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On a Roman Cargo of *Marmor Thasium:* the Cala Cicala Shipwreck (Crotone, Italy)

Salvatore Medaglia - Armando Taliano Grasso - Fabrizio Antonelli - Raffaella De Luca - Domenico Miriello - Antonio Lagudi - Fabio Bruno

In June 2017 a multi-departmental research group of the University of Calabria conducted some investigations on a marble cargo at Cala Cicala, located at a depth of approximately 6 meters along the southern section of the promontory of Capo Colonna (Crotone). The cargo is composed of 36 marble elements of various sizes, mostly pillars and blocks, of a total weight of about 179 tons. Many of the marble artefacts are stepped parallelepipeds, while the largest monoliths exceed 6 meters in length. During the Cala Cicala survey, the team experimented an innovative approach to study the underwater site using digital and mechatronic technologies applied to conventional archaeological documentation in order to clean, document, and analyse the archaeological remains. The minero-petrographic investigations, conducted in collaboration with the IUAV University of Venice, made it possible to identify the marbles with those quarried at Aliki and at the Cape Vathy on the island of Thasos. More precise chronological data are given by some Ionic capitals and Attic marble bases, now on display at the National Archaeological Museum of Capo Colonna, discovered on the site of the shipwreck before 1929. The evidence found at Cala Cicala contributes significantly to our knowledge of many aspects of the exploitation of the quarries on the island of Thasos and on the manufacturing traditions of local marble workshops. Before these investigations, the only known underwater evidence of loads of Thasian marble was limited to the Apulian wrecks of San Pietro in Bevagna and Torre Sgarrata which seem to be more recent than the wreck of Cala Cicala. The quality of marble from the promontory of Aliki, a variety predominantly used for architectural applications, was never found before in other shipwrecks.

Introduction and research background (A. Taliano Grasso)

The first reports on the wreck of Cala Cicala date back to a letter of July 9, 1929 from Raffaele Lucente, by then the Director-Curator of the Civic Museum of Crotone, to the Superintendent Edoardo Galli about the delivery of three marble Ionic capitals and five marble column bases. These items were part of the first batch of materials donated by Marquis Filippo Eugenio Albani to the Museum[1]. From the museum's inventory compiled by Gennaro Pesce in 1934, we can learn that these artefacts came from the waters of Cala Cicala, by the promontory of Capo Colonna[2], where they were evidently recovered by fishermen or divers[3]. This valuable information

[1] The donation of the Marquis Albani includes a total of 775 artefacts whose final acquisition took place after a long period on May 20, 1935, in virtue of the *Royal decree* no. 1264. Regarding this donation see CORRADO 2018: 171-215; on the aforementioned letter preserved in the Archive of the Superintendency in Reggio Calabria (Arch. SABAP RC-VV, c. XI, pos. 7, prat. 1, prot. 1806) see CORRADO 2018: 176.
[2] In particular, the inventory mentions the following places of origin: "Cicala", "Crotone (Cicala-Capo Colonna)", "from the sea of Cicala" (CORRADO 2018: 200, 243-244, 419; MEDAGLIA 2020: 117).

allows us to attribute both the capitals and the bases to the wreck of Cala Cicala, whose cargo still lies at modest depth a few hundred meters off the south coast of Crotone[4] (fig. 1).

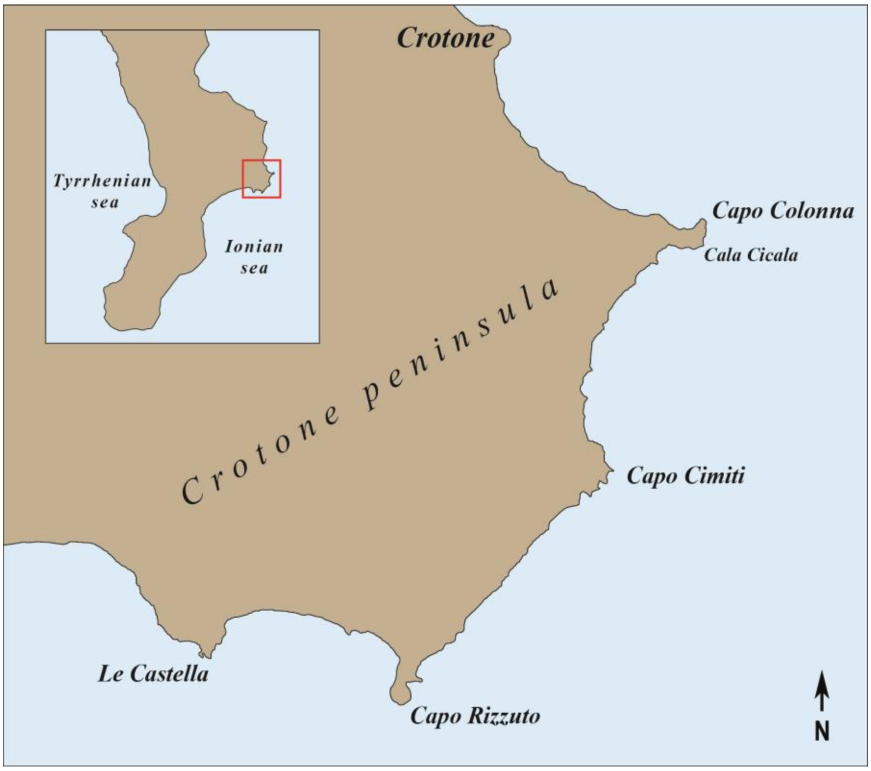

Fig. 1. Crotone Peninsula and the location of Cala Cicala (drawing by S. Medaglia).

[3] This is hardly surprising if we consider that private divers carried out the first recoveries of underwater archaeological artefacts along the coast of Crotone already in the first decade of the 20th century. This is exactly the case of the discoveries made in 1908-1909 by the Tricoli brothers, fishermen by profession, as the recovery of *labra* and marble columns belonging to the well-known wreck of Punta Scifo A, another *navis lapidaria* sunk a few hundred meters south of Cala Cicala (MEDAGLIA 2008: 104-108; MEDAGLIA 2010: 290-294; MEDAGLIA 2020: 114-116).

[4] The aforementioned document, which refers to the lot of materials delivered on July 9, 1929, included not only the capitals and marble bases, but also «a large amphora, with two handles, marked CA^DMI RVBRI» and «a limestone slab with the inscription EX IMPERIO / SEXTILIA DIONISIA» [*scil.* DIONYSIA] which in Pesce's inventory, dated 1934, are indicated as coming from "Crotone" and "Crotone (Mare Capo Col.)", respectively. However, it is quite odd that both the amphora - a Dressel 6A currently on display in the National Archaeological Museum of Crotone - and the inscription, together with a marble capital and plinth of an Ionic column, were mentioned in a note by Paolo Orsi published in *Notizie degli Scavi* of the 1901 in which the archaeologist from Rovereto states that these artefacts were recovered during the works carried out in the Port of Brindisi and that, «together with a lot of materials from Calabria», he saw them in the collection of the nobleman Filippo Albani of Crotone (ORSI 1901: 505). Therefore, the exact origin of the materials, both for those seen by Orsi and those acquired by the Museum of Crotone in July 1929, is still unclear: did they come from Brindisi or from Crotone and its surroundings? Could the capital and the plinth of the Ionic column, seen by Orsi in the Albani collection, be somewhat concealed within the marquis's lot included in the civic collections and which Gennaro Pesce attributed to Cala Cicala? The fact is that, among the 755 finds mentioned in the *Atto Notarile* stipulated in Crotone on October 26, 1933 which contains the *Elenco degli oggetti che formano la collezione del March. Filippo Eugenio Albani* (CORRADO 2018: 181-196), there are no other artefacts attributable to Ionic bases and capitals other than the eight pieces recognized as belonging to Cala Cicala. Furthermore, in the *Elenco*, the origin of the finds is not always specified (as it is also the case of the specific case of capitals and bases: CORRADO 2018: 191); however, at the bottom of the same notarial document, it is stated that «The origins, already known, of each object, will be specified in the inventory cards and on the register», meaning that the completion of the missing data was postponed to a later stage. According to what M. CORRADO states (2018: 199) after having thoroughly studied the Albani collection, the register mentioned in the notarial deed «can certainly [...] be identified with the inventory of the Museum compiled in 1934», where the missing information were integrated «drawing from the memory and/or notes belonging to the donor» (i.e. the Marquis Albani). In summary, even assuming that Orsi's assertion were to be correct, we should remove only one capital and one base from the lot of Cicala marbles. It seems though unlikely to split only two artefacts, insofar as the whole batch composed of bases and capitals appears stylistically homogenous to the point it suggests a material created in a specific architectonical project. On the stele of *Sextilia Dionysia* placed *ex imperio* (*AE* 1965, 158), which dates back to the II century AD, see the recent work by DE NICOLÒ 2016: 212-213, which removes it from the epigraphic *corpus* of Crotone and attributes it to Brindisi. On the stamps of *Rubrius* and *Cadmus* on Dressel 6A, see MONGARDI 2013: 462-464 and references.

Clearly, the news of the presence of marble artefacts in the waters of the southern sector of the Capo Colonna promontory continued to circulate among local seafarers, to the extent that it was also believed they could belong to the remains of the nearby Greek temple consecrated to *Hera*[5]. At the end of the 1950s, the diver Domenico Carolei from Crotone reported on "some columns and many square blocks of stone [which] lay submerged in the waters of the cape [*sct*. Capo Colonna], in the midst of a great many fragments of amphorae, for a radius of hundreds of meters and not far from the rock on which the solitary column stands"[6]. In view of this information, the Directorate of Antiquities and the Superintendency of Calabria, led at the time by Alfonso de Franciscis, authorised Gianni Roghi of the "Experimental Center of Underwater Archaeology" to perform some exploratory surveys in April 1960[7]. Unfortunately, the survey carried out by Roghi on his own on April 20, in absence of Carolei (who was engaged elsewhere on that day) and in unfavourable weather conditions, did not provide the desired results and the remains of the wreck were not tracked down[8].

Several years passed and on July 20, 1983, Luigi Cantafora, another local diver, reported yet again the remains of the same shipwreck in the area of Cicala. This piece of news spread quickly on several national newspapers and was mistakenly associated with a new discovery[9]. Nevertheless, it was thanks to this further report that in the same year the Superintendency initiated some underwater control surveys that were assigned to an external research company, the Aquarius of Milan directed by Dr. Alice Freschi, which conducted the surveys between 13 and 14 September. The results of these brief investigations, condensed into a meagre work diary, ascertained that it was a load of partially worked blocks and column shafts of white marble. On this occasion, a rapid survey of a part of the cargo was carried out and no remains attributable to the ship's hull were found[10].

As far as the research background is concerned, it is worth reporting that, at the end of the first decade of the 21st century, Jeffrey G. Royal presented a clumsy study in which he wrongly claimed that the Cala Cicala remains did not belong to a shipwrecked naval cargo, but rather to a pile of marble *spolia* collected during the Roman period and coming from the Greek sanctuary of Hera Lacinia[11].

The site and the research methodology (F. Bruno, A. Lagudi, S. Medaglia)

The marble remains of the cargo belonging to the wreck of Cala Cicala are located at a distance slightly under 300 m from the southern side of the Capo Colonna promontory, at about 9 kilometres south/south-east in a straight line from Crotone (fig. 1). The artefacts lie at a depth between 4.8 and 6.5 meters and cover a rocky seabed area of 20.5 x 23.5 m[12] (fig. 2). In the area concerned by the shipwreck, the seabed is composed mainly of large limestone boulders that are what remains of the adjacent degraded Pleistocene marine terrace[13] (fig. 3).

A multidisciplinary team of the University of Calabria[14], in collaboration with the then "Superintendency of Archaeology, Fine Arts and Landscape for the provinces of Catanzaro, Cosenza and Crotone" and the "Capo

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[5] VACCARO 1978: 665.
[6] ROGHI 1961, p. 58; ROGHI 1971: 310-311. This is the Doric column belonging to the famous sanctuary consecrated to Hera Lacinia, widely mentioned by Greek and Roman sources and of which there are considerable remains on the top of the Capo Colonna promontory (the ancient *Lakinion akron* of the Greeks and the *promunturium Lacinium* of the Romans). On the sanctuary area of the *Lacinio*, see GIANGIULIO, SABBIONE 1985 (for ancient sources) and MEDAGLIA 2010: 270-286 (for archaeological evidence).
[7] On the activities of the Experimental Center of Underwater Archaeology in the Crotone area, see PALLARÉS 1983: 23, 25 and MEDAGLIA 2020: 118-119.
[8] ROGHI 1961, p. 58; ROGHI 1971: 311; MEDAGLIA 2010: 286-287; CORRADO 2018: 419; MEDAGLIA 2020: 218-219.
[9] GANDOLFI 1986: 667-668 (with a review of the newspapers that reported the news).
[10] FRESCHI 1983.
[11] ROYAL 2008. *Contra* BARTOLI 2010. For the first scientific cataloguing of the wreck of Cala Cicala see MEDAGLIA 2008; MEDAGLIA 2010.
[12] MEDAGLIA 2010: 286-287.
[13] Vd. *infra*: 13.
[14] The team, led by Salvatore Medaglia, was composed of scholars from three different Departments of the University of Calabria: Department of Cultures, Education and Society, Department of Biology, Ecology and Earth Sciences and Department of Mechanical, Energetics and Management Engineering whose representatives were Armando Taliano Grasso, Domenico Miriello, and Fabio Bruno, respectively.

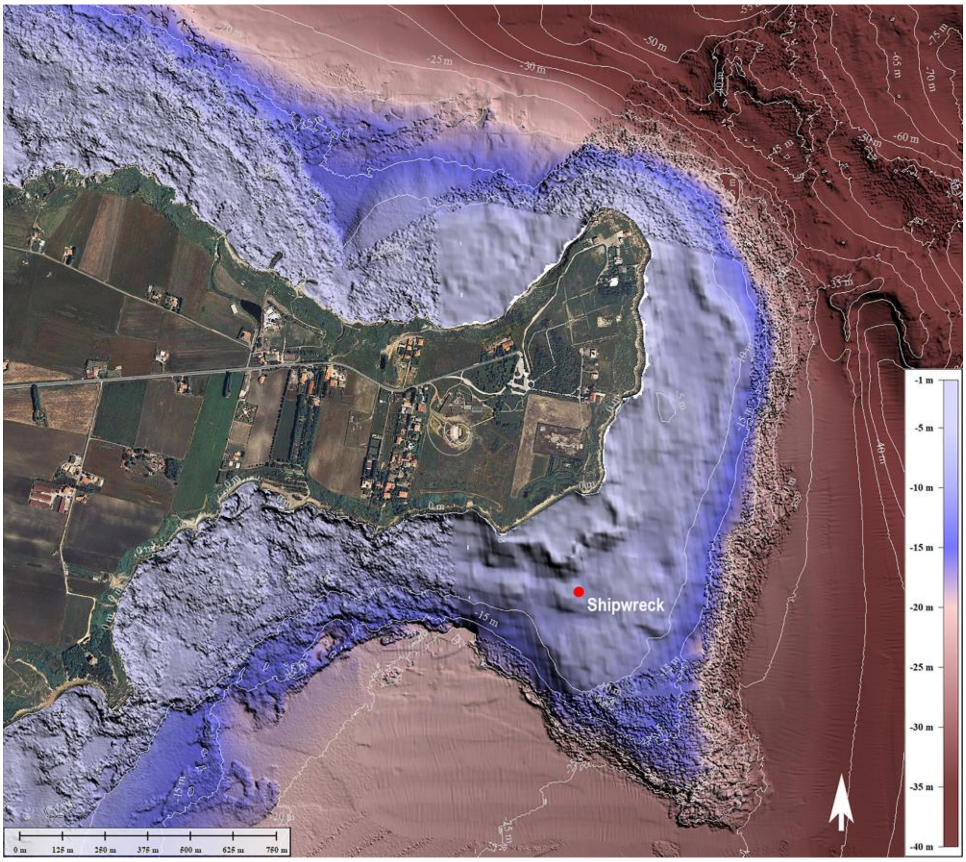

Fig. 2. Capo Colonna promontory. The location of the wreckage on an orthophoto with morpho-bathymetric map (GIS processing by F. Mauri).

