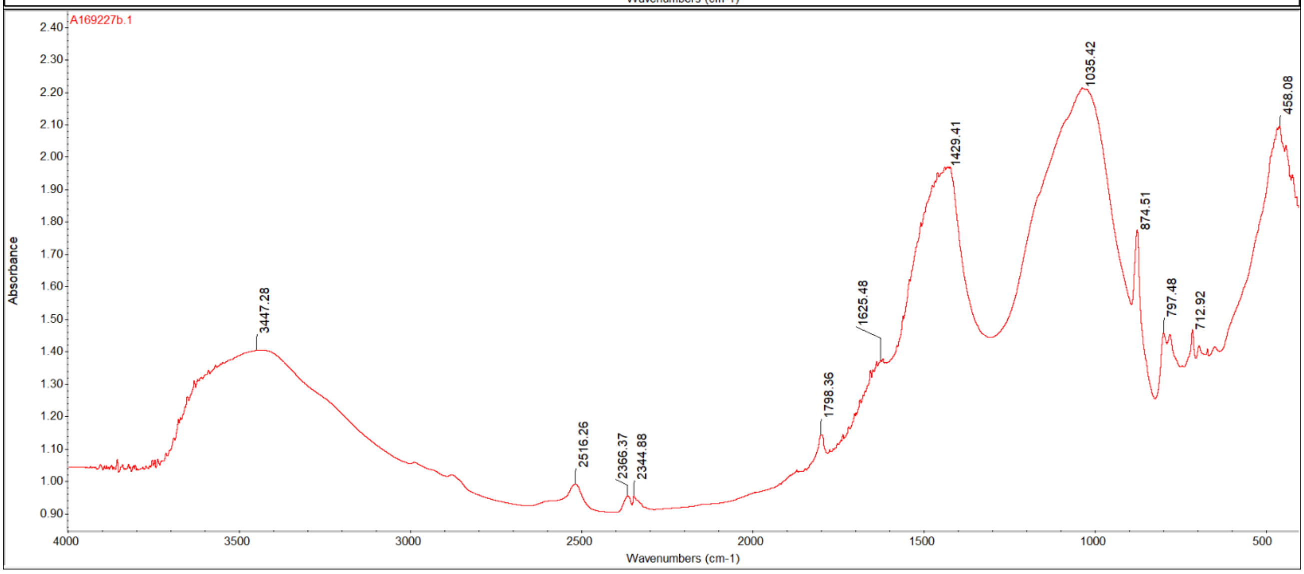
669.42
628.12
453.94



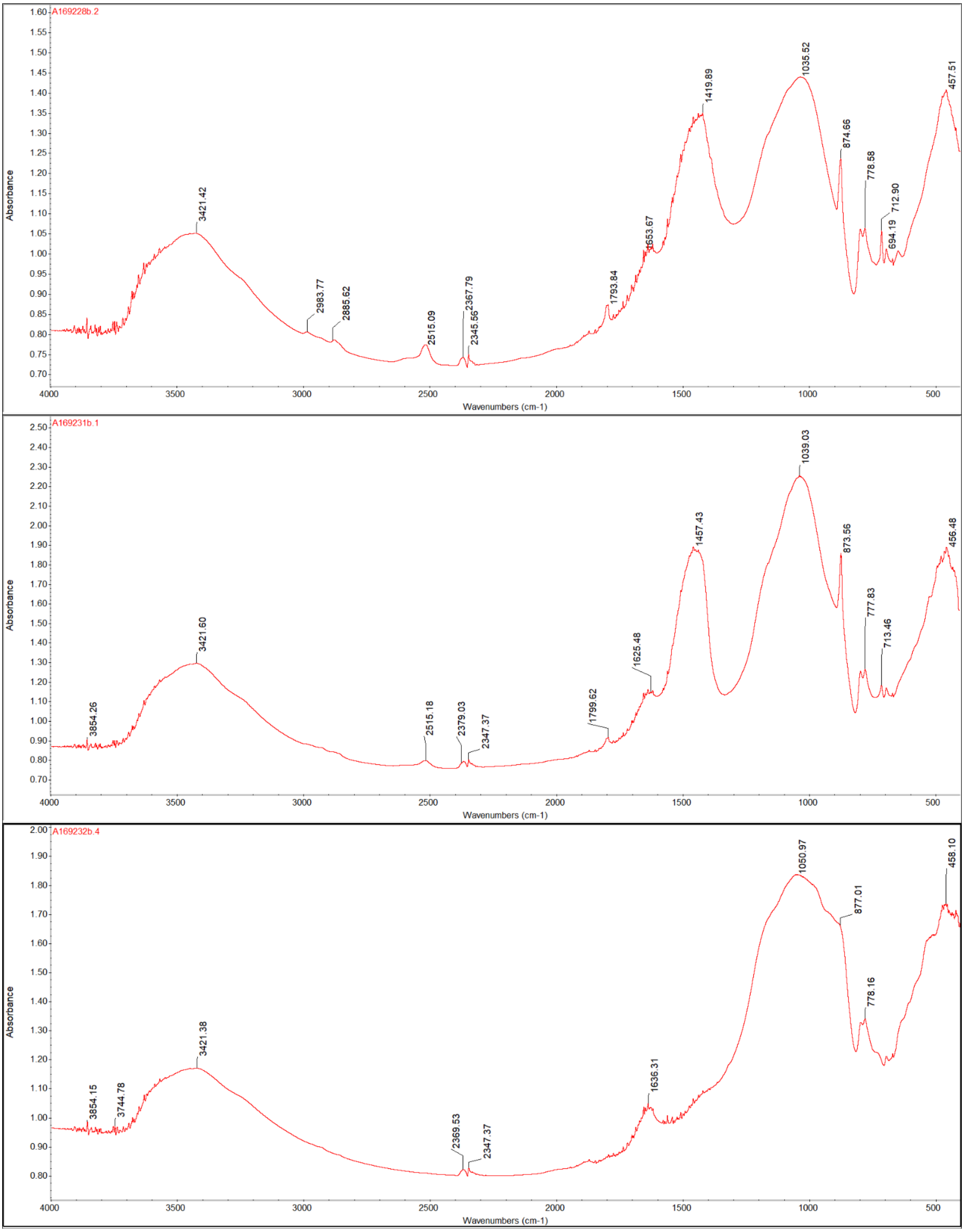
A169222b.1
Absorbance
Wavenumbers (cm-1)
3415.04
2365.18
2344.33
1625.33
1062.58
973.24
916.25
869.67
669.33
637.62
514.14
458.24

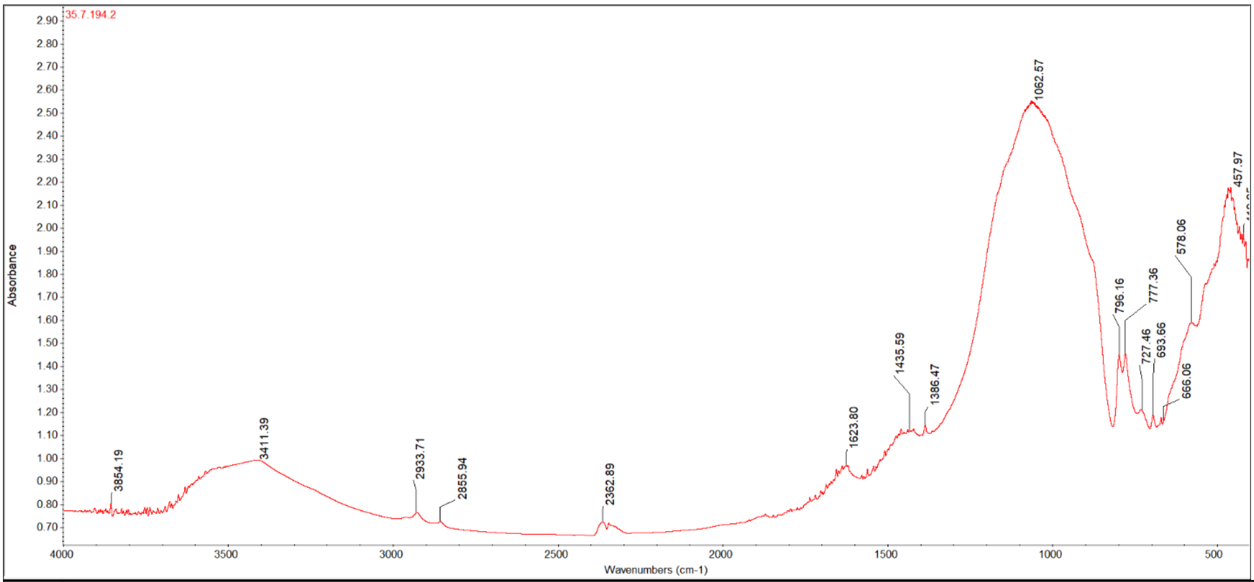


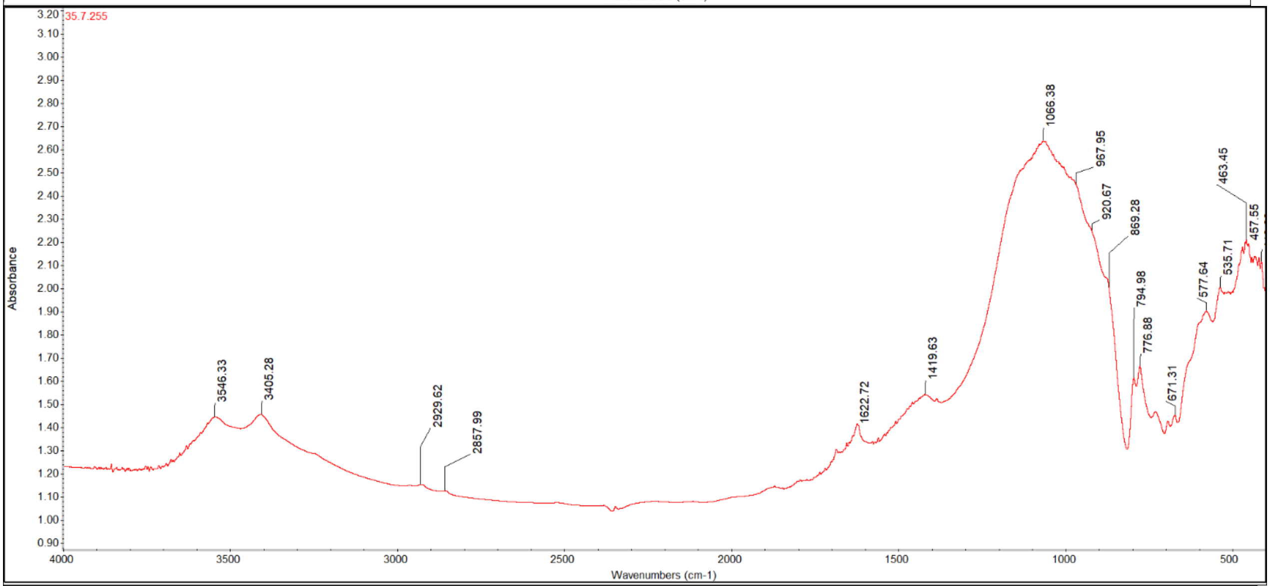
A169226b.2
Absorbance
Wavenumbers (cm-1)
3854.13
3421.54
2369.53
2345.54
1636.26
1419.64
1035.45
973.24
916.25
873.17
669.43
631.29
465.90

