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A Multianalytical Approach to Identifying the White Marbles Used in Roman Imperial Sculptures from Tarraco (Hispania)

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Abstract: A selection of the most outstanding white marble sculptures from Tarraco has been archaeometrically studied to know more about the marble sources and their respective artistic workshops. All are imperial portraits of the 2nd century AD (Trajan, Hadrian, *Lucius Verus* and *Marcus Aurelius)* and a *thoracata* bust assigned to Hadrian, found on display at the National Archaeological Museum of Tarragona (MNAT). The well-established multimethod approach, combining petrography, cathodoluminescence, C and O isotopes and Sr and Mn trace element composition, has revealed the use of different very fine- to fine-grained marbles of the highest quality exploited in classical times. In contrast to what was thought until now, in which all the pieces had been assigned to Luni-Carrara, this present study identifies the use of two varieties of the recently discovered site of Göktepe near Aphrodisias and Paros-*lychnites* marbles, being Carrara, in minority. This study confirms the importance of strontium concentration and the contribution of cathodoluminescence to distinguish Göktepe from Carrara marble, while carbon and oxygen isotopes were crucial for the identification of Cycladic marble. Finally, in line with recent published interdisciplinary studies, the marble provenance forces us to rethink the discourse on the use of marble, its sculptural workshops and its distribution in this temporal context.

Keywords: archaeometry; marble; Roman imperial portraits; Göktepe; Carrara; Tarraco

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1. Introduction

There is no doubt that marble portraits are one of the most attractive artistic legacies of Roman sculpture. Imperial statuary and portraiture, as reflected by the sculptures and epigraphs preserved, especially those dedicated to dynastic cycles, flooded all the places of public representation of the Roman cities, in theaters, temples, basilicas and forum complexes in general, thus turning the images of the emperors and their families into effigies that were very familiar and identifiable to all the inhabitants of the empire.

There are many contributions dedicated to the iconographic typology, style and dating of portraits, among which those made by the German school delving into stylistic and typological analyses stand out [1–5]. The identification of sculptural workshops where the artists produced their work, with their own stylistic features, has also received the attention of various scholars [6–9], and the portraits found in Hispania have not been an exception [10–20]. The incursion of archaeometric papers into the study of portraits based on the origin of the marble as an additional source of information is relatively recent, with different contributions much more frequent in the last few years [21–24]. This approach, which combines the formal descriptive nature of the sculptural pieces with the type of marble used in them, provides an additional perspective that marks differences with traditional archaeological or art history works. Dealing with high-quality marbles selected from imperial quarries, the sculptural workshops of the *urbis* have been associated with the use of any of the marbles of great technical quality of imperial property, since it is admitted that in Rome there were available large quantities of marble blocks distributed from the quarries of the Eastern Mediterranean and from Luni-Carrara. In the few cases in which sculptural works were signed by their master sculptors, the itinerancy of the artisans has been associated with carrying out the artistic work.

On the other hand, before the recent discovery of Göktepe marble quarries in ancient Caria, many portraits made of fine-grained marble were attributed directly to Italian workshops, thinking that they were pieces carved on Lunense marble. In the case of the Hispanic pieces, given the abundance of this Italic marble on the Mediterranean façade [25], it even served as an additional argument to consider that those portraits, thought to be all of Luni marble, had been probably made by provincial or local workshops in Tarraco. This attribution was also made for many Hispanic pieces, not only portraits, since in the 1980s–1990s, marble was identified mostly based on simple visual inspection or, at best, using the petrographic method. This is the case of the pieces re-evaluated in this paper, all carved in fine to very fine-grained white marbles of excellent quality, identified now as classical marbles from different origins using a multimethod approach.

This contribution, therefore, is framed within the studies of the provenance of stone materials, where archaeometry is of enormous interest in marble studies. In recent years, archaeometry has also been efficiently applied in the definition of the sources of other types of stones used to make artifacts [26], infrastructure [27] or even to know the origin of the additives found in Roman concrete [28].

2. Archaeological Pieces

The analyzed pieces were four Roman portraits representing emperors from the 2nd century AD, specifically Trajan, Hadrian, *Marcus Aurelius* and *Lucius Verus*, together with an acephalous bust with military *thoracata* traditionally attributed to Hadrian. They have been numbered 1 to 5 in Table 1. This ensemble found at Tarraco is on display at the Museu Nacional Arqueològic de Tarragona (MNAT) together with other portraits from earlier dynasties that are pending their archaeometric revision. All together, they constitute one of the most numerous collections of imperial portraits on the Iberian Peninsula. As far as the historical, artistic and archaeological questions are concerned, only the most significant aspects are indicated here, directing the reader to the relevant bibliography for more detailed information on each case (Table 1).

