STUDIES ON OLD KINGDOM POTTERY

edited by
T. I. RZEUSKA
A. WODZIŃSKA

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Centre d'Archéologie Méditerranéenne de l'Académie Polonaise des Sciences
avec la collaboration de l'Institut d'Archéologie de l'Université de Varsovie

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ABBREVIATIONS

AA	*American Anthropologist*, Arlington, Virginia
AAMT	Advances in Archaeological Method and Theory, University of Arizona, Tuscon
AANT	*American Antiquity*, Washington, DC
ACE Reports	The Australian Centre for Egyptology Reports, Sydney
ADAIK	Abhandlungen des Deutschen Archäologischen Instituts Kairo (Ägyptologische Reihe), Glückstadt, Hamburg, New York, Mainz am Rhein
Ä&L	*Ägypten und Levante*, Wien
Archaeometry	*Archaeometry*, Oxford
Archeologia	*Archeologia*, Warsaw
Archeologia Geographica	*Archeologia Geographica*, Hamburg
ARCUS	*Berichte aus Archäologie, Baugeschichte und Nachbargebieten*, Potsdam
ArOr	*Archiv Orientálni, Quarterly Journal of African and Asian Studies*, Praha
ASAE	*Annales du Service des Antiquités de l'Égypte*, Le Caire
AV	*Archäologische Veröffentlichungen des Deutschen Archäologischen Instituts Abteilung Kairo*, Berlin, Mainz am Rhein
ÄA	Ägyptologische Abhandlungen, Wiesbaden
ÄAT	*Studien zu Geschichte, Kultur und Religion Ägyptens und des Alten Testaments*, Wiesbaden
BAR	*British Archaeological Reports, International Series*, Oxford
BASOR	*Bulletin of the American Schools of Oriental Research*, Ann Arbor
BÄ	Beiträge zur Ägyptologie, Wien
BÄBA	Beiträge zur ägyptischen Bauforschung und Altertumskunde, Kairo
BCE	*Bulletin de liaison du groupe international d'étude de la céramique égyptienne*, Le Caire
BdÉ	*Bibliotèque d'Étude, Institut français d'archéologie orientale*, Le Caire
BES	*Bulletin of the Egyptological Seminar*, New York
BIFAO	*Bulletin de l'Institut français d'archéologie orientale*, Le Caire
BMFA	*Bulletin of the Museum of Fine Arts*, Boston
BP	*Biology and Philosophy*, Dordrecht
BSAK	Studien zur altägyptischen Kultur, Beihefte, Hamburg
BSFE	*Bulletin de la Société française d'égyptologie*, Paris
CA	*Current Anthropology*, University of Chicago, Chicago
CCE	*Cahiers de la céramique égyptienne*, Le Caire
CdE	*Chronique d'Égypte, Bulletin périodique de la Fondation Égyptologique Reine Elisabeth*, Bruxelles
CRAIBL	*Comptes rendus de l'Académie des inscription et belles-lettres*, Paris
EA	*Egyptian Archaeology. Bulletin of the Egypt Exploration Society*, London

EEF	Egypt Exploration Fund, London
EES	Egypt Exploration Society, London
ÉtTrav	*Études et Travaux du Centre d'Archéologie Méditterranéenne de l'Académie Polonaise des Sciences*, Varsovie
FIFAO	Fouilles de l'Institut français d'archéologie orientale, Le Caire
Genèva	*Bulletin du musée de Genève. Musée d'art et d'histoire*, Genève
GM	*Göttinger Miszellen,* Göttingen
HdO	Handbuch der Orientalistik, Leiden
Hesperia	*Journal of the American School of Classical Studies at Athens*, Athens
IBAES	*Internet-Beiträge zur Ägyptologie und Sudanarchäologie*
JAMT	*Journal of Archaeological Method and Theory,* Dordrecht
JAR	*Journal of Archaeological Research,* New York
JARCE	*Journal of American Research Center in Egypt,* Boston
JAS	*Journal of Archaeological Science*, New York
JEA	*Journal of Egyptian Archaeology*, London
JFA	*Journal of Field Archaeology*, Boston University, Boston
JSSEA	*Journal of the Society for the Study of Egyptian Antiquities*, Toronto
LA	*Louisiana Archaeology,* Springhill
LÄ	Lexikon der Ägyptologie, vols. I-VII, Wiesbaden
MDAIK	*Mitteilungen des Deutschen Archäologischen Instituts Kairo,* Berlin, Wiesbaden, Mainz am Rhein
MIFAO	Mémoires publiés par les membres de l'Institut français d'archéologie orientale, Le Caire
OLA	Orientalia Lovaniensia Analecta, Leuven
OMRO	*Oudheidkundige Mededelingen uit het Rijksmuseum van Oudheden te Leiden,* Leiden
OrAnt	*Oriens Antiquus. Rivista del Centro per le antichità e la storia dell'arte del Vicino Oriente*, Roma
OrMonsp	Orientalia Monspeliensia, Montpellier
PAM	*Polish Archaeology in the Mediterranean*, Warsaw
Památky archeologické	*Památky archeologické*, Praha
PP	*Perception and Psychophysics*, Austin
PR	*Psychological Review*, Washington, DC
Radiocarbon	*Radiocarbon*, Tucson
SAAC	Studies in Ancient Art and Civilization, Cracow
SAGA	Studien zur Archäologie und Geschichte Altägyptens, Heidelberg
SAK	*Studien zur Altägyptischen Kultur*, Hamburg
SAOC	Studies in Ancient Oriental Civilization, Chicago
Science	*Science,* Washington, DC
SDAIK	Sonderschriften des Deutschen Archäologischen Instituts Abteilung Kairo, Mainz am Rhein, Berlin
TMO	Travaux de la Maison de l'Orient et de la Méditerranée, Lyon
WES	Warsaw Egyptological Studies, Warsaw
WB	A. Erman, H. Grapow, Wörterbuch der ägyptischen Sprache, vols. I-VI, Berlin und Leipzig
ZÄS	*Zeitschrift für ägyptische Sprache und Altertumskunde*, Berlin, Leipzig

FOREWORD

Egypt has been the object of uninterrupted exploration for the past two centuries. Successive expeditions, regardless of whether they were working in archaic cemeteries or in a medieval Coptic monastery, focused on the study and publication of the most spectacular finds: architecture, decoration and texts. The artefacts was rarely the subject of in-depth research and pottery was no exception. Despite being the most numerous group in the archaeological finds assemblage, ceramic material has long waited, and actually continues to wait, for more suitable interest on the part of archaeologists. The modest literature on the subject is sufficient proof of the slight interest in this category. In most publications concerning particular funerary complexes, especially of Old Kingdom date, the information on the pottery is scarce, if included at all. One may be forgiven for thinking that material is selected for publication based on criteria of intactness and "prettiness".

This state of affairs is due not so much to limited interest in pottery as to the huge quantities of sherds unearthed during even a single season – from a few to several thousands of diagnostic fragments. Not without significance is the fact that most of the tombs and temples were plundered already in Antiquity, often repeatedly, and many were reused in later periods, leaving the ceramic material in a disturbed and fragmentary condition. The complex situation requires from potential ceramologists not just patience, but also knowledge of pottery ranging from the Archaic period through the Middle Ages, including imports from the Mediterranean area. Many archaeologists are overwhelmed by the mass of material and prefer to leave it for "future" research, which is usually belated. Furthermore, analyses of Old Kingdom pottery are often based on accidental and frequently erroneous observations. One lingering conviction is that pots made of "poor" clay represent offering or cult pottery, while vessels of "good quality" clay (particularly of Nile A, and B1) are referred to as "red ware" or "Meidum ware", come from burial chambers. However, it is not the quality of the pottery that answers questions about its provenance or original function. Where a pot came from, and what specific event it is witness to, can be determined only from the archaeological context.

The subject of the present study is a technological, chronological and cultural analysis of pottery of the Old Kingdom. Some chapters refer to technological issues of pottery manufacture in the late Old Kingdom; the authors discuss the results of analyses of the materials used in pottery production, shaping techniques and surface treatment, while the others present a cultural analysis of the pottery. The authors did not wish to leave this important material exclusively as a typology accompanied with the dating of particular groups of pots and the function of individual vessels. The pottery proved to be one of the most important testimonies concerning burial customs, funerary cult, plunder, and daily life of the Ancient Egyptians.

For the past several years one may observe a slow but constant increase in interest in Old Kingdom ceramics. In order to deepen our knowledge it is important not only to publish and to read older publications, but also exchanging ideas during meetings in groups of specialists. Such meetings allow vivid discussion, exchange of thoughts and new ideas, as well as international cooperation.

The present publication was inspired by the workshop on ceramics from the Old Kingdom organized by Teodozja I. Rzeuska and Anna Wodzińska in 2007 in the Institute of Archaeology (University of Warsaw). The meeting was very successful, however, the organizers realized that the subject is much more complex and requires further studies. In order to receive different views on the material, more ceramicists were invited to participate in the publication devoted solely to ceramics dating from the Old Kingdom.

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PETROGRAPHIC AND CHEMICAL ANALYSES OF SELECT 4TH DYNASTY POTTERY FABRICS FROM THE GIZA PLATEAU

MARY OWNBY (University of Cambridge)

INTRODUCTION

A standard classification of the different ceramic fabrics, comprising the fired clay and added materials, in Ancient Egyptian pottery was established during a conference at Vienna in 1980.[1] This classification scheme, known as the Vienna System, was designed to allow pottery from any site to be discussed using roughly the same terms, thus facilitating comparisons of pottery throughout Egypt. However, when the Vienna System was being developed, pottery predominantly from the Middle and New Kingdoms was available for study, with only a few samples from other periods being incorporated into the classification. Later petrographic and chemical studies[2] have elaborated and confirmed this classification system. Unfortunately, few studies have investigated the applicability of the Vienna System for Old Kingdom pottery.[3] This is due in part to the fact that few projects focused on pottery of this period but also to the unavailability of samples that could be used for analysis. Recent excavations at the Workman's Village on the Giza Plateau have revealed a large corpus of Old Kingdom pottery dating primarily to the 4th Dynasty.[4] The petrographic examination of samples of pottery from Giza that represent several fabric groups have allowed the validity of the Vienna Classification system to be assessed for 4th Dynasty pottery. Additionally, the Giza Plateau Mapping Project (GPMP) fabric classification has been investigated to confirm the fabric designations.

Ten samples were chosen for this investigation to examine the finer Nile clay fabrics and two Marl clay fabrics identified in the field. These provisionally correlated to Nile B1 and Nile B2, and Marl C fabrics in the Vienna System (Table 1). The GPMP fabrics GN2 and GN3 are roughly similar to Nile B1, while the GPMP fabrics GN4, GN6, and GN7 are generally comparable to Nile B2. The Marl samples are classified as GM3, which is equivalent to Marl C. Briefly, these fabrics are described as:[5]

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[1] NORDSTRÖM 1986; NORDSTRÖM and BOURRIAU 1993.

[2] BOURRIAU *et al.* 2006; BOURRIAU and NICHOLSON 1992; BOURRIAU, SMITH, and NICHOLSON 2000.

[3] The examination of thin sections of Old Kingdom pottery by J. RIEDERER (1988) was conducted before the Vienna System had been established. Similarly, NOLL's (1981) chemical analysis of four sherds from Giza was also before the Vienna System was in place.

[4] WETTERSTROM and LEHNER 2007; WODZIŃSKA 2007.

[5] From WODZIŃSKA 2007.

GN2: very homogenous clay with moderate amounts of very small (<0.5mm) and small (0.5mm) grains of rounded sand; sometimes contains small amounts of organic plant material burned off during firing;

GN3: same as GN2 but with large quantities of mica (1.0-0.5mm);

GN4: small amounts of very small elongated grains of sand (<0.5mm) and moderate amounts of plant remains (0.5mm-1cm); sometimes some white matte particles (<0.5mm) are present;

GN6: same as GN4 but with large quantities of mica (0.5-1mm);

GN7: large amounts of organic remains (1-1.5mm long and 1mm wide), small amounts of round, light brown, transparent grains of sand;

GM3: contains many round light brown and brown grains of sand in various sizes (<0.5-0.5mm); many white particles (<0.5-0.5mm) having been fired at elevated temperatures grown larger (approximately three times their original size) and later explode forming very small white craters with black or dark gray centers; this type of clay is dark gray with whitish spots in the break, i.e. limestone.

For comparison, a summary of the Vienna System descriptions for Nile B1, Nile B2, and Marl C are as follows:[6]

NILE B1: large quantities of fine sand with some medium and coarse sand, prevalent micaeous inclusions, and common particles of fine plant remains (<2mm);

NILE B2: even more fine and medium sand than in Nile B1 with occasional pieces of limestone, some decomposed; fine to medium plant remains are conspicuous along with some coarser pieces;

MARL C: fabric with a speckled appearance due to the large quantities of decomposed limestone ranging in size from medium to coarse; also includes fine to medium sand, inclusions of what appears to be unmixed marl clay, and light and dark micaceous particles.

Clearly, there is a large degree of concordance between the descriptions and therefore, probably a good amount of similarity between the designated fabrics. However, to test this initial assumption, petrographic and chemical analyses were conducted. This also enabled a much more detailed description of the GPMP fabrics.

The ten samples examined comprised rim sherds from several different types of vessels so that the visual, petrographic, and chemical information could be related to any differences in vessel form (Table 1). The forms covered by the samples include hand-made plates (CD1 and CD2), bowls with straight rim and slightly carinated walls (CD5), bowls with a carination and round base known as "Meydum bowls" (CD6), carinated bowls with

[6] From NORDSTRÖM and BOURRIAU 1993.

a hemispherical body and round base (CD7), and ledge-rim bowls with most likely a flat base (CD24).[7] These vessel types often have different slips applied to their surfaces with the CD5, CD6, and CD24 bowls having an interior and exterior red slip, CD1 plates with an interior red slip only, and CD7 bowls with a characteristic white slip on the interior and exterior surfaces. The CD7 white-slipped carinated bowls are the most abundant bowl type at Giza and thus of great interest in how the fabric compares to the others.[8]

Table 1: Sample list.

Sample #	Vessel Type	Vienna Fabric	GPMP Fabric	Notes
MO1	CD7	Marl C	GM3	ext. white surface
MO2	CD7	Marl C	GM3	ext. white surface
MO3	CD7	Nile B2	GN4	int./ext. white slip
MO4	CD7	Nile B2	GN4	int./ext. white slip
MO5	CD5	Nile B1	GN2	int./ext. red slip
MO6	CD5	Nile B1	GN3	int./ext. red slip
MO7	CD24	Nile B2	GN4	int./ext. red slip
MO8	CD1	Nile B2	GN6	int. red slip
MO9	CD6	Nile B2	GN6	int./ext. red slip
MO10	CD2	Nile B2	GN7	uncoated

METHODOLOGY

To make the results from this study comparable to the previous investigations of Egyptian pottery fabrics,[9] the same procedures for analysis and description were employed. Initially, freshly broken chips from the sample sherds were taken parallel to the vessel wall and examined under a binocular microscope at 25x magnification. This ensured that the description could be related to a sherd viewed in the field, usually at 10x magnification, and the thin section that is typically analyzed at 40x magnification. During the binocular light microscope examination, the sorting, porosity, structure, and hardness were noted, while the wall thickness was measured (in millimeters) and the firing and surface color were determined with a Munsell Soil Color Chart. Porosity was designated as open, medium, dense, or incipient vitrification. Hardness was characterized as crumbly, medium-hard, or hard and was usually determined when the chip was taken from the sherd with pliers. The structure was related to the presence or absence of elongated pores and decomposed limestone. For the inclusions in the fabric, the primary focus was on the size of the sand (predominantly quartz), plant remains (burnt out impressions or silica skeletons), and limestone particles (sometimes decomposed) measured with a graticule in the eyepiece of the microscope. Size range of the minerals was as follows: fine, 0.06-0.25mm; medium, 0.25-0.5mm, and coarse, greater than 0.5mm. A different measuring system was needed for the much larger plant remains. Therefore, particles less than 2mm in size were labeled as fine, those 2-5mm in length as medium and those over 5mm as coarse. Other constitu-

[7] See Wodzińska 2007 for a more detailed descriptions.

