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A Marble Bust Newly Discovered by the Trapani Lombardo Family of Reggio Calabria (Southern Italy)

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Abstract: This research concerns a stylistic and archaeometric study of an ancient marble female bust recently discovered by the Trapani Lombardo family of Reggio Calabria (Southern Italy) and delivered to the Superintendency of Archaeology, Fine Arts, and Landscape for the metropolitan city of Reggio Calabria and Vibo Valentia (SABAP). Based on the first technical, stylistic, and iconographic observations made by the competent bodies, it is a half-length portrait bust from the Roman era, which precisely had the function of faithfully reproducing the physiognomy of the depicted subject. The research aimed to establish the authenticity of the artwork and the origin of the raw material, providing indications about the textural and compositional features and of the alteration products as well as identifying traces of any previous restoration interventions. For these purposes, after a preliminary assessment of the state of conservation of the bust using visual inspections supported by a handheld digital microscope, different analytical techniques, including polarized optical microscopy (OM), scanning electron microscopy coupled with energy dispersive spectrometry (SEM-EDX), carbon and oxygen stable isotope ratio determinations ($\delta^{13}C$ and $\delta^{18}O$), X-ray diffraction (XRD), and Fourier transform infrared spectroscopy (FT-IR), were used. The results highlighted the originality of the artifact, thus remarking on the importance of the precious archaeological find to be included in the cataloging of tangible assets in the panorama of Italian cultural heritage.

Keywords: archaeometry; diagnostic; cultural heritage; marble; museum; Reggio Calabria; Roman age; Roman female bust

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1. Introduction and Stylistic, Iconographic Analysis of the Bust

The extensive exploitation of marble in classical antiquity as a building material as well as for statuary has led experts to a growing interest in the diagnostic and archaeometric investigations of these stones, focusing, above all, on establishing their provenance [1,2]. The use of marble since ancient times is a result of the intrinsic beauty of the material, which can be enhanced through various manufacturing and is capable of generating impressive aesthetic products for constructive and ornamental works [1,3]. Archaeologists, art historians, and conservators have always shown great interest in the provenance of ancient marble artifacts, which is also one of the most debated topics for scientists working in the field of georesources or earth sciences in general. To date, the adoption of reliable methods and multidisciplinary scientific approaches to determine the provenance of this precious material has meant that important artifacts of uncertain origin can be located in a specific production area, often providing key elements to ascertain their authenticity and evolutionary history, for example, to know the range of commercial relationships and trade routes pursued in antiquity. The minero-petrographic and geochemical methods are by now well established [4], even if in continuous evolution [1], and allow us to achieve a consistent identification of the areas of origin by employing numerous laboratory investigations. In this multidisciplinary context, even the diagnostic aspect is becoming increasingly interesting for scientists contextually evaluating the state of conservation of the material to guarantee the conservation of the artworks over time and for future generations. This contribution represents the first study aimed at the characterization, attribution of origin, and evaluation of the state of conservation of a newly discovered marble bust from Reggio Calabria (Southern Italy). According to the information provided by the Trapani Lombardo family, the bust was accidentally found in 1908 during the construction works of Trapani Lombardo Palace in Corso Garibaldi at Reggio Calabria. The building was rebuilt after the devastating earthquake of 1908, and during its construction, the remains of a Roman villa, with mosaics and precious marbles, were uncovered [5]. However, the sculpture was recovered only a few decades later and, despite its quality, was placed in a storage room within the same building and forgotten until January 2022. Afterward, the artifact was handed to the Superintendency, and subsequently, the restoration project started.