2.1. Trajan (Sample 1) (Figure 1a)

The effigy of Trajan was found in 1866 inside a modern wall in an imprecise location within the city of ancient Tarraco. Its total height is 28.5 cm, but it is broken in the middle part of the neck and shows blows that mainly affect the nose and chin. The head is tilted to the left, and the work of the locks of hair is concentrated around the forehead, with a slight outline on the sides and back [1,2]. As E. M. Koppel has already noted, it can be included in the fourth type of portraits of this emperor, although the sculptor reserved a certain freedom in reproducing the model. It has been interpreted as a posthumous image of the already deified emperor, having been produced in the Hadrianic period, probably in a local workshop [10] (p. 93), an approach that must now be re-evaluated in the light of this present study.

2.2. Hadrian (Sample 2) (Figure 1b)

The second imperial portrait head depicts Hadrian. It was found in 1868 in Méndez Núñez str. of Tarragona. Its total height is 24 cm. The head, which shows the emperor at an advanced age and with realistic features, corresponds to a particular type of portrait, the so-called "Tarragona type" [1] (p. 58); [6] (p. 186); [19] (p. 583). The piece has been dated to the 130s of the 2nd century AD, due to the sculptural work of the eyeball and the delicate but clear use of the trepan, and may be contemporary with the previous portrait of *divus*

Traianus. It has been thought to have been manufactured in a provincial workshop, most probably local [10] (p. 94); [6] (p. 186).

Table 1. Marble pieces under study with their different reference numbers for the MNAT (Museu Nacional Arqueològic de Tarragona), LEMLA (Laboratori per l'estudi dels materials lapidis a l'Antiguitat) and ICAC (Institut Català d'Arqueologia Clàssica).

Sample	MNAT	LEMLA	ICAC	Personage	Relevant References Pages (pp.); Number (num.); Plate (pl.); Idem (Id)	Chronology
1	388	1139	TAR-1254	Trajan *divus*	[10], pp. 92–93, num. 124, pl. 53,3–6; [14], p. 268, num. 7, p. 271, figures 5a,b.	Hadrian age (c. 130–140 AD)
2	389	1138	TAR-1255	Hadrian "Tarragona type"	[10], pp. 94–95, num. 126, pl. 55,1–4; [1], p. 58; [6], p. 186, num. 137. [17], p. 179, pl. XVII, 1–2; [29], p. 88; [19], pp. 583–584; [24], Herrmann 2023, p. 99.	Hadrian age (c. 130–140 AD)
3	12261	1148	TAR-1256	Hadrian? *Thoracata*	[10], pp. 52–53, num. 76, pl. 25,1–2; [11], pp. 14–16, num. 2, pl. 5; [30], p. 52, num. 12.	Hadrian age (c. 117–135 AD)
4	386	1137	TAR-1257	*Marcus Aurelius*	[10], pp. 33–34, num. 46, lam. 13; [30], p. 163, num. 116; [9], pp. 329–330, pl. 109; [5], p. 32, lam. 15, note 5; [2], p. 26, num. B 35, lam. 50; [17], pp. 173–174, pl. XIII, 1–2; [31], pp. 142–143, figure 12.	c. 152–160 AD
5	387	1136	TAR-1258	*Lucius Verus*	[10], pp. 34–35, num. 47, pl. 14; [30], p. 120; Rodà 1990, p. 301; [12], p. 53; [17], pp. 173–174, 181–182, pl. XIX, 1–2; [31], p. 142–145, figure 13.	c. 161–169 AD

2.3. Hadrian? Bust (Sample 3) (Figure 1c)

Found in 1929 in the *schola* of the *collegium fabrum*, in Tarragona. Its total height is 40 cm. The bust is perfectly preserved, but the portrait, which would have been carved in the same block, has been lost, as evidenced by the broken neck. It has a cuirass under which the tunic or *colobium* can be seen. In the center is a depiction of a winged Medusa (*gorgoneion*), the humerus is surmounted by a lion's head and the mantle or *paludamentum* is folded over the left shoulder. The sculpture is well made and has been unanimously considered to be the product of a local workshop. The chronology seems to fit in well with the Hadrianic period (AD 117–135) and it would possibly represent the emperor himself [10,11,30].

2.4. Marcus Aurelius (Sample 4) (Figure 2a)

This portrait was found in 1864 in the vicinity of the colonial *forum* of Tarraco. Its total height is 29 cm. It is broken at the base of the neck, just below the beard, which is well preserved. It is a whole piece, with only the loss of the end of the nose. It certainly represents the young emperor *Marcus Aurelius*, according to the second of the types established for this emperor, which can be dated to the 150s of the 2nd century AD and more precisely between 152 and 160 AD [2] (p. 26). The portrait is of excellent technical quality, and due to certain differences with respect to the properties of the second-type portrait and the fact that it was thought to be sculpted in lunense marble, it was interpreted as an earlier portrait from a good provincial workshop [10] (p. 34). This assignation was accepted in the subsequent bibliography [16] (p. 301); [12] (p. 53); [15,25]. However, some authors have already pointed to its possible character as an imported work [5,17]. More recently, although without providing arguments or reviewing the bibliography, it is also considered an imported work [29]. Citing technical issues, it was suggested that it was made in Rome [31].

