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A case study for an archaeometric characterisation of Sicilian Middle Bronze Age pottery (15th-13th c. BC)

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1. Introduction

The Middle Bronze Age (MBA) in Sicily (15th–13th c. BC) represents a crucial moment in the evolution of prehistoric pottery production. However, the scarcity of specific petrographic and chemical studies has represented until now a serious interpretative handicap for archaeologists (Jones, Levi 2004). The recent study of an important MBA pottery complex from the site of Grotte di Marineo (Licodia Eubea, Catania), on which petrographic and geochemical analyses – Optical Microscopy (OM), X-Ray Fluorescence (XRF), Fourier Transform Infrared Spectroscopy (FTIR) – were conducted, offered the possibility to add significant new data in this field. The analyses, carried out on a group of diagnostic samples representing the 13% of the entire complex, allowed to obtain precise characteristics of six fabrics that surpassed the misleading identification based on the simple autoptic examination. For each fabric the firing temperature was established, pointing out that 900° C was already reached at the beginning of the MBA. A constant relationship was found between fabrics and certain chronological sub-phases and shape types, lighting up some technological and cultural traits about the pottery production of this period, totally unknown before this work.

2. The MBA pottery production in the territory of Catania

The main open problem of the archaeological research on Sicilian prehistoric pottery is the lack of data about technological traits of the production and the petrographic and geochemical characteristics. If some relevant works have been published about the Neolithic (Barone et al. 2010), the Early Bronze Age (Agodi et al. 2000) and the Iron Age (Kolb, Speakman 2005; Pappalardo et al. 2008), the scenario for the MBA (mid-15th – mid-13th c. BC) is rather scarce with just an exception represented by the studies on the pottery production of the Aeolian Islands (Levi, Jones 2005; Williams, Levi 2001).

The Sicilian MBA, corresponding with the Thapsos Culture, from the name of the eponymous site in the Peninsula of Magnisi (Orsi 1895; Voza 1972; 1973), has a chronological development different from that of the Italian Peninsula, as clarified in **Table 1**. Pottery production of this period shows a certain degree of experimentalism bringing to a prominent technical evolution that firmly established some standards in every phase of the operation chain, from clay selection to manufacture, from decoration to firing.

The arrival of Late Helladic (LH) IIIA/IIIB Mycenaean and Cypriote fine wares in Sicily can be identified as a turning event that affected the behaviour of local artisans, inspiring them to further achievements (La Rosa 2004). The technical superiority of Mycenaean pottery production (French, Tomlinson 2004) and its appreciation among the natives of those areas of Southern Italy and Sicily (van Wijngaarden 2002), interested in the Mycenaean commerce, brought to the phenomenon of local production of Mycenaean pottery known as Italo-Mycenaean (Bettelli 2002; Buxeda i Garrigós et al. 2003) and Sicano-Mycenaean (Tanasi 2005; Jones, Levi 2004), as an alternative to the limited number of imports (Vagnetti 1999).

The repertoire and the traits of Thapsos pottery are mainly known thanks to the explorations of several cemeterial contexts of the territory of Siracusa carried out by Paolo Orsi between the end of the 19th and the first decade of the 20th c. (Leighton 1986). Since the work of Orsi did not focus so much on the territory of Catania, with an exception represented by the excavation of the prehistoric site of Barriera (Orsi 1907; Procelli 2007), it has not been possible to undertake any interpretative analysis about Thapsos pottery production in this area. Just in the past decade, thanks to new research (Procelli 1992; Privitera 2010) and excavations both in Catania (Branciforti 1999; Tanasi 2010) and its municipalities, such as Valverde (Branciforti 1999) and Caltagirone (Tanasi 2008), new discoveries contributed to the definition of a peculiar production of 'Aetnean Thapsos pottery' that can be clearly distinguished from the traditional 'Siracusan Thapsos pottery.'

The present paper is part of a more articulated research project on the typological, stylistic and technical analysis of the Thapsos pottery of the territory of Catania, where for the first time great emphasis is given to the archaeometric characterisation of ceramic materials (Barone et al. 2011a; 2012a).

Table 1. Comparative chronological chart of the Early and Middle Bronze Ages in Sicily, Southern Italy and the Aegean.
Tab. 1. Porównawczy diagram chronologiczny wczesnej i środkowej epoki brązu na Sycylii, w południowej Italii i Egei.

Chronology	Sicily		Southern Italy	Aegean
ca. 2200/2100–1440/1420 BC	Early Bronze Age	Castelluccio	Early Bronze Age 1–2 Middle Bronze Age 1–2	MH – LH II
1440/1420–1400/1380 BC	Middle Bronze Age	Thapsos I	Middle Bronze Age 3 (Apennine)	LH IIIA1
1400/1380–1310/1300 BC		Thapsos II		LH IIIA2
1310/1300–1270/1250 BC		Thapsos III	Late Bronze Age 1 (Sub-Apennine)	LH IIIB1

Fig. 1. Plan of the suburban area of Grammichele and Monte Marineo (D. Tanasi).
Ryc. 1. Plan obszaru podmiejskiego Grammichele i Monte Marineo.

3. The prehistoric site of Grotte di Marineo, Licodia Eubea (Catania)

The site of Grotte di Marineo is located on the northern slope of Mount Marineo, that is in the administrative territory of the town of Licodia Eubea, even if it is closer to the town of Grammichele (**Fig. 1**). The site, explored by the Superintendence of Cultural and Archaeological Goods of Catania (*Soprintendenza per i Beni Culturali ed Archeologici di Catania*) between 1988 and 1989 (Consoli 1988–1989), consists of four natural caves, three of which are state property (Caves 1, 2 and 4), while the fourth (Cave 3) is in private property (*proprietà Cucuzza*).

Fig. 2. Marineo, Cave 1, stratigraphic deposit (Photo D. Tanasi).
Ryc. 2. Marineo, jaskinia 1, depozyt stratygraficzny.

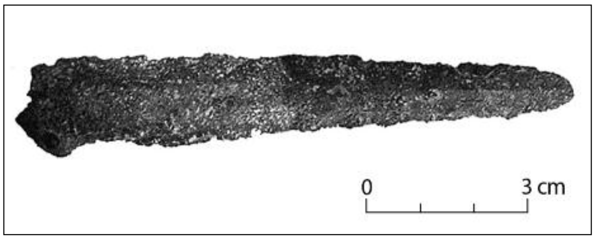

Fig. 3. Bronze dagger MA88/215 from Cave 1 (Photo D. Tanasi).
Ryc. 3. Sztylet brązowy MA88/215 z jaskini 1.

Caves 1 and 3 produced the most relevant data, although the excavations were not carried out following the stratigraphic criteria, and without proper graphic and photographic documentation (**Fig. 2**). The pottery found testified to a continuous occupation from the Neolithic (Diana facies) to the 6th c. BC, with a gap just in the Late Bronze Age (North Pantalica facies).

The main MBA contexts were represented in Test Pit 2 (Layers 2–4) and Test Pit 3 (Layer 2) in Cave 1 and Test Pit 1 (Layers 4 and 5) in Cave 3, from which come relevant finds, such as the bronze dagger MA88/215 (**Fig. 3**), and the basalt casting mould MA88/321 (**Fig. 4**).

To infer a hypothesis about the use of the caves of Grotte di Marineo during the MBA could be rather risky both for the absence of a scientific method of excavation and for wide ranges of problems concerning the interpretation of the cave use.

The function of caves in prehistory is often interpreted in utilitarian terms as short-term residential sites, mainly based on traces in the archaeological record of food preparation and production of lithic artefacts (Bersgsvik, Skeates 2012). But caves were also arenas for social aggregations (Conkey 1980) and 'natural places' that offered access to the world of ancestors, gods and the dead, being well suited for liminal rituals and communication with those entities (Bradley 2000; Skeates 2010). Caves could also host rituals commonly performed elsewhere in the open air but, as places of natural wonder, they amplified magical powers and were more apt for special performances (Skeates 2012). Burials, primary or secondary are also very common in prehistoric caves in the Mediterranean. However, what archaeologists generally call 'burials' in caves can result from natural and cultural, ritualistic and non-ritualistic processes, including death by accident, murder, human sacrifice and post-funerary rituals (Mouret 2004).

A few other MBA cave sites known in eastern Sicily, such as Chiusazza (Tinè 1965), Calafarina (Orsi 1907), Gisana (Guzzardi 1985–1986) and Barriera (Orsi 1907), offer a scenario of both ritual and funerary use. In the case of Grotte di Marineo, we could suggest that the use was mainly ritual, since there are no traces of burials or activities related to dwelling.

4. The MBA ceramic complex of Grotte di Marineo

The study of pottery has brought to the selection of 221 diagnostic samples that were classified through an autoptic analysis into three groups (**Fig. 5**): Group 1, attested for 22%, is fine, hard and compact, with clay paste colour between 2.5 YR 7/3 and 7.5 YR 5/2 and few grits smaller than 0.25 mm; Group 2, attested for 30%, is semi-fine, hard and compact, with clay paste colour between 5 YR 6/6 and 10 Y 6/1 and many grits measuring between 0.25 mm and 1 mm; Group 3, attested for 48%, is coarse, soft and porous, with clay paste colour between 2.5 YR 7/6 and 5 YR 4/4 and many grits larger than 1 mm.

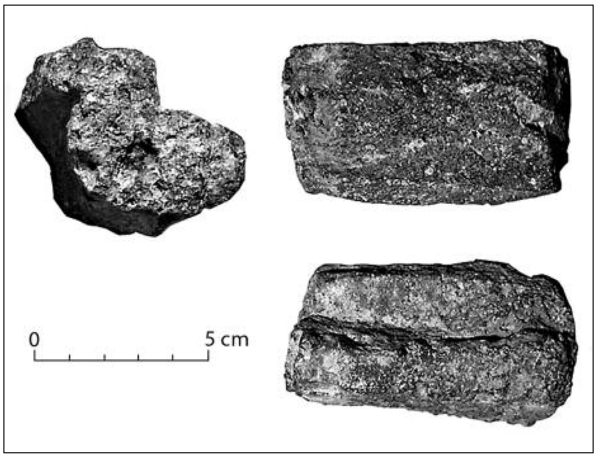

Fig. 4. Basalt casting mould MA88/321, from Cave 1 (Photo D. Tanasi).

Ryc. 4. Bazaltowa forma odlewnicza MA88/321 z jaskini 1.

Based on the type and frequency of the grits, Group 1 and Group 2 were both split into four subgroups (1A, 1B, 1C, 1D and 2A, 2B, 2C, 2D) and Group 3 into two subgroups (3A and 3B) (**Fig. 6, Table 2**).

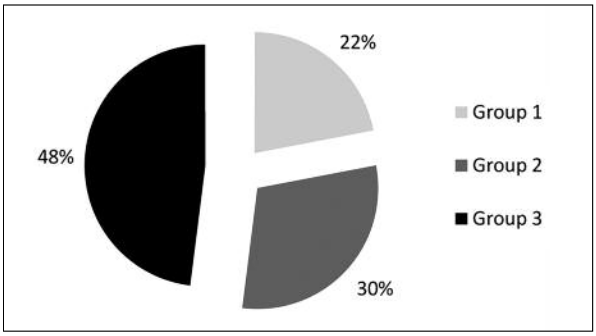

Fig. 5. Chart indicating the pottery groups' percentage.

Ryc. 5. Diagram ukazujący odsetek grup ceramiki.

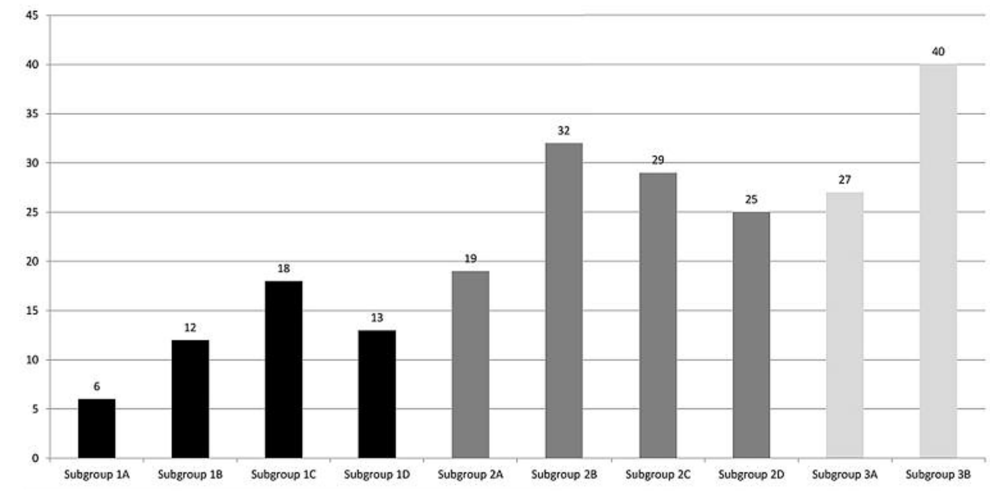

Fig. 6. Chart indicating the subdivision of three main groups into further subgroups observable on a selection of 221 samples.