The sculpture (Figure 1) was identified as a Roman original of a female private portrait, datable due to its stylistic characteristics to the very limited period between the end of the age of Commodus and the very first years of the Severan age when the hybrid and peculiar typology of the half-length portrait bust became less rare [6]. This class diverges from the portrait head typology as it includes part of the chest and sometimes the attachment of the shoulders and even the arms of the subject. The bust is hollow in the lower part, with evident traces of roughing; the wide and deep lateral grooves are associated with a circular hole, centrally positioned in the front part, useful for allowing the insertion of a vertical pin. The head is rotated to the right; the oval of the face is soft but firm, with slightly sunken cheeks; the eyes are wide with large pupils; the eyebrow arches are very close to the upper part of the nose; and the presence of some expression lines visible on the forehead and on the neck suggests the woman is no longer young in age. Unfortunately, the nose, mouth, and part of the left eye are unrecognizable due to the abrasion affecting the central and left part of the face; this element could be the result of a *damnatio memoriae* or the consequence of a pickaxe's blows during the discovery. It is evident, however, that both eyes look upwards, but it is not clear whether the right eye is excessively oriented. The gaze of the eyes is intense and expressive thanks to the depth and size of the pupils, a typical trait of portraiture between the late Antonian and Severan periods. The accentuated proportions of the head and physiognomic features described raise a question regarding the exact and original positioning of the sculpture. Even *Regium Iulium* written sources, in particular epigraphs [7], show the existence of honorary statues, especially *imagines clipeate,* dedicated to women of the most important families. During the II and III centuries, women often funded honorary statues themselves or demanded one in exchange for their benefactions to the city; such statues increased the prestige of her family and, at the same time, allowed women to even be memorialized in public spaces. It is still difficult to determine if our bust was displayed in a public space or a private context, such as the Roman villa (inside a niche?) discovered under the modern Trapani Lombardo palace. Scholars assert that, especially during the III century, a large part of the ornamental and decorative apparatus of the rooms used for public events in private villas, of the thermal spaces, or peristyles consisted of sculpture collections, often heterogenous, which also testified to the loyalty and closeness of the owner to the imperial family [8]. Clearly, this is a pivotal point because the context affects the conservation state and even the statue's dimensions. Another complicating factor to the current state of studies is that it cannot be excluded that the bust could actually be reworked to a full-length sculpture [9,10], and so many questions still remain open. Certainly, the most striking visual feature is the elaborate coiffure that encases the head with a thick mass of hair worked into undulating finger waves, and a very large, plaited bun takes up the entirety of the back of the head. Note the appearance of a separate ringlet of hair decorating her cheek: this is a specific variation, acknowledged in several coins [11] and portraits of Julia Domna, the Syrian wife of Septimius Severus dating to the early part of her reign (193–211 AD). Parallel evidence comes from *Arco degli Argentarii's* inner side, where the emperor and his wife are represented flanked by Caracalla and Geta. Hairdressing plays a fundamental role in a woman's personal identity; it can be considered a multiple-level marker because showing the same coiffure as the emperor was an ideological statement about social status, gender, and cultural values [12]. Finally, all the evidence collected allows us to consider the "Trapani-Lombardo" bust as a product of Severan art [13], with a close comparison with another Severan private portrait from Casale Monferrato, now displayed at the local civic museum [14]; both sculptures reflect the same artistic language, as demonstrated not only by the elaborate hairstyle and garment but also by the metallic rendering of the folds of the drapery, executed with deep furrows.

Figure 1. Front (**A**) and back (**B**) view of the ancient bust after cleaning procedures.

Regarding the executive technique, considering the absence of additional stone portions and metal pins, it is highly probable that the bust was made from a single block.

The different carving techniques used for the execution of the head and the torso reflect on the conservation state of the statue; while the head still maintains a smooth finish typical of marble, the area of the garment shows a very rough and opaque surface due to the alteration processes involved.

2. State of Conservation of the Bust

The conservation state of artworks is determined by multiple factors, which may simultaneously occur on the surface [15–17]. Deterioration depends not only on the environmental conditions to which the artifact is exposed (indoor or outdoor conditions) but also on the intrinsic properties of the substrate, such as the different material composition and the various stonework processing techniques [18].

The accurate investigation of both the constitutive material and the alteration and degradation phenomena allowed us to suppose the chronology of the artifact's conservative history and its phase successions.

When recovered, the bust showed evident decay forms attributable to prolonged exposure to outdoor environmental factors and poor conservative conditions.

To the naked eye, a thick layer of soiling, consisting of dust and coherent deposits, covered the entire bust's surface and the numerous substrate undercuts. Further degradation forms detected on the stone surface were (a) microcavities (alveoli) of a conical shape, particularly noticeable along the neck, on the drapery of the garment, and the outline of the face and (b) a wide superficial alteration diffused on the garment and layered in several levels (Figure 2). Such layered alterations corresponding to a fresh crack were carefully investigated through a handheld digital microscope. Observations allowed us to locate three different layers: (1) the inner unaltered core; (2) a reddish-brownish layer; and (3) a more superficial layer, in which the calcite crystals appear detached, showing the typical saccaroid texture of marble.