Fig. 3. Overview of Cala Cicala taken by a drone showing the curb of rocks that surround the lagoon in the foreground (photo by F. Mauri).

Rizzuto" Marine Protected Area, conducted a campaign of underwater surveys on the wreck of Cala Cicala from 12 to 17 June 2017[15]. The research campaign was funded by the European Community as part of the Interreg Med - "BLUEMED" project[16]. This project – currently completed and of which the Cala Cicala wreck is one of the "pilot sites" – was aimed at stimulating the development of sustainable and responsible tourism in the coastal areas and islands of the Mediterranean by focusing on the promotion and protection of the underwater natural and cultural heritage[17].

During the Cala Cicala campaign, the team experimented with an innovative approach for the study of the underwater site, in which digital and mechatronic technologies were introduced into a conventional archaeological documentation method in order to clean, document, and analyse the archaeological remains. The main steps of the methodology include: 1) a preliminary opto-acoustic survey of the site; 2) a direct underwater survey within a radius of about 100 meters from the archaeological site to ascertain its full extent; 3) the execution of cleaning operations; 4) the sampling of materials by means of micro-coring and other documentation activities (manual measurements, analytical cataloguing and detail photography); 5) the detailed 3D recording of the area (fig. 4).

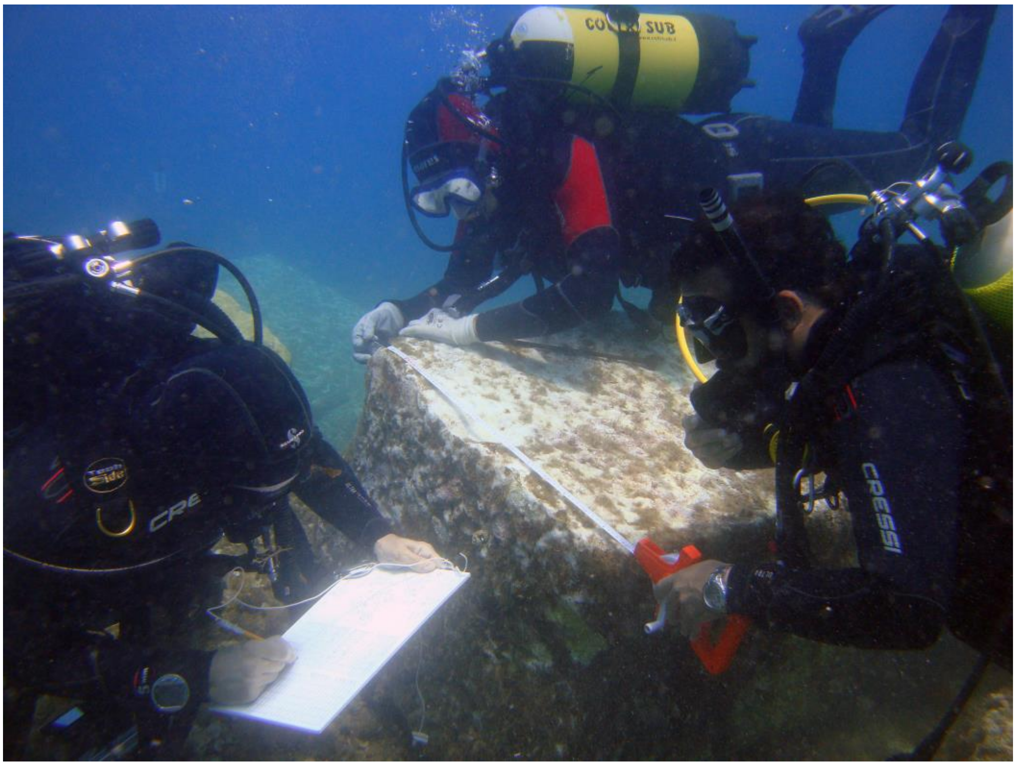

Fig. 4. Cala Cicala. Divers while measuring marble block of the shipwreck (photo by S. Medaglia).

The preliminary survey for fieldwork planning was conducted through an acoustic mapping of the site, which returned a detailed bathymetry of the seafloor in which the archaeological remains are located. Data were collected by using a Multibeam Reson Seabat 8125, a 240-beam array with 120° of swath coverage and a

[15] The underwater activities were attended by the archaeologists Paola Caruso (SABAP-CS), Raffaele Peluso, and Alessandro Manna, the engineers Fabio Bruno, Antonio Lagudi, Alessandro Lupinacci, Dario Tricoli, and the technicians of the Diving Center "MadeinSub" Francesco Megna, Giovanni F. Monizzi, and Andrea Tiplaldi. We wish to thank Dr. Simone Scalise, the Port Authority of Crotone and Dr. Piero Cappa ("Capo Rizzuto" Marine Protected Area). A special appreciation goes to Dr. Valentina Rossetti and Dr. Raffaele Peluso for taking care of the 3D documentation work.
[16] Interreg Med-Bluemed, "Plan/test/coordinate Underwater Museums, Diving Parks and Knowledge Awareness Centres in order to support sustainable and responsible tourism development and promote Blue growth in coastal areas and islands of the Mediterranean", n. 703 (https://bluemed.interreg-med.eu).
[17] On the activities of the Bluemed project see Dive in Blue Growth 2020.

pulse frequency of 455 KHz. This system is particularly suitable for applications in shallow waters (up to 100 m depth) where an ultra-high resolution is required (fig. 5). The equipment was integrated with a probe for measuring the sound speed through the water column and a motion sensor. During the acquisition, the use of a GPS with differential correction ensured a sub-metric precision on positioning, as confirmed by a less than one value for the "precision dilution of positioning" standard parameter. All components of the acoustic equipment were managed by means of the Quality Integrated Navigation System (QINSy) package. The final Digital Terrain Model (DTM) obtained by Multibeam data consists in a 1.5 cm squared grid cell size matrix that covers the seabed for about approx. 0.1 square kilometres. Data were mainly acquired following E-W striking navigation lines, (i.e. perpendicularly to the main slope line), thus reducing beam errors arising from lateral loss of energy and improving the survey coverage. The elevation ranges from -2.8 m below sea level (bsl) to -14 m bsl. The general morphology shows a rugged surface with a chaotic appearance, mostly covered by large boulders.

Moreover, a preliminary optical survey was conducted, specifically addressed to plan the cleaning and documentation. A GoPro Hero 4 silver model (a consumer-brand high-definition sport camera with a 12MP HD CMOS sensor, 1/2.5" in size) was used to acquire the underwater data. It records at different video and photo resolutions and Fields-Of-View (FOVs). In this experimentation, we used the camera (set in video mode) at a resolution of 1080p and a FOV of 108°. Recorded videos were processed to build a 2D photo-mosaic of the archaeological site.

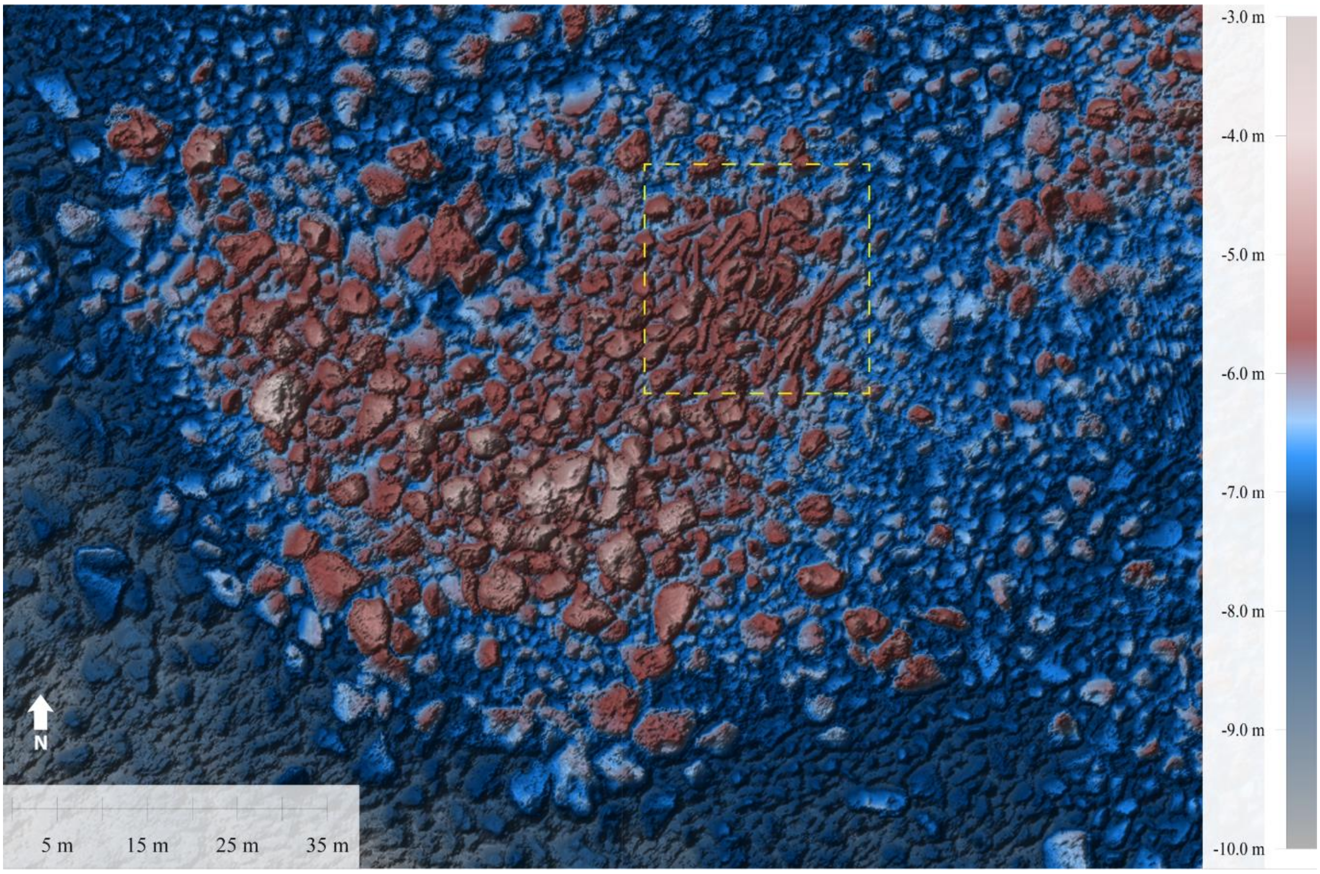

Fig. 5. Cala Cicala. MBES acoustic bathymetry of the underwater archaeological site and the surrounding area (MBES image by DiMEG - University of Calabria; elaborated by F. Mauri).

After these preliminary activities, the cleaning of the marble artefacts from the infesting vegetation was carried out by means of traditional manual tools, such as chisels, metal spatulas, scalpels, and an electromechanical underwater tool. This electric device, developed by the University of Calabria, allows the removal of loosely adhering deposits and various marine organisms that colonise the surface of the archaeological remains in few minutes. In particular, this tool can be equipped with brushes and abrasive wheels of different shapes and materials that allow for an efficient removal of all kinds of epilithic organisms, such as algae, sponges, and molluscs (fig. 6). Another underwater mechatronic tool, also developed by the University of Calabria, was used as a core drill to obtain annular cuttings (20 mm in diameter and 30 mm in length)[18]. The drill has an aluminium body and is equipped with a 1200-W brushed motor that provides a maximum torque of 30 Nm and a maximum no load speed of 1500 rpm[19] (fig. 7).

Fig. 6. Cala Cicala. Cleaning of the blocks with an electric underwater brush (photo by F. Bruno).

Fig. 7. Cala Cicala. Sampling with an underwater mechatronic drill (from Antonelli et al. 2000; photo by S. Medaglia).

[18] ANTONELLI *et al.* 2020: 2.
[19] BRUNO *et al.* 2016.

The detailed 3D recording of the marble remains was carried out according to standard photogrammetric techniques. The camera used to take the underwater pictures was a Nikon D7000 reflex camera with a CMOS (Complementary Metal-Oxide Semiconductor) sensor size of 23.6 x 15.8 mm and a resolution of 4928 × 3264 pixels (16.2 effective megapixels), equipped with an AFNikkor 20 mm lens. The camera was mounted in an underwater housing manufactured by Ikelite, equipped with a spherical port (dome port).

The camera network planned to survey the site consisted in open loop strips taken at a mean distance of 2 m above the sea bottom, ensuring a mean Ground Sample Distance (GSD) of 0.075 (cm/pixel). The camera was in downward-looking position and was moved horizontally right–left and left–right on overlapping strips along straight lines, ensuring a 70-80% forward overlap and 50% side overlap. The occluded areas, not visible in downward-looking position, were acquired using oblique poses.

A Structure-from-Motion (SfM) 3D reconstruction was performed using the commercial software Agisoft Metashape Pro®. A local metric coordinate system based on a network of Ground Control Points (GCPs) was set in the software to scale and reference the sparse 3D reconstruction. In particular, 18 markers were used as GCPs whereas their Euclidian coordinates were retrieved through 3HSite® software using *in situ* measurements. A non-linear optimization strategy, in which both cameras pose, and interior orientation parameters were adjusted, was applied to minimize error at GCP coordinates. The average root mean-square error (RMSE) achieved at this step was 0.015 m for ground coordinates. The GCP RMSE encompasses both errors in the GCP measures and intrinsic accuracy of the sparse SfM reconstruction. Finally, a Multi-View Stereo (MVS) algorithm was used by Metashape to produce a dense 3D point cloud from the refined intrinsic orientation and ground-referenced camera exterior orientation. Finally, the 3D model of the marble remains was obtained after the meshing and the texturing process. A dataset of c.a. 1000 images was processed for the 3D reconstruction giving in output a 47.047.780 million dense point cloud and a mesh of ca. 83.000.000 polygons (figs. 8-9).

Multi-Image Photogrammetry and 3D modelling of the artefacts played a very important role in our work, which aims to go far beyond the surveying and the topographical mapping of the site. As it will be discussed in detail below, many marble artefacts have lost their original linear shapes due to marine erosion and currently appear as extremely complex and irregular solids. The innumerable cavities and ledges of the very rough surfaces did not allow us to calculate the volume by means of a traditional, precise type of survey, so we opted for digital modelling.