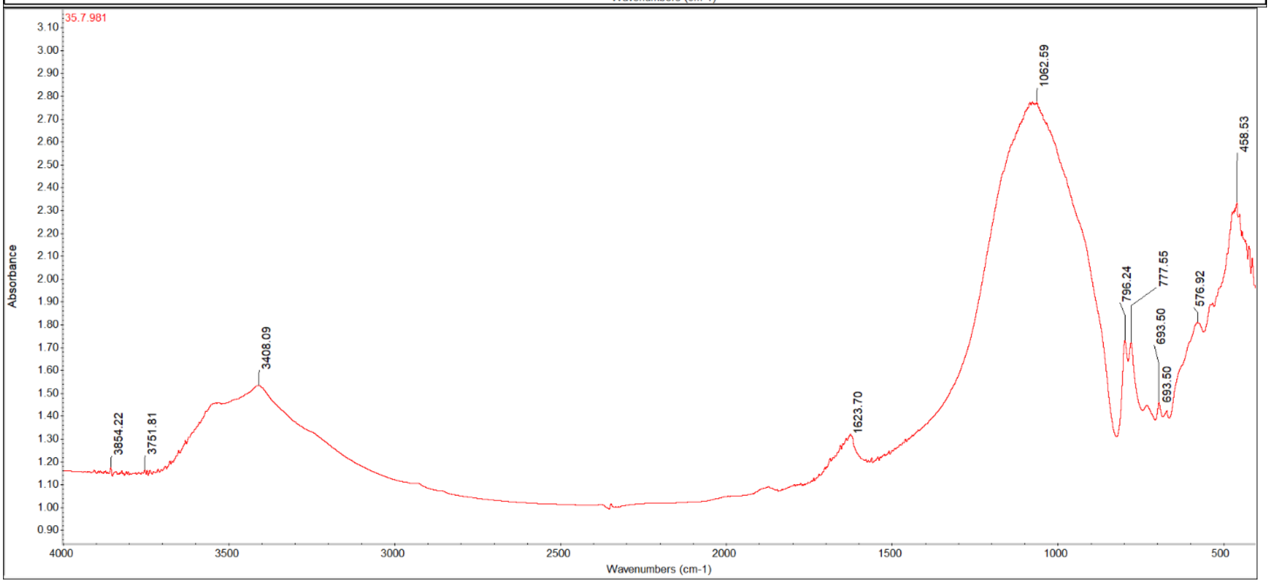


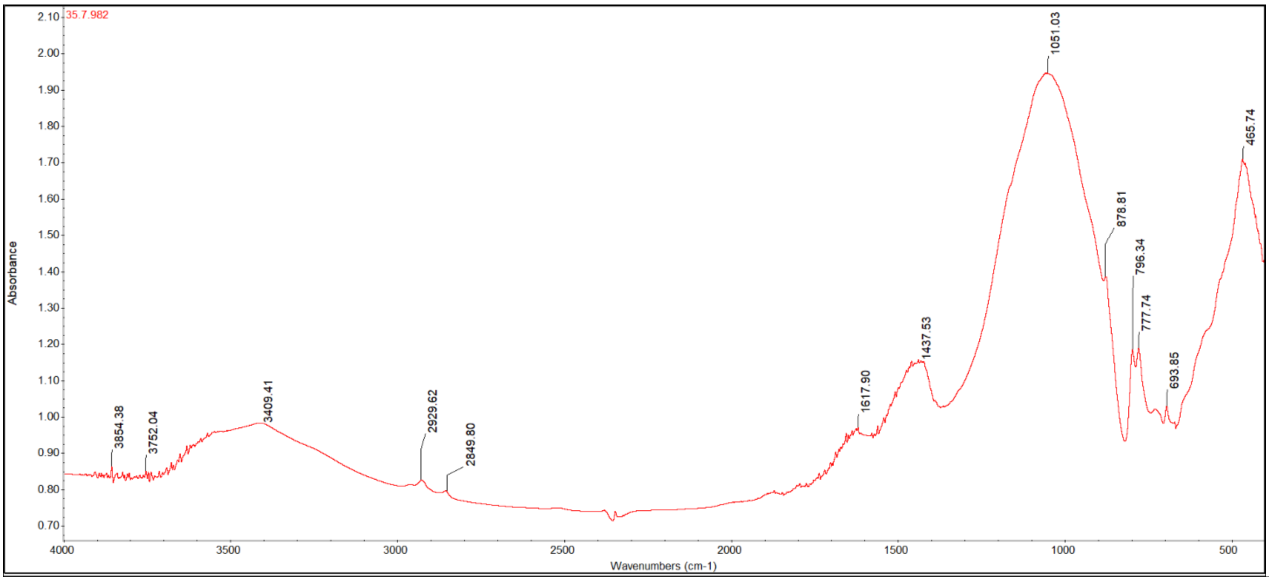
A169227b.1
Absorbance
Wavenumbers (cm-1)
3447.28
2516.26
2366.37
2344.88
1798.36
1625.48
1429.41
1035.42
874.51
797.48
712.92
458.08

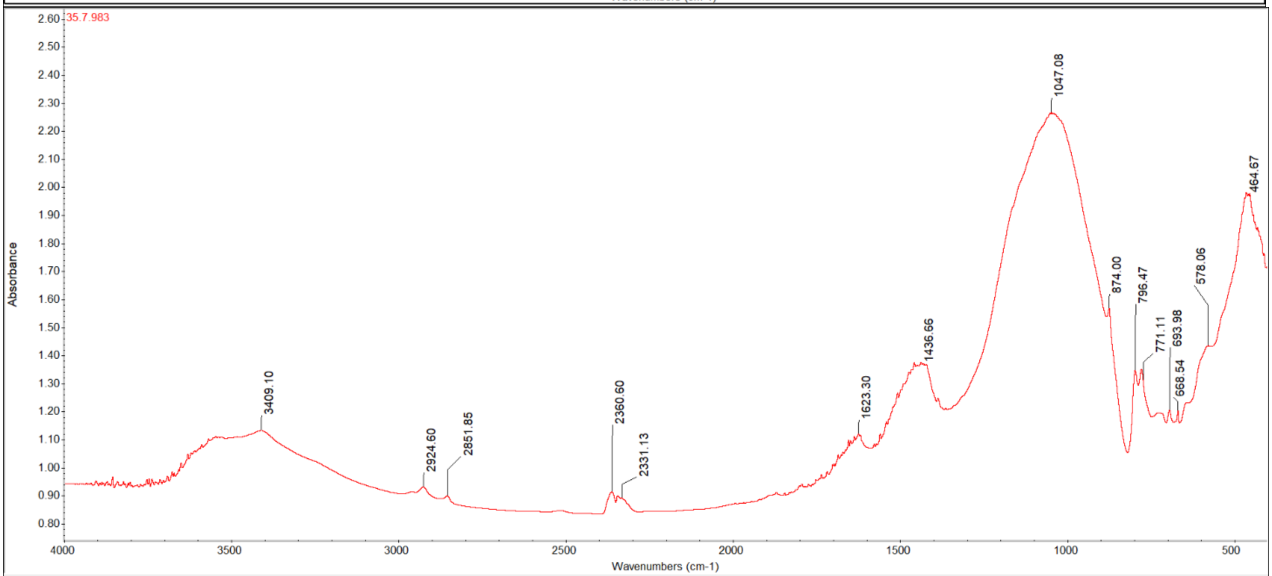

A169228b.2
Absorbance
3421.42
2983.77
2885.62
2515.09
2367.79
2345.56
1793.84
1653.67
1419.89
1035.52
874.66
778.58
712.90
694.19
457.51
Wavenumbers (cm-1)
A169231b.1
Absorbance
3854.26
3421.60
2515.18
2379.03
2347.37
1799.62
1625.48
1457.43
1039.03
873.56
777.83
713.46
456.48
Wavenumbers (cm-1)
A169232b.4
Absorbance
3854.15
3744.78
3421.38
2369.53
2347.37
1636.31
1050.97
877.01
778.16
458.10
Wavenumbers (cm-1)

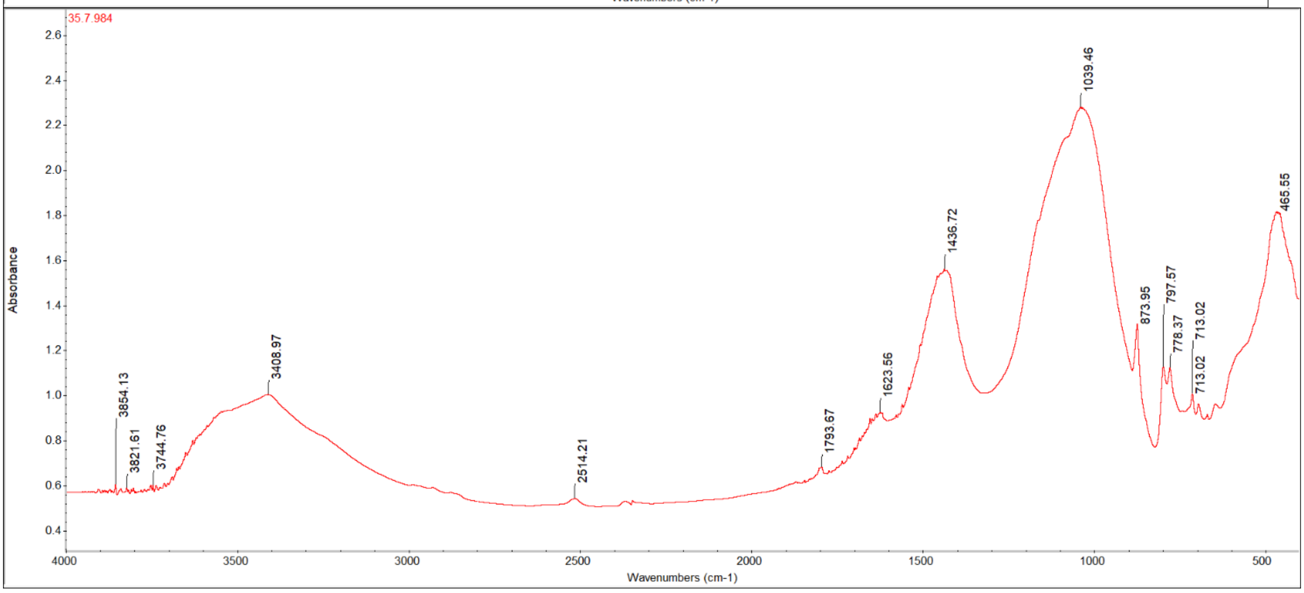

35.7.194.2
Absorbance
Wavenumbers (cm-1)
3854.19
3411.39
2933.71
2855.94
2362.89
1623.80
1435.59
1386.47
1062.57
796.16
777.36
727.46
693.66
666.06
578.06
457.97

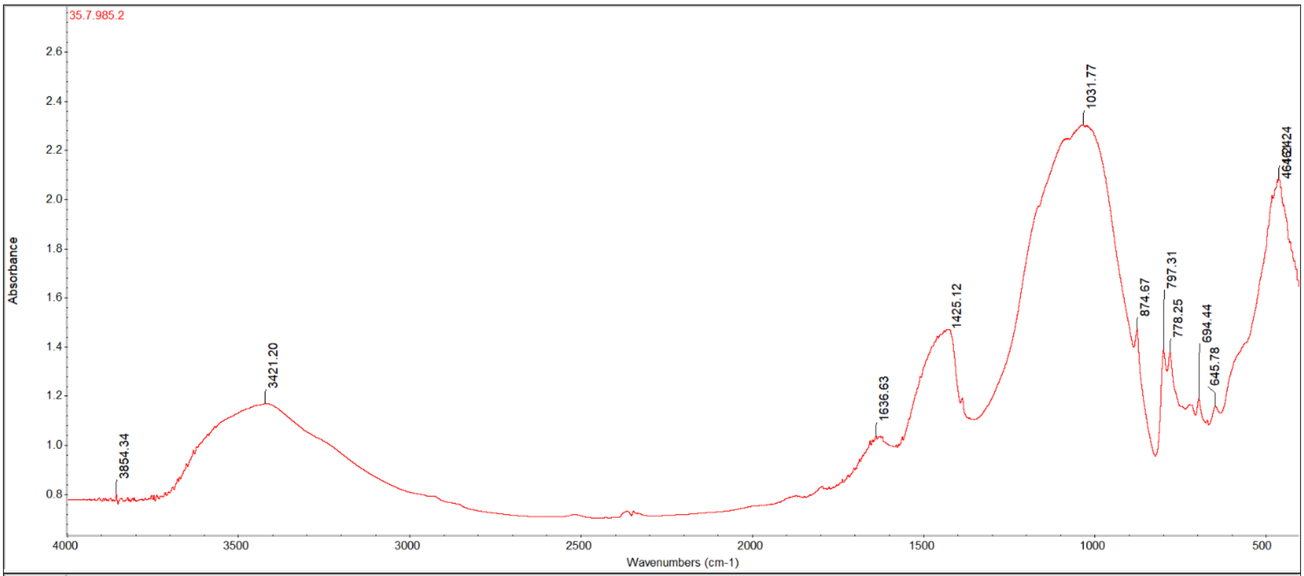

35.7.255
Absorbance
Wavenumbers (cm-1)
3546.33
3405.28
2929.62
2857.99
1622.72
1419.63
1066.38
967.95
920.67
869.28
794.98
776.88
671.31
577.64
535.71
463.45
457.55