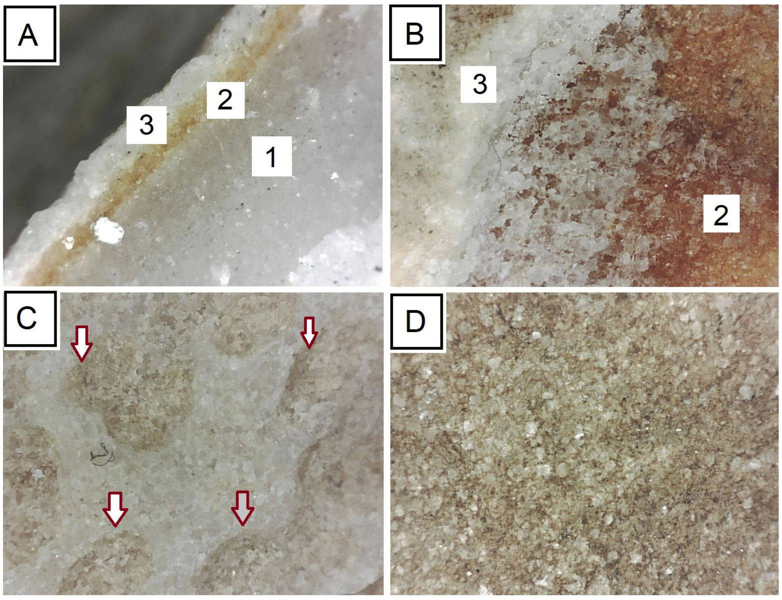

Figure 2. Images taken by handheld digital microscope corresponding to a fresh crack, showing marble stratigraphy with evidence of the three layers (**A**); details at higher magnification of the reddish patina and the more whitish superficial one (**B**); evidence of alveoli highlighted by red arrows (**C**); and superficial secondary calcite crystals (**D**). Note: (1) inner unaltered core; (2) reddish-brownish layer; and (3) superficial layer.

Based on the preliminary observations, the weathering forms detected could be attributable to long exposure of the artifact outdoors and to the interaction of the material with various environmental agents (i.e., biological, chemical, etc.). In particular, the origin of this alteration form could be linked to the mechanical and chemical damage caused by a crustose endolithic species of lichens [19–21]. The rhizines of lichens may penetrate deep into stone microcracks, while their thallus, relative to the different states of hydration, can expand or contract, creating the formation of small cavities. The latter is a phenomenon better known as pitting [22]. In particular atmospheric conditions (e.g., rainfall), these cavities can increase in size due to microkarst phenomena, which lead to an increase in the porosity of the stone and to the development of secondary mechanisms of alteration [23].

Furthermore, from a chemical point of view, chemical weathering processes present on the bust's surface could also depend on the interaction between the material and the oxalic acid and carbon dioxide secreted by lichen rhizines and produced by their metabolic activity. In fact, carbon dioxide commonly reacts with water forming carbonic acid, which persists in the microcracks and pores of stone, causing the dissolution of the calcium carbonate and the formation of a more soluble salt (calcium bicarbonate). The latter could undergo leaching processes or could precipitate again as calcium carbonate [24,25].

Assuming the presence of biological communities (such as lichens) on the marble artifact, even in the past, this is in close correlation with the detected alterations and their distribution on the bust (such as in the proximity of fissures, concavities, and microcracks). More specifically, it is possible to state that such a phenomenon is more widespread in areas with nonuniform geometries, with grooves, undercuts, etc., which probably represent areas more subject to humidity, infiltration, and the stagnation of rainwater. It would be reasonable to assume that moisture and rainwater accumulation in areas prone to greater accumulation (i.e., the face, nose, lips, and under the neck) contributed to encouraging biological growth.

In more detail, based on the visual inspection, it was observed that the abovementioned microcavities (alveoli) stop in correspondence with the chipping phenomenon observable along the nose and the lips, revealing that the alveoli were already present on the surface when the nose and the lips were damaged. At the moment, the original location of the sculpture is not known, but given the weathering forms that occurred on the surface, it is reasonable to assume that in the past, it was exposed outdoors and in conditions of clear air (lichens are excellent bioindicators of air quality).

In addition, as far as the reddish-brownish patina is concerned, which is particularly accentuated nearby the areas affected by pitting, it was possible to preliminary assume a dual nature: it could be either a deliberate coloring (patinatura) or once again of an alteration form.

