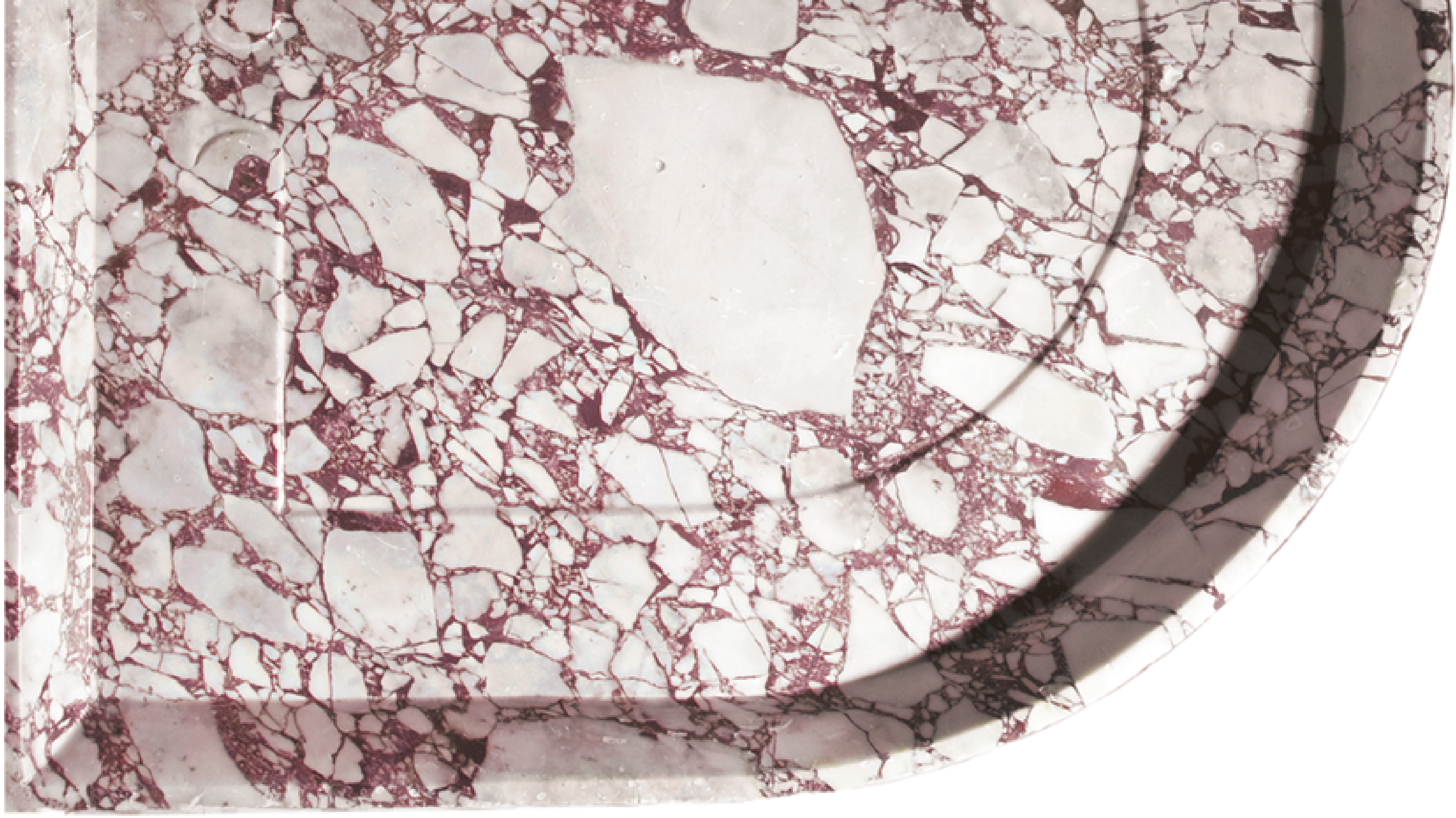

ASMOSIA XI

Interdisciplinary Studies on Ancient Stone

PROCEEDINGS

of the XI ASMOSIA Conference, Split 2015

Edited by Daniela Matetić Poljak and Katja Marasović

ARTS ACADEMY IN SPLIT

UNIVERSITY OF SPLIT

UNIVERSITY OF SPLIT, FACULTY OF CIVIL ENGINEERING, ARCHITECTURE AND GEODESY

Interdisciplinary Studies on Ancient Stone

Proceedings of the XI ASMOSIA Conference (Split 2015)

Publishers:

ARTS ACADEMY IN SPLIT
UNIVERSITY OF SPLIT

and

UNIVERSITY OF SPLIT
FACULTY OF CIVIL ENGINEERING,
ARCHITECTURE AND GEODESY

Technical editor:
Kate Bošković

English language editor:
Graham McMaster

Computer pre-press:
Nikola Križanac

Cover design:
Mladen Čulić

Cover page:
Sigma shaped *mensa* of *pavonazzetto* marble from Diocletian's palace in Split

ISBN 978-953-6617-49-4 (Arts Academy in Split)
ISBN 978-953-6116-75-1 (Faculty of Civil Engineering, Architecture and Geodesy)

e-ISBN 978-953-6617-51-7 (Arts Academy in Split)
e-ISBN 978-953-6116-79-9 (Faculty of Civil Engineering, Architecture and Geodesy)

CIP available at the digital catalogue of the University Library in Split, no 170529005

Association for the Study of Marble & Other Stones in Antiquity

ASMOSIA XI

Interdisciplinary Studies of Ancient Stone

Proceedings of the Eleventh International Conference of ASMOSIA,
Split, 18–22 May 2015

Edited by
Daniela Matetić Poljak
Katja Marasović

Split, 2018

Nota bene

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CONTENT

DOI: https://doi.org/10.31534/XI.asmosia.2015/02.05

ARCHAEOMETRIC ANALYSIS OF THE ALABASTER THRESHOLDS OF VILLA A, OPLONTIS (TORRE ANNUNZIATA, ITALY) AND NEW SR AND PB ISOTOPIC DATA FOR *ALABASTRO GHIACCIONE DEL CIRCEO*

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Abstract

A total of 13 thresholds composed of one or more blocks of alabaster (calcitic onyx alabaster) survive *in situ* at Villa A at Oplontis. The thresholds, which belong to Villa A's original phase of construction in the middle of the first century BC, arguably represent the most spectacular example of alabaster-use to survive from the villas and houses preserved by the eruption of Mt Vesuvius in AD 79. This article presents the results of the minero-petrographic and isotopic studies carried out on samples from these thresholds to determine their source. While a number of quarry sources can now be ruled out, the actual quarry source still remains uncertain. The results reiterate the need for a thorough investigation and re-examination of the sources of alabaster used in the Roman period in order to provide a comprehensive database of the alabaster quarries that may have been operating during Antiquity.

Keywords
Ancient calcareous alabasters, archaeometry, Villa A, Oplontis, Sr-Pb provenance fingerprinting

Introduction

Although alabaster was quarried in a number of locations throughout the ancient world and was highly valued during the Roman period for ornamental uses, many aspects related to its quarrying and use remain unexplored (Fig. 1). With reference to the study of ancient alabaster-use, there are two interrelated issues: the incomplete knowledge of all the sources (and the shortage of specific studies of archaeometric characterisation) and the fact that despite the wide distribution of alabaster in the Roman period, few objects or sites have been analysed and assigned to specific ancient quarries.[1] Part of the problem relates to the fact that calcitic alabaster deposits are very common throughout the Mediterranean with small outcrops that are difficult to identify for scientific study (thus many ancient sources have probably not yet been identified). We also have a very limited number of samples from individual quarries and extraction sites, which means a low representative selection, and it is possible that the quarries of the main varieties used in the Roman period could have been completely exhausted.