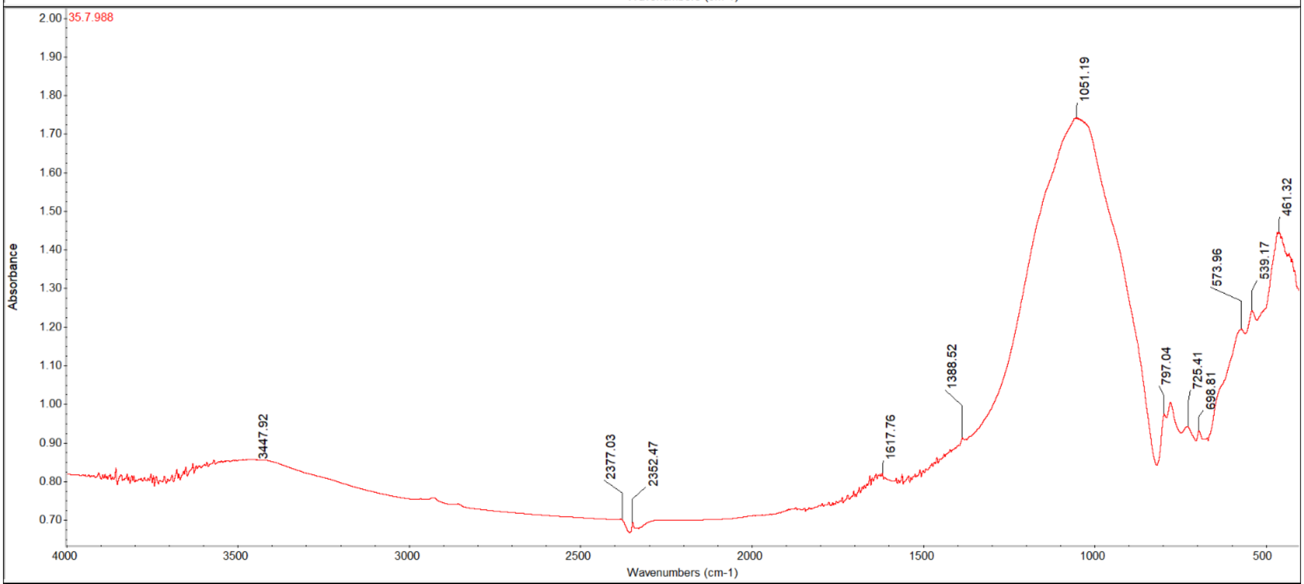

35.7.981
Absorbance
Wavenumbers (cm-1)
3854.22
3751.81
3408.09
1623.70
1062.59
796.24
777.55
693.50
693.50
576.92
458.53

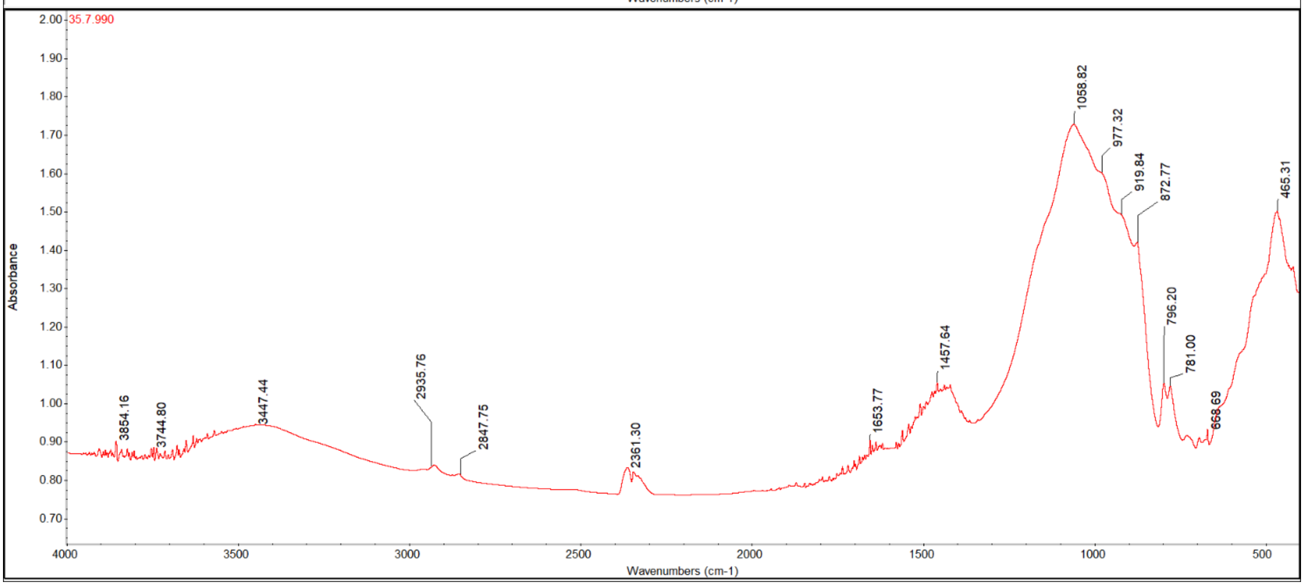

35.7.982
Absorbance
Wavenumbers (cm-1)
1051.03
465.74
878.81
796.34
777.74
693.85
1437.53
1617.90
3409.41
2929.62
2849.80
3854.38
3752.04

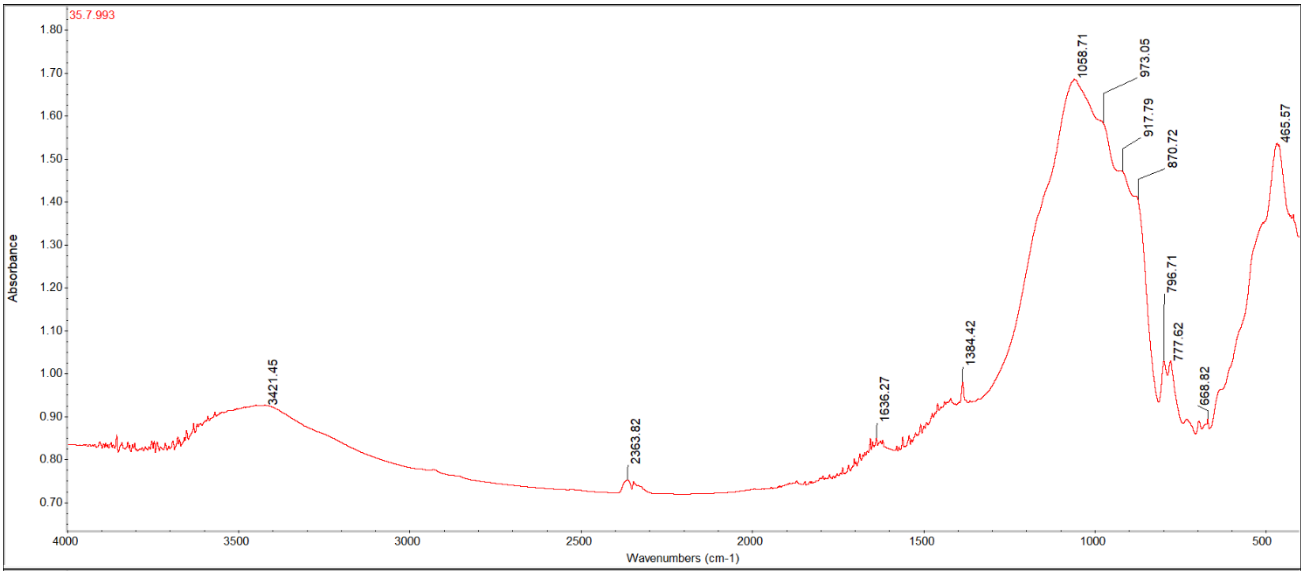

35.7.983
Absorbance
Wavenumbers (cm-1)
1047.08
464.67
578.06
874.00
796.47
771.11
693.98
668.54
1436.66
1623.30
3409.10
2360.60
2331.13
2924.60
2851.85

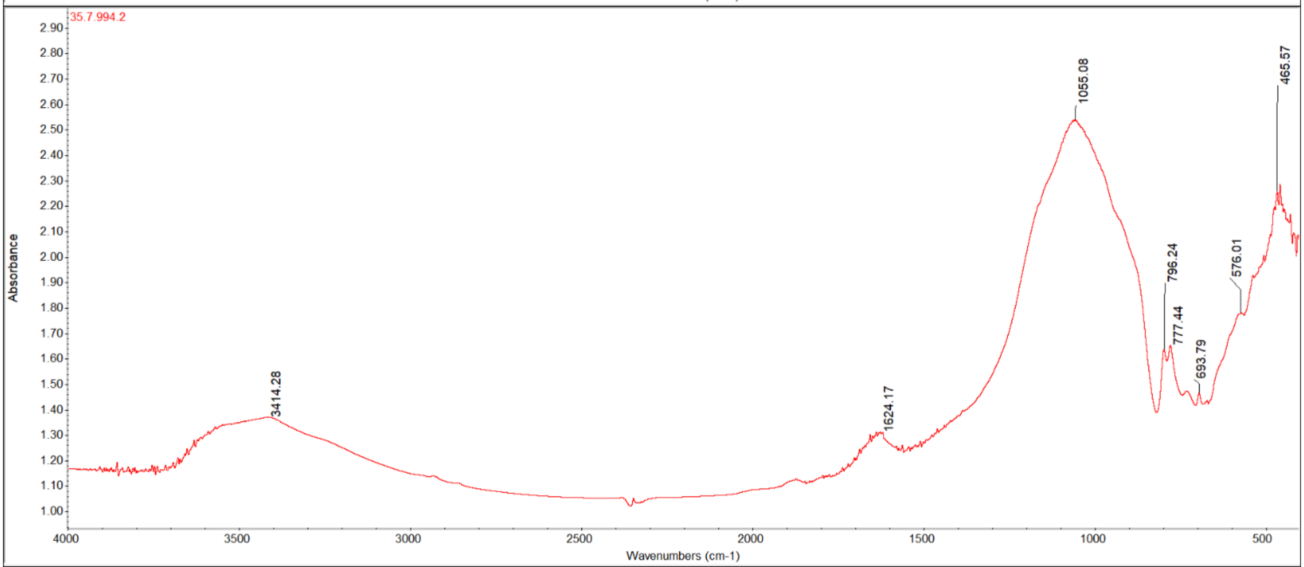

35.7.984
Absorbance
Wavenumbers (cm-1)
1039.46
465.55
1436.72
873.95
797.57
778.37
713.02
713.02
1623.56
1793.67
3408.97
2514.21
3854.13
3821.61
3744.76