A three-step approach was used for the estimation of the volume of each element of the cargo by processing the sub-centimetre accuracy 3D point cloud obtained through photogrammetry. A “manual segmentation” was initially performed using CloudCompare® software to separate areas corresponding to the individual blocks from the global model. Then, a curve-fitting algorithm was applied to represent the boundary of each element. These profiles were finally imported in the CAD software SolidWorks®, in which the final volumetric model of each marble block was obtained by imposing symmetry constraints on the shape of the object not covered with 3D points (the part close and/or in contact with the seabed not visible during the underwater survey). Once volumetric models of the individual marbles had been available, it was therefore easy to calculate their mass and volume in the CAD software (fig. 10).

Mineralogical-petrographic and isotopic analyses (F. Antonelli, R. De Luca, D. Miriello)

The marbles of the ship's cargo of Cala Cicala were studied by adopting an archaeometric approach based on the application of optical microscopy, X-ray diffraction, and isotopic analysis ($\delta^{13}C$ vs. $\delta^{18}O$) to provide information about the compositional features of the samples, determine their provenance and support the archaeological discussion about the quarry history and the trade[20]. As demonstrated in extensive recent literature[21], the archaeometric study of stone materials can be very useful for acquiring information about the origin and the provenance of white and coloured marbles.

[20] Antonelli *et al*. 2020.

[21] I.e. Miriello *et al.* 2012; Pensabene *et al.* 2012; Medaglia *et al.* 2013; Antonelli *et al.* 2014 and references therein.

Fig. 8. Cala Cicala. Top view of the 3D model of the shipwreck (photo by V. Rossetti).

Fig. 9. Cala Cicala. 3D model of the archaeological site (N-W view) (photo elaborated by R. Peluso, 3D Research - University of Calabria).

Fig. 10. Cala Cicala. Volumetric models of the items no. 16, 17 and 10 overlaid on the 3D model (elaborated by R. Peluso, 3D Research - University of Calabria).

The analyses performed on the stone cargo of the shipwreck of Cala Cicala[22] showed the importance of the archaeometric study of these materials. The ship's cargo is composed of 35 blocks of white marbles and one block of quartzite in the form of elongated elements and blocks, and all of the samples were subjected to

[22] ANTONELLI *et al*. 2020.

investigation. The data highlighted the presence of two main groups of marbles; the first consists of whitish to light grey calcitic marbles (table 1) with an heteroblastic mosaic microstructure (figs. 11a, 11b) composed of calcite crystals with curved and sutured boundaries and a maximum grain size (MGS) ranging from 3.06 mm to 6.35 mm. Common accessory minerals are quartz, K-mica, and graphite, always quite abundant; apatite, hematite, pyrite, epidote, plagioclase, and serpentine are rarer and less abundant.

The second group (table 2) is composed of snow-white dolomitic marbles (figs. 11c, 11d), which show an MGS ranging from 1.58 mm to 3.25 mm and an homeoblastic to heteroblastic mosaic microstructure made of interlocked (and sometimes strained) crystals. The accessory minerals, rare and never abundant, are quartz, muscovite, graphite and, occasionally, apatite and iron oxides. The combination of minero-petrographic data with isotopic signatures of all 35 marbles allowed for attributing their origin to the Greek island of Thasos, in the northern Aegean Sea[23]. In particular, all the calcitic marbles (first group) come from the wide opencast quarries of Aliki[24], while the dolomitic ones (second group) originate from Cape Vathy[25] in the Vathy-Saliara district on the north/north-eastern side of the island.

In a preliminary analysis of the only block of quartzite present in the Cala Cicala ship's cargo, it was possible to hypothesize the same origin for both groups of the marbles, taking into account the presence of some small quarries of quartzite on the island of Thasos (i.e. on Mount Ypsarion and in the Cape Phanari area) opened into a vein interbedded with marbles and already exploited in ancient times[26]. However, this hypothesis should be confirmed by further analyses.

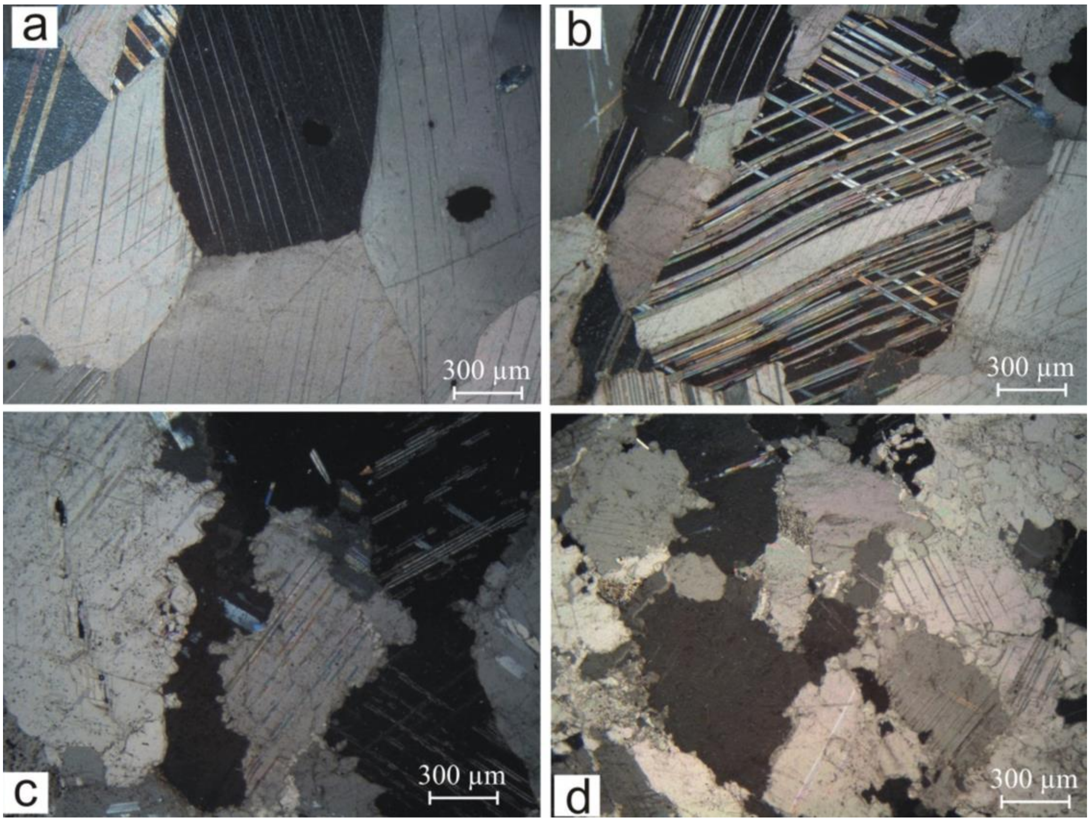

Fig. 11. Photomicrographs, under crossed polars, of some representative marble samples of the stone cargo of Cala Cicala shipwreck: (a) Sample C13, heteroblastic mosaic of calcite crystals with curved boundaries; (b) Sample C15, heteroblastic mosaic of strained calcite crystals; (c) Sample C22; heteroblastic mosaic made of dolomite crystals with sutured and curved boundaries; (d) Sample C19; homeoblastic regular mosaic of interlocked dolomite grains (by ANTONELLI et al. 2020, modified by the authors).

[23] ANTONELLI, LAZZARINI 2015; BRUNO *et al.* 2002a.
[24] SODINI *et al.* 1980.
[25] HERZ 1988
[26] KOZELJ, WURCH-KOZELJ 2011.

FIRST GROUP – CALCITIC MARBLES – PROVENANCE FROM THASOS ALIKY							
	Fabric		**MGS** (mm)	**GBS**	**Accessory Phases**	**$\delta^{18}O$** (PDB)	**$\delta^{13}C$** (PDB)
1	HE	Mosaic, strained and slightly foliated	3.78	curved	Ms, Gr, Ap, Ore min & Fe-Ti ox, Dol	-1.79	2.83
2	HE	Mosaic, strained	4.80	curved ± sutured	Qtz, Gr, Ap, Ore min & Fe-Ti ox, Ep	-0.02	3.64
3	HE	Mosaic, strained and slightly foliated	3.06	curved, sutured	Qtz, Gr, Ms, Ep, Ap	-0.23	3.70
4	HE	Mosaic, strained and slightly foliated	4.56	curved ± sutured	Qtz, Ep, Ms, Gr, Ore min & Fe-Ti ox, Pl, Srp	-0.33	3.37
5	HE	Mosaic, strained and slightly foliated	4.24	curved ± sutured	Qtz, Gr, Ms, Ap	-0.80	3.48
6	HE	Mosaic, strained and slightly foliated	4.70	sutured ± curved ± embayed	Gr, Qtz, Ms, Ore min & Fe-Ti ox,	-0.29	3.17
10	HE	Mosaic, strained	4.42	curved ± sutured	Gr, Ms, Qtz, Pl, Ore min & Fe-Ti ox	0.56	3.22
11	HE	Mosaic, with strained crystals	3.75	curved	Qtz, Gr, Ms, Ore min & Fe-Ti ox	-2.31	3.07
12	HE	Mosaic, strained	5.62	curved ± sutured	Qtz, Gr, Ore min & Fe-Ti ox	0.54	3.21
13	HE	Mosaic, strained	3.80	curved, sutured	Qtz, Ms, Gr	0.19	3.13
14	HE	Mosaic with strained crys-tals	5.64	curved, sutured	Qtz, Ms, Srp, Ap, Ore min & Fe-Ti ox	-0.42	3.66
15	HE	Mosaic, strained and slightly foliated	3.82	curved ± sutured	Qtz, Ms, Ep	-0.35	3.71
16	HE	Mosaic, strained and slightly foliated	6.35	curved	Qtz, Ms, Gr, Ep	-0.25	3.58
17	HE	Mosaic, strained	4.60	curved, sutured	Qtz, Ms, Srp, Ap, Pl,	-0.07	3.64
26	HE	Mosaic, strained	5.27	curved	Qtz, Ms	-0.12	3.55
27	HE	Mosaic, with strained crystals, slightly foliated	4.86	curved ± sutured	Qtz, ms, Ore min & Fe-Ti ox , Srp, Gr, Ap, Pl	0.04	3.38
28	HE	Mosaic, with strained crystals, slightly foliated	4.70	curved, em-bayed	Ms, Gr, Qtz, Ep, Ore min & Fe-Ti ox	-1.87	2.71
34	HE	Mosaic, strained	4.58	curved	Gr, Ore min & Fe-Ti ox, Qtz, Ms, Ap	-0.39	3.08
35	HE	Mosaic, with strained crystals	4.42	curved ± sutured	Qtz, Ore min & Fe-Ti ox, Ms, Gr	-0.23	3.52
36	HE	Mosaic, with strained crystals	3.86	curved	Qtz, Srp, Ms,Ap	-1.94	2.49

Tab. 1. Minero-petrographic features of the marble samples belonging to the first group [MGS: maximum grain size; GBS: shape of the carbonate grain boundaries; HE: heteroblastic. Accessory Phases in order of abundance: Ap: apatite; Dol: dolomite, Ep: epidote; Gr: graph-ite; Ms: potassic mica; Ore min. & Fe-Ti ox: ore minerals and Fe or Ti oxides; Pl: plagioclase; Qtz: quartz; Srp: serpentine] (by Antonelli et al. 2020, modified by the authors).

SECOND GROUP – DOLOMITIC MARBLES – PROVENANCE FROM THASOS CAPE VATHY								
	Fabric		**MGS** (mm)	**GBS**	**Accessory Phases**	**Dol**	**$\delta^{18}O$** (PDB)	**$\delta^{13}C$** (PDB)
7	HE	Mosaic, slightly foliated	2.80	sutured	Ms, Gr, Qtz, Ap	A	-4.73	3.44
8	HO	Regular Mosaic	2.55	sutured	Gr, Qtz, Ms, Ap	A	-3.57	3.67
9	HE	Mosaic with strained crystals	3.25	sutured	Ms, Gr, Qtz, Ap	A	-2.38	4.10
18	HO	Regular mosaic	2.42	sutured	Qtz, Ms, Gr	A	-4.84	3.47
19	HO	Regular mosaic	1.58	sutured ± embayed	Qtz, Gr	A	-4.77	3.68
20	HO	Mosaic with some strained crys-tals	1.85	sutured	Qtz, Ms	A	-6.12	3.52
21	HE	Mosaic	2.62	sutured	Ms	A	-2.75	3.74
22	HE/ HO	Mosaic, slightly foliated	3.25	sutured ± curved	Ms, Qtz, Gr	A	-4.26	3.54
23	HE	Mosaic, slightly foliated	2.60	sutured	Gr, Ms	A	-3.22	3.57
24	HE	Mosaic, with some strained crys-tals	2.62	sutured	Ms, Gr	A	-5.27	3.68
25	HE	Mosaic, with some strained crys-tals	2.26	sutured	Ms, Gr	A	-4.02	3.87
30	HO	Regular Mosaic	2.72	sutured	Qtz, Ms, Ore min. & Fe-Ti ox	A	-3.81	3.80
31	HO/ HE	Mosaic, slightly foliated	3.18	sutured	Ms, Gr, Qtz	A	-4.50	3.49
32	HE	Mosaic, slightly foliated	2.55	sutured ± curved	Ms, Qtz, Ore min. & Fe-Ti ox	A	-5.50	3.31
33	HE	Regular Mosaic	2.82	sutured, curved	Ms, Ore min. & Fe-Ti ox	A	-3.24	3.86

Tab. 2. Minero-petrographic features of the marble samples belonging to the second group [MGS: maximum grain size; GBS: shape of the carbonate grain boundaries; HE: heteroblastic; HO: homeoblastic. Accessory Phases in order of abundance: Ap: apatite; Dol: dolomite, Gr: graphite; Ms: potassic mica; Ore min. & Fe-Ti ox: ore minerals and Fe or Ti oxides; Qtz: quartz]
(by Antonelli et al. 2020, modified by the authors).

The marble cargo (S. Medaglia)

During the investigations of 1983, 30 marble artefacts were registered. However, the new researches of 2017, thanks to the already mentioned meticulous removal of seaweeds from the finds, allowed the identification of new artefacts, so that it is now possible to affirm with certainty that the total number of currently submerged artefacts amounts to 36 units (table 3). It can be assumed that in the 1983, Aquarius campaign some marble elements were mistaken for seabed rocks. The new stone elements added to the already known pieces are nos. 1, 6, 7, 8, 33, 32, and 36. With respect to the investigations of 1983, it was not possible to find an elongated arte fact that was supposed to lie in the southern sector of the schematic map created at the time by the Aquarius[27] (fig. 12).

[27] FRESCHI 1983.