Thus, further identification of ancient alabaster quarries, scientific quarry data and the determination of the quarry provenance of individual objects remain a key part of understanding the origin, and therefore, distribution of and trade in alabaster. In line with this, we have attempted to determine provenance for the most important alabaster thresholds at Villa A at Oplontis (Torre Annunziata, Italy).[2] To this end, the article focuses on the alabaster thresholds from Villa A in their ancient context, their macroscopic characteristic, the sampling and methods used in their analysis, and the results, as well as new quarry data. This includes new Sr and Pb isotopic compositions for *alabastro*

1 Despite the work of BARBIERI *et al.* 2002a and 2002b; BRUNO 2002; ÇOLAK, LAZZARINI 2002; LAZZARINI *et al.* 2012; HERRMANN Jr. *et al.* 2012, SCARDOZZI 2012, much still needs to be done (see BARKER and PERNA in this volume).

2 The authors would like to thank the Oplontis Project (directed by J. Clarke and M. Thomas of the University of Texas at Austin and in collaboration with the Soprintendenza Speciale per i Beni Archeologici di Napoli e Pompei), for permission to take a total of 7 samples for analysis.

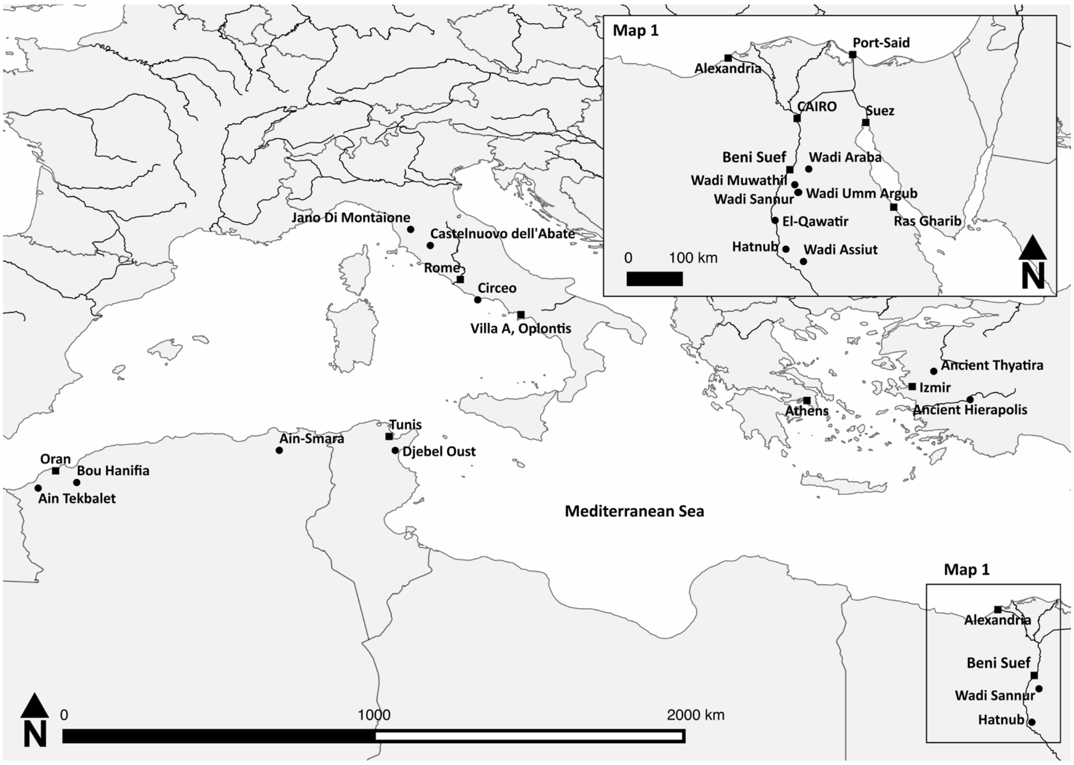


Fig. 1. Location of the ancient quarries of the most important coloured alabasters/ travertines used by the Romans (drawing: S. Barker)

ghiaccione del Circeo from La Batteria,[3] presented here for the first time, as well as a sample of a local *ghiaccione* alabaster from Hierapolis.[4] This is followed by a discussion and suggestions for further research.

The alabaster thresholds of Villa A in their ancient context

Villa A (the so-called Villa of Poppaea) is one of the largest and best-documented villas in the area destroyed by the eruption of Mount Vesuvius in AD 79.[5] An analysis of the stone decoration charted the use of stone through all phases of the Villa's history, from the initial construction of the Villa (c. 50 BC), to the renovations and additions during the Augustan period (c. AD 1-15) and finally to the east wing, constructed during the Julio-Claudian period after AD 45, and placed each phase within the context of wider stone use in the Bay of Naples and Italy.[6] This included an investigation of the 14 thresholds composed of one or more blocks of alabaster surviving *in situ* at Villa A that decorate the elegantly Second-Style painted rooms, such as the atrium (5), *triclinium* 14, *salone* 15 and *cubiculum* 11, as well as (surprisingly) some service areas (Fig. 2). See Table 1 for details of the alabaster thresholds sampled and Figures 3-7.

By the middle of the first century BC, the taste for imported marble was well established in Rome, but quantities remained very small, and almost none of it is known outside the most élite houses in the capital, let alone in provincial Campania. Pliny the Elder testifies to the novelty of alabaster, presumably calcareous, in mid-first-century BC Rome. According to him (following Nepos, 99-24 BC) Lentulus Spinther and Balbus, in 54 BC and 13 BC respectively, were amongst the first Romans to display alabaster items.[7] The stone's popularity continued into the late Flavian period as we learn from Statius' *Silvae* (after AD 93) where he describes the private baths of Claudius Etruscus (AD 1-90) and the house of Violentilla, which were lavishly lined with onyx.[8]

Large quantities of alabaster in single contexts were exceptional due to the dynamics of extraction and

3 BRUNO 1998.

4 The authors are most grateful to G. Quarta of the CNR laboratory at Lecce and G. Scardozzi of the Marmora Phrygiae Project for the sample.

5 On the importance and context of Villa A, see GAZDA 2016. On the history of the excavations, see CLARKE 2014. See The Oplontis Project Website for details of the project and its publications to-date: http://www.oplontisproject.org.