Ryc. 6. Diagram ukazujący podział trzech głównych grup na dalsze podgrupy, obserwowalne na wybranych 221 próbkach.

Table 2. Different occurrence of grits (tempers) in groups and subgroups, based on autoptic analysis.
Tab. 2. Różnice w występowaniu ziaren piasku (domieszki) w grupach i podgrupach, na podstawie analizy makroskopowej.

Groups	**1 (fine)**				**2 (semi-fine)**				**3 (coarse)**	
Subgroups	1A	1B	1C	1D	2A	2B	2C	2D	3A	3D
Calcareous	×	×	×	×	×	×	×		×	×
Volcanic	×				×	×	×	×	×	×
Volcanic glass			×							×
Chamotte				×	×					
Pebbles							×			×
Quartz		×				×	×		×	×

An exception to this categorisation is represented by the single piece MA88/443, a cup decorated with plastic rope bands, showing volcanic sand, clay paste colour 10 YR 6/3, slip colour between 10 YR 8/1 and 10 YR 6/6, and burnished surface that resembles directly some fabrics attested in the Catania city, on Montevergine Hill and Barriera (Privitera 2007: 271) and at Monte San Paolillo (Tanasi 2010).

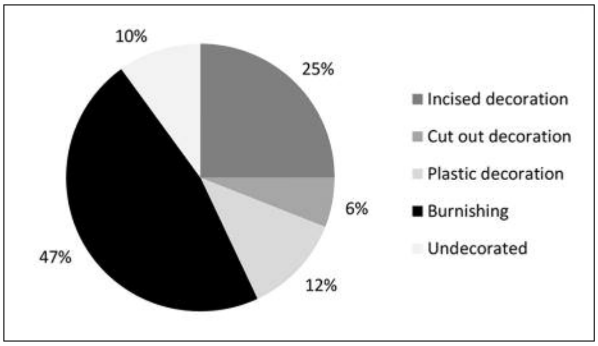

Fig. 7. Chart indicating the share of decoration techniques.
Ryc. 7. Diagram ukazujący udział procentowy technik dekoracyjnych.

With regard to decoration techniques (**Fig. 7**), a half of the samples is just burnished, while few ceramics are undecorated. There is also a low percentage of surfaces which also have incisions, excisions and reliefs. Such traits are traditionally much more diffused in the Thapsos pottery of the territory of Siracusa. Definitely rare is the slip, that, when present, has been applied both through full immersion and the use of a brush. Pattern burnishing is also uncommon. It is present on specimens MA88/45 and MA88/440. Thanks to the good condition of some pottery, it was also possible to identify the use of a white paste for fill-ing the grooves left by incision and excision (MA88/160), as a secondary decoration, being attested mainly at the site of Thapsos, in the Magnisi Peninsula.

Concerning the process of pottery forming, in several cases digital and palm prints and traces of tools' use with a V- or U-shaped point sections (MA88/284) were observed (**Fig. 8**), as well as some examples of wheel-made pottery fragments were identified (MA88/163).

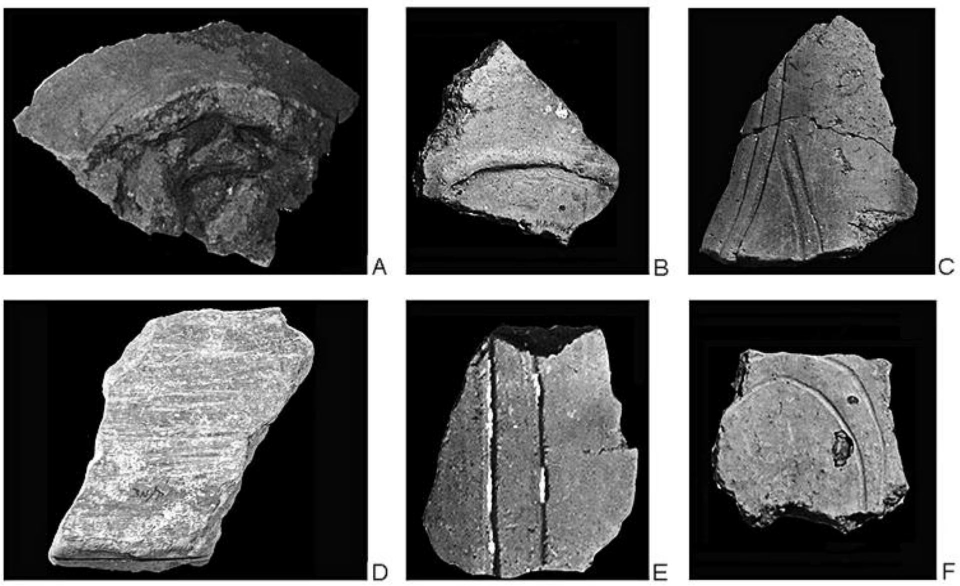

Fig. 8. Traits of Thapsos pottery: A – finger and palm prints; B – palette tool signs; C – incisions with 'U-' and 'V-shaped' sections; D – traces of shaping on the potter's wheel; E – filling with white paste; F – superficial voids and cracks (Photo D. Tanasi).
Ryc. 8. Cechy ceramiki Tapsos: A – odciski palców i dłoni; B – znaki narzędzia paletowego; C – nacięcia o przekrojach U- i V-kształtnych; D – ślady toczenia na kole garncarskim; E – wypełnienie białą pastą; F – powierzchniowe luki i pęknięcia.

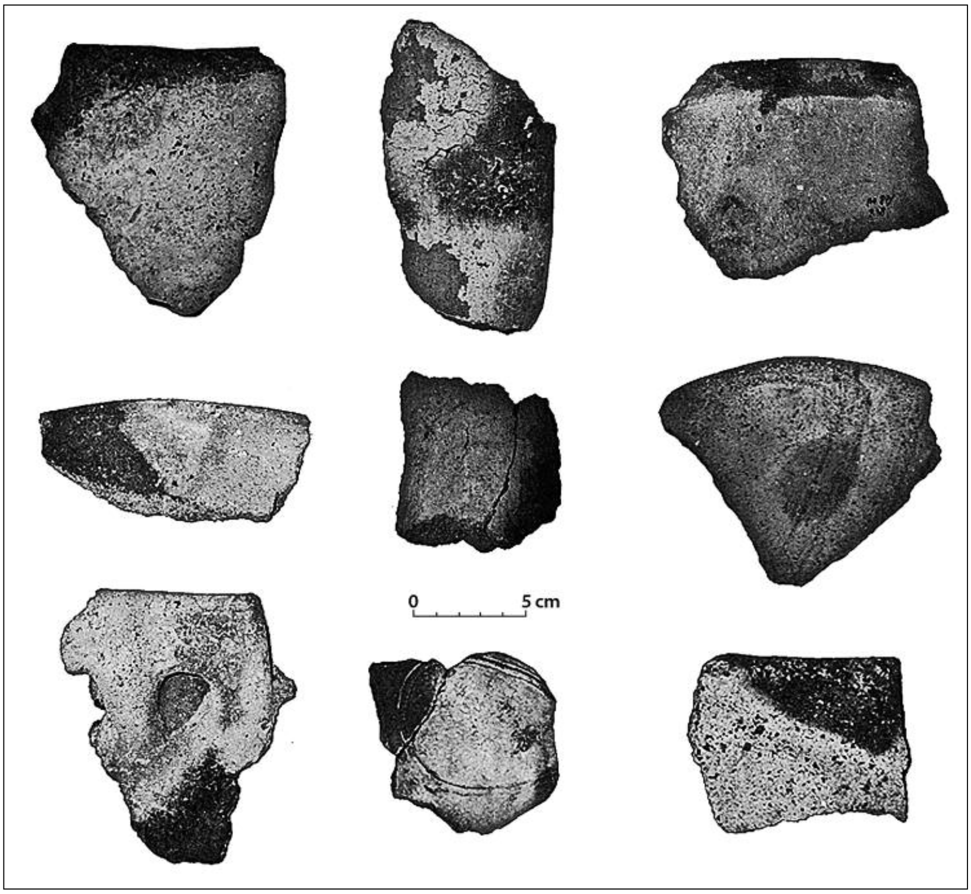

Fig. 9. Black blotches due to firing on Thapsos pottery from Marineo (Photo D. Tanasi).

Ryc. 9. Czarne plamy powstałe w efekcie wypału na ceramice Tapsos z Marineo.

A peculiarity is represented by the high percentage of minced seashell added to the fabric of the cup MA88/135, maybe testifying to particular productive strategies followed by the potters.

In the larger vessels, such as the basin MA88/156, by the base it is possible to detect superimposed and distinct layers of not properly amalgamated clay on the section of the wall to, as it appears in some Thapsos pithoi from Monte San Paolillo (Barone et al. 2011b).

Black blotches due to burning are also present in 50% of the samples (**Fig. 9**), which is maybe related to the firing method and kiln type.

Finally, repair holes are present on 18% of the samples, still indicating a low technical level of production or maybe the impossibility of replacing broken vessels due to a distance from the production centre.

With regard to shapes (**Fig. 10**), the most significant element is a high presence of open vessels: cups and basins are significantly present while scarcely attested are pouring and dipping vessels, as well as plates and bowls. On the other hand, jars usually coming with discoid lids and cooking pots are numerous. In general, simple and pedestal cups are of Groups 1 and 2, while jars, cooking vessels and sometimes basins belong to Group 3.

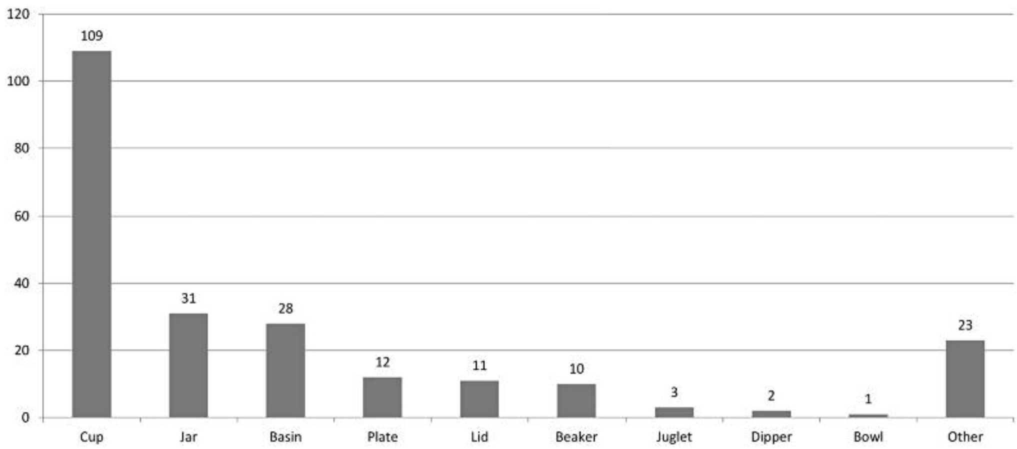

Fig. 10. Chart indicating the presence of individual shapes within the typological groups.

Ryc. 10. Diagram ukazujący obecność poszczególnych kształtów w obrębie grup typologicznych.