[8] See Wodzińska 2006 for a more detailed study of these white carinated bowls.

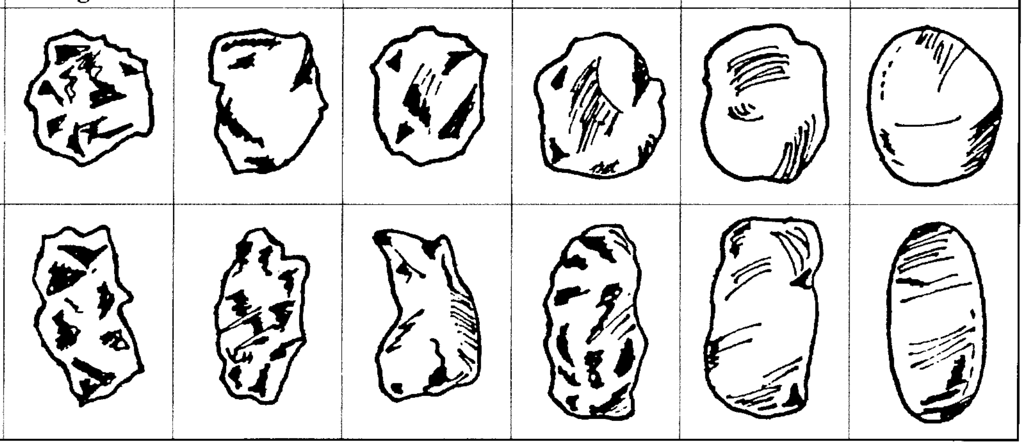
[9] Bourriau and Nicholson 1992; Bourriau, Smith, and Nicholson 2000.

ents in the fabric were generally identified as mica, soft red-brown particles, red-brown rock particles, black rock particles, and argillaceous inclusions for pieces of shale or pure clay. These components were quantified as rare [1], common [2], or prevalent [3]. The parameters described above were recorded on forms and entered into a database.

For the petrographic analysis, two to four thin-sections were made from the cross section of each sherd in order to get a more representative view of the fabric. Using a petrographic microscope at 40x and 100x magnification, each thin section was scanned to determine the color of the thin section in plain and cross polarized light, the estimated percentage of inclusions, the sorting, the approximate shape range for the quartz/feldspar temper inclusions (Table 2) and the optical activity of the fabric. The grain size range for the inclusions was also determined with the classifications comprising, very fine (0.0625-0.125mm), fine (0.125-0.25mm), medium (0.25-0.5mm), coarse (0.5-1.0mm), and very coarse (1.0-2.0mm). All mineral inclusions were identified and separated into those that were common and those that were less frequent. This information was also recorded on forms and later entered into the same database.

Table 2: Grain shape diagram (Powers' scale of roundness).

Class	1 Very Angular	2 Angular	3 Sub-Angular	4 Sub-Rounded	5 Rounded	6 Well Rounded
High Sphericity 2						
Low Sphericity 1						



Chemical compositional data on the fabrics was determined using X-ray Fluorescence Spectrometry (XRF). This instrument was chosen because there are existing non-destructive XRF data from some of the Giza material. In order to assess the reliability of these data, a comparison to destructive XRF data was needed. Additionally, the technique is capable of acquiring precise data on the heavy rare earth elements and trace elements that are often important for distinguishing between fairly similar fabrics. Each of the ten samples was analyzed, with samples MO8 and MO10 being tested twice to examine the internal consistency of the samples. The sherds were powdered with a ball mill and pressed into wax pellets. Each pellet was analyzed three times giving 36 total analyses. The resulting data were normalized by taking the elemental concentrations and dividing them by the sum of the major elements before multiplying by 100. This is standard procedure for XRF data in which the sums will vary between the analyses. For statistical treatment the normalized data were transferred into base 10 logarithms, thus putting all the data on the same scale since the major elements are reported in weight% and the minor and trace elements in parts per million (ppm). Principal Components Analysis (PCA) was run utilizing the Statistical Package for Social Scientists (SPSS) program on the data to investigate their groupings and to highlight the elements that were accounting for the variability in the data. Further statistical methods were not employed because of the low number of samples. Typically, there should be many more analyses than elemental variables. In this case, there were 36 analyses and 30 elemental variables that could be used, i.e. had values for all samples.

RESULTS

The macroscopic and microscopic description of each sample is given in Appendix I. The information has been formatted in the same way as those given in Bourriau and Nicholson[10] and Bourriau, Smith, and Nicholson[11] to ensure comparability and to support a particular standard for publishing the results from these types of analyses. A discussion of the fabrics follows, organized by the Vienna System and starting with the Nile clay fabrics. Images of the sherds and the thin sections are in Appendix II.

GPMP GN2 and GN3 (Nile B1)

The two samples, MO5 and MO6, are both derived from slightly carinated bowls with interior and exterior red slip. Macroscopically, both samples have a small amount of fine to medium sand and fine, infrequent limestone inclusions. MO6, unlike MO5, has a minor amount of fine to coarse plant remains. Other inclusions in both samples include mica, and red-brown and black rock fragments. The sorting of MO5 is very good, while MO6 has fair sorting. The differences in plant remains and sorting probably resulted in the designation of the two separate GPMP fabrics. In comparison to the Nile B1 description, the prevalent fine sand, mica and plant remains in the MO5 and MO6 samples fits well. The images of Nile B1 in Nordström and Bourriau[12] also support the attribution of MO5 and MO6 to Nile B1. Finally, the Nile B1 sherd images from Saqqara also show a good amount of comparability to the Giza GN2 and GN3 samples.[13]

The distinction between the samples is also seen microscopically where MO5 has a fair sorting of the mineral inclusions, while MO6 has poor sorting. Additionally, MO6 has a much larger amount of inclusions than MO5. However, both have inclusions ranging in size from very fine to coarse (0.0625-1mm). The mineral constituents are typical of Nile clay (quartz, feldspars, mica, pyroxenes, amphiboles, chert, epidote, red iron oxides, and opaque minerals) and include a small quantity of plant remains and limestone. Differences in inclusions comprise olivine and zircon in MO5 and chalcedony in MO6. However, these are still typical minerals in Nile clay. The red slip on the interior and exterior of the vessels is optically oriented, suggesting the slip was applied in a single horizontal direction.

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[10] Bourriau and Nicholson 1992.

[11] Bourriau, Smith, and Nicholson 2000.

[12] Nordström and Bourriau 1993.

[13] Rzeuska 2006.

In comparison to the thin sections of Nile B1 from Memphis and dating to the 18th Dynasty, the two Giza examples have coarser inclusions of quartz[14]. However, both the Memphis and Giza samples lack conspicuous amounts of plant remains and show a dominance of red iron oxides. Sample MO5 is more similar to the Nile B1 fabric seen in these thin sections than sample MO6. Likewise, sample MO5 is more similar to the thin section images of Nile B1 from Saqqara.[15] The difficulties in separating the Nile B1 and Nile B2 fabrics are not unusual as the division is based predominantly on how much large sand and organic material was added by the potter.

Technologically, MO6 does not appear to have been made on a wheel with consistent centrifugal force, as there is little evidence for the alignment of the pores or inclusions.[16] However, the finer MO5 sample has some pores with elongation that might suggest a slow rotating force was employed during manufacture. For both samples, the color of the fabric, the slight optical activity of the matrix and the intact limestone suggests the samples were fired at low temperatures, probably between 700°C and 800°C. This is high enough to create the silica bodies of the plant remains (above 600°C) but low enough not to vitrify the matrix (making it optically inactive) or decompose the limestone, both of which occur at around 850°C.[17]

GPMP GN4, GN6, AND GN7 (NILE B2)

Several of the Giza samples appear comparable to Nile B2. This includes the white carinated bowls MO3 (GN4) and MO4 (GN4), a red-slipped ledge-rim bowl MO7 (GN4), the red slipped plate MO8 (GN6) and unslipped plate MO10 (GN7), and a "Meydum" red-slipped bowl MO9 (GN6). All of the samples have a good amount of fine sand with a lesser amount of medium and coarse sand. Additionally, minor amounts of fine to coarse limestone are present in all the samples. The ledge-rim bowl and "Meydum" bowl lack the coarse sand and medium to coarse limestone, while the carinated bowls and plates are more similar in fabric. The plant remains are few and fine in the carinated bowls, few and fine to medium in the ledge-rim bowl, common and fine to coarse in the plates, and common and only fine in the "Meydum" bowl. The carinated bowls contain common fine mica and fair sorting of the inclusions. The ledge-rim bowl has fair sorting and fine mica, red-brown and black rock fragments. Fair sorting also characterizes the plates along with rare to common fine mica, rare fine to medium red-brown soft particles, and rare fine red-brown and black rock particles. Finally, the "Meydum" bowl has rare fine mica and

[14] BOURRIAU, SMITH, and NICHOLSON 2000.

[15] RZEUSKA 2006.

[16] Statements about the technology of production of the Giza samples are preliminary and were made based on thin sections taken from the cross section of the sherd close to the rim. This will influence the determinations of technology, as 1) for examination of vessel manufacture, thin sections are usually made parallel to the wall; and 2) for Egyptian pottery, using centrifugal force to finish the rim is known from the Predynastic period onwards; therefore if the rim appears wheel-turned, that does not mean that the entire vessel was manufactured with consistent use of a wheel (COURTY and ROUX 1995; VANDIVER and LACOVARA 1985/1986).

[17] These temperature ranges are general estimates only based on several factors seen petrographically. Due to the variability in when certain diagnostic features will occur based on clay chemistry, inclusions, firing temperature, duration of firing, and consistency of atmosphere, it is difficult to be more precise than a designation of low fired (below 850°C) and high fired (above 850°C), *cf.* RICE 1987; SHAW *et al.* 2001.

red-brown rock particles and rare medium red-brown soft particles with good sorting of the inclusions. The carinated bowls and ledge-rim bowls, fabric GN4, have more fine plant remains and fair sorting. The "Meydum" bowl as expected has good sorting and mostly rare fine components. While GN6 is the same fabric for the "Meydum" bowl and one of the plates, the plate has coarser inclusions and only fair sorting. In these qualities, it is more similar to the other plate of fabric GN7, which also has coarser components and fair sorting. The characteristics of all the samples suggest Nile B2 is a good designation though there are similarities to the Nile B1 samples that cloud their separation. Additionally, the images of Nile B2 in NORDSTRÖM AND BOURRIAU[18] confirm that the white carinated bowls, the "Meydum" bowl, and one of the plates (MO10) are Nile B2, but that the ledge-rim bowl and the other plate (MO8) appear slightly finer and are possibly more similar to Nile B1. The images of Nile B1 and Nile B2 from the Saqqara excavations also support the conclusion that some of the Giza samples are finer than typical Nile B2 samples.[19] This disparity probably relates to the fact that the Giza samples are from bowls and plates that can tend to be produced from finer clay materials than jars and cooking pots.

The thin-section analyses of the GPMP GN4, GN6, and GN7 samples confirmed their typical mineral constituents and highlighted some differences in percent of inclusions and sorting. The white carinated bowls (MO3 and MO4) of fabric GN4 have fair sorting of inclusions that make up 10% of the matrix in MO3 and 15% in MO4. Both samples have the same set of minerals comprising quartz, feldspars, mica, some limestone, amphiboles, chert, pyroxenes, red iron oxides, opaque minerals, and clay pellets. MO3 has inclusions above 0.5mm, while MO4 has a few coarse inclusions (0.5-1mm). Both have a good quantity of silica bodies from the burnt-out plant remains. The white slip is optically oriented suggesting it was applied horizontally around the vessel. The other vessel of GN4 is the ledge-rim bowl (MO7) that has 10% inclusions and fair sorting of fine to coarse sized inclusions (0.125-1mm). Additional minerals in this sample include chalcedony and epidote. There are some plant remains and the red slip is optically oriented. The "Meydum" bowl (MO9) of fabric GN6 has poor sorting of very fine to coarse inclusions (0.0625-1mm) that comprise 15% of the matrix. The mineral constituents are the same as the other GPMP samples with quartz, feldspars, mica, some limestone, amphiboles, chert, pyroxenes, red iron oxides, opaque minerals, and clay pellets, but also a few pieces of epidote and olivine. The plant remains are somewhat common and the red slip is optically oriented. The other sample of fabric GN6 is one of the plates (MO8) that while having similar mineral components (but with fewer plant remains), has a lower percentage of inclusions (only 10%) that range in size from very fine to very coarse (0.0625-2mm). This sample has poor sorting and the interior red slip is optically oriented. This plate is similar to the other plate sample (MO10) that is fabric GN7 with 10% inclusions that are poorly sorted, however, those inclusions in MO10 range from very fine to medium (0.0625-0.5mm). The minerals are quartz, feldspars, mica, amphiboles, chert, pyroxenes, red iron oxides, opaque minerals, grog, and clay pellets, and the occasional chalcedony and epidote. The silica bodies from burnt-out plant remains are common.

Comparison to the Nile B2 thin sections of sherds from the Dynasty XVIII levels at Memphis did not reveal a great deal of similarity to the Giza Nile B2 samples.[20] While in

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[18] NORDSTRÖM and BOURRIAU 1993.
[19] RZEUSKA 2006.
[20] BOURRIAU, SMITH, and NICHOLSON 2000.

general terms the Giza samples do fit the description of Nile B2, they often had much more silt-sized quartz inclusions than the Memphite material. The "Meydum" bowl (MO9) and one of the plates (MO10) showed the most agreement to the Memphis Nile B2 thin sections, but the other plate (MO8), the ledge-rim bowl (MO7), and one of the white carinated bowls (MO3) lacked the large quartz and plentiful organic plant remains. These differences are probably related to how the potter prepared the pastes for the Giza samples and does not eliminate them as of the Nile B2 fabric, rather some of them would be a finer version of Nile B2 than the others. The examination by ARNOLD[21] of Nile B1 and Nile B2 sherds from Dahshur also revealed difficulties in consistently separating these two groups.