(a)

(b)

(c)

Figure 1. Sculptures analyzed: (**a**) Trajan; (**b**) Hadrian "Tarragone type"; (**c**) Hadrian? *Thoracata*.

(a)

(b)

Figure 2. Sculptures analyzed: (**a**) *Marcus Aurelius*; (**b**) *Lucius Verus*.

2.5. Lucius Verus (Sample 5) (Figure 2b)

This portrait, like the previous one, was found in 1864 in the area of the colonial *forum*. Its total height is 31 cm. It is in a perfect state of preservation, and it is included in the only type of portrait of this emperor created at the beginning of the period of his reign (161–169 AD). It was maintained with slight variations throughout his empire and even for his posthumous images as *divus*. In the case of the Tarragona portrait, the hair mane lacks the intense trepan work that characterizes the other portraits of *Lucius Verus*, as can also be seen in the example at the National Archaeological Museum in Madrid [32]. The type is absolutely canonical and has been considered to have been carved at the beginning of the emperor's reign in a provincial workshop in Tarraco [10].

3. Materials and Methods

All pieces were macroscopically examined using a handheld magnifying lens, from which several fragments of fine-grained marble were sampled for the analyses. A well-established sequential multimethod analytical approach [33] was applied, including mineralogical and geochemical techniques [34,35]. This approach focuses on comparison with the analytical properties of a set of quarries selected as likely sources on the basis of art history and archaeological information. The known classical fine-grained marbles exploited and traded during imperial times, especially for statuary sculpture, are Paros-*lychnites*, Afyon (Docimium), Pentelicon, Carrara and Göktepe. Other fine-grained marbles, of lesser repercussion in their distribution in the Western Empire, such as Hymettos or Doliana, reported by some authors [36] have not been considered in this work. The results were compared with our own reference database and a review of the analytical data included in different publications related to the provenance of fine-grained marbles, as detailed in the discussion section.

Polarized light optical microscopy and qualitative cathodoluminescence (CL) were applied to one thin section for each sample (TAR-1254 to TAR-1258). A standard optical microscope, a Nikon Eclipse 50iPOL, with an automatic digital Nikon Coolpix5400 camera, available at the *Unidad de Estudios Arqueométricos* (UEA) of the ICAC laboratory of Tarragona, was used to examine the mineralogy, microstructure (including texture), Grain Boundary Shape (GBS), Maximum Grain Size (MGS) and Most Frequent Size (MFS), since they are valuable for marble identification in combination with other analytical results [34,36]. A Technosyn CL8200Mk5-1, provided by Cambridge Image Technology Ltd. (Cambridge, UK), coupled to the microscope at the ICAC laboratory, was also used to take CL images of the thin sections. The electron energy applied was 15–20 kV, the beam current operated at 250–300 μA and the vacuum was 0.17 mbar (17 Pa). The CL images were automatically recorded (29 mm focal length, f/4.6 aperture, 1 s exposure time, ISO-200), and three parameters were registered: color, intensity and distribution of CL [35,37].

To check the presence of dolomite, X-ray powder diffraction (XRPD) was carried out using an automatic Philips PW 1130/00 diffractometer (CuKa radiation at 40 kV, 20 mA; data recorded in the 3–70° 2φ range, 1°/min, 2 s/step). Oxygen and carbon isotopes were determined on the calcium carbonate samples using isotope ratio mass spectrometry (IRMS) at the laboratory of the *Istituto di Geologia Ambientale e Geoingegneria in Rome* (Consiglio Nazionale delle Richerche, CNR) by means of the usual acid digestion technique at 72 °C using a Thermo Gasbench II in line with a Delta+ mass spectrometer. The results are expressed in the usual delta notation ($\delta^{18}O$ and $\delta^{13}C$), which represents the relative deviation in parts per thousand of the heavy isotope/light isotope ratio of the sample from that of an international reference standard (V-PDB). The analytical precision was better than 0.1‰ for both isotopes.

Finally, a Varian Vista-PRO inductively coupled plasma atomic emission spectrometer (ICP-AES) at the Earth Science Department of Sapienza University of Rome, Italy, was used for trace element determination in samples with petrographic uncertainties. Sample aliquots were dissolved in solutions of HCl (3%) to measure Sr and Mn elemental concentrations (ppm). Deionized water (resistivity 18 MΩ cm^{-e}) obtained from a Milli-Q purification system was used to prepare all standard and sample solutions. Internal standards and the precision of the method are explained elsewhere [34,38]. This technique was only applied to those samples that showed clear evidence of being Göktepe or Carrara from the results of the other analyses.