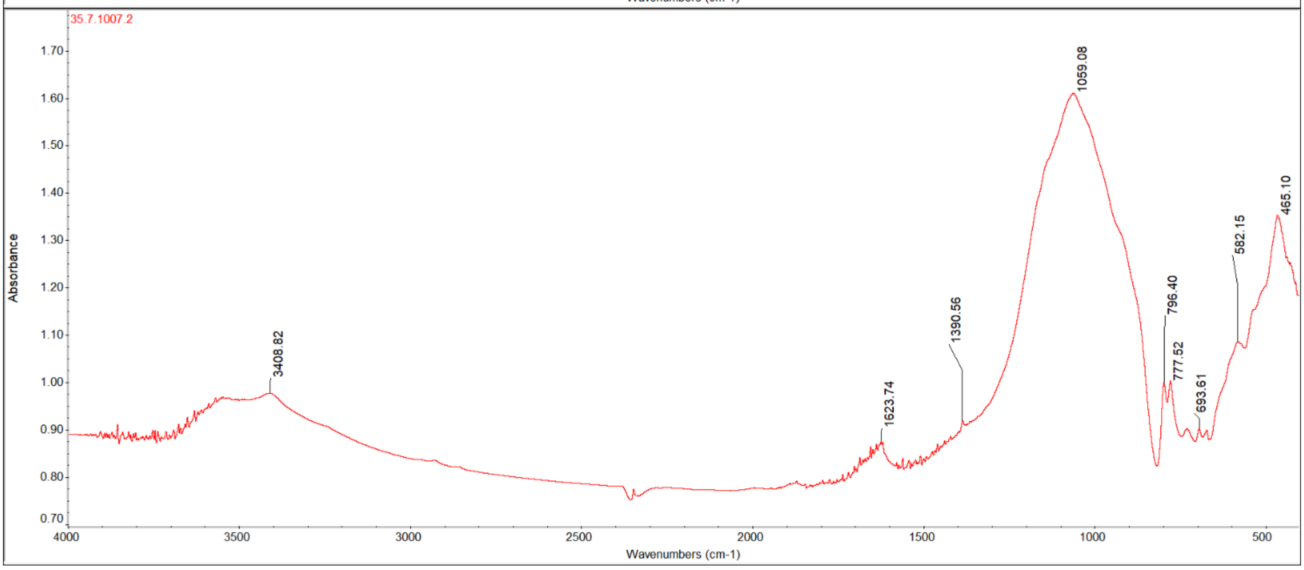

35.7.985.2
Absorbance
Wavenumbers (cm-1)
3854.34
3421.20
1636.63
1425.12
1031.77
874.67
797.31
778.25
694.44
645.78

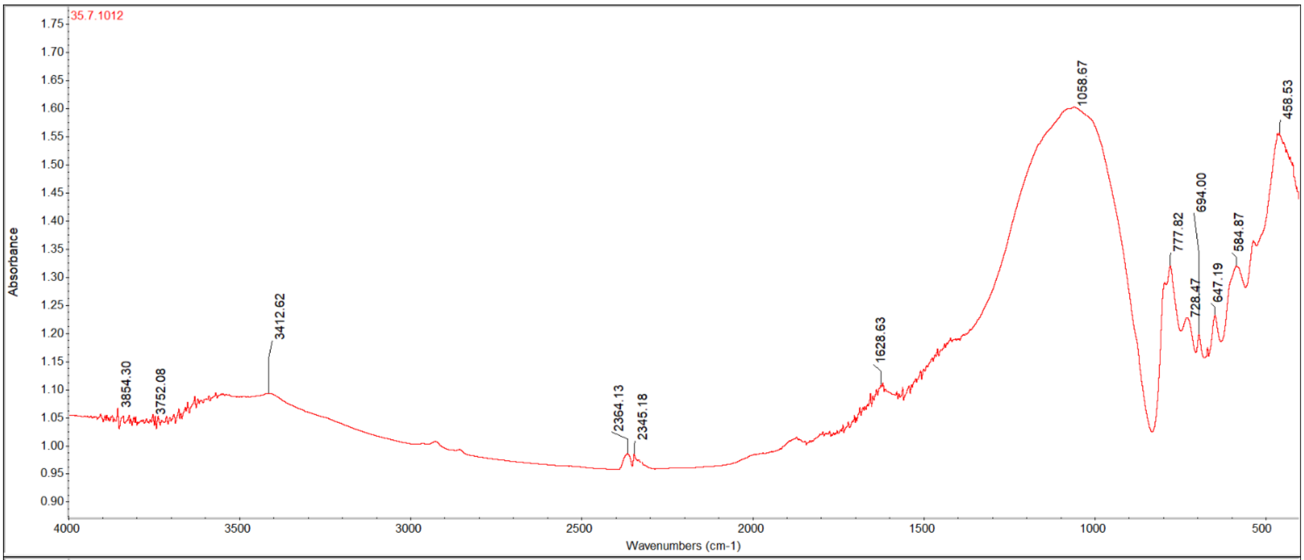

35.7.988
Absorbance
Wavenumbers (cm-1)
3447.92
2377.03
2352.47
1617.76
1388.52
1051.19
797.04
725.41
698.81
573.96
539.17
461.32

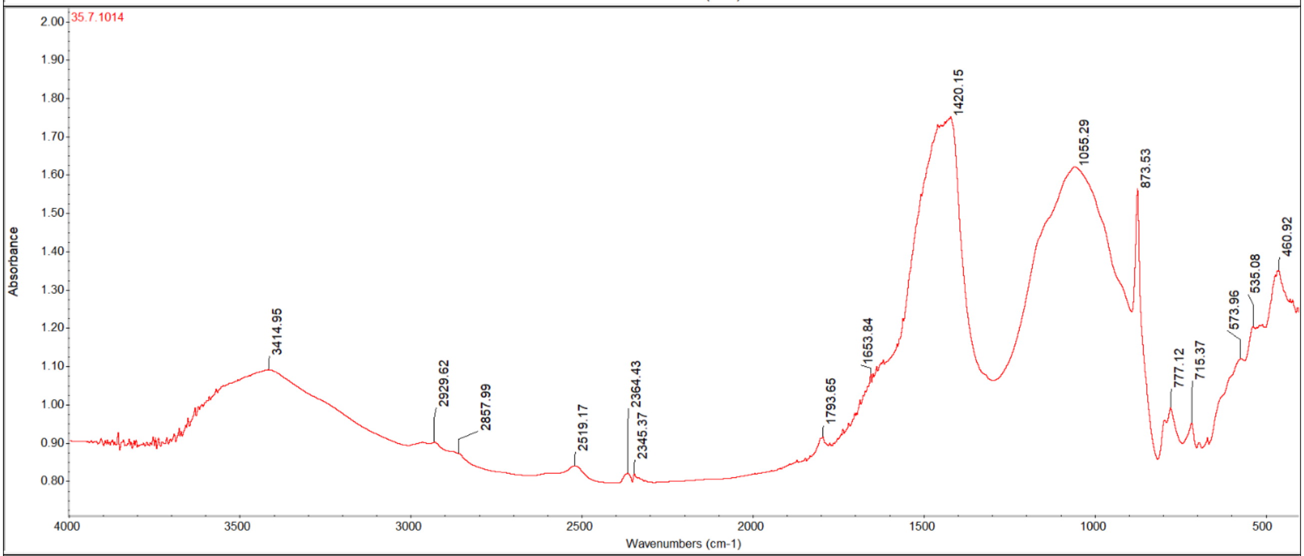

35.7.990
Absorbance
Wavenumbers (cm-1)
3854.16
3744.80
3447.44
2935.76
2847.75
2361.30
1653.77
1457.64
1058.82
977.32
919.84
872.77
796.20
781.00
668.69
465.31

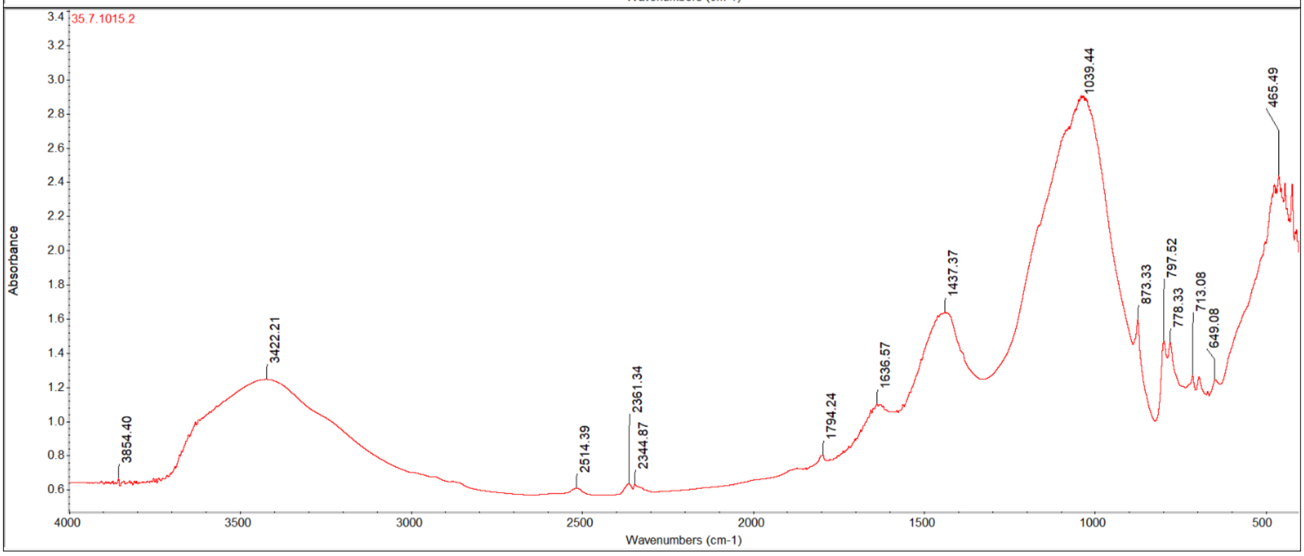

35.7.993
Absorbance
Wavenumbers (cm-1)
1058.71
973.05
917.79
870.72
465.57
796.71
777.62
668.82
1384.42
1636.27
3421.45
2363.82
4000
3500
3000
2500
2000
1500
1000
500
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70

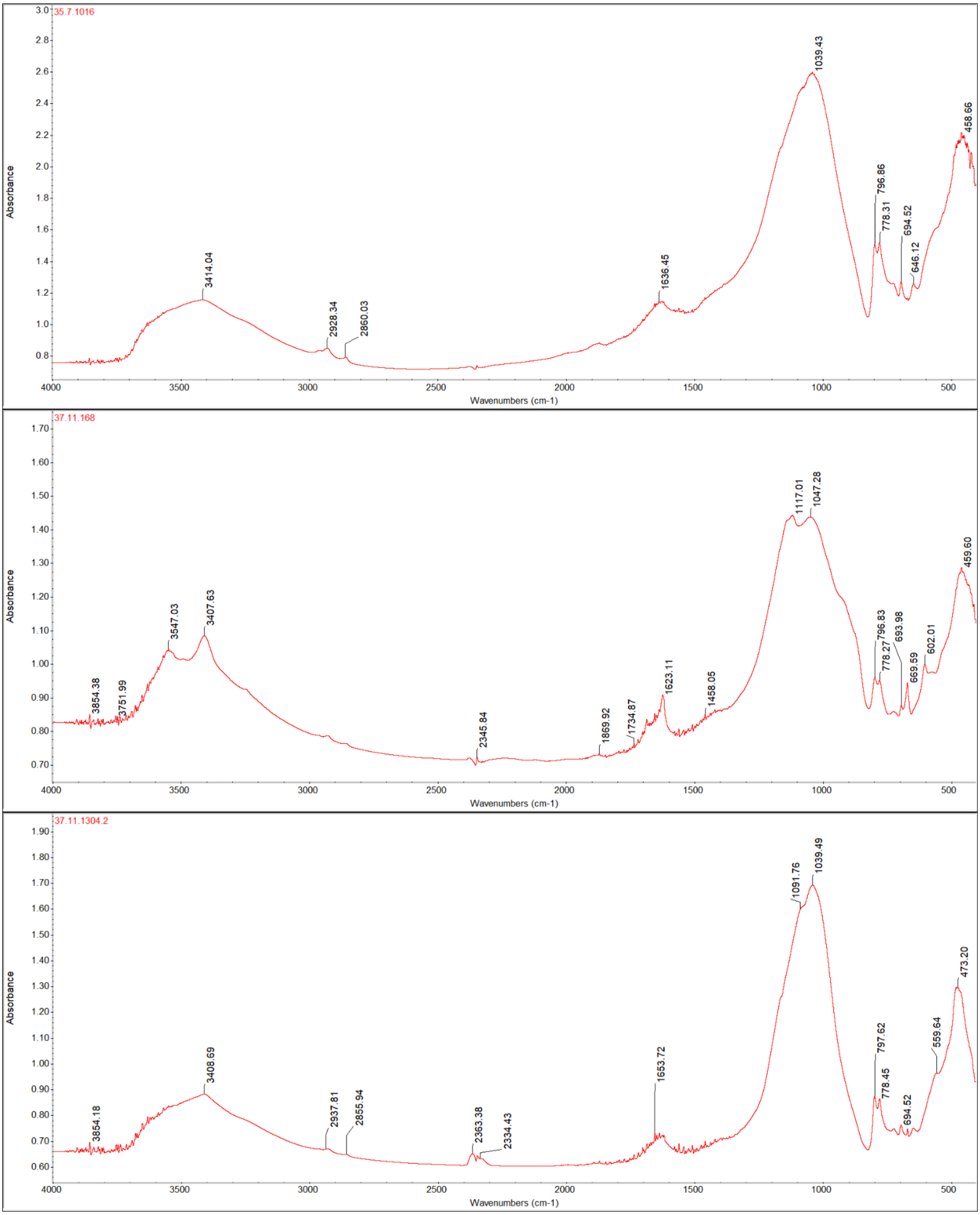

35.7.994.2
Absorbance
Wavenumbers (cm-1)
1055.08
465.57
796.24
777.44
693.79
576.01
3414.28
1624.17
4000
3500
3000
2500
2000
1500
1000
500
2.90
2.80
2.70
2.60
2.50
2.40
2.30
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00


35.7.1007.2
Absorbance
Wavenumbers (cm-1)
1059.08
465.10
582.15
796.40
777.52
693.61
1390.56
1623.74
3408.82
4000
3500
3000
2500
2000
1500
1000
500
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70


35.7.1012
Absorbance
Wavenumbers (cm-1)
3854.30
3752.08
3412.62
2364.13
2345.18
1628.63
1058.67
777.82
728.47
694.00
647.19
584.87
458.53


35.7.1014
Absorbance
Wavenumbers (cm-1)
3414.95
2929.62
2857.99
2519.17
2364.43
2345.37
1793.65
1653.84
1420.15
1055.29
873.53
777.12
715.37
573.96
535.08
460.92


35.7.1015.2
Absorbance
Wavenumbers (cm-1)
3854.40
3422.21
2514.39
2361.34
2344.87
1794.24
1636.57
1437.37
1039.44
873.33
797.52
778.33
713.08
649.08
465.49