Based on the preliminary observations and given the various hypotheses formulated during the discovery of the artifact, a more intensive and multianalytical investigation with a collection of microsamples became necessary.

3. Sampling and Analytical Methods

The female bust was studied using laboratory investigations after obtaining some microsamples of the material to be analyzed. Sampling (Figure 3) was performed with the assistance of the restorers acting on behalf of the Superintendency of Archaeology, Fine Arts, and Landscape for the metropolitan city of Reggio Calabria and Vibo Valentia (SABAP) in order to collect representative fragments useful for providing a correct interpretation of the data. Specifically, five microsamples were chipped-off from the base of the bust and at the front nearby the breasts, using suitable stainless-steel tools (lancets and small chisels) to establish the composition of the raw materials and the possible presence of alteration products. Diagnostic investigations of the selected microfragments were carried out using different and complementary analytical methodologies also chosen based on the amount of samples available. Specifically:

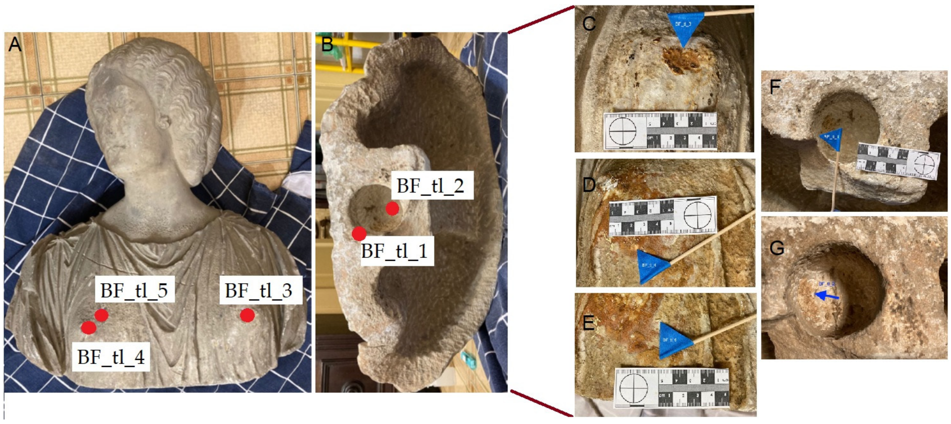

Figure 3. Representative images of sampling points (**A**,**B**) with details of alteration products and constituent material taken from the bust (**C**–**G**).

Polarizing optical microscopy (OM) to define the mineralogical and textural features of the constituent material (i.e., marble) of the bust (sample BF_tl_1). Thin section observation was carried out through a Primotech 40 (Primotech Zeiss) microscope coupled with a digital camera to capture images. The analyzed textural features included the grain boundary shape (GBS), the shape preferred orientation (SPO), and the maximum grain size (MGS) of calcite and/or dolomite crystals, as these features are dependent on the metamorphic evolution of the protolith.

X-ray diffractometry (XRD) was performed using a Bruker D8 Advance X-ray diffractometer (Bruker, Karlsruhe, Germany) and Bragg–Brentano geometry, with a copper sealed tube X-ray source producing Cu k radiation (wavelength of 1.5406 Å) from a generator operating at 40 kV and 40 mA. The diffracted X-rays were recorded on a scintillation counter detector located behind a set of long Soller slits/parallel foils. Scans were collected in the range of 3–65° 2θ, using a step size of 0.014° 2θ and a step counting time of 0.2 s. EVA software (DIFFRACplus EVA version 11.0. rev. 0) was used to identify mineral phases in samples BF_tl_1 and BF_tl_3 by comparing experimental patterns with 2005 PDF2 reference patterns.

Mass spectrometry was used for the measurement of carbon and oxygen stable isotopes ($\delta^{13}C$, $\delta^{18}O$) of sample BF_tl_1. Analysis was performed at the mass spectrometry laboratory of the Department of Earth and Marine Sciences of the University of Palermo (Palermo, Italy) using an automated continuous flow carbonate preparation GasBench II device [26] and a ThermoElectron Delta Plus XP mass spectrometer. A small amount of powder was obtained using a micromill or with a small handheld 2 mm drill. The powders were heated at 400 °C to remove organic components and later subjected to acidification at 50 °C. Samples were calibrated to Vienna Pee Dee Belemnite (V-PDB) using an internal standard (Carrara Marble with $\delta^{18}O = -2.43$‰ vs. V-PDB and $\delta^{13}C = 2.43$‰ vs. V-PDB) and NBS19. Standard deviations of oxygen and carbon isotope measures were estimated as 0.08 and 0.1‰, respectively, based on ~100 repeated samples. All isotope data were reported per mil (‰) relative to the V-PDB standard.

