Polychromy on the Amathus Sarcophagus, a "Rare Gem of Art"

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THE ELABORATELY SCULPTED and painted limestone sarcophagus on display in the new Cypriot galleries at The Metropolitan Museum of Art was brought to New York in 1872–73 by General Luigi Palma di Cesnola, who was to become the Museum's first director in 1879. Cesnola and his family had arrived in Cyprus on December 25, 1865, to serve as American consul.[1] The British and French consuls were already in place and, in fact, were already digging for antiquities.[2] Cesnola followed their lead, exploring the areas around Dali (ancient Idalion), Athienou (Golgoi), and later Amathus. He published the results of his efforts in 1877 (*Cyprus: Its Ancient Cities, Tombs, and Temples*), combining anecdotes of his adventures and descriptions of the local inhabitants with a brief history of the island and the report on his archaeological discoveries.

Amathus is situated on an acropolis on the southern coast of the island, northeast of modern Limassol (Figure 1). Near the sea, in a well-watered valley and close to forests as well as rich copper sources in the Troodos Mountains,[3] the site offered many advantages to the artisans and traders who settled there. According to Cesnola (whose opinion has more recently been expressed by others), the town was founded by Phoenicians, who also settled at nearby Paphos and Kition and whose traditions persisted in the region, especially at Amathus.[4] Cesnola was equally interested in the city's Homeric associations, reminding his readers that Agamemnon was said to have installed a colony of Greeks at Amathus on his return from Troy.[5]

Associated with the ancient settlement were three groups of tombs. One of them, with graves ranging in date from the period known as Cypro-Geometric II (ca. 950–850 B.C.) to the Greek Classical era (ca. 500–350 B.C.), was located in a field east of the north aqueduct, just outside the city wall (see Figure 1).[6] Within this group of about one hundred tombs was the one that contained the painted sarcophagus under discussion (Colorplate 1, Figures 3–6), recovered in fragments by Cesnola sometime in the early 1870s, possibly before his first reported campaign at Amathus in 1874–75.[7]

The one-, two-, and four-chambered tombs unearthed by Cesnola northeast of Amathus were built of fine ashlar masonry; he described the individual blocks as measuring on average 14 feet by 7½ feet by 2 feet.[8] He stated that the tombs were buried more than 40 feet deep in the earth;[9] however, subsequent visitors to the area noted that the remains lay just below the surface of the ground.[10] Although the great majority of tombs at Amathus were disturbed by the time Cesnola got there, nearly all still contained sarcophagi of local limestone or of marble.[11] The so-called Amathus sarcophagus at The Metropolitan Museum of Art is the most elaborate and arguably the most interesting example found by Cesnola on Cyprus. The four-chambered tomb where it was found—one of two in the group—was described by Cesnola as follows: "This tomb consisted of a square room used as an antechamber, and three lateral rooms, to the right and left, and opposite the entrance door. The sculptured sarcophagus was in the centre of the inner room, facing the entrance, and lay there in a heap broken to pieces by the vandals who centuries ago had opened this tomb, and being perhaps disappointed in not finding the treasure they sought, wreaked their vengeance on this rare gem of art."[12]

He continued: "In the chambers adjacent to that in which the great sarcophagus was found were two plain sarcophagi, one in white marble and the other in calcareous stone, both of which had been greatly damaged."[13] A picturesque tale of Crusader knights (the aforementioned "vandals") discovering the tomb—which provides a romantic pedigree for Cesnola's efforts—follows this passage, from which we gather that there were three sarcophagi, including one of imported marble, in the large, elaborate and carefully constructed tomb. There can be little doubt that the occupant was an important personage in the city of Amathus.