For a discussion of technology, the best approach is to separate the GPMP samples into their form groups. The white-slipped carinated bowls show a deep red fabric, lack of optical activity, and a decomposed calcium carbonate slip. These features suggest they were highly fired to temperatures probably up to 1000°C.[22] The dark gray bands in sample MO4 indicates the atmosphere probably varied between oxidizing and reducing. The alignment of the pores and plant remains do not suggest centrifugal force was utilized during production. The other Nile clay samples do not show evidence for temperatures this high and it is likely the white-slipped carinated bowls were selectively fired to higher temperatures for specific reasons, probably relating to function. More samples would be needed to support this hypothesis. The ledge-rim bowl shows little alignment of pores suggesting a turning force was not used to produce it. The matrix is slightly active and the plant remains have been burned out indicating a low firing temperature between 700°C and 800°C. The "Meydum" bowl and one of the plates (MO8), both GPMP fabric GN6, also showed no evidence for wheel manufacture or high firing temperatures. However, the second plate (MO10), fabric GN7, has sections showing an optically inactive matrix suggesting a higher firing temperature, probably up to 850°C. The voids in this sample are not aligned and as a plate, there is no reason to believe a turning device was needed for formation.

GPMP GM3 (MARL C)

At the macroscopic level, sample MO1 seems typical of the Marl C fabrics with a grey break and noticeable large argillaceous inclusions.[23] Decomposed limestone is also very easy to see in the fabric. The other inclusions are a small amount of fine sand, and a few red-brown and black rock particles that are fairly sorted. These characteristics match very well the description of Marl C and visually MO1 is similar to the published Marl C samples.[24] A designation of the Giza sample as Marl C1 or Marl C compact seems more appropriate than Marl C2. Microscopically, the sample has 30% inclusions that are dominated by quartz sand and decomposed limestone with fair sorting and a size range of very fine to coarse (0.0625-1mm). Additional inclusions consist of feldspars, mica, red

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[21] ARNOLD 1988.

[22] This temperature estimate was made based on refired samples of modern Nile clay pottery showing a similarity in color between a sample fired to 1000°C and the MO3 and MO4 samples. The refired experiment was carried out by the author as part of a technological study of crucible firing temperatures from the workshops at Qantir. See PUSCH and REHREN (eds.) forthcoming.

[23] WHITBREAD 1986.

[24] BADER 2001; CYGANOWSKI 2003; NORDSTRÖM and BOURRIAU 1993; RZEUSKA 2006.

iron oxides, and opaque minerals. A few silica bodies from burnt out plant remains were noted along with a very minor amount of amphiboles, chert, and pyroxenes. In comparison to the published petrographic images of Marl C fabrics, there is sufficient similarity to confirm that MO1 is most likely an early example of Marl C.[25]

One of the most unique technological features of the Marl C fabric is the white scum seen on the surface. This feature of Marl C has been previously discussed by ARNOLD,[26] NOLL,[27] and BADER.[28] In the past, this has been called a "self-slip",[29] but both thin section analysis and scanning electron microscopy (SEM) suggest that the white coating is not a self-slip. Petrographically, the coating is not distinct from the vessel matrix, but appears as a grayish area towards the edge (Pl. II.A). When compared to the white slips on the Nile clay carinated bowls there is an obvious difference as the latter features a distinct line separating the slip from the vessel surface (Pl. II.B). These distinguishing characteristics were also noted by PAPE[30] in his petrographic examination of some Marl vessels. The Giza Marl C sample was analyzed by SEM to assess its fine surface characteristics and to map any movements of elements to the surface that would be due to the migration of salts when the vessel dried.[31] Interestingly, when the cross section was chemically mapped there did not appear to be any significant movement of elements such as calcium or sodium. When images were taken directly on the coating it appeared flakey and crusty suggesting it is not as uniform or thick as it looks macroscopically. The chemical analyses made of a large area of the coating showed little elemental differences between the coating and the matrix. However, when only certain thick spots of the coating were analyzed for their elemental concentrations, there was an increase in calcium content. More research will be conducted on this scum surface found on Marl C samples to explore the other suggested processes for its development.[32] In terms of the manufacture of this sample, there was no indication that the vessel had been made on any type of rotating device. The decomposed limestone implies that the vessel was highly fired to above 850°C.

Giza sample MO2 is visually dissimilar from MO1, but obviously a Marl or Nile/Marl clay mix. The reddish fabric contains a fair amount of fine sand and limestone with good sorting. There are no silica plant remains, but a few pieces of fine red-brown and black rock particles are present. Microscopically, the fabric has around 30% inclusions mostly of quartz and limestone with minor amounts of feldspars, mica, pyroxenes, red iron oxides, and opaque minerals. Additionally, the sample contains large reddish to yellow argillaceous inclusions that probably derive from the original clay source.[33] Minor inclusions consist of silica bodies from burnt-out plant remains, amphiboles, chert, and

[25] CYGANOWSKI 1003; NORDSTRÖM and BOURRIAU 1993.

[26] ARNOLD 1981.

[27] NOLL 1981.

[28] BADER 2001.

[29] The term self-slip usually refers to a fine coating on the exterior of the vessel made with the same clay that was used to manufacture the vessel. Typically, it does not appear as different from the matrix in thin section; *cf.* RICE 1987.

[30] PAPE 1991.

[31] BADER 2001; MATSON 1971.

[32] This work was carried out with the assistance of Prof. Dafydd Griffiths and will shortly be published in more detail in Ägypten und Levante as Issues of Scum: Technical Analyses of Egyptian Marl C to Answer Technological Questions.

[33] WHITBREAD 1986.

epidote. The sorting is fair and the size range for the inclusions is very fine to medium (0.0625-0.5mm). In comparison to the images of Marl A in NORDSTRÖM AND BOURRIAU,[34] MO2 appears most similar to the examples of Marl A2 due to the prevalence of sand in this Giza sample. Additionally, the equivalent size of the sand and limestone, along with the argillaceous inclusions, is more similar to the description of Marl A2 than the other Marl fabrics.[35] If Giza sample MO2 is of the Marl A2 fabric, this would be a very early example.

A comparison to thin-sections of Marl and mixed Nile/Marl clay fabrics from New Kingdom contexts at Memphis and Saqqara also indicated that MO2 is more similar to the Marl A2 samples.[36] Unfortunately, no thin sections of Marl A1 or Marl A3 were available for examination. Finally, a comparison of the MO2 sherd and the images of Marl C and mixed clay fabric sherds from Saqqara, suggests the Giza fabric is neither a Marl C nor a mixed clay sample.[37] This is further confirmed by the thin section images of the mixed clay fabric P60, which do not resemble the thin sections of Giza MO2.[38] The light reddish color of the fabric, the integration of the calcareous material with the clay, and the presence of an exterior white scum on the surface of the sherd all support an attribution to the Marl A category. However, it should be noted that assigning a Marl A sherd to one of the four sub-groupings can be very difficult and therefore it may be better to simply refer to the Giza example as a general Marl A.[39]

This sample has a scum surface that is less obvious than the one on MO1. Petrographically, this surface appears as a grayish zone on the exterior side of the sample and includes the same set of minerals as the matrix, into which it blends (Pl. II.C). Once again, these characteristics suggest some kind of light calcium concentration on the exterior of the sample, possibly formed by the evaporation of water carrying calcium sulfate during the drying phase followed by solidification during firing. The limestone in this sample is not decomposed except on the edges of the sherd, suggesting, along with the optical activity of this sample's matrix, a low firing temperature between 700°C and 800°C and possibly briefly up to 850°C. In terms of manufacture, there is no evidence for the use of any centrifugal force.

CHEMICAL DATA

The XRF data (Appendix III) were investigated initially by plotting the amount of iron against the amount of calcium in the samples, as these are the elements with the most obvious differences between Marl clay fabrics and Nile clay fabrics. The graph shows that the Marl samples are distinctly separate from the Nile clay samples and from each other, further suggesting that they are unique (Pl. III.A). Interestingly, the Marl C sample has less calcium than the Marl A sample, while the iron levels are similar. Furthermore, the position of the Marl A sample towards the bottom of the diagram and away from the Nile

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[34] NORDSTRÖM and BOURRIAU 1993.
[35] NORDSTRÖM and BOURRIAU 1993.
[36] BOURRIAU and NICHOLSON 1992; BOURRIAU, SMITH, and NICHOLSON 2000.
[37] RZEUSKA 2006.
[38] RZEUSKA 2006.
[39] BOURRIAU *et al.* 2006.

clay samples confirms that this sherd is not a mix of Nile and Marl clay. Previous investigations of mixes have suggested they are likely to chemically fall between the Nile and the Marl clay samples.[40]

Principal Components Analysis[41] confirmed the distinction between the Marl A, Marl C, and Nile clay samples (Pl. III.B). However, the separation of one of the Nile clay samples, MO4, from the rest of the group, and in fact from the other white carinated bowl sample MO3, was unexpected. Examination of the elemental concentrations of MO4 indicated that it has increased amounts of sodium, potassium, and chlorine. There are two possible explanations for this difference, 1) the thicker slip on the sample contributed to elevated levels of these elements, and 2) that a post-depositional movement of salt (NaCl) led to increased sodium and chlorine levels. Support for the second explanation comes from SEM analysis of white slips on Nile clay vessels from Saqqara that suggested that they are predominantly composed of either limestone ($CaCO_3$) or gypsum ($CaSO_4 2H_2O$).[42] More analyses of white carinated bowls would further clarify whether MO4 is an aberrant sample or whether its chemical signature is one that can occasionally characterize these vessels.

When the elemental concentrations for chlorine, potassium, phosphorus, and sodium were omitted from the PCA, all the samples designated as Nile B2 clustered together. In addition, there is also a clearer separation of those samples classified as Nile B1 from the Nile B2 samples (Pl. IV.A).

In order to investigate the ability of the data to separate the chemically similar Nile clay samples, a PCA was performed on just these samples. This also allowed the GPMP fabrics to be investigated. The PCA separated the GPMP samples assigned as Nile B1 and Nile B2, and even resulted in most of the samples forming their own individual clusters. An examination of the data suggested that by plotting the concentrations of aluminum against iron, the samples could be effectively separated and more easily visualized (Pl. IV.B). The study by REDMOUNT and MORGENSTEIN[43] also revealed that values of aluminum and iron are helpful in separating Nile clay samples. In the diagram, the proximity of samples to each other does not reflect the use of similar clay and temper material for producing the same vessel types. On the contrary, the Nile B1 carinated bowls (MO5 and MO6) are not close to each other and neither are the Nile B2 white slipped carinated bowls (MO3 and MO4). Rather, there is a cluster comprising the plates (MO8 and MO10), the ledge-rim bowl (MO7) and one of the white slipped carinated bowls (MO3). The remaining samples are clearly separated into their own groups, including the "Meydum" bowl (MO9). When the GPMP fabric is brought into the discussion, there are some chemical differences within the fabric groups. This is to be expected since fabric classifications focus on the potter's alteration and use of materials. Therefore, the GN4 group (MO3 and MO7) lacks sample MO4 and is clustered with fabrics GN2 (MO5), GN6 (MO8), and GN7 (MO10). Fabrics GN2 and GN3 (MO6) are separated; however, the two GN6 samples (MO8 and MO9) are not together. Overall, this suggests that similar materials were used

[40] MALLORY-GREENOUGH and GREENOUGH 1998; REDMOUNT and MORGENSTEIN 1996.

[41] This statistical technique examines the variability within the data and creates two lines (i.e. components) that account for most of this variability; the data are then plotted in relation to the two lines. The technique also indicates how much variability is covered by each component and which elements are contributing; *cf.* SHENNAN 1997, 265-300.

[42] RZEUSKA 2006.

[43] REDMOUNT and MORGENSTEIN 1996.

to make a variety of fabrics and vessel types. This possibly indicates that several pottery producers utilized slightly different proportions of materials for making their vessels but whom all made similar types of pottery. The ability to separate chemically the Nile B1 and Nile B2 samples is probably due to the variation in temper added, rather than inherent chemical differences in the clay. In fact, the petrographic examination of the samples showed that samples MO4, MO6, and MO9 all had more quartz than the others did, and this may explain why they are separated into their own groups. This is due to the dilution of aluminum and iron by the increased amount of silica contributed by the quartz temper.[44]

DISCUSSION

This study has utilized binocular light microscopy, thin section petrography, and chemical analyses to investigate several GPMP fabrics and their relationship to the Vienna System of ceramic fabric classification. For the Nile clay fabrics, good correlation was found between the GPMP fabrics GN2 and GN3 with Nile B1 and the GPMP fabrics GN4, GN6, and GN7 with Nile B2. However, certain samples did show a finer Nile B2 fabric, confirming that separating the two Nile clay groups can be difficult. The chemical data also suggested that there were differences relating to the addition of temper that cut across both the GPMP fabrics and the Nile clay designations. Analysis of more samples would further help to refine the GPMP classifications. The concordance with the Vienna System is not surprising, as this categorization was intentionally made broad in order that it would be applicable across periods and throughout the Nile Valley. The GPMP Marl C group was comprised of two samples that both featured large argillaceous inclusions. However, these samples could be separated by the conspicuous decomposed limestone in MO1 and the uniformity in both the size and amount of sand and limestone (not decomposed) in MO2. They proved to be different both visually and chemically. Comparative analyses suggested that MO1 is a Marl C, while MO2 is a Marl A. Additional samples could narrow down these designations into a sub-category. The presence of a Marl C sample at Giza suggests that this fabric was utilized in the Old Kingdom even if it did not become prevalent until the Middle Kingdom. Similarly, if the Marl A is Marl A2, as seems likely, this supports the idea that this fabric was also employed in the Old Kingdom rather than predominantly appearing in the Middle Kingdom.

The technological information gathered during the analyses, while preliminary and quite general, confirm that during the Old Kingdom, consistent centrifugal force was not employed to manufacture a majority of the vessels. Only one of the slightly carinated bowls (MO5) showed some evidence for wheel turning. The high firing temperatures for the white slipped carinated bowls may suggest a local industry at Giza specializing in their production, a hypothesis supported by their uniqueness at the site. The only other highly fired sample was the Marl C sherd, while the Marl A and the Nile clay samples were all low fired. This is not surprising, but does not negate the use of either a small kiln or a covered bonfire for their manufacture, as most of the samples appear to have been

[44] Unfortunately, a comparison cannot be made between the Giza XRF data and the published NAA data on Marl A, Marl C, Nile B1, and Nile B2, *cf.* BOURRIAU *et al.* 2006. This is because the two techniques have different levels of sensitivity in determining the concentrations of the elements. Only by analyzing several of the NAA samples by XRF could a correlation be established to link the two datasets and utilize them together, but only for certain elements.

consistently heated in a controlled atmosphere. Overall, further study of the forming methods and firing conditions of pottery from Giza should help to clarify how the pottery was manufactured and if there was any specialized production of certain vessel types.

CONCLUSIONS

The utilization of various techniques of analysis has enabled the characterization and investigation of the GPMP fabrics and shed light on archaeological questions. This study has confirmed their utility within Egyptian fabric studies and should encourage their continued application to understanding Egyptian pottery. Further studies on the nature of the Giza fabrics are planned. Scientific examination of Old Kingdom pottery from several sites along the Nile is intended. As this conference brought individuals together who studied Old Kingdom pottery, the future looks bright in terms of gaining a much better appreciation for the technological variability and sophistication to be found in pottery production during this formative period in Egyptian history.