Leaving apart the two tokens (MA88/171, MA88/273) and the spindle whorl MA88/274, all the ceramic material was ordered according to a typological sequence. Since bowls, jugs and lids were represented by too fragmentary specimens, it was possible to distinguish typological classes just for cups, plates, basins and jars, still representing the largest part:

– Cup of Type I: hemispheric and deep body with thinned rim (MA88/122, MA88/128, MA88/458, MA88/452), sometimes marked by a horizontal groove (MA88/39) and with lip slightly inverted (MA88/14), usually undecorated or with incised decoration (**Fig. 11**).
– Cup of Type II: hemispheric and shallow body with inverted rim, with simple flat base of conical pedestal and plastic decoration with curvilinear rope bands (MA88/255–256, MA88/119) (**Fig. 12**).
– Cup of Type III: conical body with inverted and rounded (MA88/126) or triangular rim (MA88/18) (**Fig. 13**).
– Cup of Type IV: slightly carinated body with straight (MA88/26), slightly inverted (MA88/104, MA88/249) or inverted (MA88/01, MA88/451) rim (**Fig. 13**).
– Cup of Type V: carinated body with rim distinct by a horizontal groove (MA88/317) (**Fig. 13**).
– Cup of Type VI: carinated body, with rounded inverted lip (MA88/280) (**Fig. 13**).
– Plate of Type I: carinated body with straight (MA88/167), inverted (MA88/28) or everted rim (MA88/89), usually with incised decoration (**Fig. 14**).
– Basin of Type I: hemispheric body with straight rounded rim and horizontal lug handles (MA88/110, MA88/254) (**Fig. 15**).
– Basin of Type II: conical body with straight thinned rim, and plastic decoration with ripe bands (MA 88/253) (**Fig. 15**).
– Basin of Type III: globular body with pointed handles ('anse cuspidate') (MA88/163); shape identifiable just from the discovery of the typical pointed handle.
– Jar of Type I: hemispheric body with indistinct thickened rim (MA88/459) (**Fig. 16**).
– Jar of Type II: conical body with inverted rim and a couple of lug handles (MA88/117) (**Fig. 16**).
– Jar of Type III: globular body with everted and thinned rim (MA88/444), sometimes marked by a rope band (MA88/447) (**Fig. 16**).
– Jar of Type IV: globular body with low distinct neck and everted rim with flattened lip (MA88/154) (**Fig. 16**).

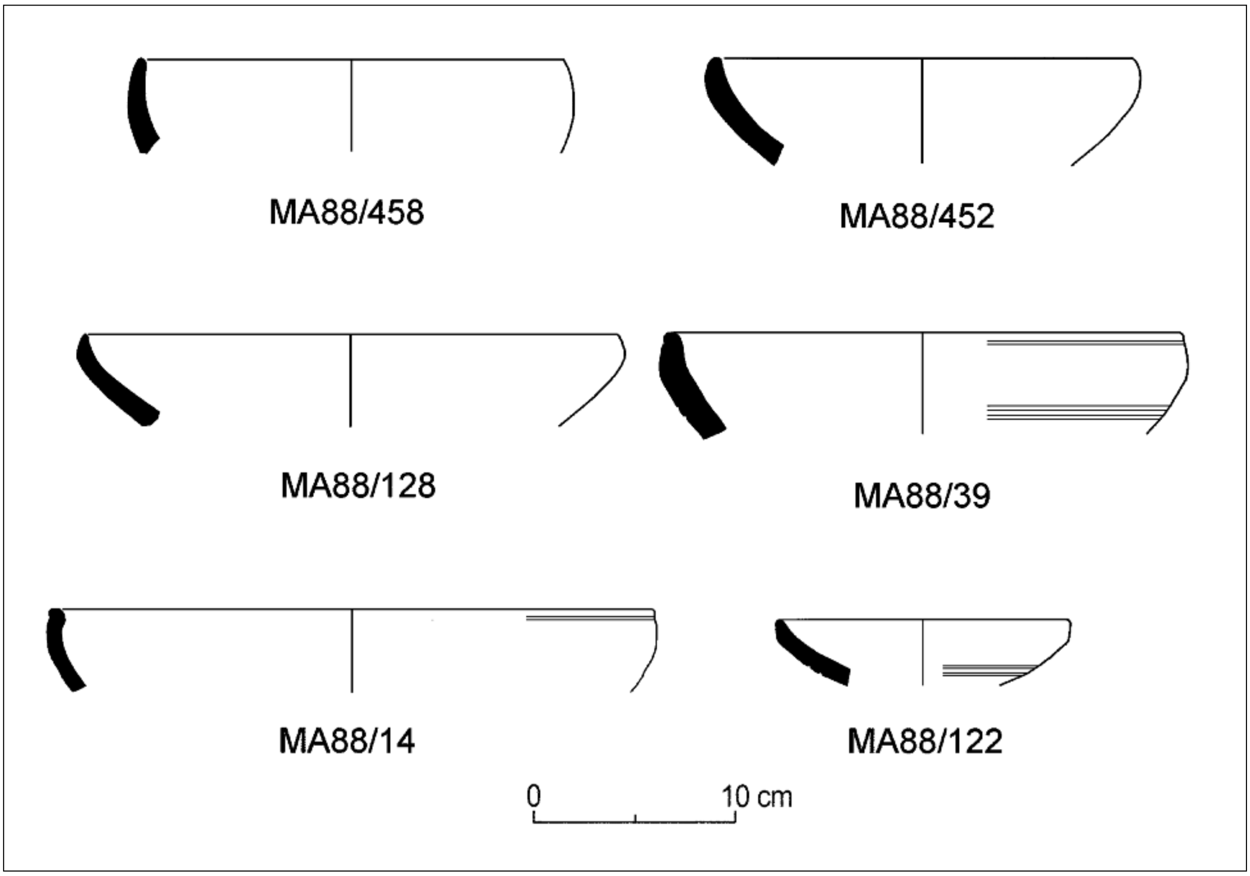

Fig. 11. Cups of Type I (Drawing D. Calì).
Ryc. 11. Czarki typu I.

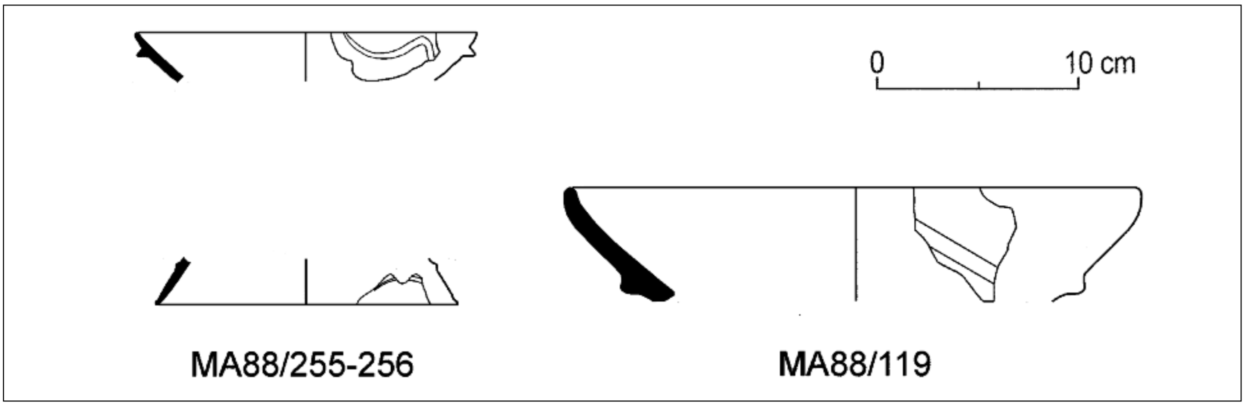

Fig. 12. Cups of Type II (Drawing D. Calì).

Ryc. 12. Czarki typu II.

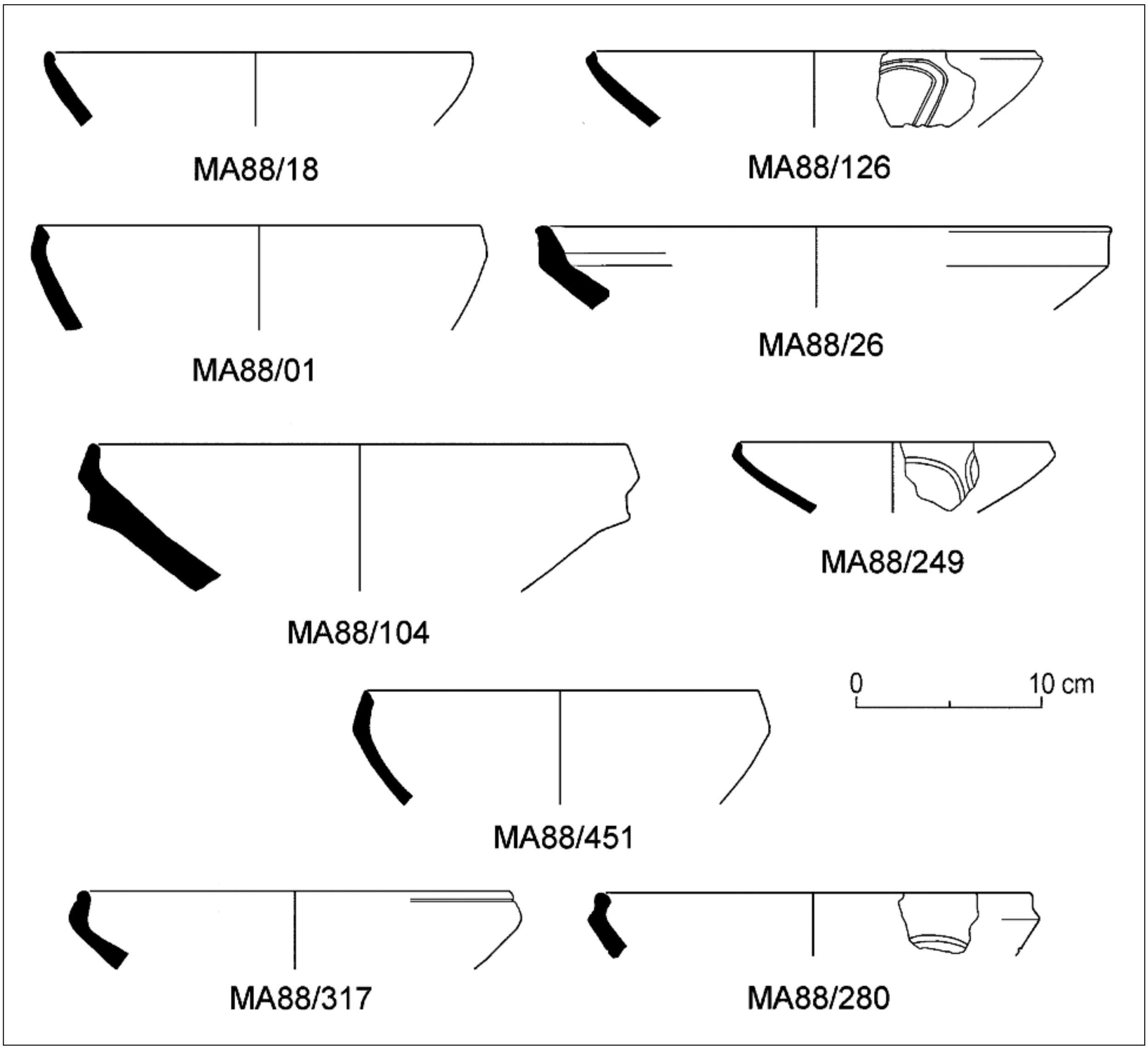

Fig. 13. Cups of Type III: MA88/18, MA88/126; of Type IV: MA88/01, MA88/26, MA88/104, MA88/249, MA88/451; of Type V: MA88/317; of Type VI: MA88/280 (Drawing D. Calì).

Ryc. 13. Czarki typu III: MA88/18, MA88/126; typu IV: MA88/01, MA88/26, MA88/104, MA88/249, MA88/451; typu V: MA88/317; typu VI: MA88/280.

Before the discussion about the chronological classification of each type, it is noteworthy that the system of reference used is that set up by G. Alberti (2004; 2008). The types identified at Grotte di Marineo have several parallels in the traditional Thapsos repertoire. Contexts providing better comparisons are Serra del Palco di Milena (La Rosa, D'Agata 1988), Scirinda (Castellana 2000) and Monte San Paolillo (Tanasi 2010). In particular it could be useful to compare the cups and basins of Grotte di Marineo with those discovered at Monte San Paolillo, the site that, with its evidence, has greatly contributeed to raising the problem of the existence of Aetnean Thapsos pottery.

The cup of Type I (MA88/122, MA88/128, MA88/452) resembles Type CA 75 of Monte San Paolillo; the cup of Type III (MA88/18, MA88/86) can be compared with examples CA 77 and CA 50 (Tanasi 2010: 86, fig. 11).