Concerning the Carrara–Göktepe discrimination, the different research groups working on classical marbles solve it in different ways. While those of petrographic formation give an important weight to observation and textural interpretation [36,39,40] as a first step for marble identification, others focus on discriminant analysis as a tool of determination [41–43]. Additional methods for the discrimination of Göktepe and Carrara have relied on the combination with $^{87}Sr/^{86}Sr$ isotopes [44], on the importance of the specific profile of the solid-state nuclear magnetic resonance (NMR) [45] or on the use of a refinement of the XRPD parameters [46].

The combination of petrographic results, including qualitative CL, stable isotopes and Sr and Mn concentration values, has proved satisfactory for the discrimination between Göktepe and Carrara [34]. Two petrographic varieties were distinguished on white Göktepe marble (wG1 and wG2) using MGS, MFS, texture, microstructure and CL. While lithotype wG1 is an extremely fine marble with MGS $\leq$ 0.6 mm and MFS $\leq$ 0.2 mm and distinctively low CL intensity, lithotype wG2 is fine-grained (MGS $\leq$ 1.1 mm and MFS $\leq$ 0.4 mm) with a texture and microstructure quite similar to Luni-Carrara marble, but unlike Luni, the CL intensity of this wG2 type is very low, while Carrara has a medium CL intensity [34,35,37].

4. Results and Discussion

The results of the mineralogical–petrographic examination, the main CL characteristics, isotopic values and Sr and Mn concentrations are summarized in Table 2, where the marble quarry origin is proposed, taking into account all data, which from here on will be presented and the identification will be discussed, comparing them with the analytical data available for each of the techniques.

Table 2. Petrographic, optical-CL properties, mineralogical composition, isotopes and Sr and Mn concentrations.

Sample Personage	MGS	MFS	GBS	Texture Fabric	Qualitative CL-Optical	Mineralogy	δ^{13}C ‰	δ^{18}O ‰	Sr ppm	Mn ppm	Marble Origin
1. Trajan *divus*	0.4 mm	Extremely fine (0.2 mm)	Curved to straight	Homeoblastic mosaic slightly strained	Low CL	Calcite	+2.8	−2.6	379	4.7	Göktepe wG1 type
2. Hadrian “Tarragona type”	0.7 mm	Very fine (0.4 mm)	Straight to curved	Homeoblastic polygonal mosaic	Low—Medium CL	Calcite Microdolomite	+2.1	−1.0	136	36.8	Carrara
3. Hadrian? *Thoracata*	2 mm	Fine–medium (0.7–1.8 mm)	Curved	Heteroblastic mosaic	Low—bluish CL	Calcite	+4.8	−3.2			Paros-1 *Lychnites*
4. *Marcus Aurelius*	0.7 mm	Very fine (0.4 mm)	Curved to straight	Homeoblastic polygonal mosaic	Very Low CL	Calcite	+2.6	−3.0	713	6.3	Göktepe wG2 type
5. *Lucius Verus*	1.2 mm	Very fine–fine (0.4–0.9 mm)	Curved to straight	Heteroblastic mosaic	Low—bluish CL	Calcite	+4.9	−3.1			Paros-1 *Lychnites*

In Figure 3, representative photomicrographs in crossed polarized light (on the left) and CL images (on the right) are shown for each sample. MGS are displayed in Figure 4.

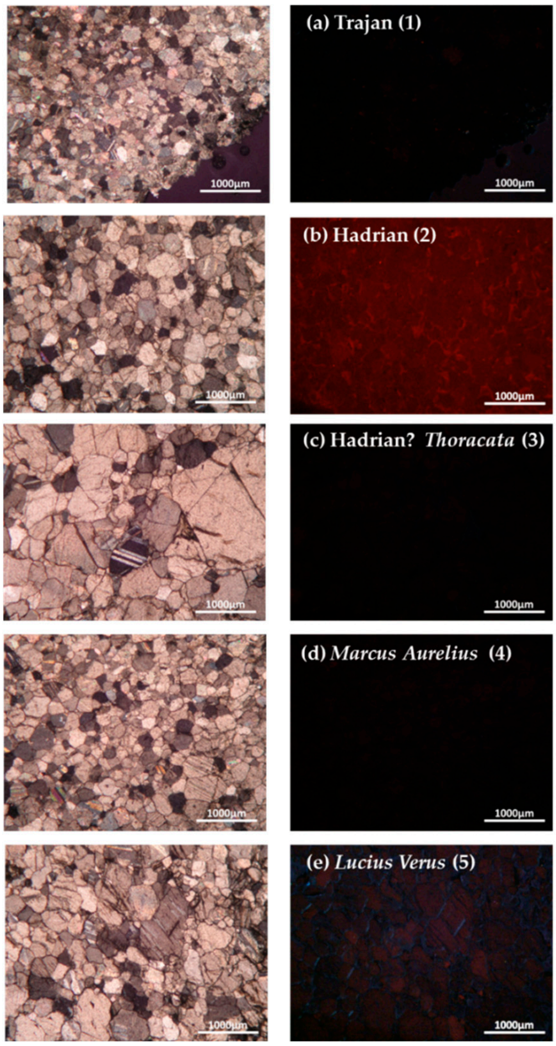

Figure 3. Photomicrographs in crossed polarized light (on the left) and CL images (on the right) of each sample.

