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CAMPANIAN WINE FOR PUNIC SICILY: PETROGRAPHIC AND ARCHAEOLOGICAL STUDIES OF GRAECO-ITALIC AMPHORAE FROM PALERMO

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ABSTRACT

This contribution proposes a combination of archaeological fabric analysis and petrographic research applied to the study of 35 sherds of Graeco-Italic amphorae mostly found in Palermo, but also in Pantelleria and Malta (Tab. 1). The provenance identification derived from both approaches gives evidence for the arrival, in North-Western Sicily, of presumable wine amphorae from central-Tyrrhenian Italy since the very late 4th century BC. The production of the majority of the material has been confidentially attributed to the area of the Gulf of Naples/Ischia, but a second large group originates from several, still unidentified production sites to be located along the coastal strip of Campania or Lazio. Interestingly, apart from this dominating Italian assemblage, two amphorae match the petrographic finger-print of raw materials of the Eastern Nebrodi/Calabrian-Peloritani arc. The documentation of large quantities of 3rd century-BC Tyrrhenian Graeco-Italic amphorae in Palermo together with single sherds from North-Eastern Sicily testify to the importance of the commercial axis connecting the Campanian production sites with the most important consumption areas located in Carthage's epikrateia in Western Sicily.

KEYWORDS: Graeco-Italic amphorae from Tyrrhenian Italy, combination of archaeological fabric study and petrographic analysis, Gulf of Naples, Western Sicily, Carthage's sphere of influence, commercial axis

1. INTRODUCTION AND ARCHAEOLOGICAL BACKGROUND

The archaeological bibliography related to the class of Graeco-Italic amphorae is extremely vast. Specifically, during the last years a handful of in-depth studies, combined with archaeometric analyses, have notably promoted our knowledge on Tyrrhenian production sites and their morphological repertoires (Olcese, 2010; Cibecchini and Capelli, 2013; Pugliese, 2014; Gassner and Sauer, 2015; Gassner and Sauer, 2016). Because of the generally poor conservation status of the amphorae fragments considered herein, V. Gassner's rim typology (Gassner and Sauer, 2015; Gassner and Sauer, 2016) based on materials from later 4th to late 3rd/early 2nd-centuries BC stratigraphies excavated in Velia turned out to be the most appropriate tool for their morphological classification. However, Cibecchini's recent study (Cibecchini and Capelli, 2013) dedicated to the 3rd-century BC Gr.-Ita. Va-Vc variants from wreck-finds has also been taken into consideration. By contrast, the later, 2nd-century BC shapes of this class still lack a satisfactory typology and will hence be generically defined as 'Late Graeco-Italic' amphorae (for a synthesis see Cibecchini and Capelli, 2013).

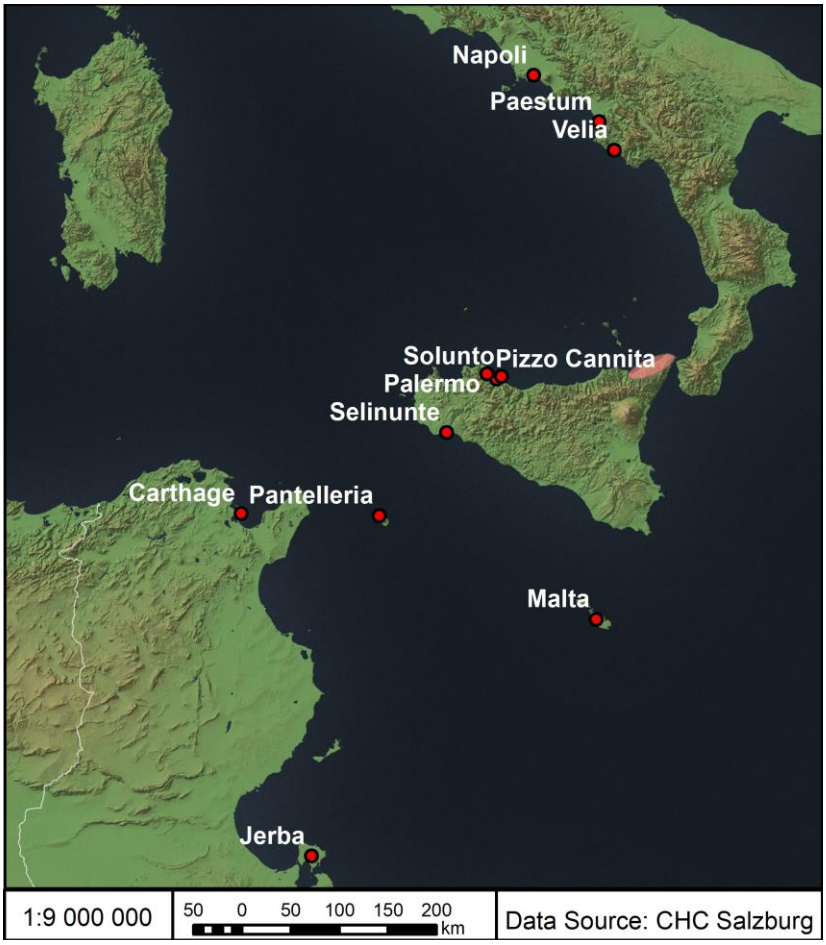
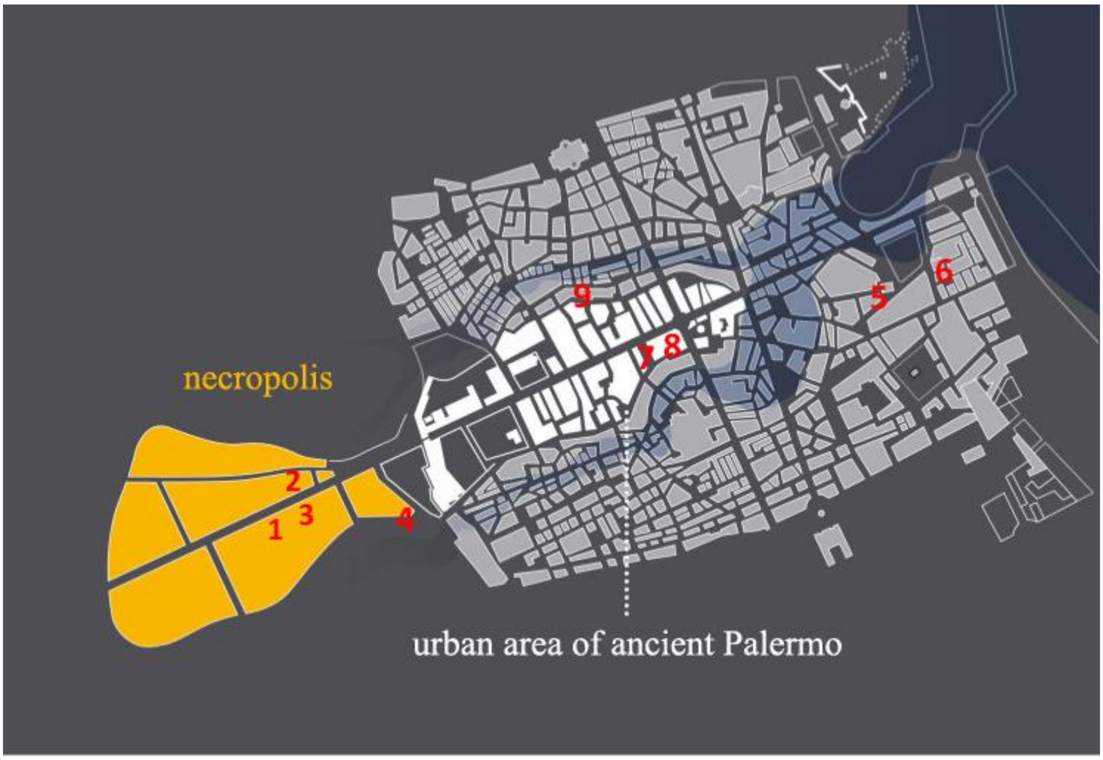


Figure 1. Sites/areas mentioned in the present paper.

For Western Sicily, the present paper constitutes the first systematic study of a significant number of Graeco-Italic amphorae from stratigraphic excavations. The studied ceramic assemblage makes part of wider research (Bechtold, forthcoming a) on the wide-spread distribution of ca. 250 late-4th to 2nd-centuries BC Tyrrhenian Graeco-Italic amphorae from consumption sites located in Carthage's sphere of influence (Western Sicily, Malta, Carthage, Jerba and Pantelleria, see Fig. 1). Within the framework of the present contribution, we focus on a set of 35 fragments of Graeco-Italic amphorae of presumed Campanian production mostly found in Palermo (Tab. 1), which have all been submitted to petrographic analyses. Moreover, four non-Tyrrhenian items have also been analysed.

2. THE ARCHAEOLOGICAL CONTEXTS OF THE GRAECO-ITALIC AMPHORAE

The majority of the selected fragments has been found in recent rescue excavations (2011, 2015) undertaken by the Soprintendenza BB.CC.AA. di Palermo in the historical centre of Palermo. These comprise the Punic necropolis along modern-day Corso Calatafimi, civ. 133-137 (short CAL, see Fig. 2,2) and at Piazza Indipendenza (short PIO, see Fig. 2,3) (Aleo Nero et al., 2012), in the urban area at Piazza Bologni (short PB, see Fig. 2,7) (see Aleo Nero et al., 2018) and below the Steri/Sala delle Verifiche (short STV, see Fig. 2,6) nearby the ancient harbour of the city. Furthermore, a few single fragments come from the acropolis excavations and the suburban survey of Cossyra/Pantelleria (Bechtold, 2013a). Finally, one item has been collected within the framework of the 'Malta Survey Project' in North-Western Malta (Docter et al., 2012).



1. Caserma Tukory, 2. Corso Calatafimi n. 133-137, 3. Palazzetto Orlando, 4. Piazza Indipendenza/Orléans, 5. Palazzo Mirto, 6. Steri, ex Sala delle Verifiche, 7. Piazza Bologni, 8. Via D'Alessi, 9. Via Celso

Figure 2. Palermo: Location of the excavation areas where the amphorae finds considered herein were unearthed from (Archivio Soprintendenza BB.CC.AA. di Palermo).

The fragments from Pantelleria and Malta and a handful of items from Palermo cannot be associated with datable archaeological contexts. By contrast, two amphorae from Palermo have been recovered in stratified deposits attributed to the first half (Pl. 2,5) and the mid-3rd (Pl. 3,11) century BC respectively (Bechtold, 2015a). Two more fragments from the necropolis of Piazza Indipendenza and almost all of the 19 items selected from the Steri excavation come from stratigraphic units which on the basis of the amphorae finds cannot be dated earlier than the mid-3rd century BC. It must be stressed, however, that in relation to these excavations at present only the amphorae fragments have been studied. In detail, only three of the 120 diagnostic amphorae fragments (70 Graeco-Italic, 45 Punic and 5 Greek amphorae) from around twenty layers excavated at Steri/Sala delle Verifiche (2011), an area located at the Northern side of modern Piazza Marina, nearby the ancient port, date prior to the late 4th century BC. The rest of these materials can be attributed to the time span between the end of the 4th and the mid-3rd centuries BC, whilst at least one third of the set might also have circulated during the second half of the 3rd or early 2nd centuries BC. At the present stage of study, we might assume that the Graeco-Italic amphorae from the Steri excavation should be related to Panormos' (ancient Palermo) 3rd-century BC commercial harbour area (in detail see Bechtold, forthcoming b).

Table 1. Concordance between archaeological and petropraphic data. The datings of the archaeological deposits of Steri/STV and Piazza Indipendenza/PIO are based on the study of the amphorae material only. Columns three and five refer to the database of FACEM (www.facem.at.).

