

ISOTOPIC SOURCE DETERMINATION OF GREEK AND ROMAN MARBLE SCULPTURES IN THE MUSEUM OF FINE ARTS, BOSTON: RECENT ANALYSES

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Abstract. *Our approach to the provenance of Greek and Roman sculptures has emphasized the identification of the quarry source of as many sculptures as possible using only minimally destructive techniques. Stable carbon and oxygen isotope analysis may be the best single method for determining marble provenance, but the quarry source frequently cannot be unequivocally identified. When employed in combination with X-ray diffraction, grain-size determination, stylistic analysis, literary information, and archaeological data, however, the identification of a single likely quarry was possible for 90% of the sculptures examined.*

We report here on the analysis of 68 Greek and Roman

marble sculptures in the Museum of Fine Arts, Boston, to add to the 67 presented at ASMOSIA III. Our results demonstrate the utility of these complementary methods, and highlight the effectiveness of integrated, interdisciplinary research efforts. In many instances, initial identifications made by informed visual inspection were confirmed by the laboratory analyses; in others, the new identifications have considerable archaeological and art historical significance.

Key-words. *Marble - Calcite - Dolomite - Stable isotope ratio analysis - X-ray diffraction - Museum of Fine Arts - Boston*

Introduction

This paper is a continuation of a similar communication in ASMOSIA III, and should be read in conjunction with it. It reports work in progress to determine the quarry sources of marble sculptures in the Museum of Fine Arts, Boston (MFA) and the Arthur M. Sackler Museum, Harvard University. It results from a long-term collaboration, originally suggested by David Mitten of Harvard, of a group of researchers who include archaeology, art history, and archaeological science among their interests. The ASMOSIA III communication from this group (van der Merwe *et al.*, 1995) concerned the quarry sources of 67 marble sculptures from the Museum of Fine Arts and 16 from the Sackler Museum. We now report on the quarry sources of 68 additional Greek and Roman marble sculptures in the MFA. We have examined these sculptures visually, under simple magnification, to characterise the mineralogy; confirmed visual identification of dolomitic marble by means of X-ray diffractometry or elemental analysis; and

measured the stable carbon and oxygen isotope ratios of the marble, comparing the results with known isotopic data on marble sources of the Mediterranean. Using all the information together allows us to make secure attributions to single quarry sources for 75% of the sculptures, with highly probable attributions for an additional 15%.

Methods and Results

Fresh breaks through the weathered surfaces of the marble sculptures were visually inspected under low magnification to distinguish calcitic and dolomitic marble and to determine grain size. Powder samples were removed from the fresh breaks by scraping with a sharp blade, catching the grains on smooth weighing paper and transferring them to a small pill vial. The sample requirement for X-ray diffractometry is one to two milligrams, and for isotopic analysis (both carbon and oxygen) it is the same. A sample of ten milligrams is ample for repeated analyses, if they should

prove necessary. This is such a small amount that the sampling site on the sculpture can be located only if one knows exactly where to look: the procedure is essentially non-destructive.

Visual inspection and X-ray diffractometry were carried out at the MFA. Carbon and oxygen isotope ratios were measured in a VG PRISM II mass spectrometer located in the Department of Earth and Planetary Sciences at Harvard. This instrument is equipped with a carbonate autosampler, using a common acid bath. Details of the procedure appear in our previous paper in the ASMOSIA III volume (van der Merwe *et al.*, 1995). The cost of stable isotope measurements is about \$20 per pair (carbon and oxygen). X-ray diffractometry costs about \$20 per sample, and was utilised only to confirm visual identifications of dolomitic marble.

The results of our analyses are provided in Table 1. For purposes of attribution, isotopic ratios were compared with quarry data produced by Herz (1992, with new additions), Matthews *et al.* (1992), and Moens *et al.* (1992). When isotopic data for all known quarries are considered, only 1 out of 68 cases provides a unique solution (HI-775, Paros 1). Additional considerations of mineralogy, grain size, and to a lesser extent, historical context, provide secure or probable attributions to a single quarry for 61 of the sculptures (90%).

Source Identifications

When the carbon and oxygen isotope data for all relevant marble quarries are plotted, a bewildering amount of overlap of the isotopic quarry fields results (Herz, 1992; Moens *et al.*, 1992: fig. 5). As demonstrated in Table 1, more than one source identification occurs for all but 1 of the 68 sculptures, the possibilities being more than a dozen in many cases. Adding a third item of information to the procedure raises the accuracy substantially. This is especially the case here for sculptures identified as being of dolomitic marble or of fine-grained white marble.

