

MINOAN BARBOTINE WARE: STYLES, SHAPES, AND A
CHARACTERIZATION OF THE CLAY FABRIC

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ABSTRACT

This thesis examines the styles, shapes, and chemical composition, and ceramic fabric of Minoan Barbotine Ware. During the Middle Minoan period, Barbotine Ware exemplifies the creative ingenuity of the Minoan potter. The vessels' elaborate decorative motifs play an integral part in the development of Minoan pottery. Barbotine Ware remains an ill-defined tradition. This paper will analyze the styles and shapes of Barbotine Ware vessels, as well as provide a chemical and petrographic study of Barbotine Ware from Kommos. The ultimate goal is to provide a thorough study of all aspects of the Ware in the hopes that future scholars may better understand its place within Minoan pottery and appreciate how it exemplifies the spirit of experimentation during the Middle Bronze Age on Crete.

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TABLE OF CONTENTS

	Page
ABSTRACT.....	ii
ACKNOWLEDGMENTS	iii
LIST OF FIGURES	v
LIST OF ABBREVIATIONS.....	viii
CHAPTER	
1. INTRODUCTION: Motives, Objective, Methodology	1
2. THE POTTERY: Background, and Barbotine Ware Styles and Shapes	6
3. CHARACTERIZATION STUDY: SEM, EDS, and Petrographic Reports	18
4. CONCLUSIONS.....	31
FIGURES	35
BIBLIOGRAPHY.....	51

LIST OF FIGURES

Figure	Page
1. Incised Style Jug. Jug with MM IA incised design, from Knossos	35
2. Dark on light style Jug. Jug with simple dark painted bands, MM IA. From Knossos	35
3. Floral Motif in Kamares Ware. Jar with white and orange floral patterning on the upper body, MM IIB. From the Herakleion Archaeological Museum, Crete	35
4. Kamares Ware Vessels. Uniquely shaped vessels with elaborate polychrome decoration, from MM IIB. From the Herakleion Archaeological Museum, Crete	35
5. Kamares Ware Bowls, and Cups. Fine tableware from MM IIB decorated with the polychrome Kamares Ware motifs. From the Herakleion Archaeological Museum, Crete	36
6. Dynamic Motifs found on Kamares Ware Vessels from MM IIB. Painted polychrome decoration with interlocking floral patterns. From the Herakleion Archaeological Museum, Crete	37
7. Barbotine Ware Patterns. MM IB Sherds from the British Museum showing regularly spaced ridges, irregular polygonal ridges, and protuberances	37
8. Jug from Phaistos. MM IB Jug with irregular polygonal ridges Barbotine decoration. From Levi, Festos, 1976	37
9. Tray from Phaistos. MM IB Tray with irregular polygonal ridges Barbotine decoration. From Levi, Festos, 1976	37
10. Wide Mouthed Jar from Phaistos. MM IB jar with irregular polygonal ridges. From Levi, Festos, 1976	38
11. Beaked Jug. Beaked Barbotine Ware Jug, MM IB. From the Metaxas Collection, Herakleion Archaeological Museum, Crete	38
12. Three Handled Jug from Knossos. MM IB Barbotine Ware Jug from Knossos, with elaborate decoration	39
13. Plain Regularly Spaced Ridged Jug. Jug from the Little Palace at Knossos. From Evans, 1914	39
14. Jar Sherd with Regularly Spaced Ridges. MM IB sherd with regularly spaced ridges forming a patterned area	40

15. Jug with Crinkled Ridge Decoration. A MM IB Jug with crinkled ridge decoration.
From the Herakleion Archaeological Museum, Crete40
16. Jugs Sherds from Phaistos. EM III sherds with protuberances work decoration from
Phaisto. From Todaro, 200540
17. Jug with Horizontal Protuberances. MM IB jug decorated with painted horizontal
protuberances. From the Heraklion Archaeological Museum41
18. Jug with Vertical Protuberances. MM IB jugs decorated with vertical protuberances.
From the Heraklion Archaeological Museum41
19. Jugs with Painted Protuberances. Two MM IB jugs decorated with painted
protuberances. From the Herakleion Archaeological Museum41
20. Beaked Jugs. Beaked jugs are among the most common shape with Barbotine
decoration. First two photos from left, from the Herakleion Archaeological Museum,
Crete. Photo on the far right, from the British Museum42
21. Pithoid Jars with Barbotine Decoration. Pithoi are among the most common shape
with Barbotine decoration. Top left photo, from the Herakleion Archaeological
Museum, Crete. Other three photos, from Levi, Festos, 197642
22. Bridge Spouted Jars with Barbotine decoration. Two Bridge Spouted jars with plastic
decoration and polychrome painted designs from MM IB. From the Herakleion
Archaeological Museum, Crete43
23. Elaborate Barbotine Ware Bowls. The photo on the left shows a Stemmed bowl
pedestal from Knossos. The photo on the right shows a shallow bowl fragment from
Knossos. Both dated to MM IB43
24. Conical Cups with Barbotine Ware Decoration. The cup on the left is from Phaistos,
and the cup on the right is from Gournes44
25. Barbotine Vessels. Uniquely shaped vessel with Barbotine decoration and
polychrome painted motifs from MM IB. From the Herakleion Archaeological
Museum, Crete44
26. Barbotine sherd. MM IB sherd of Barbotine Ware from the 1976 Kommos
Excavations45
27. SEM Photomicrographs. Photomicrographs of the vitrification stages. (a) Shows the
degree of vitrification in the initial firing with its appearance of isolated smooth
surface areas of filaments of glass in the fresh fracture surface. (b) Shows a sample
which was fired at 850 degrees Celsius where continued vitrification occurs. (c)
Shows a sample fired at 900 degrees Celsius where extensive vitrification occurs, and

(d) shows a sampled fired at 950 degrees Celsius where the vitrification structure looks almost completely glassy	45
28. EDS Results for Body of Vessel. Elemental distribution in body	46
29. EDS Results for Slip. Elemental distribution in slip	47
30. Petrographic Photo of Voids. Petrographic photo showing the vesicles and vugs within the clay matrix	48
31. Petrographic Photo of Clay Matrix. Petrographic photo showing the preferential orientation of fabric and voids	48
32. Metamorphic Quartzite. Petrographic photo showing a large piece of metamorphic quartzite	49
33. Pillow Basalt. Petrographic photo showing a pillow basalt inclusion (a mineral found local to Kommos)	49
34. Slip. Petrographic photo of the Barbotine slip and its interaction with the body of the vessel	50

LIST OF ABBREVIATIONS*Elements*

Al – Aluminum

Ca – Calcium

Cl – Chlorine

Fe – Iron

K – Potassium

Mg – Magnesium

Mn – Manganese

Na – Sodium

O – Oxygen

S – Sulfur

Ti – Titanium

V – Vanadium

Other

AJA – American Journal of Archaeology

BSA – British School at Athens

EDS – Energy Dispersive X-Ray
Spectrometry

EM – Early Minoan

JHS – Journal of Hellenic Studies

MM – Middle Minoan

SEM – Scanning Electron Microscopy

CHAPTER 1

INTRODUCTION: MOTIVES, OBJECTIVES, METHODOLOGY

Pottery production during Middle Bronze Age, ca. 2100 to 1600 BCE, undergoes a major change in technology, giving way to a highly imaginative decorative style called Barbotine Ware.¹ It is a period of experimentation and creativity in which many different styles of ornamentation exist: the conventional incised style, dark on light style; White on Dark Ware; and Barbotine Ware.² Of these, Barbotine ware is perhaps the most unusual and the most intriguing. Barbotine is used to signify rough plastic relief on the surface of a clay vessel. It is most often used in the Mesara region of Crete to decorate jugs with round bodies and small raised spouts. The term Barbotine, derived from the French verb *barboter*, was originally used to denote the bits of slip that repaired slight flaws in porcelain. Proto Barbotine decoration occurs as early as EM I.³ The ware actually begins appearing around EM III, ca. 2100 BCE, but does not reach the height of its popularity until MM IB to IIA, ca. 1900 to 1750 BE, and it is almost completely abandoned by MM IIB, ca. 1700 BCE.

Barbotine Ware is important to Cretan archaeology for several reasons: it belongs to a long Middle Bronze Age tradition of creative polychrome pottery, and it defines a chronological phase, so that its presence can be used to date other artefacts to MM IA to MM IB. While small deposits of Barbotine Ware have been found in EM III contexts,

¹ Peter Warren, and V. Hankey, *Aegean Bronze Age Chronology*. (Bristol, 1989).

² Philip P. Betancourt, *The History of Minoan Pottery*. (Princeton: Princeton University Press, 1985), 68-70.

³ Doro Levi, "Le varietà della primitiva ceramica cretese," in *Studi in onore di Luisa Banti* (Roma, 1965), 223- 239.

marking the ware's beginnings at that early date, it is the large deposits from MM I contexts at sites like Phaistos and Knossos, that securely mark Barbotine Ware's popularity to MM IA and MM IB. Large deposits of Barbotine Ware indicate a MM I date.⁴ The ware has been examined only briefly in excavation reports, and primarily on stylistic grounds by Karen Foster in her book titled *Minoan Ceramic Relief*.⁵ In spite of the considerable work on the style, however, little scientific analysis has been done on Barbotine Ware. No scanning electron microscopy has ever been used for the ware. So Barbotine Ware still remains a rather ill-defined tradition. This project is intended to build upon Foster's work by including, not only an overview the decorative schemes and common shapes, but also a scientific study of the clay fabric used for Barbotine Ware production. The characterization and designation of the fabric type used in Barbotine Ware production enables one to identify this type of pottery as a Ware unto itself. The goal is twofold: to provide a comprehensive study of the shapes and stylistic variations found within the Barbotine Ware tradition, and to define its clay fabric through chemical and petrographic analysis.

The chemical and petrographic analysis is done on a Barbotine Ware jug sherd from Kommos. Kommos was excavated between the years 1976 and 2005. Excavations were carried out by the University of Toronto, under the directorship of Joseph Shaw, assisted by his wife Maria, under the auspices of the American School of Classical Studies. Kommos is an important Middle Minoan site, specifically in relation the Middle Minoan pottery. In the Bronze Age Kommos was a busy harbor town with an important

⁴ Philip P. Betancourt, *Kommos II: The Final Neolithic through Middle Minoan III Pottery*. (Princeton: Princeton University Press, 1990), 28-29. The large number of Barbotine Ware sherds helped indicate an MM IB context.

⁵ Karen Foster, *Minoan Ceramic Relief*. (Göteborg: P. Åström, 1982).

connection to trade between Crete, the Aegean Islands to the north, and the Near East.⁶

The abundance of Barbotine Ware sherds found at the site allow a further understanding of the clay fabric used in Barbotine Ware production.