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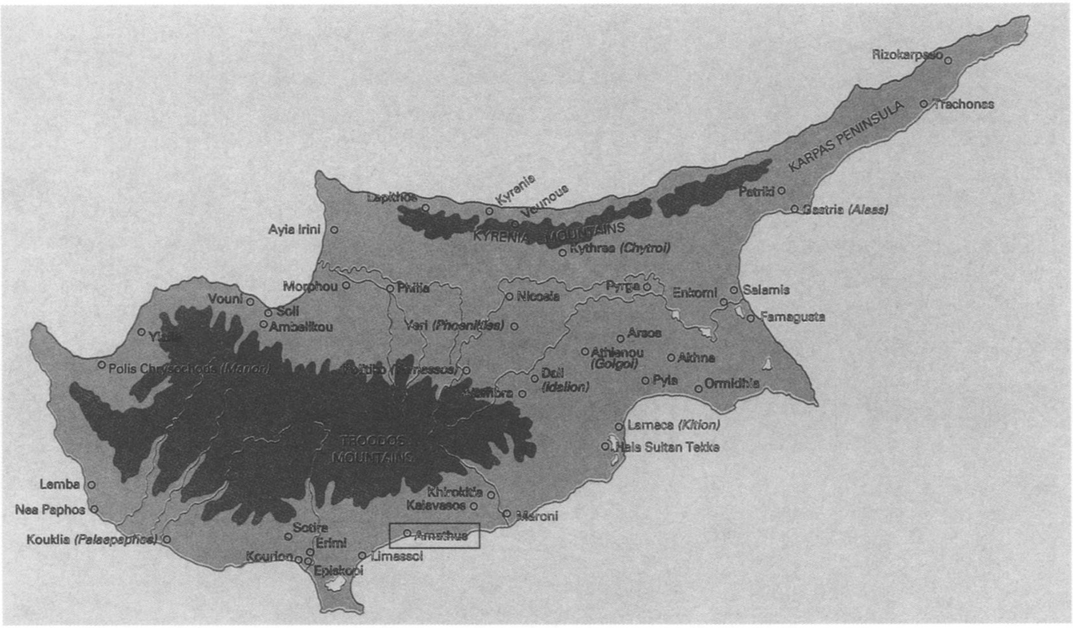

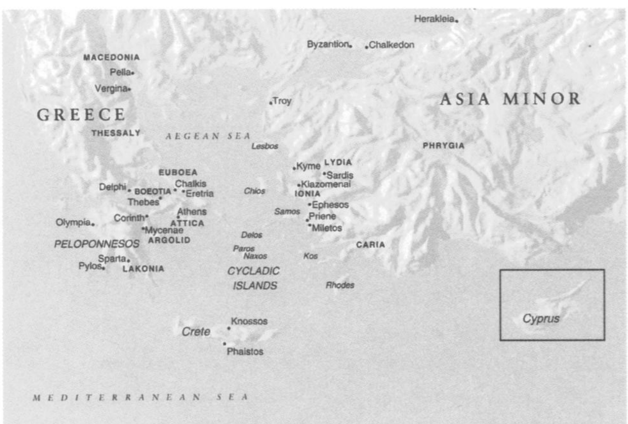

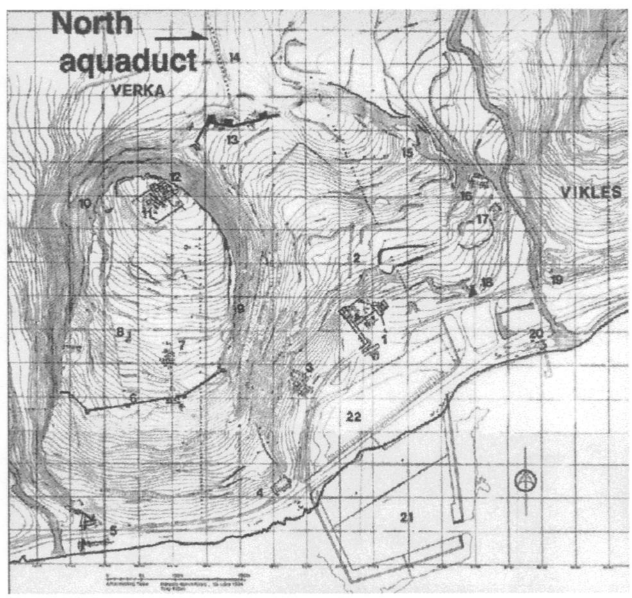

Figure 1. Maps of Cyprus, the eastern Mediterranean, and Amathus (map of Cyprus: after Veronica Tatton-Brown, *Ancient Cyprus*, 2nd ed. [London, 1997], p. 12, ©British Museum; map of the eastern Mediterranean: detail of *Ancient Art from Cyprus* [New York, 2000], p. xiv; map of Amathus: courtesy Pierre Aupert)