Dolomitic Marble (Cape Vathy, Thasos)

Herrmann (1992) reported briefly at the second ASMOSIA conference on some of our isotopic identifications of dolomitic marble from Cape Vathy on Thasos. At ASMOSIA III, Herrmann and Newman (1995) provided a detailed assessment of the Boston Three-sided Relief, which our isotopic measurements showed to be from the same source. We report here on nine more sculptures from the MFA that can be firmly attributed to the Cape Vathy quarry.

The nine sculptures were first identified visually (by Herrmann) as being of dolomitic marble. Most sculptures are of calcitic marble, which is a calcium carbonate, while dolomite is a calcium magnesium carbonate with a glittery appearance. With practice, dolomite can be visually identified with near-perfect accuracy, but we still consider it

necessary to confirm such identifications by other means. This was done (by Newman) by analysing for magnesium in a small chip with an electron microprobe in one case. The procedure we have adopted since involves X-ray diffractometry of marble powder to identify dolomitic mineral, which was done in eight cases. The visual identification of dolomite was confirmed for all nine sculptures. The same was true for 14 sculptures reported on at ASMOSIA III.

The Cape Vathy quarry on Thasos was the only known source of sculpture-grade dolomitic marble in classical times. It is, therefore, not surprising that all nine sculptures identified as dolomitic marble have isotopic ratios consistent with those of the Cape Vathy quarry. The same was true for 13 of 14 dolomitic sculptures published earlier (van der Merwe *et al.*, 1995). The single outlier (MFA 76.729, Fragment of a Roman Sarcophagus) has been analysed in considerable detail: it is mineralogically heterogeneous, exhibits several crystal morphologies (including some dolomite), and has isotope ratios very much unlike those of Cape Vathy. The source is in all likelihood Mt. Pentelikon (Tykot *et al.*, this volume).

Fine-Grained, White Marble

Isotopic analysis of calcitic marble can yield a large number of possible sources when compared with the database assembled by Herz (1987, 1988, 1992, plus additions). Unpublished isotopic ratios from a database compiled by L. Moens, P. De Paepe, and M. Waelkens suggest that only three quarries provided fine-grained, sculptural-grade, white marble in classical times (pers. comm.). These are Mt. Pentelikon in Athens, Dokimeion (or Afyon) in Turkey, and Carrara in Italy. The maximum grain size of marble from these quarries is 1.8 mm (Moens *et al.*, 1990), and their isotopic fields overlap only slightly. The visual identification of fine-grained, white marble thus often provides an opportunity for unequivocal attribution of a single quarry source by means of isotopic analysis.

Of the 68 sculptures reported on here, 42 were visually identified as being of fine-grained, white, calcitic marble. Of these, 3 fell in the isotopic field for Dokimeion, 22 are consistent with the Pentelikon field, and 17 were identified as being from Carrara. Among the latter, one sculpture (HI-712) fell just outside the edge of the Carrara isotopic field, and was rated "highly probable."

Other Sculptures

For the remaining 17 sculptures, we combined isotopic data with visual characterisation of the mineralogy and with historical information to reach conclusions about their quarry sources. Nine sculptures were attributed to the Paros 1 quarry, having isotopic ratios consistent with that of the quarry (one has a unique isotopic solution) and mineralogy matching that of Paros 1 marble. The remaining eight sculptures can be attributed with varying degrees of probability to the quarries of Paros 2, Naxos, and Prokonnesos (or Marmara), while two remain unidentified.