The second chapter is intended to provide the reader with context for the petrographic and chemical analysis in chapter four. In the second chapter is a brief overview of Middle Minoan polychrome pottery styles, providing context and background for appreciating the stylistic importance of Barbotine Ware and also placing it within the long tradition of pottery production on Crete. Barbotine Ware presents a beginning step in the Minoan polychrome pottery tradition. The initial phases of the Minoan polychrome style have been called Pre-Kamarens, and Early-Kamarens Wares (MM IA – MM IB).⁷ Barbotine Ware fits right into this phase of Minoan polychrome, but should not just be relegated to a Kamarens style of decoration because of its three-dimensionality. The chapter also presents an overview of the popular decorative schemes, and shapes used for Barbotine Ware. This information should enable the reader to trace Barbotine Ware's historical development and decorative functions.

Chapter three contains the SEM-EDS and petrographic studies. Scanning electron microscopy (SEM) with linked energy dispersive spectrometry (EDS) and petrographic studies were conducted on a sample dated to MM IB from Kommos in southern Crete, to characterize the clay fabric and understand the elemental composition of the clay. The micromorphology and vitrification microstructure of the sample was examined by a scanning electron microscope.

⁶ Joseph W. Shaw, Maria C. Shaw, eds. *Kommos: An Excavation on the South Coast of Crete*. 3 vols. (Princeton: Princeton University Press, 1990). 25-29.

⁷ Gisela Walberg, *Kamarens: A Study of the Character of Palatial Middle Minoan Pottery*. Göteborg: P. Åström, 1976). 30-41.

A scanning electron microscope is a type of electron microscope that produces images of a sample by scanning it with a focused beam of electrons. The electrons interact with atoms in the sample, which contain information about the sample's surface topography and composition. This technique yields high resolution images of ceramic surfaces making it an excellent tool in the study of archaeological ceramics. The sample was also broken up into sub-samples, which were each re-fired in an oxidizing atmosphere at temperatures ranging from 650 to 950 degrees Celsius, at 50 degree intervals. The sub-samples were then studied under the SEM in comparison with the original sample; the degree of vitrification and equivalent firing temperatures were then assessed to determine the original firing temperature.

An EDS test provided an analysis of the elemental composition of the sample, in order to corroborate with the evidence found through petrographic analysis. The EDS results quantified the major and minor elements found in the clay. The beam was focused on the body of the sherd and on the area containing the slip, to determine the compositional differences of each material. A thin-section of the sample was studied under a petrographic microscope in both plane and cross-polarized light. Petrography was performed to determine the clay fabric of the sample, pinpoint its provenance, and learn about the techniques used in the production of the clay and formation of the vessel.

The fourth, and final chapter, consists of the larger conclusions: the role Barbotine Ware plays in polychrome pottery decoration, and the ceramic technology used in its production. By characterizing the fabric of Barbotine Ware, along with its decorative motifs, it can be classified as a specific Minoan ware. This system follows Betancourt, 2008; a fabric is named in capitalized letters if it has been defined by ceramic

petrography and assigned a specific region in Crete, and a ware is capitalized if its style or ornament can be defined and its fabric has been defined by ceramic petrography.⁸ This project will define Barbotine decoration as a specific Ware within Minoan pottery, on par with Kamares Ware, and solidify its importance in Aegean Bronze Age archaeology.

⁸ Philip P. Betancourt, *The Bronze Age Begins: The Ceramics Revolution of Early Minoan I and the New Forms of Wealth That Transformed Prehistoric Society*. (Philadelphia: INSTAP Academic Press, 2008). 25-32.

CHAPTER 2

THE POTTERY: BACKGROUND, AND BARBOTINE WARE STYLES AND SHAPES

The development of Middle Minoan pottery begins with a rustic start in MM IA, and culminates with the finely decorated pottery of the Late Bronze Age. Barbotine Ware appears, in its earliest stages, a bit before MM IA, in EM III. The style gradually becomes more popular and picks up significantly in MM IA, along with the conservative incised style, dark on light style, and White on Dark Ware. Red paint is added to the decoration in MM IA, and orange, crimson and yellow are used in MM IB. MM IB represents a major development in technology and style. The potter's wheel is used for the first time in Crete, and thin, well-made pottery begins to overtake the rougher handmade varieties. Polychrome paint becomes the norm, and the general motifs become more dynamic and sophisticated, with Minoan artistic principles reaching full maturity.⁹

Barbotine Ware and Kamares Ware, are the two major innovative pottery wares of the Middle Minoan period. MM IA is the last phase to use exclusively handmade pottery in Crete; it is decorated with conservative linear motifs. The use of red paint is introduced during this period. White on Dark Ware continues, especially on Eastern Crete, and a dark on light style painted directly on the clay is popular everywhere. In central Crete simple incised decoration adorns vessels. Early Barbotine Ware ornamentation can be seen in simple ridges in Central Crete, and early stages of Kamares Ware appear in the use of red and orange paint along with added white. Most MM IA

⁹ Philip P. Betancourt, *The History of Minoan Pottery*. (Princeton: Princeton University Press, 1985), 80.

shapes are efficient and functional.¹⁰ MM IA can be characterized by conservative yet diverse pottery. Hints of experimentation and variation appear.

The potter's wheel takes hold during MM IB. The shapes are thin, and many seem to be inspired by metalwork, lending a more embellished feel to the pottery. Modeling is popular in early MM I, with added plastic figurines placed on, or in the vessel. The incised style is still popular in MM I, and these decorations are often used as area filling patterns. Zigzags, diagonals, crosshatched areas, short dashes, and punctuations are the most common motifs (Figure 1).¹¹ Barbotine Ware reaches its full potential in MM IB, and its decoration and shapes will be discussed later on. The dark on light style has designs painted directly onto the clay, and white painted linear decoration continues to be popular. The ornament is often matte and slightly dull, and designs are often cursory, with random drips and accidental effects.¹²

Kamare Ware begins to emerge in MM IA, but the decorations are far simpler than the MM IIB period of Kamare Ware. It is defined by polychrome decoration. Kamare Ware does not reach full maturity until MM IIB, with elaborate floral, figural, and geometric designs painted on a dark slip that covers all or most of the surface. The paint used consists of red, orange, crimson, and white. Other decorative techniques, like Barbotine decoration, are added occasionally.¹³ The brilliant designs and thin walls are exemplary of the Minoan artistic style. In the initial phases of Kamare Ware, during MM

¹⁰ Philip P. Betancourt, *The History of Minoan Pottery*. (Princeton: Princeton University Press, 1985), 80-85.

¹¹ Philip P. Betancourt, *The History of Minoan Pottery*. (Princeton: Princeton University Press, 1985), 80-85.

¹² Philip P. Betancourt, *The History of Minoan Pottery*. (Princeton: Princeton University Press, 1985), 87.

¹³ Gisela Walberg, *Kamare: A Study of the Character of Palatial Middle Minoan Pottery*. Göteborg: P. Åström, 1976), 73-74.

IA, torsion is already present in the decoration. The use of curvilinear designs and running spirals looks forward to the next phase.

In the next phase, the Early Kamares phase, Barbotine decoration is used to create a contrast between smooth and rough areas. This contrast is often further accentuated by the use of different colors. The decoration shows more variety than before and more decorative motifs are used, including dots, petals, and whirls. Running spirals now encircle the whole vessel. There are also large spirals used alone as main decoration, usually one or two on each side of the vase. The upper, most convex parts of the vessels are often accentuated, while the decoration on the lower part radiates upwards from the base. White is the dominating color for the painted decoration both of vessels with Barbotine decoration and for those with a smooth surface. In the vases with a smooth surface, red and yellow paint plays a more important role than in those with Barbotine decoration.¹⁴ Dark on light style continues with simple motifs in dark paint. It is found throughout the island, and varies considerably. Designs are painted directly onto the clay surface, resulting in a dull matte surface (Figure 2). The style is often cursory and simple, but represents an important characteristic of Minoan life – a preference for decoration on even the most common objects.¹⁵

Classical Kamares Ware appears in MM IIB. The finest pieces come from the palaces at Phaistos and Knossos, associating the style with the palace workshop. Whirling and radiating motifs are characteristic of the classical Kamares Ware phase. For the first time plant life and animal life are important in the inspiration and decoration of the

¹⁴ Gisela Walberg, *Kamares: A Study of the Character of Palatial Middle Minoan Pottery*. (Göteborg: P. Åström, 1976), 77-78.

¹⁵ Philip P. Betancourt, *The History of Minoan Pottery*. (Princeton: Princeton University Press, 1985), 80-87.

pottery (Figure 3). The shapes become particularly creative, with special forms, or embellishments on old forms (Figure 4). Bowls and cups with crinkled rims and pronounced carination are very popular (Figure 5). The decorative repertoire is vast, and the elements are often combined in unusual and unique ways. The composition is always flat, and no sense of dimension is present. The result is a purely decorative scheme with a visual impact emphasized by colorful patterns on a dark background. The design make good use of movement, directing the eye around the vessel to emphasize its form (Figure 6). This sense of movement and dynamism is seen first in the earlier polychrome Barbotine Ware tradition. Gisela Walberg would place Barbotine Ware in her Early Kamares Ware phase, with its thin walls and dynamic motifs.

Minoan Barbotine Ware decoration is conventionally divided into three groups: Plain and crinkled ridges; irregular polygonal ridges; and protuberances (Figure 7). The irregular polygonal ridge decoration (or as Evans has so named, barnacle work¹⁶) is used in conjunction with monochrome glaze, with white or black dots painted over the ridges, and with highly defined ridges. The plain or crinkled ridges appear either regularly or irregularly spaced, with painted areas in between. Protuberances come in a variety of patterns: some geometric or curvilinear; some surrounding undecorated spaces; some arranged irregularly; and others dabbed with paint.¹⁷

The ceramic techniques involved in producing Barbotine Ware are unique to each group. For the irregular polygonal ridges, the vessel is prepared with a thick layer of viscous slip and a flat tool is then pressed down onto slip and rapidly lifted straight off. This technique produces a sharp irregular network of ridges. To create a pattern of ridges

¹⁶ Arthur Evans, *The Palace of Minos at Knossos IV*. (London: Macmillan, 1921-1935), 100-102.

¹⁷ Karen Foster, *Minoan Ceramic Relief*. (Göteborg: P. Åström, 1982), 2.

using this method, one can set the flat tool down in different direction. To create a variation on the perpendicular polygonal ridges, the slip can be manipulated by dabbing the applied slip with the fingertips and pulling upwards, creating roughly circular and gently sloping ridges. Smooth channels can be made by dragging a blade across the finished Barbotine work. As for plain and crinkled ridges, a small amount of slip is applied to the surface and pushed a short distance to the side with a flat tool, setting it down immediately behind the new ridge and the pushing the slip sideways again. Irregular or angled ridges were created by varying directions of the sideways pushing. The crinkles can be created by carefully prodding the ridges with a small stick. Large protuberances can be made by taking a moist clay pellet, shaping it with the fingers and affixing it to the vessel. For smaller, more regularly aligned and shaped protuberances, two methods could have been used: the first by drilling a small hole into a wooden peg, pushing moist clay into the pit, removing excess clay with a taut string, or pressing the peg onto the surface of the vessel, creating neatly shaped consistent protuberances with no excess clay at the surface. The second method entails filling a nozzle, probably a goat's bladder, with the slip and squeezing it out onto the surface of the vessel.¹⁸

Irregular polygonal ridges are comprised of four principal varieties: monochrome, white spotted, black spotted, and highly defined.¹⁹ The earliest of this style appears in MM IA at both Knossos and Phaistos. At Phaistos, this variety usually occurs on globular-conical jugs with one thick round handle. Ridge work is usually found in one broad band around the widest part of the body, while above and below are brown painted

¹⁸ Karen Foster, *Minoan Ceramic Relief*. (Göteborg: P. Åström, 1982), 5. With the help of the potter Robert Parrott, Foster experimented with Barbotine techniques.