A scanning electron microscope, ultrahigh resolution SEM (UHR-SEM) ZEISS Cross-Beam 350 equipment, coupled with a spectrometer EDS/EDAX OCTANE Elite Plus—Silicon drift type, was used to obtain information about morphology and chemical composition (in terms of major elements) of samples BF_tl_4 and BF_tl_5. Instrumental conditions set for EDS analysis were HV: 15 keV and probe current: 100 pA.

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}. Due to the complexity of the FT-IR absorbance profiles, the samples' spectra were also compared with those of standard minerals and/or organic compounds from databases and literature [27,28] for a reliable assignment of the bands.

A list of the examined microsamples, brief descriptions, and the analytical techniques used are summarized in Table 1.

Table 1. List of the examined microsamples, brief descriptions, and employed analytical techniques.

Sample Id	Brief Description	Employed Techniques
BF_tl_1	White marble microfragment from the hollow under the base of the bust	OM; XRD; $\delta^{13}C$ and $\delta^{18}O$ isotopes
BF_tl_2	Whitish material from the hollow under the base of the bust superimposed on the constituent marble of the artifact	FT-IR
BF_tl_3	Reddish material from the left breast	FT-IR; XRD
BF_tl_4	Reddish material from the right breast	FT-IR; SEM-EDX
BF_tl_5	Incoherent whitish material superimposed onto BF_tl_4	FT-IR; SEM-EDX

4. Results and Discussion

Diagnostic investigations of the selected microsamples were carried out in two main stages: (a) the mineralogical–petrographic and geochemical characterization of representative fragments taken from the artifact, even including a study on the possible provenance source and (b) the characterization of superficial damage and alteration products by studying the interaction between the superficial deposit and the main stone material.

4.1. Mineralogical–Petrographic and Geochemical Characterization of the Bust

Sample BF_tl_1 from the hollow under the base of the bust (Figure 3; Table 1) was subjected to minero-petrographic and geochemical studies to characterize the material and hypothesize its origin.

Polarizing Optical Microscopy, X-ray Diffraction, and Isotopic Analysis

Sample BF_tl_1 is a white marble characterized by a fine grain size (MGS < 1 mm) and a homeoblastic texture (Ho) with small-to-tiny grains, forming triple points in places. The grain size ranges from 0.1 mm to 0.43 mm (MGS), often with clear cleavage traces, while the grain boundary shape (GBS) varies from curved to straight. The shape preferred orientation (SPO) of the grains was not observed (Figure 4).

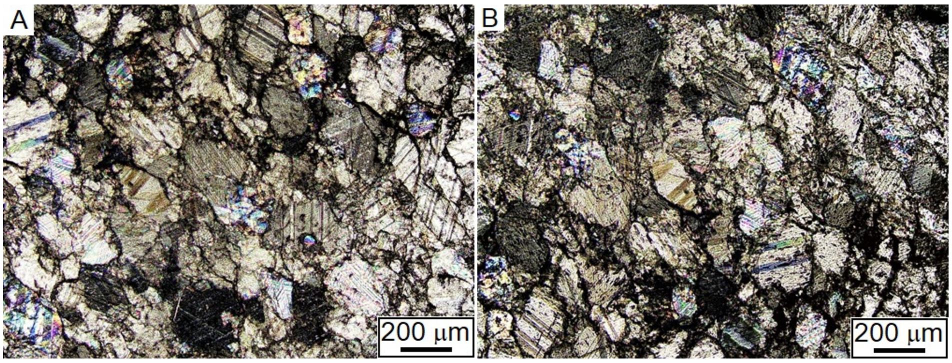

Figure 4. Representative photomicrographs (cross-polarized light) showing textural features of the marble fragment. Central (**A**) and lateral (**B**) portion of the section with evidence of homeoblastic texture and triple points.