6 See BARKER and FANT, *forthcoming.*

7 Pliny, *NH,* 36.59-60.

8 Statius, *Silvae*, I.5.1-65; I.2.149.

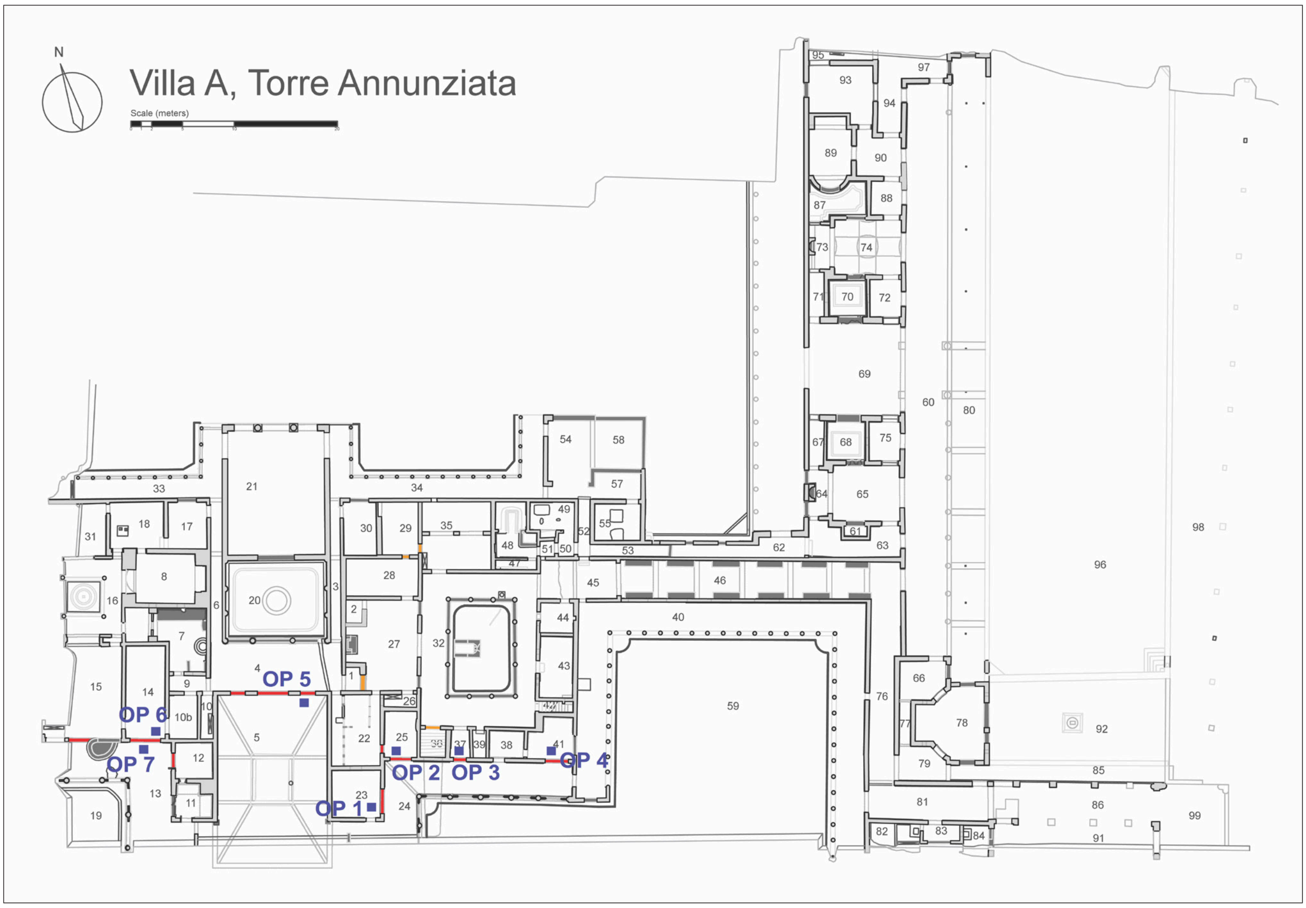


Fig. 2. Plan of Villa A, Oplontis and sample locations (photo: Oplontis Project)

Threshold Location	Sample Number	Description	Estimated Volume
23/24	OP 1	Threshold installed in three blocks. From north to south, the three blocks measure 88 x 45 cm, 81 x 45 cm, and 70 x 45 cm respectively. The total length of the threshold is 238 cm. The northern and southern blocks have square hinge sockets cut into the stone.	0.5 m^3
24/25	OP 2	Threshold installed in three blocks. From west to east, the blocks measure 70 x 37 cm, 67 x 37 cm, and 59 x 37 cm respectively. The total length of the threshold is 196 cm. The eastern and western blocks of alabaster have square hinge sockets cut into the stone.	0.35 m^3
37/24	OP 3	Solid threshold installed in one piece. The threshold measures 120 x 37 cm. There is a substantial fissure in the stone c. 32 cm west of the east wall. There are two square hinge sockets cut into the block at the east and west sides.	0.22 m^3
41/24	OP 4	Threshold, inserted in two blocks. The two blocks measure 95.5 x 38 cm and 124.0 x 38 cm. The total width is 219.5 cm. The stone is broken but complete. There are two integrated hinge sockets on the east and west sides.	0.41 m^3
5/4	OP 5	Threshold installed in three blocks. From east to west, the blocks measure 150 x 23 cm, 155 x 23 and 145 x 22 cm. The total width is 450 cm. There are two integrated hinge sockets on the east and west sides.	0.5 m^3

Table 1. Details of the alabaster thresholds sampled (table: S. Barker)

Fig. 3.
Villa A, Oplontis. Threshold 23/24, Sample OP1(photo: Oplontis Project)

Fig. 4.
Villa A, Oplontis. Threshold 25/24, Sample OP 2 (photo: Oplontis Project)

Fig. 5.
Villa A, Oplontis. Threshold 37/24, Sample OP 3 (photo: Oplontis Project)

Fig. 6.
Villa A, Oplontis.
Threshold 41/24,
Sample OP 4 (photo:
Oplontis Project)

Fig. 7.
Villa A, Oplontis.
Threshold 13/14,
Samples OP6 and
OP7 (photo:
Oplontis Project)

thus availability. Its limited distribution in comparison to the distribution of polychrome marble made the use of alabaster a clear indication of the wealth and status of the house owners. The evidence from Villa A leaves no doubt about the almost exclusive use of this stone in élite contexts, thus confirming the testimony of ancient authors on the presence of such material in the houses of the wealthy. Alabaster only began to be exploited more frequently by the Romans in the mid-first century AD,[9] when in fact we find it more widely in houses within the Vesuvian area (see Barker and Perna this volume). Within the initial construction, the Villa's use of alabaster is therefore not only striking but it also stands out as perhaps the most spectacular example of alabaster-use to survive from the villas and houses preserved by the eruption of Mt Vesuvius in AD 79.[10] The use of alabaster for the thresholds has of course already been noted,[11] however the importance of the Villa's use of alabaster has only recently been recognized.[12]

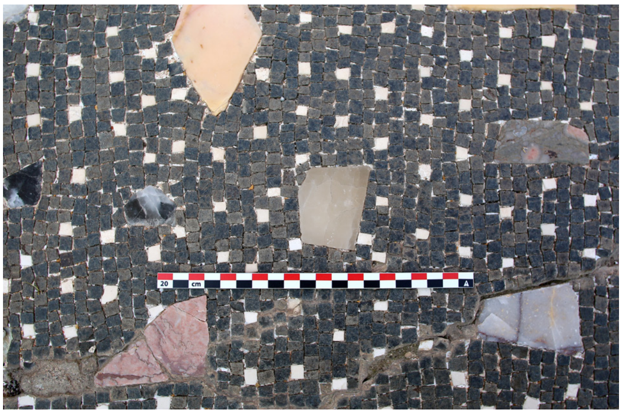
In its original construction, Villa A's alabaster thresholds joined and perhaps surpassed contemporary élite houses in Rome, headlined by M. Lepidus (consul in

9 BRUNO 2002; LAZZARINI *et al.* 2009; 2012; ÇOLAK, LAZZARINI 2012; HERRMANN Jr. *et.al.,* 2012.

10 All of the alabaster thresholds can be dated to the original construction during the Second-Style period, c. 50 BC, see BARKER and FANT *forthcoming*.

11 PISAPIA 1997, 559.

12 BARKER and FANT, *forthcoming.*



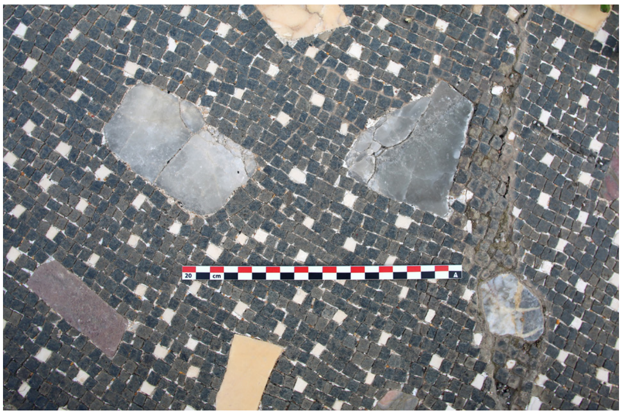


Fig. 8a, 8b. Casa di Umbricius Scaurus (VII, 16 (Ins. Occ.), 12-15), Pompeii. Mosaic pavement in Atrium (2), detail of the alabaster inserts (photos: S. Barker)

Fig. 9. Casa di Umbricius Scaurus (VII, 16 (Ins. Occ.), 12-15), Pompeii. Atrium (2), impluvium (photo: S. Barker)

78 BC), who first displayed a solid threshold block of *giallo antico*.[13] The most common use of alabaster in private houses contemporary to the thresholds at Villa A was as small inserts in pavements. For example, the Second-Style mosaic pavement in room 62 (*atriolo tetrastilo*) of the Villa dei Misteri includes many inserts of alabaster that have been identified visually as *alabastro del Circeo*,[14] although it is more likely that they are bleached Egyptian onyx. Inserts of alabaster macroscopically similar to the alabaster thresholds of Villa A (especially threshold 25/25, OP 02) are found in the mosaic pavement of the atrium of the Casa di Umbricius Scaurus (VII, 16 (*Ins. Occ.*), 12-15) at Pompeii (Fig. 8a, 8b), which also features a drain at the north end of the *impluvium* in the same type of alabaster (Fig. 9).