¹⁹ Karen Foster, *Minoan Ceramic Relief*. (Göteborg: P. Åström, 1982), 5.

stripes. The spout rim is often outlined by rough protuberances, with a boss on each side of the handle. Jugs from Room IL and Room LXIII are among the examples of this variety at Phaistos (Figure 8).²⁰ Two vessels from Phaistos have black-painted irregular ridges. One is part of a flat tray from Room CIII. It is also decorated with black irregular polygonal ridges and smooth channels black bordered red lines (Figure 9). The other is a shallow wide-mouthed conical jar from Room IL, with two horizontal handles set mid-way up the sides and short spout. Most of the surface is covered by irregular polygonal ridges (Figure 10).²¹ Several sherds with monochrome irregular polygonal ridges have been found at Phaistos and Kommos. The sherds come from jugs, pithoid jars, and open bowls. Several jugs of this variety were contained in the large tholos tomb and ossuary cells at Hagia Triada. In general the jugs are globular-conical and have short spouts and one or three thick handles that often have Barbotine protuberances. Several of these jug types have a horizontal zone of Barbotine work around their widest part, and are embellished by smooth channels in the Barbotine.²²

The tholos tombs in the Mesara yield many types of Barbotine Ware vessels, only a few of which have monochrome irregular polygonal ridges. Two particularly fine examples come from the Metaxas Collection: two jugs, with long upswept beaks, vertical handles, and white stripes around the necks (Figure 11).²³ Numerous pieces come from Knossos; nearly all are of the black painted variety and most have channels smoothed across the Barbotine surface. The finest Knossian example is the three-handled jug found

²⁰ Doro Levi, *Festòs e la civiltà minoica. Incunabula Graeca 60*. (Edizioni dell'Ateneo: Roma, 1976), 144-45, fig. 214.

²¹ Doro Levi, *Festòs e la civiltà minoica. Incunabula Graeca 60*. (Edizioni dell'Ateneo: Roma, 1976), 53, pl. 60c., 550, pl. XVb. The tray was described as an offering table.

²² Karen Foster, *Minoan Ceramic Relief*. (Göteborg: P. Åström, 1982), 5.

²³ Leonard Von Matt, *Ancient Crete; with 30 Colour Plates and 153 Black-and-White Photographs*. (London: Thames and Hudson, 1968), ill. 50.

in a narrow passageway southwest of the palace (Figure 12).²⁴ This elaborate jug is decorated with light-colored irregular polygonal ridges with four smooth triangular areas containing lace patterns in red, brown, and white on a yellow background below the ridges, while double festoons hang from a red stripe and a row of roughly formed protuberances. Rough protuberances also border the spout rim.

Barbotine Ware designs were created on vessels made on turntables, as well as on simple wheels. A study of the vessels shows Barbotine decoration is present on pottery with and without wheel marks. Karen Foster has studied the chronology of each of the three groups of Barbotine Ware. I will only briefly summarize her data here. Irregular polygonal ridge decorations of all sub-varieties (monochrome, white spotted, black spotted, and highly defined) appear in the MM IA/Pre-Kamares period, and was most frequently used during MM IB/ Early Kamares period. While classical and post-Kamares examples are comparatively rarer, they still show that this means of surface manipulation was retained as a part of the Kamares decorative repertory. Irregular polygonal ridge decoration was applied most often to jugs, pithoid jars, and bowls, as their surfaces provide the necessary space for this type of surface manipulation.

Possible centers of location for the production of irregular polygonal ridge decoration relies on the quantity of published vessels from given sites or areas, and on the presence of local characteristics. Phaistos, Hagia Triada, and Knossos seem to be the three principle centers of production for irregular polygonal ridge Barbotine because they yield the greatest number of Barbotine Ware finds. The large number of pieces from Kommos and the Mesara suggest that one or more workshops were located to the south

²⁴ Karen Foster, *Minoan Ceramic Relief*. (Göteborg: P. Åström, 1982), 9, pl. 6.

of Phaistos, though the Phaistos and Hagia Triada might have supplied the material found in southern Crete. Malia and Palaikastro yield only a small number of Barbotine Ware finds, ruling out possible large centers of production in those areas. While it is not possible to identify the products of specific potters, one can detect some local specialties. While spotted jugs were made mostly at Phaistos, while black spotted jugs were made mostly at Hagia Triada and not at all at Knossos.²⁵ A local specialty may also be seen in Kommian Barbotine Ware sherds, which are mostly decorated with the irregular polygonal ridged pattern.²⁶

There are four principal sub-varieties of plain regularly spaced ridges. Most of the first sub-variety consists of jugs decorated by ridges designed to create the effect of torsion (Figure 13). This type of ridge decoration seems to have been limited to the EM III – MM I period. The second and third sub-varieties use the ridges as elements of nonrepresentational and pictorialized designs. Both are found on pieces of Early Kamares date (MM IB/IIA). The designs often consist of foliate bands attached to ridges stems and checkerboard patterns with ridged horizontals and verticals (Figure 14). The fourth sub-variety include pieces with ridge decoration where the light and shadow of the relief work create the design, rather than painted patterns; these again show an early Kamares range. Various vessel shapes bear this type of Barbotine work.²⁷

As in the case of their plain ridged counterparts, crinkled regularly spaced ridges appear on MM I jugs and produce the effects of torsion. A second sub-variety of this type of decoration appears in nonrepresentational designs on bridge-spouted jars, cups, and

²⁵ Karen Foster, *Minoan Ceramic Relief*. (Göteborg: P. Åström, 1982), 53-60.

²⁶ Philip P. Betancourt, *Kommos II: The Final Neolithic through Middle Minoan III Pottery*. (Princeton: Princeton University Press, 1990), 65-73.

²⁷ Karen Foster, *Minoan Ceramic Relief*. (Göteborg: P. Åström, 1982), 60.

pedestals. A third sub-variety uses crinkled ridges as mid ridges for white dots. Overall crinkled ridges seem to have been used as embellishment on their own, without painted design, more often than plain ridges. The earliest piece is a jug from Koumasa, and the latest is a MM II cup from Knossos.²⁸

Principal centers for both plain and crinkled ridge decoration were located at Phaistos and Knossos. Hagia Triada, which produced so much irregular polygonal ridge work, does not seem to have produced any regularly spaced ridge work. Plain irregularly spaced ridge work seems to have been only used on vessels at Knossos (Figure 15). Since it was difficult to produce satisfactorily, irregularly spaced ridge work may have been an innovation of a particular workshop at Knossos.²⁹

Regularly spaced plain protuberances can be arranged in different varieties. Widely spaced protuberances have an early date, with examples from EM I and MM IA (Figure 16). Simona Todaro, in her study on the pottery from Phaistos, dates the beginnings of Barbotine Ware pottery to the EM III period.³⁰ The EM III date for the earliest Barbotine Ware pottery is confirmed by Doro Levi's earlier study of Phaistos pottery. Levi dates Pre-Barbotine decoration as early as the Final Neolithic period, and Proto-Barbotine decoration to EM I – MM I, with true Barbotine showing up in EM III.³¹ The most frequently seen pattern of plain protuberances consists of two or more horizontal rows of protuberances, usually placed around the widest parts of jugs, jars, and cups (Figure 17). The earliest is a jug from EM I/II from Pyrgos while the latest is a set of

²⁸ Karen Foster, *Minoan Ceramic Relief*. (Göteborg: P. Åström, 1982), 60.

²⁹ Arthur Evans, "The Tomb of the Double Axes," *Archaeologia* 65 1914: 78, fig. 86.

³⁰ Simona Todaro, "The EM III Phase in South Central Crete: New Data from Phaistos," (*Aegean Archaeology* 10, 2005), 65-85.

³¹ Doro Levi, "Le varietà della primitiva ceramica cretese," in *Studi in onore di Luisa Banti* (Roma, 1965), 223- 239.

jugs from MM III from Knossos. Most of the pieces belong to the MM I/ Early Kamares period. Most of the vessels decorated with vertical protuberances date to the same period. Protuberances arranged in a rectilinear or curvilinear pattern (Figure 18) follow the same chronological distribution with a few extending into MM IIB/IIIA, or the classical Kamares period. Painted protuberances comprise arrangements of white, red, or black dabbed protuberances. There are occasionally a few cases where white and red patterns appear over the protuberances (Figure 19). These painted varieties appear most often in MM IB/IIA, or the Early Kamares period. Pieces with regularly spaced protuberances were distributed throughout central, eastern, and southern Crete, with major find spots at Knossos, Phaistos, Hagia Triada, and somewhere in the Mesara region as well. Regional preferences may include: widely spaced, one horizontal row, and vertical rows at Knossos; and two or more horizontal rows, rectilinear and curvilinear patterns in the southern centers.³²

The shapes of the vessels decorated with Barbotine decoration include jugs, jars, bowls, cups, and an occasional ritual vessel. Of the jugs, the most common are small beaked jugs with Barbotine decoration on main part of the body, and occasionally on the shoulders and handles (Figure 20). Pithoid jars are a common shape, adorned with Barbotine decoration on the upper body, and handle (Figure 21). Bridge spouted jars, also commonly have Barbotine decoration on the upper body (Figure 22). Elaborate bowls also contain Barbotine decoration on the body (Figure 23). Conical cups, and fancier crinkled rim cups often receive plastic decoration (Figure 24). A number of unique shapes are adorned with Barbotine decoration as well (Figure 25). The variety of shapes

³² Karen Foster, *Minoan Ceramic Relief*. (Göteborg: P. Åström, 1982), 64-72.

adorned with Barbotine decoration allow some insight as to the function of Barbotine Ware. The patterning and modeling of the decoration is used for fine table or house wares made to be shown off. The abstracted, yet highly complicated design elements of Barbotine Ware is both intellectually and aesthetically stimulating.