As regards the MGS of crystals in the examined marble sample, the values are less than 0.4 mm. The comparison with data from the literature [29–33] reported in the diagram of Figure 5 shows that sample BF_tl_1 has the typical MGS of Carrara, Dokymeion (Afyon), Aphrodisias, Göktepe, Penteli, and Hymettos. The other petrographic parameters investigated (GBS and SPO) were also compared with the literature data for ancient quarries in the Mediterranean region [32,34–36], further confirming the above considerations drawn using the MGS ranges (Figure 5). It is noteworthy to point out that the more recent petrographic studies on fine-grained white marbles used in antiquity [2,37] have shown that although marbles may exhibit a unique set of features, their fabrics and grain size are more variable than initially suggested, and several types of fine-grained white marbles can be confused with each other. In particular, there are very close petrographic similarities between Carrara and Göktepe marble. To overcome these ambiguities, several geochemical analytical methods are strongly suggested as key criteria to distinguish them [38–40], with particular attention to the recent and improved methodology proposed by [4] and from the new approach of [1].

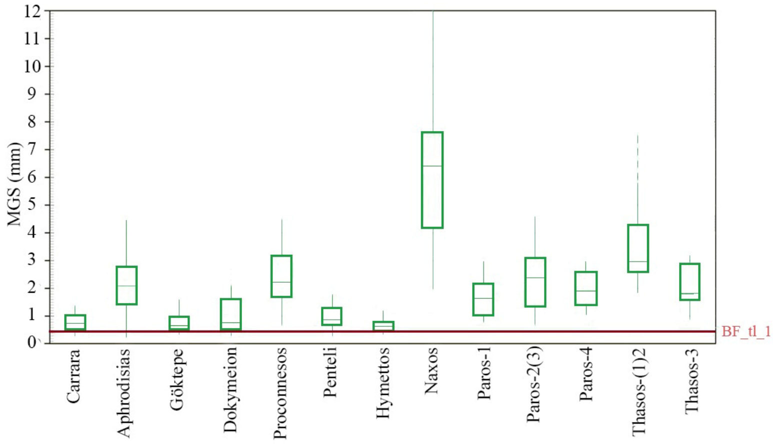

Figure 5. MGS diagram for marbles of the Mediterranean area. Comparison between literature data and sample BF_tl_1.

Concerning the mineralogical composition, the XRD analysis revealed that the sample is a pure calcitic marble. The mineralogical composition is a further discriminating parameter regarding the origin of ancient white marble items [1,30,34,41–63]. The determination of the oxygen and carbon isotopic ratios ($\delta^{13}C$ and $\delta^{18}O$) was used for the first time by Craig and Craig [44] for the attribution of the origin of Mediterranean white marbles. However, it is worth noting that these measurements are not always unique in providing a specific source of origin but are complementary to the results obtained from other diagnostic investigations mainly related to minero-petrographic and geochemical data. The obtained isotopic signatures of $\delta^{13}O$ and $\delta^{18}C$ for sample BF_tl_1 are, respectively, −1.43 (V-PDB) and 3.17 (V-PDB); they were then plotted on the diagram proposed by Antonelli and Lazzarini [41] concerning the fine-grained fields (Figure 6). Figure 6 highlights that the sample falls within the Carrara and Hymettus fields as possible sources of origin, both characterized by a fine grain and a calcitic composition.

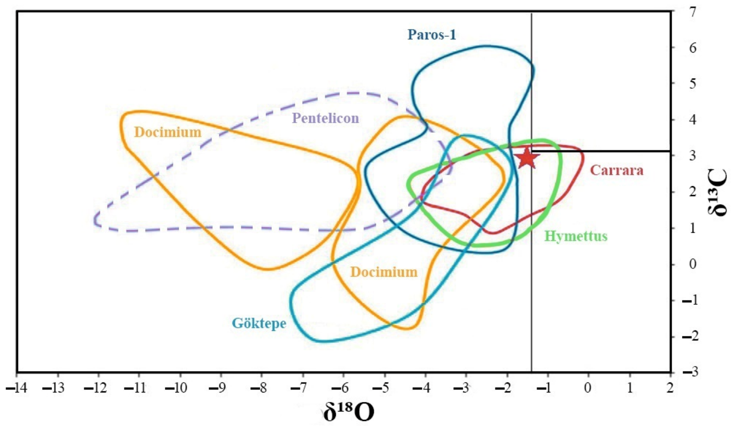

Figure 6. Isotope diagram for fine-grained marbles from the Mediterranean area. Comparison between literature data and sample BF_tl_1.

The data obtained suggest that none of the previous analytical investigations alone can provide unequivocal interpretations about the origin area of the marble examined. Conversely, the intersection of the whole dataset and the comparison with the literature databases allow the following consideration about the potential marble source to be drawn.