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BIBLIOGRAPHY

Arnold, D.
1981 Ägyptischen Mergelton („Wüstentone“) und die Herkunft einer Mergeltonware des Mittleren Reiches aus der Gegend von Memphis, in: D. Arnold (ed.), *Studien zur altägyptischen Keramik*, SDAIK 9, Mainz am Rhein, pp. 167-191.

Arnold, D.
1988 Pottery, in: Di. Arnold (ed.), *The South Cemeteries of Lisht. The Pyramid of Senwoseret I*, vol. 1, New York, pp. 106-146.

Bader, B.
2001 *Typologie & Chronologie der Mergel C-Ton Keramik*, Tell el-Dab'a XIII, Wien.

Bourriau, J.D., Bellido, A., Bryan, N., and Robinson, V.
2006 Egyptian Pottery Fabrics. A Comparison between NAA Grouping and the 'Vienna System', in: E. Czerny (ed.), *Timelines. Studies in Honour of Manfred Bietak, vol. 3*, OLA 149, Leuven, pp. 261-292.

Bourriau, J.D., and Nicholson, P.T.
1992 Marl Clay Pottery Fabrics of the New Kingdom from Memphis, Saqqara and Amarna, *JEA* 78, pp. 29-91.

Bourriau, J.D., Smith, L.M.V., and Nicholson, P.T.
2000 *New Kingdom Pottery Fabrics. Nile Clay and Mixed Nile/Marl. Clay Fabrics from Memphis and Amarna*, London.

COURTY, M.-A., and ROUX, V.
1995 Identification of Wheel-Throwing on the Basis of Ceramic Surface Features and Microfabrics, *JAS* 22, pp. 17-50.
CYGANOWSKI, C.J.K.
2003 An Intersite Comparison of Middle Kingdom Lower Egyptian Marl C Fabric, PhD thesis, University of Cambridge, Cambridge.
MALLORY-GREENOUGH, L.M., and GREENOUGH, J.D.
1998 New Data for Old Pots. Trace-Element Characterization of Ancient Egyptian Pottery Using ICP-MS, *JAS* 25, pp. 85-97.
MATSON, F.R.
1971 The Study of Temperatures Used in Firing Ancient Mesopotamian Pottery, in: R.H. BRILL (ed.), *Science in Archaeology* (Number), Cambridge, Mass, pp. 65-79.
NOLL, W.
1981 Bemalte Keramik Altägyptens. Material, Rohstoffe und Herstellungstechnik, in: D. ARNOLD (ed.), *Studien zur altägyptischen Keramik*, SDAIK 9, Mainz am Rhein, pp. 103-108.
NORDSTRÖM, H.-A.
1986 Ton, in: W. HELCK and E. OTTO (eds.), LÄ 6, Wiesbaden, cols. 629-634.
NORDSTRÖM, H.-A., and BOURRIAU, J.
1993 Ceramic Technology. Clay and Fabrics, in: D. ARNOLD and J. BOURRIAU (ed.), *An Introduction to Ancient Egyptian Pottery*, SDAIK 17, Mainz am Rhein, pp. 147-190.
PAPE, A.
1991 Keramik – eine schwierige Quelle. Interdisziplinäre Methoden ihrer Erforschung, *ZÄS* 118, pp. 54-68.
REDMOUNT, C.A., and MORGENSTEIN, M.E.
1996 Major and Trace Element Analysis of Modern Egyptian Pottery, *JAS* 23, pp. 741-762.
RICE, P.M.
1987 *Pottery Analysis. A Sourcebook*, Chicago.
RIEDERER, J.
1988 The Microscopic Analysis of Pottery from the Old Kingdom, in: S. SCHOSKE (ed.), *Akten des Vierten Internationalen Ägyptologen Kongresses, München 1985*, BSAK 1, Hamburg, pp. 221-230.
RZEUSKA, T.I.
2006 *Pottery of the Late Old Kingdom. Funerary Pottery and Burial Customs*. Saqqara II, Warsaw.
SHAW, J.W., VAN DER MOORTEL, A., DAY, P.M. and KILKOGLU, V.
2001 *ALM IA Ceramic Kiln in South-Central Crete. Function and Pottery Production*, Hesperia Supplement 30, Athens.
SHENNAN, S.
1997 *Quantifying Archaeology*, Edinburgh.
VANDIVER, P., and LACOVARA, P.
1985/1986 An Outline of Technological Changes in Egyptian Pottery Manufacture, *BES* 7, pp. 53-85.
WETTERSTROM, W., and LEHNER, M., (eds.)
2007 *Project History, Survey, Ceramics, and the Main Street and Gallery III.4 Operations. The Giza Plateau Mapping Project*, Giza Reports 1, Boston.
WHITBREAD, I.K.
1986 The Characterization of Argillaceous Inclusions in Ceramic Thin Sections, *Archaeometry* 28, pp. 79-88.
WODZIŃSKA, A.
2006 White Carinated Bowls (CD7) from Giza Plateau Mapping Project. Tentative Typology, Use and Origin, in: M. BÁRTA, F. COPPENS and J. KREJČÍ (eds.), *Abusir and Saqqara in the Year 2005, Proceedings of the Conference Held in Prague (June 27-July 5, 2005)*, Prague, pp. 405-429.
2007 Preliminary Ceramic Report, in: W. WETTERSTROM and M. LEHNER (eds.), *Project History, Survey, Ceramics, and the Main Street and Gallery III. Operations. The Giza Plateau Mapping Project*, Giza Reports 1, Boston, pp. 275-315.

APPENDIX I: MACROSCOPIC AND MICROSCOPIC DESCRIPTIONS

MO1, hemispherical carinated bowl with white surface, Fabric GM3 (Marl C) (Pl. V.A)

Inclusions: sand – fine [1], medium [1]; limestone – fine [3], medium [1]; mica – fine [1]; red-brown rock particles – fine [1]; black rock particles – fine [1]; gray argillaceous inclusions – coarse [1]. Fair sorting, dense porosity, medium hard structure with decomposed limestone particles. Vessel wall – 5 mm. Break colour: 10YR5/3 brown. Surfaces: 5Y8/2 pale yellow.

Microscopic Description:
Colour PPL: dark brown
Colour XPL: very dark brown
Frequency of Inclusions (estimated): 30% (quartz and decomposed limestone)
Sorting: Fair (excludes AIs)
Approximate Shape Range: 2.1 – 2.4 and 1.1 – 1.4 (quartz); 2.4 – 2.6 and 1.4 – 1.6 (limestone)
Main Inclusions: quartz, polycrystalline quartz, K-feldspars (anorthoclase), plagioclase, mica (muscovite and biotite), limestone (mostly decomposed), red iron oxides, opaque minerals, argillaceous inclusions, and serpentine
Additional Inclusions Present: burnt-out plant remains, amphiboles, calcitic clay pellets, chert, and pyroxenes
Comments: little burnt-out plant remains; exterior scum surface appears calcium-rich and while visually different from the matrix is clearly apart of it and not a distinct slip; fabric is optically inactive

MO2, hemispherical carinated bowl with white surface, Fabric GM3 (Marl A) (Pl. V.B)

Inclusions: sand – fine [3], medium [1]; limestone – fine [3], medium [1]; red-brown rock particles – fine [1]; black rock particles – fine [1]. Good sorting, dense porosity, medium hard structure with decomposed limestone particles. Vessel wall – 5 mm. Break colour: zones 5YR6/6 reddish yellow, core 7.5YR6/6 reddish yellow. Surfaces: outer 7.5YR8/3 pink, inner 5YR6/6 reddish yellow (bit of speckled cream).

Microscopic Description:
Colour PPL: medium tan, edges medium red
Colour XPL: dark tan, edges dark red
Frequency of Inclusions (estimated): 30%
Sorting: Good (excludes AIs)
Approximate Shape Range: 2.1 – 2.5 and 1.1 – 1.5 (quartz) and 2.4 – 2.6 and 1.4 – 1.6 (limestone)
Main Inclusions: quartz, polycrystalline quartz, K-feldspars (anorthoclase and microcline), plagioclase, mica (muscovite and biotite), limestone (sparry and micritic), calcite, red iron oxides, opaque minerals, argillaceous inclusions, pyroxenes, and serpentine
Additional Inclusions Present: burnt-out plant remains, microfossils, amphiboles, chert, and epidote; possibly tourmaline and zircon

Comments: little burnt-out plant remains; quite a bit of muscovite and K-feldspars; fabric is optically active; scum surface blends into matrix but is still visually distinct

MO3, hemispherical carinated bowl with interior and exterior white slip, Fabric GN4 (Nile B2) (Pl. VI.A)

Inclusions: sand – fine [2], medium [1], coarse [1]; limestone – fine [1], medium [1]; plant remains – fine [1]; mica – fine [2]; black rock particles – fine [1]. Fair sorting, dense porosity, medium hard structure with decomposed limestone particles. Vessel wall – 6 mm. Break colour: outer zones 2.5YR5/6 red, thin middle zones 10R3/2 dusky red, inner zones 2.5YR5/6 red, core 2.5Y5/3 light olive brown. Surfaces: outer 2.5YR5/8 red, inner 2.5YR5/8 red.

Microscopic Description:
Colour PPL: edges dark red, core medium gray
Colour XPL: edges very dark red, core black
Frequency of Inclusions (estimated): 10%
Sorting: Fair
Approximate Shape Range: 2.2 – 2.5 and 1.2 – 1.4
Main Inclusions: quartz, polycrystalline quartz, K-feldspars (anorthoclase and microcline), plagioclase, mica (muscovite and biotite), red iron oxides, opaque minerals, pyroxenes, serpentine and burnt-out plant remains
Additional Inclusions Present: limestone (micritic, some decomposed), clay pellets (iron-rich and calcitic), amphiboles, chert, garnet, and organic animal remains (probably bone); possibly chlorite, epidote, quartzite, and volcanic glass
Comments: fabric is optically inactive, calcitic clay pellets have Nile clay mineral inclusions (same for the subsequent calcitic clay pellets)

MO4, hemispherical carinated bowl with interior and exterior white slip, Fabric GN4 (Nile B2) (Pl. VI.B)

Inclusions: sand – fine [2], medium [1], coarse [1]; limestone – fine [1], medium [1]; plant remains – fine [1]; mica – fine [2]; black rock particles – fine [1]. Fair sorting, dense porosity, crumbly structure with decomposed limestone particles. Vessel wall –7 mm. Break colour: zones 2.5YR5/8 red, core 10R5/6 red. Surfaces: outer 2.5YR5/8 red (slip 2.5Y8/2 pale yellow), inner 2.5YR5/8 red (slip 2.5Y8/2 pale yellow).

Microscopic Description:
Colour PPL: dark red
Colour XPL: very dark red
Frequency of Inclusions (estimated): 15%
Sorting: Fair
Approximate Shape Range: 2.1 – 2.4 and 1.1 – 1.4
Main Inclusions: quartz, polycrystalline quartz, K-feldspars (anorthoclase and microcline), plagioclase, mica (muscovite and biotite), red iron oxides, opaque minerals, clay pellets (iron-rich), pyroxenes, serpentine and burnt-out plant remains
Additional Inclusions Present: limestone (micritic and decomposed), amphiboles, calcitic

clay pellets, chalcedony, chert, and organic animal remains (probably bone); possibly chlorite, epidote, kyanite, garnet, grog, and zircon
Comments: calcium carbonate slip is optically oriented, but fabric is optically inactive

MO5, slightly carinated bowl with interior and exterior red slip, Fabric GN2 (Nile B1) (Pl. VII.A)

Inclusions: sand – fine [1], medium [1]; limestone – fine [1]; mica – fine [2]; red-brown rock particles – fine [1]; black rock particles – fine [1]. Very good sorting, dense porosity, medium hard structure with decomposed limestone particles. Vessel wall – 4 mm. Break colour: zones 7.5YR5/6 strong brown, core 10YR4/2 dark grayish brown. Surfaces: outer 7.5YR6/6 reddish yellow (slip 2.5YR4/8 red), inner inside slip 10R4/6 red.

Microscopic Description:
Colour PPL: medium tan
Colour XPL: dark tan
Frequency of Inclusions (estimated): 5%
Sorting: Fair
Approximate Shape Range: 2.2 – 2.5 and 1.2 – 1.4
Main Inclusions: quartz, polycrystalline quartz, K-feldspars (microcline), plagioclase, mica (muscovite and biotite), red iron oxides, opaque minerals, pyroxenes (aegirine), and serpentine
Additional Inclusions Present: burnt-out plant remains, limestone (micritic), amphiboles, chert, epidote, olivine, and zircon; possibly chlorite and tourmaline
Comments: little burnt-out plant remains; fabric is slightly optically active and slip is optically oriented

MO6, slightly carinated bowl with interior and exterior red slip, Fabric GN3 (Nile B1) (Pl. VII.B)

Inclusions: sand – fine [2], medium [1]; limestone – fine [1]; plant remains – fine [1], medium [1], coarse [1]; mica – fine [2], medium [1]; red-brown rock particles – fine [1]; black rock particles – fine [1]. Fair sorting, dense porosity, medium hard structure with decomposed limestone particles. Vessel wall – 9 mm. Break colour: 7.5YR5/6 strong brown. Surfaces: outer 7.5YR5/4 brown (slip 10R5/6 red), inner 7.5YR5/4 brown (slip 10R4/6 red).

Microscopic Description:
Colour PPL: medium tan
Colour XPL: dark tan
Frequency of Inclusions (estimated): 20%
Sorting: Poor
Approximate Shape Range: 2.2 – 2.5 and 1.2 – 1.4
Main Inclusions: quartz, polycrystalline quartz, K-feldspars (anorthoclase and microcline), plagioclase, mica (muscovite and biotite), red iron oxides, opaque minerals, pyroxenes (aegirine), and serpentine
Additional Inclusions Present: burnt-out plant remains, limestone (micritic), amphiboles, calcitic clay pellets, chalcedony, chert, and epidote; possibly chlorite, garnet, kyanite, olivine, tourmaline, zircon, and zoisite

Comments: little burnt-out plant remains; fabric is slightly optically active and slip is optically oriented

MO7, ledge-rim bowl, Fabric GN4 (Nile B2) (Pl. VIII.A)

Inclusions: sand – fine [2], medium [1]; limestone – fine [1]; plant remains – fine [1], medium [1]; mica – fine [1]; red-brown rock particles – fine [1]; black rock particles – fine [1]. Fair sorting, dense porosity, medium hard structure with decomposed limestone particles. Vessel wall – 8 mm. Break colour: zones 5YR5/4 reddish brown, core 10YR5/1 gray. Surfaces: outer 7.5YR6/6 reddish yellow (slip 10R6/6 light red), inner 7.5YR6/6 reddish yellow (slip 10R4/4 weak red).