Several proposals have been made as to what inspired Barbotine Ware: it may have been used to cover the irregularities of the coil manufacturing process;³³ as an aid to color since its elaborate surfaces would have produced shade and light;³⁴ as an imitation of marine forms, in the case of the irregular polygonal ridges;³⁵ or perhaps as a the positive, raised counterpart to the incised and stamped ware.³⁶ Barbotine Ware's three dimensional ornamentations are abstract designs based on the ceramic characteristics of the slip and vessel surface. Karen Foster suggests that the ornamentation has an imitative function, used to enlarge the number of stylistic conventions used to imitate the appearance of different types of stones. Stones such as banded limestone, breccia, conglomerate, and white spotted obsidian were often imitated in Minoan vase painting. This was done in a trompe l'oeil mode or in a more purely geometric style of patterning. Their imitation is visual rather than tactile and physical.³⁷ In Barbotine Ware the same effect of mimicry is achieved with the added three-dimensional quality. In Minoan vase painting, white-spotted obsidian and conglomerate were rendered by painting white spots on black backgrounds. In the case of Barbotine Ware this takes on the form of black

³³ Joseph Hazzidakis, *Tylissos À L'époque Minoenne;étude de Préhistoire Crétoise*. (Paris: Geuthner, 1921), 68.

³⁴ Duncan MacKenzie, "The Pottery of Knossos," *JHS* 23, (1903), 174.

³⁵ Arthur Evans, *The Palace of Minos* (4 vols., reprint). (New York: Biblo and Tannen, 1964), 100-102.

³⁶ Gisela Walberg, *Kamars: A Study of the Character of Palatial Middle Minoan Pottery*. (Göteborg: P.Astom, 1976), 41.

³⁷ Karen Foster, *Minoan Ceramic Relief*. (Göteborg: P. Åström, 1982), 76-78.

irregular polygonal ridges (e.g. figure 8). Veined breccia also provided a model for some Barbotine patterns, including some of the more complex irregular polygonal ridges.³⁸

Barbotine Ware ornamentation enhances the spatial potentialities of the vessel surface. The added plastic decoration is independent of whatever spatial properties the vessel shape confers, and in many ways enhances the shape by creating a visual link between the surface and the decoration. While Barbotine's function may be imitative of stone, or even metalwork, its decoration can be seen as an attempt at artistic abstraction, creating two spatial worlds in one three-dimensional form.

Barbotine Ware, as Gisela Walberg has noted, forms an important part of the decorative composition of the Minoan polychrome paint tradition seen in Kamares Ware pottery. It lends to the surface of a vessel a spatiality separate from, but still visually connected with, the three dimensional Kamares meld of shape and decoration.³⁹ Barbotine decoration, in its uniqueness, results in an extraordinary sense of movement amplified by the visual fluidity of the slip.

³⁸ Karen Foster, *Minoan Ceramic Relief*. (Göteborg: P. Åström, 1982), 77.

³⁹ Gisela Walberg, *Kamares: A Study of the Character of Palatial Middle Minoan Pottery*. (Göteborg: P. Åström, 1976), p. 83-95, for a detailed stylistic analysis of the pottery style.

CHAPTER 3

CHARACTERIZATION STUDY: SEM, EDS, AND PETROGRAPHIC REPORTS

A sherd of Barbotine Ware from MM IB, found at the site of Kommos, on Crete, has been analyzed by three separate techniques, consisting of scanning-electron microscopy, energy dispersive x-ray spectroscopy, and thin-section petrography. I received permission to study the sherd from Temple University; it is part of Temple University's Archaeology laboratory and Temple University's collection of Kommos pottery. The analysis was conducted in order to obtain information about the ceramic technologies employed during the sherd's creation. The study has several specific objectives which contributed to the larger goal: to discover the firing temperature of the sherd and the atmosphere in which it was fired and to identify the raw materials exploited (clay and temper) and to indicate their possible source within the local area. The petrographic analysis of the Barbotine Ware sherd is compared to other petrographic samples from the site of Kommos, studied at the Mineralogical Laboratory at Temple University by Philip Betancourt and George Myer.

Most of the pottery finds in Kommos from MM IB are made up of three fabric groups: fine buff, tempered buff and coarse red.⁴⁰ The sherd from this analysis fits into the tempered buff group, which was employed for open and closed vessels.⁴¹ The tempered buff fabric group from the previous Kommos study is characterized by a pink to

⁴⁰ Philip P. Betancourt, *The History of Minoan Pottery*. (Princeton: Princeton University Press, 1985), 17.

⁴¹ Philip P. Betancourt, *Kommos II: The Final Neolithic through Middle Minoan III Pottery*. (Princeton: Princeton University Press, 1990), 3.

reddish yellow to light brown color range; the paste is somewhat fine with the presence of coarser particles such as metamorphic rocks, sandstone, siltstone, basalt, and phyllite.

Kommos, a prehistoric to early Roman site, is located on the south central side of Crete along the shore of the Mesara.⁴² Two other Minoan sites, Phaistos and Hagia Triada, are located farther inland to the northeast. During Kommos' Bronze Age phase, covering much of the Early Minoan to Late Minoan periods, a sizeable community was present.⁴³ Several houses have been completely or partially excavated, suggesting habitation from EM I (before 2500 B.C.E.) until LM IIIB (ca. 1200 B.C.E.).⁴⁴

Only a few decorated MM IB vessels were found at Kommos. Some of the designs were evidently early version of the finer Kamares Ware of MM II. Some of the vessels were decorated in the White on Dark Ware styles, and some were decorated with the dark on light technique. Barbotine Ware, especially barnacle work (or irregular polygonal ridges), was typical of the phase. Its rough texture was used in large areas especially on jugs and jars. Often the Barbotine was applied in combination with dark painted bands or dots.⁴⁵ By MM IIA there was a marked decline in Barbotine Ware production. Though Barbotine ware was still found in small quantities, it was far less common in MM IIA than in MM IB.⁴⁶ The use of irregular polygonal ridges (barnacle

⁴² Philip P. Betancourt, *Kommos II: The Final Neolithic through Middle Minoan III Pottery*. (Princeton: Princeton University Press, 1990).

⁴³ Joseph W. Shaw, Maria C. Shaw, eds. *Kommos: An Excavation on the South Coast of Crete*. 3 vols. (Princeton: Princeton University Press, 1990).

⁴⁴ Peter Warren, and V. Hankey, *Aegean Bronze Age Chronology*. (Bristol, 1989), 120-127.

⁴⁵ Philip P. Betancourt, *Kommos II: The Final Neolithic through Middle Minoan III Pottery*. (Princeton: Princeton University Press, 1990), 29.

⁴⁶ John, D.S. Pendlebury, *The Archaeology of Crete: An Introduction*. (New York: Norton, 1965), 137, for a suggestion that the invention of the potter's wheel was responsible for this decline.

work) declined, whereas the use of small protrusions (prickles) would continue to be employed in small quantities throughout the Middle Bronze Age.⁴⁷

Most of the Barbotine Ware found at Kommos was from Context 5, Trench 11A. Trench 11A was a small test trench in the Lower Hillside area. The material from this context was fairly homogenous. Most of the sherds were fairly small. The abundance of Barbotine Ware helped to define this phase. The Barbotine decoration occurred in a number of varieties, both with and without polychrome, totaling 16.60 percent of the diagnostic sherds.⁴⁸ The piece that has been analyzed is from this context. It is a body sherd from what was most likely a jug. It has a convex profile and was probably made on a simple wheel. The Barbotine consists of zones of irregular polygonal ridges with dark painted bands in between the zones. This was a very common class of jugs in MM IB contexts at Kommos, but very rare in MM IIA and later contexts. The decoration is diagonal and placed on the body in such a way as to emphasize the curvature of the vessel.⁴⁹ It is part of the tempered buff fabric group. The natural constituents in the clays and soils used at Kommos consist of angular to sub-angular fragments of feldspar, quartz, and other minerals. Most of these particles are under 50 micrometers in size. The tempered buff contain particles with a greater variety of minerals than the fine buff fragments from Kommos, and the contours of these fragments are more rounded than those of the small natural inclusions. Since mineralogy, size range, and shape contrast to those smaller fragments found in all sherds, it is likely that the larger fragments represent

⁴⁷ Philip P. Betancourt, *Kommos II: The Final Neolithic through Middle Minoan III Pottery*. (Princeton: Princeton University Press, 1990), 30.

⁴⁸ Philip P. Betancourt, *Kommos II: The Final Neolithic through Middle Minoan III Pottery*. (Princeton: Princeton University Press, 1990), 28-32.

⁴⁹ Philip P. Betancourt, *Kommos II: The Final Neolithic through Middle Minoan III Pottery*. (Princeton: Princeton University Press, 1990), 67.

temper added by the potters. All Kommian pastes seem to have been tempered by the addition of terra rosa, or some similar soil with low plasticity.⁵⁰

This Barbotine sherd exemplifies the creative ornamental repertoire of the MM IB period, with its dark diagonal bands painted on a lighter background alongside the dabs of slurry in irregularly spaced polygonal ridges, also called barnacle work by Evans (Figure 26). Some of the ridges are painted with dark dots. The maximum dimension of the sherd is 10 cm. The fabric, as defined by Munsell, is reddish-yellow in color. Barbotine Ware still remains a rather ill-defined tradition, so the following scientific analysis will present new interpretative data allowing for a more accurate understanding of the properties and production of the pottery, and help define the style as a Ware.

SEM Analytical Results

The microscopic morphology and vitrification microstructure of the sample was examined by scanning electron microscope which allows the electrons to interact with atoms in the sample containing information about the sample's surface topography and composition. This technique yields high resolution images of ceramic surfaces making it an excellent tool in the study of archaeological ceramics.⁵¹ The SEM study was conducted at the Electron Microscopy Facility at Penn Regional Nanotechnology Facility with the help of the Director, Douglas Yeats, and Jamie Ford.

⁵⁰ Philip P. Betancourt, *Kommos II: The Final Neolithic through Middle Minoan III Pottery*. (Princeton: Princeton University Press, 1990), 6.

⁵¹ Yannis Maniatis, and M.S. Tite, "Ceramic Technology in the Aegean World during the Bronze Age," in *Thera and the Aegean World I*, ed. C. Doumas, (Athens, 1978), 483-492.