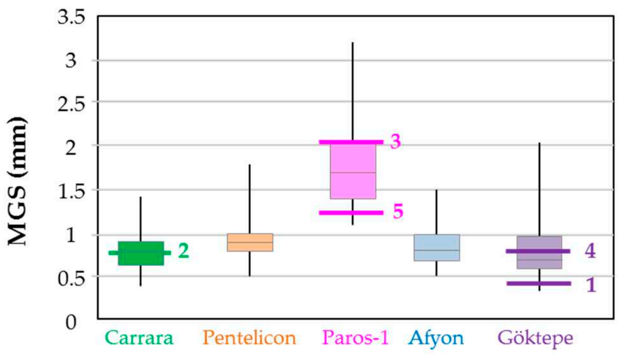

Figure 4. Maximum grain size (MGS) diagram of the white, fine-grained marbles. Each sample is represented by a numbered line and plotted on the boxplot and whiskers of the most probable marble source after the petrographic and CL observations. Quarry samples after [34,36,41,44,47].

4.1. Trajan (Sample 1)

This white, very fine-grained calcitic marble has no accessory minerals observable at the microscale or detected using XRPD. Figure 3a shows its mosaic homeoblastic texture, with calcite crystals that exhibit curved to straight GBSs, even occasionally embayed, in an apparently isotropic microstructure to slightly strained fabric. MGS is 0.4 mm and MFS is ≤0.2 mm, revealing the extremely fine grain of this marble (Figure 4), which can be categorized as ultrafine, a feature very significant for its identification. Certainly, those parameters, along with the homogeneous low intensity of CL, are very distinctive for the best quality of white Göktepe marble (lithotype wG1) [34], identified in certain sculptures of Villa Adriana [39,48,49] and in the marble of the sculptural program from the Lusitanian Quinta das Longas villa [50].

Concerning the C and O isotopes shown in Table 2, with values of −2.6‰ ($\delta^{18}O$) and +2.8‰ ($\delta^{13}C$), they are compatible with Göktepe marble, as can be seen in the two different isotopic diagrams (Figure 5a,b) for classical fine-grained marbles with respect to different databases [34,36,40,41,44,47,51]. Indeed, the isotopic signature of sample 1 falls inside the overlapping area of Göktepe and Carrara isotopic fields in Figure 5a, but in Figure 5b, it follows the main cluster of the Göktepe marble [34] and is outside the probabilistic ellipse of the Carrara isotopic field [34,41]. To check this quarry attribution, an additional criterion to identify Göktepe was used, as many authors have reported [34,41,44,52]. That is the high elemental concentration of Sr and the low concentration of Mn with respect to other fine-grained marbles, and in particular, with respect to Carrara marbles. Both elements were measured (data in Table 2) and plotted in different representative diagrams (Figures 6 and 7), confirming the Göktepe origin.