35.7.1016
Absorbance
Wavenumbers (cm-1)
3414.04
2928.34
2860.03
1636.45
1039.43
796.86
778.31
694.52
646.12
458.66
37.11.168
Absorbance
Wavenumbers (cm-1)
3854.38
3751.99
3547.03
3407.63
2345.84
1869.92
1734.87
1623.11
1458.05
1117.01
1047.28
796.83
778.27
693.98
669.59
602.01
459.60
37.11.1304.2
Absorbance
Wavenumbers (cm-1)
3854.18
3408.69
2937.81
2855.94
2363.38
2334.43
1653.72
1091.76
1039.49
797.62
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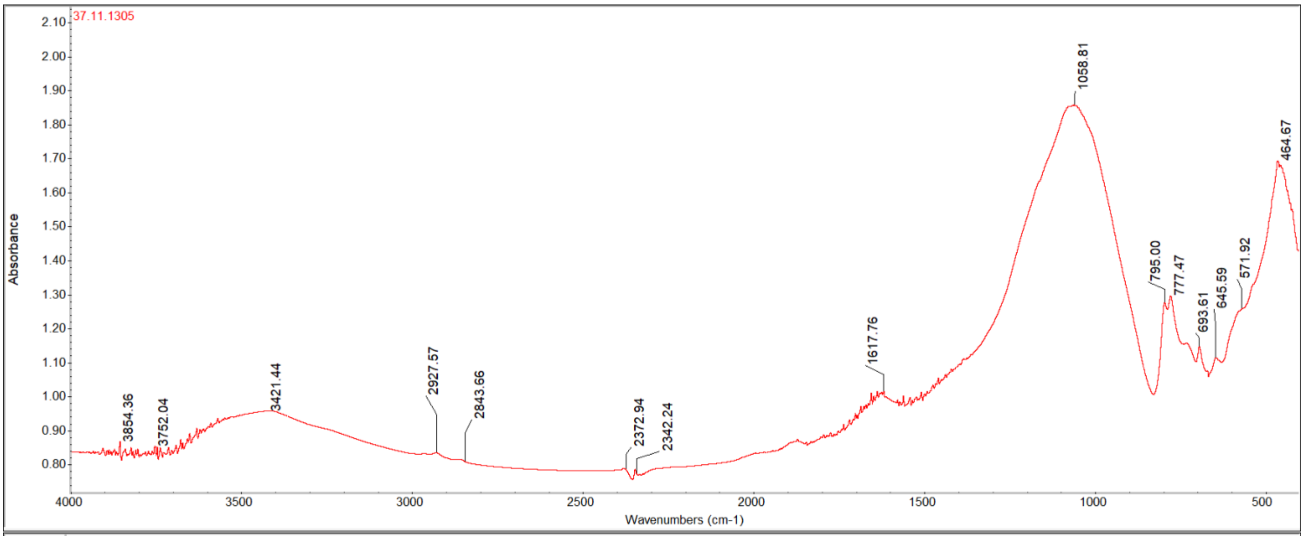
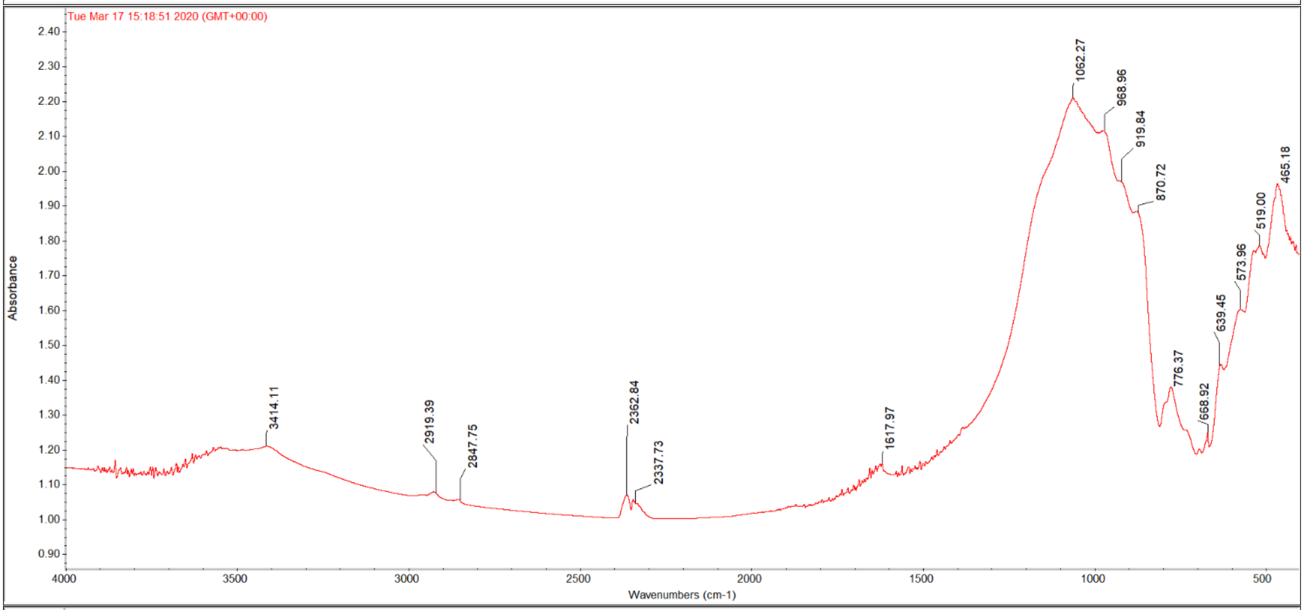
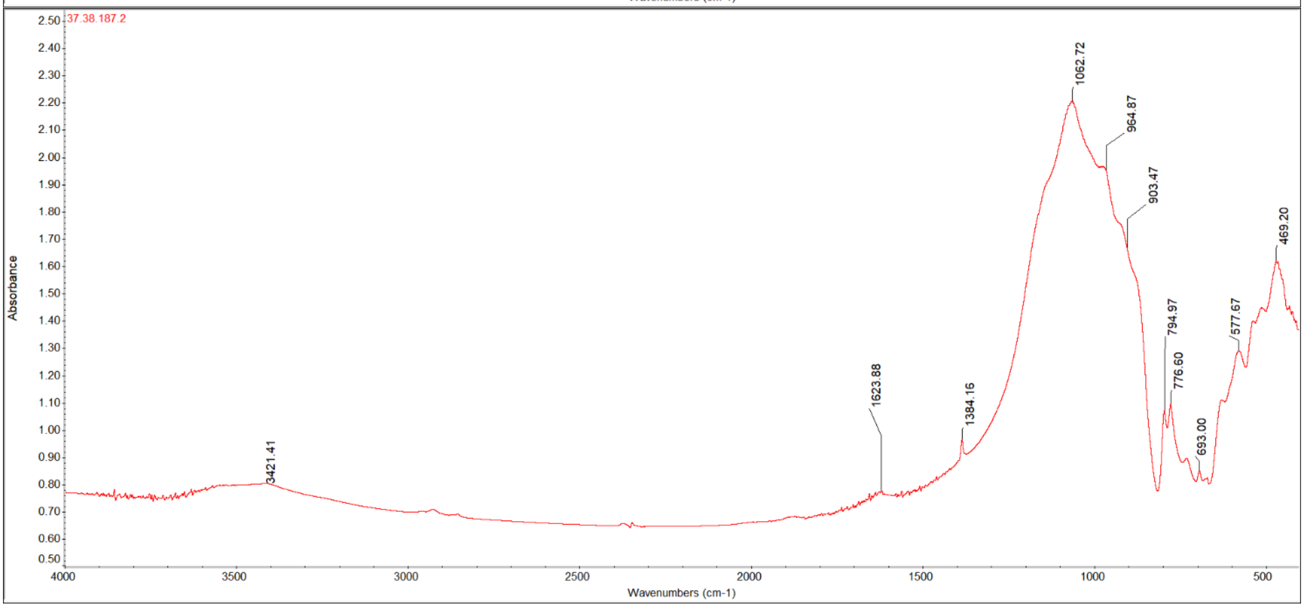
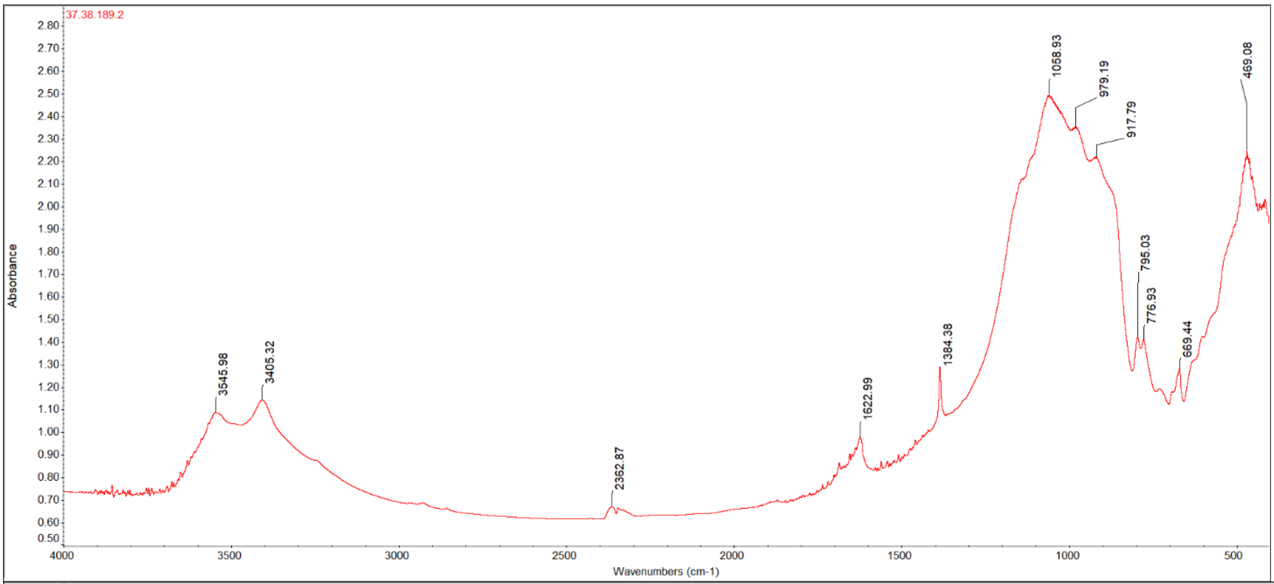
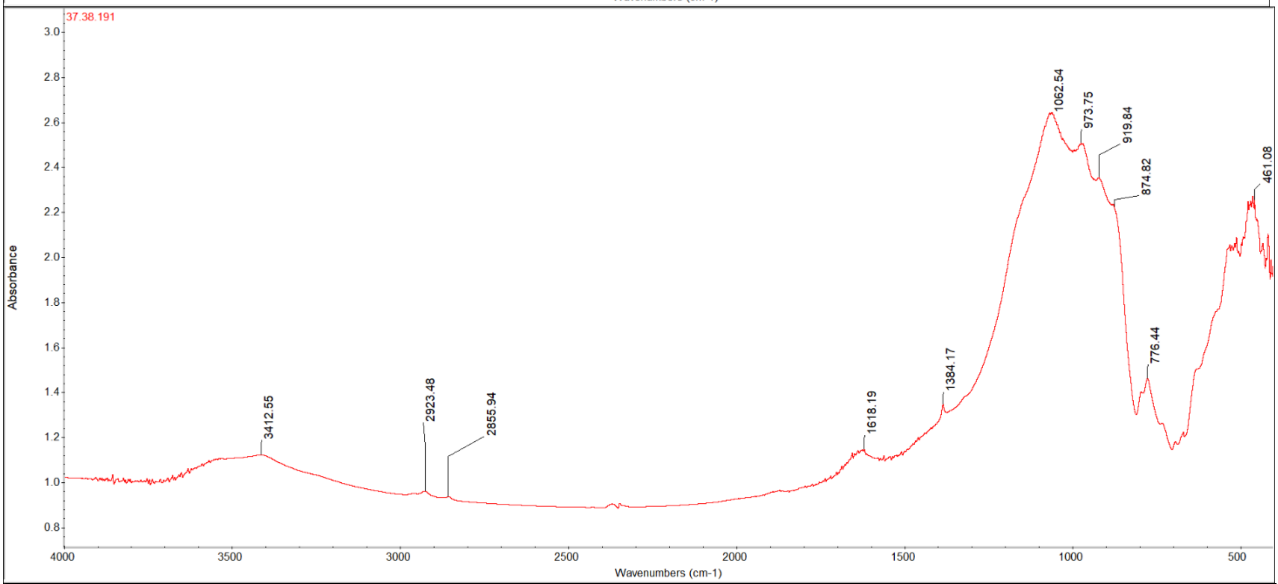
694.52
559.64
473.20