Site of discovery	Site inventory	FACEM inventory	Type Gassner / Cibecchini	FACEM fabric	Petrographic group	Published	Deposit dating	Plate
Palermo	PB 720/1	M 106/180	Gassner 8/Gr.-Ita. III	BNap-A unpublished	Gulf of Naples/Ischia	Aleo Nero et al., 2018, cat. 45, Bechtold forthcoming b, pl. 3,2	Modern period	1,1
Palermo	STV 29/8	M 106/179	Gassner 9/Gr.-Ita. Va	BNap-A unpublished	Gulf of Naples/Ischia	Bechtold, forthcoming b, pl. 4,13	c. mid-3rd century BC	1,2
Palermo	STV UE 4/1	M 106/193	Gassner 10/Gr.-Ita. Vb	BNap-A-3	Gulf of Naples/Ischia		3rd century BC	1,3
Pantelleria	PN 08 ACR RIC 247.1-1	M 119/260	Gassner 11/Gr.-Ita. Va?	BNap-A-3	Gulf of Naples/Ischia		Survey find	1,4
Palermo	STV 27/10	M 106/174	Gassner 11	BNap-A-6	Gulf of Naples/Ischia	Bechtold, forthcoming b, pl. 3,7	Not prior to mid-3rd century BC	1,5
Palermo	PB 300/301/1	M 106/176	Gassner 11/Gr.-Ita. Vc	BNap-A unpublished	Gulf of Naples/Ischia	Aleo Nero et al., 2018, cat. 47	Surface find	1,6
Palermo	STV 27/7	M 106/171	Gassner 12/Gr.-Ita. Vc	BNap-A-7	Gulf of Naples/Ischia		Not prior to mid-3rd century BC	1,7
Palermo	PIO 8	M 106/67	Gassner 12/Gr.-Ita. 12b/c	BNap-A-6	Coastal Campania/Lazio		c. mid-3rd century BC	1,8
Malta	MSP B16/P7/2	M 105/5	Gassner 8 close to	BNap-A-8 close to	Gulf of Naples/Ischia	Docter et al., 2012, 133-134, fig. 27, cat. 41	Survey find	1,9
Palermo	PB 703/3	M 106/194	Gassner 11/Gr.-Ita. Vb	BNap-A-8	Gulf of Naples/Ischia	Aleo Nero et al., 2018, cat. 49	Modern	1,10
Palermo	STV 63/2	M 106/158	Gassner 11/Gr.-Ita. Vc	BNap-A-8	Gulf of Naples/Ischia		Not prior to mid-3rd century BC	1,11
Palermo	STV 34/52	M 106/189	Gassner 11/Gr.-Ita. Vc	BNap-A-8	Gulf of Naples/Ischia		Not prior to mid-3rd century BC	1,12
Palermo	STV 42/7	M 106/162	Gassner 10/Gr.-Ita. Vb	BNap-A-10	Gulf of Naples/Ischia	Bechtold, forthcoming b, pl. 3,5	c. mid-3rd century BC	2,1
Palermo	STV 28/10	M 106/164	Gassner 11/Gr.-Ita. Vb	BNap-A-10	Gulf of Naples/Ischia		Second quarter 3rd century BC	2,2
Pantelleria	PN 08 ACR RIC UT 235.1-2	M 119/151	Gassner 12/Gr.-Ita. Vb	CAMP-A-2 close to	Coastal Campania/Lazio	Bechtold, 2013, 498, cat. 134, pls. 37, 92,10	Survey find	2,3
Pantelleria	PN 10 ACR XVI 4414-1	M 119/259	Gassner 11/Gr.-Ita. Vc with graffito	CAMP-A-3 close to	Coastal Campania/Lazio		Not prior to mid-2nd century BC	2,4
Palermo	CAL 13.4	M 106/65	Gassner 10/Gr.-Ita. Va	CAMP-A-3	Coastal Campania/Lazio	Bechtold, forthcoming b, pl. 3,6	First half of 3rd century BC	2,5

Palermo	STV 62/4	M 106/191	Gr.-Ita. VIa?	CAMP-A-3	Coastal Campania/Lazio		Not prior to mid-3rd century BC	2,6
Palermo	PB 500/502/1	M 106/155	Unattributed	CAMP-A-4	Coastal Campania/Lazio	Aleo Nero et al., 2018, cat. 52	Surface find	2,7
Palermo	STV 29/5	M 106/167	Gassner 10/Gr.-Ita. Va	CAMP-A-4	Coastal Campania/Lazio		c. mid-3rd century BC	2,8
Palermo	STV 34/51	M 106/151	Gassner 11/Gr.-Ita. Va	CAMP-A-4	Coastal Campania/Lazio		Not prior to mid-3rd century BC	2,9
Palermo	STV 28/1	M 106/175	Gassner 11/Gr.-Ita. Vb	CAMP-A-4	Coastal Campania/Lazio	Bechtold, forthcoming b, pl. 3,3	Second quarter 3rd century BC	3,1
Palermo	STV 29/6	M 106/170	Gassner 12/Gr.-Ita. Vc	CAMP-A-4	Coastal Campania/Lazio		c. mid-3rd century BC	3,2
Palermo	STVV 34/41	M 106/150	Gassner 12/Gr.-Ita. Vc	CAMP-A-4	Coastal Campania/Lazio		Not prior to mid-3rd century BC	3,3
Pantelleria	PN 04 ACR RIC UT 115.1-9	M 119/154	Hybrid type	Unattributed	Coastal Campania/Lazio	Bechtold, 2013, 498, cat. 136, pl. 37.	Survey find	3,4
Palermo	PB 309/1	M 106/154	Gassner 8/Gr.-Ita.. III	Unattributed	Coastal Campania/Lazio	Aleo Nero et al., 2018, cat. 44; Bechtold, forth-coming b, pl. 3,1	Medieval fill	3,5
Palermo	STV 22/21	M 106/186	Unattributed	Unattributed	Coastal Campania/Lazio		c. mid-3rd century BC	3,6
Pantelleria	PN 04 ACR RIC 86.1-20	M 119/262	Gassner 12/Gr.-Ita. Vc	Unattributed	Coastal Campania/Lazio	Bechtold, 2013, 498, cat. 136, pl. 37	Survey find	3,7
Palermo	STV UE 68/1	M 106/177	Gassner 12/Gr.-Ita. b/c	PAE-A-1	Coastal Campania/Lazio		Not prior to mid-3rd century BC	3,8
Pantelleria	PN 04 ACR RIC UT 182.1-5	M 119/261	Gassner 12/Gr.-Ita. Vc	PAE-A-3	Coastal Campania/Lazio		Survey find	3,9
Palermo	STV 27/32	M 106/184	Gassner 13/Gr.-Ita. Vc	PAE-A-1	Coastal Campania/Lazio		Not prior to mid-3rd century BC	3,10
Palermo	PB 701/28	M 106/58	Gassner 8	Unattributed	Eastern Nebrodi/Calabrian-Peloritani arc	Aleo Nero et al., 2018, cat. 53, Bechtold, forth-coming b, pl. 4,12	Mid-3rd century BC	3,11
Palermo	STV 42/1	M 106/182	Gassner 12/Gr.-Ita. Vc	Unattributed	Eastern Nebrodi/Calabrian-Peloritani arc		c. mid-3rd century BC	3,12
Palermo	PIO 5	M 106/62	Gassner 10/Gr.-Ita. Va	Unattributed	Loner		Second quarter 3rd century BC	3,13
Palermo	STV 27/1	M 106/183	Gassner 12/Gr.-Ita. Vb	Unattributed	Loner		Not prior to mid-3rd century BC	3,14

3. THE AMPHORAE AND THEIR GEOGRAPHICAL PROVENANCE: ARCHAEOLOGICAL FABRIC STUDIES AND TYPES

The starting point of this study was the macroscopic examination of all the available materials (Bechtold, forthcoming a). Ceramic samples chipped from freshly broken surfaces of ca. 250 fragments have been subdivided into fabric groups by the use of hand lens. According to the standardised methods developed for the database of FACEM (see in detail http://facem.at/project/about.php#photography), digital photos taken from a representative number of items chosen from each of these provisional assemblages have been compared with the reference samples of fabrics attributed to the Gulf of Naples (Gassner and Sauer, 2016), Elea (Gassner and Sauer, 2015) and Poseidonia (Gassner and Trapichler, 2011), already published in the database mentioned above. The samples analysed by the means of petrography (Tab. 1, chapter 4) represent a selection of the most relevant archaeological fabrics identified among the ca. 250 fragments in view of their archaeometric characterisation. By contrast, Figures 3-5 show the effective, numeric incidence of fabrics/fabric ensembles and production areas, grouped by macroscopic criteria (see above), and their typological repertoires in relation to the whole assemblage of Graeco-Italic amphorae found at Palermo.

The largest group of petrographically analysed samples (N=14, see Tab. 1) has been referred to eight different archaeological fabrics attributed to the Gulf of Naples. According to V. Gassner and R. Sauer, fabrics BNap-A-1 to BNap-A-7 are likely to originate from "...the town of Naples...", while BNap-A-8 to BNap-A-11 have been related more generally to the Bay of Naples (Gassner and Sauer, 2016; for Naples see also Pugliese, 2014). Among 164 studied fragments of the Graeco-Italic class from Palermo (Figs. 3-4), amphorae of supposed Napoletanean provenance are very frequent (46 items or 28%), namely a fabric which finds close microscopic comparisons among coarse wares from the mid-3rd to mid-2nd centuries BC pottery workshop area of Piazza N. Amore (for the fabrics see Trapichler, 2012; for the excavations Giampaola et al., 2014; Pugliese, 2014); well attested are also fabrics BNap-A-6 and Bnap-A-7 (Fig. 3), while less documented appear to be the presumably earliest Napoletanean fabrics BNap-A-2 to BNap-A-3 (Gassner and Sauer, 2016) which dominate, by contrast, among the Campanian amphorae from the construction levels of temple B on the acropolis of Selinunte, dated c. 300 BC (preliminary data on these amphorae in Aleo Nero et al., 2018; Bechtold, 2015b).

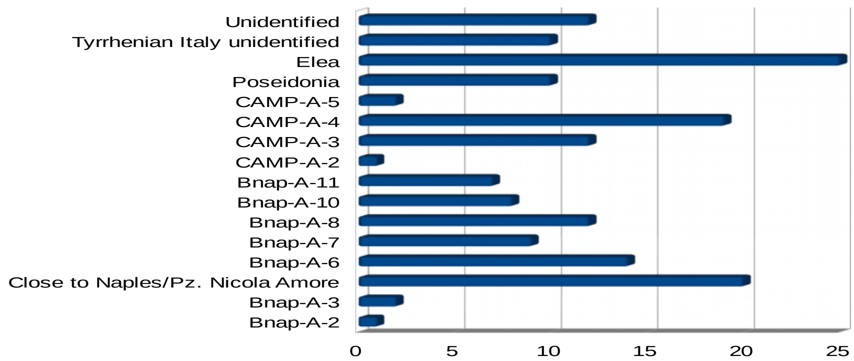


Figure 3. Quantitative incidence of fabrics/fabric groups among the Graeco-Italic amphorae found in Palermo (N=164).

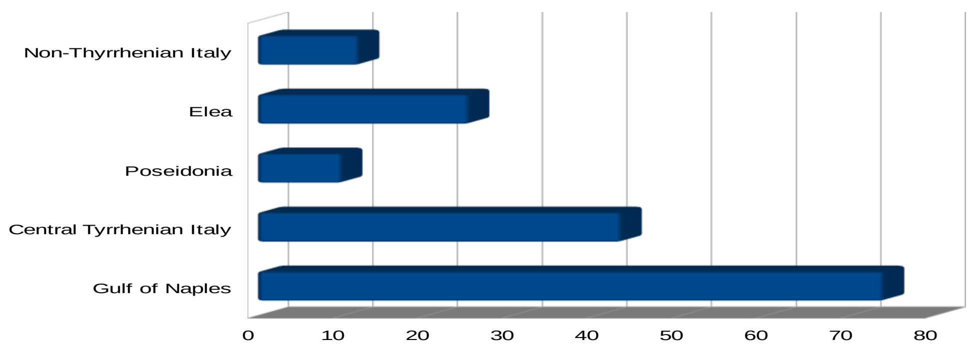


Figure 4. Quantitative incidence of production areas among the Graeco-Italic amphorae found in Palermo (N=164).