| Harvard Lab.No. | Museum Number | Sculpture Name | Reference: Catalogue Description. Provenance | $\delta^{13}\text{C}$ (‰) | $\delta^{18}\text{O}$ (‰) | Isotopic Quarry Matches | Attribution | Justification |
|-----------------|---------------|--|---|---------------------------|---------------------------|--|-------------|--------------------------|
| HI-357 | MFA 95.67 | Hermes | C&V 145: Fine-grained marble, probably from the Greek mainland. From the neighborhood of Capua | 4.92 | -3.37 | Sa,Pa-1,Pr?,E1 | Pa-1 | |
| HI-358 | MFA 98.641 | Polykleitan Hermes | C&V 144: Greek island marble. From the neighborhood of Capua | 3.71 | -3.06 | Th-CV,Pa-1,Pr,Sa | Th-CV | XRD: Dolomite |
| HI-359 | MFA 03.744 | Lady of the Late Flavian Period | C&V 349: Coarse-grained Greek marble. Bought in Rome | 3.52 | -3.59 | Th-CV,Pa-1,Pr,Sa? | Th-CV | XRD: Dolomite |
| HI-360 | MFA 03.746 | Youth ("The Nelson Head") | C&V 146: Parian marble. Probably found in Italy | 3.85 | -3.82 | Th-CV,Pa-1,Pr?,E-1?,Sa | Th-CV | XRD: Dolomite |
| HI-361 | MFA 03.753 | Top and Shaft of a Grave Stele | C&V 23: Grayish white marble with large crystals, certainly from northwest Asia Minor or Proconnesos Island. Found near the Tomb of Aias in the Troad | 0.82 | -10.43 | Ch-2, N? | N? | |
| HI-362 | MFA TL 19.183 | Corner of a Sarcophagus Lid | Herrmann 1990:fig. 25: dolomite. From Rome? | 3.65 | -3.31 | Th-CV,Pa-1,Pr,Sa | Th-CV | XRD: Dolomite |
| HI-363 | MFA 63.120 | Polyphemos | C&V 105: Parian marble. Thought to have come from Italy | 3.85 | -3.03 | Th-CV,Pa-1,Pr,E-1?,Sa | Th-CV | XRD: Dolomite |
| HI-364 | MFA 68.768 | A General of the Antonine Period | C&V 360: Very crystalline Greek marble, from the northern islands (?). | | | | Th-CV | XRD: Dolomite |
| HI-365 | MFA 1970.242 | Tyche-Fortuna | C&V 189: Greek island marble. Seemingly from Rome | 3.95 | -4.59 | Pe?,Th-CV,Sa,E-1 | Th-CV | XRD: Dolomite |
| HI-367 | MFA 1970.267b | Fragment of a Meleager Sarcophagus (?) | C&V 241: Island marble? From Rome | 3.12 | -3.92 | Pe,Th-CV,Pr | Th-CV | XRD: Dolomite |
| HI-368 | MFA 1971.93 | The Emperor Marcus Aurelius | C&V 365: Crystalline Greek marble, probably from the mainland? Acquired in Rome in 1908 | | | | Th-CV | EM: Dolomite |
| HI-711 | MFA 00.311 | Man of the Late Republic: Horace (?) | C&V 324: fine-grained Greek mainland (?) marble. From Italy; evidently acquired in Rome | 1.98 | -2.31 | C,Th,Pa-2,N-M,Hy,M, Dol-2,Pr,U,He,De-1?,My | C | fine-grained |
| HI-712 | MFA 01.8195 | Hanging Marsyas | C&V 170: fine-grained, Greek mainland (?) marble. Bought in Rome | 2.51 | -3.00 | C,D,Th,Pa-2,N-M,Hy,M,Dol-2, Pr,U,He,De-1,My,A2 | prob. C | fine-grained, dull white |
| HI-713 | MFA 01.8200 | Aphrodite | C&V 159: fine-grained marble. | 2.43 | -4.99 | Pe,D?,Th-CV,N,U,E-2, Ch-1 | Pe | fine-grained |
| HI-716 | MFA 01.8213 | Section of a Marble Vase | C&V 312: Italian (Luna) marble. Bought in Rome; from area of Rome or Naples | 2.63 | -5.09 | Pe,Th-CV,N,U,E-2?,Ch-1 | Pe | fine-grained |

