ACTA IMEKO
ISSN: 2221-870X
September 2023, Volume 12, Number 3, 1 - 5

Preliminary archaeometric analysis on a marble bas-relief of unknown origin

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ABSTRACT
This paper addresses an archaeometric study of a marble bas-relief seized by the Cosenza Carabinieri Unit for the Protection of Cultural Heritage and Anti-Counterfeiting (Calabria, Italy). The research aimed to collect data on the authenticity of the artwork, providing indications about the compositional features of the sampled materials. An analytical approach based on the use of SEM-EDX and FT-IR techniques along with a stylistic evaluation of the artwork, allowed us to answer the requests posed by the institutions and to set the work in a different historical context from the Roman production.

Section: RESEARCH PAPER

Keywords: Illicit trade; forensic investigations; FTIR-ATR; SEM-EDX; marble bas-relief

Citation: Maria Pia Albanese, Luciana Randazzo, Mauro F. La Russa, Armando Taliano Grasso, Maurizio Paoletti, Michela Ricca, Preliminary archaeometric analysis on a marble bas-relief of unknown origin, Acta IMEKO, vol. 12, no. 3, article 28, September 2023, identifier: IMEKO-ACTA-12 (2023)-03-28

Section Editor: Leonardo Iannucci, Politecnico di Torino, Italy

Received January 31, 2023; **In final form** May 9, 2023; **Published** September 2023

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1. INTRODUCTION

The importance of forensic investigations in the field of illicit trade in cultural heritage can be seen from the amount of information obtained by investigating samples through a multidisciplinary and scientific approach [1], [2]. Every clandestine excavation is deplorable because it steals precious objects from the community and above all because it destroys an entire historical and/or archaeological documentation [3]. The phenomenon of clandestine archaeological excavations must necessarily start from the awareness of their classification as a criminal phenomenon. The meaning of cultural heritage is, above all, given by the relationship between artefacts and their context of origin: removed from it by clandestine excavations and robberies, archaeological finds and works of art are only dumb objects [4]. In the case of forensic studies, it often happens to analyse decontextualized findings and therefore without information on the discovery, production techniques, raw materials used, iconographic style and so on [5]. Depriving artefacts or cultural assets of their history can destroy all information related to their production, cultural references and commercial relationships; thus, the communities definitively lose part of their cultural identity. Consequently, the decontextualization of the artwork or an archaeological find can sometimes leave large gaps in historical, archaeological and scientific studies.

This paper focuses on an archaeometric and stylistic study of a marble bas-relief seized by the Cosenza Carabinieri Unit for the Protection of Cultural Heritage and Anti-Counterfeiting (Calabria, Italy). The research aimed to collect data on the raw materials, providing indications about the compositional features of the sampled materials and if the find could stylistically belong to the Roman time.

Based on the requests made by the Institutions, the materials (i.e. traces of mortar and plasters) present on the main body of the marble slab were analysed, with the aim of identifying possible markers that could give indications on a specific context of origin/production; furthermore, an iconographic stylistic analysis was carried out.

An analytical approach based on the use of Scanning Electron Microscopy (SEM) with Energy Dispersive X-Ray (EDX) analyser and Fourier-Transform Infrared spectroscopy (FT-IR) in attenuated total reflection (ATR) [6]-[9] along with a stylistic evaluation of the artwork, allowed to set the ancient object in a historical context different from the Roman production, thus responding to the assumptions made by the Institutions.

2. STYLISTIC EVALUATION AND DESCRIPTION OF THE MARBLE SLAB

The artwork provided by the Cosenza Carabinieri Unit for the Protection of Cultural Heritage and Anti-Counterfeiting consists of a marble slab carved in bas-relief sized approximately $42 \times 35 \times 11$ cm³. Specific data on the find (i.e., geographical locations, group identity, etc.) have not been included for security and privacy reasons.

Materially, the slab is composed of a single piece of marble where only one side (the front) is sculpted (Figure 1, A). The back (Figure 1, B) looks like raw marble where the only carved part is a smooth groove in the upper part, probably shaped to facilitate a wall anchoring. This hypothesis could also justify the presence of a groove (Figure 1, C) in the lower side of the slab, about 4 cm long, occupied by a *"grappa"* consisting of a folded metal bar, generally used to fix the bas-reliefs to walls.

The bas-relief on the front shows a complex and rich iconography of human figures made whole or in faces placed in profile. In the foreground it is possible to recognize the silhouettes of a child and a woman depicted on a seat or a throne; from the latter, the front limbs of an animal protrude laterally, probably a goat or a horse (Figure 2, A).