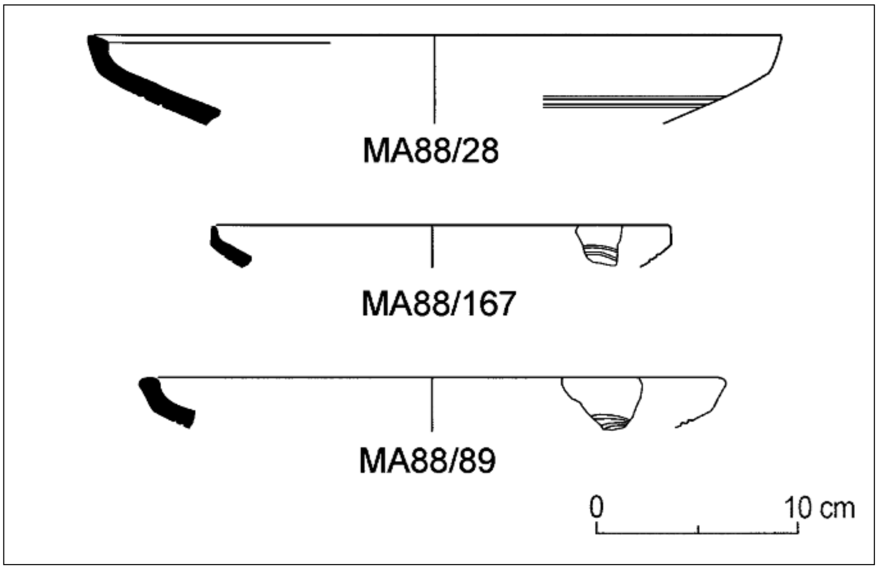

Fig. 14. Plates of Type I (Drawing D. Calì).

Ryc. 14. Talerze typu I.

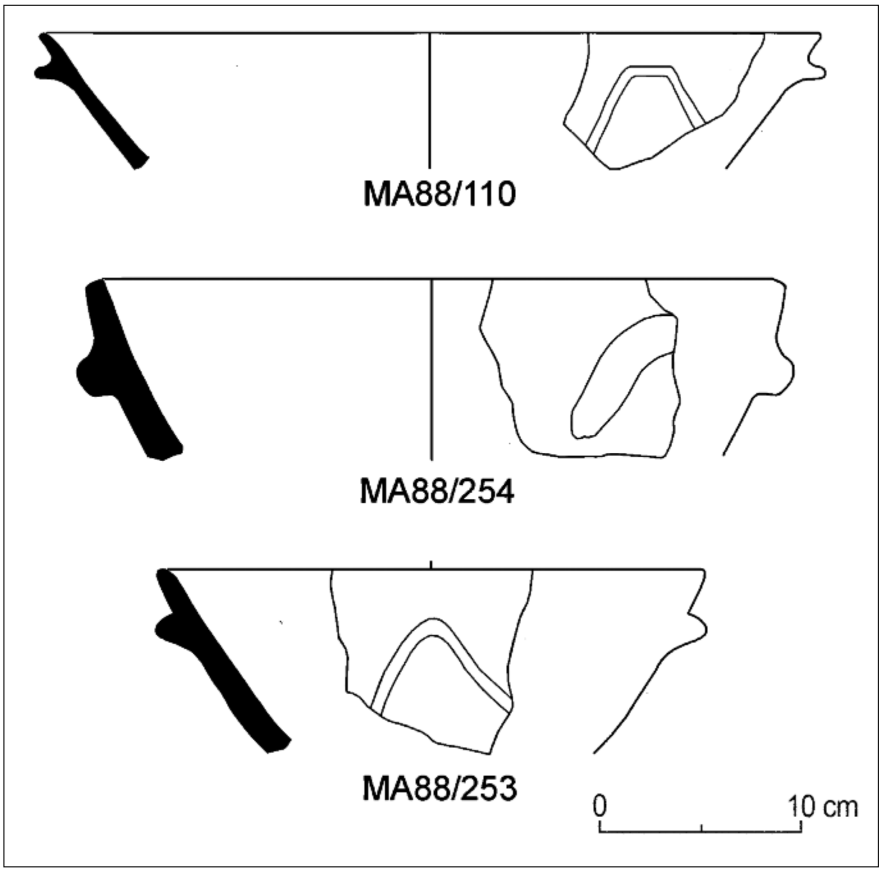

Fig. 15. Basins of Type I: MA88/110, MA88/254; of Type II: MA88/253; (Drawing D. Calì).

Ryc. 15. Misy typu I: MA88/110, MA88/254; typu II: MA88/253.

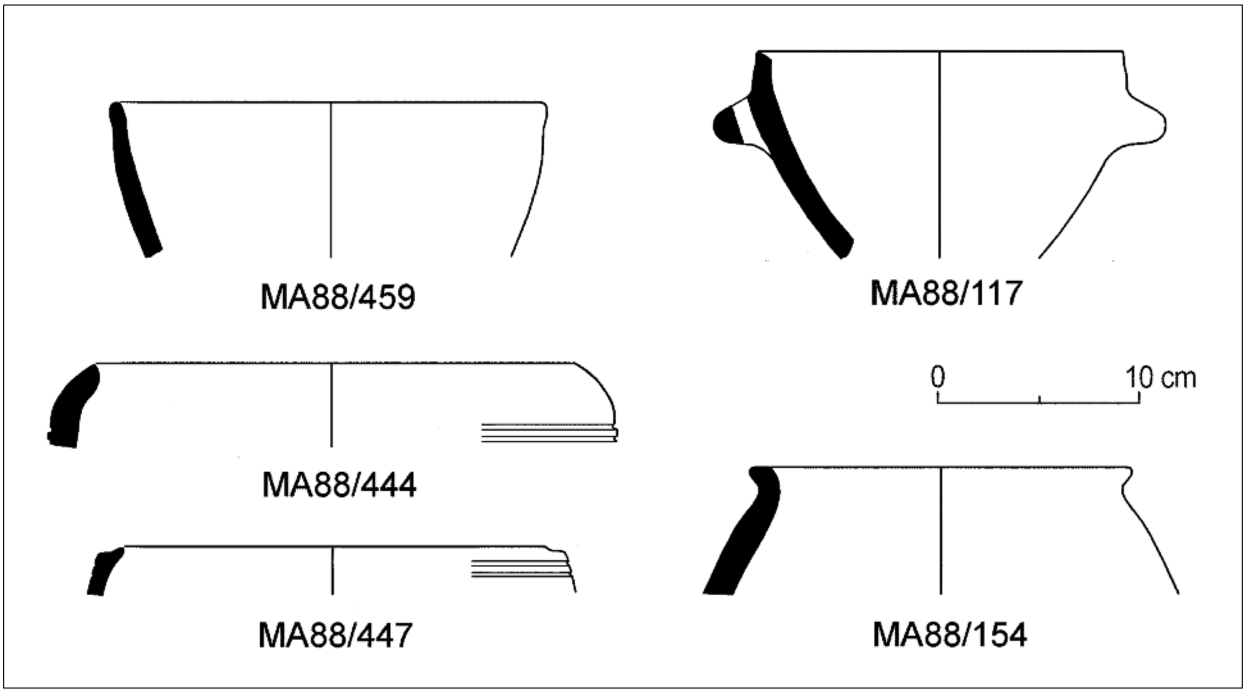

Fig. 16: Jars of Type I: MA88/459; of Type II: MA88/117; of Type III: MA88/444, A88/447; of Type IV: MA88/154 (Drawing D. Calì).
Ryc. 16. Dzbany typu I: MA88/459; typu II: MA88/117; typu III: MA88/444, MA88/447; typu IV: MA88/154.

The cup of Type IV (MA88/451) has a parallel in CA 66; the cup of Type VI (MA88/280) resembles CA 111, and the basin of Type II (MA88/248, MA88/253) is similar to CA 110 (Tanasi 2010: 86, fig. 11). For providing other chronological links, it can be stated that the cup of Type II (MA88/255–256, MA88/119) has the same traits of Type CP I in Alberti's seriation of MBA pottery from Aeolian Islands, dated to Phase Thapsos I; the cup of Type IV (MA88/249) resembles Type CP V of the same seriation that is dated to Thapsos II–III; the jar of Type IV (MA88/154) again is comparable to the jar OL IIa–c in the same seriation that is dated to Thapsos II–III (Alberti 2008: pl. 29).

Finally, of great interest is the fragmentary preserved basin of Type III (MA88/163), which features are alien to MBA repertoire and are closer to traits of the following pottery production of the North Pantalica Period (Tanasi 2008).

Without precise stratigraphic data, based on the outcome of the typological analysis it can be inferred that the occupation of the site lasted for all the three sub-phases of the Thapsos Period, as testified to by the chronological interpretation of the main types (**Table 3**).

Table 3. Chronological chart with main pottery types distinguished in the three phases of the Thapsos Period.
Tab. 3. Diagram chronologiczny z głównymi typami ceramiki wyróżnionymi w trzech fazach okresu Tapsos.

<table>
<tr><td>Thapsos I
(1440/1420–1400/1380 BC)</td><td>Cup of type II
(MA88/255, MA88/256, MA88/119)</td><td rowspan="2">Cup of type VI
(MA88/280)
Basin of type II
(MA88/248, MA88/253)
Cup of type III
(MA88/18, MA88/126)</td><td></td></tr>
<tr><td>Thapsos II
(1440/1380–1310/1300 BC)</td><td></td><td rowspan="2">Jar of type IV
(MA88/154)</td></tr>
<tr><td>Thapsos III
(1310/1300–1270/1250 BC)</td><td>Cup of type I
(MA88/122, MA88/128, MA88/452)
Cup of type IV
(MA88/86, MA88/451)
Basin of type III
(MA88/163)</td><td></td></tr>
</table>

5. Petrographic and geochemical analysis

In order to test the interpretative hypotheses about technology based on the autoptic examination and to provide some new data about the archaeometric characteristics of MBA pottery, which are – as stated above – completely missing, 31 samples representing all the subgroups were selected. They underwent petrographic analysis (MO), geochemical analysis (XRF) and FTIR measurements.

Concerning the entry codes of the specimens, LE stands for Licodia Eubea; the first Arabic number (1, 2, 3) refers to the pertinence to a group; the letter indicates the subgroups and the second number differentiates the specimens (**Table 4**).

Petrographic observations permitted to distinguish and to characterise six fabrics (**Fig. 17**) according to the Whitbread (1995) classification: Fabric A – with inclusions formed by abundant limestone and fossiliferous groundmass (LE1B, LE1B1, LE1B2); Fabric B – with inclusions formed by volcanic glass (LE2B2, LE1A and LE2B) and occasionally by other volcanic fragments (LE1A) or limestone (LE2B), the groundmass is scarcely fossiliferous; Fabric C – with inclusion of volcanic glass and quartz and unfossiliferous groundmass (LE1C, LE1C1); Fabric D – inclusion formed by volcanic glass, volcanic fragments (LE2A) and limestone, the groundmass is fossiliferous (LE2C3, LE2A); Fabric E – characterised by the presence of grog together with volcanic glass and limestone (LE2C1), volcanic glass and rock fragments (LE1A1, LE1A2, LE1D, LE2B4, LE2D) and limestone (LE3B1). In all the samples the groundmass is fossiliferous (LE2C1) or abundantly fossiliferous; Fabric F – with volcanic glass, rock fragments and minerals (pyroxenes and plagioclases) and fossiliferous groundmass (LE1D1, LE2A1, LE2A2, LE2A3, LE2B1, LE2B3, LE2C, LE2C2, LE2D1, LE3A, LE3A1, LE3A3, LE3A2).

A distinguishable trait of most of the described fabrics is the presence of inclusions formed by volcanic fragments (more or less weathered glass, rock and minerals clasts) while the use of grog, widespread in the Ancient Bronze pottery of the neighbouring site of Ramacca (Agodi et al. 2000), is limited to Fabric E. Furthermore, the samples may be distinguished also on the basis of the quantity of fossils in the groundmass.

The inclusions and the groundmass are compatible with potential raw materials cropping out in the Licodia Eubea area (Grasso et al. 2004). In particular, the volcanic rock has the mineral composition and the structure close to that observed in the Plio-Pleistocene alkali basalts and tholeiites (Beccaluva et al. 1998; Di Grande et al. 2002) while the weathered volcanic glass resembles the Pliocene palagonitised submarine volcanites outcropping in Licodia Eubea's neighbouring (Honnorez 1967). Finally, the mudrocks of the Miocenic Tellaro Formation

Table 4. List of the sampled specimens with the typological attribution and relative chronology.
Tab. 4. Lista okazów, z których pobrano próbki, wraz z klasyfikacją typologiczną oraz chronologią względną.