Although Cesnola did not mention it in his 1877 publication, all four sides and probably much of the lid of the sarcophagus were painted in red, green, black, and two shades of blue. Almost every centimeter of stone was highly colored, with the exception of the symbolic figures on the short ends of the sarcophagus, where only details were picked out in color. The background of each side was patterned in blue and red, and the bands of decoration above and below the figural scenes were also painted in contrasting shades (a reconstruction of the polychromy on the sarcophagus is illustrated in Colorplate 1, and the subject is discussed in detail below).

Date and Iconography

According to Cesnola, the approximate date of the sarcophagus is suggested by comparing it with a Lycian frieze from Building G at Xanthus, tentatively dated by Henri Metzger to the second quarter of the fifth century B.C., just after the destruction of the city in about 470 B.C.[14] In particular, Cesnola noted the similarity between the "topknots" on the horses' bridles in the two works.[15] John L. Myres first suggested a date for the sarcophagus, based on style, of about 550–500 B.C., but after comparing the sphinxes on the lid to examples from the Archaic period he eventually

Figure 2. Phoenician carved ivory plaque, found in Room SW7, Fort Shalmaneser, Nimrud, Iraq, 8th century B.C. Ivory, 25 x 5.9 x 1 cm. The Metropolitan Museum of Art, Rogers Fund, 1959 (59.107.8) (all photographs are by the author, unless otherwise noted)

arrived at a date in the early fifth century B.C.[16] Also basing her judgment more on style than on iconography, Veronica Tatton-Brown concluded in 1981 that the sarcophagus fits best in the second quarter of the fifth century B.C., somewhere between 460 and 450 B.C.[17] In 1996 Pierre Aupert brought the date back to the time favored by Myres, the first decades of the fifth century B.C.[18] Most recently curators in the Metropolitan Museum Carlos A. Picón and Joan R. Mertens have concurred with Vassos Karageorghis that the sarcophagus should be dated to about 475 B.C.[19]

The beginning of the fifth century B.C. was a time of momentous conflict between Greece and Persia, and Cyprus provided some of the fields on which the struggle between East and West was played out. Amathus, alone among Cypriot cities, remained loyal to the Persians when the island was invaded by Ionian Greeks.[20] In time, other cities, too, such as Kourion, turned the tide of battle on Cyprus against the Greeks and in favor of the Persians. All the while, Greek imports and influence seem to have continued to flow into the island, alongside those of the Phoenicians (major suppliers of luxury goods to the East), testifying to the mixed allegiances of communities throughout Cyprus since at least the sixth century B.C.[21]

The scenes and figural types presented on the Amathus sarcophagus would be consistent with the hand of a sculptor and/or the taste of a patron who was in some respects familiar with art of both the East and the West. As will be discussed below, the iconography and ornament have parallels in the Near East; however, the faces depicted on the sarcophagus are decidedly not Oriental—nor are they even Cypriot in appearance. Compare them with the visages of Assyrians on Ashurbanipal's relief sculpture from Nineveh,[22] for example, and the rest of the Cypriot-looking sculpture at Amathus.[23] Their very "Greek" aspect, reminiscent of the faces of late-sixth-century-B.C. statues from the Athenian Acropolis,[24] hints at types familiar to the sculptor, who may well have been following models from Greece in fashion a couple decades or so before the sarcophagus was carved.