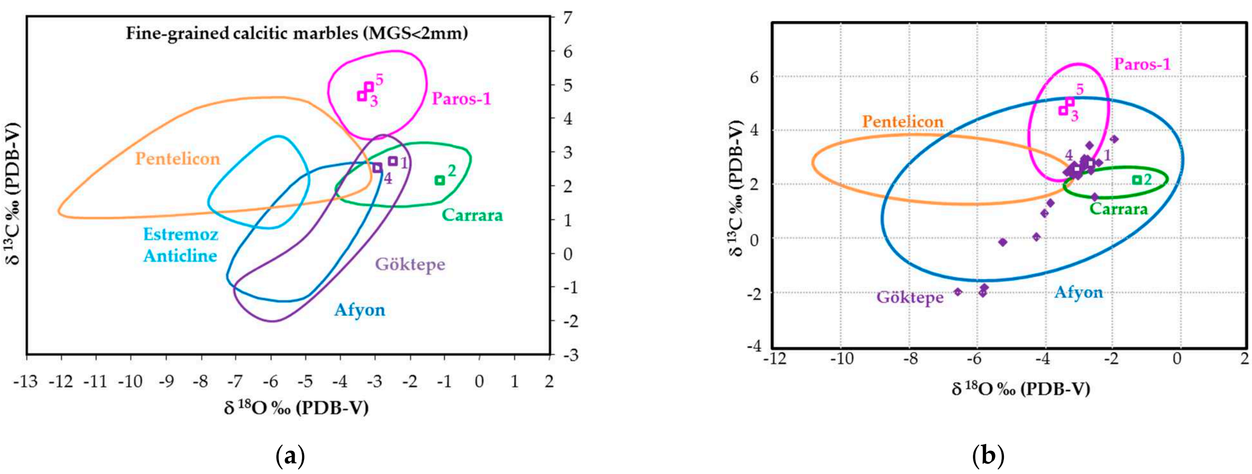

Figure 5. Isotopic C and O signatures of the portrait samples plotted on two different diagrams for classical fine-grained marbles: (**a**) isotopic diagram adapted from [40] with data from [34,36,41,44,47,51]; (**b**) scatterplot of the C and O isotope compositions of the Göktepe white marble adapted from [34], with the probability distribution (99%) of isotope data represented by ellipses from [47].

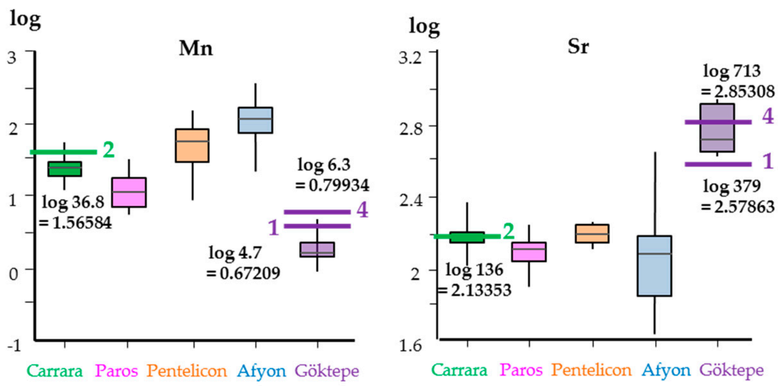

Figure 6. Box and whisker plots of Mn and Sr log-transformed concentration data from fine-grained marbles and the representation of the archaeological samples 1, 2 and 4, adapted from [52].

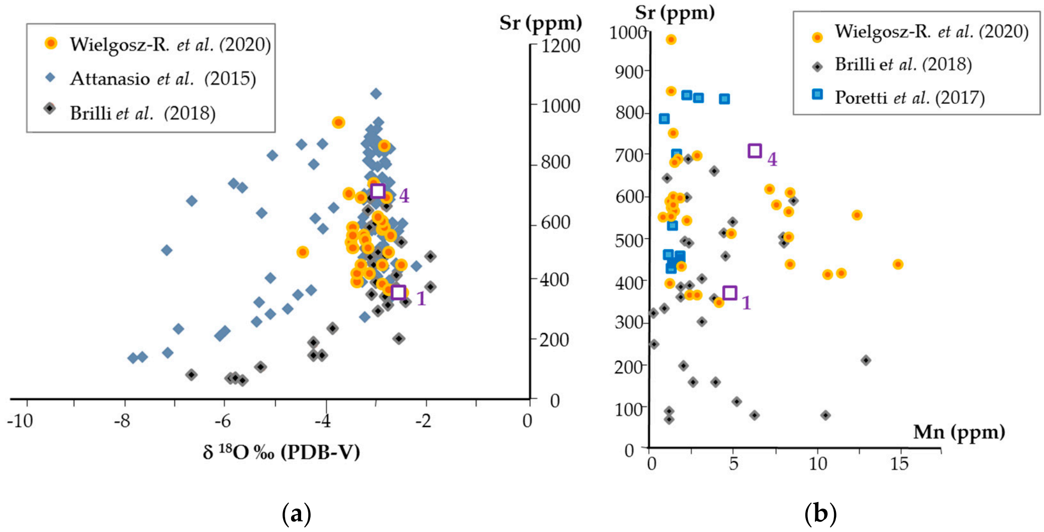

Figure 7. Scatterplots of the concentration of Sr (units in ppm) of the white Göktepe quarry marble modified from [34], with additional data from [41,44,52] and the archaeological samples 1 and 4 to confirm their Göktepe assignation: (**a**) Sr *versus* $\delta^{18}O$ diagram; (**b**) Sr *versus* Mn.

4.2. Hadrian (Sample 2)

This white sample of very fine-grained calcitic marble has scarce microdolomite as an accessory mineral detected using XRPD and is observable at the microscale by its more reddish CL behavior. Figure 3b illustrates the polygonal mosaic homeoblastic texture, where calcite crystals exhibit straight to curved GBSs with typical triple points in an isotropic microstructure with MGS of 0.7 mm and MFS of 0.4 mm (Table 2 and Figure 4). These petrographic features are typical of Luni-Carrara marble but not exclusive, because certain varieties of white Göktepe (wG2) exhibit the same texture and grain size [41,44,53]. However, the CL behavior with low to medium intensity helps to discard Göktepe and reaffirm the Carrara origin [34,37]. Furthermore, CL intensity and distribution reject Afyon and Pentelicon. Other parameters also point to the Italian origin of this marble, as the isotopic values are −1.0‰ ($\delta^{18}O$) and +2.1‰ ($\delta^{13}C$), which are inside the Carrara isotopic field in all the databases in Figure 5. Furthermore, the Sr and Mn concentrations are compatible with Carrara but not with Göktepe (Figure 6).