There are only three examples of thresholds, all at Pompeii, which feature alabaster: the Casa di Cerere (I, 9, 13) and the Villa dei Misteri, both datable to the Second-Style period, and the Casa de "Euxinus" (I, 11,12), which is difficult to date precisely.[15] The latter features a block, most likely recycled, inserted into a rough cement floor.[16] The Casa di Cerere features a threshold of polychrome mosaic with a rhombus pattern motif, either side of which are small rectangular slabs of alabaster (Fig. 10), probably from Egypt or Italy.[17] The threshold at the Villa dei Misteri, located in room 47 off room 62 (*atriolo tetrastilo*), features two types of alabaster, probably from Egypt (Fig. 11).

Blocks for thresholds are more typically of white marble, and even they only became common at Pompeii after the Augustan period.[18] Other than the exceptional example of M. Lepidus noted above and a few examples at Pompeii,[19] thresholds of marbles other than white at Pompeii and Herculaneum date to the Fourth-Style period. The owners of the Casa di N. Popidius Priscus (VII, 2, 20) at Pompeii, for example, seem to have been in the process of installing stone thresholds of green porphyry and *cipollino verde* at the time of the eruption,[20] and at the Casa dei Cervi in Herculaneum a slab of *alabastro a*

13 Pliny, *NH,* 36. 49.

14 CICIRELLI, GUIDOBALDI 2000, 43, fig. 57.

15 For the Casa di Cerere: *PPM* II, 219. For the house at I.11.12: *PPM* II, 582-583.

16 The block is located in *fauces* (a).

17 The threshold is located between *cubiculum* (k) and *tablinum* (j). *PPM* II, 219, fig. 72.

18 FANT 2007.

19 One possible exception is a threshold of gray marble between the *apodyterium* (v) and garden (2) in the Casa delle Nozze d'Argento (V, 2, 1) probably dated to the Second-Style period; *PPM* III, 731.

20 FANT 2007, 340. The thresholds are piled up in the corner of the house's large peristyle, but their measurements correspond to the widths of the doorways facing that courtyard.

Fig. 10. Casa di Cerere (I, 9, 13), Pompeii. *Cubiculum* K. Threshold of polychrome mosaic with a rhombus pattern motif, on either side of which are small rectangular slabs of alabaster, datable to the Second-Style period (photo: S. Barker)

Fig. 11. Villa dei Misteri, Pompeii. Alabaster threshold in room 47 off room 62 (*atriolo tetrastilo*), datable to the Second-Style period (photo: S. Barker)

pecorella was set into the Fourth-Style mosaic directly in front of the entrance into *oecus* 16. In this context, therefore, the Villa's solid threshold blocks of alabaster must have made a spectacular impression when the Villa was inaugurated in the mid-first century BC. They highlight the luxury status of the Villa within the wider context of private residences in Campania.

It is for these reasons that we decided to undertake archaeometric analysis of the Villa A thresholds, with the expectation that the results should provide further data regarding the potential sources and uses of this ornamental stone during Antiquity.

Macroscopic characterisation

Visual characteristics of the Villa A alabaster vary from dark beige to light grey with wavy patches and no banding and coarse to very coarse compact crystalline calcite. This corresponds to a variety of alabaster known as *alabastro ghiaccione*, a calc-synter,[21] characterized by a translucent white grey to greenish base with some brown inclusions. A number of ancient quarries could be plausible sources of *ghiaccione*: Jano di Montaione in Tuscany, Circeo in Latium, Uthina/Thuburbo Maius near present-day Djebel Oust in North Africa;[22] the Hierapolis area in the Pamukkale plateau[23] of Asia Minor

21 LAZZARINI 2002, 35.

22 LAZZARINI *et. al*. 2012, 437-438.

23 There are small quantities of *alabastro fiorito* from these quarries in the floors at Pompeii and Herculaneum; BRUNO 2002, 19.

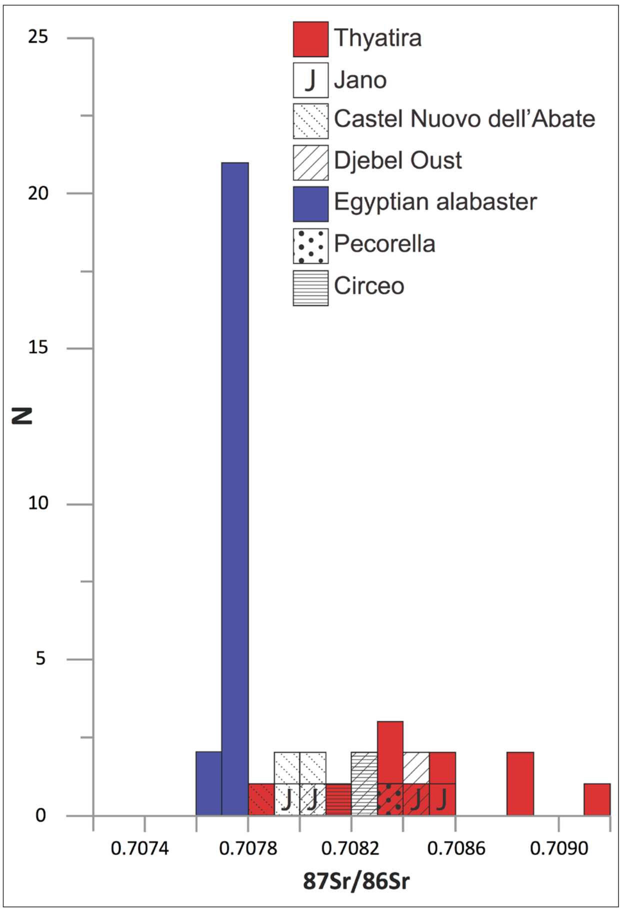


Fig. 12. Histogram with Sr isotopic ratios of possible alabaster sources for the Oplontis samples (drawing, after LAZZARINI *et al.* 2012, with additions by S. Barker)

(*marmor Hierapolitanum*). Alabasterine gypsum could derive from Fayyum (Egypt) and the island of Crete.[24] Due to the difficulty of positive identification via visual analysis (most of the quarries noted above could have produced white *ghiaccione* alabaster with similar macroscopic and microscopic characteristics), a total of 7 samples from 6 thresholds were subjected to archaeometric analysis with the aim of determining the source of the stone and whether several varieties were used to compose individual thresholds, particularly those of rooms 13/14 and 23/24.

Sampling and Analytical Methods

All seven samples were subjected to minero-petrographic and isotopic study. XRD (CuKa at 40 KV, 20 mA) analyses were performed at Laboratorio di Analisi dei Materiali Antichi to check the presence of calcite/aragonite and the type of Fe-oxides/hydroxides. In the light of research suggesting the superiority of strontium isotope analysis as a method for provenancing calcite-alabaster/travertine[25], $^{87}Sr/^{86}Sr$ analyses were performed at the Institut für Geologie, Universität Bern. As an additional discriminating tool, Pb isotopic compositions were determined on the same samples used for Sr isotope analyses. At present, there are only Pb data available for the Circeo quarry, and the present analyses can only address the homogeneity of the provenance of the Villa A samples. We plan to augment the database to include Pb isotope data.