Sample	Inv. No.	Typological attribution	Chronology
LE1A	MA88/216	Cup of Type III	Thapsos II
LE1A1	MA88/293	Cup of Type II	Thapsos I
LE1A2	MA88/407	Basin of Type I	Thapsos I
LE1B	MA88/255	Cup of Type II	Thapsos I
LE1B1	MA88/119	Cup of Type II	Thapsos I
LE1B2	MA88/280	Cup of Type VI	Thapsos I
LE1C	MA88/445	Cup of Type II	Thapsos I
LE1C1	MA88/177	Cup of Type VI	Thapsos I
LE1D	MA88/297	Cup of Type VI	Thapsos I
LE1D1	MA88/409	Cup of Type VI	Thapsos I
LE2D	MA 88/253	Basin of Type II	Thapsos II
LE2A	MA88/338	Cup of Type III	Thapsos II
LE2A1	MA88/401	Basin of Type II	Thapsos II
LE2A2	MA88/451	Cup of Type IV	Thapsos III
LE2A3	MA88/403	Cup of Type VI	Thapsos I
LE2B	MA88/128	Cup of Type I	Thapsos II–III
LE2B1	MA88/413	Cup of Type I	Thapsos II–III
LE2B2	MA 88/122	Cup of Type I	Thapsos II–III
LE2B3	MA88/421	Cup of Type VI	Thapsos I
LE2B4	MA88/306	Cup of Type VI	Thapsos I
LE2C	MA88/272	Cup of Type VI	Thapsos II
LE2C1	MA88/185	Cup of Type III	Thapsos II
LE2C2	MA88/445	Cup of Type I	Thapsos II–III
LE2C3	MA88/313	Cup of Type VI	Thapsos I
LE2D1	MA88/409	Cup of Type I	Thapsos II–III
LE3A	MA88/465	Basin of Type I	Thapsos I
LE3A1	MA88/248	Basin of Type II	Thapsos II
LE3A2	MA88/154	Jar of Type IV	Thapsos II–III
LE3A3	MA88/444	Basin of Type I	Thapsos I
LE3B	MA88/346	Cup of Type II	Thapsos I
LE3B1	MA88/18	Cup of Type IV	Thapsos III

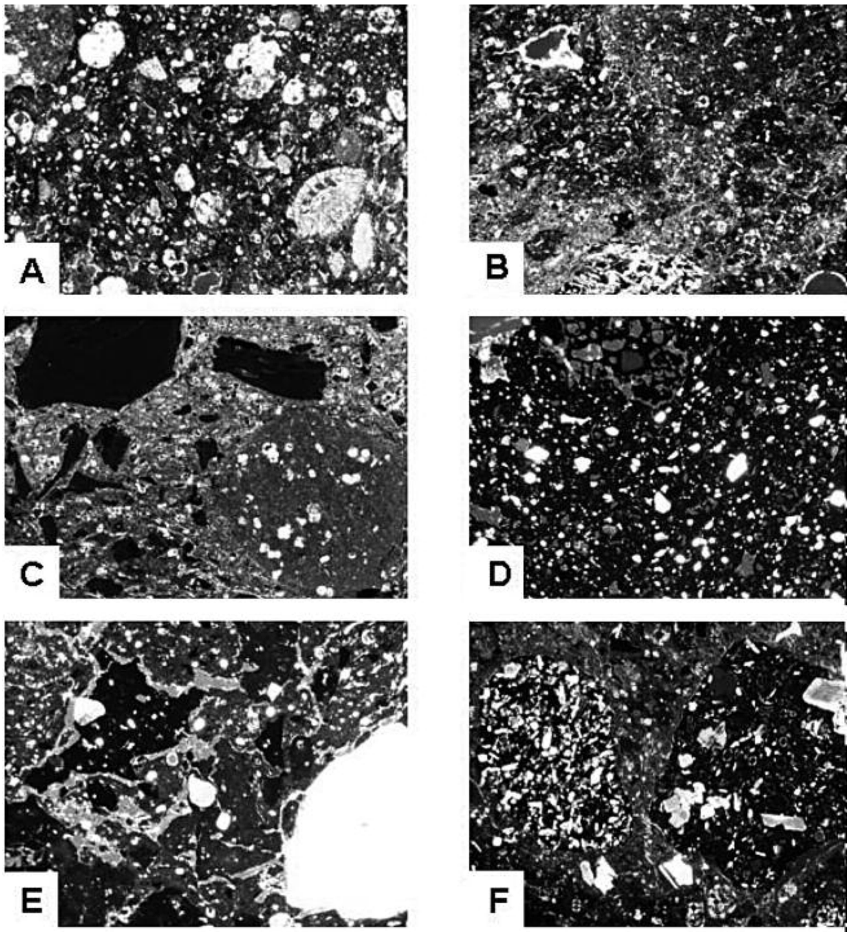

Fig. 17. Thin sections of the specimens belonging to the 6 identified fabrics: A – Fabric A (LE1B1); B – Fabric B (LE1A); C – Fabric C (LE2C3); D – Fabric D (LE1C1); E – Fabric E (LE2C1); F – Fabric F (LE2B3) (Photo D. Tanasi).

Ryc. 17. Szlify przezroczyste okazów wykonanych z 6 zidentyfikowanych materiałów: A – materiał A (LE1B1), B – materiał B (LE1A); C – materiał C (LE2C3); D – materiał D (LE1C1); E – materiał E (LE2C1); F – materiał F (LE2B3).

and/or the Quaternary alluvium may be recognised as clayey raw material.

Regarding optical activity, the samples belonging to Fabrics A, D and E (with the exception of LE3B1) have medium to high birefringence while it is low or absent in Fabrics B, C and F. This data may be used for the firing temperature estimate. In fact, low or absent birefringence is, in many cases, indicative of the achievement of high firing temperature when the reaction brings to modifications of the original mineralogical composition of the groundmass (mainly clay minerals and calcite) and to the formation of cryptocrystalline new phases (anorthite, diopside, wollastonite and gehlenite).

The results were compared with the semi-quantitative mineralogical composition obtained by previous X-Ray Diffraction (XRD) measurements and infra-red spectroscopy (FTIR) (Barone et al. 2012a).

Fabrics A, D and E underwent relatively low firing temperature (<800° C), as suggested by the medium-high optical activity and by the presence of clay minerals and abundant calcite. On the contrary, samples belonging to Fabrics B and C are characterised by low or absent optical activity and by the presence of higher temperatures CaO--silicates (~900° C). Finally, in the samples of Fabric F there are both calcite and Ca-silicates (800–900° C) (Barone et al. 2011a).

The chemical composition of the samples belonging to the six petrographic fabrics (A–F) is reported in **Table 5**. The data were processed using the statistical methodology mainly based on the log-ratio technique introduced by Aitchison (1986) and employed in order to avoid the constant sum problem; the centred log-ratio transformation (clr) of data is applied as follows:

$$x \in SD \rightarrow y = \ln (xD / gD (x)) \in RD$$

where x is the vector of the D elemental compositions, y is the vector of the log-transformed compositions, xD = (x1, x2, . . . , xD) and gD(x) = (x1·x2·. . .·xD)1/D.

This operation transforms the raw data from their constrained sample space, the simplex Sd (d = D – 1), into the real space Rd, in which parametric statistical methods can be applied to the transformed data. Subsequently, the clr-transformed data set was explored by biplots, a graphical representation of variables and cases projected on planes of principal components. Both the clr-transformation and the biplot calculations were obtained by using CoDaPack (Thió-Henestrosa, Martín-Fernández 2005), a compositional software program that implements the basic methods of analysis of compositional data based on log-ratios, following the methodology introduced by Aitchison (1986) widely used in archaeometric studies (Aitchison et al. 2002; Buxeda i Garrigós 1999; Barone et al. 2005; 2011c; 2011d; 2012b).

Table 5. Chemical composition of the samples belonging to the six petrographic Fabrics (A–F).
Tab. 5. Skład chemiczny próbek należących do sześciu materiałów petrograficznych (A–F).

fabric		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Sr	V	Cr	Co	Ni	Zn	Rb	Y	Zr	Nb	Ba	La	Ce
A	LE1B	39.09	0.33	11.18	2.05	0.03	0.94	30.39	0.37	2.98	0.28	678.1	39.9	51.7	16.9	52.1	46.7	32.7	15.0	91.5	11.4	178.6	31.0	43.0
A	LE1B1	39.02	0.33	11.19	2.05	0.03	0.89	30.70	0.36	2.94	0.26	688.0	37.5	52.5	15.1	52.5	44.5	31.4	14.9	89.9	12.0	205.1	30.6	66.3
A	LE1B2	38.64	0.34	11.51	2.16	0.03	0.98	32.50	0.37	3.19	0.26	722.0	38.3	54.4	16.3	55.5	45.0	33.3	15.7	90.5	10.7	205.0	26.7	52.6
B	LE2B2	54.70	0.74	32.79	6.38	0.08	2.56	13.29	1.04	3.91	0.53	658.9	86.6	99.5	30.9	44.0	78.1	94.8	26.7	160.1	18.5	455.7	30.5	79.0
B	LE1A	57.25	0.80	35.86	6.46	0.11	2.56	11.91	0.81	3.08	0.52	475.9	93.3	102.8	25.0	41.8	83.0	88.6	28.5	207.3	18.7	292.3	41.9	90.3
B	LE2B	55.04	0.76	34.88	6.59	0.08	2.84	12.85	0.77	3.82	0.47	692.8	83.8	106.2	30.1	46.6	85.0	100.2	28.3	172.6	20.1	347.5	36.5	89.6
C	LE1C	59.09	0.79	35.53	6.24	0.11	2.65	12.16	0.65	2.79	0.40	409.7	80.8	103.1	27.4	46.6	70.0	82.3	29.7	234.3	18.8	271.0	31.8	76.8
C	LE1C1	59.93	0.78	35.27	6.09	0.11	2.51	12.00	0.65	2.68	0.39	402.3	80.8	96.0	25.5	47.6	70.7	80.3	29.8	226.3	16.9	260.3	32.2	75.2
D	LE2A	55.50	1.02	27.73	7.43	0.12	3.23	14.75	0.77	2.00	0.69	520.5	86.5	137.6	37.9	92.6	65.3	51.0	28.1	197.1	34.7	331.7	41.8	105.6
D	LE2C3	49.99	0.85	20.05	5.80	0.08	2.34	18.55	0.84	2.93	0.30	557.8	56.2	113.6	36.1	81.0	65.3	33.7	17.6	95.5	12.3	130.1	25.3	61.3
E	LE2C1	50.71	0.60	25.98	4.34	0.06	1.62	20.63	0.49	3.56	0.23	509.7	83.6	85.6	25.6	46.9	55.3	67.6	26.2	143.1	16.9	290.4	32.2	77.7
E	LE3B	48.31	0.48	20.75	3.44	0.04	1.64	21.48	0.27	3.33	0.34	665.9	59.5	75.3	24.0	50.4	64.3	64.8	25.9	99.4	11.9	143.7	28.6	74.5
E	LE1A1	48.24	0.49	21.52	3.73	0.04	1.46	21.39	0.30	4.14	0.42	710.4	61.9	84.6	24.2	46.2	57.2	61.6	21.0	117.5	14.8	205.9	29.0	53.5
E	LE1A2	48.85	0.60	21.23	4.13	0.05	1.89	20.46	0.46	3.43	0.34	701.8	58.6	98.4	26.7	62.4	63.5	51.0	19.2	111.6	15.8	246.8	26.3	58.7
E	LE3B1	55.05	0.77	31.15	6.21	0.11	2.44	12.70	0.90	3.99	0.66	415.2	83.1	99.7	27.5	54.8	73.6	81.4	29.3	171.7	20.2	287.6	36.4	76.2
F	LE1D	51.02	0.66	25.81	4.79	0.05	1.92	18.88	0.45	3.83	0.34	739.3	72.5	102.2	29.6	61.4	65.8	65.0	24.3	135.8	18.1	286.4	33.5	69.6
F	LE1D1	52.01	0.82	28.18	6.19	0.07	2.43	17.51	0.58	3.33	0.52	749.8	81.9	124.7	30.3	69.8	73.5	69.9	27.4	149.4	19.2	260.9	32.9	83.3
F	LE2A1	50.34	0.76	26.78	5.97	0.07	2.38	19.67	0.58	3.41	0.60	758.6	81.4	120.6	28.9	71.3	69.6	69.4	25.0	144.8	19.7	237.7	35.7	77.9
F	LE2A2	50.91	0.86	21.69	5.84	0.09	2.71	19.84	0.69	2.47	0.19	521.9	63.0	123.4	35.7	88.6	59.3	35.7	18.6	119.2	14.7	156.3	23.4	32.0
F	LE2A3	50.13	0.83	22.33	5.77	0.09	1.95	20.61	0.46	3.04	0.25	569.0	53.7	105.2	34.2	77.0	60.8	46.5	20.2	131.9	15.2	175.1	27.0	56.8
F	LE2B1	51.01	0.76	23.85	5.38	0.06	1.94	17.55	0.48	3.39	0.43	643.9	63.1	120.5	31.4	67.9	71.7	50.3	21.5	119.7	16.3	257.7	27.7	58.8
F	LE2B3	48.39	1.07	21.68	7.36	0.10	4.24	18.29	0.65	2.33	0.66	799.0	86.9	199.7	45.2	151.3	66.8	37.3	24.9	149.2	40.3	259.3	54.5	116.4
F	LE2B4	45.13	0.45	15.62	3.01	0.04	1.59	25.41	0.46	3.60	0.40	800.5	68.3	79.9	19.2	44.2	50.7	42.0	17.9	95.1	12.9	210.4	27.5	50.7
F	LE2C	49.33	0.95	23.84	7.48	0.11	3.48	18.77	0.81	2.77	0.53	618.9	71.9	154.0	43.1	101.7	75.9	45.3	21.6	115.4	17.5	168.6	28.8	56.8
F	LE2C2	47.67	0.83	22.54	6.50	0.09	2.85	22.87	0.57	2.31	0.35	581.0	64.4	138.8	37.6	108.4	68.9	48.5	21.0	115.4	16.5	241.4	33.5	65.9
F	LE2D	47.55	0.46	19.43	3.28	0.04	0.93	21.96	0.35	4.11	0.48	681.4	58.9	74.3	20.7	35.4	55.7	55.5	18.7	108.5	13.5	303.8	29.2	47.4
F	LE2D1	51.45	0.96	23.12	6.59	0.09	2.26	16.02	0.47	3.27	0.39	577.7	56.0	143.4	38.6	87.3	72.1	38.5	18.9	106.9	18.0	197.0	31.3	67.8
F	LE3A	46.28	0.79	20.84	6.49	0.09	2.82	22.98	0.61	3.21	0.76	719.0	72.6	129.2	39.3	94.6	68.3	50.6	20.7	115.4	16.5	210.4	26.4	65.6
F	LE3A1	49.90	0.97	25.74	7.66	0.10	3.70	18.70	0.75	2.56	0.60	757.5	76.2	157.0	45.5	97.7	74.1	52.9	21.4	124.6	18.3	203.8	30.7	56.9
F	LE3A3	50.60	0.82	23.40	6.07	0.09	2.59	17.64	0.55	3.74	0.52	657.0	77.4	133.8	37.7	83.3	64.5	41.6	21.1	117.1	17.2	581.8	24.6	75.7
F	LE3A2	44.05	0.90	15.40	6.51	0.11	3.72	23.69	0.91	2.83	0.60	586.2	71.2	155.9	46.1	127.9	61.3	21.8	17.1	85.1	13.5	113.8	17.9	46.8