Firing is the most important part in the pottery production procedure. The firing hardens, strengthens, and stabilizes the raw material, readying it for further treatment. The microtextural relationship between the paste matrix and mineral inclusions transforms based on firing temperature, duration, and the atmosphere in the kiln (oxidizing or reducing). The sample has been broken up into sub-samples, which were each re-fired in an oxidizing atmosphere at temperatures ranging from 650 to 950 degrees Celsius, at 50 degree intervals. The sub-samples were then studied under the SEM in comparison with the original sample; the degree of vitrification and equivalent firing temperatures were then assessed to determine the original firing temperature.⁵² These four SEM photomicrographs (Figure 27), show the differences in vitrification structure when the sample was fired above 800 degrees Celsius. Photo (a) shows the degree of vitrification in the initial firing of the original sample with its appearance of isolated smooth surface areas of filaments of glass in the fresh fracture surface. Photo (b) shows a sample which was fired at 850 degrees Celsius where continued vitrification occurs. Photo (c) shows a sample fired at 900 degrees Celsius where extensive vitrification occurs, and photo (d) shows a sample fired at 950 degrees Celsius where the vitrification structure looks almost completely glassy. Microtextural studies on the ceramics provide additional evidence for the division into groups. In the samples fired at lowest temperatures, no reactions on minerals, mineral-rims or inter-phase contact zones are observable. The temperature-sensitive carbonate inclusions show no alteration or modification compared to unfired calcareous material (see Figure 27). At a slightly

⁵²Yannis Maniatis, and M.S. Tite, "Ceramic Technology in the Aegean World during the Bronze Age," in *Thera and the Aegean World I*, ed. C. Doumas, (Athens, 1978), 483-492, for a detailed description of the procedure used to assess the degree of vitrification and firing temperature.

higher temperature, above 850 degrees Celsius, the development of a reaction domain around carbonate fragments is apparent in the ceramics. It is indicated by a thick zone enriched in Ca, which appears as a bright halo around the carbonate fragments, as a consequence of calcium transport from the grain into the porous paste matrix. Beside the newly formed reaction area, the carbonate fragments show different degrees of mineral detachment, as sometimes an intact crystal core remains. In the enlarged affected zone, no phase reactions due to the Ca-enrichment can be determined. The sample fired at highest temperatures as during the firing process variable phase reactions took place. The most noticeable reaction that takes place at this stage of firing is the total decomposition of calcareous inclusions and the simultaneous development of a second temperature triggered reaction zone — a glassy reaction rim where the calcareous grains and the clayish paste matrix mix.

With increasing firing temperature, the extent of the glassy phase increases until ultimately the total vitrification stage in which a continuous smooth vitrified layer is formed over the entire fracture surface. In the samples fired under increasingly higher temperature a continuous vitrification can be observed, and the temperatures at which the vitrification structure changes can be determined, to figure out the original firing temperature. This confirmed that the fragment was fired between the temperatures of 800-850 degrees Celsius, in an oxidizing atmosphere. The temperature and atmosphere of the firing is used for highly fired, finer vessels, indicating that this sherd belongs to a vessel meant to be seen and used perhaps as tableware.

EDS Analytical Results

An EDS test provided an analysis of the elemental composition of the sample, in order to corroborate with the evidence found through petrographic analysis. Energy Dispersive X-Ray Spectrometry (EDS) which uses backscattered electron images in the SEM display compositional contrast that results from different atomic number elements and their distribution. EDS allows one to identify what those particular elements are and their relative proportions (Atomic % for example). Initial EDS analysis usually involves the generation of an X-ray spectrum from the entire scan area of the SEM. The Y-axis shows the counts (number of X-rays received and processed by the detector) and the X-axis shows the energy level of those counts.

The EDS results quantified the major and minor elements found in the clay. The beam was focused on the body of the sherd and on the area containing the slip, showing interesting results. Two separate graphs of the EDS results (Figure 28) illustrate the percentages of the elements in the body, and (Figure 29) the percentages found in the slip. The peaks show that the body of the sample contains a large amount of silicon. Iron, calcium, aluminum, oxygen, and potassium are the next greatest percentages of elements. Magnesium, sulfur, chlorine, titanium, manganese, and vanadium are also among the elements present. The elements in the slip are essentially the same, but appear in quite different quantities: the proportions of the elements potassium and calcium are nearly reversed, and a much greater presence of magnesium, iron, oxygen, and sodium appear in the slip. The slip's elemental composition is also missing chlorine and manganese.

These slight differences between the surface decoration and the body of the sherd point to a choice made by the potter to slightly refine the slip material making it more

suitable for the surface decoration. The potter used a very similar clay recipe for the body and the slip, but he further refined the slip material making it easier to manipulate. The petrographic evidence will help further conclude this theory in that most of the same mineral inclusions appear in the ceramic matrix of the body of the vessel as well as the slip of the vessel, but in different proportions and sizes. These EDS results do not comply with Joseph Noble's early study on Attic pottery in which he concludes that the slip and the body of the vessel are composed of the same clay, but with slight elemental variations.⁵³ They suggest instead, that two different raw materials were used for the vessel.

Petrographic Results

Combined with the SEM-EDS study, a thin-section of the same sample was analyzed under a petrographic microscope in both plane and cross-polarized light. Petrography is an incredibly useful tool for the study and classification of clay fabrics. A petrographic microscope transmits polarized light through the ceramic thin section, allowing for the identification of the clay matrix and non-plastic inclusions.⁵⁴ Pores and voids can be recorded, as well as details of surface modification and decoration. A thin section can be created by chipping off a small piece of the ceramic material, attaching the resultant flat surface to a glass microscope slide, and then grinding the ceramic surface

⁵³ Joseph Noble, "The Technique of Attic Vase-Painting," *AJA* 64, (1960): 307-318. It is worth noting that Noble was not dealing with Bronze Age techniques.

⁵⁴ Sarah E. Peterson, S.E., *Thin Section Petrography of Ceramic Materials*. (Philadelphia: INSTAP Academic Press, 2009), 1-3.

down to a desired thickness.⁵⁵ At the standard thickness mineral inclusions within the clay fabric become transparent allowing light to be transmitted through, or reflect off, the mineral inclusions revealing their characteristic optical properties.⁵⁶ The fabric can then be identified through the examination of its plastic and aplastic components, microstructure, and texture.⁵⁷ The petrographic study is in almost complete agreement with the chemical analysis.

In this study, the materials composing the clay are separated into two types, plastic and aplastic, based upon certain material properties. Paste refers to the entire ceramic matrix including plastic and aplastic components. Plastic components are predominately clay minerals and generally comprise most of the sherd or matrix. Non-clay minerals and rock fragments are referred to as aplastic components and can be identified through petrographic analysis. Aplastic materials greater than 0.1 mm in diameter are evaluated for crystal shape (angular, subangular, subrounded, or rounded), color (clear, translucent, or colored), and pleochroism (change of color upon rotation of the stage in plane polarized light). Opaque minerals, which appear black under plane-polarized light, are also evaluated. Temper is generally defined by archaeologists as aplastic material added to clay to enhance the workability or firing characteristics of the paste⁵⁸. It is often difficult to ascertain whether specific aplastic components of pottery have been deliberately added to enhance the workability of the paste or are present

⁵⁵ The thin-section was created at National Petrographic Services, Inc. The petrographic analysis was done at the Department of Geology in Temple University by George Myer, and at the University of Pennsylvania Museum's petrography lab, by Marie-Claude Boileau.

⁵⁶ Sarah E. Peterson, S.E., *Thin Section Petrography of Ceramic Materials*. (Philadelphia, INSTAP Academic Press, 2009), 12-14

⁵⁷ Sarah E. Peterson, S.E., *Thin Section Petrography of Ceramic Materials*. (Philadelphia: INSTAP Academic Press, 2009), 12-14.

⁵⁸ Prudence, M. Rice, *Pottery Analysis: A Sourcebook*. (Chicago: University of Chicago Press, 2006), 74.

simply as naturally occurring constituents of the clay. In this study, aplastic materials with grain sizes smaller than 0.1 mm are considered to be naturally occurring components of the paste material. Aplastic materials with grain sizes greater than 0.1 mm are classified as tempering materials which have been added by the potter.

The petrography results characterize the clay fabric of the original sample. The microstructure of the sample contains a number of voids, which constitute the gray areas in the general matrix of the clay. Vesicles and vugs, or spherical and irregularly shaped voids, are present and can be seen (Figure 30). The preferential orientation of the voids can be observed; the voids or gray areas are parallel to the clay fabric, which is also preferentially oriented to the vessel (Figure 31). The groundmass is a reddish-brown color, indicative of a hematitic fabric, meaning the general matrix is rich in iron oxide. It has low optical activity indicating that the sample was well fired. There are also dark reddish-brown subangular to subrounded inclusions; it is not clear as to whether they are clay concentrations and/or grog, a kind of temper. Grog is a ceramic material occasionally used in pottery to add a specific texture to the clay paste.

The fabric includes particles of the following materials in sizes under 50 micrometers:

1. Crystallized quartz, vein quartz, and cryptocrystalline quartz.
2. Plagioclase feldspar.
3. A carbonate, possibly calcite, or dolomite.
4. Pillow basalt containing soda-straw plagioclase
5. Metamorphic rock consisting of several minerals.
6. Few lumps of clay.

And particles of the following materials in sizes above 50 micrometers:

1. Metamorphic rock containing quartz, plagioclase, and an amphibole (perhaps hornblende).
2. Quartzite.
3. Phyllite sherds showing kink banding.
4. Pillow basalt, containing soda-straw plagioclase crystal.
5. Amphibole quartz schist.
6. Epidote.
7. Serpentine.
8. Chert.
9. A pyroxene, possibly diopside.
10. Quartz Sandstone.
11. Limestone.
12. Siltstone.

The fabric is bi-modal, containing large inclusions that contrast sharply with an otherwise homogeneous paste including tiny natural particles found in Kommos pottery samples. This suggests that they are non-plastic inclusions, or temper. Various geological environments are represented in the temper. Many fragments come from a metamorphic environment (feldspar, quartz, quartzite, phyllite, and amphibole), the basalt is from an igneous environment, and the sandstone and limestone are sedimentary and locally abundant in and near Kommos. The mixture of the geological environments and the rounded shape of the particles indicate a strong possibility that the temper was sand. An

examination of beach sand from Kommos reveals particles very similar to those in the pottery sherd.⁵⁹

Among the inclusions in the fabric the most abundant is metamorphic quartz (Figure 32). It is anhedral in shape, which means the original quartzite grain separated into smaller grains. Most of the quartzite inclusions appear strained, which indicates metamorphic quartz. The quartz contains flakes of cross-biotite in it. The less abundant inclusions are, white mica, feldspar, sandstone, chert, and phyllite. Pillow basalt (Figure 33) was also present, which is particularly significant because it is characteristic of Cretan South Coast fabric.

The Cretan South Coast fabric has been defined by Eleni Nodarou, in her study of the petrographic groups from Aphrodite's Kephali. The fabric is characterized by a flysch mélange of inclusions.⁶⁰ The fabric contains a variety of minerals and rocks that have washed down from the mountains, and from different geological backgrounds. While it cannot be concluded that the pottery was produced in Kommos, the clay fabric is certainly from the South Coast Mesara area. This region stretches from Kommos to Ierapetra and farther east, so it is difficult to tell exactly where the clay originated from. The Cretan South Coast fabric, as defined by Betancourt and Myer, is most often brown but occurs in a wide range of brown to red hues. The grains generally range from medium coarse to coarse. The most distinctive feature, viewed only through thin section, is the presence of a whole assemblage of rounded to subrounded grains including phyllite,

⁵⁹ Philip P. Betancourt, *Kommos II: The Final Neolithic through Middle Minoan III Pottery* (Princeton: Princeton University Press, 1990), 10-11.