Sr and Pb were purified from the Ca matrix using miniaturized chromatographic columns and analyzed on a Nu Instruments™ multicollector plasma source mass spectrometer, following LAZZARINI *et al.* and Villa, respectively.[26] The results were compared with the alabasters of Jano di Montaione and Castelnuovo dell'Abate (Tuscany), Circeo, Uthina/Thuburbo Maius, Thyatira (Asia Minor), Hierapolis, and a number of Egyptian alabasters, for which Sr isotope ratios are known (Fig. 12).[27] In addition, two previously untested varieties of *ghiaccione* have been compared: a sample of *ghiaccione* from Hierapolis provided by G. Quarta of the CNR laboratory at Lecce, which is of local origin, and the *alabastro ghiaccione del Circeo* from la Batteria. The complete analytical data (Sr and Pb isotope ratios) for both of these varieties are presented here for the first time.

New quarry for *alabastro ghiaccione del Circeo*

The ancient quarry at La Batteria near the Circeo promontory may be reached with difficulty by ground from the face of Torre Cervia, but is more easily accessible from the sea. The quarry contains several blocks of white *ghiaccione in situ*, likely quarried in the Renaissance, and a rather wide area covered by ancient debris. Two samples, one with a fragment of the "mother limestone", were taken and submitted to analysis. The X-Ray diffraction of both samples showed only the presence of calcite, and the thin section cut parallel to the crystal growth, showed the usual fibrous-radiated fabric typical of all alabasters. Such minero-petrographic features (composition and fabric) unfortunately proved of no use for provenance studies.

The Sr isotope analyses of the two *ghiaccione* samples, AGH-1 and AGH-2, have yielded identical results:

24 HARRELL 2012, 19 (for Egypt) and BARBIERI 2002b (for Crete).

25 ÇOLAK, LAZZARINI 2002, 38-40; LAZZARINI *et al.* 2012.

26 LAZZARINI *et al.* 2012; VILLA 2009.

27 Recent work has increased the database of microscopic characterisation of various alabasters, including those from Egypt (Eastern Desert), Algeria (Ain Tekbalet, Bou Hanifia), Tunisia (Djebel Oust), Turkey (Harmandali, Golemezli), Crete and Italy; BARBIERI *et al.* 2002a; 2002b; ÇOLAK, LAZZARINI 2002; LAZZARINI *et al.* 2006; 2012.

Fig. 13. Alabaster block with architrave and frieze. From the excavation of the southern sector of the Early Byzantine city walls at Hierapolis (Sample 185) (photo: G. Scardozzi)

Fig. 14. Detail of the alabaster block with architrave and frieze. From the excavation of the southern sector of the Early Byzantine city walls at Hierapolis (Sample 185) (photo: G. Scardozzi)

Fig. 15. The macroscopic aspect of the alabaster block from the southern sector of the Early Byzantine city walls at Hierapolis (Sample 185) (photo: G. Scardozzi)

$^{87}Sr/^{86}Sr$ (AGH-1) = 0.708232 ± 0.000024 (2 sigma errors); $^{87}Sr/^{86}Sr$ (AGH-2) = 0.708231 ± 0.000044. These data contrast with a previous analysis of a sample from a modern quarry of the yellow-brown Circeo alabaster.[28] See Table 2 for the Oplontis samples and Table 3 for the current Sr isotope database.

Data for the Hierapolis sample

The Hierapolis sample was collected during the 2013 field campaign of the Marmora Phrygiae Project (co-ordinated by G. Scardozzi) and was taken from a block with architrave and frieze (Fig. 13, 14 & 15), re-used in the southern sector of the Early Byzantine city walls. The monument in which it was originally used is unknown. The architrave block can be dated to the second century BC. The main quarries of this type of stone are near Hierapolis: one is between 400 and 800 m to the west of the city, the second is about 1.8-2 km northwest of the city, and a third quarry is in the Gölemezli area, c. 13 km northwest of Hierapolis.[29] The Sr isotope analyses of the *ghiaccione* alabaster sample from Hierapolis (Sample 185)[30] have yielded the following results: $^{87}Sr/^{86}Sr$ = 0.707880 ± 0.000024 (Tables 2 and 4**)**.

Results

Initial visual analysis suggested that the yellow-honey variety of alabaster from Oplontis could have been sourced from Egypt (*cotognino*) and the dark white and translucent blocks could have been from Italy; however, the result of pure calcite from the XRD analyses rules out a provenance from Fayyum or Crete (Fig. 16). The calcite-alabaster from Egypt and Hierapolis also can be ruled out, but the latter and Castelnuovo dell'Abate overlap with the comparatively dispersed fields of Jano di Montaione, Thyatira, and Uthina/Thuburbo Maius (Tables 2 and 3 and Fig. 17). There is some ambiguity regarding the *alabastro ghiaccione del Circeo*: the three analysed quarry samples are not compatible with most of the Oplontis thresholds, but they might be compatible with threshold 23/24, whose Sr isotopic composition is greatly different from that of the other five thresholds analysed (Fig. 18a & b). Moreover, the three quarry samples analysed suggest the same genetic heterogeneity as the larger datasets of Thyatira and Jano di Montaione. Thus, pending a more comprehensive sampling of the Circeo quarries, they cannot be conclusively excluded as potential sources.

28 LAZZARINI *et al.* 2006

29 SCARDOZZI 2012.

30 The number 185 was used during the sample's collection. Its final project ID number is H13_173.

Sample no.	$^{87}Sr/^{86}Sr$	2 sigma	$^{206}Pb/^{204}Pb$	2 sigma	$^{207}Pb/^{204}Pb$	2 sigma	$^{208}Pb/^{204}Pb$	2 sigma	$^{208}Pb/^{206}Pb$	2 sigma	$^{207}Pb/^{206}Pb$	2 sigma
OP 1	0.708214	0.000026	18.4941	0.0023	15.6588	0.0022	38.6530	0.0074	2.08996	0.00025	0.84668	0.00004
OP 2	0.708295	0.000035	18.5145	0.0016	15.6568	0.0019	38.6908	0.0051	2.08985	0.00017	0.84566	0.00005
OP 3	0.708314	0.000033	18.5741	0.0029	15.6646	0.0025	38.7617	0.0073	2.08693	0.00015	0.84338	0.00003
OP 4	0.708332	0.000039	18.4332	0.0085	15.6808	0.0071	38.6104	0.0166	2.09471	0.00016	0.85068	0.00005
OP 5	0.708296	0.000044	18.1912	0.0061	15.6318	0.0052	38.2648	0.0130	2.10344	0.00011	0.85931	0.00003
OP 6	0.708292	0.000036	18.5264	0.0018	15.6688	0.0021	38.7472	0.0065	2.09145	0.00019	0.84575	0.00004
OP 7	0.708305	0.000037	18.3880	0.0015	15.6516	0.0016	38.5441	0.0047	2.09614	0.00013	0.85116	0.00004
Hierapolis (#185)	0.707880	0.000024	18.6724	0.0031	15.6915	0.0028	38.8056	0.0076	2.07822	0.00017	0.84041	0.00004

Table 2. Results of the analysis of the Sr and Pb isotopic compositions for the sampled alabaster thresholds of Villa A and the Giovanni Quarta sample #185 from Hierapolis theatre analysed at the Institut für Geologie in Bern by Igor M. Villa (table: I. Villa)

Egypt						Crete						
El-Qawatir	Hatnub	Wadi Sannur	Wadi Barschawi	El-Ghurayib	Bosra-Wadi Assyuti	Anopoli	Ierani	Proph. Elias	Eleftherna Milopotamou	Kaverna-Labyrinth, Gortis	Atsipopoulo	Afrata-Kissamou
0.70770	0.70770	0.70772	0.70771	0.70771	0.70773	0.70826	0.70847	0.70880	0.708942	0.708312	0.70908	0.708951
0.70771	0.70772	0.70776	0.70774	0.70774	0.70777	0.70808	0.70845	0.70798				
0.70772	0.70772	0.70776				0.70818	0.70840	0.70850				
0.70774	0.70774	0.70780				0.70817	0.70809	0.70802				
0.70777	0.70775					0.70820	0.70803	0.70804				
0.70780	0.70777					0.70802	0.708373	0.70804				
	0.70778							0.70892				
								0.70894				
								0.70789				
								0.70880				