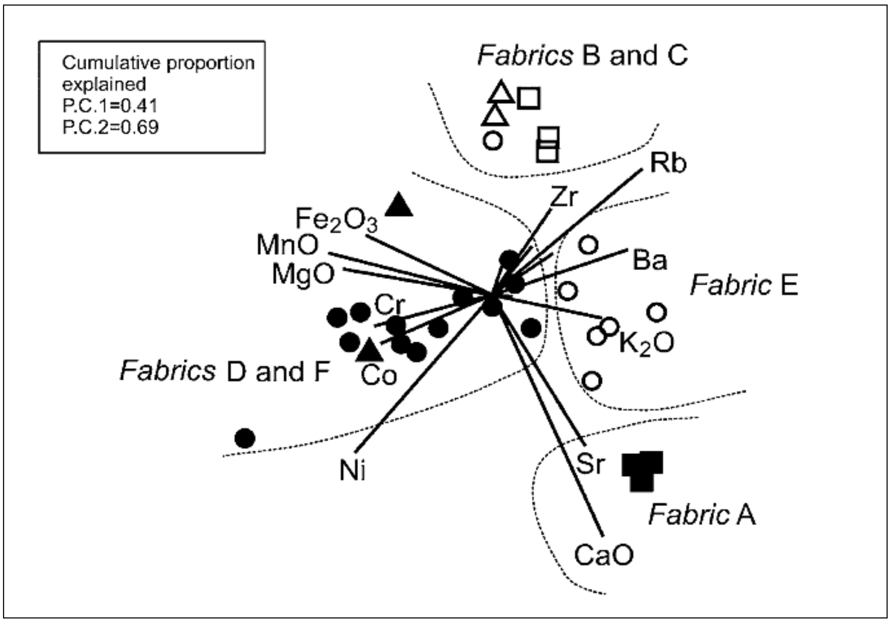

Fig. 18. Biplot of the two principal components.

Ryc. 18. Wykres podwójny dwóch głównych składników.

The biplot of **Fig. 18** represents the elements and the studied samples plotted in the plane of the first two principal components. It explains 69% of the total variance of major and trace elements. On the whole, there is a very good correspondence between the petrographic observations and the sample clusters obtained in the biplot: a) the CaO abundance is discriminant between the very fossiliferous Fabric A and the scarcely fossiliferous Fabrics B and C; b) the abundance of volcanic inclusions separated the Fabric F samples from the Fabric E on the basis of Fe_2O_3, MgO, MnO, Cr, Co and Ni contents.

6. Conclusive remarks

The first and the most significant result of the archaeometric analysis is to take note that the autoptic analysis, on which the archaeological scientific literature of the past decades about pottery technology is based, can be imprecise and misleading.

Abandoning the previous classification into three groups (1–3) and focusing just on the 6 fabrics (A–F) identified on petrographic base it is possible to highlight some relevant data on the relative dating of the particular fabrics (**Table 6**).

Fabrics A and C seem to be exclusive for shapes of Phase Thapsos I (1440/1420–1400/1380 BC), Fabrics D just attested and E mainly attested on samples of Phase Thapsos II (1400/1380–1310/1300 BC), and Fabrics B and F occurring just in those of Phase Thapsos III (1310/1300–1270/1250 BC), as to suggest the shift between different fabrics used throughout the entire chronological development of the MBA. As a further example, it can be stated that Fabric B occurs more frequently in cups of Type II (such as MA88/255) and VI (such as MA88/280), distinctive of Phase Thapsos I, while Fabrics E and F can be

Table 6. Comparative chart showing relations between specimens, fabrics and the relative dating.

Tab. 6. Diagram porównawczy ukazujący relacje między okazami, materiałami oraz datowaniem względnym.

Chronology	Sample	Fabric
Thapsos I	LE1B	A
Thapsos I	LE1B1	
Thapsos I	LE1B2	
Thapsos II–III	LE2B2	B
Thapsos II	LE1A	
Thapsos II–III	LE2B	
Thapsos I	LE1C	C
Thapsos I	LE1C1	
Thapsos II	LE2A	D
Thapsos I	LE2C3	
Thapsos II	LE2C1	E
Thapsos I	LE3B	
Thapsos I	LE1A1	
Thapsos II	LE2D	
Thapsos I	LE2B4	
Thapsos I	LE1D	
Thapsos III	LE3B1	
Thapsos III	LE2A2	F
Thapsos II	LE2C	
Thapsos II	LE3A1	
Thapsos II–III	LE3A2	

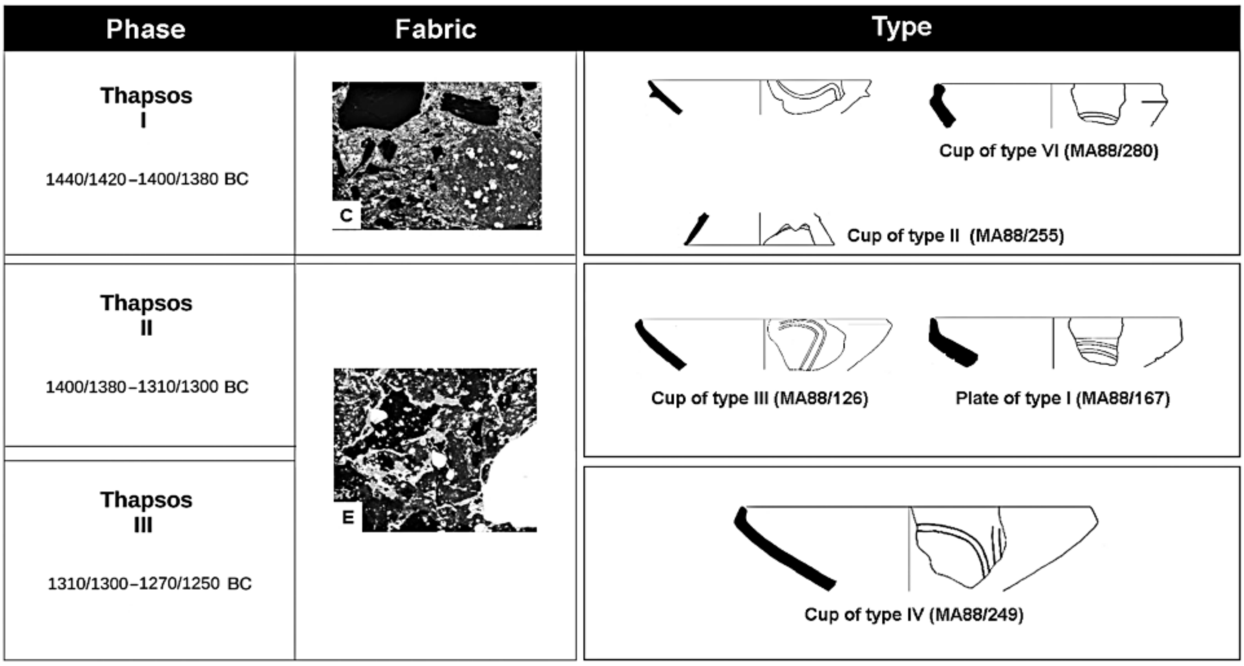

Fig. 19. Exclusive occurrence of Fabrics C and E in types of the three Thapsos chronological sub-phases.
Ryc. 19. Wyłączne występowanie materiałów C i E w typach trzech podfaz chronologicznych Tapsos.

found indifferently in cups of Type III (such as MA88/126) and plates of Type I (such as MA88/167), both typical of Phase Thapsos II, and cups of Type IV (such as MA88/249), more common in Phase Thapsos II (**Fig. 19**).

But the hypothesis that the shift is the effect of some technical achievement due to experimentalism that took place during the Thapsos Period seems just apparently contradicted by the estimation of firing temperature. In fact, Fabrics A, E and D show lower firing temperature (<800°–900° C) than B, C and F (>900° C).

Instead of having a gradual increase in the firing temperature from <800° to 900° C during the development of three chronological Thapsos sub-phases, we can already observe that in Fabric C the temperature reaches 900° C. This ultimately means that the firing temperature cannot be taken as a chronological criterion, since 900° C was already reached in kilns at the beginning of the Thapsos Period, and that the shift from A/C to D/E and to B/F did not conform to the subsequent chronological phases.

These considerations introduce the main research question: how can one explain the use of 6 different fabrics, sometimes coexisting and with fluctuating firing temperatures, at Grotte di Marineo along the course of the Thapsos Period?

Assuming that all the materials found at Grotte di Marineo have come from the same production centre, the first option can be that the potters preferred some fabrics to others, changing from phase to phase in order to improve the production, despite the fact that firing temperature depended just on the type of kiln used. In this case the differences in the fabrics can be due to experiments of changing clay sources or modifying the added tempers.

But assuming that the materials could have come from different workshops, another option could be that each workshop had its own distinctive methodology and features for pottery making, including clay sources, tempers and kiln types. This could also explain the occurrence of low firing temperatures in the samples of Fabric E, related to Phase Thapsos III.

A good discrimination could be a further analysis of the sources of clay. The results of the petrographic analysis pointed out that in the samples of Fabrics A, D, E and F, a CaO-rich clayey sediment, probably of the Tellaro Formation, was used as raw material, while Fabrics B and C were obtained with an alluvium Ca-poor sediment. A field study aimed to identify in the neighbouring area the two different deposits could add some data about the possible geographic location of the production centre/centres and help to clarify how the production of Grotte di Marineo raw clay for the potters proceeded.

To understand how the pottery of Grotte di Marineo was made and why it was made in that way could also assist to understand for what reason it was made and brought inside the cave. In other words, it can facilitate the complex interpretation of the use of this cave site. In fact, for example, the hypothesis of a ritual function of the cave complex tallies better with ceramic materials produced by different and distant workshops and brought on purpose in the caves.

In conclusion, the main achievement of this research has been to have disclosed a wide scenario of cultural perspective and further interpretations on the evidence of Grotte di Marineo that would be still hidden without the contribution of the archaeometric analyses.

Since archaeometry has demonstrated its ability to affect positively the cognitive abilities of the archaeologists, it becomes urgent in the research agenda of Sicilian prehistory to organise a systematic plan of analyses. With regard to the MBA pottery of the territory of Catania, what has been achieved is not enough for characterising the Aetnean production, but the research project is not over yet. In fact, another similar research is currently ongoing on the ceramics of Monte San Paolillo. Once the results of that site is available for comparison with those of Grotte di Marineo, the MBA pottery technology of at least a part of Sicily should be clearer.