⁶⁰ Eleni Nodarou, "Petrographic analysis of the Pottery," in *Aphrodite's Kephali: An Early Minoan I Defensive Site in Eastern Crete*, ed. P.P. Betancourt, (INSTAP Academic Press: Philadelphia, 2013), 162-164.

several types of quartz, basalt, plagioclase, and sometimes shell fragments.⁶¹ These inclusions make this an identifiable clay. Characteristics of the large grains suggest that they are beach sand added as temper. The subrounded to rounded contours contrast with the angularity of the tiny inclusions that are likely natural constituents of the clay. The roundness of the large inclusions indicate that they are water-worn. They also consist of materials from varied geological backgrounds. Kommos contains huge amounts of beach sand, and it would be logical for a potter to use this material for temper. The Barbotine Ware sherd from Kommos has the majority of these inclusions in abundance.

The thin section was made through the Barbotine decoration, which was easily discernible under both plane and cross polarized light (Figure 34). The slip, or decoration, is under 50 micrometers in thickness, which is fairly thin. There are visible quartz grains in the slip that are subrounded in appearance, which again, indicates that they may be temper. The Barbotine material, as applied on top of the pottery can be seen, in the way it is built up on top of the body. The slip material is not the same as the material used for the body, as shown by the elemental analysis of the EDS study; the slip contains more iron, which results in its darker brown color. The bi-modal inclusions in the slip also indicate the use of temper.

⁶¹ Philip p. Betancourt, and George H. Myer, "South Mesara Fabric," Δώρον: τιμητικός τομός για τον καθηγητή Σπύρο Ιακωβίδη, Δανηλίδου, Δέσποινα, ed. Σειρά Μονογραφιών 6, Αθήνα: Ακαδημία Αθηνών, Κέντρον Ερεύνης της Αρχαιότητος. (2009), 73-82.

CHAPTER 4

CONCLUSIONS

The purpose of this project was to define Barbotine Ware more fully, and help identify it, not just as a style, but as a distinct Ware within the history of Minoan Pottery.⁶² By the Middle Minoan period, Cretan potters developed a complex system of relief decoration created by slip manipulation, known as Barbotine Ware. The style begins appearing in the Early Minoan period, with Barbotine decorated jugs from Phaistos and Knossos, and falls out of fashion by the MM IIB period. During its most popular period, Barbotine Ware appears throughout Crete, though concentrated in the Central, and South Central regions. The three main patterns have been distinguished as irregular polygonal ridges, plain and crinkled ridges, and protuberances. The first variety includes monochrome examples in plain, buff, and black. Plain and crinkled ridges may be regularly or irregularly spaced, close together, or dabbed with color. The decoration appears either as self-sufficient embellishment, or in combination with painted decoration. Protuberances appear in many rectilinear and curvilinear arrangements.

Specific characteristic types of Barbotine Ware decoration seem to be popular during each period. EM III- MM IA vessels are generally adorned with irregular, monochrome, polygonal ridges. A few pieces are made with white and black decoration. Exaggerated polygonal ridges are also used. Of the ridge decoration there are plain

⁶² Philip P. Betancourt, *The Bronze Age Begins: The Ceramics Revolution of Early Minoan I and the New Forms of Wealth That Transformed Prehistoric Society*. (Philadelphia: INSTAP Academic Press, 2008). 25-32. A Ware, as defined by Betancourt, is the definition of a style of decoration as well as the definition of the clay fabric. If these two criteria are not met then the pottery is defined as a style and not a proper ware. Within Minoan pottery literature the use of the terms style and ware can be inconsistent.

irregular spaced ridges, as well as some plain and crinkled ridges. Protuberances occur regularly spaced and in contiguous arrangements. The most elaborate Barbotine Ware varieties appear in the MM IB period, all of the sub-varieties are found, and most continue into MM IIA. Polychrome paint becomes more popular in the MM IB – MM IIA period. The repertoire finally becomes more limited, and fades out by MM IIB.

Vessel shapes with Barbotine Ware decoration are mostly household and table wares. Jugs are the most popular vessel for the decoration. The shape of the jug itself, rounded body and upturned spout, plays into the dynamic plastic decoration which seemingly moves along the curves of the vessel. Cups, bowls, jars, and trays are also adorned with Barbotine decoration. These vessels were perhaps on display, provoking intellectual stimulation with their abstracted and dynamic motifs.

The three-dimensional design of Barbotine Ware endows a vessel with an additional spatial quality increasing the potential of its surface decoration. This also creates a tension between the vessel's two and three dimensional design elements resulting in a product that is aesthetically challenging. Most of the Barbotine Ware vessels are an experiment with abstraction, though some provided new means of imitation stone, and metal vessels. Barbotine Ware, beginning the polychrome tradition found in later Kamares Ware, heightens the sense of movement that is the hallmark of Kamares pottery decoration because the movement of the slip is arrested in particular patterns⁶³. Barbotine Ware shapes consist of mostly small jugs, jars, bowls, cups, and some ritual shapes. These are all highly embellished, and likely intended as fine houseware.

⁶³ Karen Foster, *Minoan Ceramic Relief*. (Göteborg: P. Åström, 1982), 144.

Ceramic analysis of the Barbotine Ware sherd from Kommos classifies the style as a defined Minoan Ware. The fabric has been classified as South Coast Cretan fabric because of the mélange of inclusions found within the clay matrix. It is difficult to determine the exact location of the pottery production as the Cretan South Coast clay is found from Kommos to Ierapetra. The distribution and size of the inclusions indicate that the potters made a specific choice to add temper to the natural clay in order to increase, or decrease the plasticity of the clay. The temper is most likely beach sand from nearby Kommos as it contains the same particles found in the clay fabric. The pottery is fired at a relatively high temperature, around 800-850 degrees Celsius, in an oxidizing atmosphere. This is confirmed by the SEM photographs as well as the petrographic analysis which exhibits a clay matrix with low optical activity (indicative of a highly fired clay). The clay material used for the slip is a very similar recipe as that used for the body, but with a higher concentration of the heavier elements. The slip clay was further refined so it could be easily manipulated and built up as slip decoration.

Barbotine Ware is an integral part of the Minoan polychrome pottery tradition, which culminates in the well-loved Kamares Ware pottery. Barbotine Ware begins this polychrome tradition and enhances the dynamism and creativity seen in the styles which follow. While not always considered generally aesthetically pleasing, Barbotine Ware is an experiment, on the part of Minoan potters, in abstraction; the pottery displays a remarkable sense of movement, both visual and stylistic, that is heightened by the arrested fluidity of the slip. Barbotine Ware is part of a larger tradition of experimental pottery from the Minoan artistic repertoire. It forms a part of the polychrome tradition which culminated in Kamares Ware. Barbotine Ware, along with Kamares Ware, is one

of the most interesting and creative styles of pottery produced not only in the Middle Minoan period, but throughout Minoan history. It truly is an artistic product, of a highly sophisticated and creative culture.

FIGURES



Figure 1. Incised Style Jug.
Jug with MM IA incised design,
from Knossos.

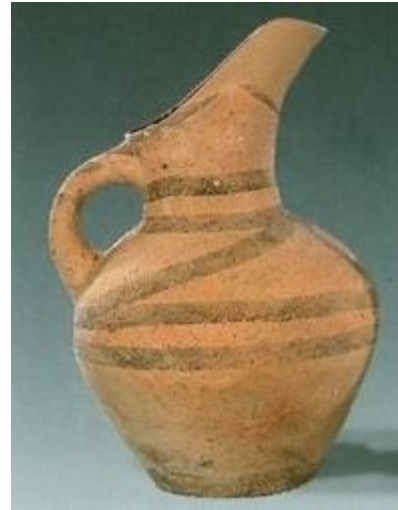


Figure 2. Dark on light style
Jug. Jug with simple dark
painted bands, MM IA. From
Knossos.



Figure 3. Floral Motif in Kamares Ware. Jar with white and orange floral patterning on the upper body, MM IIB. From the Herakleion Archaeological Museum, Crete.



Figure 4. Kamares Ware Vessels. Uniquely shaped vessels with elaborate polychrome decoration, from MM IIB. From the Herakleion Archaeological Museum, Crete.



Figure 5. Kamares Ware Bowls, and Cups. Fine tableware from MM IIB decorated with the polychrome Kamares Ware motifs. From the Herakleion Archaeological Museum, Crete.



Figure 6. Dynamic Motifs found on Kamares Ware Vessels from MM IIB. Painted polychrome decoration with interlocking floral patterns. From the Herakleion Archaeological Museum, Crete.



Figure 7. Barbotine Ware Patterns. MM IB Sherds from the British Museum showing regularly spaced ridges, irregular polygonal ridges, and protuberances.

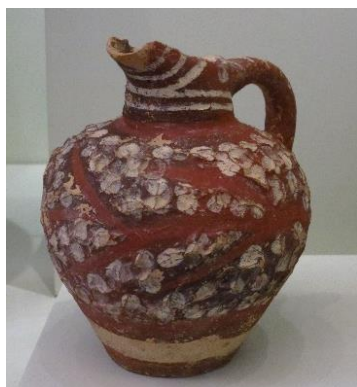


Figure 8. Jug from Phaistos.
MM IB Jug with irregular polygonal ridges Barbotine decoration. From Levi, *Festos*, 1976.



Figure 9. Tray from Phaistos.
MM IB Tray with irregular polygonal ridges Barbotine decoration. From Levi, *Festos*, 1976.



Figure 10. Wide Mouthed Jar from Phaistos. MM IB jar with irregular polygonal ridges.
From Levi, *Festos*, 1976.⁶⁴



Figure 11. Beaked Jug. Beaked Barbotine Ware Jug, MM IB. From the Metaxas
Collection, Herakleion Archaeological Museum, Crete.

⁶⁴ Karen Foster, *Minoan Ceramic Relief*. (Göteborg: P. Åström, 1982), pl. 1.

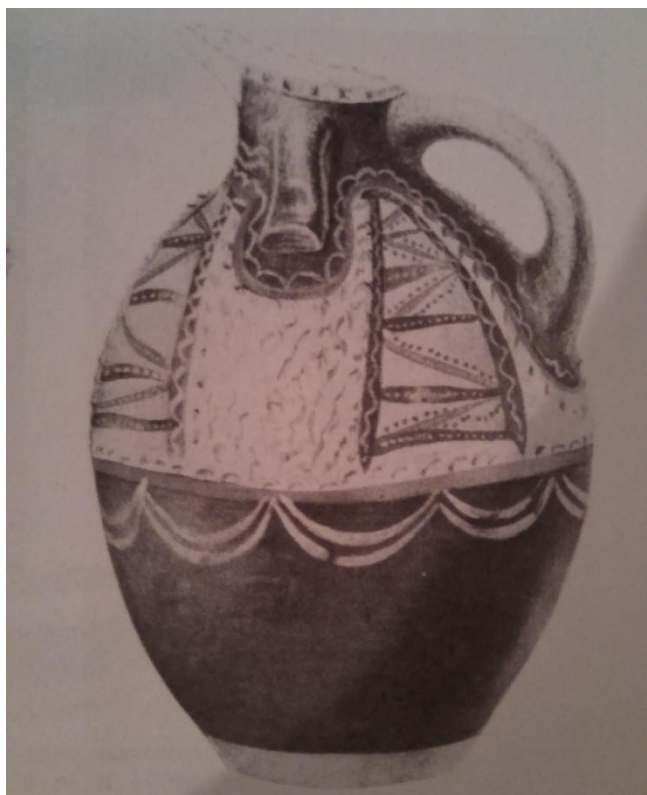


Figure 12. Three Handled Jug from Knossos. MM IB Barbotine Ware Jug from Knossos, with elaborate decoration.⁶⁵



Figure 13. Plain Regularly Spaced Ridged Jug. Jug from the Little Palace at Knossos. From Evans, 1914.