Table 3. Alabaster Sr isotope data-base for Egypt and Crete (after BARBIERI 2002b, Tables 2 and 3)

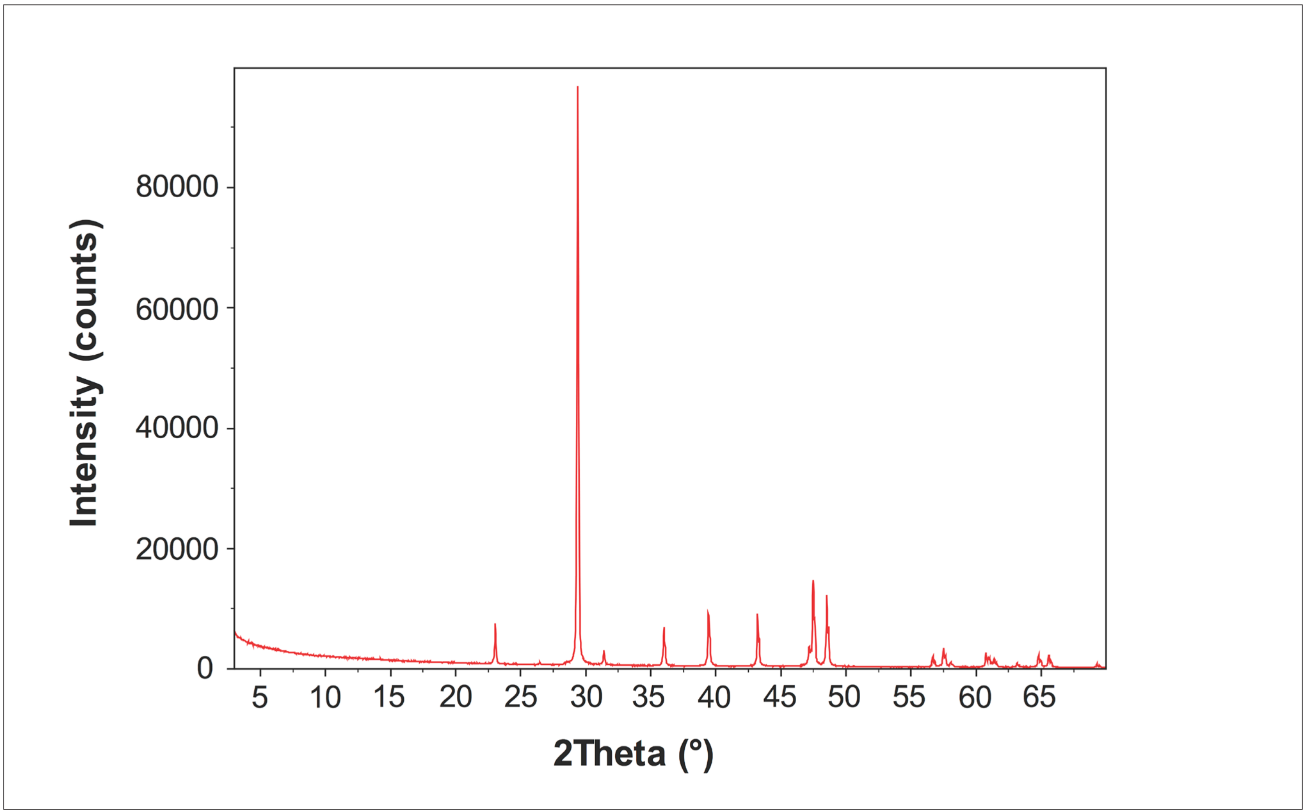


Fig. 16. X-Ray diffractogram (Cu Ka, 40 KV, 20mA) of sample 7 showing only the peaks of calcite (Ca CO3) (drawing: L. Lazzarini)

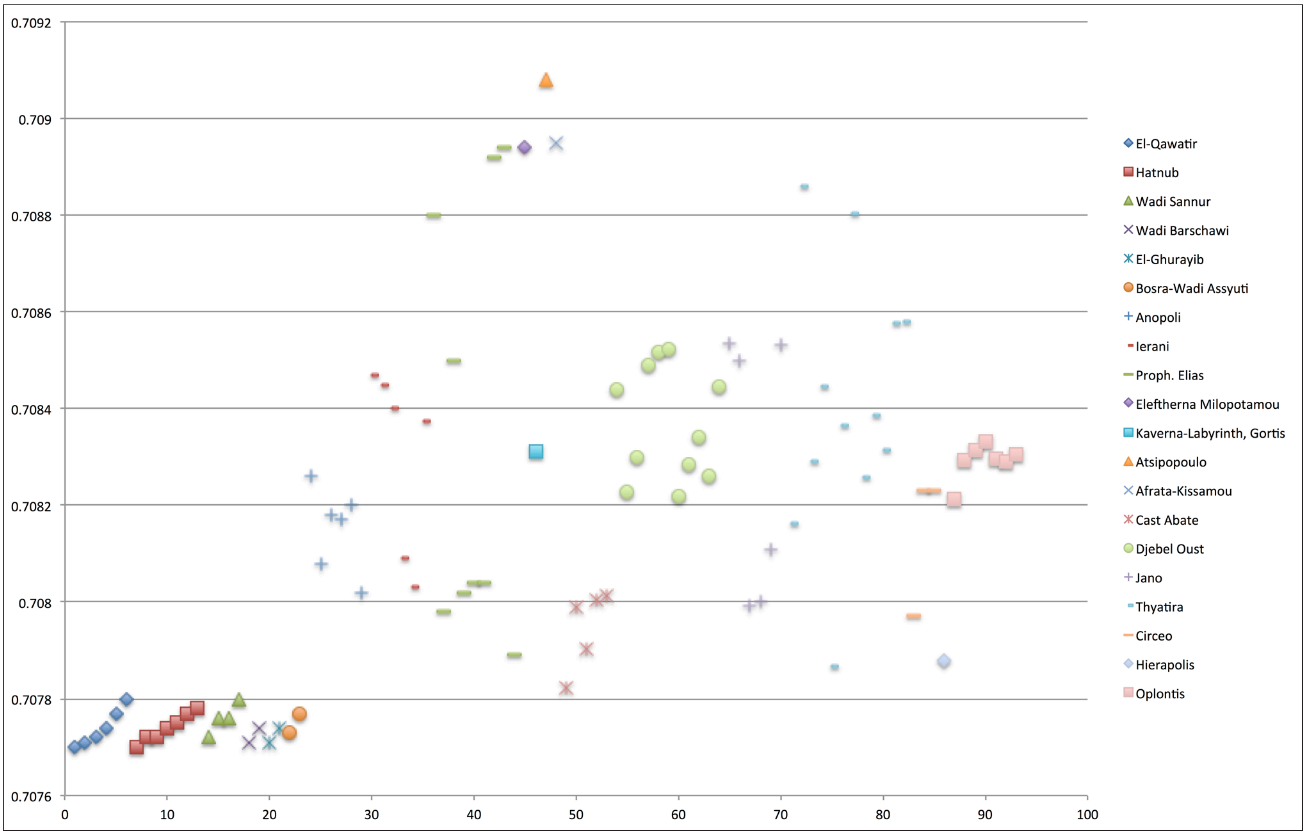


Fig. 17. Known Sr isotope results for alabaster quarries and Oplontis threshold samples. (drawing: I. Villa and S. Barker)

Italy			North Africa	Asia Minor	Artefact Samples	
Castelnuovo dell'Abate	Jano di Montaione	Circeo	Djebel Oust	Thyatira	Hierapolis Theatre	Oplontis
0.707824	0.708536	0.707973	0.708439	0.708162	0.707880	0.708214
0.707989	0.708500	0.708232	0.708229	0.708859		0.708295
0.707903	0.707994	0.708231	0.708299	0.708292		0.708314
0.708003	0.708002		0.708491	0.708446		0.708332
0.708012	0.708109		0.708517	0.707868		0.708296
	0.708533		0.708524	0.708365		0.708292
			0.708218	0.708804		0.708305
			0.708286	0.708259		
			0.708340	0.708385		
			0.708260	0.708315		
			0.708446	0.708578		