ID Number	Type A: Block; P: Pillar / elongated element	Stepped	Max dimensions (cm)	Volume	Origin
1	P		636 x 104 x 60.8	3.53 m^3	Aliki
2	P		240 x 103 x 60.2	1.28 m^3	Aliki
3	P		410 x 75.1 x 67.8	1.93 m^3	Aliki
4	P		560 x 106 x 65.9	1.96 m^3	Aliki
5	P		640 x 108 x 60	2.85 m^3	Aliki
6	P		442 x 109 x 49	1.73 m^3	Aliki
7	B	X	217 x 116 x 56	1.26 m^3	C. Vathy
8	B		140 x 137 x 63.9	1.16 m^3	C. Vathy
9	B		284 x 188 x 101	5.06 m^3	C. Vathy
10	P		389 x 73 x 59	0.79 m^3	Aliki
11	P		430 x 73.8 x 48.9	1.30 m^3	Aliki
12	P		684 x 81.6 x 70.4	1.29 m^3	Aliki
13	P		685 x 80.4 x 64.5	3.29 m^3	Aliki
14	P		401 x 83.4 x 70.1	1.67 m^3	Aliki
15	P		426 x 96 x 67	2.21 m^3	Aliki
16	P		636 x 119 x 58	3.29 m^3	Aliki
17	P		445 x 53 x 53	0.64 m^3	Aliki
18	P	X	237 x 75.8 x 63.5	1.14 m^3	C. Vathy
19	B	X	278 x 125 x 75.5	2.58 m^3	C. Vathy
20	B	X	248 x 115 x 106	2.76 m^3	C. Vathy
21	B	X	244 x 187 x 95.3	3.35 m^3	C. Vathy
22	B	X	257 x 120 x 67.5	1.70 m^3	C. Vathy
23	B	X	330 x 125 x 60.4	2.41 m^3	C. Vathy
24	B	X	203 x 98.2 x 73.9	1.73 m^3	C. Vathy
25	B		125 x 109 x 82.5	1.09 m^3	C. Vathy
26a	P		202 x 67.4 x 52	0.58 m^3	Aliki
26b	P		169 x 75.2 x 35.4	0.41 m^3	Aliki
27	P		272 x 61.2 x 46	0.66 m^3	Aliki
28	P		601 x 116 x 59.4	3.06 m^3	Aliki
29	P		295 x 113 x 48.6	1.15 m^3	?
30	B		100 x 100 x 45.6	0.44 m^3	C. Vathy
31	B	X	237 x 126 x 51.5	1.35 m^3	C. Vathy
32	B	X	293 x 103 x 97.9	2.64 m^3	C. Vathy
33	B		105 x 90.5 x 40.1	0.36 m^3	C. Vathy
34	P		399 x 89.6 x 63.6	1.03 m^3	Aliki
35	B		170 x 92.7 x 55	0.84 m^3	Aliki
36	B		222 x 79.8 x 22.3	0.36 m^3	Aliki
		TOTAL	64.88 m^3		

Tab. 3. Summary table with the typological, metric, and dimensional data of the marble artefacts (elaborated by S. Medaglia).

The cargo presents two broad categories of stone artefacts: blocks and elongated elements. Both the former and the latter look roughed-out, worked directly in the quarry to make their shape more regular for the transport. The surfaces were roughly worked, and only in the case of the southern face of the block no. 21, there are clear parallel toolmarks left by a great punch/chisel (fig. 13).

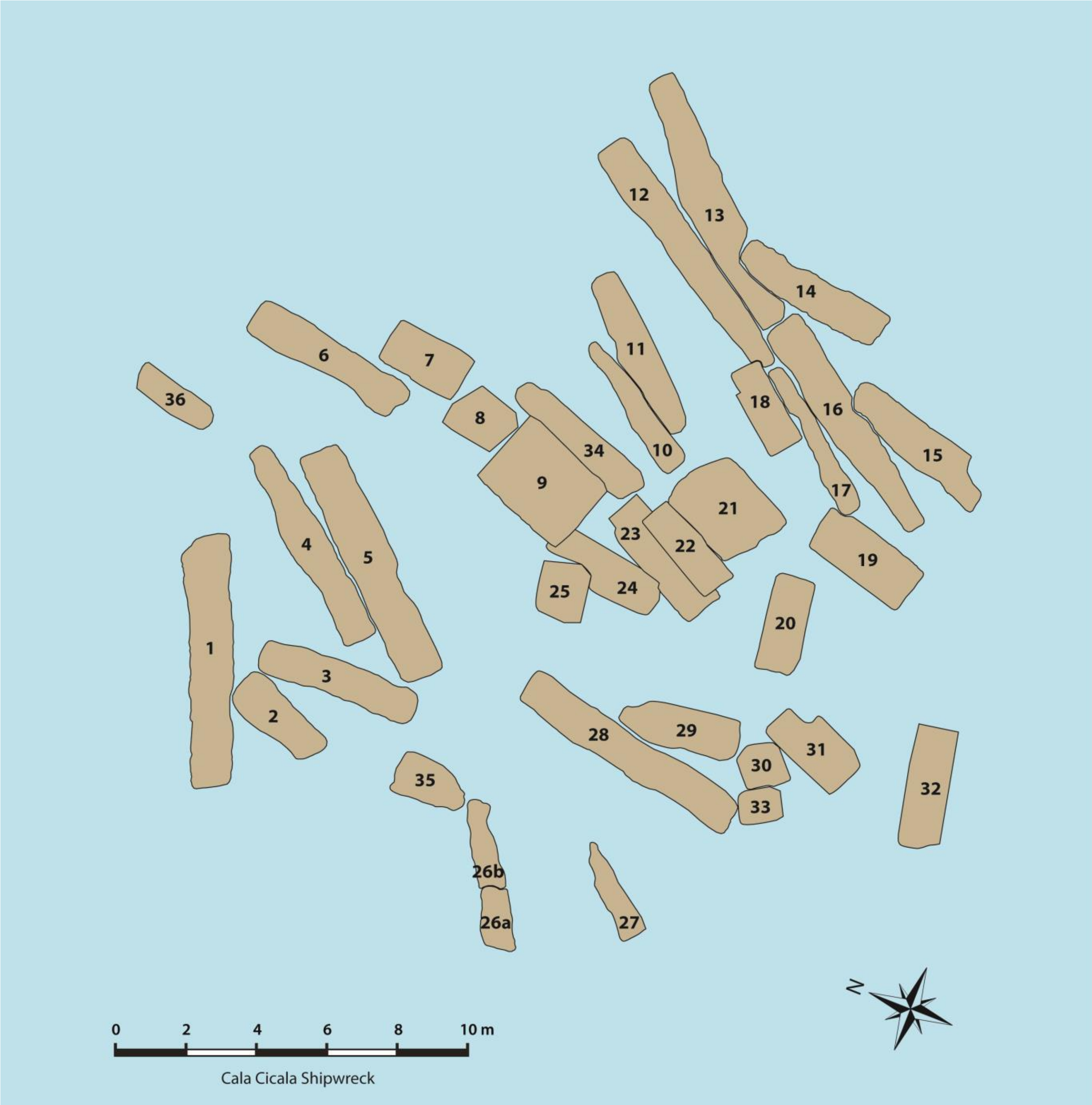

Fig. 12. A simplified plan (with only the footprint of the artefacts) of the wreck of Cala Cicala (drawing by S. Medaglia).

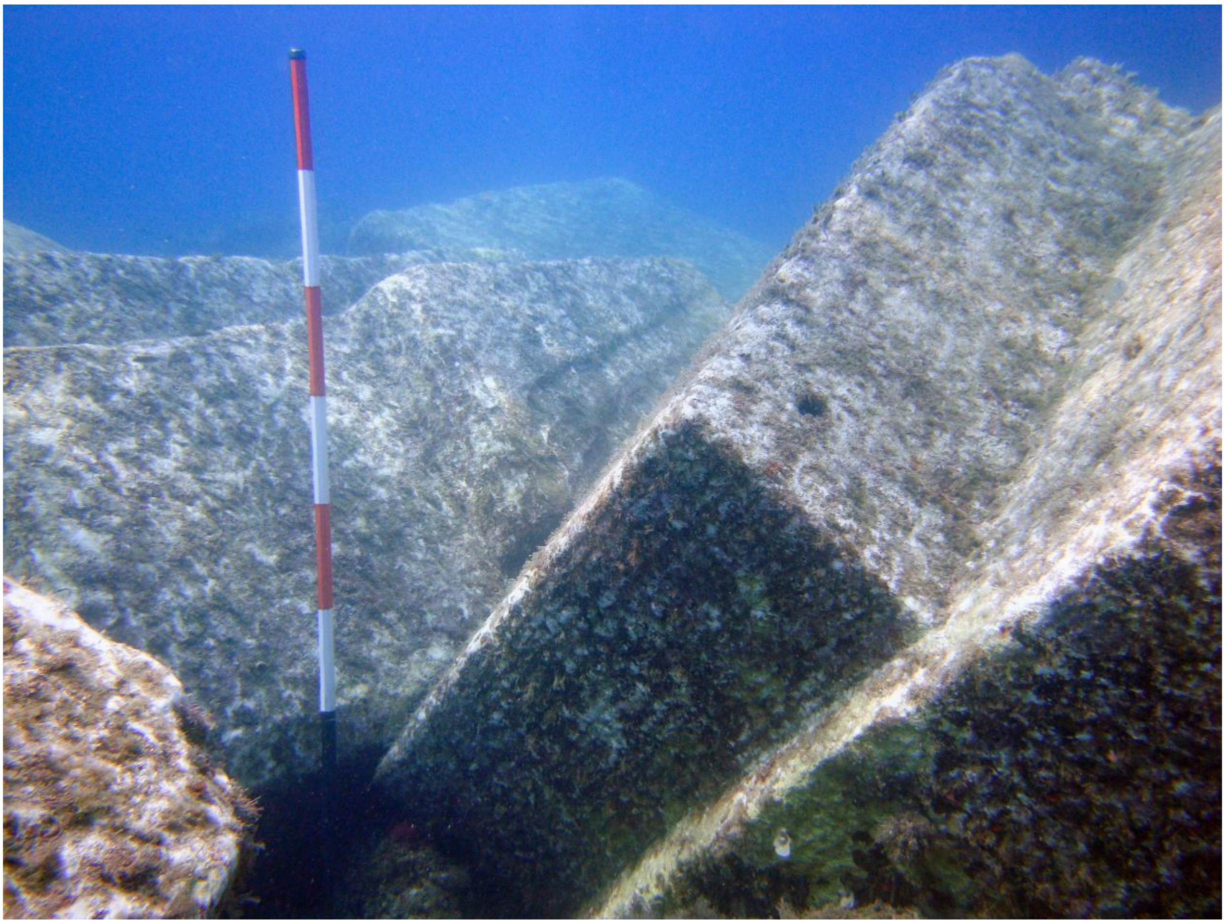

Fig. 13. Cala Cicala. Detail of one of the sides of block no. 21 with parallel toolmarks left by a punch (photo by S. Medaglia).

In lithological terms, the morphological diversification between elongated elements and blocks corresponds to a different mineral-petrographic structure[28], which in turn translates, on a practical level, into the provenance of the marbles from two different quarries of extraction. In fact, almost all the blocks (with the exception of no. 18) were extracted at Cape Vathy, while all the elongated monoliths come from the Aliki quarrying area (fig. 14).

The blocks are 16 in total (nos. 7, 8, 9, 19, 20, 21, 22, 23, 24, 25, 30, 31, 32, 33, 35, 36) and have different shapes and sizes. The maximum dimensions of the individual blocks are extremely diversified: they range from a minimum of 1.99 x 0.70 x 2.2 m of the artefact no. 36, to 2.8 x 1.88 x 1.01 m for the block no. 9. Some are simple parallelepipeds (nos. 8, 9, 25, 30, 33, 35, 36), while others are stepped. As far as the latter ones are concerned, some of them show one or two steps (18, 19, 20, 23, 24), while others are characterized by multiple steps (nos. 7, 21, 22, 31, 32) (figs. 15-16). The presence of steps is therefore only attested on marbles from the Vathy promontory.

As it is known, the presence of squared recesses of various sizes in perpendicular planes is a typical feature of Roman quarry blocks[29]. The stepped blocks were perfected in this way because they were intended for the production of slabs and this specific shape made the blocks lighter for transport. It might have also been aimed at increasing the efficiency of the final production of slabs of more or less standardised sizes[30]. We have documentary evidence of stepped marble elements both in some wrecked cargoes – such as those of Giardini

[28] See *supra*; and ANTONELLI *et al.* 2020.
[29] WAELKENS 1990: 64-65; BRUNO 2002b; RUSSELL 2013: 82, 234.
[30] WAELKENS 1990: 64-65.

Fig. 14. Thasos island (Greece). In red, the position of the most important historical quarries (drawing by S. Medaglia).

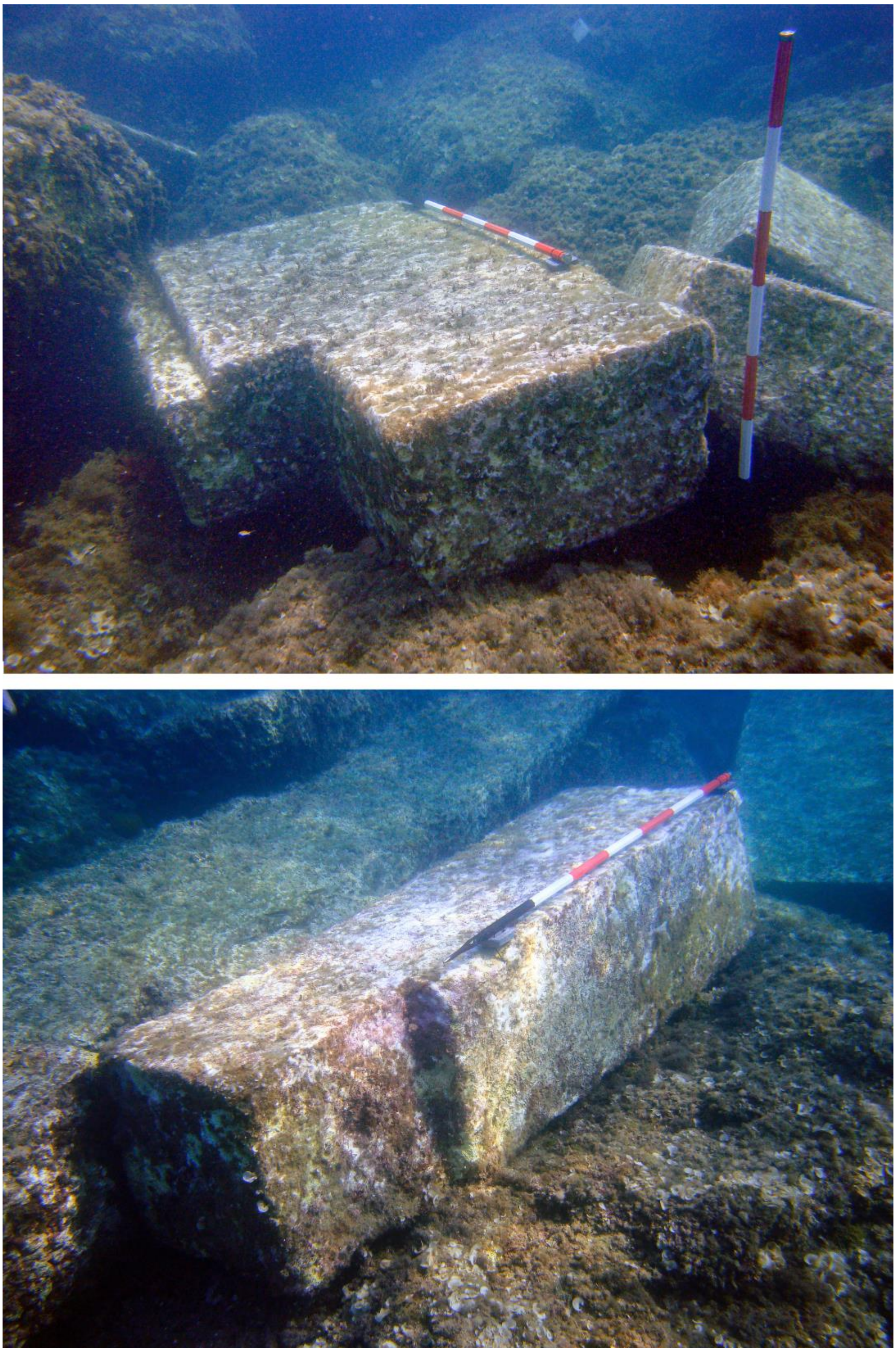

Fig. 15. Cala Cicala. Blocks nos. 31, top, and 18, bottom, with one single step (photo by S. Medaglia).