Microscopic Description:
Colour PPL: light to medium tan
Colour XPL: medium to dark tan
Frequency of Inclusions (estimated): 10%
Sorting: Fair
Approximate Shape Range: 2.2 – 2.4 and 1.2 – 1.5
Main Inclusions: quartz, polycrystalline quartz, K-feldspars (anorthoclase and microcline), plagioclase, mica (muscovite and biotite), red iron oxides, opaque minerals, clay pellets (iron-rich and calcitic), amphiboles, pyroxenes (aegirine), and serpentine
Additional Inclusions Present: burnt-out plant remains, limestone (micritic), chalcedony, chert, and epidote; possibly chlorite, garnet, grog, olivine, tourmaline and zircon
Comments: some burnt-out plant remains; quite a bit of plagioclase; fabric is slightly optically active and slip is optically oriented

MO8, plate or flat bowl with interior red slip, Fabric GN6 (Nile B2) (Pl. VIII.B)

Inclusions: sand – fine [2], medium [1], coarse [1]; limestone – fine [1], medium [1]; plant remains – fine [2], medium [1], coarse [1]; mica – fine [1]; red-brown soft particles – fine [1]; red-brown rock particles – fine [1]; black rock particles – fine [1]. Fair sorting, dense porosity, medium hard structure with decomposed limestone particles. Vessel wall – 9 mm. Break colour: 5YR5/6 yellowish red. Surfaces: outer 7.5YR5/4 brown, inner 7.5YR5/4 brown (slip 10R4/6 red).

Microscopic Description:
Colour PPL: medium brown
Colour XPL: dark brown
Frequency of Inclusions (estimated): 10%
Sorting: Poor
Approximate Shape Range: 2.2 – 2.5 and 1.2 – 1.4
Main Inclusions: quartz, polycrystalline quartz, K-feldspars (anorthoclase and microcline), plagioclase, mica (muscovite and biotite), red iron oxides, opaque minerals, clay pellets (iron-rich and calcitic), amphiboles, pyroxenes (aegirine), and serpentine
Additional Inclusions Present: burnt-out plant remains, limestone (micritic), calcite, chalcedony, chert, epidote, grog, olivine, and tourmaline; possibly garnet, kyanite, zircon, and zoisite

Comments: little burnt-out plant remains; fabric is slightly optically active and slip is optically oriented

MO9, carinated "Meydum" bowl with interior and exterior red slip, Fabric GN6 (Nile B2) (Pl. IX.A)

Inclusions: sand – fine [2], medium [1]; limestone – fine [1]; plant remains – fine [2]; mica – fine [1]; red-brown rock particles – medium [1]; black rock particles – fine [1]. Good sorting, dense porosity, medium hard structure with decomposed limestone particles. Vessel wall – 5 mm. Break colour: 7.5YR5/4 brown. Surfaces: outer 10YR6/4 light yellowish brown (slip 5YR6/4 light reddish brown), inner 10YR6/4 light yellowish brown (slip 5YR6/4 light reddish brown).

Microscopic Description:
Colour PPL: edges medium tan, core medium reddish tan
Colour XPL: edges dark tan, core dark reddish tan
Frequency of Inclusions (estimated): 15%
Sorting: Poor
Approximate Shape Range: 2.2 – 2.5 and 1.2 – 1.5
Main Inclusions: quartz, polycrystalline quartz, K-feldspars (anorthoclase), plagioclase, mica (muscovite and biotite), red iron oxides, opaque minerals, clay pellets (iron-rich), amphiboles, pyroxenes (aegirine), serpentine, and burnt-out plant remains
Additional Inclusions Present: limestone (micritic), chert, epidote, olivine, and rock fragments; possibly chlorite, garnet, grog, kyanite, zircon, and zoisite
Comments: fabric is slightly optically active and slip is optically oriented

MO10, plate or flat bowl with no slip, Fabric GN7 (Nile B2) (Pl. IX.B)

Inclusions: sand – fine [2], medium [1], coarse [1]; limestone – fine [1], coarse [1]; plant remains – fine [2], medium [1]; mica – fine [1]; red-brown soft particles – medium [1]; red-brown rock particles – fine [1]. Fair sorting, dense porosity, medium hard structure with decomposed limestone particles. Vessel wall – 10 mm. Break colour: outer zones 7.5YR5/6 strong brown, inner zones 2.5YR5/6 red, core 2.5Y4/2 dark grayish brown. Surfaces: 5YR5/6 yellowish red.

Microscopic Description:
Colour PPL: medium tan edges, medium red middle
Colour XPL: dark tan edges, dark red middle
Frequency of Inclusions (estimated): 10%
Sorting: Poor
Approximate Shape Range: 2.1 – 2.5 and 1.1 – 1.5
Main Inclusions: quartz, polycrystalline quartz, K-feldspars (perthite and microcline), plagioclase, mica (muscovite and biotite), red iron oxides, opaque minerals, clay pellets (iron-rich), pyroxenes (aegirine), serpentine, and burnt-out plant remains
Additional Inclusions Present: amphiboles, chalcedony, chert, epidote, and grog; possibly garnet, kyanite, olivine, and quartzite
Comments: fabric is slightly optically active with a core less active

APPENDIX III: RAW (NOT NORMALIZED) XRF DATA. BLANKS ARE DETERMINATIONS BELOW THE DETECTION LIMIT.

Sample	Fabric	Na_2O %	MgO %	Al_2O_3 %	SiO_2 %	P_2O_5 %	SO_3 %	Cl %	K_2O %	CaO %	TiO_2 %	V_2O_5 %
MO 1	Marl C (GM3)	1.37	2.21	15.86	48.46	0.24		0.10	1.10	9.57	0.65	0.02
MO 1_r01	Marl C (GM3)	1.51	2.16	15.90	48.15	0.24		0.11	1.10	9.54	0.64	0.02
MO 1_r02	Marl C (GM3)	1.37	2.16	15.71	48.29	0.24		0.11	1.08	9.51	0.64	0.02
MO 2	Marl A (GM3)	2.98	1.88	14.35	38.68	0.20	0.21	0.91	1.02	11.52	0.58	0.02
MO 2_r01	Marl A (GM3)	3.07	2.03	14.35	38.69	0.20	0.21	0.91	1.01	11.54	0.59	0.02
MO 2_r02	Marl A (GM3)	3.09	1.97	14.26	38.48	0.20	0.21	0.91	1.00	11.47	0.58	0.02
MO 3	Nile B2 (GN4)	1.10	2.09	15.99	52.26	0.55		0.02	1.53	3.05	1.31	0.04
MO 3_r01	Nile B2 (GN4)	1.07	2.16	16.16	52.39	0.56		0.02	1.52	3.06	1.31	0.04
MO 3_r02	Nile B2 (GN4)	1.31	2.16	16.09	51.96	0.55		0.02	1.52	2.98	1.31	0.03
MO 4	Nile B2 (GN4)	1.54	2.44	14.25	53.06	0.63	0.33	0.20	2.05	3.32	1.12	0.03
MO 4_r01	Nile B2 (GN4)	2.34	2.50	14.39	53.00	0.64	0.32	0.20	2.06	3.33	1.13	0.03
MO 4_r02	Nile B2 (GN4)	1.98	2.37	14.11	52.64	0.63	0.32	0.19	2.08	3.29	1.11	0.03
MO 5	Nile B1 (GN2)	1.68	2.56	15.80	50.13	0.29		0.01	1.18	4.35	1.19	0.03
MO 5_r01	Nile B1 (GN2)	1.04	2.37	15.69	50.12	0.28		0.01	1.15	4.32	1.17	0.04
MO 5_r02	Nile B1 (GN2)	1.07	2.34	15.70	49.83	0.28		0.02	1.14	4.32	1.19	0.03
MO 6	Nile B1 (GN3)	1.17	2.26	13.95	53.66	0.26		0.02	1.10	2.87	1.10	0.03
MO 6_r01	Nile B1 (GN3)	1.02	2.17	14.02	53.89	0.27		0.02	1.08	2.88	1.10	0.03
MO 6_r02	Nile B1 (GN3)	0.92	2.22	13.95	53.58	0.26		0.02	1.09	2.88	1.10	0.02
MO 7	Nile B2 (GN4)	1.24	2.31	15.15	51.52	0.26		0.03	1.34	2.68	1.29	0.03
MO 7_r01	Nile B2 (GN4)	1.12	2.28	15.21	51.55	0.26		0.03	1.35	2.65	1.29	0.03
MO 7_r02	Nile B2 (GN4)	1.38	2.24	15.14	51.58	0.26		0.03	1.34	2.64	1.28	0.03
MO 8(1)	Nile B2 (GN6)	1.04	2.30	15.26	51.42	0.27		0.01	1.22	3.03	1.30	0.03
MO 8(1)_r01	Nile B2 (GN6)	0.88	2.25	15.31	51.29	0.28		0.01	1.23	3.03	1.30	0.03
MO 8(1)_r02	Nile B2 (GN6)	1.04	2.27	15.38	51.50	0.28		0.01	1.25	3.04	1.31	0.03
MO 8(2)	Nile B2 (GN6)	1.02	2.35	15.23	51.93	0.26		0.01	1.24	2.94	1.29	0.03
MO 8(2)_r01	Nile B2 (GN6)	1.18	2.27	15.36	52.12	0.26		0.01	1.26	2.98	1.28	0.04

Sample	Fabric	Na_2O %	MgO %	Al_2O_3 %	SiO_2 %	P_2O_5 %	SO_3 %	Cl %	K_2O %	CaO %	TiO_2 %	V_2O_5 %
MO 8(2)_r02	Nile B2 (GN6)	0.97	2.26	15.33	51.97	0.27		0.01	1.24	2.95	1.28	0.03
MO 9	Nile B2 (GN6)	1.05	2.14	14.25	52.60	0.35		0.02	1.26	2.74	1.17	0.03
MO 9_r01	Nile B2 (GN6)	1.26	2.23	14.32	52.82	0.34		0.02	1.25	2.75	1.19	0.03
MO 9_r02	Nile B2 (GN6)	1.13	2.23	14.12	52.67	0.34		0.02	1.27	2.75	1.16	0.03
MO 10(1)	Nile B2 (GN7)	1.47	2.22	15.50	49.92	0.50	0.03	0.05	1.43	2.87	1.31	0.04
MO 10(1)_r01	Nile B2 (GN7)	1.10	2.16	15.58	49.84	0.50	0.03	0.05	1.46	2.89	1.33	0.03
MO 10(1)_r02	Nile B2 (GN7)	1.20	2.11	15.58	49.76	0.50	0.03	0.05	1.43	2.87	1.32	0.03
MO 10(2)	Nile B2 (GN7)	1.22	2.17	15.67	51.00	0.47	0.03	0.04	1.44	2.87	1.30	0.03
MO 10(2)_r01	Nile B2 (GN7)	1.43	2.24	15.69	51.20	0.48	0.03	0.04	1.45	2.89	1.32	0.03
MO 10(2)_r02	Nile B2 (GN7)	0.83	2.16	15.63	50.87	0.48	0.03	0.04	1.46	2.86	1.31	0.03

Sample	Fabric	Cr_2O_3 %	MnO %	Fe_2O_3 %	Co ppm	Ni ppm	Cu ppm	Zn ppm	Ga ppm	Ge ppm	As ppm
MO 1	Marl C (GM3)	0.02	0.05	6.76	101.00	37.80	22.90	162.90	20.50		8.20
MO 1_r01	Marl C (GM3)	0.02	0.05	6.76	101.00	44.80	34.90	148.30	22.70	2.50	7.70
MO 1_r02	Marl C (GM3)	0.01	0.05	6.77	87.00	46.00	33.00	153.70	22.20	1.70	7.00
MO 2	Marl A (GM3)	0.02	0.05	5.91	67.00	37.70	39.10	126.60	18.90	1.80	9.60
MO 2_r01	Marl A (GM3)	0.02	0.05	5.91	92.00	32.90	38.20	121.30	20.10	2.00	9.60
MO 2_r02	Marl A (GM3)	0.02	0.05	5.90	74.00	32.10	38.10	125.10	17.40	2.20	7.80
MO 3	Nile B2 (GN4)	0.02	0.14	10.51	135.00	79.70	101.60	165.10	22.40	3.00	5.20
MO 3_r01	Nile B2 (GN4)	0.02	0.13	10.54	159.00	75.70	104.40	163.10	23.10	2.00	4.60
MO 3_r02	Nile B2 (GN4)	0.02	0.13	10.50	138.00	83.70	100.00	155.80	23.70	2.00	5.90
MO 4	Nile B2 (GN4)	0.02	0.14	9.08	164.00	67.60	73.10	129.90	18.40	2.40	5.30
MO 4_r01	Nile B2 (GN4)	0.02	0.14	9.09	168.00	66.40	78.60	132.60	20.30	2.10	4.60
MO 4_r02	Nile B2 (GN4)	0.02	0.13	9.08	139.00	64.60	73.40	133.40	19.60		4.90
MO 5	Nile B1 (GN2)	0.02	0.14	9.76	176.00	59.90	75.90	143.90	20.10	1.80	6.70
MO 5_r01	Nile B1 (GN2)	0.02	0.14	9.75	162.00	74.60	78.50	150.00	22.30	2.70	6.80
MO 5_r02	Nile B1 (GN2)	0.02	0.14	9.72	120.00	70.80	70.70	144.80	22.00	2.90	7.30
MO 6	Nile B1 (GN3)	0.02	0.17	8.40	131.00	65.20	67.50	121.80	17.50	1.80	4.70

Sample	Fabric	Cr_2O_3 %	MnO %	Fe_2O_3 %	Co ppm	Ni ppm	Cu ppm	Zn ppm	Ga ppm	Ge ppm	As ppm
MO 6_r01	Nile B1 (GN3)	0.02	0.17	8.42	107.00	64.10	67.40	121.30	16.40	2.60	4.30
MO 6_r02	Nile B1 (GN3)	0.02	0.17	8.44	98.00	65.20	76.50	122.90	19.10	1.30	4.80
MO 7	Nile B2 (GN4)	0.02	0.14	9.99	142.00	68.90	80.30	138.10	22.00	2.10	4.60
MO 7_r01	Nile B2 (GN4)	0.02	0.15	9.96	116.00	79.30	75.60	136.80	18.90	1.70	6.60
MO 7_r02	Nile B2 (GN4)	0.02	0.15	9.98	103.00	76.90	72.40	142.00	19.90	1.70	5.60
MO 8(1)	Nile B2 (GN6)	0.02	0.16	10.17	145.00	73.10	97.00	146.30	19.30	2.60	4.30
MO 8(1)_r01	Nile B2 (GN6)	0.02	0.16	10.14	168.00	74.10	97.40	135.80	23.00	2.30	4.80
MO 8(1)_r02	Nile B2 (GN6)	0.02	0.16	10.17	130.00	81.00	96.50	147.70	20.60	2.10	4.00
MO 8(2)	Nile B2 (GN6)	0.02	0.16	10.14	139.00	75.30	94.70	144.60	21.70	2.40	6.20
MO 8(2)_r01	Nile B2 (GN6)	0.02	0.16	10.18	137.00	81.70	97.00	148.30	21.10	2.70	6.00
MO 8(2)_r02	Nile B2 (GN6)	0.02	0.16	10.11	177.00	80.40	88.60	149.30	19.10	1.60	3.90
MO 9	Nile B2 (GN6)	0.02	0.14	9.29	162.00	68.90	88.60	154.50	20.60	1.90	6.10
MO 9_r01	Nile B2 (GN6)	0.02	0.14	9.33	163.00	62.60	86.50	159.30	19.80	0.80	4.90
MO 9_r02	Nile B2 (GN6)	0.02	0.13	9.29	180.00	61.70	83.20	151.70	17.60	1.20	4.90
MO 10(1)	Nile B2 (GN7)	0.02	0.16	10.51	148.00	81.30	99.20	155.70	18.50	2.50	6.30
MO 10(1)_r01	Nile B2 (GN7)	0.02	0.16	10.50	171.00	71.70	97.40	148.00	21.90	1.70	5.20
MO 10(1)_r02	Nile B2 (GN7)	0.02	0.16	10.50	161.00	81.20	97.70	151.90	21.50	2.00	5.50
MO 10(2)	Nile B2 (GN7)	0.02	0.16	10.47	138.00	83.80	107.00	154.80	20.90	3.30	7.50
MO 10(2)_r01	Nile B2 (GN7)	0.02	0.16	10.50	166.00	86.00	105.10	157.60	20.90	2.20	5.10
MO 10(2)_r02	Nile B2 (GN7)	0.02	0.16	10.46	161.00	71.80	103.80	150.50	21.20	2.20	6.10