The fabric group hypothetically attributed to Neapolis includes amphorae of Gassner's rim types 8-12 (Gassner and Sauer, 2015) dating from the late 4th to the late 3rd centuries BC and a few Late Graeco-Italic items (Fig. 5). Almost all of the non-analysed fragments of this latter shape recorded at Palermo have been found in Via Celso (Fig. 2,9) which is currently the only area which has yielded a notable group of amphorae certainly dating to the 2nd century BC. In relation to Gassner's classification for Velia, it must be stressed however, that so far there are not any references of amphorae attributed to the Gulf of Naples of the earliest rim types 8-9 of the last third of the 4th or early 3rd centuries BC (Gassner and Sauer, 2016). Nevertheless, Gassner's rim type 8 / Gr.-Ita. III appears to be documented amongst the production of Ischia and Naples (?) (Olcese, 2010). Some more items of Gassner's rim shape 9 (here classified as Gr.-Ita. IV) of supposed Napoletanean fabric have been recently published by L. Pugliese (2014). Finally, several fragments of this early type have been sampled at Gela and Poggio Marcato di Agnone in South-Eastern Sicily (Olcese, 2010).

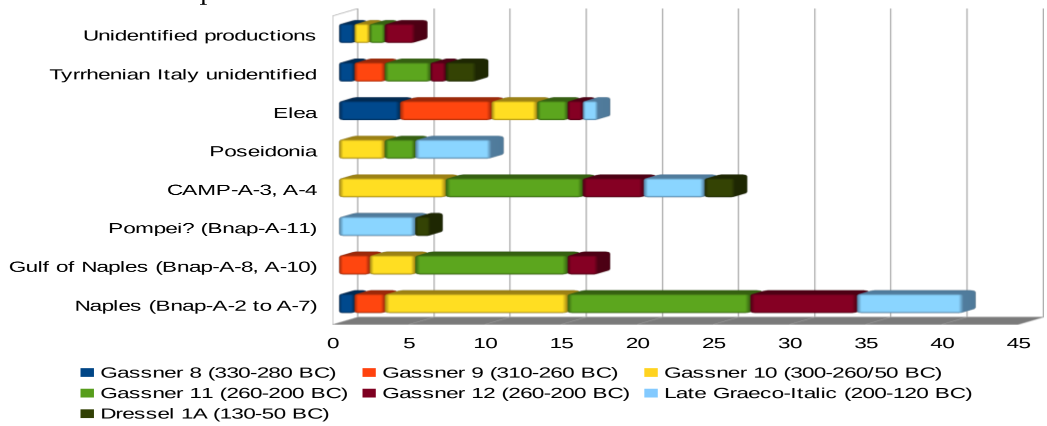


Figure 5. Quantitative incidence of types among the production sites/areas of Graeco-Italic amphorae found in Palermo (N=131).

Among the amphorae assemblage from Palermo, Gassner's rim 11 (Pl. 1,4-6) definitively stands out in frequency, followed by rim shapes 10 (Pl. 1,3) and 12 (Pl. 1,7-8), while the earlier types 8 (Pl. 1,1) and 9 (Pl. 1,2) are less attested. In this regard it must be underlined that to my knowledge, at present the two fragments of Gassner's later 4th to early 3rd-centuries BC rim 8 / Gr.-Ita. III (Pl. 1,1.9) from Palermo and Malta represent the first analysed and published samples of this shape from consumption sites located outside Campania which can be associated, on the basis of petrographic analysis, with raw materials of the 'Gulf of Naples/Ischia' area. I anticipate here the identification of ca. ten more fragments of this type from Jerba, Selinunte, Cossyra and Pizzo Cannita (Pa) attributed, on the basis of archaeological fabric studies, to the Gulf of Naples (Bechtold, forthcoming a). To conclude, at Palermo vessels possibly associated with the production of Naples (BNap-A-2 to BNap-A-7) mainly date to within the first half of the 3rd century BC (Gassner rim 10) or to the second third or second half of the 3rd century BC (Gassner's rims 11-12, see Gassner and Sauer, 2015).

Fabrics BNap-A-8 (Pl. 1,9-12) and Bnap-A-10 (Pl. 2,1-2), more generally attributed to the region of the Bay of Naples, show a similar chrono-typological distribution pattern to the presumed Napoletanean series above. By contrast, at present BNap-A-11 includes almost half of the 2nd and early 1st-century BC amphorae from Palermo attributed to the region of the Gulf of Naples, but no 3rd-century BC item. This picture is confirmed by five more items from Malta, Carthage, Jerba and Pantelleria attributed to fabric BNap-A-11 and studied within the scope of the research mentioned above (Bechtold, forthcoming a-b), which all refer to Late Graeco-Italic and Dressel 1A amphorae. In this respect, it is probably significant that fabric BNap-A-11, unfortunately still not studied archaeometrically, is formed by three Dressel 2-4 amphorae from the Italian Palatino excavations at Rome which have been associated with the production of Pompei (for the Roman Dressel 1 and 2-4 types see the Southampton amphora database with further references, http://archaeologydataservice.ac.uk/archives/view/amphora_ahrb_2005/). For further research we have though to keep in mind that the peak of distribution of fabric BNap-A-11 seems to be later than that of the other series originating from the Gulf of Naples.

A second group of analysed samples (N=10, Tab. 1) has been assigned into four different archaeological fabrics labelled CAMP-A-2 to CAMP-A-4, attributed to the broader, geographical area limited by the plain of the Volturno river and Capua to the north and by the Gulf of Salerno and the Tusciano river plain to the south (Gassner and Sauer, 2016). More specifically, the well attested fabrics CAMP-A-3 and CAMP-A-4 (Figs. 3, 5) include 3rd-century BC types of Gassner's rims 10-12 (Pls. 2,4-9, 3,1-3), as well as some 2nd-century BC Late Graeco-Italic items and a couple of Dressel 1A amphorae. Nothing can be stated anout the diachronic occurrence of the scarcely documented fabrics CAMP-A-2 (Pl. 2,3) and CAMP-A-5. At present and for morphological reasons, we might subsume that the group of still unidentified, Campanian productions 'CAMP-A' (34 fragments), which represents around 21% of the assemblage from Palermo (Fig. 3), starts to reach North-Western Sicily at earliest at the beginning of the 3rd century BC (Fig. 5).

Despite their suspected Tyrrhenian origin, four samples remain without attribution to one of Gassner's archaeological fabrics (Tab. 1): M 119/154 (Pl. 3,4), M 106/154 (Pl. 3,5), M 106/186 (Pl. 3,6), M 119/262 (Pl. 3,7). Highly interestingly, M 106/154 matches Gassner's rim shape 8 of the later 4th-early 3rd centuries BC, thus testifying for the occasional co-presence of other imports than those from the Gulf of Naples/Ischia and Lucania during this initial phase of commercial expansion of Campanian wine towards Carthage's epikrateia. Moreover, and on the basis of our archaeological fabric study, three samples selected out of a group of ten fragments (Fig. 5) including Gassner's rim shapes 10-12 (Pl. 3,8-9) and Late Graeco-Italic amphorae (Pl. 3,10) have been attributed to Poseidonia (Gassner and Trapichler, 2011; Gassner and Sauer, 2015).

The last group of Graeco-Italic amphorae submitted to petrographic analysis encompasses four fragments attributed to non-Tyrrhenian productions. This small set includes a later 4th-century BC fragment of Gassner's rim 8 (Pl. 3,11) and one item of Gassner's rim 12 (Pl. 3,12) dating to the mid or the second half of the 3rd century BC. Presently, these two fragments are the only ones of suspected Sicilian origin, excluding, however, the production sites located in the Western or Southern part of the island (see also Bechtold, forthcoming b). Finally, two 3rd-century BC Graeco-Italic amphorae M 106/62 (Pl. 3,13) and M 106/183 (Pl. 3,14) still remain without archaeological provenance hypothesis.

4. PETROGRAPHIC ANALYSIS

Thin-section petrographic analyses of the above-described set of Graeco-Italic amphorae samples were carried out on a Leica DC 200 polarizing microscope equipped with a digital camera. The relative abundance of non-plastic inclusions (expressed as area %) was determined by conventional point-counting procedures (Matthew, 1991). The main textural and compositional features of the recognized ceramic pastes are summarized in Table 2 and documented through representative photomicrographs (Figs 5-7). Moreover some of the categorical and ordinal variables obtained (both textural and compositional, such as: grain abundance in % area, class of abundance of specific minerals and/or rock fragments within the natural aplastic inclusions, etc) were selected (see supplementary materials in Table S1) for their statistical treatment by multiple correspondence analysis (MCA). This was achieved by firstly transforming the categorically coded textural and compositional data into a binary form (0/1 entries) adapting the procedure developed by Cau Ontiveros and co-authors (Cau Ontiveros et al., 2004). The transformed data matrix was subsequently treated through the MCA by using S-plus software (MathSoft, Inc.) after the null categories have been omitted.

Table 2. Petrographic features of ceramic samples after thin section observations

Sample code	Aplastic inclusions							Groundmass			Secondary calcite	Microfabrics
	Distribution	Sorting	Aplastic grain size distribution	MGS (mm)	Packing (%)	Mineralogical phases	Rock fragments	Bioclasts Limestones Micritic clots	Lumps	Optical activity		
106/58	Non homogeneous	Bimodal	coarse silt – medium/coarse sand	1.2	15%	Qtz (++), Bt (+), Fsp (++), Pl (+), St (+)	medium grade metamorphic rocks (++)	-	++	inactive	-	3
106/182	Non homogeneous	Serial	coarse silt, medium sand and coarse sand (sporadic)	1.1	15-20%	Qtz (+++), Qtz pol (++), Ky (r), Fsp (+), Ttn (r), Ep (r), Op (+)	chert (+), medium grade metamorphic rocks (+)	+	+	birefringent	+	3
105/5	Non homogeneous	Serial	coarse silt to coarse sand	0.8	20-25%	Sa (+++), Cpx (++/+++), Pl (++)	trachytoid rocks (++),volcanic glass (+)	+++	++	inactive	-	1
106/176	Non homogeneous	Serial	coarse silt to coarse sand (sporadic)	0.8	20-25%	Cpx (+++), Sa (++), Bt (++), Grt (r), Op (++), Pl (+), F (r)	trachytoid rocks (++),volcanic glass (+)	++	++	inactive	+	1
106/194	Non homogeneous	Bimodal	medium sand - coarse sand	0.7	20-25%	Cpx (+++), Sa (++), Bt (+), Am (r), Grt (r), Op (+), F(r), Pl (+)	trachytoid rocks (+),volcanic glass (r)	++	++	inactive	+	1
106/180	Non homogeneous	Bimodal	coarse silt – fine sand – medium	0.6	20-25%	Sa (+++), Pl (++), Cpx (++), Bt (++),	trachytoid rocks (+),volcanic	++	++	inactive	-	1