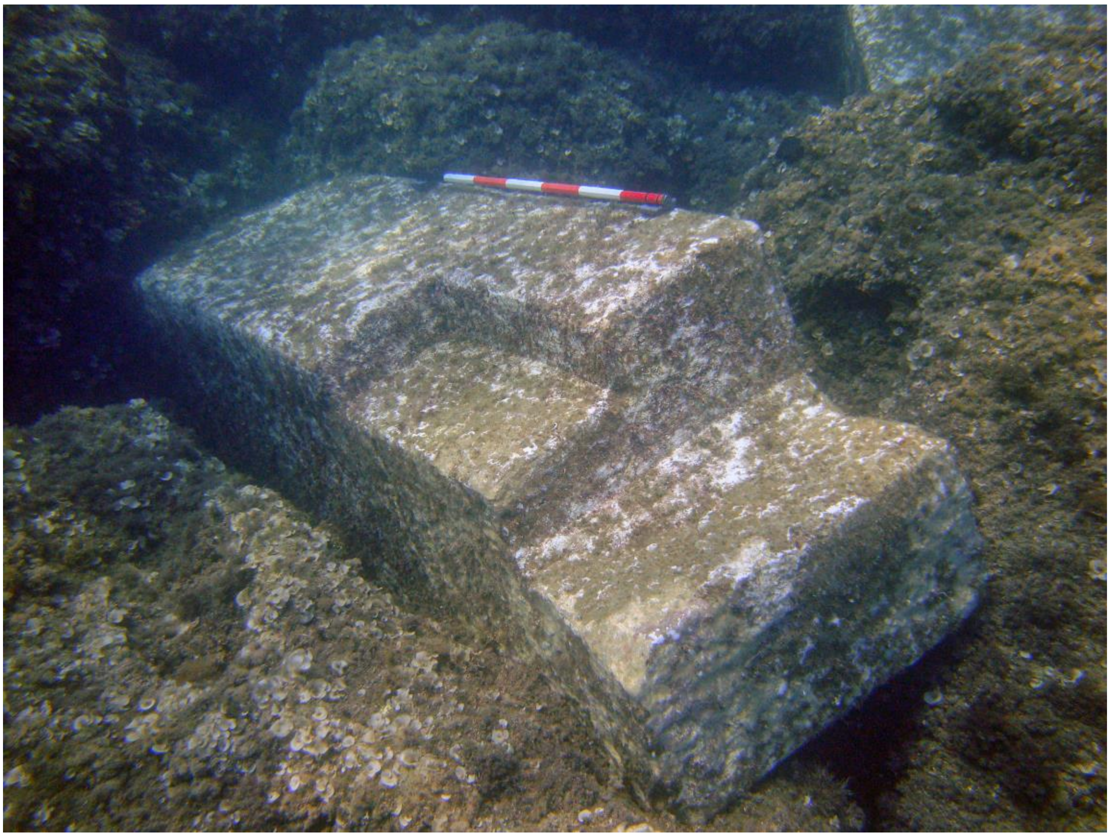

Fig. 16. Cala Cicala. Stepped block no. 32 (photo by S. Medaglia).

Naxos (Messina)[31], Punta Scifo A (Crotone)[32], Porto Cervo[33], Şile (Black Sea)[34], Punta del Francese (Sassari)[35], and Torre Sgarrata (Taranto)[36] – and in the *stationes marmorum* of Rome (Marmorata) and *Portus* (Fossa Traiana)[37]. In these *stationes*, this technique seems to be applied mostly (but not exclusively) on coloured marbles, i.e. those mainly intended for the construction of *opus sectile* floorings and wall veneering (*crustae*)[38]. For example, in *Portus* (Canal of Fiumicino) only 2.24% out of 134 stepped blocks are made of white marble, while the remaining blocks are all in coloured marble and breccias[39].

As far as Thasian marble is concerned, a clear parallel could be drawn between the stepped blocks of Cala Cicala and the wreck of Torre Sgarrata that, as is well known, also carried marble from the island of Thasos[40]. A block with stepped cuttings is attested, in a state of partial extraction, also in the quarry at Cape Vathy[41].

We made an attempt to isolate, also in the light of the literature on particular loads of marble (Capo Granitola, Isola delle Correnti, Marzamemi 1, Torre Sgarrata)[42], the measurements related to the height of various

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[31] Basile 1987: 386-387.
[32] Pensabene 1978; to be integrated, for a correct dating of the wreck, with Medaglia 2008: 105-107 and Medaglia *et al.* 2013: 159, note 114.
[33] Beltrame *et al.* 2021: 2.
[34] Beykan 1988; Russell 2013: 128.
[35] Beltrame, Lazzarini, Antonelli 2020: 1083 (one element only).
[36] Gabellone *et al.* 2009: 325-328.
[37] Baccini Leotardi 1979; Pensabene 2002a: 27 ff.
[38] Pensabene 2002a: 27 and 29; Bruno 2002a: 186.
[39] Pensabene 2002a: 28 (table).
[40] Gabellone *et al.* 2009, p. 327, figg. 11, 13-15.
[41] Sodini *et al.* 1980, pp. 81-82, fig. 3. Two quarry blocks from Vathy-Saliara, one parallelepiped and one shapeless, were identified, through petrographic analysis, among the materials from the Fossa Traiana (see Bruno *et al.* 2002b, p. 351).
[42] Pensabene 2002a; Gabellone *et al.* 2009.

artefacts by converting them into Roman linear units, in this case the *pes* (29.57 cm) with its multiples and submultiples[43].

In doing so, and not neglecting the fact that this is raw material, it was possible – although indicatively and more effectively than the other linear dimensions – to subdivide the blocks according to the following table:

Ancient Roman units of length	**Block number (in bold) and the actual preserved height (cm, in brackets)**
1 dodrans (¾ feet) = 22.17 cm	**36** (22.3)
1 cubitus (1 ½ feet) = 44.35 cm	**30** (45.6)
1 pes + 1 dodrans (1¾ feet) = 51.74 cm	**31** (51.5); **35** (55)
1 dupondius (2 feet) = 59.14 cm	**23** (60.4)
2 pedes + 1 quadrans (2 ¼ feet) = 66.53 cm	**22** (67.5)
1 gradus (2 ½ feet) = 73.92 cm	**19** (75.5); **24** (73.9)
2 pedes + 1 dodrans (2 ¾ feet) = 81.31 cm	**25** (82.5)
3 pedes + 1 quadrans (3 ¼ feet) = 96.10 cm	**21** (95.3); **32** (97.9)
3 pedes + 1 semipes (3 ½ feet) = 103.49 cm	**9** (101)
4 pedes = 118.28 cm	**20** (115)

The other category of marbles transported by the ship is represented by 20 elongated artefacts (nos. 1, 2, 3, 4, 5, 6, 10, 11, 12, 13, 14, 15, 16, 17, 18, 26, 27, 28, 29, 34). These artefacts rarely have sharp edges, so the faces are joined with a soft, almost rounded roughing (fig. 17). While considering this morphological peculiarity and the features of the column shafts abandoned in the quarry of Thasos[44], we are inclined to believe that these elements were not intended to be transformed into columns, as it was claimed since the first investigations[45].

Within this category, three artefacts (nos. 6, 29, and 34) stand out from the others, although they maintain a narrow and elongated shape. By observing their section, a smooth and well-shaped slab-like appendix of 2 cm can be seen halfway up their height, contrasting with the coarse roughing-out of the rest of the artefact (fig. 18). During the early underwater documentation activities, we even hypothesized that they were different overlapping elements, which over time became cohesive due to marine encrustations. Since this scenario can be discarded, the slab-like frame could indicate the point where the artefact was to be split at its destination to obtain other elements, whose function is unknown to us (fig. 19).

Fig. 17. Cala Cicala. View of the pillar-like artefacts nos. 12 and 13 (photo by S. Medaglia).

[43] For a summary table of Roman linear and surface measurements see DI STEFANO MANZELLA 1987: 184-185.
[44] On the techniques for extracting column shafts in the quarries of the peninsula of Aliki, see SODINI, LAMBRAKI, KOŽELJ 1980: 118 (for some examples of elements abandoned in the quarry see pp. 93, fig. 22; 102, fig. 43, 105, fig. 47, 109, fig. 57).
[45] ROGHI 1961: 58.

Fig. 18. Cala Cicala. Two side views of the item no. 34 with a protruding profile along the midline (photo by S. Medaglia).

Fig. 19. Cala Cicala. Detail of the slab-like appendix of artefact no. 29 (photo by S. Medaglia).

As for the blocks, the dimensions of the elongated elements are highly varied. The longest monoliths exceed 6 meters (nos. 1, 5, 12, 13, 16, 28). In addition, for these artefacts, the maximum height was used to draw some parallels with the Roman linear measurements centered on the *pes*, its multiples and submultiples:

Ancient Roman units of length	**Block number (in bold) and the actual preserved height (cm, in brackets)**
1 cubitus (1 ½ feet) = 44.35 cm	**27** (46)
1 pes + 1 dodrans (1¾ feet) = 51.74 cm	**17** (53); **26a** (52)
1 dupondius (2 feet) = 59.14 cm	**1** (60.8); **2** (60.2); **5** (60); **10** (59); **16** (58); **28** (59.4)
2 pedes + 1 quadrans (2 ¼ feet) = 66.53 cm	**3** (67.8); **4** (65.9); **15** (67); **18** (63.5)
1 gradus (2 ½ feet) = 73.92 cm	**12** (70.4); **14** (70.1).

To sum up, it is clear that the maximum width of the elongated marble artefacts is included in an ideal interval between one *cubitus* (44,35 cm) and one *gradus* (i.e. 2 ½ feet, 73.92 cm).

The blocks whose size is between a *palmus maior* or *dodrans* (22.17 cm) and four *pedes* (118.28 cm) are more varied than the elongated monoliths. For the artefacts with dolomitic fraction coming from the Vathy promontory, we noticed some modularity, perhaps related to some form of size standardization of the quarry products. The fact is that for just over half of them (nos. 9, 18, 19, 20, 21, 22, 31, 32) the length is between 237 cm = 8 *pedes* and 293 cm = 10 *pedes* (1 *pertica*).

As a partial confirmation of these calculations based on the Roman *pes*, we can observe that the wreck of Torre Sgarrata stands out as the only other shipwreck known so far where elements of Thasian marble are attested (blocks). The height measurements of some artefacts of Cala Cicala seem to find a parallel with some Thasian marble blocks in the Apulian wreck. In fact, this site contains several elements with a maximum height between 48 and 52 cm (inv. nos. 160659, 160660, 160663, 160664, 160671, 160670)[46] which roughly imply, as in Cala Cicala (nos. 17, 26a, 31, 35), the equivalent of 1¾ feet, i.e. the ideal measure of 51.74 cm. Another measure of height that recurs in both the cargoes of Cala Cicala (nos. 12, 14, 19, 24) and Torre Sgarrata (where oscillations between 72 and 76 cm can be found) is the *gradus* (2 ½ feet) of 73.92 cm (inv. nos. 186157, 186158, 160665, 160666, 160674)[47].

However, it should be noted that some artefacts of the Cala Cicala cargo seem to drift from the units of measurement based on the canonical Roman foot of 29,57 cm. One would think, as a preliminary working hypothesis to be confirmed (especially considering that we are dealing with rough quarry blocks and not refined architectural elements), that these marble elements may have been extracted using the local measurement system on the island of Thasos, which was based on a foot length of 32.53 cm. This unit of measurement is known to have been used for the sarcophagi quarrying in *marmor thasium* exported in Roman times to Thessaloniki[48]. The elongated elements of Cala Cicala nos. 6 (49 cm), 11 (48.9 cm), and 29 (48.6 cm), in fact, are very close to the size of a foot and a half (48.79 cm), while the maximum height of block no. 33 (40.1 cm) seems to be based on the local metric value of 1 ¼ feet (= 40.66 cm). The artefact no. 7 (56 cm) refers instead to the lo-

[46] GABELLONE *et al.* 2009: 325-326, table 2.
[47] GABELLONE *et al.* 2009: 325-326, table 2.
[48] STEFANIDOU-TIVERIOU 2009: 22.

cal measure of 1 ¾ feet (= 56.92 cm); finally, elements nos. 8, 13, and 34 are close to the measure of 2 feet (= 65.06 cm).

As we have already observed at the beginning of this paper, some stone elements recovered before 1929 could be potentially included in the submerged artefacts in Cala Cicala as an integral part of the cargo. These are some Ionic capitals and Attic marble bases whose exact origin went lost during their transfer from the Civic Museum to the National Museum of Crotone (fig. 20). Only recently, thanks to Margherita Corrado's investigation of archival documents, it was possible to attribute them with certainty to the wreck of Cala Cicala[49] (fig. 21). These marble artefacts were studied for the first time by Patrizio Pensabene in an article dated 1978, together with the marbles belonging to the cargo of the Punta Scifo A wreck[50]. The same scholar returned multiple times to these artefacts, either excluding them from the cargo[51] or attributing the finds with some reservations to the wreck Punta Scifo A[52] due to the fact that they are not included in the lists published by Paolo Orsi, the author of the first report of the wreck[53].