The iconography and style of certain elements are much older, suggesting that some Phoenician traditions at Amathus were as deeply rooted as they were strong. Already in the fourteenth and thirteenth centuries B.C., ivory workers at Ugarit, on the Levantine coast opposite Cyprus, were producing figural scenes bordered by the same stylized-tree formation that was carved on the piers of the long sides of the Amathus sarcophagus more than seven hundred years later. This vegetal motif also persisted in Syrian and Phoenician ivories—for example, in a carving of two sphinxes from Arslan Tash of the second half of the ninth century B.C.,[25] and in an eighth-century plaque exported to Nimrud in Mesopotamia (Figure 2), where the products of Phoenician ivory carvers were highly prized.

The procession scenes on each long side of the sarcophagus are not unusual in their iconography (see Figures 3, 4). As Cesnola himself noted, such scenes appear on the frieze of horsemen and chariots recovered at Xanthus from a sepulchral monument.[26] Procession scenes frequently occur in nonsepulchral contexts on wall reliefs in Assyria and Persia. Those from the reign of Ashurbanipal (ca. 630 B.C.) in the palace of his predecessor Sennacherib, include representations of very similar horse tack, especially the

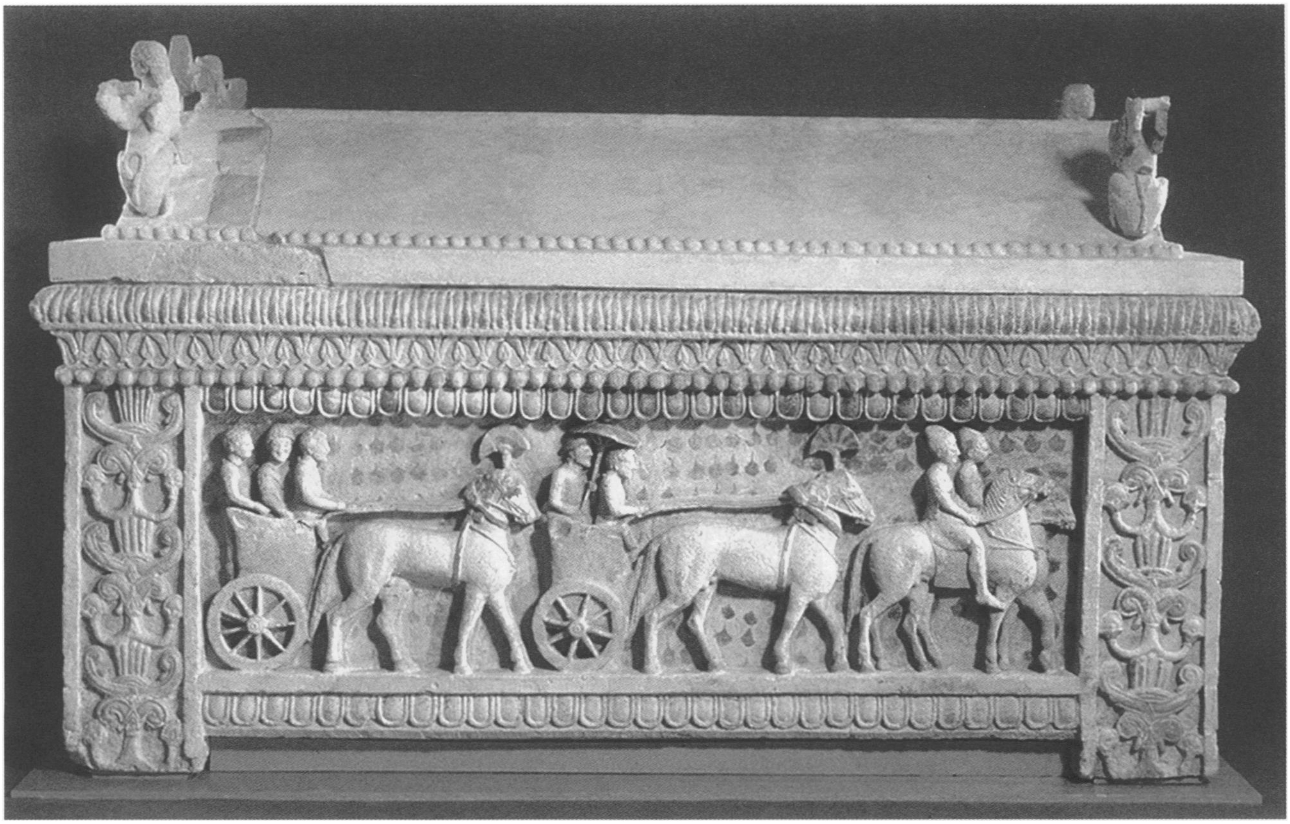

Figure 3. Side A of the Amathus sarcophagus, from Cyprus, ca. 475 B.C. Limestone, 147.3 x 228.8 x 109.5 cm overall sarcophagus. The Metropolitan Museum of Art, The Cesnola Collection, Purchased by subscription, 1874–76 (74.51.2453)