⁶⁵ Karen Foster, *Minoan Ceramic Relief*. (Göteborg: P. Åström, 1982), pl.6.



Figure 14. Jar Sherd with Regularly Spaced Ridges. MM IB sherd with regularly spaced ridges forming a patterned area.



Figure 15. Jug with Crinkled Ridge Decoration. A MM IB Jug with crinkled ridge decoration. From the Herakleion Archaeological Museum, Crete.



Figure 16. Jugs Sherds from Phaistos. EM III sherds with protuberances work decoration from Phaisto. From Todaro, 2005.⁶⁶

⁶⁶ Simona Todaro, "The EM III Phase in South Central Crete: New Data from Phaistos," (*Aegean Archaeology* 10, 2005), 68, fig. 2.



Figure 17. Jug with Horizontal Protuberances. MM IB jug decorated with painted horizontal protuberances. From the Heraklion Archaeological Museum.



Figure 18. Jug with Vertical Protuberances. MM IB jugs decorated with vertical protuberances. From the Heraklion Archaeological Museum.



Figure 19. Jugs with Painted Protuberances. Two MM IB jugs decorated with painted protuberances. From the Herakleion Archaeological Museum.



Figure 20. Beaked Jugs. Beaked jugs are among the most common shape with Barbotine decoration. First two photos from left, from the Herakleion Archaeological Museum, Crete. Photo on the far right, from the British Museum.



Figure 21. Pithoid Jars with Barbotine Decoration. Pithoi are among the most common shape with Barbotine decoration. Top left photo, from the Herakleion Archaeological Museum, Crete. Other three photos, from Levi, *Festos*, 1976.⁶⁷

⁶⁷ Doro Levi, *Festos e la civiltà minoica. Incunabula Graeca 60. Edizioni dell'Ateneo, Roma*, 144-45.



Figure 22. Bridge Spouted Jars with Barbotine decoration. Two Bridge Spouted jars with plastic decoration and polychrome painted designs from MM IB. From the Herakleion Archaeological Museum, Crete.



Figure 23. Elaborate Barbotine Ware Bowls. The photo on the left shows a Stemmed bowl pedestal from Knossos. The photo on the right shows a shallow bowl fragment from Knossos. Both dated to MM IB.⁶⁸

⁶⁸ Karen Foster, *Minoan Ceramic Relief*. (Göteborg: P. Åström, 1982), pl. 16 and pl. 19.



Figure 24. Conical Cups with Barbotine Ware Decoration. The cup on the left is from Phaistos, and the cup on the right is from Gournes.⁶⁹



Figure 25. Barbotine Vessels. Uniquely shaped vessel with Barbotine decoration and polychrome painted motifs from MM IB. From the Herakleion Archaeological Museum, Crete.

⁶⁹ Karen Foster, *Minoan Ceramic Relief*. (Göteborg: P. Åström, 1982), pl. 20 and pl. 22.



Figure 26. Barbotine sherd. MM IB sherd of Barbotine Ware from the 1976 Kommos Excavations.

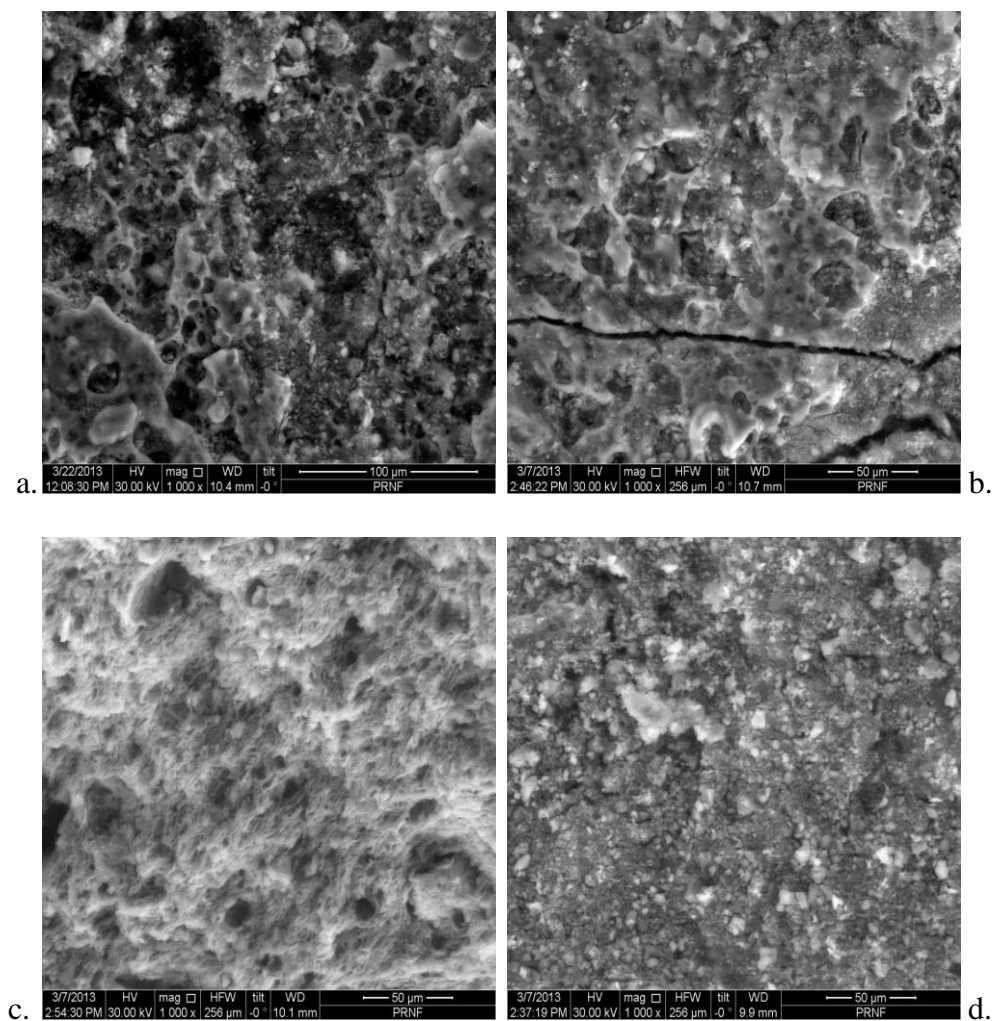
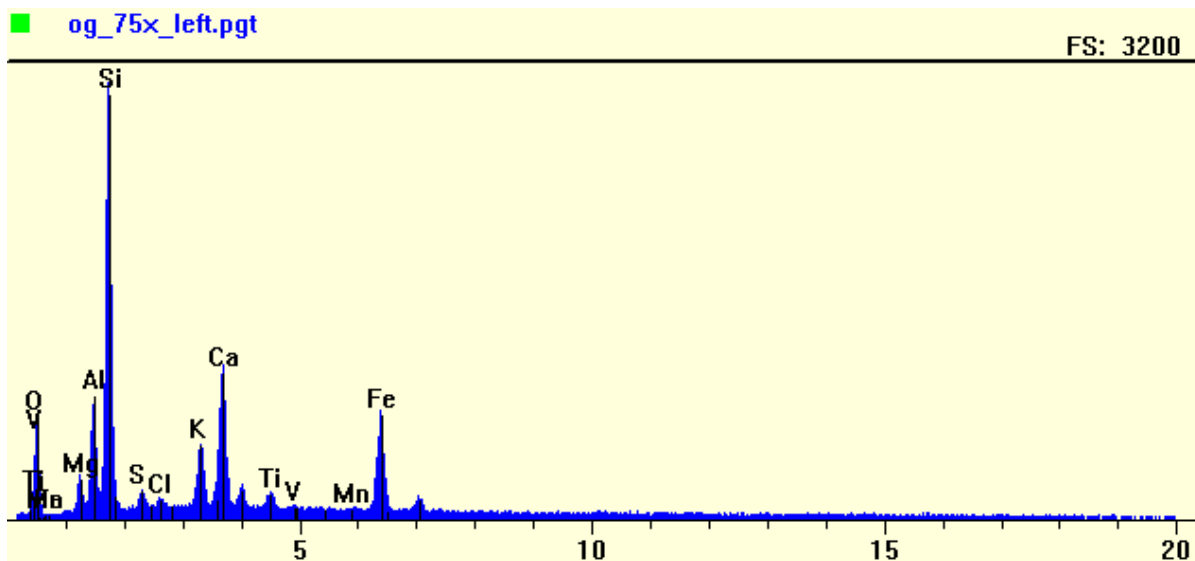
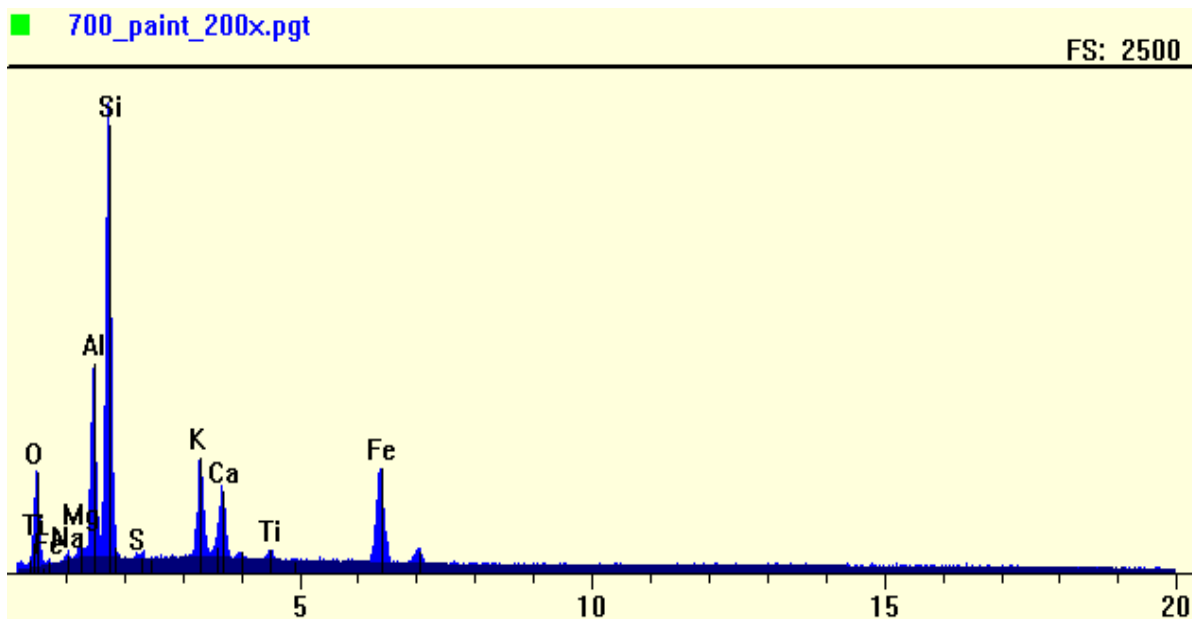


Figure 27. SEM Photomicrographs. Photomicrographs of the vitrification stages. (a) Shows the degree of vitrification in the initial firing with its appearance of isolated smooth surface areas of filaments of glass in the fresh fracture surface. (b) Shows a sample which was fired at 850 degrees Celsius where continued vitrification occurs. (c) Shows a sample fired at 900 degrees Celsius where extensive vitrification occurs, and (d) shows a sampled fired at 950 degrees Celsius where the vitrification structure looks almost completely glassy.