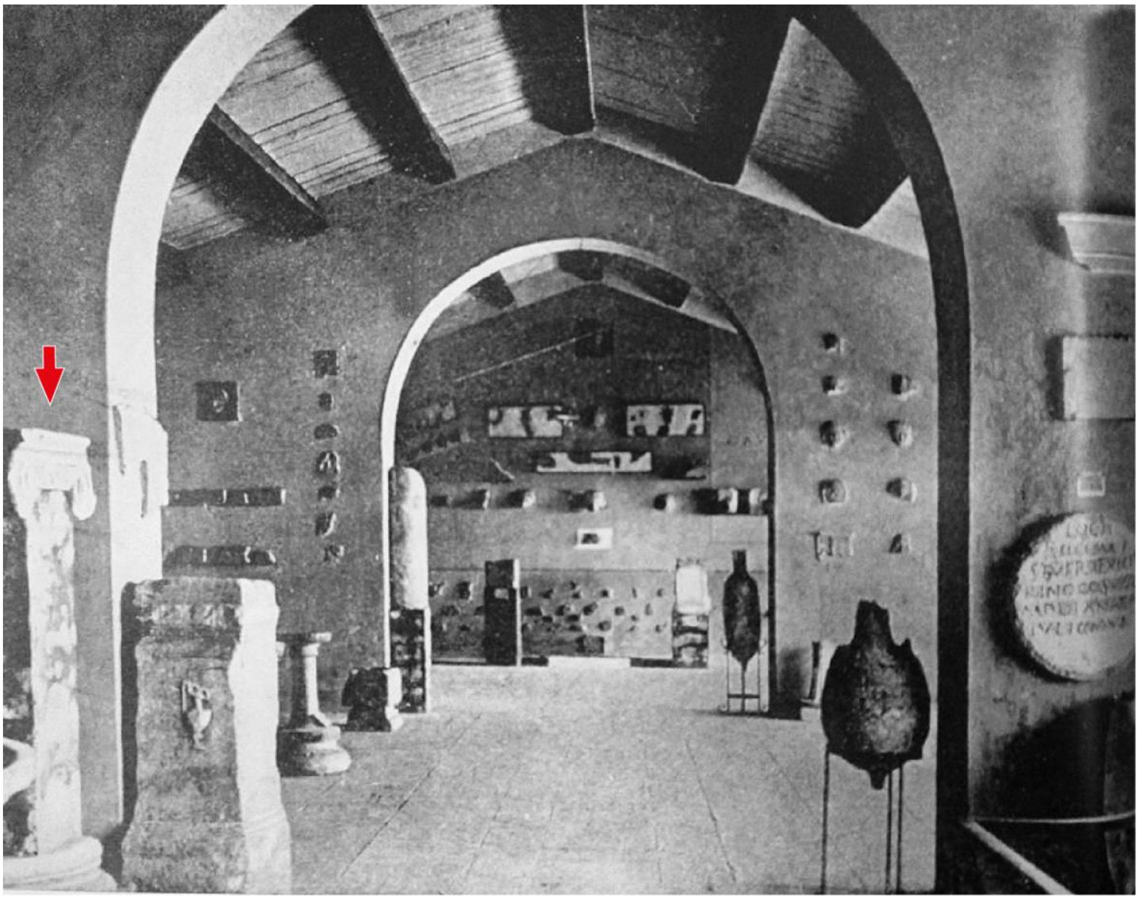

Fig. 20. Crotone, Civic Museum. One of the Ionic capitals on display in 1934 in room I of the Civic Museum, then located in the former Sotto Campana barracks of the Castle of Carlo V (from L*ARIZZA 1934: 153).*

[49] CORRADO 2018: 176, 243-244, 419. It should not be surprising that semi-finished marble artefacts or finished ones, yet unpolished, can travel on the same vessel along with raw materials from the cave, as it was proved, for instance, in the shipload of the Punta Scifo A wreck nearby (see, *supra,* footnote 32). Whatever the nature of the marble of the bases and capitals it should not create any difficulties, as the presence of mixed marble loads is attested, for example, without leaving the Crotone peninsula, in the wreck of Punta Scifo D (MEDAGLIA *et al.* 2013; MEDAGLIA 2015) or in the aforementioned Punta Scifo A. Anyway, we plan to proceed with the petrographic examination of these artefacts as soon as possible.
[50] PENSABENE 1978.
[51] PENSABENE 2002a: 37.
[52] PENSABENE 2020: 169-171
[53] ORSI 1911: 118-124; ORSI 1921.

Fig. 21. The three Ionic marble capitals currently on display at the National Archaeological Museum of Capo Colonna (photo by S. Medaglia).

In any case, the three Ionic capitals, very similar to each other and every one of them about a Roman foot high, show an almost-finished condition and are characterized «by a smooth pulvino held tight by a baldric, with the echinus decorated by an elegant, yet cold and mechanical, Ionic *kyma* with triple egg-and-dart, with the horizontal channel of the volutes under the abacus and with two spirals in the volute with a button at their centre»[54]. On a closer inspection, however, some differences can be noted[55]: one of the capitals presents half-palmettes with four lobes, cuspidate lancets and a baldric with three central astragals separated by two concave bands; in the other two specimens, the palmettes have three lobes and the *balteus* is configured with a slightly convex ribbon, bordered by two astragal-shaped fillets (fig. 22)[56].

Nevertheless, we believe that the generic attribution of the capitals in the first century AD is prudent, although there is no lack of elements that seem to lead back to the Augustan age. The formal conservatism of the late Hellenistic tradition may be found primarily in the coincidence between the imaginary line that connects the eyes of the volutes with the laying surface of the echinus[57]. These elements, along with other ones that characterize the fine workmanship of the capitals – including the plasticity of the cutting of the Ionic *kyma,*

[54] PENSABENE 2020: 169.
[55] A) Height 29 cm; laying surface diam. 54.3 cm; abacus sides 57 x 51 cm; max. width between volutes 76 cm; volutes diam. 21.5 cm; b) inv. no. 126264, height 30 cm, laying surface diam. 51 cm, abacus sides 62 x 57 cm, max. width between volutes 79 cm, volute diam. 23.5 cm; c) inv. no. 126263, height 29 cm, laying surface diam. 51 cm, abacus sides 53 x 53 cm, max. width between volutes cm 72, volutes diam. 19.8 cm: see PENSABENE 2020: 169-170, nos. 83-85 (from which the measurements are taken).
[56] PENSABENE 1978: 108; PENSABENE 2002a: 37; PENSABENE 2020: 169-170.
[57] PENSABENE 1978: 116; PENSABENE 2020: 169. On the subject see also PENSABENE 2018: 149-150.

Fig. 22. 3D reconstruction of the Ionic capital with inv. no. 126264 of the National Archaeological Museum of Capo Colonna. Acquired by M. Collina (University of Calabria); reconstructed by R. Peluso (3D Research - University of Calabria).

which gives the artefacts an almost metallic look even without using a drill – are visible in numerous finds, generically traced back to the age of Augustus or to the years just before the Principate.

As pointed out by Pensabene[58], the capitals from Cala Cicala (now in Capo Colonna) can be rightfully compared with some of the Augustan-period specimens found in Ostia at the "Portichetto" of the sarcophagus in Schola del Traiano (now at the Piccolo Mercato)[59]. More similarities, at least for the workmanship of the *kyma,* can be found with some Augustan-period capitals (from Aphrodisias and Kaunos) studied by Oran Bingöl[60]

[58] We would like to thank Patrizio Pensabene and Oran Bingöl for the information and fruitful exchanges about the capitals. The author is solely responsible for all statements made in the present work.

[59] PENSABENE 1978: 116 (with reference to PENSABENE 1973: nos. 107-108, pl. VIII; for no. 107 see also PENSABENE 2007: 158, fig. 84, 160). These comparisons may also be applied to the kyma of elements nos. 110 and 111, found in Ostia and now at the Piccolo Mercato, dating back to the first decades of the 1st century AD and to the Augustan age, respectively (PENSABENE 1973: 39, pl. VIII).

[60] BINGÖL 1980: no. 100, pl. 1; no. 165, pl. 1, 22; no. 43, pl. 2 (which however presents the decorated abacus).

and with another Augustan capital now in the Regional Museum of Messina[61]. The idea that the capitals of Cala Cicala were inspired by the models of the late Hellenistic tradition is particularly evident in the clear similarities with some of the Ionic capitals found in the cargo of Mahdia, a wreck located along the Tunisian coast and dated to the beginning of the 1st century BC[62]. Among other things, the capitals of Cala Cicala present, as in some Ionic capitals of Attic origin found in Mahdia, a strong similarity with the workmanship of the *kyma*[63] and, sometimes, with the configuration of the half palmettes with only the upper leaf facing upwards.

The Attic bases have pretty similar shapes[64] with a lower plinth surmounted by a *torus*, one *scotia* placed between two fillets and another *torus* above which, in two of the five specimens, is a little thicker and slightly more protruding than the underlying fillet. In dimensional terms, the heights of these artefacts can be generally divided into two groups: the first with two bases 2 ½ feet wide and with an overall height of one *pes*; the other with heights of ¾ feet and bases 2 ½ feet wide as well (fig. 23).

Fig. 23. Four of the five Attic bases from the Albani Collection; now at the National Archaeological Museum of Capo Colonna (a: photo by S. Medaglia; b-d: from Bartoli 2008).

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[61] Fuduli 2013: 56-57, 70, figs. 16-17.
[62] Merlin, Poinssot 1956; Martin, Lézine 1959; Ferchiou 1994.
[63] Ferchiou 1994, pp. 198-200, nn. B 107, B 110, B 112, B 114, B 115, B 177.
[64] A) Height 23 cm; plinth 73 x 73 cm; top torus diam. 61 cm; b) height 23 cm: plinth 68 x 68 cm; top torus diam. 61 cm; c) height 32 cm: plinth 72 x 72 cm; top torus diam. 57 cm; d) height 25 cm: plinth 74 x 74 cm; top torus diam. 64 cm; e) height 31 cm: plinth 72 x 72 cm; top torus diam. 62 cm; a letter K engraved on the upper face of the torus: see Bartoli 2008: 264-269. See also Pensabene 2020: 170, nos. 86-90, 174, figs. 109-113 (with slight size variations).

Despite the absence of archaeometric analyses, Pensabene assigns both the capitals and the bases to quarries of white Docimium marble (synnadic of Phrygia) on the basis of macroscopic observations[65]. Regarding the origins of the capitals and bases, however, it would be appropriate to suspend judgment until comprehensive petrographic examinations are carried out: in fact, due to the material homogeneity of the submerged load of Cala Cicala, it cannot be excluded that these elements may have been extracted in the quarries on the island of Thasos where, among other things, a production of Ionic capitals was attested, especially in Aliki[66]. Nevertheless, the absence of the pointed tip in the half-palmettes, often present in the capitals from Thasos and extending into the first half of the circle of the volutes[67], may imply a different origin for these artefacts, perhaps from a Greek insular context, or indeed from the Anatolian area as Pensabene suggested[68].

The state of preservation of the artefacts (A. Taliano Grasso, D. Miriello)

Unlike the blocks, that are in a rather good state of preservation, the elongated marbles show, by contrast, an advanced erosive state. The surfaces of the latter are never flat (although some are roughed out) but present some roughness and grooves attributable to natural erosion phenomena. In some points, the wear of the stone surface is particularly pronounced, and the profile looks strongly irregular (nos. 4, 10, 13, 17, and 27). The wearing out is localized mainly in the points where the artefacts are in contact with the calcarenitic rocks of the seabed. Due to the effect of the waves, which at shallow depths is particularly strong during bad weather, the rubbing between a harder surface (with a calcitic base) and a softer one (organogenic calcarenite of the seabed) caused the marble artefacts to dig and stabilize themselves between the rocks. The result, particularly evident in elements nos. 4, 5, 10, 12, 27, and 28, is that some parts of the elements appear perfectly set in the calcarenitic rocks of the seabed. However, the abrasion of the surfaces also occurred through the rubbing between two marble elements placed in contact with each other, as can be observed, for example, in elements nos. 13 and 14 (fig. 24).

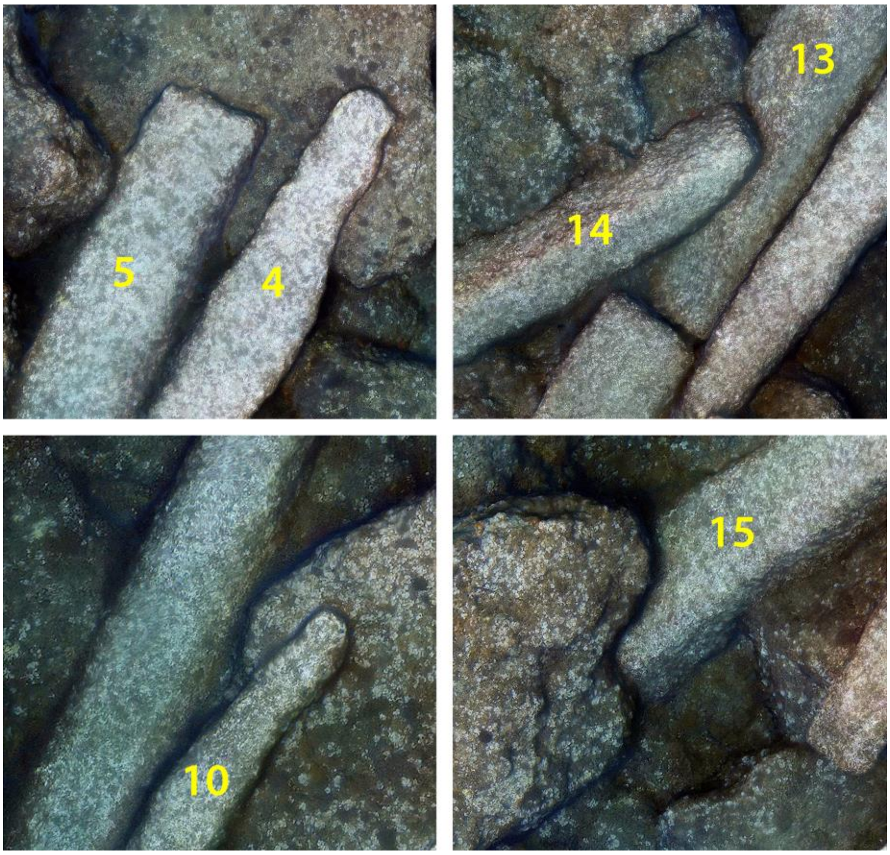

Fig. 24. Cala Cicala. Details of the 3D survey with some examples of attrition along the contact surfaces between the partially calcitic marbles and the organogenic calcarenites on the seabed (elaborated by S. Medaglia).

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[65] «Translucent white marble, livid in the background and with medium-small sparkling crystals» for the capitals; «white marble with medium-small sparkling crystals» for the bases: see Pensabene 2020: 169 and 170 (see also Pensabene 1978: 108; Pensabene 2002: 37).
[66] Sodini, Herrmann 1977.
[67] Sodini, Herrmann 1977: 497, fig. 56.
[68] Pensabene 2020: 169.

In the light of the above, we can ascertain a clear distinction between blocks and elongated elements with respect to the preservation of their respective materials. The artefacts with dolomitic fraction of Cape Vathy (blocks) were preserved much better when compared with those with a calcitic fraction (softer, elongated monoliths) from the Aliki quarries, showing unequivocal (and sometimes considerable) signs of wear.

The bases and capitals currently held at the National Museum of Capo Colonna should be analysed separately. They show a widespread biological degradation both on the surface and the innermost layers of the marble. This alteration is visible on the external surface as a “pitting” (widespread, minute circular holes), while the innermost layers, now visible, present numerous cavities and galleries. This degradation is attributable to perforating sponges that have dissolved d the calcium carbonate through physical and chemical processes of bioerosion. This action, in some case, caused also the loss of a significant amount of material.