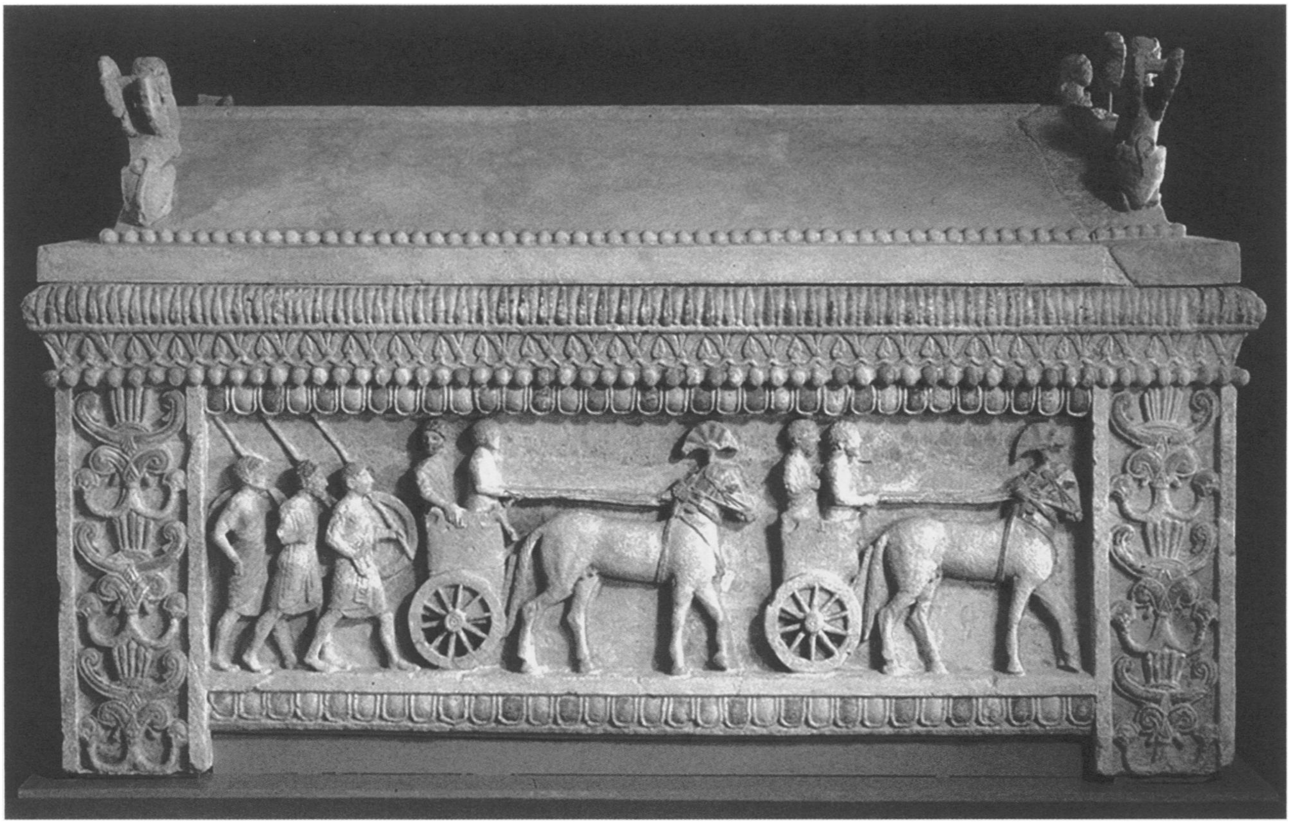

Figure 4. Side B of the Amathus sarcophagus

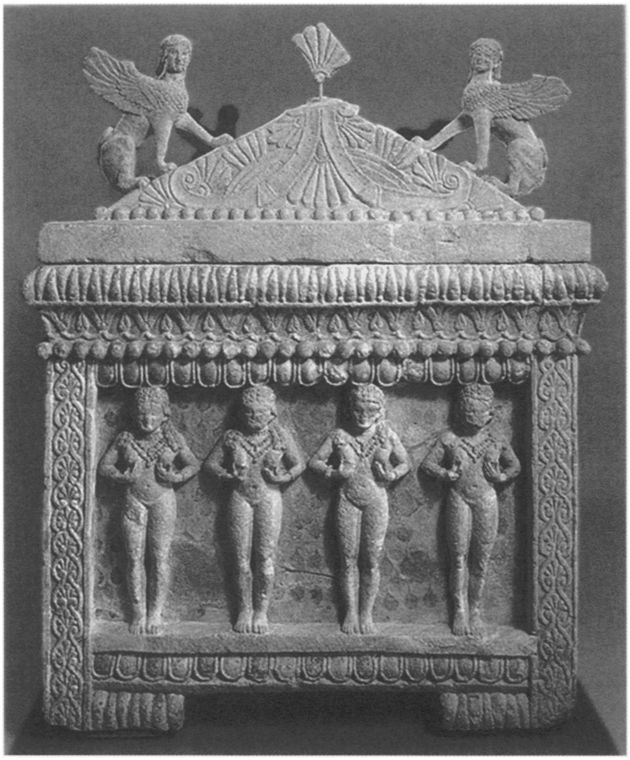

Figure 5. Side C of the Amathus sarcophagus

Figure 6. Side D of the Amathus sarcophagus

details of the harness. However, the liveliness of the figures on the Amathus sarcophagus—both their postures and their facial expressions—is unlike anything from the Near East (where a shallower type of relief carving was used to render both animated and more sedate scenes).[27] Cesnola suggested that the figures in the parasol group on Side A of our sarcophagus may represent a Persian satrap and his attendant, as does a similar group on the Nereid Monument, of about 400 B.C., also from Xanthus. [28] Amathus was, in fact, part of the Persian satrapy under Darius at the end of the sixth century B.C.; the motif may therefore acknowledge Persian traditions of wall-relief carving. But, as Cesnola observed, the processions on the Amathus sarcophagus "would seem to have been part of funeral obsequies," not parades of tribute bearers, such as those that decorated palace walls at Nineveh and Persepolis.

The naked women on one short side of the sarcophagus (Figure 5) have been identified as figures representing the Phoenician goddess Astarte,[29] although their posture and gesture have a long history in the Near East. In Cyprus, tradition holds that Astarte became Aphrodite, the preeminent deity of the island.[30] A cult center devoted to Astarte/Aphrodite was located at Amathus in the vicinity of Vikles (see Figure 1), possibly about 500 B.C. and, if so, was contemporary with the Amathus sarcophagus.[31]

Egyptian influence is apparent on the other short side of the sarcophagus, where four figures of the god Bes appear (Figure 6). A horned deity, sometimes in the form of an anthropomorphized bull but sometimes in the guise of the Near Eastern Humbaba or the Egyptian Bes, was second in importance only to Astarte/Aphrodite in Cyprus. The presence of both deities on the Amathus sarcophagus suggests an attempt to ward away evil on the one hand (ensuring the deceased a safe journey to the next world?)[32] and to conjure fecundity on the other. The representation of male figures on one side and female figures on the other emphasizes the idea of fertility.[33]