			sand			Grt (r), Op (+)	glass (+)					
106/174	Moderately homogeneous	Serial	coarse silt to medium and coarse sand	0.8	20%	Cpx (+++), Sa (++), Pl (+), Bt (+), Op (+), Grt (r), Am (+), F (r)	trachytoid rocks (+), subvolcanic rocks (r), volcanic glass (++)	++	++	inactive	-	1
106/171	Moderately homogeneous	Bimodal	fine sand - medium sand	0.7	20%	Cpx (++), Sa (++), Grt (r), Am (r), Bt (r), Pl (r), Op (+++), Ol (r)	Volcanic glass (++), trachytoid rocks (++), subvolcanic rocks (r)	++	+	inactive	+	1
106/164	Moderately homogeneous	Bimodal	coarse silt – very fine sand fine sand – medium sand	0.6	15-20%	Cpx (+++), Sa (++), Grt (r), Am (r), Bt (r), Pl (r), Qtz (r), Ms (+), Ol (r), Op (+), F (r)	Volcanic glass (++), trachytoid rocks (++)	++	+	inactive	-	1
106/179	Moderately homogeneous	Bimodal	medium sand - coarse sand	0.7	20-25%	Cpx (+++), Sa (+++), Grt (r), Am (r), Bt (+), Ol (r), Pl (r), Op (++), F (r)	Volcanic glass (++), trachytoid rocks (++), subvolcanic rocks (r)	++	++	inactive	-	1
106/189	Non homogeneous	Bimodal	coarse silt - medium sand	0.5	15%	Cpx (+++), Sa (+++), Grt (r), Am (r), Bt (+/r), Ol (r), Pl (r), Ms (+), Op (++), F (r)	Volcanic glass (++), trachytoid rocks (++)	+	++	inactive	-	1
106/162	Moderately homogeneous	Bimodal	coarse silt/fine sand- medium/coarse sand	0.7	20-25%	Cpx (+++), Sa (++), Grt (r), Am (r), Bt (+/r), Ol (r), Pl (r), Ms (+), Op (++/+), F (r)	Volcanic glass (++), trachytoid rocks (++)	++	++	inactive	-	1
106/158	Homogeneous	Good	medium sand	0.6	20%	Cpx (+++), Sa (++), Grt (r), Am (r), Bt (+/r), Ol (r), Pl (r), Ms (+), Qtz (r), Op (++/+)	Volcanic glass (++), trachytoid rocks (++), subvolcanic rocks (r)	++	++	inactive	-	1
106/193	Moderately homogeneous	Serial	coarse silt to very coarse sand	1.6	20%	Cpx (++), Sa (+), Grt (r), Am (r), Bt (+), Ol (r), Pl (r), Ms (+), Qtz (r), Op (+), F (r)	Volcanic glass (++), trachytoid rocks (++), subvolcanic rocks (+)	++	++	inactive	-	1
119/260	Moderately homogeneous	Bimodal	coarse silt/fine sand - medium sand	1	15-20%	Cpx (++), Sa (+++), Grt (r), Am (r), Bt (+/r), Ol (r), Pl (r), Op (+)	Volcanic glass (++), trachytoid rocks (++), subvolcanic rocks (r)	+	++	inactive	-	1
106/65	Homogeneous	Serial	coarse silt to medium sand	1.3	25-30%	Sa (+++), Cpx (++), Pl (+), Qtz pol (+), Qtz (+), Mc (r), Bt (r), Op (r)	trachytoid rocks (+),volcanic glass (+), acid crystalline rocks (+), chert (+)	++	++	inactive	+	2
106/154	Non homogeneous	Bimodal	coarse silt – fine sand medium sand – very coarse sand	1	20%	Cpx (++), Sa (+), Grt (r), Am (r), Pl (++), Ms (+), Qtz (r), Bt (+)	trachytoid rocks (++),volcanic glass (+), acid crystalline rocks (+), chert (+)	+	++	inactive	-	2
106/155	Homogeneous	Serial	coarse silt to medium sand	0.6	25-30%	Sa (+), Cpx (++), Pl (+), Qtz pol (+), Qtz (++), Mc (r), Bt (r), Op (+)	trachytoid rocks (+), volcanic glass (+), acid crystalline rocks (+), chert (+)	+++	++	inactive	-	2
106/67	Homogeneous	Serial	coarse silt to medium sand	0.5	25-30%	Cpx (++), Sa (+++), Bt (r), Am (r), Grt (r), Pl (r), Ol (r), Op (+), Qtz (+), Qtz pol (r)	trachytoid rocks (++), volcanic glass (++), acid crystalline rocks (+)	++	++	inactive	+	2
106/186	Moderately homogeneous	Serial	coarse silt – very fine sand medium sand	0.8	20-25%	Cpx (++), Sa (+), Pl (++), Op (+), Qtz (+++), Qtz pol (+)	acid crystalline rocks (++), quartz-feldspathic rocks (+), trachytoid rocks (+)	+	++	inactive	-	2
106/184	Moderately homogeneous	Serial	coarse silt to very coarse sand	2.8-3	20-25%	Cpx (+), Sa (r), Qtz (+++), Qtz pol (r), Kfs (r), Pl (+), Bt (r), Ms (r), Op (+), F (r)	Acid crystalline rocks (++), quartzarenites (+)	+++	++	inactive	-	2
106/175	Moderately homogeneous	Good	medium sand	1.6	20-25%	Cpx (++), Sa (+), Grt (r), Am (r), Bt (r), Pl (r), Qtz (+), Ms (+), Qtz pol (+), Op (+), Ol (r)	Volcanic glass (++), trachytoid rocks (+), acid crystalline rocks (++), chert (r)	++	++	Inactive	-	2
106/167	Moderately homogeneous	Serial	coarse silt to very coarse sand	1.2	25%	Cpx (++), Sa (++), Grt (r), Am (r), Bt (r), Pl (+), Qtz (+++), Qtz pol (++), Ms (+)	Volcanic glass (+), trachytoid rocks (++), chert (+), acid crystalline rocks (++)	+++	+++	inactive	-	2
106/170	Moderately homogeneous	Good	coarse silt – fine sand	0.6	25%	Cpx (++), Sa (+), Pl (+), Grt (r), Ms (+), Bt (r), Qtz (+), Qtz pol (r)	Volcanic glass (+), trachytoid rocks (+), chert (+), acid crystal-	+++	++	inactive	-	2

							line rocks (+), quartzarenites (+)					
106/150	Non homoge-neous	Serial	coarse silt to coarse sand (sporadic)	0.9	20%	Sa (+), Cpx (+/r), Ms (++), Bt (r), Qtz (+++), Qtz pol (++), Pl (r), F (r)	trachytoid rocks (r), chert (+), acid crystalline rocks (+), quartzarenites (+)	+++	+	inactive	-	2
106/151	Non homoge-neous	Serial	coarse silt to coarse sand (sporadic)	0.9	20%	Sa (+), Cpx (r), Ms (++), Bt (r), Qtz (+++), Qtz pol (++), Pl (r), Mc (r), F (r)	trachytoid rocks (r), chert (+), acid crystalline rocks (+), quartzarenites (+), subvolcanic rocks (r)	+++	+	inactive	-	2
106/191	Homogeneous	Serial	coarse silt to medium sand	0.7	25-30%	Sa (++), Cpx (+++), Pl (+), Qtz (++), Qtz pol (++), Mc (r), Bt (r), Grt (r), Am (r), Op (+), F (r)	trachytoid rocks (+), volcanic glass (+), acid crystalline rocks (++), chert (+)	++	++	inactive	-	2
106/177	Homogeneous	Serial	coarse silt, medium sand and coarse sand (rare)	0.7	20-25%	Qtz (++), Qtz pol (+), Pl (+), Kfs (+), Cpx (+), Sa (r), Am (r) , F (r)	acid crystalline rocks (++), quartzarenites (r), volcanic glass (r)	+++	++	inactive	-	2
119/262	Homogeneous	Serial	fine and medi-um sand to coarse sand	0.7	25%	Cpx (+++), Sa (+), Grt (r), Am (r), Bt (+/r), Pl (+), Ms (++), Qtz (++), Qtz pol (+), Op (++), F (r)	Volcanic glass (r), trachytoid rocks (+), acid crystalline rocks (+), chert (+)	+	+++	inactive	-	2
119/259	Moderately homogeneous	Serial	coarse silt to coarse sand	0.8	20-25%	Cpx (+++), Sa (++), Bt (+), Pl (+), Ms (+), Qtz (++), Qtz pol (+), Op (+)	Volcanic glass (+), trachytoid rocks (+), acid crystalline rocks (++), chert (+)	++	++	inactive	+	2
119/151	Homogeneous	Serial	fine sand, medium sand (sporadic), coarse sand (rare)	0.9	15-20%	Cpx (++), Sa (++), Bt (+), Pl (+), Ms (+/++), Qtz (+/++), Qtz pol (+), Op (+), Kfs (+)	Volcanic glass (+), trachytoid rocks (+), acid crystalline rocks (+), chert (+)	++	++	inactive	-	2
119/154	Homogeneous	Good	fine sand, medium sand (sporadic), coarse sand (rare)	0.9	15-20%	Cpx (+/++), Sa (+/++), Bt (+), Pl (r), Ms (++), Qtz (++), Op (r), Qtz pol (+)	Volcanic glass (+), trachytoid rocks (+), acid crystalline rocks (++), chert (+), quartzarenites (+)	++	++	inactive	-	2
119/261	Homogeneous	Serial	coarse silt to medium sand	0.4	20-25%	Cpx (+/++), Sa (+/++), Bt (+), Pl (r), Qtz (++), Op (r), Qtz pol (+)	chert (+), acid crystalline rocks (+)	+/++	++	inactive	-	2
106/62	Homogeneous	Serial	coarse silt to coarse sand	0.8	25-30%	Qtz (+++), Fsp (++), Qtz pol (r), Pl (r)	-	+++	++	inactive	-	loner
106/183	Homogeneous	Good	fine sand and medium sand	0.4	25%	Qtz (+++), Fsp (++), Pl (++), Ms (+), Qtz pol (+)	acid crystalline rocks (++), quartz-feldspathic rocks (++), chert (+)	+	+	inactive	-	loner

Legend: (+++) prevalent, (++) common, (+) sporadic, (r) rare; MGS = Maximum Grain Size; Cpx = Clinopyroxene; Sa = Sanidine; Grt = Garnet; Am = Amphibole; Bt = Biotite; Fsp = K-Feldspar; Pl = Plagioclase; Mc = Microcline; Ms = Muscovite; Ol = Olivine; Qtz = Quartz monocrystalline; Qtz pol = Quartz policrystalline Ky = Kyanite; Ttn = Titanite; Ep = Epidote; St = Staurolite, F = Feldspathoids, Op = Opaque minerals.

4.1. *Micro-Fabric 1*

A conspicuous number of the analysed amphorae (13 samples out of a total of 35), mostly found at the excavation sites located in Palermo, showed a very similar microscopic fabric in terms of both compositional and textural characteristics of the aplastic granules.

Such amphorae samples are characterized by the presence of aplastic inclusions of solely volcanic nature (medium-coarse sized sand), which were specifically added (i.e. tempering) to a fossiliferous calcareous clay. Aplastic grain-size distribution is more often markedly bimodal thus corroborating the assumption of on purpose tempering. The first modal class consists of coarse silt (0.04-0.06 mm) to very fine sand (0.06-0.125 mm), the second one is represented by grains falling within the medium sand range (0.25-0.5 mm). Granules with a size greater than 0.5 millimetres are sporadically detected. Packing of the inclusions varies overall from 15 to 25%. For what concern the composition of the aplastic inclusions, a distinction should be made between the medium-coarse fraction and the relatively finer fraction. In fact, the inclusions with an average size greater than 0.1 mm are exclusively composed of monomineralic granules and lithic fragments of volcanic origin. Between monomineralic grains the prevailing constituents are felsic minerals (sanidine and less abundant plagioclase), femic minerals (green to colourless clinopyroxene is much more abundant than the biotite laths) and opaque oxides. Usually, the felsic/femic ratio is less than 1, reaching 1 only rarely. Among the volcanic lithic fragments, the trachytes with vitrophyric texture (microphenocrysts of alkaline feldspar) are usually subordinate with respect to monomineralic grains but relatively more common than both volcanic glass (scoriae with sub circular pores) and syenitoid subvolcanic rocks. Accessory constituents are sporadic to rare and include alkaline amphibole, olivine (always altered and oxidized), garnet and feldspathoids (nepheline and sodalite). The relatively finer fraction of the inclusions (0.04-0.1 mm) is essentially composed by alkaline feldspar, minute crystals of white mica and rarely monocrystalline quartz. It is believed that these latter mineralogical components were originally present in the clayey raw material used for the manufacture of amphorae (Fig. 6).