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Bibliography

Agodi S. et al.
2000 S. Agodi, A.M. Gueli, P. Mazzoleni, D. Mege, E. Procelli, L. Sapuppo, S.O. Troja, *Il villaggio dell'Antico Bronzo di c.da Torricella: un progetto per lo studio e la datazione dei materiali*, "Bollettino dell'Accademia Gioenia di Scienze Naturali in Catania" 33/257, 175–186.

Aitchison J.
1986 *The Statistics Analysis of Compositional Data*, London.

Aitchison J. et al.
2002 J. Aitchison, C. Barceló-Vidal, V. Pawlowsky-Glahn, *Some Comments on Compositional Data Analysis in Archaeometry, in Particular the Fallacies in Tangri and Wright's Dismissal of Logratio Analysis*, "Archaeometry" 44, 295–304.

Alberti G.
2004 *Contributo alla seriazione delle necropoli siracusane*, (in:) V. La Rosa (ed.), *Le presenze micenee nel territorio siracusano, Atti del Primo simposio siracusano di preistoria siciliana*, Padova, 99–170.
2008 *La ceramica eoliana della facies del Milazzese. Studio crono-tipologico e culturale sulla base dei dati editi da Filicudi, Lipari, Panarea, Salina*, B.A.R. International Series 1767, Oxford.

Barone G. et al.
2005 G. Barone, A. Lo Giudice, P. Mazzoleni, A. Pezzino, *Chemical Characterization and Statistical Multivariate Analysis of Ancient Pottery from Messina, Catania, Lentini and Siracusa (Sicily)*, "Archaeometry" 47, 745–762.
2010 G. Barone, C.M. Belfiore, P. Mazzoleni, A. Pezzino, M. Viccaro, *A Volcanic Inclusions Based Approach for Provenance Studies of Archaeological Ceramics: Application to Pottery from Southern Italy*, "Journal of Archaeological Science" 37, 713–726.
2011a G. Barone, V. Crupi, F. Longo, D. Majolino, P. Mazzoleni, D. Tanasi, V. Venuti, *FT-IR Spectroscopic Analysis to Study the Firing Processes of Prehistoric Ceramics*, "Journal of Molecular Structure" 993, 147–150.
2011b G. Barone, P. Mazzoleni, D. Tanasi, C. Veca, *La tecnologia della produzione ceramica nel Bronzo Medio siciliano: il caso dei pithoi di Monte San Paolillo (Catania)*, "Rivista di Scienze Preistoriche" 61, 175–198.
2011c G. Barone, P. Mazzoleni, C. Ingoglia, M.G. Vanaria, *Archaeometric Evidences of the 4^{th}–2^{nd} Century B.C. Amphorae Productions in North Eastern Sicily*, "Journal of Archaeological Science" 38, 3060–3071.

2011d G. Barone, V. Crupi, F. Longo, D. Majolino, P. Mazzoleni, V. Venuti, E. Aquilia, *Potentiality of Non Destructive XRF Analysis for the Determination of Corinthian B Amphorae Provenance*, "X-Ray Spectrometry" 40/5, 333–337.

2012a G. Barone, P. Mazzoleni, A. Patanè, D. Tanasi, *Analisi petrografiche e geochimiche su ceramiche preistoriche siciliane dell'età del Bronzo Medio (XV–XIII secolo a.C.)*, (in:) M.P. Riccardi, E. Basso (eds.), *Atti del VI Congresso Nazionale di Archeometria, Scienza e Beni Culturali*, Bologna, 1–11.

2012b G. Barone, P. Mazzoleni, G. Spagnolo, E. Aquilia, *The Transport Amphorae of Gela: A Multidisciplinary Study on Provenance and Technological Aspects*, "Journal of Archaeological Science" 39, 11–22.

Beccaluva L. et al.

1998 L. Beccaluva, F. Siena, M. Coltorti, A. Di Grande, A. Lo Giudice, G. Macciotta, R. Tassinari, C. Vaccaro, *Nephelinitic to Tholeiitic Magma Generation in a Transtensional Tectonic Setting: An Integrated Model for the Iblean Volcanism, Sicily*, "Journal of Petrology" 39, 1547–1576.

Bersgsvik K.A., Skeates R.

2012 *Caves in Context: an Introduction*, (in:) K.A. Bersgsvik, R. Skeates (eds.), *Caves in Context. The Cultural Significance of Caves and Rockshelters in Europe*, Oxford, 1–9.

Bettelli M.

2002 *Italia meridionale e mondo miceneo: ricerche su dinamiche di acculturazione e aspetti archeologici*, Firenze.

Bradley R.

2000 *An Archaeology of Natural Places*, London.

Branciforti M.G.

1999 *Siti e insediamenti nella regione etnea*, (in:) M. Barra Bagnasco, E. De Miro, A. Pinzone (eds.), *Magna Grecia e Sicilia, stato degli studi e prospettive di ricerca*, Roma, 241–258.

Buxeda i Garrigós J.

1999 *Alteration and Contamination of Archaeological Ceramics: the Perturbation Problem*, "Journal of Archaeological Science" 26, 295.

Buxeda i Garrigós J. et al.

2003 J. Buxeda i Garrigós, R.E. Jones, V. Kilikoglu, S.T. Levi, Y. Manitiatis, J. Mitchell, L. Vagnetti, K. Wardle, S. Andreu, *Technology Transfer at the Periphery of the Mycenaean World: The Case of Mycenaean Pottery Found in Central Macedonia (Greece) and the Plain of Sybaris (Italy)*, "Archaeometry" 45/2, 263–284.

Castellana G.

2000 *La cultura del Medio Bronzo nell'agrigentino ed i rapporti con il mondo miceneo*, Agrigento.

Conkey M.W.

1980 *The Identification of Prehistoric Hunter-Gatherer Aggregation Sites: The Case of Altamira*, "Current Anthropology" 21/5, 609–630.

Consoli A.

1988–1989 *Licodia Eubea: ritrovamenti preistorici in Contrada Marineo*, "Beni Culturali Ambientali Sicilia" 9–10/3, 84.

Di Grande A. et al.

2002 A. Di Grande, P. Mazzoleni, A. Giudice, L. Beccaluva, G. Macciotta, F. Siena, *Subaerial Plio-Pleistocene Volcanism in the Geo-Petrographic and Structural Context of the North-Central Iblean Region (Sicily)*, "Periodico di Mineralogia" 71, 159–189.

French E.B., Tomlinson J.

2004 *The Contribution of Chemical Analysis to Provenance Studies*, (in:) J. Balensi, J.-Y. Monchambert, S. Müller--Celka (eds.), *La céramique mycénienne de l'Égée au Levant. Hommage à Vronwy Hankey*, Travaux de la Maison de l'Orient 41, Lyon, 15–25.

Grasso M. et al.

2004 M. Grasso, B. Behncker, I. Di Geronimo, S. Giuffrida, F. La Manna, R. Maniscalco, H.M. Pedley, S. Raffi, H.U. Schmincke, D. Strano, G. Sturiale, *Carta geologica del settore Nord-Occidentale dell'Avampaese Ibleo e del Fronte della Falda di Gela*, Catania.

Guzzardi L.
1985–1986 *Nuovi dati sulla cultura di Thapsos nel Ragusano*, "Archivio Storico per la Sicilia Orientale" 81–82, 219–240.

Honnorez J.
1967 *La palagonitisation: un aspect du volcanisme sous marin: l'alteration du verre basique de Palagonia (Sicile)*, (PhD thesis, Universite Libre de Bruxelles).

Jones R.E., Levi S.T.
2004 *Risultati preliminari delle analisi di ceramiche micenee dalla Sicilia sud-orientale*, (in:) V. La Rosa (ed.), *Le presenze micenee nel territorio siracusano. Atti del Primo simposio siracusano di preistoria siciliana in memoria di Paolo Orsi*, Padova, 171–185.

Kolb M.J., Speakman R.J.
2005 *Elymian Regional Interaction in Iron Age Western Sicily: A Preliminary Neutron Activation Study of Incised/Impressed Tablewares*, "Journal of Archaeological Science" 32, 795–804.

La Rosa V.
2004 *Le presenze micenee nel territorio siracusano: per una storia del problema*, (in:) V. La Rosa (ed.), *Le presenze micenee nel territorio siracusano. Atti del Primo simposio siracusano di preistoria siciliana in memoria di Paolo Orsi*, Padova, 11–20.

La Rosa V., D'Agata A.L.
1988 *Uno scarico dell'età del Bronzo sulla Serra del Palco di Milena*, "Quaderni di Archeologia dell'Università di Messina" 3, 5–15.

Leighton R.
1986 *Paolo Orsi (1859–1935) and the Prehistory of Sicily*, "Antiquity" 60, 15–20.

Levi S.T., Jones R.E.
2005 *Analisi archeometriche delle ceramiche*, (in:) M.C. Martinelli (ed.), *Villaggio dell'età del Bronzo Medio di Portella a Salina nelle Isole Eolie*, Firenze, 241–262.

Mouret C.
2004 *Burials in Caves*, (in:) J. Gunn (ed.), *Encyclopedia of Caves and Karst Science*, New York, 167–169.

Orsi P.
1895 *Thapsos*, "Monumenti Antichi" VI, 89–150.
1907 *Necropoli e stazioni sicule di transizione VII. Caverne di abitazione a Barriera di Catania*, "Bullettino di Paletnologia Italiana" 33, 53–99.

Pappalardo E. et al.
2008 E. Pappalardo, L. Pappalardo, F.P. Romano, F. Rizzo, A. Massimino, *Caratterizzazione non distruttiva di ceramica da strato proveniente dall'edificio "E" di Polizzello (CL)*, (in:) A.M. Gueli (ed.), *Scienze e Beni Culturali. Atti del V Congresso Nazionale di Archeometria*, Siracusa, 153–162.

Privitera F.
2007 *Le grotte dell'Etna nella preistoria*, (in:) F. Privitera, V. La Rosa (eds.), *Ima Tartara. Preistoria e leggenda delle grotte etnee*, Palermo, 91–117.
2010 *I disiecta membra delle età più antiche*, (in:) V. La Rosa, M.G. Branciforti (eds.), *Tra lava e mare. Contributi all'archaiologhia di Catania*, Catania, 45–62.

Procelli E.
1992 *Appunti per una topografia di Catania pregreca*, "Kokalos" 38, 69–78.
2007 *Il territorio di Catania: le grotte di Barriera*, (in:) F. Privitera, V. La Rosa (eds.), *In Ima Tartara. Preistoria e leggenda delle grotte etnee*, Palermo, 225–229.

Skeates R.
2010 *An Archaeology of the Senses: Prehistoric Malta*, Oxford.
2012 *Caves in Need of Context: Prehistoric Sardinia*, (in:) K.A. Bersgsvik, R. Skeates (eds.), *Caves in Context. The Cultural Significance of Caves and Rockshelters in Europe*, Oxford, 166–187.

Tanasi D.

2005 *Mycenaean Pottery Imports and Local Imitations: Sicily vs Southern Italy*, (in:) R. Laffineur, E. Greco (eds.), *Emporia. Aegeans in Central and Eastern Mediterranean*, *Acts of the 10th International Aegean Conference at the Italian School of Archaeology in Athens*, *Athens 14–18 April 2004*, Aegaeum 25, Liège, 561–569.

2008 *La necropoli protostorica di Montagna di Caltagirone (CT)*, Monza.

2010 *Gli scavi di Monte S. Paolillo e le presenze di tipo egeo nel territorio di Catania*, (in:) V. La Rosa, M.G. Branciforti (eds.), *Tra lava e mare. Contributi all'archaiologhia di Catania*, Catania, 81–94.

Thió-Henestrosa S., Martín-Fernández J.A.

2005 *Dealing with Compositional Data: The Freeware CoDaPack*, "Mathematical Geology" 37/7, 773–793.

Tinè S.

1965 *Gli scavi nella Grotta della Chiusazza*, "Bullettino di Paletnologia Italiana" 69, 113–286.

Vagnetti L.

1999 *Mycenaean Pottery in the Central Mediterranean: Imports and Local Production in Their Context*, (in:) J.P. Crielaard, V. Stissi, G.J. van Wijngaarden (eds.), *The Complex Past of Pottery: Production, Circulation and Consumption of Mycenaean and Greek Pottery (Sixteenth to Early Fifth Centuries BC). Proceedings of the ARCHON International Conference*, *Held in Amsterdam, 8–9 November 1996*, Amsterdam, 137–161.