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|-----------------|---------------|--|--|---------------------------|---------------------------|--|---------------------|--|
| HI-717 | MFA 01.8215 | Fragment of a Marble Vase: Dionysiac Symbols | C&V 313: Luna (Italian) marble. Bought in Rome; from area of Rome or Naples | 2.74 | -2.86 | C,Th/Th-CV?,N-M?,Hy,M, Dol-2,Pr,U,He,De-1,My,A2? | C | fine-grained white marble |
| HI-718 | MFA 03.745 | Diomedes | C&V 149: fine-grained marble. Said to have been acquired in Italy | 2.73 | -7.61 | Pe,N,Dol-1,Iz,Sa | Pe | fine-grained marble |
| HI-719 | MFA 03.751 | Mounted Amazon and Opponent in Combat | C&V 42: Pentelic marble. Found in the vicinity of Rome | 5.19 | -4.13 | Pa-1,E-1 | Pa-1 | medium- to coarse-grained |
| HI-720 | MFA 03.754 | Athlete in the Early Classical Style | C&V 134: Fine-grained Greek marble. Bought in Rome | 5.13 | -2.95 | Pa-1,E-1?? | Pa-1 | fine- to medium-grained white, grey shadow |
| HI-721 | MFA 03.755 | Zeus Ammon | C&V 141: fine-grained marble. Bought in Rome; said to come from Formiae | 2.24 | -1.82 | C,Th,Pa-2,Dol-2,M,Hy, S?,Pr,U,He,De-1,Ja,My | C | fine-grained marble |
| HI-723 | MFA 03.758 | Hermaphrodite and Satyr's Hand | C&V 194: fine-grained marble. Bought in Rome | 2.71 | -2.68 | C,Th-CV?,Dol-2,M,Hy, Pr,U,He,De-1,My | C | fine-grained marble |
| HI-724 | MFA 07.487 | A Goddess: Hera or Hygeia | C&V 184: Crystalline marble, probably from Greek islands. Said to have been found at Alexandria | 2.73 | -6.95 | Pe,N,Dol-1,Iz,Sa | Pe | fine-grained marble |
| HI-725 | MFA 10.80 | Woman from a Funerary Statue | C&V 108: Greek mainland (?) marble. Probably from Greece | 4.28 | -3.37 | Th-CV?,Pa-1,Pr,E-1,Sa | Pa-1 | medium-grained, greyish marble |
| HI-726 | MFA 16.62 | Demeter or Kore | C&V 135: fine-grained marble, possibly from Greek mainland. From Rome | 4.96 | -2.67 | Pa-1,E-1? | Pa-1 | fine- to medium-grained marble, glassy reflections |
| HI-728 | MFA 17.324 | Aphrodite or a Nymph | C&V 98: Greek marble, evidently Parian. | 5.01 | -3.83 | Pa-1,E-1 | Pa-1 | fine- to medium-grained, sparkling, grey shadows |
| HI-729 | MFA 19.318 | Fragment of Funerary Banquet Relief | C&V 81: Greek mainland marble, presumably from Athens | 2.27 | -2.67 | C,D?,Th,Pa-2,N-M,Dol-2,M,Hy, Pr,U,He,De-1,My,A2 | Pa-2? | fine- to medium-grained, greyish |
| HI-730a | MFA 1970.241 | Table Support: Dionysos with Panther | C&V 219: Greek island marble. From a collection in Scotland | 1.89 | -3.89 | C,D,Pe,Th,Pa-2,N-M,M,Pr,U,He E-2,My,A2 | Pa-2,E-2, A2,U,M,He | medium-grained marble |
| HI-733 | MFA 1971.394 | An Antonine Prince as the Infant Herakles | C&V 366: Greek mainland marble. Said to have been found in the region of Tivoli | 2.07 | -2.13 | C,Th,Pa-2,N-M,Dol-2,M,Hy,Pr, U,He,De-1,Ja,My | C | fine-grained, white marble |
| HI-734 | MFA 1972.15 | Cinerarium (Rectangular Chest and Lid) | C&V 239: Greek marble, from the islands or western Asia Minor. Presumably from Italy | 2.25 | -1.93 | C,Th,Pa-2,N-M,Dol-2,M,Hy,Pr, U,He,De-1,Ja,My | C | very fine-grained |
| HI-735 | MFA 1972.34 | Hellenistic Prince: Ptolemy III Euergetes | C&V 128: crystalline marble, probably from western Asia Minor. Said to have been found at Pergamon | 2.68 | -0.62 | C,Th,Dol-2,M,Pr,De-1 | prob. Pr | medium- to coarse grained crystalline marble, grey bands |
| HI-736 | MFA 1972.899 | Head of Demosthenes | C&V 122: fine-grained Italian (?) marble. | 2.20 | -2.15 | C,Th,Pa-2,N-M,Dol-2,M,Hy,Pr, U,He,De-1,Ja,My | C | fine-grained marble |