4.3. Hadrian? Thoracata (Sample 3)

The white marble of this acephalous bust is of fine-to-medium grain size, with a clearly bimodal heteroblastic texture (Table 2 and Figure 3) of pure calcite composition. The MFS is 0.7 mm and 1.8 mm for the respective fine and medium crystals, which show a curved GBS. The MGS of 2 mm, the highest value of all considered marbles (Figure 4), points to a Parian marble along with its homogeneous low CL intensity with a bluish tone, only visible when the camera exposition time is prolonged and the image becomes overexposed [37]. However, the most significant feature is the high value for $\delta^{13}C$ (+4.8‰), whose projection against $\delta^{18}O$ (−3.2‰), shown in Figure 5, confirms the use of Paros-*lychnites* marble.

4.4. Marcus Aurelius (Sample 4)

The white marble of this portrait consists of a polygonal mosaic of predominantly homeoblastic, very fine-grained calcite grains with curved to straight GBS and isotropic fabric. As shown in Table 2, and as can be seen in Figure 4, their size parameters (MGS of 0.7 mm and MFS of 0.4 mm) match those measured in sample 2 assigned to Carrara, an aspect that is visualized in the corresponding images on the left of Figure 3. However, unlike sample 2, sample 4 shows nonluminescent behavior, as can be seen in the corresponding images on the right of Figure 3. This CL has been characterized as having very low intensity (Table 2) compared to the results and images provided in the paper about CL quantification [37]. This CL behavior helps to discriminate Göktepe from Carrara, in addition to ruling out other options such as Afyon and Pentelicon [34,35,37]. Regarding its isotopic signature, with −3.0‰ ($\delta^{18}O$) and +2.6‰ ($\delta^{13}C$), both marble sources (Göktepe and Carrara) are possible in the diagram of Figure 5a, but in Figure 5b, its assignment to Göktepe is much more likely. To verify its provenance from the ancient Caria and discard the Italian, its Sr and Mn concentrations were measured and found to be 713 ppm and 6.3 ppm, respectively (Table 2). Indeed, the high Sr concentration and relatively low Mn confirm its provenance in Göktepe, as can be interpreted by the plots in Figures 6 and 7. This same petrographic lithotype of white Göktepe (wG2), petrographically very similar to that typical of Carrara, was identified in pieces from Villa Adriana [39,48,49], as unlike the extremely fine-grained (wG1) described in sample 1.

4.5. Lucius Verus (Sample 5)

This white marble consists of a heteroblastic mosaic of pure calcite, which exhibits curved to straight GBSs (Figure 3). Its grain size ranges from very fine to fine, bimodal, with an MFS of 0.4–0.9 mm, but some isolated larger crystals can reach 1.2 mm (MGS). This parameter is, in this case, not discriminant among the fine-grained classical marbles (Figure 4). However, its texture and microstructure, along with its low luminescent character in a bluish tone, point to the same Paros-1 source as sample 3. This marble origin, one of the most highly appreciated by Romans, known as Paros-*lychnites*, is confirmed by the isotopic signature (Table 2) with −3.1‰ ($\delta^{18}O$) and +4.9‰ ($\delta^{13}C$), clearly inside the Paros-1 isotopic field shown in Figure 5.

5. Archaeological Considerations

The previous existing marble information concerning the noble material used for the artifacts here tested was assumed to be Italian marble from Luni Carrara, based on visual inspection or only on petrographic examination made in the 1980s–1990s. This is not surprising because, before discovering the ancient quarries of Göktepe [53], its identification was almost invariably misclassified as Carrara marble. However, the new analyses, here provided by well-established methods, have demonstrated that only one of the five pieces studied is, in fact, Luna marble. The preceding erroneous marble identification undoubtedly influenced considering all of them as pieces possibly carved in the provincial workshops of Tarraco and not in Rome itself, since Carrara marble was very widely distributed in Hispania, even more so on the Mediterranean façade [16,25]. Conversely, the new marble attribution, including the quarries of Paros-*lychnites* and Göktepe, opens a new perspective concerning sculptural production.