The female figure, with her face in profile and a slight smile, looks down to cross that of the child, hugging him and placing her right hand on the shoulder. The left arm is instead stretched downwards with the hand resting on the armrest of the seat. The female figure's hair is styled behind a pointed ear, further recalling a connotation of a goat figure. The child, placed to the left of the female figure, is represented with half human features and half goat (perhaps a small faun), with one arm stretched out towards the woman's chest. The child's face, slightly in profile to the right, is not clear; while the hair from which the ear can be seen appears thin and smooth.

Two further figures are visible: a) a putto or probably a child, with the mouth half open, presumably depicted in the act of holding something or crowning the head of the female figure; b) a person behind the child, to the left, in profile, with the body covered by a cloak and plant elements.

Also noteworthy is the area under the arm of the female figure, a sort of box in which three other figures are depicted. (Figure 2, B): the first one, on the left, looks straight ahead; the

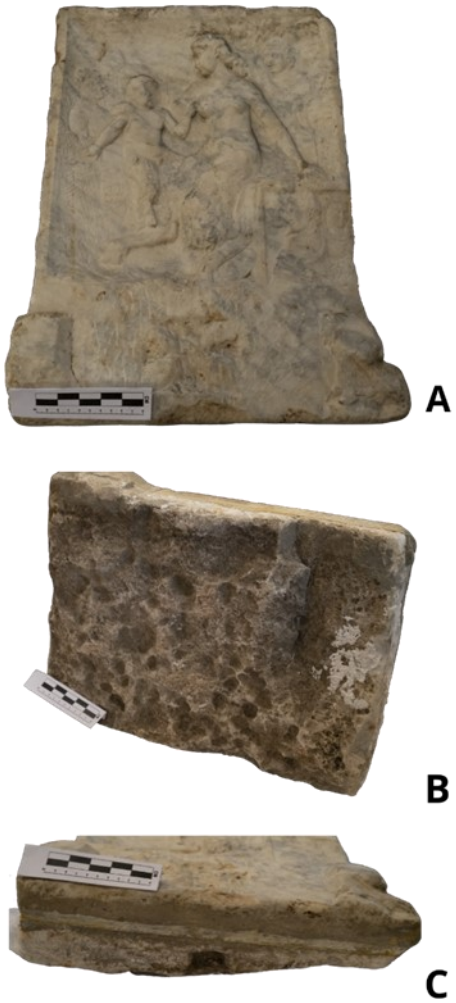

Figure 1. Front (A), Back (B) and lateral portion with "grappa" (C) of the bas-relief.

Figure 2. Details of the bas-relief iconography. Silhouettes of a child and a female figure (A) and three further figures (B).

central one is in profile and the third, on the right, looks slightly in profile and with curly hair. In this iconographic group, the central figure has a contemptuous gaze with the head covered by a crown of foliage and the body wrapped in a cloak; the goat's ear and the aquiline nose are also clearly evident.

The entire slab has no frame, as it is typical in Roman marble slabs [10], and the original color of the marble is visible on the back, while the front shows traces of wear, dirty and alterations of various origins.

On both sides of the slab, there are traces of plaster and mortar, probably used as a binder with the wall on which it was hung/anchored. The marble does not appear to be *"pavonazzetto"* or *"Carrara"* marble, perhaps it could be *"brecciato"* marble which has a beige base with veins from light tones from brown to hazelnut [11]-[13]. In any case, for the certain provenance of the marble, further investigations should be conducted.

From an initial evaluation, it is clear that the decontextualization of the object, the confusion of the elements depicted, the lack of defined details and the iconographic and stylistic inconsistencies have made it difficult to interpret and place the object in chronological order.

An initial study carried out by a consultant appointed by the Cosenza Carabinieri Unit for the Protection of Cultural Heritage and Anti-Counterfeiting (Calabria, Italy) has recognized in the marble slab an artifact of Roman time. By the way, it should be noted that the bas-relief is a sculptural technique that has existed in all historical periods, created both as an isolated slab and as decorations to be applied to relatives or funeral monuments, etc. For example, during the Renaissance, the bas-relief had one of its great expressions, thanks above all to Donatello's *"stiacciato"*.

The marble slab certainly shows the properties of a bas-relief but there are still many stylistic and iconographic doubts. This confusion makes both the chronological placement of the object and the iconographic interpretation difficult. The most plausible hypotheses could be two: an "ex novo" production from the Renaissance or post-Renaissance era [14], [15] with clear references to Roman mythology; or it is a "pastiche" with original elements of Roman times. In fact, it is not uncommon to come across remakes of works in marble.

3. SAMPLING AND ANALYTIC METHODS

The slab was studied by laboratory investigations after having taken some micro-samples.