Table 4. Alabaster Sr isotope database of quarry samples and artefact samples analysed at the Institut für Geologie in Bern by Igor M. Villa (table: I. Villa)

In order to move from negative evidence (i.e. identifying the sources that *could not* have supplied the alabaster) to a positive identification it is necessary to augment the database to include trace elements, which have been a useful geochemical tool for identifying other materials.[31] In the present work we have measured Pb isotopic compositions of the threshold samples as a supplementary discriminating tool. The dispersion of points in the $^{207}Pb/^{204}Pb$ vs $^{206}Pb/^{204}Pb$ diagram (Fig. 19) requires one or more heterogeneous sources. This can be explained in two ways: (1) the thresholds derive from different localities, which is rather implausible, given the archeologically exceptional occurrence of such large volumes of alabaster, and given the great visual similarity of the individual slabs, or (2) the geological process leading to the formation of calcareous alabaster leads naturally to a heterogeneous isotopic signature of both Sr and Pb, further to that of C and O.[32] A genesis of alabaster lenses by localized recrystallization of a pre-existing carbonate/marble protolith can easily explain the heterogeneity, as the circulating aqueous fluid did not interact completely with the protolith and left behind microscopic relicts, as attested by the variety of petrographic replacement structures.[33] Macroscopic sampling of a texturally complex mixture of replacements and relicts is expected to yield heterogeneous isotopic and elemental signatures.

The Pb isotope analyses could, at least in principle, be used to derive a model Pb-Pb age of the formation of the alabaster; however, the second genetic mechanism described above, which involves at least three separate events (the deposition of marine carbonate sediments, the metamorphism of sediments to marble, and the fluid circulation transforming marble into alabaster) implies that any alignment is more likely to represent the mixing between different fluid sources than to reflect a well-defined genesis. Indeed, the large dispersion of the points in Fig. 18b rules out an interpretation as a single-stage mineral formation event.

31 I.e. bronze sources; VILLA, 2016.

32 LAZZARINI *et al.* (2006) observed that the alabaster in Thyatira had a substantially higher and much more variable Sr isotopic composition than the surrounding marble.

33 LAZZARINI *et al.* 2006.

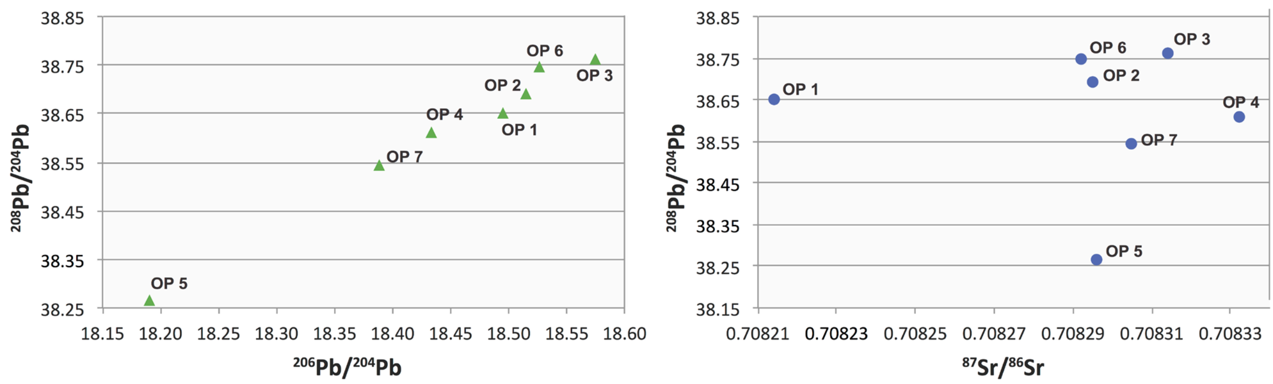


Fig. 18a, 18b. Sr and Pb isotope plots for Villa A threshold samples OP1-7 (drawing: I. Villa)

Discussion

The current results of the ^{87}Sr/^{86}Sr and Pb isotope ratio analyses indicate that the Oplontis samples are most compatible with a number of quarries: Thyatira, Djebel Oust and Circeo. Jano di Montaione also remains a possibility, albeit remote. It is highly probable that the Italian alabasters from Jano di Montaione (and Castelnuovo dell'Abate) were known and exploited as early as 50 BC; however, since they are quite large and deeply exploited, the evidence for quarrying activity is currently scarce.[34] At both Italian quarries, the mother and embedding rocks are yellowish/brownish. It is possible that an area with white/grey alabaster could have existed that is now exhausted, although this is more likely for Jano di Montaione than for Castelnuovo dell'Abate.

The quarries of ancient Thyatira are located immediately south of Harmandali and recent surveys have found debris, tool marks, and discarded architectural elements from extensive Roman quarrying at the site. The varieties from these quarries are very compact with alternating thick semi-transparent layers of pure honey-coloured calcite, and thin milky-white, opaque layers forming areas with a typical concretional fabric (Fig. 20). Examination of the Thyatira quarries[35] did not identify a *ghiaccione* variety, but Thyatira must remain a serious possibility since there are light honey-colored varieties of alabaster there and we cannot exclude the continuing modern exploitation perhaps having exhausted this variety of alabaster or further deposits remaining to be discovered in this vicinity.

Two varieties are known from the Djebel Oust alabaster quarries, c. 50 km south of Tunis (Fig. 21): holotype, characterised by a regular fabric formed by thick layers of yellowish, sometimes greenish colour

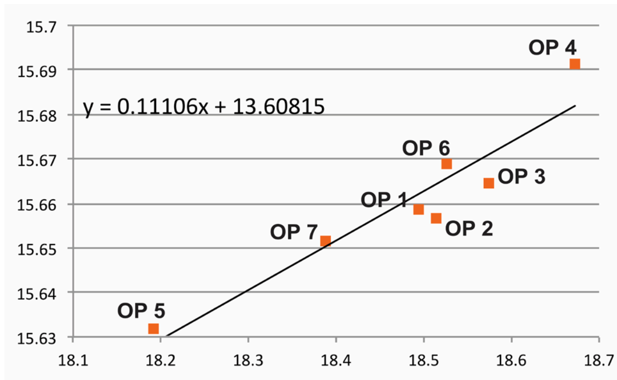


Fig. 19. Model Pb-Pb age 1.40 Ga (drawing: I. Villa)

alternating with layers of red-purplish colour, and a variety similar to Egyptian *fiorito*. Despite emerging from the analysis as a possible source, Djebel Oust may be sensibly excluded due to the absence of a white or light coloured *ghiaccione* variety at the quarry: the mother and embedding rocks are deeply yellow-red in colour. Moreover, the dark-red alabaster from Djebel Oust seems to have been mainly used for local and North African production of *sectilia* panels and is difficult to quantify – this may have been due to the physical conformation of the beds, which seems to have only allowed the extraction of relatively small blocks.[36] Moreover, the use of this stone peaked in Rome in the late Imperial period.[37]

Circeo is geographically speaking the best candidate for the Oplontis alabaster. At least four main alabaster quarries have been identified to the southwest of the Circeo promontory in Latium.[38] The *ghiaccione* variety was

34 LAZZARINI *et al.* 2012.

35 ÇOLAK, LAZZARINI 2002.