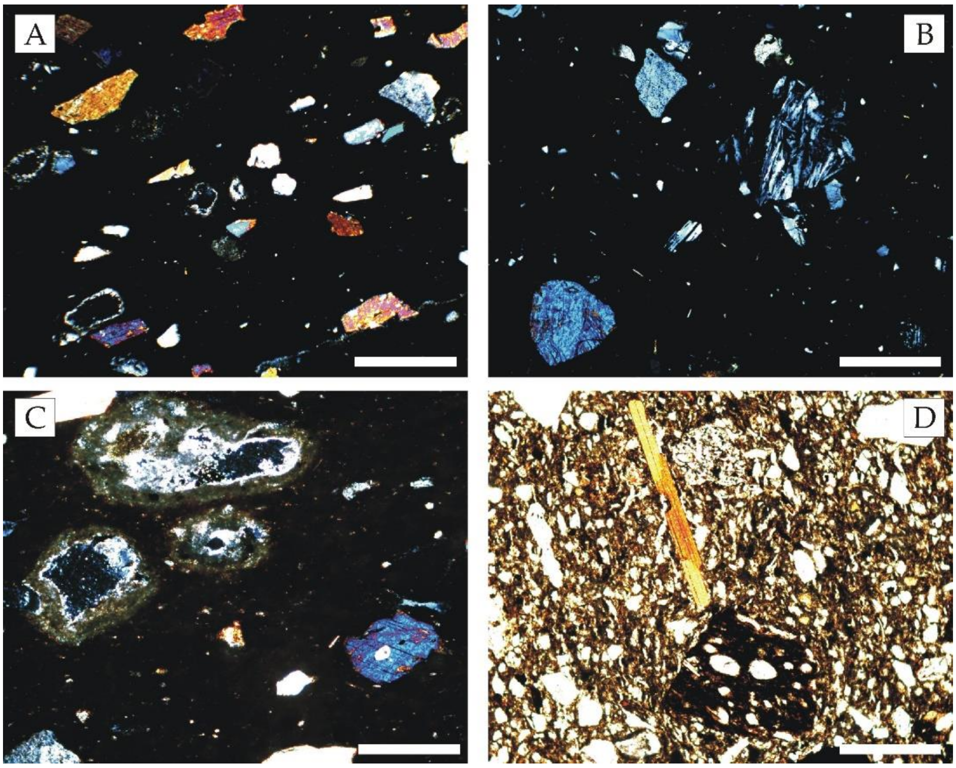


Figure 6. Representative photomicrographs of the micro-fabric 1: A) M 106/158 (crossed polars, scale bar = 0.5 mm); B) M 106/189 (crossed polars, scale bar = 0.2 mm); C) M 106/180 (crossed polars, scale bar = 0.2 mm); D) M 106/180 (plane polarised light, scale bar = 0.2 mm)

Micritic clots (microcrystalline calcite originated by the thermal decomposition of calcareous microfossils followed by recarbonation), are evident, supporting the original fossiliferous content of clay deposits.

The groundmass appears generally optically inactive (isotropic). The estimated macroporosity is around 10-15% (by comparative tables). The shape of the pores is mostly irregular (cast) while their dimensions are quite variable (mainly ranging from 0.04 mm up to 0.5 mm). No preferential orientation, potentially derived from the manufacturing process, has been identified. Frequent brownish reddish clay lumps (rich in iron oxides/hydroxides) characterize the groundmass testifying a careless mixing of the clayey raw material.

4.2. *Micro-Fabric 2*

A noticeable number of amphorae (18 out of 35) have compositional characteristics that do not comply to those encountered in micro-fabric 1 due to the presence of a more or less abundant detrital sedimentary component associated to the volcanic one (Tab. 2). From the textural point of view, samples grouped within this paste are characterized by a packing of 20-30% (areal estimation) and by a serial distribution of the aggregate, from coarse silt (0.04-0.06 mm) to coarse sand (0.5-1 mm) and more rarely up to the very coarse sand (1-2 mm). Concerning the composition of the aplastic inclusions, ten of the samples are characterized by an apparent predominance of the volcanic component with respect to the sedimentary one; on the contrary, 8 samples are characterized by a slight prevalence of the detrital sedimentary component.

The aplastic grains of volcanic origin are composed of lithic fragments (trachytes with vitrophyric texture and microphenocrysts of alkaline feldspar or, intergranular texture with plagioclase, clinopyroxene and opaque minerals, or microporphyric texture with plagioclase phenocrysts), volcanic glass (occasionally extensively vesiculated) and monomineralic granules (in order of decreasing abundance: clinopyroxene, sanidine, plagioclase, biotite, alkali amphibole, garnet). The detrital sedimentary component is composed of monocrystalline quartz, polycrystalline quartz, chert, quartz or quartz-feldspar arenites and fragments of acid crystalline rocks (Fig. 7).

The calcareous component, originally present in raw clay and then decomposed during firing process, is indirectly evidenced by the presence of *micritic clots* with typical reaction rims.

The groundmass always appears optically inactive (isotropic). Macroporosity is around the 10% (area). The shape of the pores is irregular, mainly due to the decomposition of calcareous microfossils. No significant preferential orientation was observed.

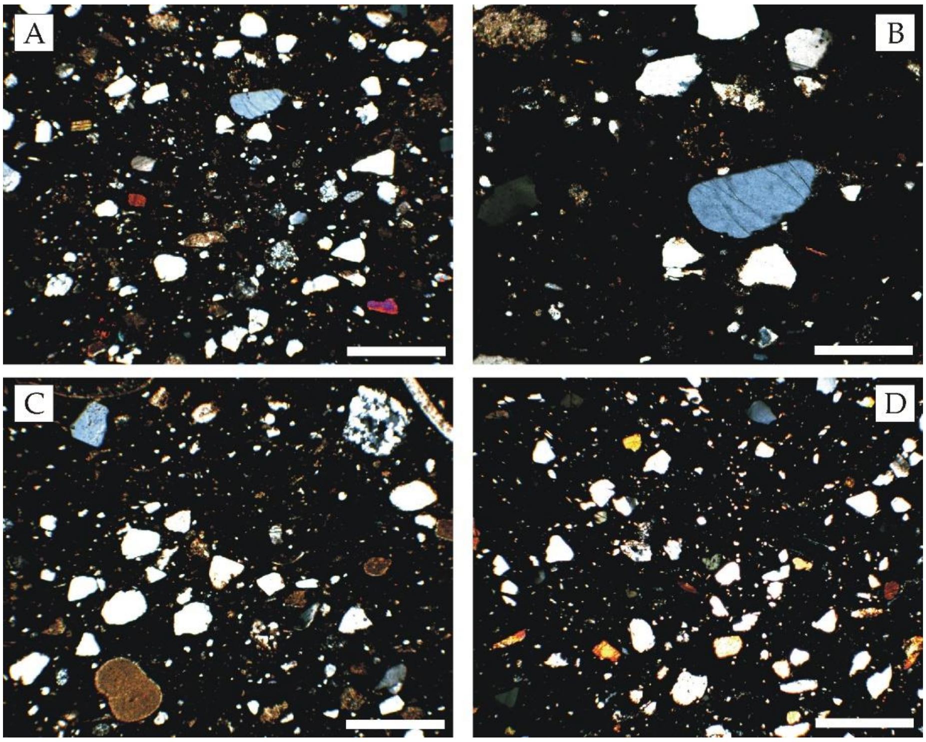


Figure 7. Representative photomicrographs of the micro-fabric 2: A) M 106/65 (crossed polars, scale bar = 0.5 mm); B) M 106-165 (crossed polars, scale bar = 0.2 mm); C) M 106/184 (crossed polars, scale bar = 0.5 mm); D) M 106/191 (crossed polars, scale bar = 0.5 mm)

4.3. *Micro-Fabric 3*

Two of the analysed samples (M 106/58 and M 106/182) can not be assigned to any of the microfabrics already described, since the volcanic component is completely absent and, moreover, lithic fragments and monomineralic granules attributable to medium and high-grade metamorphic rocks are the predominant constituents.

Sample M 106/58 has a non-homogeneous distribution of aplastic inclusions with a packing of about 15% (area). It also shows a distinct bimodality (first mode: coarse silt/very fine sand, second mode: coarse sand). Instead, sample M 106/182 shows a non-homogeneous distribution (serial), from coarse silt (0.04-0.06 mm) to coarse sand (0.5-1 mm), with a packing of 15-20% (area). However, from the compositional point of view, both are characterized by fragments deriving from medium-high grade metamorphites (micaschists) and monomineralic granules attributable to similar lithologies: quartz, K-feldspar (orthoclase, microcline), plagioclase, biotite, kyanite, amphibole, titanite, epidote, staurolite. A detrital sedimentary component is also present and it is characterized by polycrystalline quartz, bioclasts (sporadic), calcareous lithic fragments, chert. It should be noted that the sample M 106/58 has a relatively lower percentage of calcareous lithic fragments and *micritic clots* resulting from the firing process (Fig. 8A-B).

The groundmass is optically inactive in sample M 106/58, whereas sample M 106/182 is slightly birefringent. Macroporosity is around 15-20% (area). The shape of the pores is irregular resulting from the decomposition of calcareous microfossils. No significant preferential orientation was encountered.

4.4. *Loners*

Only 2 samples of the analysed 35 showed different textural and compositional characteristics with respect to the previously described micro-fabrics. These samples (coded M 106/62 and M 106/183) may be considered as 'loners' from the petrographic point of view.

Sample M 106/62 is characterized by a packing of 25-30% (areal estimation) with a serial distribution of the aplastic inclusions, from coarse silt (0.04-0.06 mm) to medium sand (0.25-0.5 mm). Monocrystalline quartz granules and K-feldspar prevails on both plagioclase and polycrystalline quartz granules. A very abundant bioclastic component (partly decomposed following the firing process and subsequently recrystallized in the form of microcrystalline calcite) is also present consisting also of lithic fragments of compact limestones and biocalcarenites (Fig. 8C). Macroporosity is estimated around 15% (area) and macropores occasionally have preferential orientations.

Sample M 106/183 has a homogeneous distribution with packing around 25% (area). Sorting is also good and the most representative dimensional classes are those of fine (0.125-0.25 mm) and medium (0.25-0.5 mm) sand. Monocrystalline quartz is the most representative constituent. K-feldspar, polycrystalline quartz, mica are components from common to subordinate. Fragments of crystalline-acid rocks, quartz-feldspar arenites and chert are also common (Fig. 8D). The groundmass is optically isotropic. Macroporosity is less than 10%. Pores are irregular in shape.

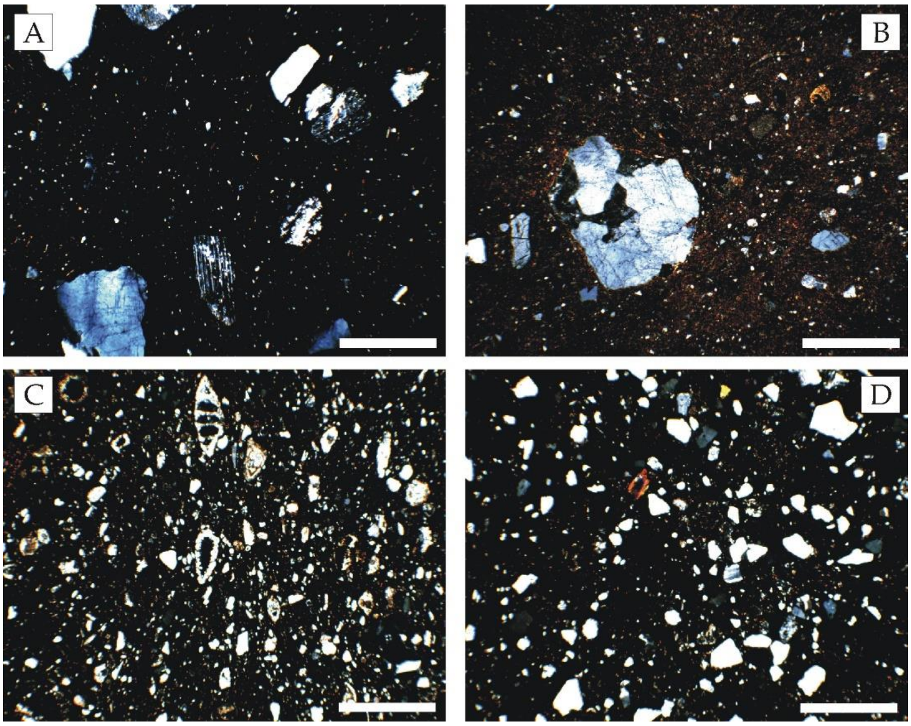


***Figure 8.** Representative photomicrographs of the micro-fabric 3 (A, B) and the two loners (C, D): A) M 106/58; B) M 106-182; C) M 106/62; D) M 106/183 (crossed polars, scale bar = 0.5 mm)*

4.5. *Presumed provenance of the detected Micro-Fabrics*

The studied amphorae can be grouped into three microscopic fabrics, which are distinguishable by means of compositional as well as textural features. This result supports the hypothesis of different production areas. This statement may be further corroborated by the multiple correspondence analysis (automatic grouping procedure) performed on the categorically coded textural and compositional data after their conversion into binary form. Figure 9 illustrates the plotting of the samples belonging to the previously identified micro-fabrics in the field defined by the two principal components C1 and C2, after omitting the two unidentified samples (loners). A clear correspondence can be immediately seen between the three paste groups thus supporting a different provenance.