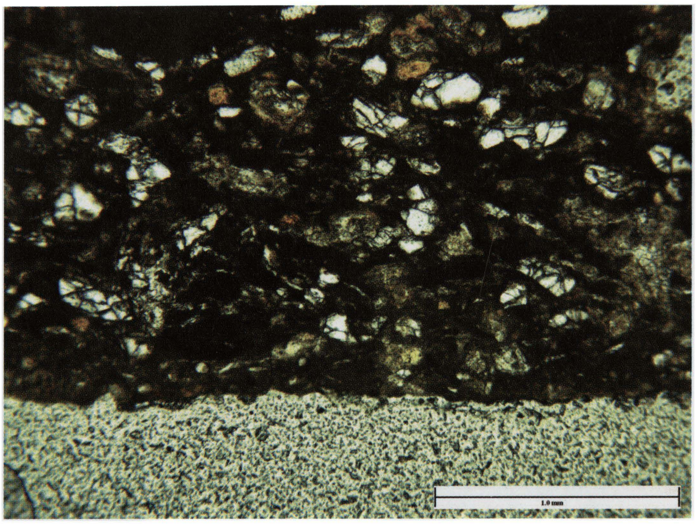
Sample	Fabric	Se ppm	Br ppm	Rb ppm	Sr ppm	Y ppm	Zr ppm	Nb ppm	Sn ppm	Ba ppm	La ppm
MO 1	Marl C (GM3)	1.30	4.70	50.40	809.30	25.90	292.90	26.20	4.00	414.50	21.00
MO 1_r01	Marl C (GM3)	0.60	4.90	47.60	808.50	26.70	272.60	23.90	3.30	417.50	16.70
MO 1_r02	Marl C (GM3)	0.50	4.50	48.80	812.40	25.50	253.00	27.30	3.30	423.80	22.70
MO 2	Marl A (GM3)	1.10	11.90	38.80	683.90	23.40	302.10	19.60	2.80	222.10	25.20

Sample	Fabric	Se ppm	Br ppm	Rb ppm	Sr ppm	Y ppm	Zr ppm	Nb ppm	Sn ppm	Ba ppm	La ppm
MO 2_r01	Marl A (GM3)	1.20	11.60	38.30	680.80	23.60	291.30	18.50	2.60	225.30	18.50
MO 2_r02	Marl A (GM3)	1.60	12.20	37.80	683.90	23.00	283.60	21.70	2.70	224.80	16.00
MO 3	Nile B2 (GN4)	1.10	2.00	55.00	345.40	35.70	231.80	19.60	4.80	455.60	12.90
MO 3_r01	Nile B2 (GN4)	1.00	2.00	55.20	346.80	34.30	232.10	21.70	3.90	466.90	17.00
MO 3_r02	Nile B2 (GN4)		1.70	54.70	346.30	34.30	240.60	22.00	4.10	470.30	14.20
MO 4	Nile B2 (GN4)	1.30	4.40	51.60	362.10	32.50	220.90	18.90	3.10	439.20	15.90
MO 4_r01	Nile B2 (GN4)	0.60	4.00	52.20	360.10	32.30	221.30	16.70	2.10	431.10	13.30
MO 4_r02	Nile B2 (GN4)	0.90	3.70	53.90	360.00	31.90	226.30	10.70	2.60	439.30	11.00
MO 5	Nile B1 (GN2)	0.50	2.30	40.60	532.20	33.00	206.40	19.60	1.90	547.30	13.70
MO 5_r01	Nile B1 (GN2)	0.80	2.10	41.00	533.20	31.80	215.10	22.40	1.70	555.80	12.30
MO 5_r02	Nile B1 (GN2)	0.70	1.80	42.10	528.40	31.40	215.30	19.90	2.00	548.40	12.80
MO 6	Nile B1 (GN3)	1.30	1.80	43.00	493.90	29.00	250.40	17.60	2.90	547.40	12.00
MO 6_r01	Nile B1 (GN3)	0.30	2.20	43.00	495.00	28.90	246.60	19.10	2.40	540.00	15.40
MO 6_r02	Nile B1 (GN3)	0.90	2.20	43.00	492.80	28.70	250.10	15.90	2.10	548.60	8.50
MO 7	Nile B2 (GN4)	0.60	2.10	48.60	470.80	31.50	253.30	19.20	2.30	550.80	11.60
MO 7_r01	Nile B2 (GN4)	0.90	2.00	47.80	469.20	32.10	251.90	23.00	2.50	560.10	18.00
MO 7_r02	Nile B2 (GN4)	1.10	1.70	45.50	473.70	32.30	259.80	16.60	1.90	559.70	14.40
MO 8(1)	Nile B2 (GN6)		1.80	41.00	510.40	30.80	228.40	20.80	3.50	583.80	10.80
MO 8(1)_r01	Nile B2 (GN6)		1.40	40.00	515.40	30.90	222.40	21.90	3.60	585.60	13.40
MO 8(1)_r02	Nile B2 (GN6)	1.10	1.30	40.70	514.40	29.40	213.60	19.40	3.50	593.70	14.30
MO 8(2)	Nile B2 (GN6)	0.70	1.50	41.80	515.50	31.00	222.20	16.80	2.70	581.60	12.10
MO 8(2)_r01	Nile B2 (GN6)		1.90	41.20	519.10	30.80	227.10	11.70	2.60	596.10	14.60
MO 8(2)_r02	Nile B2 (GN6)		1.40	41.30	513.90	29.50	228.80	19.30	2.90	594.30	12.50

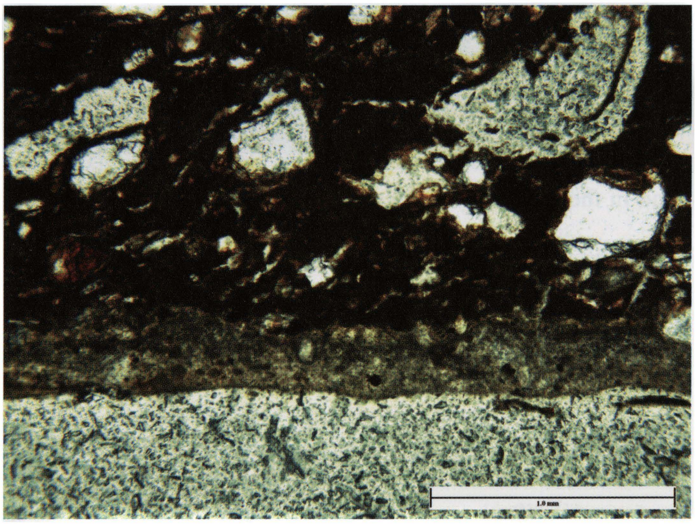
Sample	Fabric	Se ppm	Br ppm	Rb ppm	Sr ppm	Y ppm	Zr ppm	Nb ppm	Sn ppm	Ba ppm	La ppm
MO 9	Nile B2 (GN6)		1.70	44.20	520.60	30.20	234.40	15.80	2.60	652.40	8.30
MO 9_r01	Nile B2 (GN6)		1.60	45.40	522.40	31.40	234.90	15.70	1.20	646.10	7.90
MO 9_r02	Nile B2 (GN6)	1.00	1.50	44.70	520.00	30.60	233.70	16.50	1.80	669.60	17.90
MO 10(1)	Nile B2 (GN7)		2.90	43.70	475.90	32.50	200.30	21.20	3.20	574.60	8.30
MO 10(1)_r01	Nile B2 (GN7)	0.60	3.00	43.30	481.50	32.80	209.30	23.30	3.50	581.40	10.30
MO 10(1)_r02	Nile B2 (GN7)		2.90	43.20	479.20	32.30	201.30	23.30	1.90	566.80	9.10
MO 10(2)	Nile B2 (GN7)	1.00	3.10	44.20	478.30	32.90	217.00	22.20	2.90	576.60	14.50
MO 10(2)_r01	Nile B2 (GN7)		2.40	44.40	478.40	33.10	219.80	18.90	2.90	563.90	8.60
MO 10(2)_r02	Nile B2 (GN7)		2.80	43.20	479.70	33.80	224.80	21.40	3.40	572.20	14.70

Sample	Fabric	Ce ppm	Hf ppm	Ta ppm	Hg ppm	Tl ppm	Pb ppm	Bi ppm	Th ppm	U ppm	Sum
MO 1	Marl C (GM3)	46.90	13.70	10.90		1.30	15.10		11.20	15.80	86.42
MO 1_r01	Marl C (GM3)	46.50	8.50			1.00	13.50	1.20	11.00		86.19
MO 1_r02	Marl C (GM3)	43.30	9.50			0.80	13.80	0.90	9.50		85.96
MO 2	Marl A (GM3)	40.50	13.00			1.00	15.50	0.90	9.10		78.31
MO 2_r01	Marl A (GM3)	45.60	8.60	6.50		0.60	16.10	1.10	8.70		78.59
MO 2_r02	Marl A (GM3)	41.00	6.40	8.80		1.10	13.80	1.30	9.50		78.15
MO 3	Nile B2 (GN4)	34.50	8.80	15.90		1.00	7.90		3.00	9.40	88.60
MO 3_r01	Nile B2 (GN4)	36.60	8.20	11.50			9.00		2.10	4.40	88.99
MO 3_r02	Nile B2 (GN4)	34.30	7.40			0.60	8.30		3.60		88.59
MO 4	Nile B2 (GN4)	35.30	10.50	10.60			8.20		3.70	5.50	88.20
MO 4_r01	Nile B2 (GN4)	29.70		7.40			8.40		1.70		89.19
MO 4_r02	Nile B2 (GN4)	29.00	9.60			0.80	8.50		2.70		87.98
MO 5	Nile B1 (GN2)	36.00					8.80		1.80	5.30	87.13
MO 5_r01	Nile B1 (GN2)	33.50	4.90			0.90	7.90		3.10		86.12
MO 5_r02	Nile B1 (GN2)	32.30	9.00			1.10	9.30		3.00		85.78

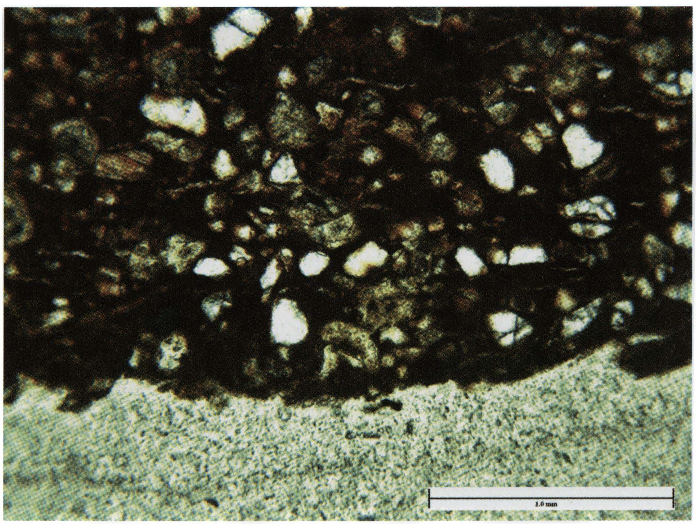
Sample	Fabric	Ce ppm	Hf ppm	Ta ppm	Hg ppm	Tl ppm	Pb ppm	Bi ppm	Th ppm	U ppm	Sum
MO 6	Nile B1 (GN3)	33.50	9.00	8.50			8.00		2.20	5.50	85.01
MO 6_r01	Nile B1 (GN3)	19.00	12.30	7.70			7.30		2.40		85.07
MO 6_r02	Nile B1 (GN3)	28.20	6.30		0.40		7.50		3.30		84.66
MO 7	Nile B2 (GN4)	39.30	7.30			0.80	7.50		3.00		86.01
MO 7_r01	Nile B2 (GN4)	38.20	5.50	8.00		1.00	4.80		2.90		85.90
MO 7_r02	Nile B2 (GN4)	39.30	9.80	13.50			6.40		2.00		86.07
MO 8(1)	Nile B2 (GN6)	33.80	6.30	9.60			8.30				86.23
MO 8(1)_r01	Nile B2 (GN6)	30.80					7.90	0.70	2.90		85.93
MO 8(1)_r02	Nile B2 (GN6)	29.70	7.90	8.20		0.60	8.20	1.30	1.10		86.46
MO 8(2)	Nile B2 (GN6)	29.00					8.40	0.40	1.90		86.63
MO 8(2)_r01	Nile B2 (GN6)	30.70	5.50	7.20			7.10		3.10		87.11
MO 8(2)_r02	Nile B2 (GN6)	38.30	6.80	12.20			9.20		1.60		86.61
MO 9	Nile B2 (GN6)	29.80		8.00	0.50		7.90		2.00		85.05
MO 9_r01	Nile B2 (GN6)	35.90	6.40	9.10	1.00		7.80		2.90		85.69
MO 9_r02	Nile B2 (GN6)	38.90	8.70	18.30	0.50		7.70		3.90		85.15
MO 10(1)	Nile B2 (GN7)	22.90	9.70	15.10			6.70	0.60	1.90		86.02
MO 10(1)_r01	Nile B2 (GN7)	33.60	6.60	7.60			7.90		1.80		85.65
MO 10(1)_r02	Nile B2 (GN7)	22.50	7.90	10.80			6.60		2.80		85.55
MO 10(2)	Nile B2 (GN7)	32.60	6.50	12.00			7.70		2.80	5.20	86.90
MO 10(2)_r01	Nile B2 (GN7)	32.20		10.20	1.00		8.80		2.40		87.48
MO 10(2)_r02	Nile B2 (GN7)	33.10	6.80	16.20			8.10		1.00		86.34



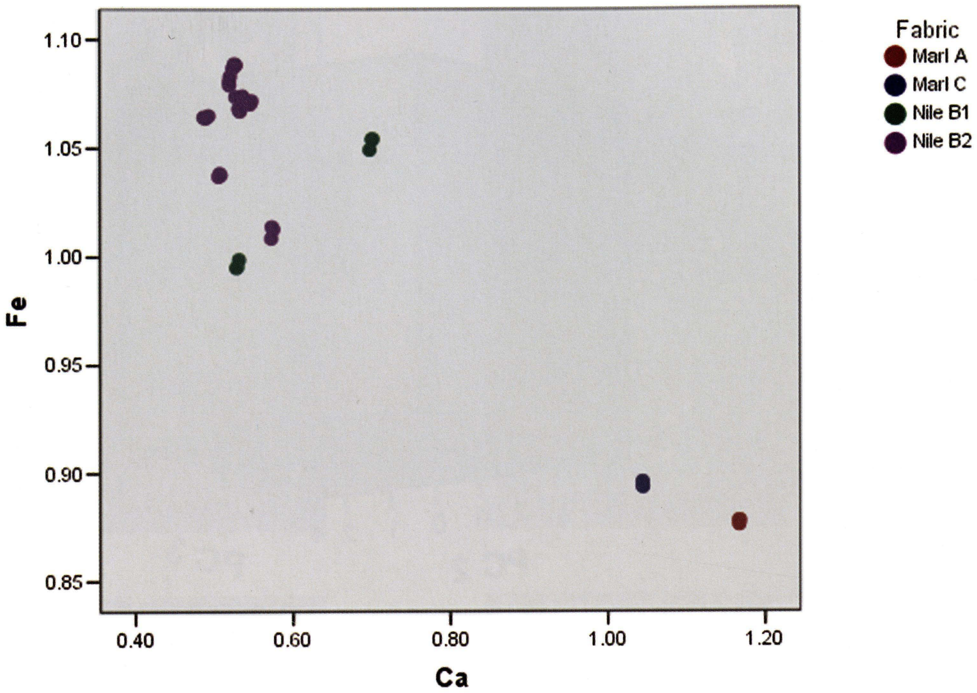
A. Scum on sample MO1, thin section viewed in plain polarized light (100x magnification).