Element	Line	keV	KRatio	Wt%	At%	At Prop	ChiSquared
Fe	KA1	6.403	0.1216	14.31	6.28	0.0	3.75
Si	KA1	1.740	0.1576	24.52	21.40	0.0	51.84
Al	KA1	1.487	0.0398	6.95	6.32	0.0	51.84
Mg	KA1	1.254	0.0112	2.37	2.39	0.0	51.84
O	KA1	0.523	0.0619	34.60	52.98	0.0	2.40
K	KA1	3.313	0.0364	4.28	2.68	0.0	19.48
Cl	KA1	2.622	0.0031	0.44	0.31	0.0	1.70
Ti	KA1	4.510	0.0107	1.35	0.69	0.0	1.30
S	KA1	2.307	0.0070	1.08	0.83	0.0	1.70
Ca	KA1	3.691	0.0842	9.85	6.02	0.0	19.48
Mn	KA1	5.898	0.0020	0.24	0.11	0.0	3.75
V	KA1	4.951	0.0002	0.02	0.01	0.0	1.30
Total			0.5357	100.00	100.00	0.0	19.56

Figure 28. EDS Results for Body of Vessel. Elemental distribution in body.



Element	Line	keV	KRatio	Wt%	At%	At Prop	ChiSquared
Al	KA1	1.487	0.0713	12.04	11.36	0.0	25.31
Si	KA1	1.740	0.1758	28.49	25.82	0.0	25.31
K	KA1	3.313	0.0593	7.15	4.66	0.0	6.38
Ca	KA1	3.691	0.0404	4.86	3.09	0.0	6.38
Fe	KA1	6.403	0.1358	15.83	7.22	0.0	1.37
O	KA1	0.523	0.0570	28.11	44.73	0.0	25.31
Mg	KA1	1.254	0.0064	1.32	1.38	0.0	25.31
Ti	KA1	4.510	0.0080	0.98	0.52	0.0	1.21
Na	KA1	1.041	0.0027	0.80	0.88	0.0	25.31
S	KA1	2.307	0.0026	0.42	0.33	0.0	1.28
Total			0.5592	100.00	100.00	0.0	10.95

Figure 29. EDS Results for Slip. Elemental distribution in slip.

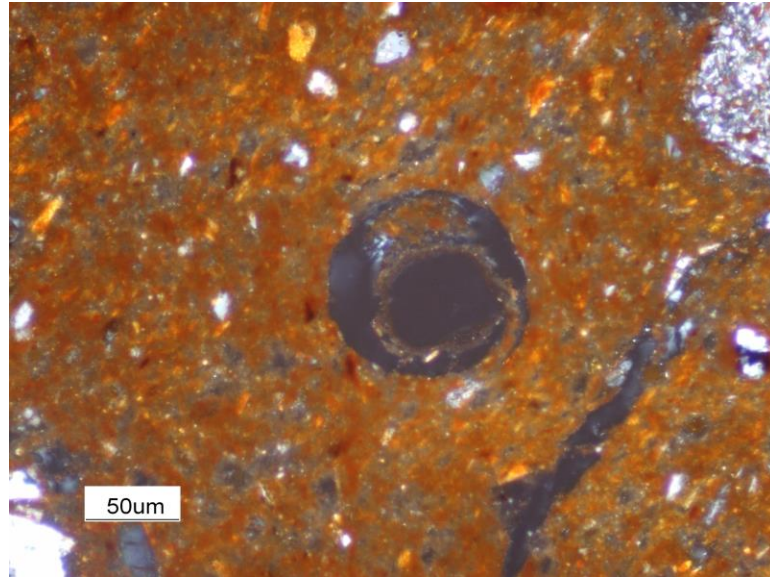


Figure 30. Petrographic Photo of Voids. Petrographic photo showing the vesicles and vugs within the clay matrix.

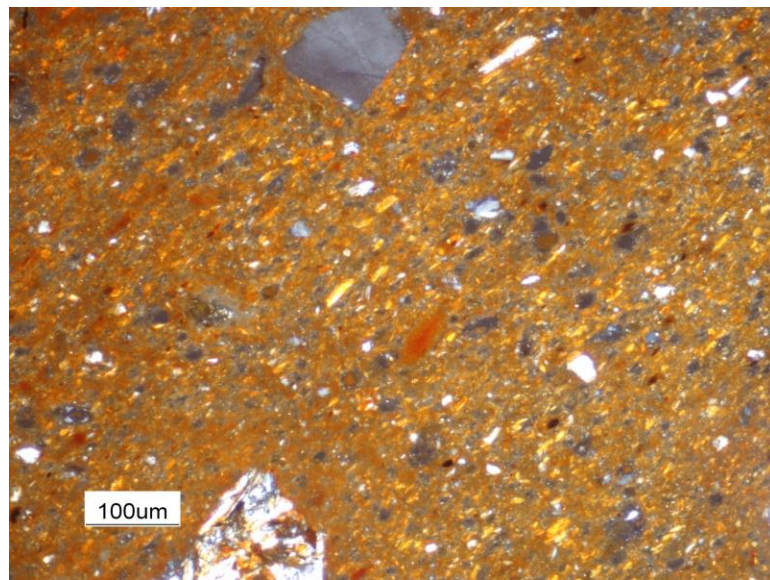


Figure 31. Petrographic Photo of Clay Matrix. Petrographic photo showing the preferential orientation of fabric and voids.

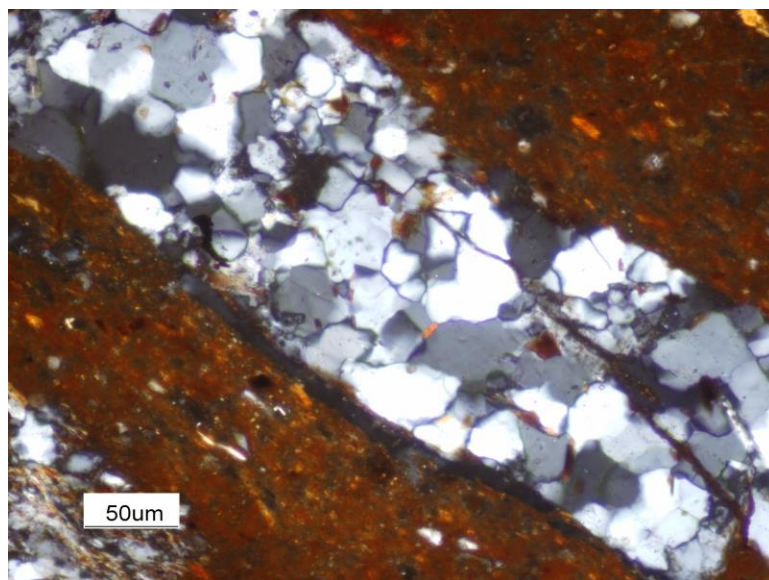


Figure 32. Metamorphic Quartzite. Petrographic photo showing a large piece of metamorphic quartzite.

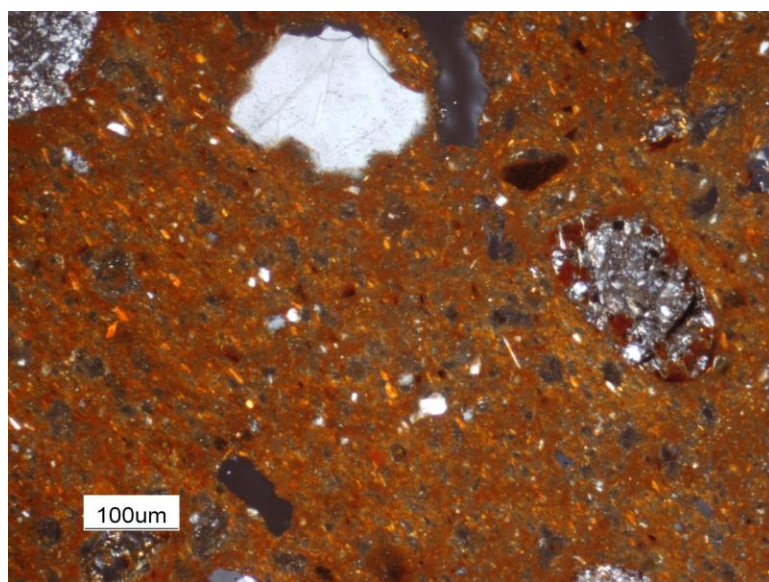


Figure 33. Pillow Basalt. Petrographic photo showing a pillow basalt inclusion (a mineral found local to Kommos).

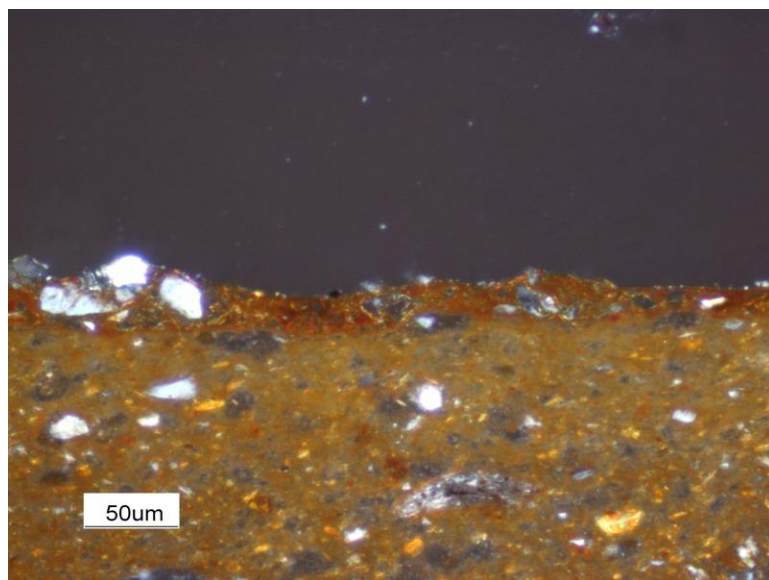


Figure 34. Slip. Petrographic photo of the Barbotine slip and its interaction with the body of the vessel.

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