The distribution of the cargo and some remarks on the underwater archaeological site (S. Medaglia)

The positions of the stone artefacts show their alignment along the north-east/south-west axis. This is demonstrated, above all, by the pillar-like elements which, with a few exceptions – probably due to the sliding of the artefacts from the original location – are all arranged according to the same orientation. According to the position of the marble elements on the seabed, a sort of shape-dependent distribution may also be observed: the longer elements lie mainly at the two ends of the archaeological site, i.e. north-west and south-east, while the blocks are located in the central sector. Therefore, the current location of the archaeological finds somehow mirrors their position during the stowage phase. In particular, it is to be assumed that the pillar-shaped artefacts, precisely because they were longer, occupied the outermost area of the hold, so as to surround the rest of the load on both sides[69].

The marble elements nos. 12, 13, 14, 15, 16, and 17 still appear well placed together, plausibly reflecting their original arrangement along the south-east side (fig. 12). However, if the eastern sector appears to be least subject to alterations with respect to the original position of the stone elements in the hold, the remaining mass of marble elements located at the opposite end shows a certain chaoticity, presumably due to the displacement of the artefacts that slipped westward to reach a position where some hollows in the rocky bottom were capable of stopping their movement. The centrally positioned blocks are presumably arranged close to the original positions, especially nos. 21, 22, 23, 24, 25. These blocks present a slab-like appearance (particularly evident in the elements nos. 22 and 23), are arranged edgewise and grouped side by side, much like, for example, the wreck of the first half of the 3rd century AD laying in the neighbouring bay of Punta Scifo[70] (fig. 25).

In the light of the above, we can assume that the alignment of monoliths nos. 4-5 and 10-18 indicates on the whole the longitudinal axis of the hull on the seabed. The arrangement of the longer stone elements along the bow-stern line is logical and furtherly confirmed by the archaeological documentation of several shipwrecks whose cargo contained columns.

We do not know if the cargo was arranged on one or two levels. It is possible that there were two layers, at least on the sides and for some artefacts only. However, it cannot be ruled out that marbles were all stowed on a single level. In fact, if we tried to put together various elements until they would assume a compact shape while keeping them on a single plane, they would form a bulk whose width would exceed 10 meters: these dimensions are not infeasible, as it is well demonstrated by some examples, though limited to stone or mixed cargoes, such as Punta Scifo D (approx. 14 meters)[71], Mahdia (approx. 13.8 meters)[72], Isola delle Correnti (approx. 10-11 meters)[73], and Porto Cervo (approx. 10 meters)[74].

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[69] MEDAGLIA 2010: 287.
[70] MEDAGLIA *et al.* 2013: 146; MEDAGLIA 2015: 9, fig. 18.
[71] MEDAGLIA *et al.* 2013: 152.
[72] HELLENKEMPER SALIES *et al.* 1994.
[73] KAPITÄN 1961; KAPITÄN 1971.
[74] PIPERE 2014: 771.

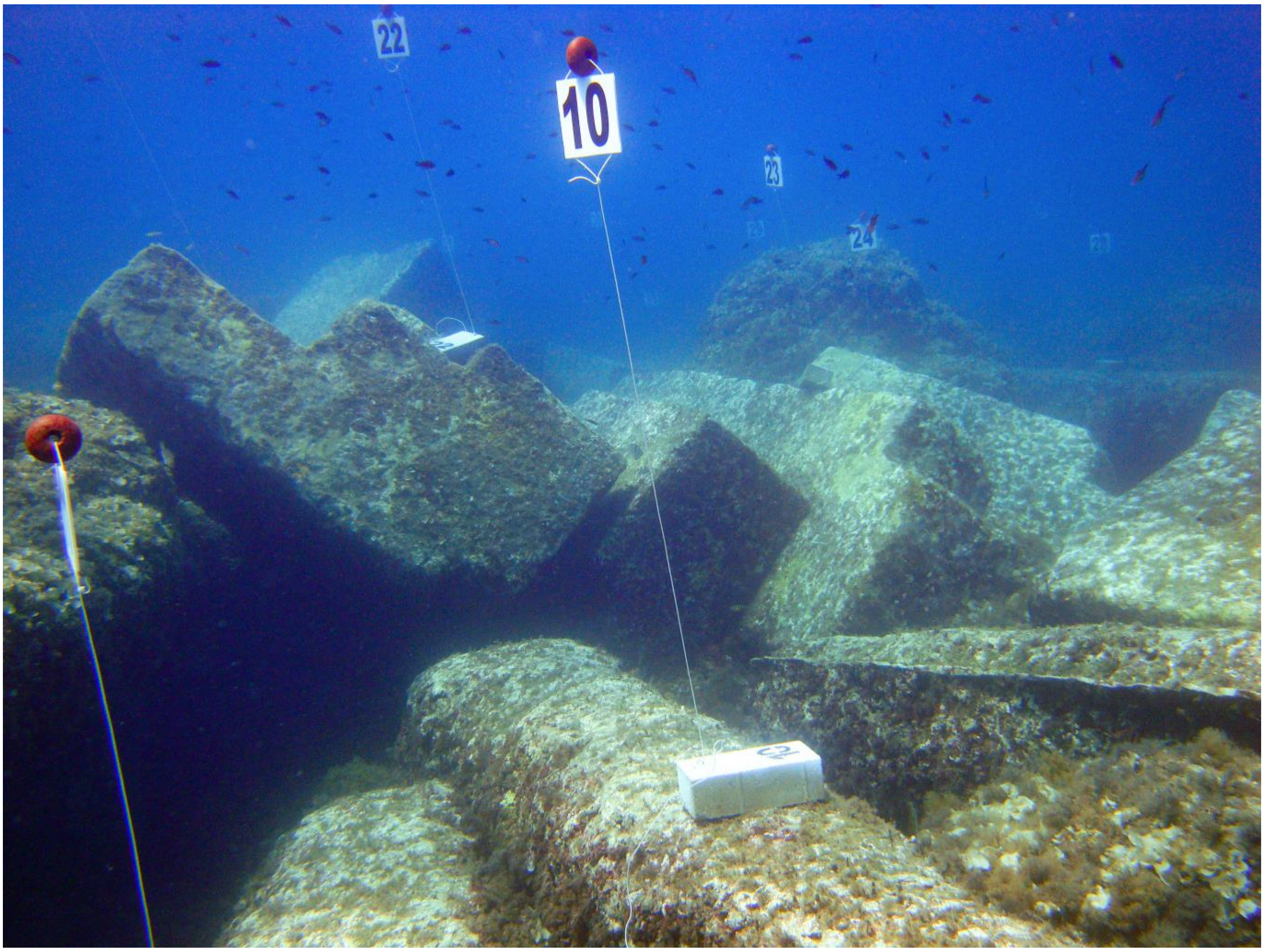


Fig. 25. Cala Cicala: central sector of the site with blocks nos. 22, 23 and 24 still well connected to each other and arranged edgewise (photo by S. Medaglia).

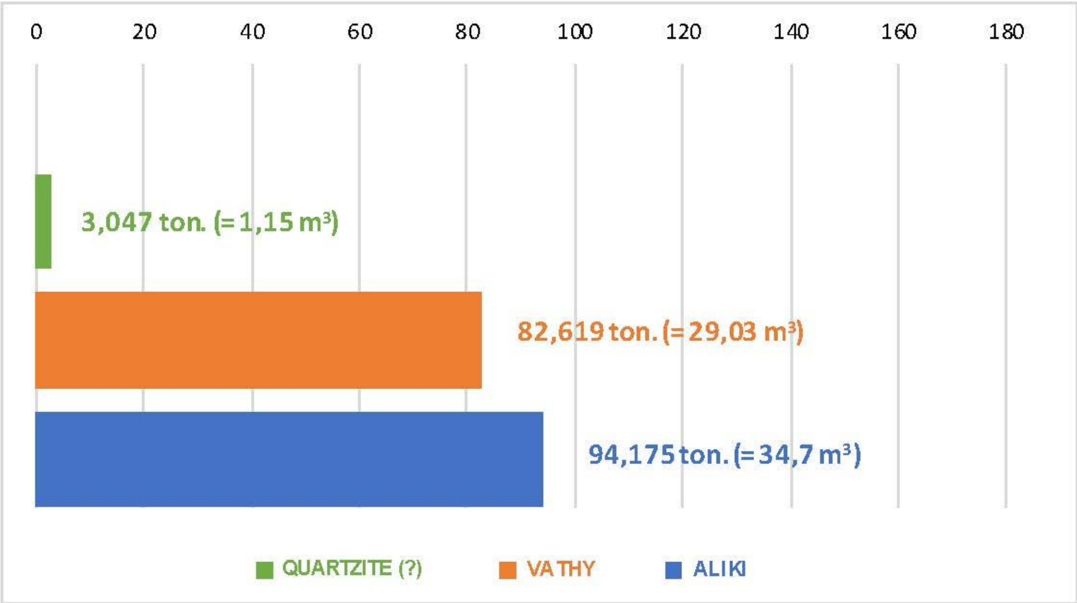
The total volume of the marbles still lying on the seabed is 64.88 m^3 (of which 29.03 m^3 coming from Cape Vathy, 34.7 m^3 from Aliki, and 1.15 m^3 for quartzite). Since the different stone types coming from the quarries of Thasos have different specific weights[75] the total weight amounts to 179.84 tons. Of the latter, 3.047 tons belong to the only quartzite element, 94.175 tons to Aliki, and 82.619 tons to the Vathy quarries (table 4).

Except for the Ionic capitals and the Attic bases, which are all partially finished (fig. 26), the rest of the stone cargo of Cala Cicala was therefore made up of elements stowed mainly in a stage of roughing out, performed directly in the quarry by the workers of the *caesurae*.

The campaigns conducted in 1983 and 2017 did not identify any elements of the hull. Moreover, the rocky seabed and the shallow depth did not help the preservation of any wood element. Equally, we should point out the absence of any archaeological finds referable to the *instrumentum navis*.

Unfortunately, there are no movable materials attributable to the provisioning of the ship's crew (such as ceramics and amphorae), as these could have contributed decisively to the dating of the archaeological context. There is no trace of the “innumerable shards of amphorae” that Carolei was still able to observe among

[75] 2846 kg/m^3 for the dolomitic fraction and 2714 kg/m^3 for the calcitic fraction, to which the average density of 2650 kg/m^3 must then be added for quartzite. See PERDIKATSIS *et al.* 2006: 502, 505 (M1 - M2). In MANIATIS 2004: 183, a slightly higher density of 2850 kg/m^3 is reported for the Thasian marble with dolomitic fraction.



Tab. 4. Percentage classification of the marble transported by the ship, divided by quarries (elaborated by S. Medaglia).

Fig. 26. One of the capitals, overturned (see supra, footnote no. 56, type A), on display at the National Archaeological Museum of Capo Colonna (photo by S. Medaglia).

the marble artefacts at the end of the 1950s[76]. The discovery of “a small late-Roman neck of an amphora” – which took place not far from the underwater site during the investigations in 1983 – cannot be assigned with certainty to the wreck, therefore it should be considered of little importance. The same applies to the fragment of an amphora recovered in the waters of Cicala and seized in 1989 by the Guardia di Finanza[77]. In this regard, it should be considered that the marine area in which the wreck is located is particularly rich in terms of archaeological evidence, though often erratic, due to numerous shipwrecks that occurred in ancient times in this dangerous coastal strip dotted with surfacing rocks and reefs[78]. As a demonstration of the presence of erratic shards among the rocks on the seabed of Cicala, it should be pointed out that, during the surveys carried out in 2017 to define the boundaries of the site, some very concretionary fragments of amphorae, generically attributable to the Greek-Hellenistic age, were found about 30 meters south-east of the marble elements, though these are certainly to be considered extraneous to the context.

Cala Cicala was located in a busy stretch of sea, not only in virtue of the forced passage through the Ionian Sea that connected the East and West Mediterranean, but also because of a local and regional maritime traffic due to the nearby presence of the Greek and then Roman city of Crotone and the renowned sanctuary dedicated to Hera, defined by Livius as «*Sanctum omnibus circa populis*»[79] and «*augustissimus regionis eius*»[80]. The Lacinio promontory itself, which in Roman times was a land (*Lacenium*[81]) and maritime (*Naus*[82]) *statio*, offered a good natural harbour mentioned numerous times on the occasion of various historical events (in Roman sources in particular[83], like the return of Hannibal in Africa in 203 BC[84]).

The only useful elements for the dating of the underwater archaeological complex come from the analysis of the capitals currently kept in the National Archaeological Museum of Capo Colonna. However, their use for chronological purposes clearly presents some degree of uncertainty as the capitals are in a nearly finished state[85], which obviously does not facilitate their classification in chrono-typological and stylistic terms. Less problematic, at least for chronological definition, is the potential exclusion from the cargo of any of the three capitals since they, although different from each other, seem to share the same stylistic formalisms[86].

Ancient Roman sources give *marmor thasium* only scant attention although its use was widespread. According to Vitruvius, the Thasian marble, along with those quarried in Paros, Heracleia and Proconnesus, was considered by the citizens of Ephesus for the construction of the Temple of Artemis[87]. Seneca reported that it became popular in his time, mostly as a lining material for pools (“*piscinas nostras circumdedit*”), while in the past it was rarely used, and with spectacular results, in some temples (“*quondam rarum in aliquo spectaculum templo*”)[88]. In *Naturalis historia,* Pliny includes it in a short list of the most famous white marbles of Greece[89]; Suetonius, for his part, mentions the *saeptum* made of Thasian marble that delimited the porphyry sarcophagus of Nero, located in the Mausoleum of the Domitii Ahenobarbi in the Campo Marzio[90]. Statius mentions it twice in the *Silvae*: firstly, it is listed among the stones (together with Carystian marble, ophite, and onyx) that were excluded by *Claudius Etruscus* from the decorations of his rich and sumptuous *balneum*[91]; secondly, he recalls it as one of the features on display in the Sorrentine villa of *Pollius Felix*[92]. Finally, Pausanias recalls two Thasian

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[76] See *supra*, note 4.
[77] Arch. Mus. Naz. Crotone, 13F, date of acquisition 26.07.1989, mat. inv. no. 1547/M.
[78] MEDAGLIA 2008; MEDAGLIA 2010.
[79] LIV., XXIV, 3, 3.
[80] LIV., XLII, 3, 6.
[81] *Tab. Peut.*, VI, 2; *An. Rav.*, IV, 31; *Guido* 30 e 72.
[82] *Itin. mar.*, 490, 1.
[83] For an overview of the sources, see MEDAGLIA 2009: 15-16.
[84] LIV., XXX, 20, 6.
[85] PENSABENE 1978: 108; CORRADO 2018: 420.
[86] This last aspect, i.e. the apparent belonging of the three capitals to the same formal and compositional tradition, could – with all the necessary precautions – represent a further clue in favour of the attribution of these marbles to the wreck of Cala Cicala, as reported in the 1934 inventory of the Civic Museum of Crotone compiled by Gennaro Pesce (see below, notes nos. 2 and 4).
[87] VITR., *De arch*., X, 2, 15. See also HOLTZMANN 1993: 25; MARC 1995: 35.
[88] SEN., *Ep. ad Lucilium*, 68, 6.
[89] PLIN., *N.h.*, XXXVI, 44.
[90] SUET., *Nero*, L.
[91] STAZ., *Silvae*, I, 5, 35-41. On this passage see the analysis by CAMPANA 2004.
[92] Staz., *Silvae*, II, 2, 85-93.

marble statues (Θασίου λίθου) dedicated to the emperor Hadrian in the sanctuary of Olympian Zeus in Athens[93].