The microfragment belonging to the bust as a constituent material is a fine-grained marble whose textural features suggest Carrara, Dokymeion (Afyon), Aphrodisias, Göktepe, Penteli, and Hymettos as the most probable provenance sources, according to the diagram proposed by Gorgoni et al. (2002) [32] and replaced by Antonelli and Lazzarini (Figure 6) [41]. However, the geochemical results allow some quarries to be excluded, as in the diagram proposed by Antonelli and Lazzarini [41] about the stable isotope composition related to fine-grained white marbles, the sample falls within the Carrara and Hymettus districts. As a result, the provenance of the sample can be ascribed to the Carrara domain, as the main textural features observed under OM on a thin section are typical of Carrara marble. Specifically, Hymettus is excluded due to the characteristic “foliated” microstructural properties absent in sample BF_tl_1. The sample, in fact, displays a typical polygonal microstructure.

4.2. Molecular and Geochemical Characterization of the Alteration Products

FT-IR, X-ray Diffraction, and SEM-EDX Analysis

Infrared spectroscopy was essentially addressed at eventually identifying inorganic (i.e., mineralogical phases resulting from alteration processes) and organic (products resulting from any restoration work) compounds within the samples. All the analyses referred to samples ground by an agate mortar and pestle. Some representative spectra are reported in Figure 7. Specifically, the acquisitions allowed us to identify:

- the presence of gypsum with characteristic peaks at about 3500, 3400, 1700, 1600, 1150, 1100, 700, and 600 cm^{-1} for sample BF_tl_2;
- the stretching vibrations of aragonite (i.e., a polymorph of calcium carbonate) peaked at 1446, 854, 712, and 700 cm^{-1} [64] for sample BF_tl_3, followed by calcite, quartz, traces of gypsum, and hematite (iron oxide);
- the stretching vibrations of calcite peaked at 1492–1429, 879, and 706 cm^{-1}, with the presence of hematite with peaks at about 560–550, 474–467, and 310 cm^{-1} for samples BF_tl_4 and BF_tl_5. In addition, gypsum was detected in BF_tl_4.

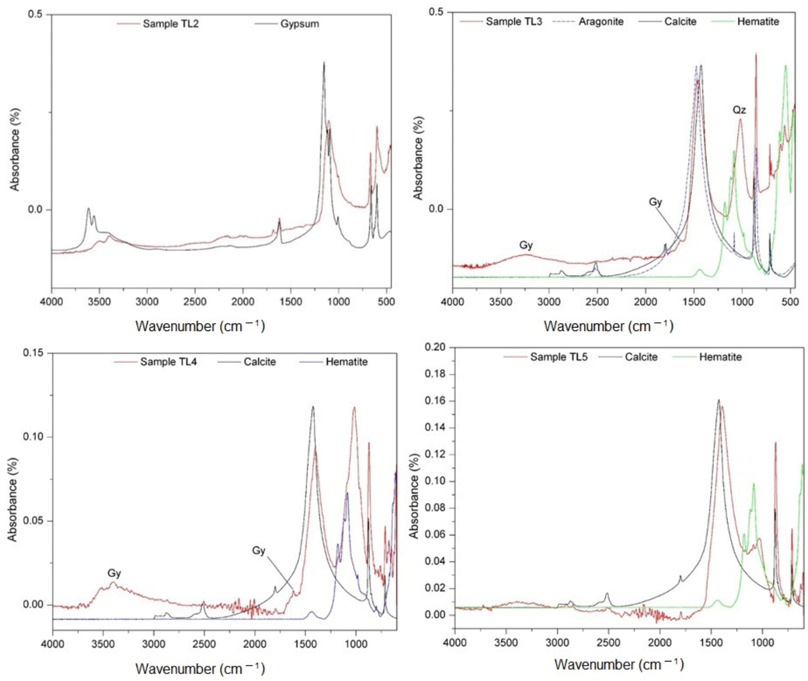

Figure 7. FT-IR spectra of the analyzed samples and comparison with the database (custom spectra library from PerkinElmer).

No organic component was detected in the investigated samples.

From the mineralogical analysis performed on sample BF_tl_3 using XRD (Figure 8), the composition of the inorganic components identified using FT-IR is further confirmed. Specifically, the presence of calcite, aragonite, and gypsum was detected.

