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Dolomitic marble from Thasos at the Louvre

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Abstract

Many Greek and Roman sculptures in the Louvre appear to be made of coarse-grained, very white dolomitic marble from the north Aegean island of Thasos, and permission was given to test twelve of them in a non-destructive way using a mobile X-ray fluorescence (XRF) spectrometer. Coarse-grained, white dolomitic marble sources were rare in antiquity, and if these Thasian-looking sculptures proved to be dolomitic rather than calcitic, it is highly likely that they were in fact made of Thasian marble. Ten of the twelve sculptures did prove to be dolomitic marble and therefore very probably Thasian in origin. This new information makes it possible to expand and enrich our knowledge of the exportation of marble from Thasos in both geographic and chronological terms. The tests furthermore confirm that dolomitic marble from Thasos was preferred for colossal replicas of Athena of the Velletri type and also reveal that a group of imperial portraits in Algeria were carved from marble blocks from Thasos. One test offered confirmation that a fragment in the Louvre was part of a relief in Izmir.

Introduction

Marble from the adjacent zones termed Cape Vathy and the Saliari area in the north-eastern part of the northern Greek island of Thasos is characteristically almost pure dolomite. As Attanasio has pointed out (2003), it is the whitest commonly used ancient marble, and it has a maximum grain size of 1-3 mm with a mean of slightly less than 2 mm, which places it among the coarse-grained marbles. Macroscopically, the stone often reveals large, glittering, flaky crystals or grains, which, together with its medium or coarse grain and unspotted whiteness, make it relatively easy to

recognize by eye. The whiteness of Thasian dolomitic marble makes it an attractive material for sculpture, but its hardness makes it difficult to work. On the Mohs scale, calcite is rated 3, while dolomite is 3.5-4.0. Similar pure white, coarse-grained dolomitic marble suitable for sculpture is also found near Malaga in southwestern Spain and was used for sculpture at least locally in Roman times (Attanasio, 2003; Lapuente *et al.*, 2002). Unfortunately analysis of stable isotopes of carbon and oxygen, the usual technique for marble provenancing, is of limited use in separating the dolomitic marbles of Malaga and Thasos since their signatures overlap substantially. A recent study, however, indicates that petrographic criteria can provide a basis for distinction (Lapuente *et al.*, 2002).

Multimethod testing has shown that coarse-grained dolomitic marble like that of Thasos and Malaga was used for ancient sculpture around the Mediterranean, inland as far east as Palmyra, and on the north shore of the Black Sea (Herrmann and Newman, 1995, 2002; Wielgosz *et al.*, 2002; Herrmann *et al.*, 2002; Fischer, 2009). It is highly likely that this dolomitic marble comes from Thasos not Malaga. The apparent absence of Malaga marble at such Spanish centers as Merida and Zaragoza (Lapuente *et al.*, 1999, 2002) tends to indicate that it was only used in the immediate region of the Malaga quarries during antiquity. Historical arguments reinforce this conclusion. The marble of Thasos was mentioned by ancient writers and was heavily used for sculpture on that island and in neighboring regions (Grandjean, 2000), but no ancient written source seems to mention marble from southwest Spain.

The Louvre displays many ancient sculptures that appear to be marble from Thasos. In 2007 the *Département des Antiquités Grecques, Etrusques et Romaines* of the Louvre granted us the opportunity to study twelve of them by non-destructive means. These pieces were chosen because their provenances offered a special geographical or historical interest. The objective of our study was to tell whether the marble was dolomite (CaMgC₂O₆) or calcite (CaCO₃), on the assumption that, if dolomite, they came from Thasos.

Materials and Methods

The measurements were carried out in a fully non-destructive way using a mobile X-ray fluorescence (XRF) spectrometer designed at the C2RMF (Figure 1), built upon a 50 kV molybdenum X-ray tube and a silicon-drift X-ray detector (12). Measurements were made on modern breaks in order to minimize the effects of weathering. Magnesium and stron-

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tium, a heavier element naturally substituting calcium, were measured in two successive runs. The magnesium and calcium X-ray lines (1.25 keV and 3.69 keV) were recorded operating at 15 kV with a helium gas stream between the X-ray detector and the marble. The strontium X-ray line at 14.16 keV was collected at 50 kV in air with a 50- μ m Zn beam filter (Figure 2). XRF spectra were processed using a program based upon the fundamental parameters method. Trials performed on reference marble samples from Thasos demonstrated the ability of the XRF system to reliably measure Mg, Ca and Sr. Under these conditions, the magnesium was measured at a depth of 7 μ m, whereas the strontium was probed much more deeply, 1.7 and 1.1 mm in dolomitic and calcitic marbles respectively (the depth at which 99% of X-rays escape). The strontium concentration (ranging from 20 to 120 μ g/g) thus constitutes a convenient indicator of the nature of the marble, unaffected by a possible surface alteration. In addition, the markedly different Sr/Ca ratio measured could be exploited to fingerprint Thasos marble (Figure 3).

Results

By the standards just outlined, ten of the twelve sculptures analysed proved to be

dolomitic marble (Table 1). Most of the dolomitic pieces had a $MgCO_3$ component between 40 and 48.6%. Two, however, had a smaller $MgCO_3$ fraction, in the neighborhood of 30% (Ma1163, 4891). This discrepancy raises the possibility of a non-Thasian origin for them. Their strontium components, however, were consistent with the rest of the dolomitic group, and at present there are no plausible dolomitic marble alternatives to Thasos. Since one of the exceptional pieces probably comes from Egypt (Ma4891), it is particularly unlikely that its marble came from an obscure quarry in Western Spain.