Micro-Fabric 1 (sample with aplastic inclusions of exclusively volcanic origin added to a calcareous clay) matches the production hypothesis at the Island of Ischia (or at Naples using clayey raw material from Ischia). In fact, the presence of clay suitable for ceramic manufacture on the volcanic island of Ischia (located about 33 km south-east from Naples) has long been known. The clay deposits, mainly quarried by galleries excavated along the northern slopes of Epomeo Mount near the village of Casamicciola, were exploited for this purpose from the most remote antiquity to recent times (Buchner and Rittmann, 1948; Buchner, 1994; Montana, 2010). The island is characterized by volcanic products, essentially consisting of alkali trachytes and, subordinately, trachybasalts, latites and phonoliths (after Vezzoli, 1988). In addition, deposits of marine clays with a rich calcareous fossil fauna, resulting from the submarine alteration of the ignimbrite products of the Epomeo Mount (Rittmann and Gottini, 1981), are also present.

Concerning the samples grouped in the Micro-Fabric 2, the distinguishing petrographic features (presence of a more or less abundant detrital sedimentary component associated to volcanic temper) suggest the provenance from an area comprised between southern Lazio and Campania (north of Naples). In fact, following the detailed quantitative petrographic descriptions made by Thierrin-Michael (1992) which concerned several production centres of Dressel 1 and Dressel 2-4 wine amphorae located along the coastal area extending from southern Tuscany to the bay of Naples, the corresponding productions can be roughly distinguished from each other by the abundance ratio of the aplastic constituents in the ceramic paste. Accordingly, in this case study, it would be possible to exclude the hypothesis of a manufacture in the renewed *atelier* located in the north of Rome (Rosignano, Albinia, Cosa), while, the detected aplastic compositions and abundance ratios put forward the area between Fondi, Minturno, Garigliano, Mondragone and Falerno, although these are hypotheses to be verified with caution.

Micro-Fabric 1 and 2 were documented on Graeco-Italic amphora by thin-section analysis under the polarizing microscope by other authors (Iliopoulos, 2010; Gassner and Sauer, 2016), which also identified them as typical productions of the Gulf of Naples or production centres located in the Tyrrhenian coastal area. Other authors agree to point out the origin of Ischia's clayey raw materials that characterize Micro-Fabric 1 also for the productions related to kilns active in the classical-Hellenistic age and located in Naples (De Bonis et al., 2016).

The last group (Micro-Fabric 3), with predominant inclusions of metamorphic origin, supports a manufacturing hypothesis on sites located in the Calabrian-Peloritani Arch area. The mineralogical and textural features presented by the above-mentioned samples are therefore compatible with those of a production site characterized by the use of alluvial sediments with abundant metamorphic inclusions, like those that can be found, concerning Sicily, in the coastal area of the Peloritani Mountains. It is interesting to point out that the same microfabric, as far as concerns the Graeco-Italic amphorae, has been recognized to match those described for finds recovered at other Sicilian sites: Messina and Milazzo in north-eastern Sicily (Barone et al., 2009; Barone et al., 2011) and Termini Imerese in north-western Sicily (Alaimo et al., 1997).

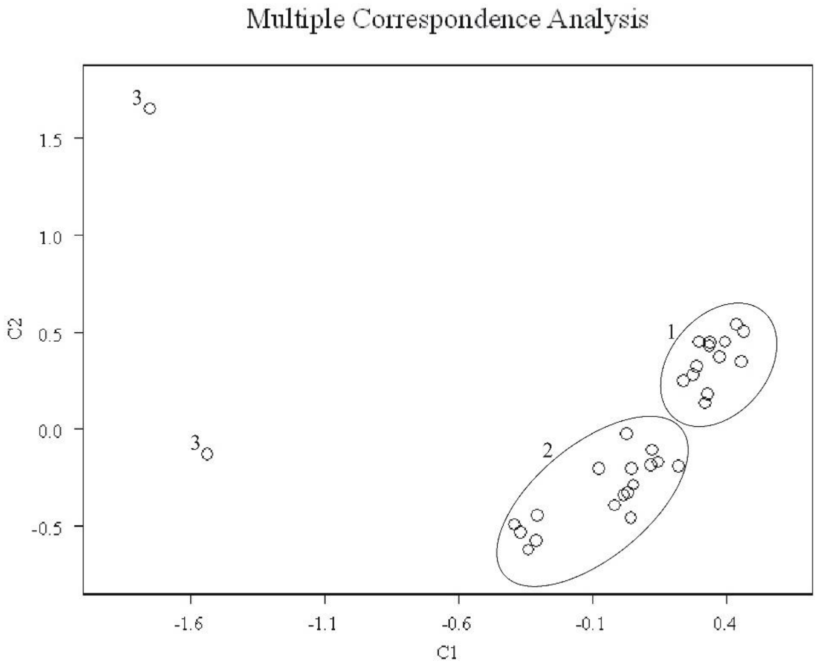


Figure 9. Two-dimensional plot based on the multiple correspondence analysis (MCA) as described in the text. Legend: 1= micro-fabric 1; 2 = micro-fabric 2; 3 = micro-fabric 3.

5. ARCHAEOLOGICAL AND ARCHAEOMETRIC DATA ON COMPARISON

Firstly, we have to underline that in all cases the attribution of the samples to archaeological fabrics or fabric groups preceded the petrographic analyses, since both studies have been accomplished independently from each other. Comparing the outcome of sample attribution of both methods (Tab. 1) and with the exception of sample M 106/67, we can state a total convergence in sample assignment to four broader geographical groups:

1) Gulf of Naples/Ischia

2) coastal Tyrrhenian Italy (Campania, Lazio, Lucania)

3) North-Eastern Sicily

4) unidentified (loners)

Specifically, and in perfect harmony with the archaeological fabric study, all of the eight samples but one (M 106/67) conferred to the hypothetical production of Naples itself, as well as the six samples attributed to the broader region of the Bay of Naples (BNap-A-8/10) match the petrographic group 'Gulf of Naples/Ischia' (Tab. 1, sub-chapter 4.1). This notable consistence of provenance identification of amphorae produced in the region of the Gulf of Naples allows for an authoritative interpretation of the distribution pattern of this class at Palermo and in Carthage's sphere of influence (see also chapter 6).

In full concordance with the archaeological fabric attribution, all of the samples of the more generic Campanian assemblage (CAMP-A) belong to the petrographic group 'Campania-Lazio' (sub-chapter 4.2). The archaeometric analyses do not permit the distinction of further sub-groups within this sample set. By consequence, presently no assessment can be made on a more detailed geographical provenance of this ensemble which includes, however, almost certainly amphorae from multiple production sites. Furthermore, the petrographic group 'Campania-Lazio' contains four more amphorae of presumed, still unidentified Tyrrhenian origin (Tab. 1). Finally, three samples associated with the production of Poseidonia belong to the archaeometric group 'Campania-Lazio', too. In conclusion, the archaeological distinction between fabrics of the Gulf of Naples and unidentified, other coastal Tyrrhenian fabrics, in all cases but one has been confirmed by petrographic analysis. This result clearly encourages the implementation of the archaeological FACEM-method.

Petrographic analysis was extremely helpful for the provenance identification of the two samples of presumed Sicilian origin (M 106/58 and M 106/182), which match the geological finger-print of raw materials characteristic of the Calabro-Peloritanean region, namely of the coastal strip of the eastern Nebrodi and the Peloritanean mountains (sub-chapter 4.3). Finally, samples M 106/183 and M 106/62 appeared to be loners from both the archaeological and archaeometric points of view.

6. ARCHAEOLOGICAL-HISTORICAL DISCUSSION

Provenance studies of 35 Graeco-Italic amphorae mainly found in Palermo, in combination with the data derived from the analysis of 164 fragments from the same excavation areas (Figs. 3-5), allow for drawing some first conclusions on the circulation of this class in the most important Punic town of early Hellenistic North-Western Sicily (for the historical aspects see Anello, 1998). The discovery of the materials in funeral contexts, urban deposits and in the harbour area (Fig. 2) clearly underlines the widespread distribution of central-Tyrrhenian, late 4th and 3rd-centuries BC amphorae all over the city's territory, testifying though for the preferential consumption of Campanian wine.

The earliest imports of Gassner's later 4th and early 3rd-centuries BC rim shapes 8-9 originate mainly from Elea, but to a minor extent also from the Gulf of Naples (Pl. 1,1-2.9), other still unidentified coastal Tyrrhenian production sites (Pl. 3,5) and from the Eastern Nebrodi/Peloritanean area in Sicily (Pl. 3,11, see also Fig. 5). The precocious documentation of Lucanian amphorae in Palermo is fully in line with the evidences offered by other consumption sites located in Carthage's sphere of influence where transport vessels from Poseidonia and Elea appear to be consistently attested from the early 4th century BC onwards (Bechtold, 2013b; Bechtold, 2015b). The initial phase of this phenomenon, archaeologically documented by Gassner's earlier 4th-century BC rim shape 7 (Gassner and Sauer, 2015) has been related "...to the wider context of mobility of individuals and groups of individuals, merchandise and resources which characterises the relations especially of Punic western Sicily and southern Italy during the 4th century BCE" (Bechtold, 2013b), closely linked to Carthage's continued call for mercenaries. Moreover, the distribution patterns of 4th-century BC amphorae produced on the one hand in Punic North-Western Sicily and on the other in Lucania clearly indicate also "...an intensification of the commercial relations between the two areas throughout the 4th century BCE..." (Bechtold, 2015a).

The new amphorae data from Selinunte, Pantelleria and now Palermo form a strong argument for the hypothesis of a consolidation of a veritable commercial axis between the central-Tyrrhenian area (coastal Lucania and especially the Gulf of Naples) and North-Western Sicily towards the very late 4th or early 3rd centuries BC (previously Bechtold, 2013b). The sealed deposits of temple B in Selinunte dated ca. 300 BC or a little later represent an excellent, archaeological example. These contexts show equal proportions of Campanian and Lucanian vessels which constitute almost half of the 66 amphorae fragments recorded in these layers (Bechtold, 2015b). The new evidences from Palermo prove that already with the regular circulation of Gassner's first half of the 3rd-century BC rim shape 10 vessels from the Gulf of Naples (Pl. 1,3), as well as other, still unidentified coastal Tyrrhenian series (Pl. 2,5.8, especially CAMP-A-4) clearly outnumber the Lucanian amphorae group (Fig. 5). In this regard, of special interest is also the recent identification of a large number of Graeco-Italic amphorae perhaps from Lucania and/or North-Eastern Sicily (group MO 01, Gassner's rim types 8-9), the Gulf of Naples (group MO 03, Gassner's rim types 8-12 and Dressel 1) and Campania-Lazio (group MO 04, Gassner's rim types 9-12 and Dressel 1) in the *chora* of Entella (Corretti et al., 2014). According to the in-depth study of these survey-materials, in Entella's hinterland, Lucanian (?) amphorae disappear towards the early 3rd century BC, while Campanian vessels dominate all over the 3rd and 2nd centuries BC.