The sampling campaign (Figure 3) was performed with the assistance of the Cosenza Carabinieri Unit for the Protection of Cultural Heritage and Anti-Counterfeiting, in order to collect materials useful for providing a correct interpretation of the data. Specifically, three samples (respectively M1, M2 and M3) were taken from different areas of the marble bas-relief (Figure 3), where the figures are represented on a plane. These are powdery fragments, whitish to yellowish in color, taken from lateral portions of the artifact, and not belonging to the marble bas-relief.

The investigations had the purpose of responding to the requests the Carabinieri Unit for the Protection of Cultural Heritage about a possible provenance of the artifact, in order to identify any mineralogical markers in the samples that could give indications on the supply areas.

Samples were analyzed with FT-IR in ATR mode and SEM-EDX. The Fourier Transformed Infrared Spectroscopy in attenuated total reflection (FT-IR-ATR) and the Electron Scanning Microscopy (SEM) with Energy Dispersive X-ray

Figure 3. Sampling points.

analysis (EDX) have several applications, especially important in the field of cultural heritage. As far as the FT-IR is concerned, the operating principle, based on the absorption of radiation in the mid-infrared (4000-400 cm^{-1}) provides information on the chemical bonds (such as carbonates, oxalates, sulphates, etc.) present in the substances composing the sample [16]-[18]. It is a semi-destructive technique and requires a minimum sample, allowing for the identification of both inorganic and organic components (for example, binders, natural resins, pigments, etc.) not otherwise detectable by other diagnostic techniques. The method is very suitable for the investigation of cultural heritage materials due to its minimal requirements for sample preparation and its provision for high resolution [18]. As far as FT-IR investigation is concerned, the used spectrophotometer was a Perkin Elmer Spectrum 100, equipped with an attenuated total reflectance (ATR) accessory. Infrared spectra were recorded in ATR mode, in the 500–4000 cm^{-1} wavenumber range, with a resolution of 4 $cm^{-}1$ [18], [19]. The samples' spectra were also compared with those of standard minerals and/or organic compounds from databases and literature [20]-[23].

SEM-EDX provides morphological and compositional information from the surface of the sample [24]-[26]. Chemically (in terms of major elements), the instrumentation makes it possible to investigate not only material properties but also alteration products [27], [28]. Investigations were carried out on samples coated with a thin and highly conductive graphite film by Ultra-High Resolution SEM (UHR-SEM) – ZEISS CrossBeam 350 equipment, coupled with a spectrometer EDX – EDAX OCTANE Elite Plus - Silicon drift type. Instrumental conditions set for EDX analysis were HV: 15 keV and probe current: 100 pA.

4. RESULTS

The samples examined (M1, M2, M3) were firstly subjected to FT-IR-ATR investigation. Analysis allowed to identify mineralogical phases and the presence/absence of organic compounds (Figure 4). The results showed the absorption bands