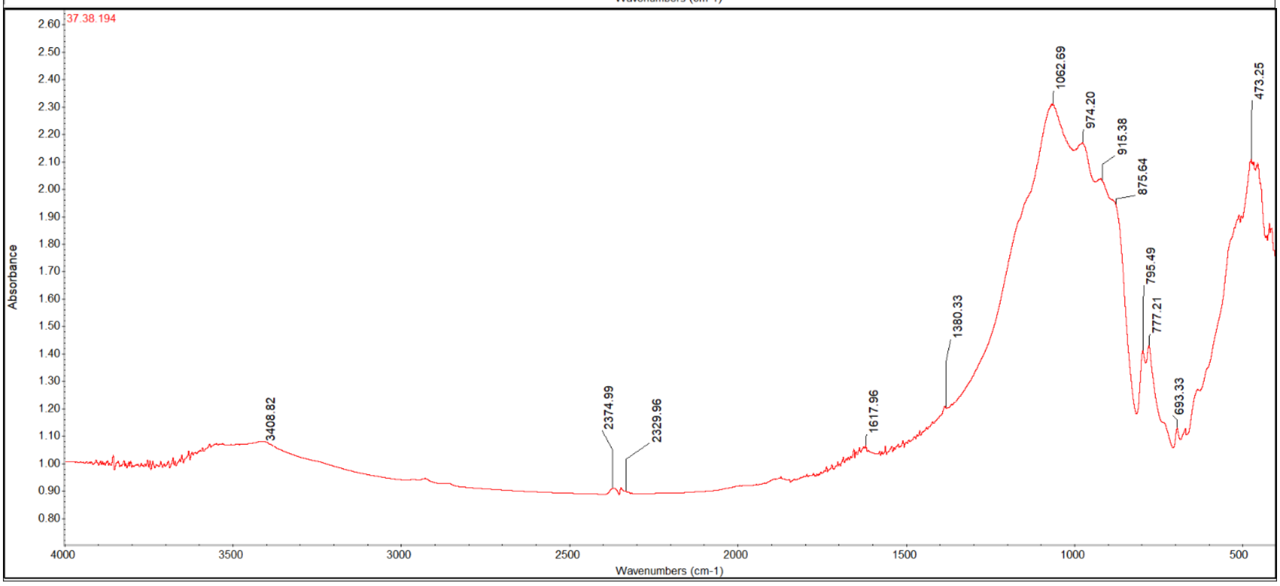

37.11.1305
Absorbance
Wavenumbers (cm-1)
3854.36
3752.04
3421.44
2927.57
2843.66
2372.94
2342.24
1617.76
1058.81
795.00
777.47
693.61
645.59
571.92
464.67

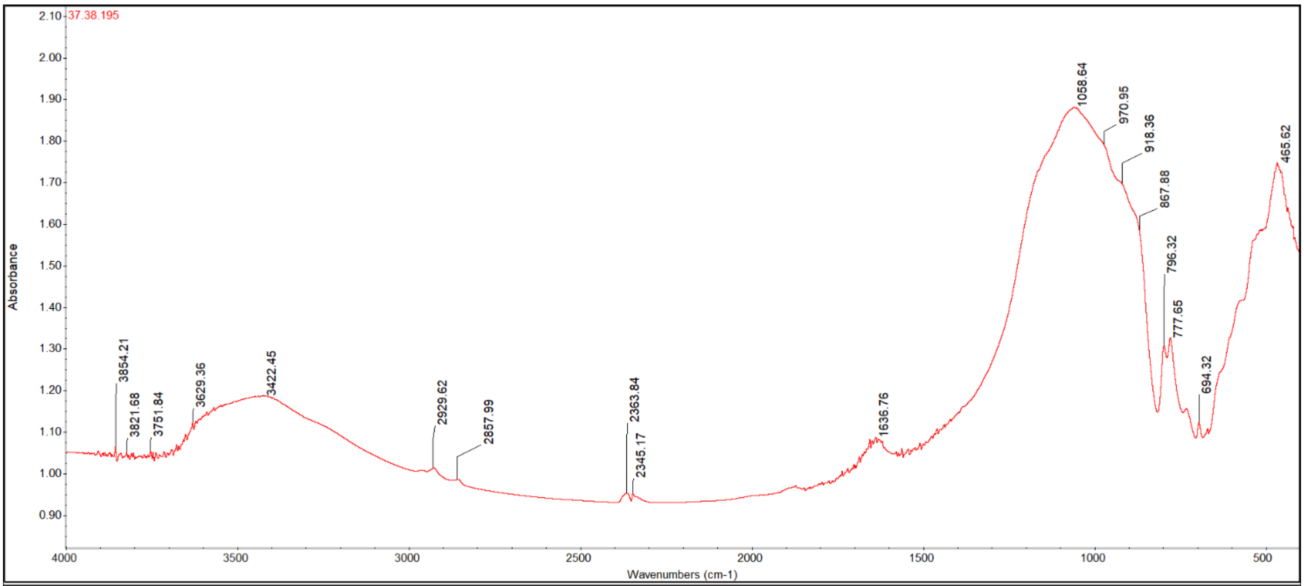

Tue Mar 17 15:18:51 2020 (GMT+00:00)
Absorbance
Wavenumbers (cm-1)
3414.11
2919.39
2847.75
2362.84
2337.73
1617.97
1062.27
968.96
919.84
870.72
776.37
668.92
639.45
573.96
519.00
465.18

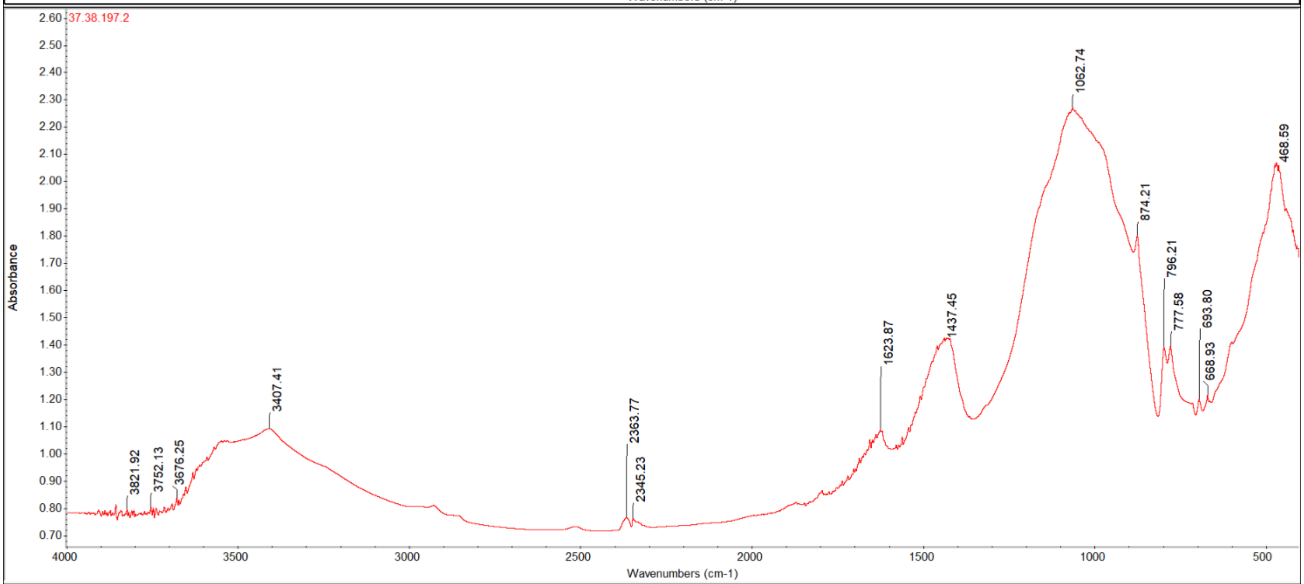

37.38.187.2
Absorbance
Wavenumbers (cm-1)
3421.41
1623.88
1384.16
1062.72
964.87
903.47
794.97
776.60
693.00
577.67
469.20

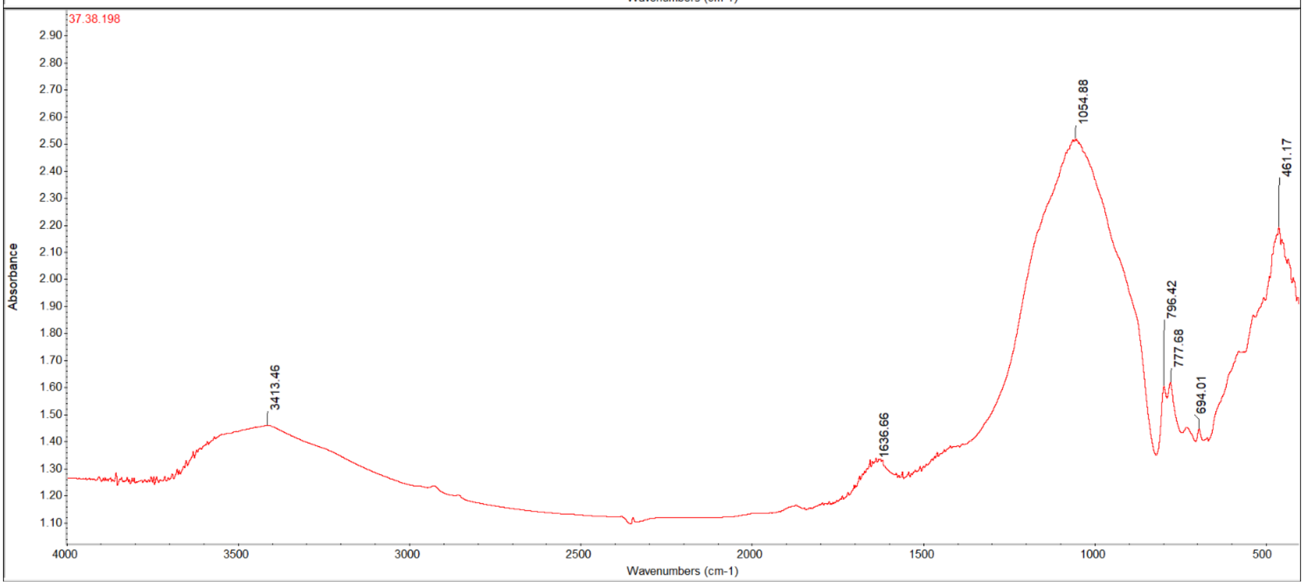

37.38.189.2
Absorbance
Wavenumbers (cm-1)
3545.98
3405.32
2362.87
1622.99
1384.38
1058.93
979.19
917.79
795.03
776.93
669.44
469.08

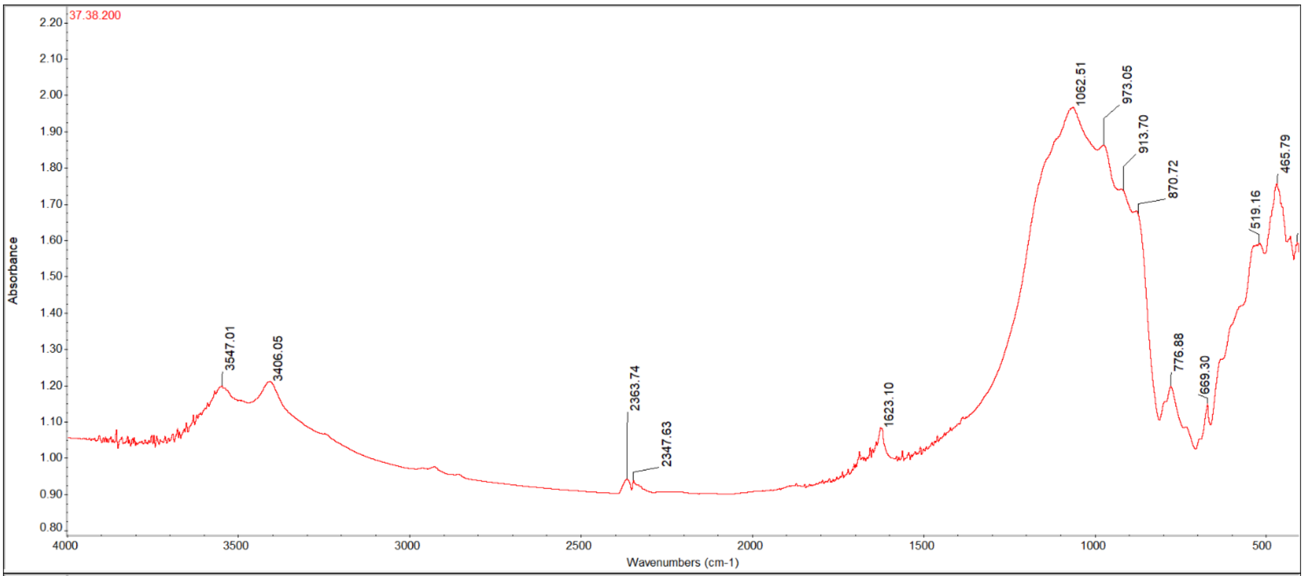

37.38.191
Absorbance
Wavenumbers (cm-1)
3412.55
2923.48
2855.94
1618.19
1384.17
1062.54
973.75
919.84
874.82
776.44
461.08