Historically, this phenomenon falls within the period following the supposed beginning of wine-production in the area of Capua-Gulf of Naples around 340 BC, after the colonial deduction of the *ager Falernus,* and the completion of the *foedus aequum* between Naples and Rome in 326 BC (van der Mersch, 2001; Olcese, 2010). Probably, the notable rise of Campanian amphorae imports at *Panormos* has to be dated to the first or second decade of the 3rd century BC, just after the Third Carthaginian-Roman contract of 306 BC, and runs parallel to the steadily increasing role of the port of *Neapolis*, linked to the commercial interests of an alliance of powerful Roman and Campanian families (Panella, 2010).

On the basis of the sample set of ca. 130 Graeco-Italic amphorae (Fig. 5), we can assume the continuous influx of vessels from Campania, especially from the Gulf of Naples, during the second and possibly also during the last third of the 3rd century BC (Gassner's rim shapes 11-12). Lucanian imports are still present, but in clearly lower proportions. The new amphorae data from Palermo though, make a strong case for the existence of stable, commercial interaction between the Bay of Naples and the Conca d'Oro most probably throughout the whole 3rd century BC (see now also Laino, 2017), even if sealed archaeological deposits posterior to the First Punic War are still missing (Bechtold, 2007). We might hence hypothesise that Panormos' port of call represented one of the major places of destination for the trading vessels of larger cabotage, moving from Campania along their southern route towards the most important consumption areas of Italian wine located in Punic Sicily and at Carthage. The Eolian archipelago formed certainly an almost obligatory stopping point for this commercial route, archaeologically documented by at least two (and perhaps four) early 3rd-century BC shipwrecks with cargoes composed mainly of Campanian Graeco-Italic amphorae (at latest Olcese, 2010; Cibecchini and Capelli, 2013).

In full harmony with these evidences, the identification of an early Graeco-Italian amphora of Gassner's rim 8 (Pl. 3,11) and a 3rd-century BC fragment of Gassner's rim 12 (Pl. 3,12), both originating from the North-Eastern Sicilian coastal region, just in front of the Eolian islands, in the area of ancient Tyndaris, Mylai and Messana, represents one of the most remarkable results of our joined research. Archaeometric studies have given evidence for the production of Gassner rim shape 8-amphorae (here defined as QCR) and more recent Graeco-Italic amphorae in the Messana area (Barone et al., 2009, subgroup 1a; Barone et al., 2011, sub-fabric A mica-rich). The documentation of small quantities of North-Eastern Sicilian Graeco-Italic amphorae in the North-Western Sicilian Punic towns of Palermo (see also sub-chapter 4.5) and Termini Imerese (Alaimo et al., 1997, group V) supports the hypothesis of a commercial involvement of this Eastern Sicilian production area in the long-distance trade between Campania and Punic Sicily. Even if we cannot exclude that the North-Eastern Sicilian amphorae reached *Panormos* on small-sized ships by coastal shipping, it seems more likely to imagine them to be loaded in a transitional port like *Lipara*, *Tyndaris* or *Mylai* on the bigger vessels moving from Campania. This latter hypothesis seems to be corroborated by the co-existence, within several archaeological deposits excavated at Milazzo, of Graeco-Italic amphorae mostly of central-Tyrrhenian provenance, associated with items of presumable local or regional fabric (Barone et al., 2009; Barone et al., 2011). Anyway, the coastal strip between *Messana* and *Mylai/Tyndaris* turns out to be one of the presently very few production areas of Graeco-Italic amphorae identified in Sicily. Hypothetically, the amphorae issue of this region has been related to the famous 'vino mamertino' mentioned by Plinius (Alaimo et al., 1997). Finally, we have to emphasise that our assemblage has given no evidence for the documentation of Graeco-Italic amphorae from western Sicily, although a local or regional production (group MO 02) has been identified among the survey materials from the *chora* of Entella (Corretti et al., 2014).

In summary and as a result, we suggest the consideration of Palermo as the main destination of the Tyrrhenian commercial route during the 3rd century BC. This hypothesis is based on the wide-spread distribution of Campanian Graeco-Italic 3rd-century BC amphorae at *Panormos*, as well as on the regular occurrence of contemporaneous Punic amphorae originating from the production area of *Solus-Panormos* in Tyrrhenian Calabria and especially in Lucania (Bechtold, 2015a). Following the assumption above, we might consider the harbour of *Panormos* as the principal distribution centre of the demanded Italian wine towards both coastal and inland western and southern Sicily (previously Olcese, 2010). Smaller-sized boats may have served the main ports (e.g. *Drepanum*, *Lilybaion*, *Selinus*) by coastal-shipping. A good example of this kind of re-distribution along the shores might be the late-3rd century BC vessel 'Terrasini 2' (Cibecchini, 2013) with a cargo composed of Graeco-Italic amphorae from the Bay of Naples, as well as from Mondragone (?) and Pyrgi (?) (Olcese, 2010). Alternatively, the navigable rivers, e.g. the Eleuterion in the north, the Iato in the west and the Belice in the south, would have represented the most important routes for commercial interaction with the indigenous populations of the Sicilian inland (Spatafora, 2012).

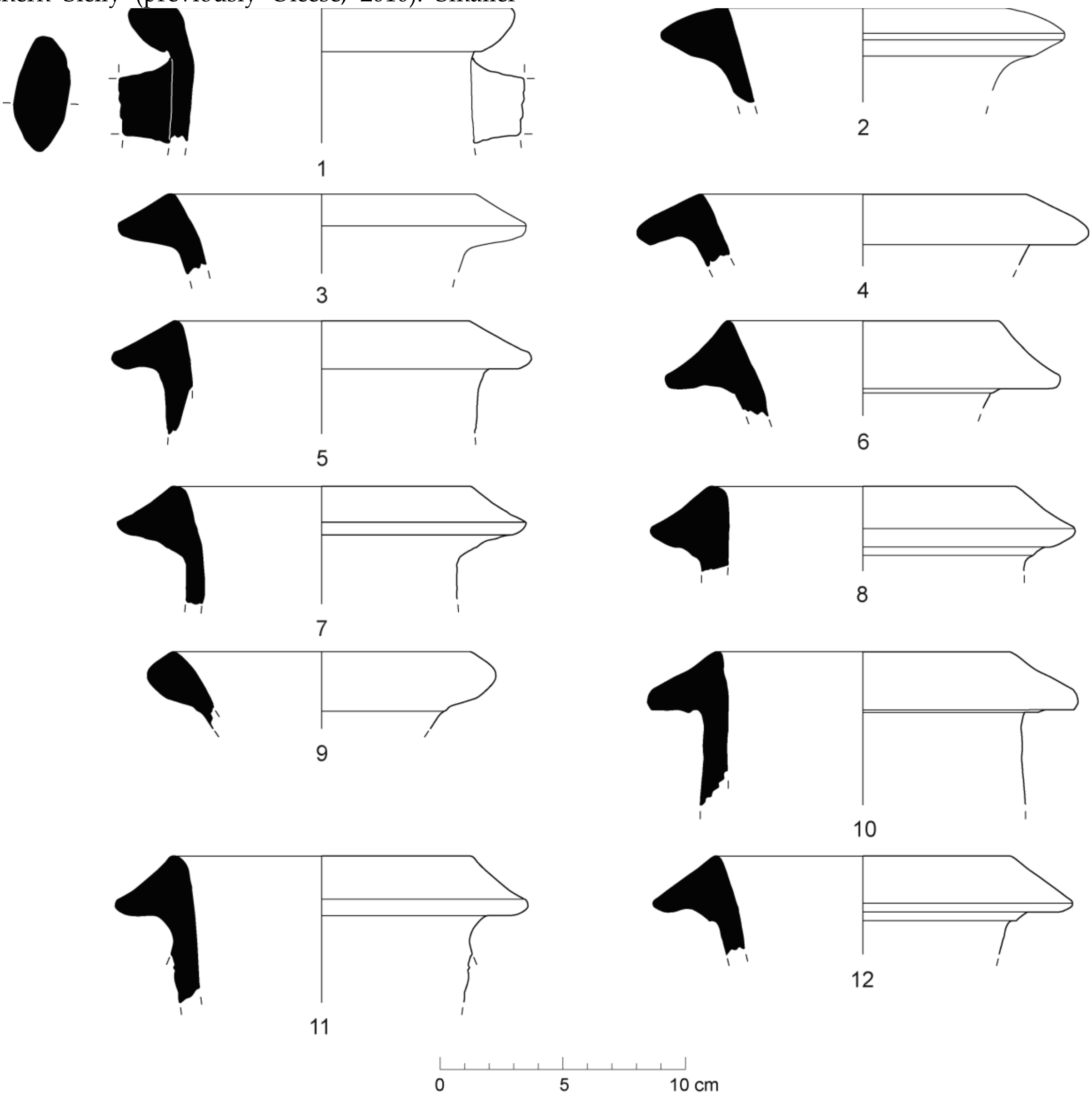


Plate 1. Graeco-Italic amphorae from the Gulf of Naples/Ischia. 1. Gassner rim 8. 2. Gassner rim 9. 3. Gassner rim 10. 4.-6. Gassner rim 11. 7.-8. Gassner rim 12. 9. Gassner rim 8 close to. 10.-12. Gassner rim 11.