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|-----------------|---------------|--|---|---------------------------|---------------------------|---|-------------|--|
| HI-737 | MFA 1972.971 | Hermachos of Mytilene | C&V 125: fine-grained Greek, probably mainland, marble. | 2.57 | -5.94 | Pe,Th-CV,N,E-2 | Pe | fine-grained, white marble |
| HI-739 | MFA 1974.123 | Reduced Version of a Standing Discobolus | C&V 152: Greek mainland (Pentelic) marble, of somewhat coarse quality with crystals. From private collection in Germany | 2.79 | -6.88 | Pe,N,Dol-1,Iz,Sa | Pe | fine-grained marble |
| HI-740 | MFA 1974.522 | Hermes Wearing a Petasos (without wings) | C&V 157: Greek mainland marble ("Hymettan"?). | 2.39 | -4.61 | Pe,D??,Th-CV,N,U,A2?? | Pe | fine-grained marble |
| HI-741 | MFA 1975.359 | Sarcophagus with Trainers, Trained Lions, and Prey | C&V 244A: marble from northwest Asia Minor, possibly Proconnesian. Presumably from Italy | 3.01 | -6.79 | Pe,N,Dol-1,Iz,Sa | Pe | fine-grained marble |
| HI-742 | MFA 1978.227 | Fragment of Statue: Head of Domitian | V&C 45: mainland Greek marble. Originally from Rome | 3.40 3.21 | -1.69 -1.69 | C,Th-CV,Dol-2?,M,Pr,De-1,Ia | C | fine-grained, good quality marble |
| HI-1535 | MFA 1979.523 | Herm Bust of Dionysos | V&C 28: Italian marble, resembling limestone. Acquired in Italy after the Civil War | 3.21 | -1.61 | | | |
| HI-743 | MFA 1979.523 | Herm Bust of Dionysos | V&C 28: Italian marble, resembling limestone. Acquired in Italy after the Civil War | 2.17 | -1.90 | C,Th,Pa-2,Dol-2,M,Hy,S,Pr,U,De-1,Ia,My? | C | fine-grained, opaque marble |
| HI-745 | MFA 1979.556 | Statue: Vibia Sabina, Wife of Emperor Hadrian | V&C 48: Greek island marble. From collection in Bavaria | 1.69 | -3.45 | C,D,Pa-2,N-M,M,Hy?,Pr,U,He,E-2,My,A2 | Pa-2? | coarse-grained, greyish. Only Pa-2 likely in West Med. |
| HI-746 | MFA 1983.681 | Head of Young Man from Historical Relief | V&C 44: probably Attic (low-grade Pentelic) marble. From art markets in Basel and London | 1.08 | -4.34 | D,M,U,He,E-2,My,A1? | D | fine-grained, with zones of large quartz-like formations |
| HI-749 | MFA 1984.19 | Section of Graeco-Roman Architectural Relief | V&C 32: Pentelic or Hymettan marble of the type used for architectural sculpture. From a British/Sicilian family collection | 2.46 | -6.41 | Pe,Th??,N,Iz?,Sa | Pe | fine-grained, white marble |
| HI-750 | MFA 1986.885 | The Philosopher Metrodorus | C&V 124: fine-grained, grayish marble (from Asia Minor?). Brought from Rome in 17th century | 2.58 | -6.23 | Pe,Th?,N,Sa | Pe | fine-grained marble |
| HI-752 | MFA 1980.196 | Reduced Replica of Athena Parthenos | V&C 19: Attic marble, probably from Mount Hymettus. From private German collection | 2.76 | -8.63 | Pe,N,Iz,Sa | Pe | fine-grained, sparkling marble |
| HI-753 | MFA 22.593 | Boy | C&V 29: Greek marble, probably Pentelic. Bought in Rome | 5.01 | -2.90 | Pa-1,E-1? | Pa-1 | medium-grained marble |
| HI-754 | MFA 23.1 | Woman in the Archaic Style | C&V 214: fine-grained Italian marble. Said to have been acquired in Naples in 1858 | 2.54 | -1.37 | C,Th,Pa-2,Dol-2,M,Pr,U,De-1,Ia | C | fine-grained marble |
| HI-755 | MFA 30.543 | Aphrodite or a Roman Lady | C&V 182: Pentelic marble. From Tivoli | 2.17 | -1.88 | C,Th,Pa-2,Dol-2,M,Hy,Pr,U,De-1,Ia,My | C | fine-grained marble |