Discussion

The test results shed light on a variety of both archeological, and art historical problems. A Greek relief of about 560 BCE from the northern Greek island of Samothrace, MA697 (cat76;

Hamaux, 1992), proved to have been made of calcitic rather than dolomitic marble. This is somewhat surprising since Samothrace lies only a short distance from Thasos and even at this early date, the quarries of the Cape Vathy area were in operation and had been used for relief sculpture (Grandjean, 2000). The scarcity or absence of Thasian dolomitic marble on Samothrace has already emerged in other studies of marble work on the island (Herrmann and Newman, 1999; Maniatis *et al.*, 2012). Together, these findings make it clear that proximity and economic convenience were not the decisive criteria for the selection of marble for fine sculpture.

A dolomitic marble head, Ma 4891, is a rare case of Thasian marble exported to a distant location in Hellenistic times. The head has been dated to the late third century BCE and attributed to Egypt (cat86; Hamaux, 1998). It can be identified as the goddess Io by the horns emerging from her forehead and could well have belonged to a statue representing the

syncretistic goddess Demeter-Kore-Io-Selene-Isis (Herrmann, 1999). The body would have been made of limestone or some other material, a common technique in Greco-Roman Egypt. The Louvre sculpture Ma 4891 has much in common with another dolomitic marble head of a goddess in Copenhagen also attributed to Hellenistic Egypt (Herrmann and Newman, 2002; Nielsen *et al.*, 1997).

The dolomitic marble sculptures in this series of tests document in various ways the diffusion of Thasian sculptural marble throughout the vast territories of the Rome Empire. Tested objects stem from the eastern shores of the Mediterranean to the Atlantic coast of France (Figure 4). The portrait of a man wearing a leafy crown of a civic dignitary, Ma3294, comes from Smyrna, modern Izmir on the Aegean coast of Turkey (cat69; Hamaux, 1998). A head of a philosopher in dolomitic marble was bought in Syria and was probably carved there, Ma3621 (cat254; Hamaux, 1998). A head of Sarapis, Ma1830, comes from



Figure 1. Portable X-ray fluorescence system and sculptures Ma1163 and Ma5101 of dolomitic marble presumably from Thasos.

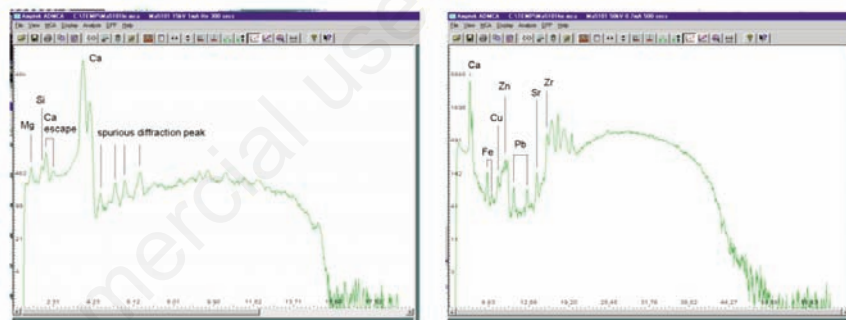


Figure 2. X-ray spectra of major elements (Mg, Ca) and trace elements (Fe, Cu, Zn, Sr, Pb).

Table 1. Composition of studied marble sculptures from the Louvre museum.

Louvre inventory no.	Description	Origin	Component							Type
			MgCO ₃ (%)	CaCO ₃ (%)	Fe (ppm)	Cu (ppm)	Zn (ppm)	Sr (ppm)	Ca/Sr	
Ma 464	Statue of Athena	Velletri, Italy	46.7	53.3	52	4	16	29	7320	D
Ma 697	Relief fragment	Samothrace, Greece	0.2	99.8	203	4	30	118	3360	C
Ma 1163	Head of Commodus	Markouna, Algeria	34.8	65.2	112	5	9	20	13100	D
Ma 1175	Head of Faustina II	Markouna, Algeria	48.6	51.4	71	6	13	28	7440	D
Ma 1346	Dionysiac sarcophagus	Gironde, France	48.1	51.9	64	12	8	28	7370	D
Ma 1830	Head of Sarapis	Carthage, Tunisia	45.1	54.9	33	7	0	23	9360	D
Ma 3294	Crowned head	Smyrna, Turkey	43.3	56.7	91	4	13	28	8080	D
Ma 3295	Relief fragment	Unknown	42.3	57.7	50	2	0	34	6880	D
Ma 3522	Head of Maxentius	Langres, France	0.0	100	50	3	11	116	3450	C
Ma 3625	Head of Philosopher	Tortosa, Syria	40.1	59.9	130	7	2	31	7840	D
Ma 4891	Head of Arsinoé II	Egypt?	29.5	70.5	124	7	13	38	7450	D
Ma 5101	Head of Marcus Aurelius	Markouna, Algeria	41.7	58.3	71	6	13	22	10400	D

Mg, magnesium; Ca, calcium; Fe, iron; Cu, copper; Zn, zinc; Sr, strontium; D, dolomitic; C, calcitic.

Making use of the completely non-destructive technique of X-ray fluorescence, it has been possible to identify ten Thasian dolomitic marble sculptures in the Louvre collection. These sculptures come from widely scattered sites around the Roman Empire, shed light on the practices of Roman sculptural workshops, and clarify the genesis of a monument divided between Turkey and the Louvre.

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