36 LAZZARINI *et al.* 2012, 444.

37 GNOLI 1988, 22.

38 BRUNO 1998, 213-220; 2002, 286.

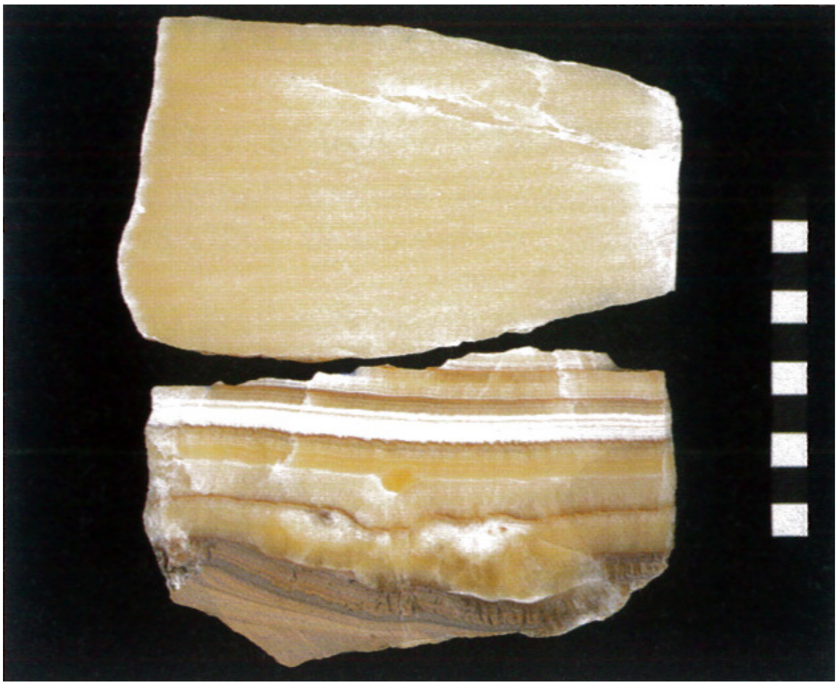


Fig. 20.
The macroscopic aspect of alabaster from the quarry of Thyatira (photo: L. Lazzarini)

Fig. 21.
Samples of the alabaster from the quarry of Djebel Oust (photo: L. Lazzarini)

sourced from a quarry site at la Batteria, but was abandoned following the exhaustion of the main yellow-brown variety. Traces of intense exploitation are still evident throughout the site. Despite quarry activity taking place here predominantly in the 18th century, exploitation during the Roman period is suggested by several architectural elements, including two columns from the Villa of Lucius Verus (second century AD). As Bruno noted, the two Circeo alabaster columns from an imperial context seem to suggest an awareness of the prestige of Italian stones.[39]

Conclusions

The compatibility of the Oplontis samples with the quarries of Thyatira and Circeo suggest that these are the most likely sources of the threshold blocks; however, pending a more comprehensive sampling of the Circeo and Thyatira quarries, neither can be conclusively confirmed or excluded as potential sources at this stage. Circeo alabaster would have represented a sensible choice both logistically and geographically due to the proximity of the quarries to shipping harbours and to the end destination.

These data, albeit incomplete, represent an important first step in the determination of the quarry source of Villa A's alabaster thresholds, but only a much larger database (which must include Sr, Pb and O isotope data and Ba/Mg/Sr element concentration ratios for all samples) will clarify this. The triple (or quadruple) discriminator would likely narrow down the field of candidate quarries. What is certain is that the owner of Villa A seems to have been caught up by the growing popularity of alabaster during the late Republican period. It is evident, judging by the size and location of the thresholds, that a considerable financial effort was put into acquiring the blocks in a period when alabaster was probably not immediately available in significant quantities.

39 BRUNO 1998.

REFERENCES

BARBIERI M., LILYQUIST C., TESTA G. 2002a: "Provenancing Egyptian and Minoan Calcite-Alabaster artifacts through ^{87}Sr/ ^{86}Sr isotopic ratios and petrography", in ASMOSIA VI, 403-414.

BARBIERI M., TESTA G., MEROLA D., POLYCHRONAKIS Y., SIMITZIS V. 2002b: "Provenancing Egyptian and Minoan Calcite-Alabaster artifacts through ^{87}Sr/^{86}Sr isotopic ratios and petrography", in ASMOSIA VI, 415-423.

BARKER S. J., FANT J. C. (*forthcoming*): "Lithic Decoration: sources, styles, repair and spoliation", in J. R. CLARKE, N. K. MUNTASSER (eds.): Villa A ("of Poppaea") at Oplontis (Torre Annunziata, Italy) Volume 2: Decorative Ensembles: Painting, Stucco, Pavements, Sculptures, New York.

BRUNO M. 1998: "Su una cava di alabastro del Circeo in località "La Batteria"", in P. PENSABENE (ed.): Marmi Antichi II, cave e tecniche di lavorazione, provenienza e distribuzione, Roma, 213-222.

BRUNO M. 2002: "Alabaster quarries near Hierapolis (Turkey)", in ASMOSIA VI, 19-24.

CLARKE J. R. 2014: "History of the Excavations 1964–1988", in J. R. CLARKE, N. K. MUNTASSER (eds.): Oplontis: Villa A ("of Poppaea") at Torre Annunziata, Italy. Vol. 1, The ancient setting and modern rediscovery, New York, 772-928.

CICIRELLI C., GUIDOBALDI M. P. 2000: Pavimenti e mosaici nella Villa dei Misteri di Pompei, Napoli.

ÇOLAK M., LAZZARINI L. 2002: "Quarries and characterisation of a hitherto unknown alabaster and marble from Thyatira (Akhisar, Turkey)," in ASMOSIA VI, 35-40.

FANT J. C., 2007: "Marble real and painted (imitation) at Pompeii", in J. J. DOBBINS, P. FOSS (eds.): The World of Pompeii, New York and Abingdon, 336-346.

GAZDA E. K. 2016: "Villas on the Bay of Naples: The Ancient Setting of Oplontis", in E. K. GAZDA, J. R. CLARKE (eds.): Leisure & Luxury in the Age of Nero. The Villas of Oplontis near Pompeii, Ann Arbour, 30-47.

GNOLI R. 1988: Marmora Romana, 2nd ed. Roma.

HARRELL A. J. 2012: "Building Stones", in: W. WENDRICH (ed.): UCLA Encyclopedia of Egyptology, Los Angeles.

HERRMANN Jr. J. J., VAN DEN HOEK A., TYKOT R. H. 2012: "Alabastro a pecorella, Aïn Tekbalet, and Bou Hanifia, Algeria: a preliminary report", in ASMOSIA IX, 463-473.

LAZZARINI L. 2002: "La determinazione della provenienza delle pietre decorative usate dai romani", in: M. De NUCCIO, L. UNGARO (eds.): I marmi colorati della Roma imperiale, Venezia, 223-265.

LAZZARINI L., VILLA I. M., VISONÀ D. 2006: "Caratterizzazione e identificazione di alabastri usati in antico", in G. M. CRISCI, C. GATTUSO (eds.): "Archeometria del Costruito. L'edificato storico: strutture e rischio sismico", Atti del convegno nazionale di Archeometria (Ravello 6-7 febbraio 2003), Bari, 273-281.

LAZZARINI L., VISONÀ D., GIAMELLO M., VILLA I. 2012: "Archaeometric characterisation of one Tunisian and two Italian calcareous alabasters used in antiquity", in ASMOSIA IX, 436-446.

PISAPIA M. S. 1997: "I pavimenti di II stile della Villa A di Oplontis," in: R. M. CARRA BONACASA, F. GUIDOBALDI (eds.): Atti del IV Colloquio dell'Associazione Italiana per lo Studio e la Conservazione del Mosaico: con il patrocinio del Ministero per i Beni culturali e ambientali (Palermo, 9-13 dicembre 1996), Ravenna.

PUGLIESE CARRATELLI G. (ed.) 1990 - 1999: Pompei. Pitture e mosaici, I - IX, Rome.

SCARDOZZI G. 2012: "Ancient marble and alabaster quarries near Hierapolis in Phrygia (Turkey): new data from archaeological surveys", in ASMOSIA IX, 573-574.

VILLA I. M. 2009: "Lead isotopic measurements in archeological objects", Archaeological and Anthropological Sciences 1, 149-153.

VILLA I. M. 2016: Provenancing bronze: exclusion, inclusion, uniqueness, and Occam's razor. In: G. GRUPE, G.C. McGLYNN (eds.): Isotopic landscapes in Bioarcheology, Heidelberg, 141-154.