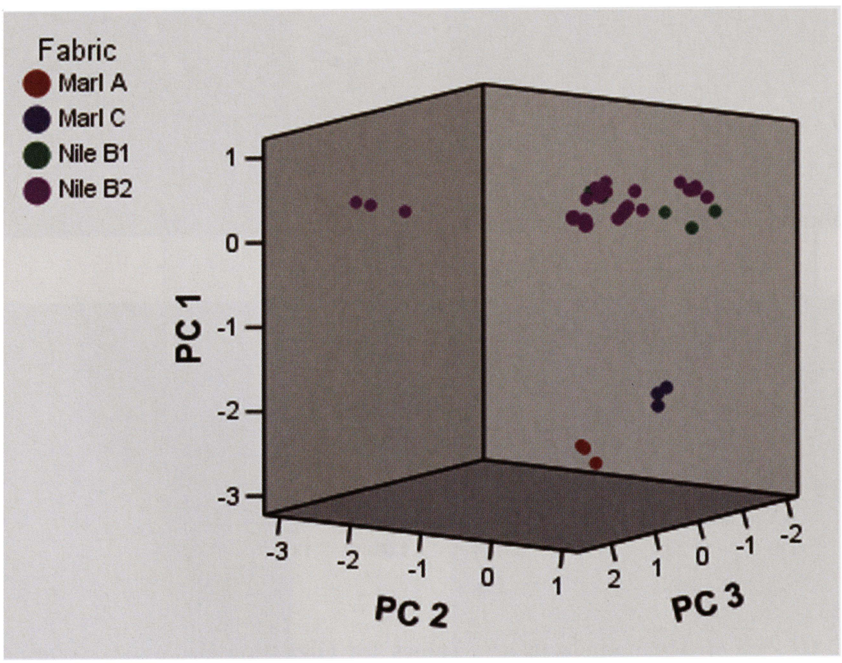
B. White slip on sample MO4, thin section viewed in plain polarized light (100x magnification).



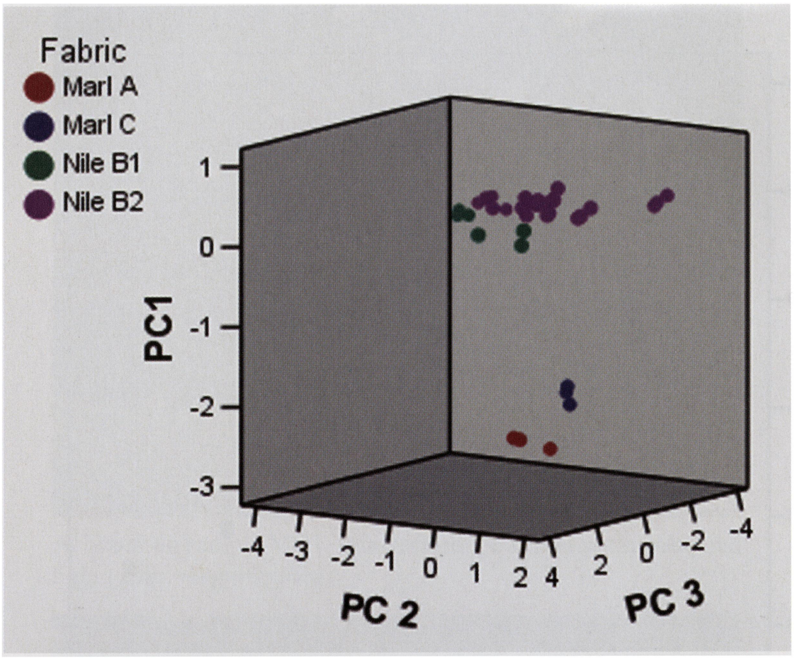
C. Scum on sample MO2, thin section viewed in plain polarized light (100x magnification).



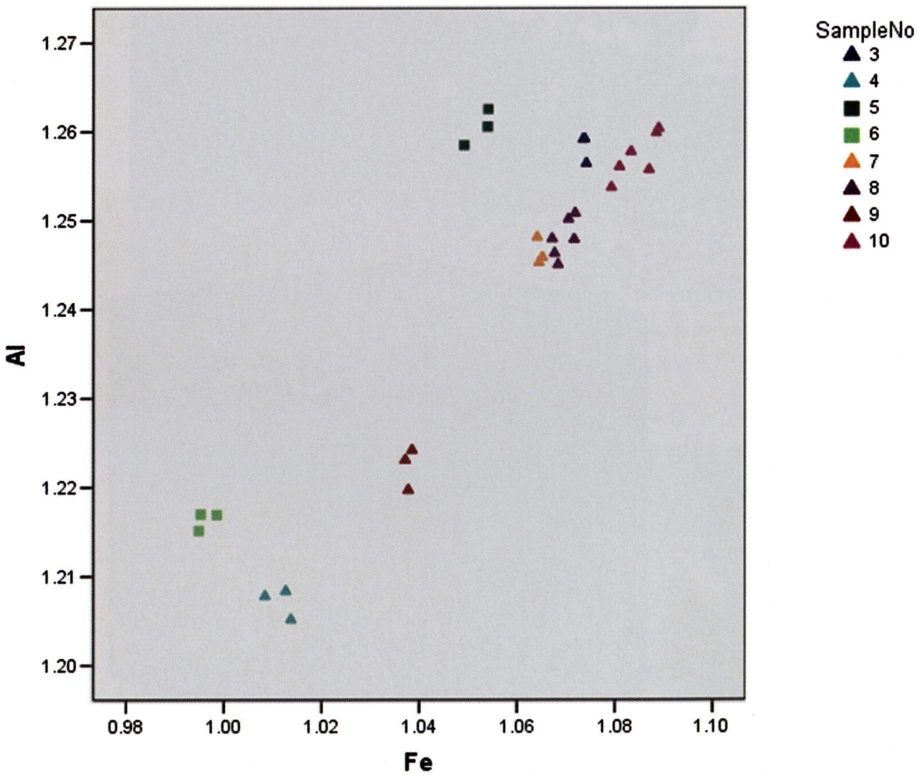
A. Plot of Iron and Calcium values in Giza samples.



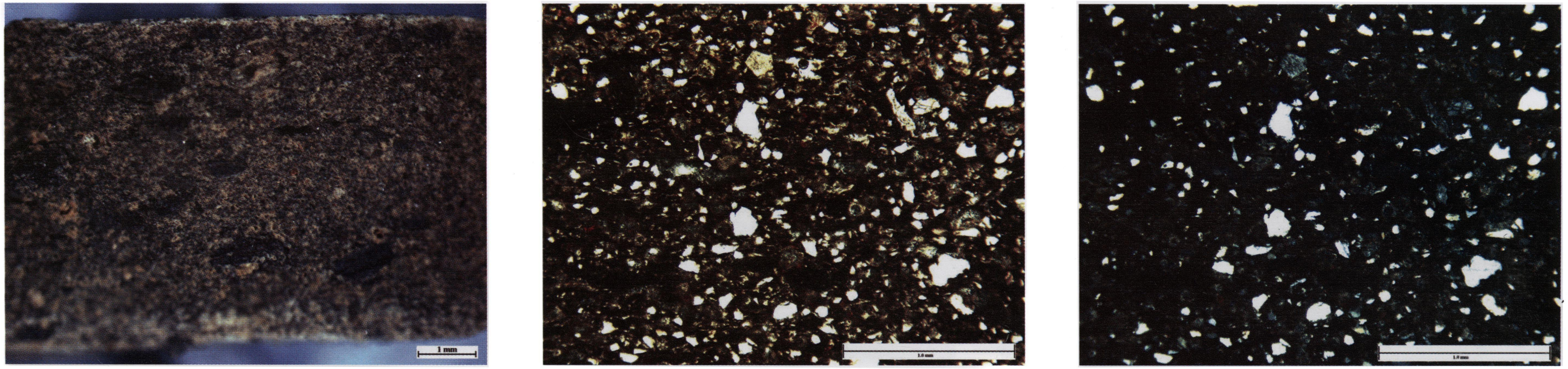
B. Principal components analysis of XRF data from Giza samples.



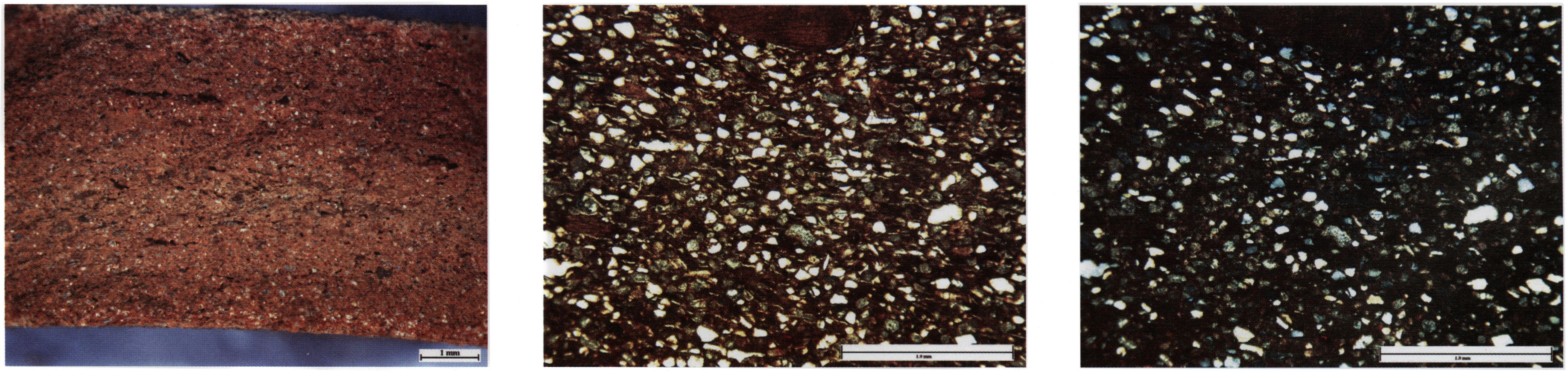
A. PCA of XRF data from Giza samples without Cl, K, P, and Na.



B. Plot of Aluminum and Iron values for Giza Nile B1 and B2 samples (triangles represent Nile B2 fabrics while squares represent Nile B1 fabrics).

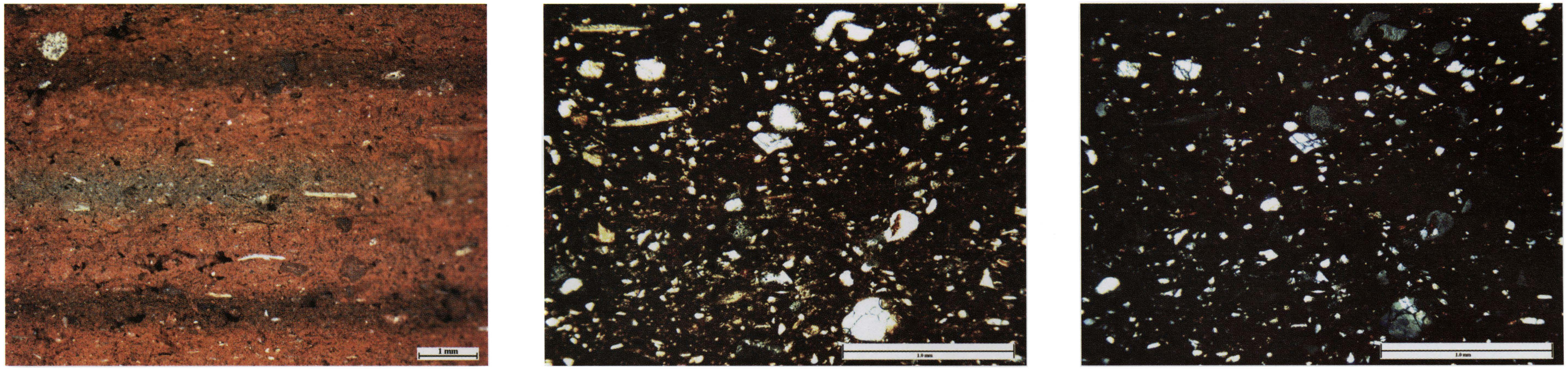


A. MO1: Marl C, GM3, carinated bowl.

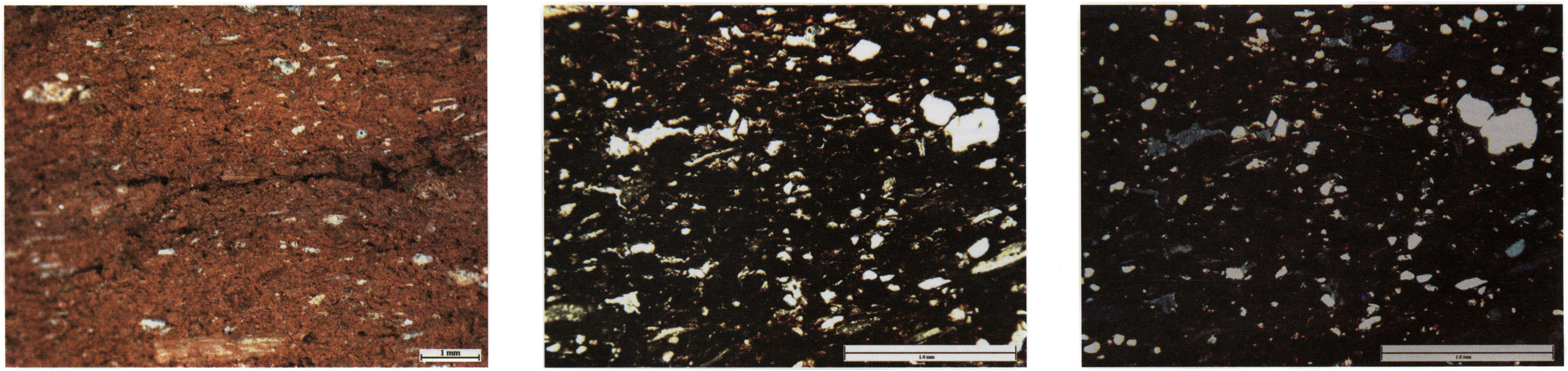


B. MO2: Marl A, GM3, carinated bowl.

Samples MO1 and MO2. Fresh break (left), PPL (middle), and XPL (right) images at 40x magnification.