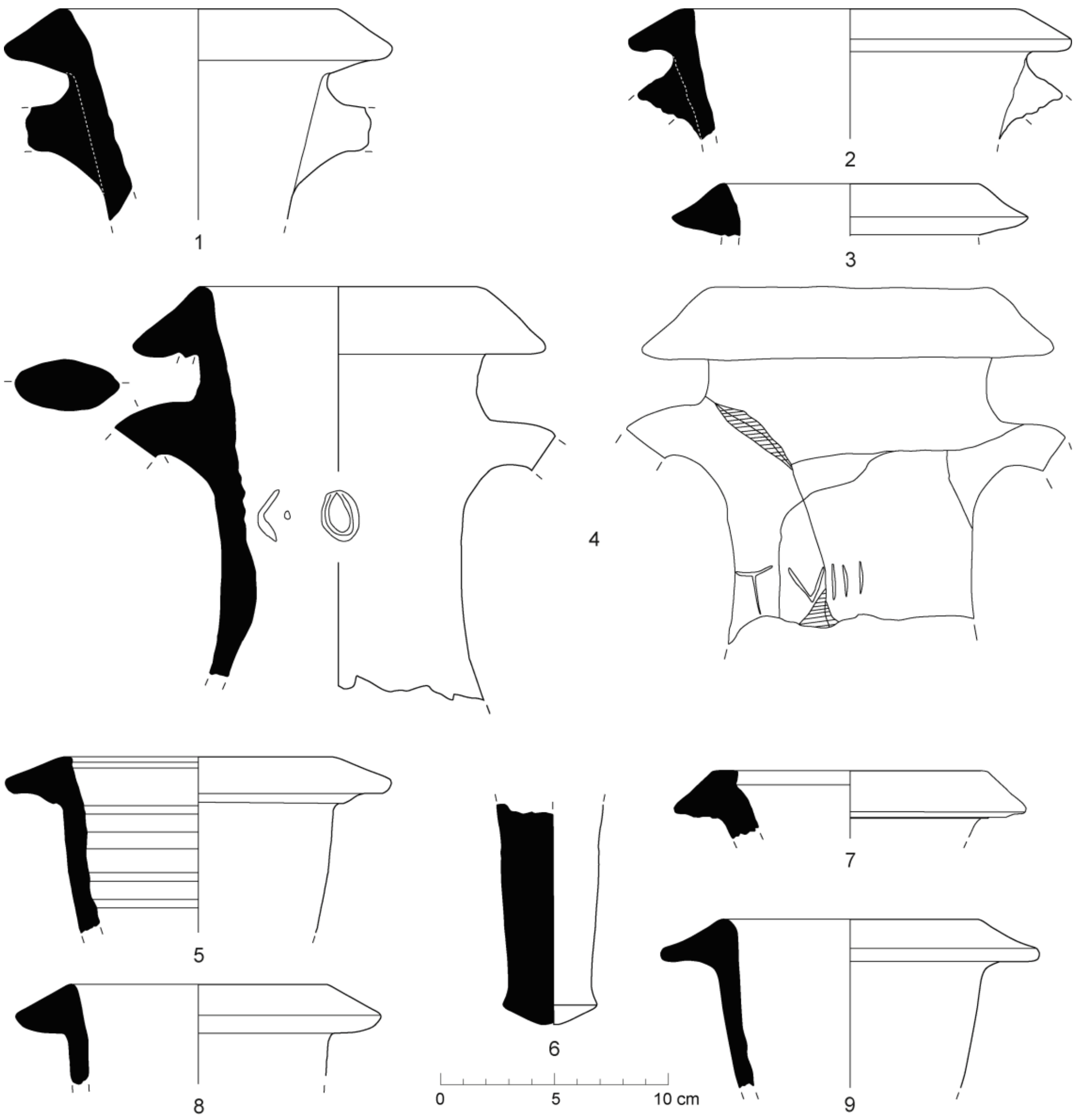


Plate 2. Graeco-Italic amphorae from the Gulf of Naples/Ischia. 1. Gassner rim 10. 2. Gassner rim 11. Graeco-Italic amphorae from coastal Campania/Lazio. 3. Gassner rim 12. 4. Gassner rim 11. 5. Gassner rim 10. 6. Gr.-Ita. VIa? 7. Hybrid type. 8. Gassner rim 10. 9. Gassner rim 11.

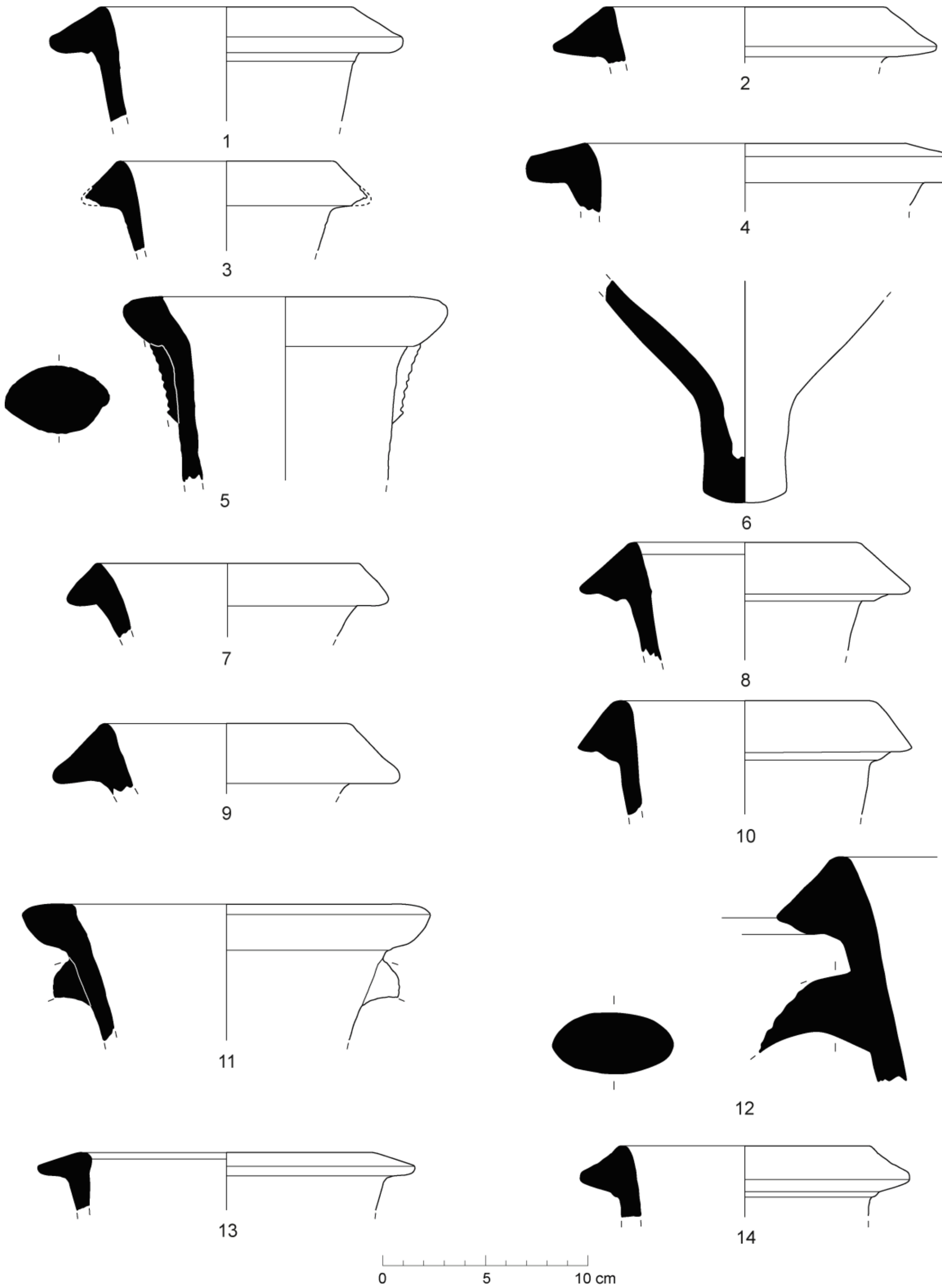


Plate 3. Graeco-Italic amphorae from coastal Campania/Lazio. 1. Gassner rim 11. 2.-3. Gassner rim 12. 4. Hybrid type. 5. Gassner rim 8. 6. Unattributed peak. 7.-9. Gassner rim 12. 10. Gassner rim 13. Graeco-Italic amphorae from the Eastern Nebrodi/Calabrian-Peloritani arc. 11. Gassner rim 8. 12. Gassner rim 12. Loners. 13. Gassner rim 10. 14. Gassner rim 12.

Table S1. Definition of the variables used for the automatic classification of the ceramic samples.

Variable Code	Variables	Description	Variable Code	Variables	Description	Variable Code	Variables	Description
VAR 1	Packing	1 = Very low (<3%)	VAR 6	Sedimentary Rocks	1 = Absent	VAR 11	Amphiboles	1 = Absent
		2 = Low (3-10%)			2 = Mudstone/Siltstone few			2 = Few
		3 = Medium (11-20%)			3 = Mudstone/Siltstone frequent			3 = Frequent
		4 = Medium/High (21-30%)			4 = Sandstone few			4 = Na-Am few
		5 = Very high (>30%)			5 = Sandstone frequent			5 = Na-Am frequent
VAR 2	Other Components	1 = Absent			6 = Limestone few	VAR 12	Micas	1 = Absent
		2 = Chamotte			7 = Limestone frequent			2 = Chlorite few
		3 = Volcanic glass few			8 = Volcaniclastic few			3 = Chlorite frequent
		4 = Volcanic glass frequent			9 = Volcaniclastic frequent			4 = Muscovite few
VAR 3	Plutonic Rocks	1 = Absent			10 = Chert few			5 = Muscovite frequent
		2 = Granitoid few			11 = Chert frequent			6 = Biotite few
		3 = Granitoid frequent			12 = 5 + 11			7 = Biotite frequent
		4 = Syenitoid few			13 = 4 + 7			8 = 5 + 7
		5 = Syenitoid frequent			14 = 7 + 10			9 = 4 + 6
		6 = Dioritoid/Gabbroid few			15 = 5 + 10			10 = 3 + 5 + 7
		7 = Dioritoid/Gabbroid frequent			16 = 6 + 8			11 = 2 + 5
		8 = Foid-bearing rocks few			14 = 7 + 10			12 = 3 + 5
		9 = Foid-bearing rocks frequent			15 = 5 + 10			13 = 3 + 7
		10 = Ultrabasic few			16 = 6 + 8			14 = 5 + 6
		11 = Ultrabasic frequent			17 = 7 + 11	VAR 13	Carbonates	1 = Absent
VAR 4	Volcanic Rocks	1 = Absent			18 = 4 + 10			2 = Dolomite few
		2 = Rhyolitoid/Dacitoid few			19 = 5 + 7 + 11			3 = Dolomite frequent
		3 = Rhyolitoid/Dacitoid frequent			20 = 2 + 4 + 10			4 = Calcite (primary) = few
		4 = Trachytoid few			21 = 10 + 4			5 = Calcite (primary) = frequent
		5 = Trachytoid frequent			22 = 2 + 4			6 = Secondary calcite
		6 = Andesitoid/Basaltoid few			23 = 2 + 10			7 = Microfossils / micritic clots/ cast few
		7 = Andesitoid/Basaltoid frequent			24 = 2 + 10 + 6			8 = Microfossils / micritic clots/ cast frequent
		8 = Foid-bearing rocks few			25 = 2 + 4 + 11			9 = Microfossils / micritic clots/ cast abundant
		9 = Foid-bearing rocks frequent			26 = 2 + 10 + 4 + 6			10 = 5 + 6

VAR 5	Metamorphic Rocks	1 = Absent			27 = 2 + 11			11 = 4 + 6
		2 = Slate- Phyllite few	VAR 7	Quartz	1 = Absent	VAR 14	Other Constituents	1 = Absent
		3 = Slate- Phyllite frequent			2 = Poly = few			2 = Tourmaline
		4 = Schist few			3 = Poly = frequent			3 = Leucite
		5 = Schist frequent			4 = Mono = few			4 = Aenigmatite
		6 = Gneiss few			5 = Mono = frequent			5 = Epidote
		7 = Gneiss frequent			6 = 3 + 5			6 = Zeolites
		8 = Amphibolite few			7 = 5 + 2			7 = Titanite
		9 = Amphibolite frequent			8 = 2 + 4			8 = Sillimanite
		10 = Blueschist/Eclogite few	VAR 8	Feldspar	1 = Absent			9 = Andalusite
		11 = Blueschist/Eclogite frequent			2 = Kfs few			10 = Kyanite
		12 = Granulites few			3 = Kfs frequent			11 = Staurolite
		13 = Granulites frequent			4 = Sa/Ano = few			12 = Apatite
		14 = Hornfels few			5 = Sa/Ano = frequent			13 = Olivine
		15 = Hornfels frequent			6 = 2 + 4			14 = Garnet
		16 = 5 + 9	VAR 9	Plagioclase	1 = Absent			15 = Opaque minerals few
		17 = 5 + 15			2 = Few			16 = Opaque minerals frequent
		18 = Serpentinite			3 = Frequent	VAR 15	Sorting	1 = Serial
		19 = 3 + 4 + 18	VAR 10	Pyroxenes	1 = Absent			2 = Bimodal
		20 = 4 + 18			2 = Opx = few			3 = Medium
		21 = 3 + 4			3 = Opx = frequent			4 = Good
		22 = 3 + 18			4 = Cpx = few			
		23 = 6 + 18			5 = Cpx = frequent			
		24 = 3 + 4 + 6			6 = Na-Px = few			
		25 = 3 + 6 + 18			7 = Na-Px = Frequent			
		26 =3 + 4 + 7						
		27 = 4 + 6 + 18						
		28 = 3 + 6						

Legend: Am = Amphibole, Opx = Orthopyroxene, Cpx = Clinopyroxene, Px = Pyroxene, Na = Sodium, Poly = Polycrystalline, Mono = Monocrystalline, Sa = Sanidine, Kfs = K-feldspar, Ano = Anorthoclase

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