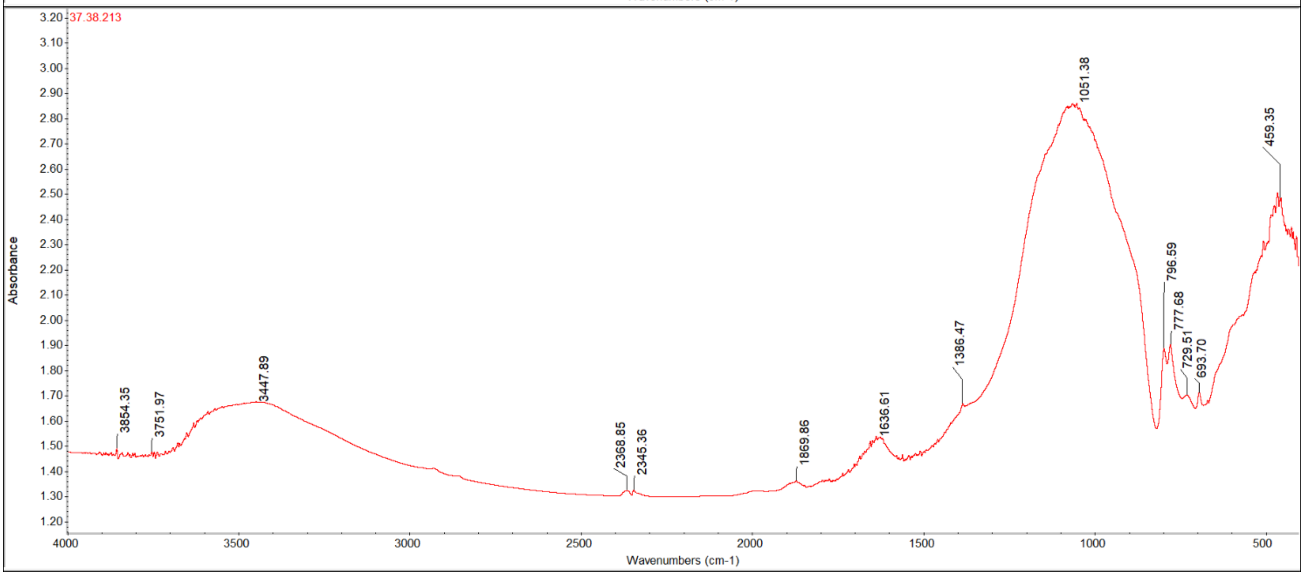

37.38.194
Absorbance
Wavenumbers (cm-1)
3408.82
2374.99
2329.96
1617.96
1380.33
1062.69
974.20
915.38
875.64
795.49
777.21
693.33
473.25

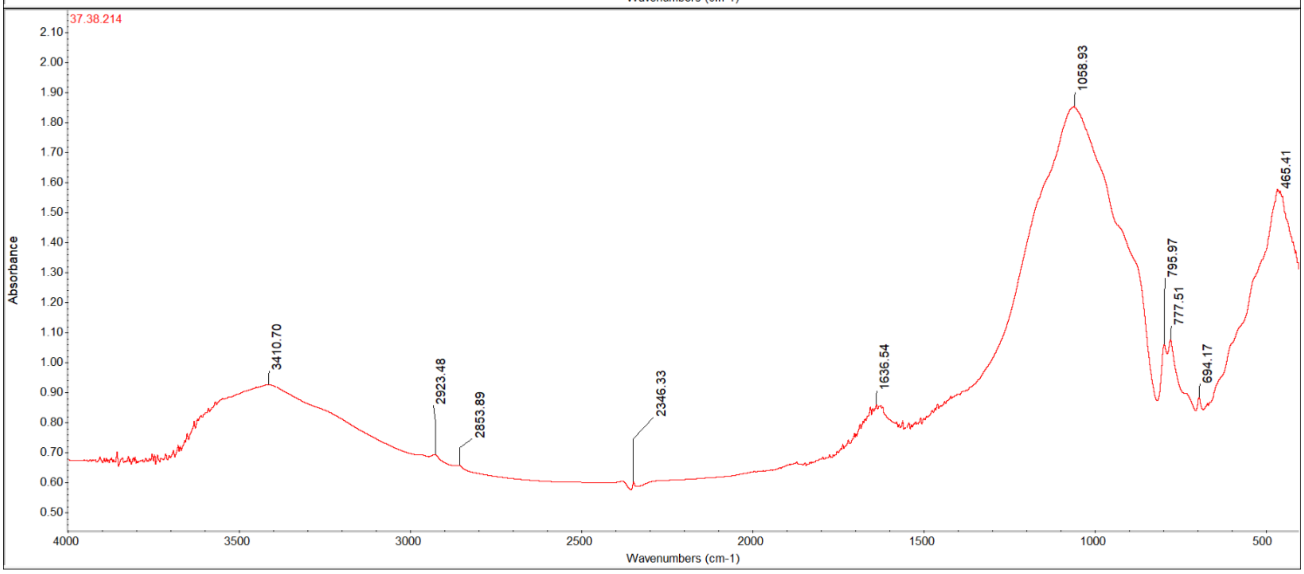

37.38.195
Absorbance
Wavenumbers (cm-1)
3854.21
3821.68
3751.84
3629.36
3422.45
2929.62
2857.99
2363.84
2345.17
1636.76
1058.64
970.95
918.36
867.88
796.32
777.65
694.32
465.62


37.38.197.2
Absorbance
Wavenumbers (cm-1)
3821.92
3752.13
3676.25
3407.41
2363.77
2345.23
1623.87
1437.45
1062.74
874.21
796.21
777.58
693.80
668.93
468.59


37.38.198
Absorbance
Wavenumbers (cm-1)
3413.46
1636.66
1054.88
796.42
777.68
694.01
461.17


37.38.200
Absorbance
Wavenumbers (cm-1)
3547.01
3406.05
2363.74
2347.63
1623.10
1062.51
973.05
913.70
870.72
776.88
669.30
519.16
465.79


37.38.213
Absorbance
Wavenumbers (cm-1)
3854.35
3751.97
3447.89
2368.85
2345.36
1869.86
1636.61
1386.47
1051.38
796.59
777.68
729.51
693.70
459.35


37.38.214
Absorbance
Wavenumbers (cm-1)
3410.70
2923.48
2853.89
2346.33
1636.54
1058.93
795.97
777.51
694.17
465.41

Appendix 11: Summary of All Scientific Groupings

Cambridge Science Number	Sherd Number	Site Name	Ware Code	Form Number	Function	PXRF Group	Petro Category	Technique	FTIR Group	Chaine Op Code
CA200234	155.10.581.20	Site 155	2A7d		Serving	1a	E.1b	Wheelmade	High	CO57
CA200235	155.11.582.17	Site 155	3A4	104	Serving	2b	E.2a	Wheelmade	Medium	CO49
CA200236	155.11.582.21	Site 155	3A4		Serving	2b	E.2b	Wheelmade	Medium	CO49
CA200237	155.11.582.28	Site 155	2A5a		Storage	1b	E.1b	Wheelmade	Medium	CO99
CA200238	155.8.579.20	Site 155	2A10b		Liquid Storage	1b	E.2a	Wheelmade	Medium	CO104
CA200239	155.8.579.23	Site 155	2A5b		Storage	1a	E.5a	Wheelmade	High	CO137
CA200240	155.8.579.35	Site 155	3B5b		Storage	1a	E.3b	Coilmade	Medium	CO108
CA200241	155.8.579.44	Site 155	2A7c		Serving	2b	E.2b	Wheelmade	High	CO57
CA200242	155.8.579.47	Site 155	2A7a		Serving	1b	E.2a	Wheelmade	High	CO57
CA200243	155.8.579.51	Site 155	2A7a		Serving	1b	E.2b	Wheelmade	High	CO57
CA200244	155.1.572.4	Site 155	6B3		Cooking	1c	E.3c	Wheelmade	Low	CO11
CA200245	155.1.572.5	Site 155	2A7a		Serving	1b	E.2a	Wheelmade	Very High	CO57
CA200246	217.1.1004.2	Site 217	2A4	441	Liquid Storage	1a	E.1a	Wheelmade	Very High	CO94
CA200247	217.1.1004.6	Site 217	2A5b		Storage	1a	E.1b	Wheelmade	Very High	CO98
CA200248	217.1.1004.7	Site 217	2B5b		Storage	1a	E.3a	Wheelmade	Medium	CO120
CA200249	217.4.1007.3	Site 217	4B4		Serving	1a	E.1b	Wheelmade	Very High	CO64
CA200250	217.2.1005.7	Site 217	3A7a	315	Serving	1b	E.2b	Wheelmade	High	CO57
CA200251	217.2.1005.8	Site 217	2A7a	330	Serving	1a	E.1b	Wheelmade	High	CO57
CA200252	217.2.1005.9	Site 217	3C4	344	Food Processing	1c	E.5a	Handmade	High	CO26
CA200253	217.2.1005.23	Site 217	2B5b		Storage	1a	E.3a	Wheelmade	Medium	CO122
CA200254	217.2.1005.26	Site 217	3A7c		Serving	1b	E.2b	Wheelmade	High	CO57
CA200255	217.3.1006.16	Site 217	3C5e	306	Serving	1c	E.2b	Wheelmade	Low	CO54
CA200256	217.3.1006.25	Site 217	2C4	330	Food Processing	1c	E.5b	Handmade	Medium	CO26
CA200257	217.3.1006.29	Site 217	6B3		Cooking	2a	E.4	Wheelmade	Low	CO11
CA200258	217.3.1006.31	Site 217	3B2	105	Dry Storage	1c	E.2a	Wheelmade	High	CO112
CA200259	217.3.1006.50	Site 217	2B5b		Storage	1c	E.5c	Handmade	Medium	CO106
CA200260	217.3.1006.55	Site 217	2B5c		Storage	1a	E.1b	Coilmade	Medium	CO108
CA200261	217.3.1006.57	Site 217	2A5b		Storage	1a	E.1a	Coilmade	Medium	CO82
CA200262	217.3.1006.63	Site 217	6B3		Cooking	2a	E.4	Wheelmade	Low	CO11
CA200263	217.3.1006.65	Site 217	2A4		Serving	2c	E.1b	Wheelmade	Very High	CO51
CA200264	217.3.1006.69	Site 217	7A7a		Serving	out	E.9	Wheelmade	Very High	CO73
CA200265	217.3.1006.73	Site 217	2A7c		Serving	2b	E.2b	Wheelmade	High	CO57
CA200266	217.3.1006.74	Site 217	2A7a		Serving	1a	E.1a	Wheelmade	High	CO57
CA200267	217.5.1008.10	Site 217	5A5b	438	Liquid Storage	1a	E.3c	Wheelmade	Very High	CO99
CA200268	217.5.1008.14	Site 217	3B4	315	Cooking	1b	E.3b	Wheelmade	Medium	CO13
CA200269	217.5.1008.15	Site 217	2C4		Cooking	1b	E.1b	Handmade	Low	CO1
CA200270	217.5.1008.28	Site 217	3A7a	109	Serving	1b	E.2b	Wheelmade	High	CO57
CA200271	217.5.1008.36	Site 217	2B5b		Storage	1c	E.1b	Wheelmade	Medium	CO122
CA200272	217.5.1008.40	Site 217	2B4	503	Other	1a	E.3c	Handmade	High	CO144
CA200274	217.5.1008.45	Site 217	2A5e		Storage	1a	E.3a	Coilmade	Very High	CO84
CA200275	217.5.1008.46	Site 217	2A8		Serving	1a	E.1a	Molded	Very High	CO46
CA200276	217.6.1009.3	Site 217	3B4	503	Other	1a	E.3b	Wheelmade	Low	CO145
CA200277	381.3.1555.4	Site 381	2A8		Serving	2b	E.3b	Molded	Very High	CO63
CA200278	381.3.1555.9	Site 381	3B4		Storage	2b	E.7	Wheelmade	Medium	CO115
CA200279	381.3.1555.11	Site 381	2A7a		Serving	1a	E.3b	Wheelmade	High	CO66
CA200280	381.3.1555.16	Site 381	3A7a		Serving	1b	E.2a	Wheelmade	High	CO57
CA200281	381.3.1555.19	Site 381	4A4	101	Storage	1a	E.1a	Wheelmade	High	CO93
CA200282	381.3.1555.20	Site 381	2A4	102	Storage	1a	E.3a	Wheelmade	Low	CO114
CA200283	381.3.1555.24	Site 381	2A4	102	Storage	1a	E.1a	Coilmade	Medium	CO79
CA200284	381.3.1555.36	Site 381	2A8		Serving	1a	E.1a	Molded	Very High	CO46
CA200285	381.2.1554.8	Site 381	2A4		Storage	1a	E.1b	Handmade	Very High	CO75
CA200286	381.2.1554.6	Site 381	6B4		Cooking	1c	E.5b	Wheelmade	High	CO14
CA200287	381.2.1554.12	Site 381	2A4	106	Storage	1a	E.1a	Wheelmade	Very High	CO94
CA200288	381.2.1554.14	Site 381	3B5b		Storage	1b	E.6	Wheelmade	Low	CO119
CA200289	381.2.1554.15	Site 381	3A4		Storage	1c	E.5a	Handmade	Medium	CO126
CA200290	381.1.1553.8	Site 381	2A4	440	Liquid Storage	1a	E.1a	Wheelmade	High	CO93
CA200291	381.1.1553.21	Site 381	2A7a	105	Serving	1a	E.3a	Wheelmade	Very High	CO66
CA200292	519.1.1915.2	Site 519	2A4	105	Storage	1a	E.1a	Wheelmade	High	CO93
CA200293	519.3.1917.2	Site 519	2A5b		Storage	1a	E.1a	Wheelmade	Very High	CO98