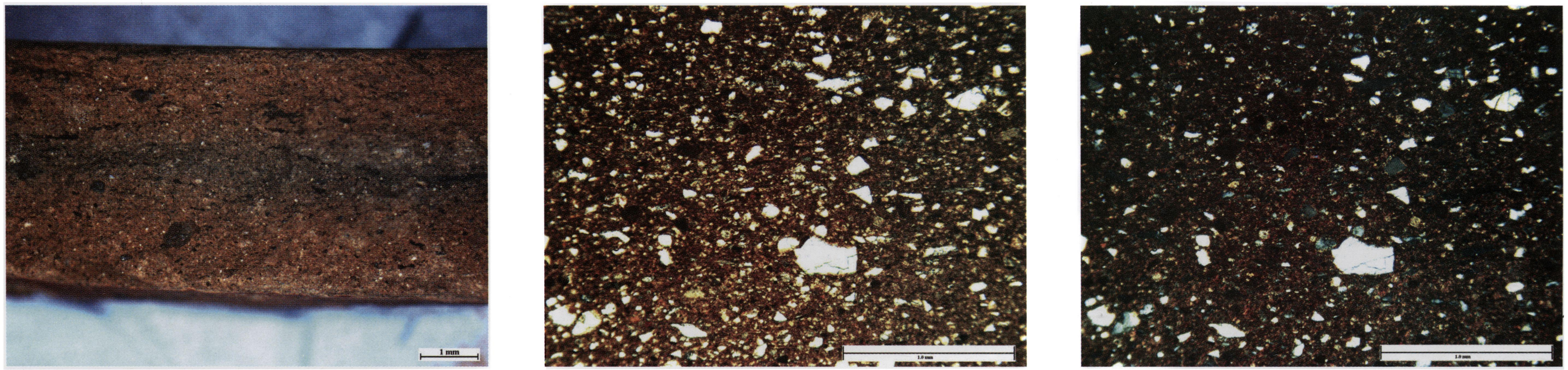


A. MO3: Nile B2, GN4, white slipped carinated bowl.

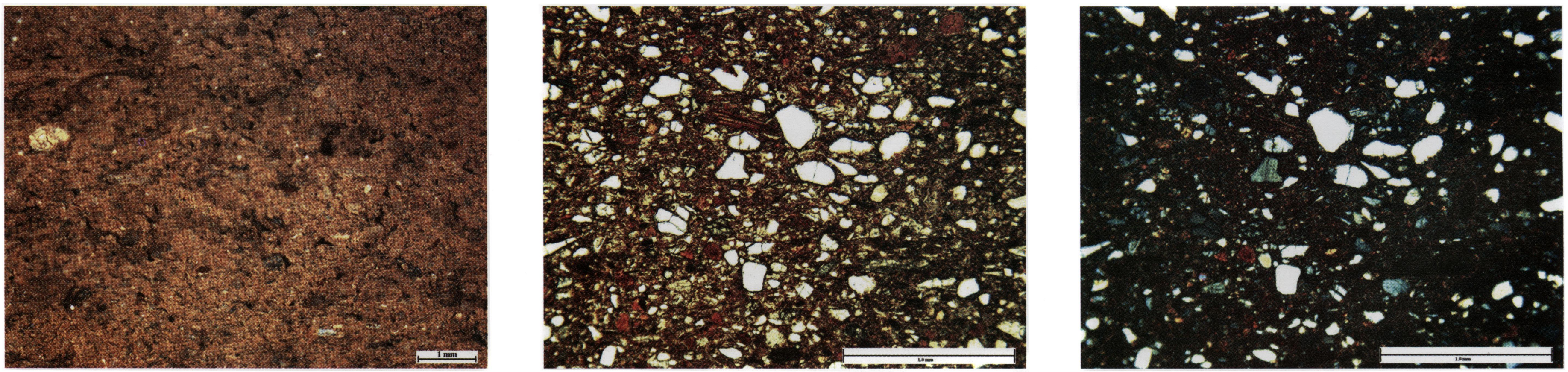


B. MO4: Nile B2, GN4, white slipped carinated bowl.

Samples MO3 and MO4. Fresh break (left), PPL (middle), and XPL (right) images at 40x magnification.

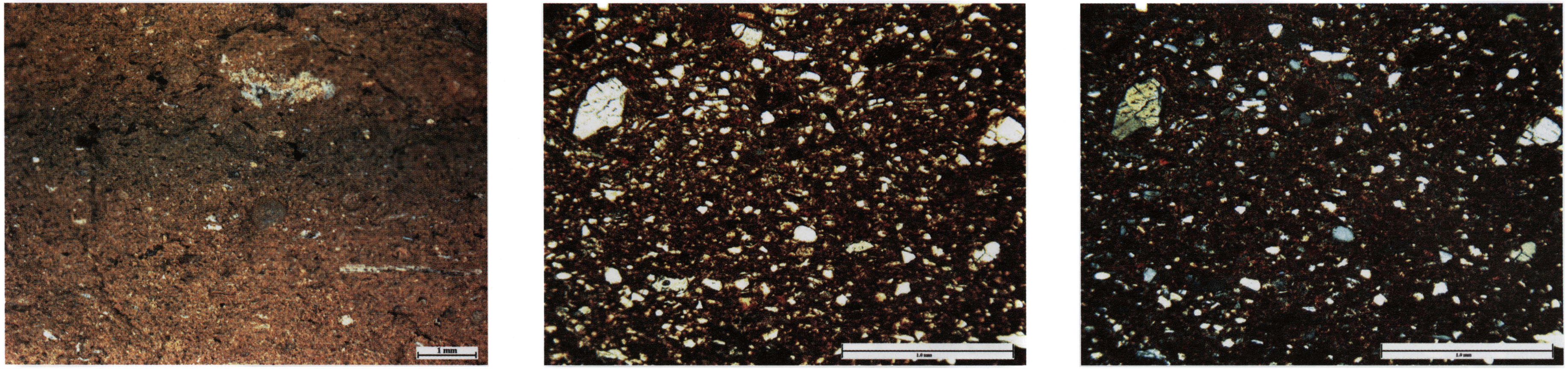


A. MO5: Nile B1, GN2, red-slipped slightly carinated bowl.

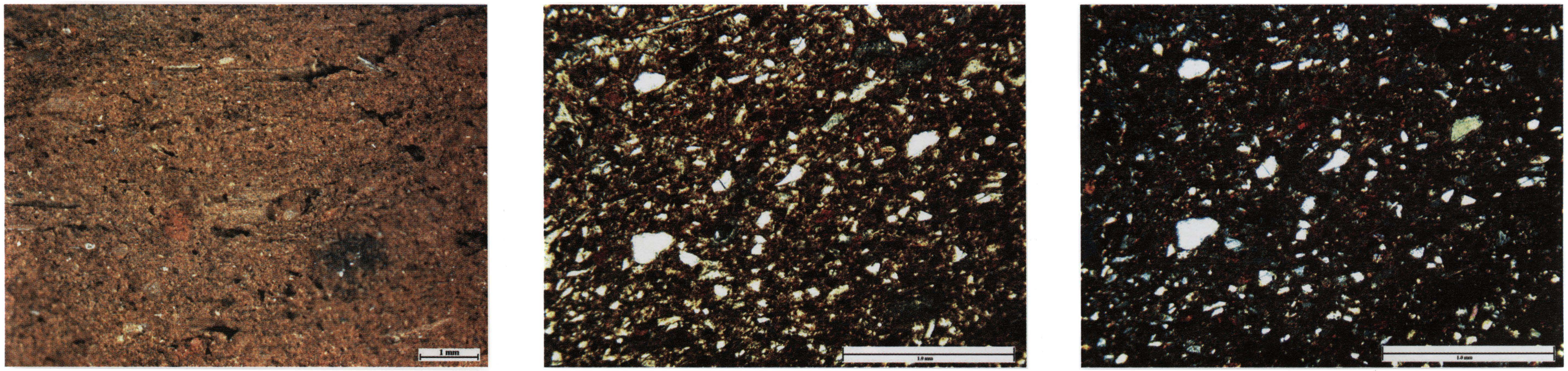


B. MO6: Nile B1, GN3, red-slipped slightly carinated bowl.

Samples MO5 and MO6. Fresh break (left), PPL (middle), and XPL (right) images at 40x magnification.

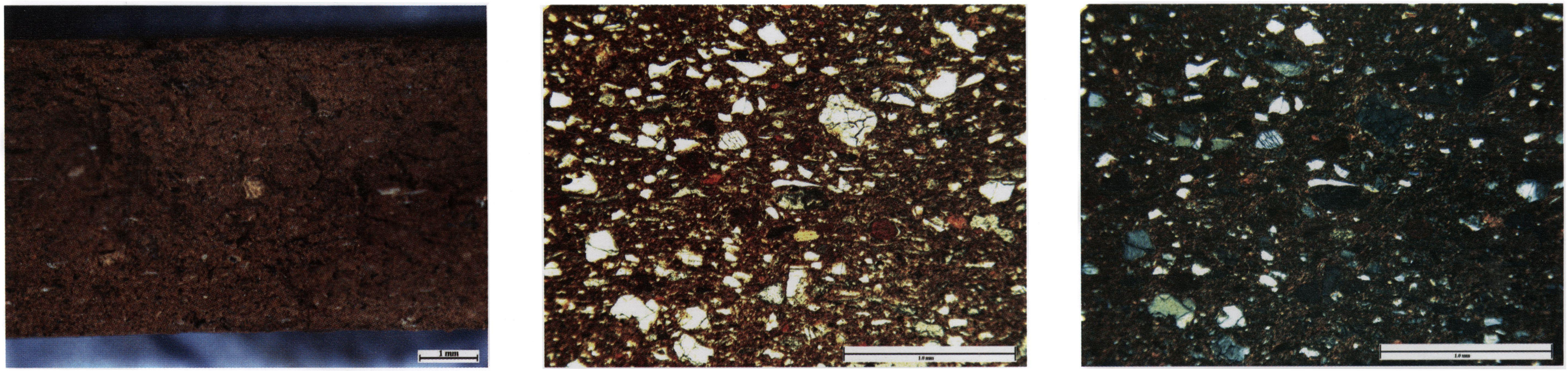


A. MO7: Nile B2, GN4, red-slipped ledge-rim bowl.

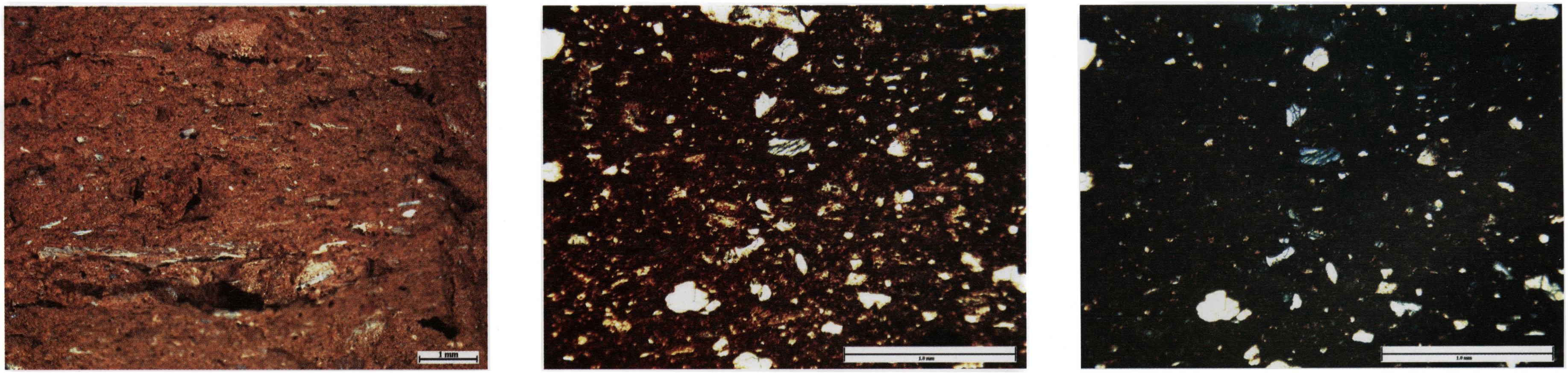


B. MO8: Nile B2, GN6, red-slipped plate.

Samples MO7 and MO8. Fresh break (left), PPL (middle), and XPL (right) images at 40x magnification.

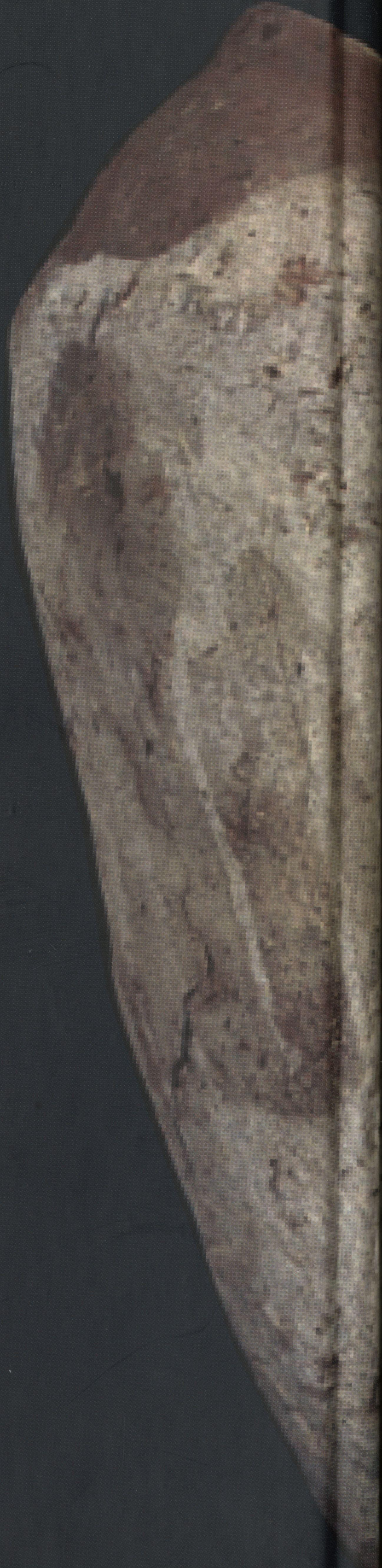


A. MO9: Nile B2, GN6, red-slipped „Meydum" bowl.



B. MO10: Nile B2, GN7, unslipped plate.

Samples MO9 and MO10. Fresh break (left), PPL (middle), and XPL (right) images at 40x magnification.



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