Though there is no doubt that marble identification may provide relevant information not only about the social and economic context but also concerning the artistic style of the ateliers working on them; different views are discussed among the scholars. In this sense, some recent archaeometric studies [21–23] suggest "that sculptors preferred, whenever possible, to use their homeland marbles that they were well acquainted to work" with [22] (p. 168). Even the itinerancy of sculptors is also proposed, in particular when the pieces were signed by the artist. On the other hand, dealing with urban production in Rome itself, the common opinion is that all kinds of marbles were available in large quantities, including Göktepe marble. Under this perspective, if the stylistic features are not conclusive to assign an artistic work to a particular sculptural production, a great difficulty in associating material with workshops must be assumed. In this regard, and in all cases with absolute caution, we could consider that the portraits here studied were metropolitan pieces worked in Rome, with the exception of the Hadrian portrait, made in Luni-Carrara, which, in view of its iconographic peculiarities, could have been carved in a local workshop in Tarraco. In addition, the fact that the portraits of *Marcus Aurelius* and *Lucius Verus*, both technically and stylistically outstanding, were made with prestigious marbles (Göktepe and *lychnites*, respectively), further emphasizes the possible metropolitan character of these artistic works.

Of course, not only the preferences of sculptors and patrons were important for the choice of one particular marble destined for a high-quality imperial portrait, but also their availability in each period. It is for this reason that this present study, dedicated to five imperial pieces that are reasonably well dated to the 2nd century AD (Table 1), provides clues that go beyond the mere identification of the marble. Indeed, the diachronic information that can be obtained attempts to better understand the use and taste of imperial marble in the Western Roman provinces over a period of time when other studies have documented changes in the choice of raw material [22,23]. Indeed, the recent archaeometric contributions to Roman portraiture, especially those dealing with 167 imperial portraits from the Augustan to late antiquity periods [22], open a new perspective on the use of classical marbles following a chronological scheme. After these authors [22] (p. 177–179), Göktepe is by far (44%) the most frequent marble used for the production of high-quality portraits, followed by Paros-*lychnites* (29%) and, at great distance, Luna marble (10%) and *Docimium* (7%). The prevalence of *lychnites* during the Augustan and Julio-Claudian periods for portraying emperors was turned out by the majority use of Luna marble during the Flavian period, with a clear predominance of Göktepe from the reign of Hadrian, increasing from the time of Trajan, and remaining the most popular during the Antoninian, Severan and late antiquity periods [21,22].

Concerning the 2nd century, from the Trajanic to the mid-Antonine periods, our marble identifications, though limited to five pieces, are in agreement with the interesting remarks offered in the mentioned papers. The first three pieces correspond to different marbles (Göktepe, Carrara and Paros-*lychnites*), for which it is significant that the portrait of Trajan was made in Göktepe, revealing its early occurrence, although it should be remembered that this particular model could have been made in Hadrian's time. During the early and mid-Antonine periods, Göktepe played an important role, and the Parian *lychnites* was still a prestigious imperial marble, following the decline of Luni-Carrara.

Finally, the panorama of the Göktepe presence in Hispania, certified by this multianalytical approach, is changing and gaining importance based on the recent analyses carried out. The superb Hadrian found in Yecla (Murcia), carved in Göktepe marble, must be added to the portraits studied here (lithotype wG2) [54]. On the other hand, belonging to the late antiquity period, diverse Göktepe were used in the sculptural cycles of the ideal figures of Quinta das Longas [50] and Valdetorres de Jarama [55]. Predictably, these cases will not be the only ones, as soon as analyses of other pieces pending re-evaluation become available.

6. Conclusions

A multimethod approach to unequivocally determine the white marble source used in imperial portraits from Tarraco has been necessary to unravel the doubts about their possible misclassification as Carrara marbles that have been repeated over the last four decades. When dealing with fine to very fine white marble, a multianalytical method is always essential, and the cases under consideration were no exception. In fact, only one portrait, Hadrian (sample 2), was finally identified as Carrara marble.

The marble identification was carried out using a sequential approach, taking into account petrography and CL features as the first step, combined with C and O stable isotopes. A complementary technique, ICP-AES, for the Sr and Mn concentrations was used in three samples to discriminate Göktepe from Carrara marbles. The combined results point to the use of the best quality white statuary Göktepe marble (lithotype wG1) in the Trajan portrait (sample 1), while in the outstanding portrait of *Marcus Aurelius* (sample 4), a different statuary Göktepe was used (lithotype wG2). As it was expected, another prestigious marble, Paros-*lychnites,* was selected for the *Lucius Verus* portrait (sample 5) and for the *Thoracata* bust of Hadrian (sample 3).

The marble provenance forces us to rethink the discourse about the provincial sculptural workshops. Probably, only the Hadrian portrait "type Tarragona" in Luni-Carrara was made by a provincial atelier linked to Tarraco. This assumption is based on its peculiar iconography coupled with the use of the Mediterranean marble most widely distributed in Hispania.

The significance of having identified the Asiatic marble of Göktepe used during the 2nd century in the Western Roman province must be emphasized, even more considering that until recently its dissemination through the Empire had been questioned. This prestigious material seems to have been introduced in Hispania in the time of Hadrian, at least according to what we have analyzed so far.

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