Cambridge Science Number	Sherd Number	Site Name	Ware Code	Form Number	Function	PXRF Group	Petro Category	Technique	FTIR Group	Chaine Op Code
CA200294	519.3.1917.5	Site 519	2A4		Storage	1a	E.1a	Wheelmade	Low	CO91
CA200295	519.2.1916.7	Site 519	3A7a	308	Serving	1c	E.1b	Wheelmade	High	CO57
CA200296	519.2.1916.9	Site 519	2A4	448	Liquid Storage	1a	E.1b	Wheelmade	High	CO93
CA200297	519.2.1916.10	Site 519	3A4		Storage	1c	E.3b	Wheelmade	Medium	CO95
CA200298	519.2.1916.13	Site 519	2A7a	111	Serving	1a	E.2a	Wheelmade	Very High	CO57
CA200299	519.2.1916.18	Site 519	2A4	101	Storage	1a	E.1a	Wheelmade	Very High	CO94
CA200300	535.1.1953.5	Site 535	2A7a		Storage	1a	E.1b	Wheelmade	High	CO103
CA200301	535.1.1953.6	Site 535	2A4		Serving	1a	E.1b	Wheelmade	Very High	CO50
CA200302	535.1.1953.7	Site 535	6B4		Cooking	1c	E.5b	Wheelmade	High	CO16
CA200303	535.1.1953.10	Site 535	2A4	102	Storage	1a	E.3a	Coilmade	Very High	CO95
CA200304	535.1.1953.12	Site 535	2A4	104	Serving	1a	E.1a	Coilmade	Very High	CO40
CA200305	535.1.1953.13	Site 535	3A4	109	Serving	1a	E.2a	Wheelmade	High	CO50
CA200306	535.1.1953.18	Site 535	3A2		Storage	1a	E.2a	Coilmade	High	CO78
CA200307	535.1.1953.21	Site 535	2C5b		Storage	1a	E.3a	Wheelmade	Very High	CO121
CA200308	535.1.1953.23	Site 535	2A5a		Storage	1a	E.1b	Wheelmade	Very High	CO98
CA200309	276.1.1241.3	Site 276	2C4		Storage	1a	E.1b	Wheelmade	Low	CO91
CA200310	276.1.1241.4	Site 276	3A4		Storage	1c	E.5a	Wheelmade	Medium	CO95
CA200311	276.1.1241.7	Site 276	2A4	111	Serving	1a	E.5c	Wheelmade	Low	CO72
CA200312	276.1.1241.9	Site 276	2A5b		Storage	1a	E.5c	Wheelmade	High	CO143
CA200313	276.1.1241.11	Site 276	2A5f		Storage	1a	E.1a	Wheelmade	High	CO100
CA200314	276.1.1241.12	Site 276	3A7a		Serving	2b	E.2a	Wheelmade	High	CO57
CA200315	276.3.1243.7	Site 276	3C4		Storage	1a	E.2a	Wheelmade	Low	CO91
CA200316	276.3.1243.13	Site 276	2A7a		Serving	1a	E.1a	Wheelmade	High	CO57
CA200317	276.2.1242.2	Site 276	2A4	Handle	Other	1c	E.3a	Handmade	Low	CO146
CA200318	276.2.1242.7	Site 276	2A7k	333	Serving	1a	E.1b	Wheelmade	High	CO57
CA200319	276.2.1242.12	Site 276	2C4		Storage	1a	E.1a	Wheelmade	Very High	CO136
CA200320	276.2.1242.14	Site 276	6B5a		Cooking	2b	E.8	Wheelmade	High	CO15
CA200321	276.2.1242.17	Site 276	3A7a	324	Serving	1b	E.2b	Wheelmade	High	CO57
CA200322	276.2.1242.21	Site 276	2C4	306	Serving	1a	E.5b	Wheelmade	Medium	CO69
CA200323	35-7-1007	Rayy	2A5e		Storage	2c	R.3	Coilmade	Medium	CO84
CA200324	35-7-1012	Rayy	2B5g	432	Serving	2a	R.5a	Wheelmade	High	CO65
CA200325	35-7-1014	Rayy	2A7a	109	Serving	2c	R.2a	Wheelmade	High	CO57
CA200326	35-7-1015	Rayy	3A4	105	Storage	1d	R.2a	Wheelmade	Low	CO91
CA200327	35-7-1016	Rayy	2B5g		Storage	2a	R.2a	Wheelmade	Low	CO102
CA200328	35-7-194	Rayy	3A7a		Serving	2c	R.2b	Wheelmade	High	CO57
CA200329	35-7-255	Rayy	2A7c		Serving	2c	R.5b	Wheelmade	high	CO66
CA200330	35-7-981	Rayy	3A7c	334	Serving	2c	R.2b	Wheelmade	High	CO57
CA200331	35-7-982	Rayy	3A5a		Storage	2b	R.2a	Wheelmade	Medium	CO96
CA200332	35-7-983	Rayy	2A4	326	Food Processing	2b	R.6	Wheelmade	Medium	CO20
CA200333	35-7-984	Rayy	3A4	435	Liquid Storage	2b	R.5a	Wheelmade	Low	CO91
CA200334	35-7-985	Rayy	3A5b	417	Liquid Storage	2b	R.5a	Coilmade	Low	CO137
CA200335	35-7-988	Rayy	3A7c		Serving	2b	R.5b	Wheelmade	High	CO66
CA200336	35-7-990	Rayy	2A5e	436	Liquid Storage	2c	R.1	Coilmade	Very High	CO101
CA200337	35-7-993	Rayy	2A4		Storage	2c	R.1	Wheelmade	Very High	CO94
CA200338	35-7-994	Rayy	2A4	104	Serving	2c	R.1	Wheelmade	Medium	CO49
CA200339	37-11-1304	Rayy	6B5e	415	Cooking	1d	R.7	Wheelmade	High	CO17
CA200340	37-11-1305	Rayy	3A5b	445	Liquid Storage	2a	R.4	Wheelmade	Medium	CO120
CA200341	37-11-168	Rayy	2A8		Serving	1a	R.3	Molded	High	CO46
CA200342	37-38-187	Rayy	2A7c	440	Liquid Storage	2c	R.1	Wheelmade	Very High	CO103
CA200343	37-38-189	Rayy	2A4	432	Liquid Storage	1a	R.2b	Wheelmade	Very High	CO94
CA200344	37-38-191	Rayy	2A7c		Serving	2b	R.1	Wheelmade	Very High	CO57
CA200345	37-38-194	Rayy	2A4	325	Serving	2b	R.1	Wheelmade	Very High	CO50
CA200346	37-38-195	Rayy	2A4		Storage	2c	R.1	Wheelmade	Very High	CO94
CA200347	37-38-197	Rayy	2A4	445	Serving	2b	R.2a	Wheelmade	Medium	CO49
CA200348	37-38-198	Rayy	2A4		Storage	2b	R.2b	Wheelmade	Medium	CO92
CA200349	37-38-200	Rayy	2A7a		Storage	2c	R.1	Wheelmade	Very High	CO103
CA200350	37-38-213	Rayy	2A5a		Storage	2c	R.2a	Wheelmade	High	CO97
CA200351	37-38-214	Rayy	2A5e	449	Serving	2b	R.2b	Wheelmade	Medium	CO55
CA200352	70-7-158	Firuzabad	3C5a	458	Storage	2b	F.3b	Wheelmade	High	CO137

Cambridge Science Number	Sherd Number	Site Name	Ware Code	Form Number	Function	PXRF Group	Petro Category	Technique	FTIR Group	Chaine Op Code
CA200353	70-7-160	Firuzabad	3C4	423	Dry Storage	1b	F.3a	Handmade	Medium	CO126
CA200354	70-7-169	Firuzabad	2C10a	430	Dry Storage	2b	F.3b	Coilmade	Very High	CO142
CA200355	70-7-170	Firuzabad	2C4	344	Food Processing	2b	F.3b	Handmade	Low	CO26
CA200356	70-7-171	Firuzabad	2C4	101	Storage	2b	F.1	Coilmade	Very High	CO80
CA200357	70-7-177	Firuzabad	2C10a	423	Dry Storage	2b	F.2c	Wheelmade	Very High	CO142
CA200358	70-7-195	Firuzabad	2B4	102	Storage	2b	F.2b	Coilmade	Very High	CO107
CA200359	70-7-196	Firuzabad	3B2	425	Dry Storage	2c	F.2a	Wheelmade	Medium	CO112
CA200360	70-7-203B	Firuzabad	2A4	434	Liquid Storage	2b	F.1	Wheelmade	Very High	CO95
CA200361	70-7-207	Firuzabad	6B4	404	Cooking	2a	F.4	Wheelmade	Very High	CO4
CA200362	70-7-209	Firuzabad	4A4	436	Liquid Storage	2c	F.1	Wheelmade	Very High	CO94
CA200363	93-4-145.8	Hasanlu	2A5c		Serving	1b	H.2	Wheelmade	Very High	CO52
CA200364	93-4-147	Hasanlu	3B5b		Cooking	2a	H.1	Wheelmade	Very High	CO15
CA200365	93-4-152	Hasanlu	3B4	436	Liquid Storage	2a	H.1	Wheelmade	Medium	CO115
CA200366	61-5-919	Hasanlu	3B7a		Storage	2b	H.1	Coilmade	High	CO110
CA200367	63-5-2038.9	Hasanlu	7A7d		Serving	Out	H.4	Molded	Very High	CO73
CA200368	63-5-2058	Hasanlu	3A7a	312	Serving	2b	H.1	Wheelmade	High	CO57
CA200369	63-5-2060	Hasanlu	2A7a		Storage	2c	H.3	Wheelmade	High	CO103
CA200370	37-33-43	Chal Tarkhan	3A4		Storage	2c	R.4	Wheelmade	Very High	CO117
CA200371	37-33-44	Chal Tarkhan	2A4		Storage	2c	R.5a	Wheelmade	Very High	CO117
CA200372	37-33-58	Chal Tarkhan	2A7a	436	Serving	2c	R.1	Wheelmade	Very High	CO57
CA200373	37-33-59	Chal Tarkhan	2A5b		Serving	2c	R.1	Wheelmade	Very High	CO52
CA200374	37-33-64	Chal Tarkhan	2A7a	307	Serving	2b	R.2b	Wheelmade	Very High	CO57
CA200723	A163161	Nippur	2C5e		Storage	1b	N.1a	Coilmade	Very High	CO84
CA200724	A163163	Nippur	6B2	401	Cooking	Out	N.4	Wheelmade	High	CO10
CA200725	A169184	Nippur	2A7d		Serving	1b	N.1a	Wheelmade	Very High	CO57
CA200726	A169206	Nippur	2A7a		Serving	1b	N.1a	Wheelmade	Very High	CO57
CA200727	A169207	Nippur	2A7a		Serving	1b	N.1a	Wheelmade	Very High	CO57
CA200728	A169210	Nippur	3A7c		Serving	1b	N.2	Wheelmade	High	CO57
CA200729	A169214	Nippur	3A7c	109	Serving	1b	N.2	Wheelmade	High	CO57
CA200730	A169219	Nippur	2B5e		Storage	1b	N.1a	Coilmade	Medium	CO109
CA200731	A169222	Nippur	2A5e		Storage	1b	N.1b	Coilmade	Very High	CO84
CA200732	A169226	Nippur	2B5e		Storage	1b	N.1b	Coilmade	Low	CO84
CA200733	A169227	Nippur	6B4	416	Cooking	1d	N.3	Handmade	Low	CO7
CA200734	A169228	Nippur	6B4		Cooking	1b	N.3	Wheelmade	Low	CO12
CA200735	A169231	Nippur	3B4	442	Liquid Storage	1b	N.5	Wheelmade	Medium	CO115
CA200736	A169232	Nippur	2B7a	453	Storage	1b	N.3	Wheelmade	High	CO123