Voza G.

1972 *Thapsos, primi resultati delle più recenti ricerche*, (in:) *Atti della XIV Riunione Scientifica dell'Istituto Italiano di Preistoria e Protoistoria in Puglia*, *13–16 ottobre 1970*, Firenze, 175–204.

1973 *Thapsos*, (in:) P. Pelegatti, G. Voza (eds.), *Archeologia nella Sicilia sud-orientale*, Napoli, 30–52.

Whitbread I.K.

1995 *Greek Transport Amphorae. A Petrological and Archaeological Study*, Athens.

van Wijngaarden G.J.

2002 *Use and Appreciation of Mycenaean Pottery in the Levant, Cyprus and Italy (ca. 1600–1200 BC)*, Amsterdam.

Williams J.L., Levi S.T.

2001 *Archeometria della ceramica eoliana: nuovi risultati, sintesi e prospettive*, (in:) M.C. Martinelli, U. Spigo (eds.), *Studi di preistoria e protostoria in onore di Luigi Bernabò Brea*, Messina, 265–304.

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Studium przypadku – charakterystyka archeometryczna ceramiki sycylijskiej środkowej epoki brązu (XV–XIII w. przed Chr.)

Ze względu na zasadniczy brak danych o technologii ceramiki sycylijskiej środkowej epoki brązu, niedawne badania ważnego zespołu ceramiki ze stanowiska Grotte di Marineo (Licodia Eubea, Katania, Włochy), który przebadano za pomocą analiz petrograficznych i geochemicznych – mikroskopia optyczna (OM), fluorescencja rentgenowska (XRF), spektroskopia fourierowska w podczerwieni (FTIR) – stworzyły możliwość uzyskania znaczących nowych ustaleń w tej dziedzinie wiedzy. Analizy pozwoliły na sporządzenie precyzyjnej charakterystyki sześciu materiałów, dla których określono temperatury wypału, wskazując, iż temperaturę 900° C osiągano już na początku środkowej epoki brązu. Odkryte powiązania między materiałami a fazami chronologicznymi wskazały na pewne cechy kulturowe produkcji ceramiki, które do tej pory były zupełnie nieznane dla tego okresu.

Analizy petrograficzne oraz badania fluorescencji rentgenowskiej i spektroskopii fourierowskiej w podczerwieni, przeprowadzone na próbkach z Grotte di Marineo, wykonane zostały celem określenia cech charakterystycznych i typologii materiału, zbadania zakresu temperatur wypału oraz przedstawienia nowych hipotez na temat strategii pozyskiwania gliny.

Brak danych o aspektach technologicznych produkcji ceramiki oraz brak charakterystyk petrograficznych i geochemicznych stanowi główny problem badań archeologicznych nad prehistorią Sycylii. W szczególności zaś dla środkowej epoki brązu, czyli okresu odpowiadającego kulturze Tapsos i jej trzem fazom chronologicznym (XV–XIII w. przed Chr.) (**Tab. 1**), jedynymi dostępnymi pracami są badania dotyczące Wysp Eolskich, podczas gdy brak jakichkolwiek studiów w tej dziedzinie dla terenów Sycylii.

Celem niniejszego artykułu jest wypełnienie tej luki poprzez omówienie materiałów ceramicznych znalezionych w Grotte di Marineo, prehistorycznym stanowisku jaskiniowym badanym w latach 1988–1989 (**Ryc. 1**). Nawarstwienia ze środkowej epoki brązu w Grotte di Marineo odkryto w sondażu 2 (warstwy 2–4), sondażu 3 (warstwa 2) w jaskini 1 oraz w sondażu 1 (warstwy 4 i 5) w jaskini 3.

Badanie materiałów ceramicznych doprowadziło do wyselekcjonowania 221 próbek diagnostycznych, które na podstawie analizy makroskopowej podzielono na trzy grupy (**Ryc. 5**): grupa 1, stwierdzona dla 22% próbek, to ceramika drobnoziarnista, twarda i zbita, o kolorze masy pomiędzy 2.5 YR 7/3 a 7.5 YR 5/2 i niewielką ilością ziaren piasku drobniejszych niż 0,25 mm; grupa 2 (48%) to ceramika średnioziarnista, twarda i zbita, o kolorze masy między 5 YR 6/6 a 10 Y 6/1 i licznych ziarnach piasku wielkości od 0,25 do 1 mm; grupa 3 (30%) to ceramika gruboziarnista, miękka i porowata, o kolorze masy między 2.5 YR 7/6 a 5 YR 4/4 oraz licznych ziarnach piasku większych niż 1 mm. W oparciu o typ i częstotliwość występowania ziaren piasku, grupy 1 i 2 zostały podzielone na cztery podgrupy każda (1A, 1B, 1C, 1D oraz 2A, 2B, 2C, 2D), zaś grupa 3 na dwie podgrupy (3A i 3B) (**Ryc. 6**, **Tab. 2**). Aczkolwiek brak dokładnych danych stratygraficznych, w oparciu o typologię kształtów można wnioskować, iż zasiedlenie stanowiska trwało przez wszystkie trzy podfazy okresu Tapsos.

Dokonano wyboru 31 próbek reprezentujących wszystkie grupy i poddano je analizom mineralogiczno-petrograficznym (OM, FTIR) oraz geochemicznym (XRF). Obserwacje petrograficzne pozwoliły na wyróżnienie i scharakteryzowanie sześciu materiałów petrograficznych (**Ryc. 17**): materiał A – z wtrąceniami uformowanymi przez wysoką zawartość wapienia i bogatej w skamieliny matrycy skalnej (LE1B[1], LE1B1, LE1B2); materiał B – z wtrąceniami uformowanymi przez szkliwo wulkaniczne (LE2B2, LE1A oraz LE2B) oraz okazjonalnie przez inne fragmenty skał wulkanicznych (LE1A) czy wapień (LE2B), matryca skalna jest uboga w skamieliny; materiał C – z wtrąceniami szkliwa wulkanicznego i kwarcu oraz matrycą skalną nie zawierającą skamielin (LE1C, LE1C1); materiał D – wtrącenia uformowane przez szkliwo wulkaniczne, fragmenty skał wulkanicznych (LE2A) oraz wapień, zaś matryca skalna zawiera skamieliny (LE2C3, LE2A); materiał E – charakteryzuje się obecnością tłucznia ceramicznego razem ze szkliwem wulkanicznym i wapieniem (LE2C1), fragmentami szkliwa wulkanicznego oraz skał

[1] LE – Licodia Eubea; 1–3 – nr grupy; B – podgrupa; kolejna cyfra – nr okazu.

(LE1A1, LE1A2, LE1D, LE2B4, LE2D) oraz wapienia (LE3B1). We wszystkich próbkach matryca skalna jest bogata lub bardzo bogata w skamieliny; materiał F – ze szkłem wulkanicznym, fragmentami skał i minerałami (pirokseny i plagioklazy), o matrycy skalnej zawierającej skamieliny (LE1D1, LE2A1, LE2A2, LE2A3, LE2B1, LE2B3, LE2C, LE2C2, LE2D1, LE3A, LE3A1, LE3A3, LE3A2).

Cechą wyróżniającą większość opisanych materiałów jest obecność wtrąceń, uformowanych przez fragmenty skał wulkanicznych, podczas gdy zastosowanie tłucznia ceramicznego ograniczone jest do materiału E. Wtrącenia i matryca skalna odpowiadają złożom, których wychodnie występują na obszarze Licodia Eubea. W szczególności skały wulkaniczne mają skład mineralny i strukturę podobną do obserwowanej w plio-plejstoceńskich bazaltach alkalicznych i toleitach, podczas gdy zwietrzałe szkliwo wulkaniczne przypomina plioceńskie palagonitowe podmorskie wulkanity tworzące wychodnie w okolicach Licodia Eubea. Wreszcie skały osadowe mioceńskiej formacji Tellaro oraz/lub aluwium czwartorzędowego mogą być uznane za surowiec gliniasty. Próbki należące do materiałów A, D i E (z wyjątkiem LE3B1) cechują się średnim lub wysokim załamaniem podwójnym światła, podczas gdy cecha ta jest słabo wykształcona lub nieobecna w materiałach B, C i F. Materiały A, D i E przeszły przez relatywnie niską temperaturę wypału (<800° C), na co wskazuje średnia–wysoka aktywność optyczna oraz obecność minerałów gliny i wysoka zawartość kalcytu. W przeciwieństwie do tego, próbki materiałów B i C charakteryzują się niską aktywnością optyczną lub jej brakiem oraz obecnością wysokotemperaturowych krzemianów z CaO (~ 900° C). Wreszcie w próbkach materiału F znajdują się zarówno kalcyt jak, i krzemiany zawierające Ca (800–900° C). Wyniki aktywności optycznej porównano ze składem mineralogicznym, określonym poprzednimi badaniami dyfrakcji rentgenowskiej (XRD) i pomiarami FTIR (por. Barone et al. 2012a).

Dane o składzie chemicznym próbek opracowano z wykorzystaniem metodologii statystycznej, opartej zasadniczo na technice proporcji logarytmicznych, wprowadzonej przez Aitchisona (1986) i szeroko stosowanej w badaniach archeometrycznych (**Tab. 5**). Wykres podwójny przedstawia pierwiastki oraz badane próbki umieszczone w płaszczyźnie dwóch głównych składników. Wyjaśnia on 69% z całkowitej wariancji pierwiastków głównych i śladowych (**Ryc. 18**). Ogólnie rzecz biorąc, na wykresie podwójnym widać bardzo dobrą zbieżność między obserwacjami petrograficznymi a skupiskami pozyskanych próbek: a) wysoka zawartość CaO jest wyróżnikiem pomiędzy bardzo bogatym w skamieliny materiałem A a ubogimi w skamieliny materiałami B i C; b) wysoka zawartość wtrąceń wulkanicznych oddziela próbki materiału F od materiału E, na podstawie zawartości Fe_2O_3, MgO, MnO, Cr, Co oraz Ni.

Pierwszym najbardziej znaczącym rezultatem analizy archeometrycznej jest zwrócenie uwagi na fakt, iż analiza makroskopowa może być niedokładna i myląca. Odstępując od wcześniejszego podziału na trzy grupy (1–3) i koncentrując się na 6 materiałach (A–F) zidentyfikowanych petrograficznie, można podkreślić pewne istotne dane dotyczące związku między materiałem a chronologią.

Materiały A i C wydają się występować wyłącznie w ceramice fazy Tapsos I (1440/1420–1400/1380 przed Chr.), materiał D jest zasadniczo potwierdzony, a materiał E głównie potwierdzony w próbkach z fazy Tapsos II (1400/1380–1310/1300 przed Chr.), natomiast materiały B i F wystąpiły tylko w próbkach fazy Tapsos III (1310/1300–1270/1250 przed Chr.). Sugeruje to przesunięcie pomiędzy różnymi materiałami wykorzystywanymi w trakcie całej sekwencji chronologicznej środkowej epoki brązu (**Tab. 6, Ryc. 19**). Jednakże hipoteza, iż przesunięcie to jest efektem jakiegoś osiągnięcia technicznego spowodowanego eksperymentami, mającymi miejsce w okresie Tapsos, wydaje się stać w pozornej sprzeczności z szacunkami temperatury wypału. Z drugiej strony, materiały A, E i D wykazują niższą temperaturę wypału (<800–900° C) niż B, C i F (>900° C). Zamiast stopniowego wzrostu temperatury wypału od <800 do 900° C w trakcie rozwoju trzech podfaz chronologicznych Tapsos, możemy zaobserwować, iż dla materiału C temperatura osiąga 900° C.

Ostatecznie oznacza to, iż temperatura wypału nie może być traktowana jako kryterium chronologiczne, ponieważ wartość 900° C osiągano w piecach garncarskich już na początku okresu Tapsos. Ponadto, przejście od A/C do D/E i do B/F nie wpisuje się w następujące po sobie fazy chronologiczne.

Przesunięcie to mogło wynikać z eksperymentalizmu technicznego pojedynczego warsztatu albo z pracy różnych centrów produkcyjnych ze szczególnymi tradycjami produkcji ceramiki. Dobrą metodą rozróżnienia mogłaby być dalsza analiza źródeł gliny. W istocie, zaplanowane już badania terenowe, których celem jest identyfikacja na okolicznym obszarze dwóch różnych depozytów, tj. bogatego w CaO sedymentu gliniastego oraz aluwialnego sedymentu ubogiego w Ca, którymi cechują się omówione wyżej materiały, może dostarczyć nowych danych o lokalizacji geograficznej centrów produkcyjnych.