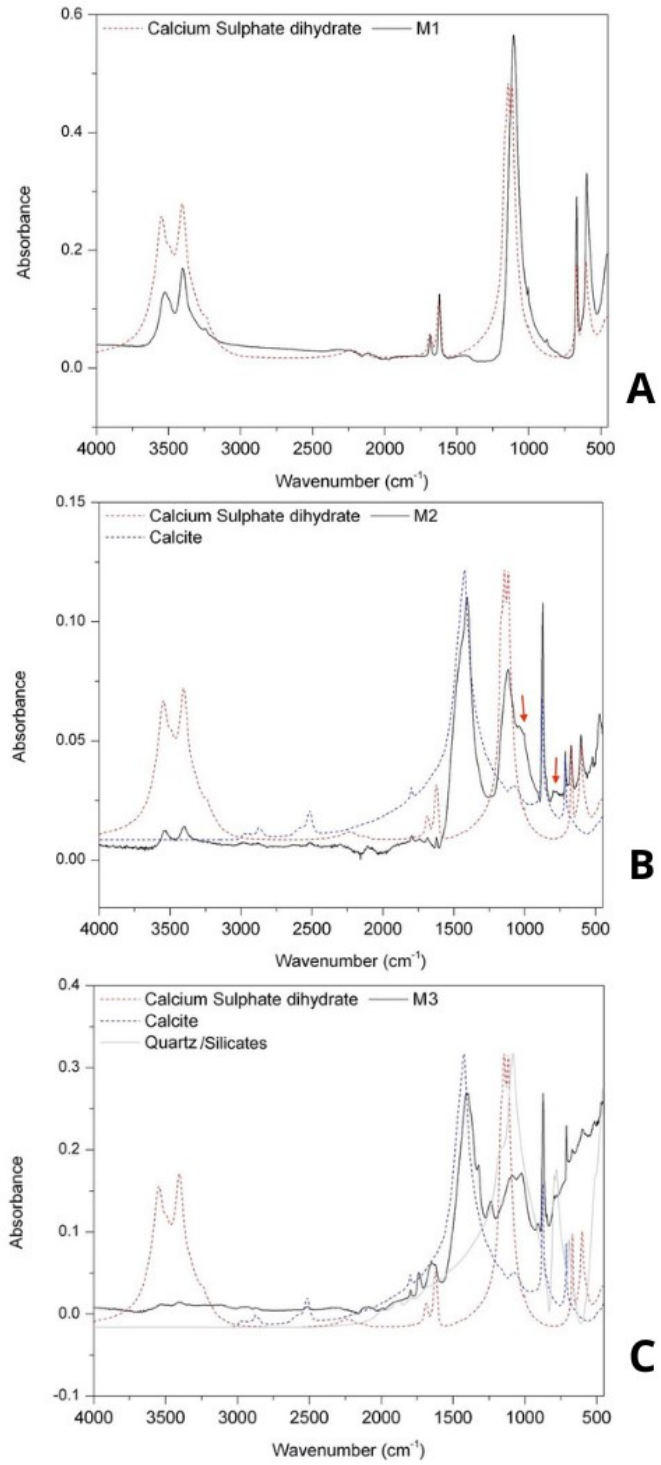

Figure 4. IR Spectra of samples M1 (A), M2(B) and M3(C). Images taken from [24].

of calcium sulphate dihydrate (gypsum, $CaSO_4*2H_2O$) for sample M1 (Figure 4, A). Such presence could be justified by the possible use of gypsum as a "*rinzaffo*" to fill some empty point and/or to fix the bas-relief to the original support. In sample M2, in addition to gypsum, traces of silicates and calcite were detected. The latter suggested the use of a mixed binder (Figure 4, B). Similar is also the composition of sample M3 (Figure 4, C).

As far as the SEM-EDX investigation is concerned, it was conducted only on M2 (Figure 5) and M3. Results further demonstrate the presence of elements linked to calcite (Ca-

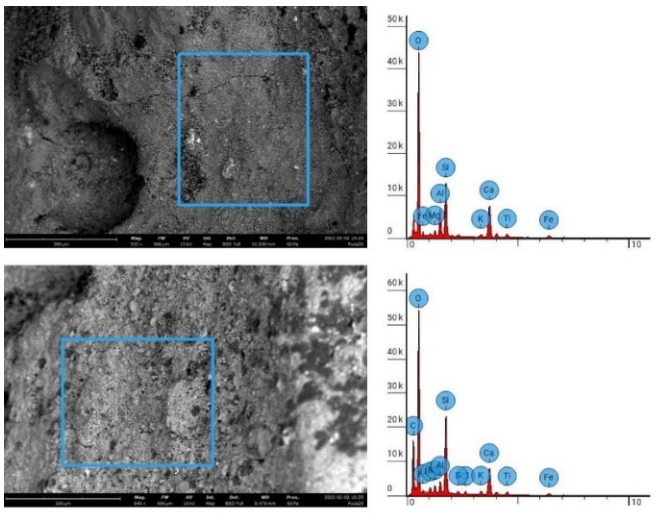

Figure 5. Representative morphological images (SEM) on sample M2 and related EDX spectra. Images taken from [28].

binder) and silicates (i.e., Si, Al, Mg, K, Ti and Fe) in M2, with the detection of Fe likely responsible for the yellowish color of the sample (Figure 5).

Furthermore, even the chemical composition of M3 shows that the yellowish-brown color of the sample is probably linked to the presence of silicates mixed with iron oxides and hydroxides.

5. CONCLUSIONS

In this study, three micro-samples taken from lateral portions of a marble bas-relief of unknown origin were examined, in order to find an answer to the doubts endorsed by the Cosenza Carabinieri Unit for the Protection of Cultural Heritage and Anti-Counterfeiting.

Specifically, the raw materials were characterized in order to find "traces" or "markers" that could deepen the knowledge on the origin of the artefact. In particular, M1 is a gypsum-based mortar while M2 and M3 are lime-based binders containing pigmented compounds, characterized by silicate minerals mixed with iron oxides/hydroxides.

The results do not show any chemical or mineralogical markers that can be traced back to the provenance of the raw materials. More information should probably be provided to scientists by institutions to compare results with any databases and be more precise in interpreting results.

Research and historical-archaeological insights will be carried out to better identify the iconography of the artifact of unknown origin, made even more difficult by confused elements and characteristics, both from an iconographic and stylistic point of view.

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