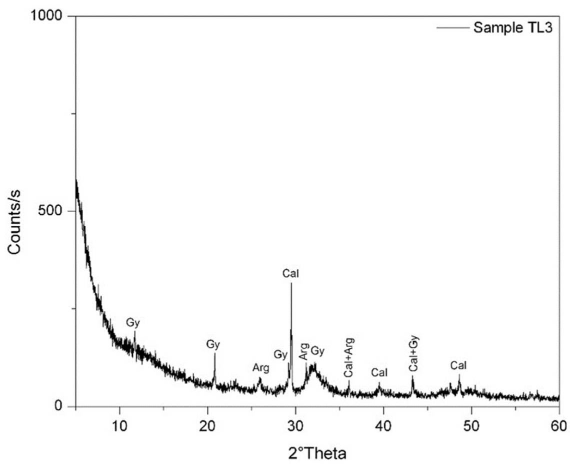

Figure 8. X-ray diffraction pattern of the analyzed sample.

As far as the SEM-EDX investigation is concerned, it further demonstrates the presence of iron oxides attributable to the reddish component of the BF_tl_4 sample. In the case of the surface layer above the reddish level (sample BF_tl_5), the analysis performed using SEM-EDX confirms its carbonate nature. Furthermore, such a level from the morphological point of view, allows us to hypothesize that it is a deposit deriving from the crystallization of secondary calcite. The representative morphological images, along with the acquisition EDX points, are shown in Figure 9.

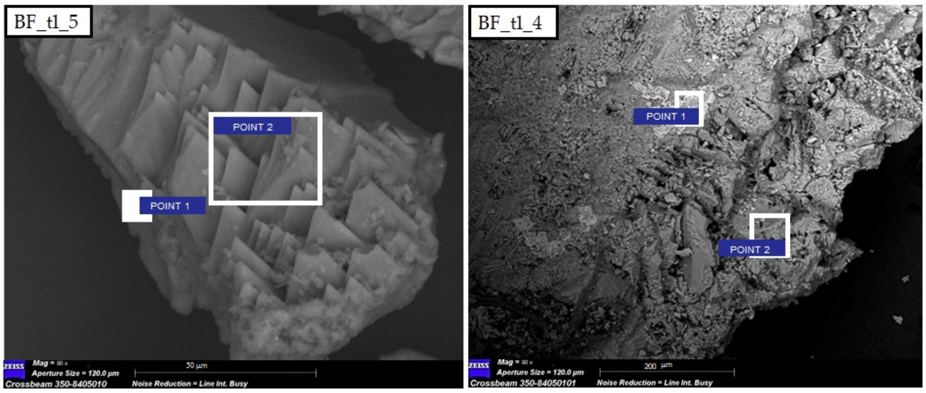

Figure 9. Electron scanning microscopy (SEM) representative images showing samples BF_tl_5 (**left**) and BF_tl_4 (**right**) and with evidence of the areas and points analyzed using EDX (white squares).

5. Conclusions

In this study, a multidisciplinary investigation was carried out to determine the material features and state of preservation of an ancient bust recently delivered to the Superintendency of Archaeology, Fine Arts, and Landscape for the metropolitan city of Reggio Calabria and Vibo Valentia (SABAP) by the Trapani Lombardo family of Reggio Calabria.

Specifically, archaeometric investigations performed on the constituent material revealed that the marble sample has minero-petrographic and geochemical parameters compatible with the Carrara district.

As regards the state of conservation, the investigations allowed us to confirm the following: The reddish-brown patina observed under the handheld digital microscope in the neighboring areas affected by the pitting phenomenon is mainly made up of iron oxides (hematite), which probably come from the soil that buried the bust before its discovery. Depending on the environmental conditions, there was probably a migration of iron oxides through the most altered external surface and their consequent deposition towards the unaltered core of the artifact. For this reason, the reddish color cannot be intentional (as it is located under the external surface at an intermediate level) but represents the result of degradation processes.

The chemical weathering of the material in the more superficial layers can be linked to the metabolic activity of some biodeteriogens (such as lichens) following their interaction with the carbonate substrate and the deposition of secondary calcite, as confirmed by our diagnostic investigations. The direct effect of this phenomenon is the erosion of the bust's surface, which results in the loss of carved details and smoothed shapes.

Through the interpretation of the alteration and degradation phenomena affecting the constitutive material, it was possible to define a conservation plane to eliminate the soiling and the encrustation layers on the surface and preserve the patina due to natural aging processes.

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