In Diocletian's *edictum de pretiis rerum venalium*, Thasian marble is priced at 50 *denarii* per cubic foot[94]. Together with Lesbian (50 *denarii*), Scyrian (40 *denarii*)[95], Proconnesian (40 *denarii*), and other unidentified marbles, it belonged to the cheapest group of construction marbles, supposedly due to its wide availability on the market[96]. In the case of Thasian marble, it is worth remembering that it was suggested that the edict fixing the *maximum* of the price was related only to the calcitic variety of Aliki which, unlike the valuable marble of Vathy, was more abundant and extracted and worked with greater ease[97]. The contiguity of the quarry fronts with the sea, and therefore with the harbours - as documented, for example, at Aliki - also contributed to the low prices of the white marble of Thasos[98].

Returning to the Cala Cicala wreck: we can reasonably assume that it sank after colliding with a rocky side of the nearby coast. In fact, the archaeological evidence is located along the slope of the relict of a marine terrace. The multibeam bathymorphology shows clearly its submerged profile (fig. 2). It is a line of surfacing rocks that marks the limit of an ancient promontory, i.e. the prolongation of the adjacent Pleistocene marine terrace called 5A which, appeared during the Upper Pleistocene in a warm interglacial period MIS 5 (A), underwent a regressive evolution due to both erosive and gravitative causes[99] (fig. 3).

Conclusions (S. Medaglia, A. Taliano Grasso, F. Antonelli)

Used on the island since the Neolithic age[100], Thasian marble was exported since the Archaic Age as indicated by the most ancient traces of its use, such as the partial decoration of the Ionic temple of Thermi, near Thessaloniki (540-520 BC)[101], the *kouros* of Malibu (530-520 BC)[102] and Vitruvius' information about its use in the construction of the Temple of Artemis in Ephesus, which we have already mentioned[103]. However, it was in Roman times that the use of Thasian marble became widespread throughout the Mediterranean basin. The transport of the two varieties of Thasian marble attested in the cargo, which were normally destined for different uses, dates back to this period.

The artefacts quarried in the Aliki district (fig. 14) – a promontory located in the south-eastern sector of the island, whose quarries were extensively studied and mapped by Jean-Pierre Sodini, Anna Lambraki, and Tony Koželj[104] – were mostly to be used in architecture. In the same quarries, marble was also extracted for a flourishing production of partially finished sarcophagi that lasted at least until the Slavic devastations that struck the island in the Late Empire[105]. The white calcitic marble with large crystals from Aliki, which in Cala Cicala is characterized by widespread and large greyish veins, was seamlessly exploited and exported until the Byzantine period (VII century AD)[106]. The quarry fronts placed directly on the shore favoured the transport of large monoliths – columns, bases, blocks, capitals, and various architectural elements – directly onto the cargo ships.

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93 Paus., I, 18, 6.
94 Giacchero 1974.
95 According to Lazzarini, Cancelliere 2000: 57, the one mentioned in the edict is the white type quarried on the island and not the far more valuable polychrome carbonate breccia, known as "marmor Scyrium" or "breccia di Settebassi".
96 Attanasio 2003: 201.
97 Lazzarini 2010: 486. As we have been able to observe, the difference in hardness between the two varieties is also visible in their state of preservation in an underwater environment.
98 Sodini, Lambraki, Koželj 1980: 119 and following; Pensabene 2002a: 18.
99 Blois 2008; Zecchin *et al.* 2009; Zecchin *et al.* 2012; Zecchin *et al.* 2018.
100 Kozelj 1993: 61.
101 Herrmann 1999: 58-59.
102 Podany 1993: 58; Holtzmann 1992.
103 Vd. *supra*: 31.
104 Sodini, Lambraki, Koželj 1980.
105 Sodini, Lambraki, Koželj 1980: 123; Wurch-Kozelj, Kozelj 2009; Maniatis *et al.* 2010; Attanasio *et al.* 2018; Herrmann, Tykot, van den Hoek 2018.
106 Sodini *et al.* 1980: 126; Marc 1995: 33; Herrmann, Barbin 1993: 102; Bruno *et al.* 2002a: 158.

Fig. 27. Cala Cicala. Block no. 20 extracted from the Vathy quarry seen from the south-east (photo by S. Medaglia).

The specialization of this area in the production of partially finished architectural elements (especially for churches) increased in the later ages[107].

The other variety of marble found in the cargo comes from the Cape Vathy promontory (fig. 14), in the north-eastern sector of the island, and was instead used mostly for statues due to the intrinsic features of dolomitic marble. Well recognizable even on a macroscopic scale[108], this variety is hard and of a beautifully pure and uniform white, with medium-large and very bright crystals (fig. 27). As evidenced by some investigations conducted on various European and American museum collections, the use of Thasos-Vathy marble was widespread in Antiquity[109]. Its use out of the island was known since the middle of the 6th century BC and throughout the Classical and Hellenistic ages in territories including Macedonia, Thessaly, Thrace, Asia Minor and the Italian peninsula[110]. In the Roman period the Vathy dolomitic marble was used on a large scale and the peak of

[107] HERRMNN, BARBIN, MENTZOS 1999: 79.
[108] HERRMANN, NEWMAN 1999: 293; HERRMANN 1999: 57; HERRMANN, VAN DEN HOEK, NEWMAN 2002: 357; ATTANASIO 2003: 202; CALLIGARO *et al.* 2013: 68; HERRMANN, ATTANASIO, VAN DEN HOEK 2014: 11. A dolomitic type with features very close to Vathy marble is the one quarried near Coin (Malaga): see LAPUENTE *et al.* 2002; BRUNO *et al.* 2002a: 157; BARONE *et al.* 2013: 317; PENSABENE 2002b: 208-211; CALLIGARO *et al.* 2013: 68.
[109] HERRMANN 1990; HERRMANN 1992; HERRMANN, NEWMAN 1999; HERRMANN 1999; HERRMANN, NEWMAN 2002; ATTANASIO 2003: 201; MANIATIS *et al.* 2010; CALLIGARO *et al.* 2013; HERRMANN, ATTANASIO, VAN DEN HOEK 2014; HERRMANN, ATTANASIO 2018.
[110] HERRMANN 1999: 58-60; MARC 1995: 35; PENSABENE 2002b: 211.

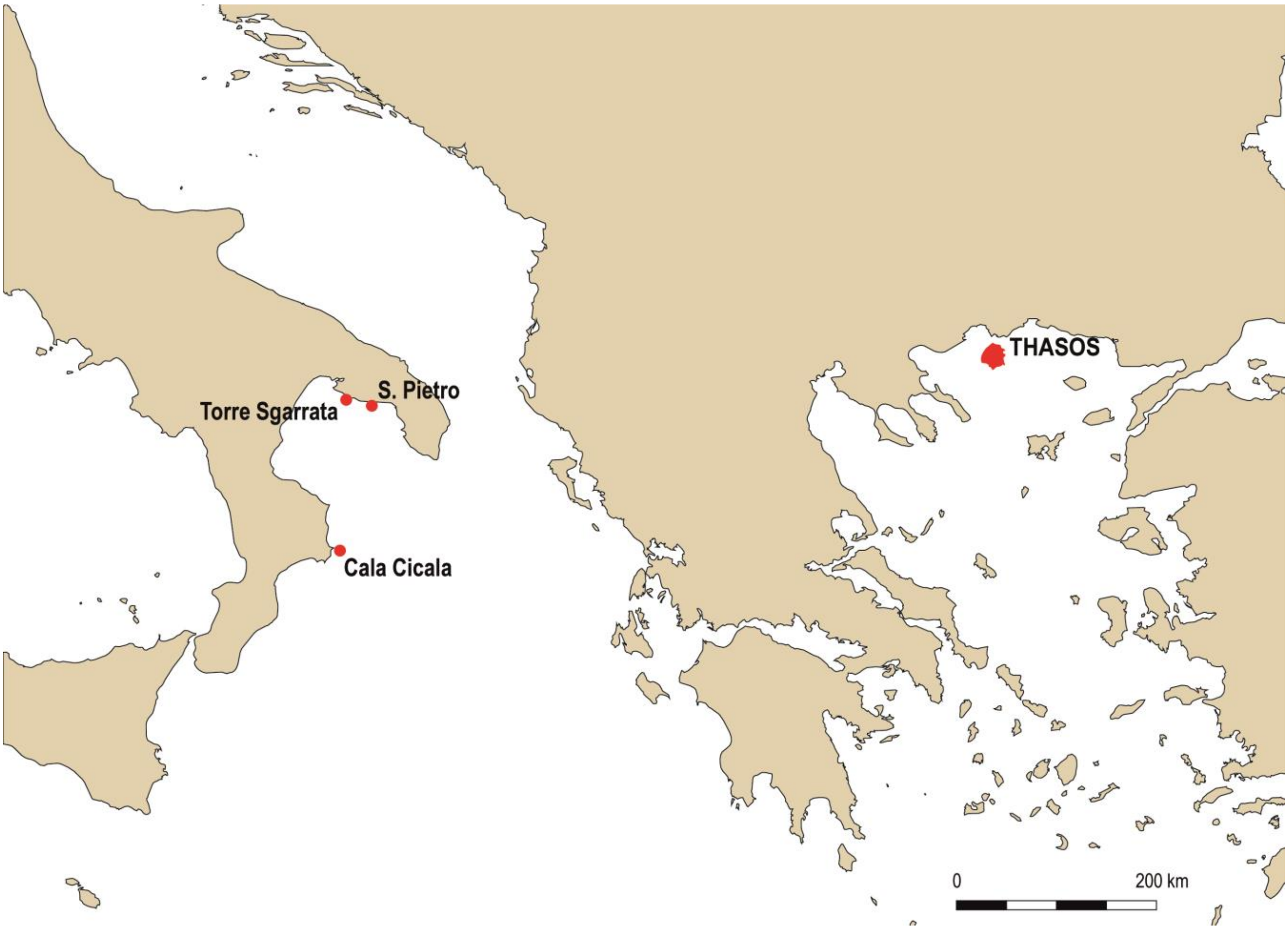

Fig. 28. Map showing the wrecks currently known as containing Thasian marble (elaborated by S. Medaglia).

exports was reached in the 2nd century AD[111]. Numerous markets were involved: apart from those already mentioned, among which Macedonia always stands out[112], others were the cities of Algeria and Tunisia, Syria, Palestine, Jordan, Egypt, Gaul, the Black Sea, Sicily, the Iberian Peninsula etc.[113]. However, the most flourishing market for this type of marble was Italy, and Rome in particular, at least until the 5th century AD[114] Another use of Vathy's dolomitic marble, apart that of statuary, was the production of partially finished vat-shaped (*lenòs*) and rectangular sarcophagi, massively exported to Rome between the 2nd and 3rd centuries AD. The most striking examples are the Apulian wrecks of San Pietro in Bevagna and Torre Sgarrata [115].

The wreck of Cala Cicala offers an important contribution to our knowledge on many aspects of the history of the exploitation of the quarries in island of Thasos and of the manufacturing traditions of local marble workshops[116]. In fact, in spite of the wide diffusion of this type of marble, the evidence from underwater archaeology regarding its maritime transport is limited. Before the investigations presented in this work, scientific knowledge was limited to the two wrecks of San Pietro in Bevagna and Torre Sgarrata which, on the whole, date between

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[111] Herrmann, Newman 1995: 73; Herrmann 1999: 63; Stefanidou-Tiveriou 2009.
[112] Herrmann, Newman 1995: 73; Herrmann, Newman 1999: 293 ss.; Herrmann 1999: 60-61; Borromeo *et al.* 2009.
[113] For an overview of the diffusion of Vathy's dolomitic statues, see, among many others, Herrmann, Newman 1995; Herrmann, van den Hoek, Newman 2002; Herrmann, Newman 2002; Triscari *et al.* 2011; Barone 2013 (in particular p. 237, fig. 6); Calligaro 2013; Russell 2013: 179-180; Herrmann, Attanasio 2018.
[114] Herrmann, Newman 1995: 73; Herrmann 1999: 63; Pensabene 2002b, p. 211; Herrmann, Newman 2002; Lapuente *et al.* 2012; Herrmann, Attanasio, van den Hoek 2014.
[115] Herrmann 1999: 63; Calia *et al.* 2009; Gabellone, Giannotta, Alessio 2009; Arnesano 2015: 20-22; Giannotta *et al.* 2015.
[116] Antonelli *et al.* 2020: 6. On the system of ownership of the Thasian marble caves during the first centuries of the Empire, see the observations in Marc 1995.

the end of the 2nd century and the first half of the 3rd century AD (fig. 28). However, unlike the Apulian wrecks, Cala Cicala presents over 179 tons of raw quarry materials in the form of blocks and large pillars instead of sarcophagi. The exclusive presence of roughed-out elements in the cargo is another important element as it provides information and metric data on the methods of extraction, roughing out, and first treatment of quarry materials. Another factor of interest is provided by the presence of material extracted on the promontory of Aliki, a variety not found elsewhere in underwater contexts.

At least the calcitic fraction of the cargo of Cala Cicala was certainly intended for architectural applications, as demonstrated by a number of elongated large-sized artefacts shaped as pillars/piers or by elements intended for the trabeation of monumental buildings[117]. The considerable lengths of some of the Aliki marbles in the cargo point, on the one hand, towards the gigantism that characterized a certain architecture for large building projects in Rome or in provincial cities, while on the other, it implied a very skilled workforce, right from the stages of extraction, lifting, and transport up to the cargo ships[118].

Considering the homogeneity of the cargo, we should assume that the ship of Cala Cicala had to stow its goods directly on the island of Thasos; however, it cannot be excluded that the marbles were shipped to Thessaloniki - where there was certainly a workshop[119] and, perhaps, even a Thasian marble logistic facility[120]. We will be able to hypothesize a further stage along the route for stowing the bases and capitals only if future chemical-physical investigations could demonstrate that these partially finished elements belong to quarries located elsewhere.

The ship was wrecked along the Ionian route, followed by stone-carrying ships coming from the Aegean islands and from the coasts of Asia Minor to reach the thriving market of the western Mediterranean. It is perhaps no coincidence that all the three wrecks with Thasian marble known so far are located precisely along this maritime route that, sailing along Puglia and Calabria, aimed for Rome.

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[117] Among these pieces we found some duplicated elements, perhaps due to specific site requirements: nos. 1 and 16; 12 and 13.
[118] On the use of very large blocks in architecture see PENSABENE, DOMINGO 2014.
[119] STEFANIDOU-TIVERIOU 2009.
[120] PENSABENE 2002a: 34; ANTONELLI *et al.* 2020: 6.

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