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|-----------------|---------------|--------------------------------------|--|---------------------------|---------------------------|--|-------------|---|
| HI-757 | MFA 34.113 | Roman Matron of the Hadriamic Period | C&V 355: Greek mainland (?) marble. Found in 1902 at Pozzuoli | 1.08 | -3.28 | D,Pa-2,M,Hy,U?,E-2,My,A1 | Pa-2? | coarse-grained marble, grey spots, Italian provenance |
| HI-758 | MFA 37.1152 | Disc with Dionysiac Relief | C&V 114: Pentelic marble (?). From Greece | 3.02 | -7.83 | Pe,N,Dol-1,Sa | Pe | fine-grained, white marble |
| HI-759 | MFA 51.1404 | Hero or Athlete | C&V 32: Greek island (?) marble. From the Simkhovitch collection | 2.10 | -2.18 | C,Th,Pa-2,N-M,Dol-2,M,Hy,Pr,U,He,De-1,Ja,My | | fine- to medium-grained |
| HI-761 | MFA 59.715 | Zeus Ammon | C&V 140: Greek mainland marble of relatively inferior quality. | 2.81 | -6.37 | Pe,N,Sa | Pe | fine-grained marble |
| HI-763 | MFA 67.1032 | Statesman or Philosopher | C&V 118: Greek mainland (?) marble. | 2.96 | -7.68 | Pe,N,Dol-1,Sa | Pe | fine-grained, white marble |
| HI-764 | MFA 69.1223 | Relief to the God Men | C&V 288: Marble from southwest Asia Minor. Found near Lake Burdur in SW Phrygia | 1.57 | -4.30 | D,N-M,M,U,He,E-2,My,A2 | D | fine-grained, white marble |
| HI-765 | MFA 76.716 | Reclining River God | C&V 211: low-grade Greek mainland marble. Presumably from Rome | 2.02 | -1.81 | C,Th,Pa-2,Dol-2,M,Hy,S,Pr,U,De-1,Ja | C | fine-grained marble |
| HI-767 | MFA 76.745 | A Satyr with Beard and Ammon's Horns | C&V 200: Luna marble. from Italy. Presumably from Rome | 2.05 | -2.22 | C,Th,Pa-2,N-M,Dol-2,Hy,M,Pr,U,De-1,He,Ja,My | C | fine-grained marble |
| HI-769 | MFA 81.1977 | Portrait of a Man | Meischner, J. <i>Jdl</i> 106(1991): 402, pl. 91.4; <i>Romans and Barbarians</i> 189. | 4.31 | -3.23 | Th-CV,Pa-1,Pr,E-1,Sa | Pa-1 | medium-grained marble, sculpture probably from Italy |
| HI-770 | MFA 84.65 | Magistrate or Man of Intellect | C&V 373: crystalline Greek marble, from the northern Aegean islands (not Thasos) or western Asia Minor. From Assos, found in the Agora | 2.73 | -6.86 | Pe,N,Dol-1,Iz,Sa | Pe | fine-grained, micaceous marble |
| HI-771 | MFA 88.352 | Sphinx | C&V 137: Greek mainland marble (?). From Rome or its surrounding regions | 2.60 | -7.22 | Pe,N,Dol-1,Iz,Sa | Pe | fine-grained, micaceous marble |
| HI-772 | MFA 92.2692 | Relief: Mithras Slaying the Bull | C&V 240: Italian marble. from Rome. Said to have been found near the Ponte Palatino | 2.15 | -2.17 | C,Th,Pa-2,N-M,Dol-2,Hy,M,Pr,U,He,De-1,Ja,My | C | very fine-grained marble |
| HI-773 | MFA 97.287 | Herakles | C&V 163: Greek marble with fairly evident grains, probably a piece of inferior Pentelic. | 2.88 | -7.46 | Pe,N,Dol-1,Iz,Sa | Pe | fine-grained marble |
| HI-775 | MFA 99.338 | Archaistic Artemis | C&V 215: Greek marble, from the mainland (?). From Italy | 5.16 | -3.18 | Pa-1 | Pa-1 | fine- to medium-grained, white |
| HI-776 | MFA 99.340 | Seated Cybele | C&V 92: Pentelic marble. Found at Amiternum near Aquila | 2.44 | -2.36 | C,Th,Pa-2,N-M,Dol-2,M,Hy,Pr,U,He,De-1,Ja,My,A2?? | C | fine-grained marble |

Conclusions

We have shown that classical Greek and Roman marble sculptures can be attributed to quarry sources with high confidence by means of informed visual inspection, X-ray diffractometry or elemental analysis, and light stable isotope ratio measurements. 90% of the 68 sculptures reported on here were attributed to a single quarry. The analytical procedures are essentially non-destructive and relatively inexpensive, given access to appropriate laboratory facilities.

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