Restoration and Conservation History before 1999

In his *Handbook of the Cesnola Collection of Antiquities from Cyprus*, published by the Museum in 1914, John L. Myres stated that the Amathus sarcophagus was restored before it was shipped to New York,[34] and an analysis of the mortar lining of the interior supports this claim.[35] At that time the fragments of stone Cesnola had found scattered about the tomb chamber were reattached to each other and to the mortar lining with a plasterlike substance of varying hardness. The sarcophagus was cleaned and then completely coated

Figure 7. Detail of Side D of the Amathus sarcophagus showing old plaster restoration when it was being removed

with a yellow-tinted limestone wash, which obscured much of the original polychromy, though the coating may also have protected it from the damaging effects of light (see below, p. 53).[36]

When Cesnola's "rare gem of art" arrived at the Museum, it was placed on display in the main hall, and there it remained, probably undisturbed, for more than eighty years. Myres mentions that it was cleaned in 1909, but I have been unable to find any record of this in the Museum's files.[37]

In 1958 the lid was removed, and red lines tracing the borders of the major fragments of stone were observed on the mortar lining. It is not clear if the sarcophagus was examined or treated after 1958, but there are no records to indicate that it was. It was displayed in 1987 until the "Cypriot Corridor" was disassembled in August of 1997.

The 1999–2000 Conservation Campaign

In preparation for the reinstallation of Cypriot art in the Metropolitan Museum, the Amathus sarcophagus was scrutinized by conservators as well as curators. We determined that a thorough examination and treatment would improve our understanding of the piece and its appearance. The latest conservation campaign thus began in August of 1999. Six conservators worked on the sarcophagus for nearly a year, two of us continuously. Our goals were to ensure that the sarcophagus was structurally stable, to identify any modern materials used in previous restorations, and to reveal as much of the original surface as possible. We also decided that the treatment on all four sides should be simple and consistent in method and materials.

After consolidating some old repairs that had deteriorated and determining that the overall structure was sound, we turned to a consideration of the surface. The greatest amount of previous restoration was found to be the additions of plaster over broken or weathered stone surfaces, and the thin limewash toned with raw sienna (a golden color) that covered plaster restoration, original stone, and in some cases the original polychromy, grossly distorting the visual effect in those areas. Tests showed us that warm water brushed on the surface loosened the raw sienna and its limewash vehicle without disturbing original polychromy, and so this procedure was carried out over the entire surface to diminish the yellow effect. As we reduced the yellow limewash, we also mechanically removed areas of plaster restoration that had been applied as a skim coat over areas of original stone. Most often, the stone was sound underneath this coating, and in some cases the original pigments were intact as well; wherever it seemed feasible to do so, the original surface was exposed (see Figure 7).

Little by little, we were able to determine which elements of the relief were originally painted with which colors, but except for some of the raw sienna, all pigments were left on original stone surfaces. Had we attempted to remove the modern blue paint from the horses' hooves, for example (see below, pp. 49, 52), we would have risked removing some ancient pigments as well. In some areas raw sienna had been painted on top of the restored blue, suggesting the order of these two restoration efforts.

A hard gypsum crust had formed over some areas of the sarcophagus while it was still buried (see below, p. 53). We cleaned the disfiguring areas of this crust away, except where it covered cinnabar, a brilliant but capricious red pigment. In those areas, we removed only enough of the crust to determine which details were red. (The information thus obtained later enabled me to prepare the color reconstructions illustrated in Colorplate 1.) Most of the patches of exposed cinnabar were sealed with a dilute clear acrylic coating in an attempt to keep the red from darkening (discussed below, pp. 53–54). In addition, we covered some small areas of red with opaque Japanese tissue paper painted the color of the stone so that future conservators might compare them with the areas that were given clear coatings.

Reconstruction of the Polychromy

An important part of the most recent conservation program was to determine the color scheme and the pigments on the sarcophagus as accurately as possible. To this end, our team of conservators mapped the colors that were visible on each side, with the exception of the yellow limewash that coated everything. We then took microscopic samples from different areas of each side in order to identify the colors, both ancient and modern, that had been applied to individual sculptural elements on the sarcophagus; sixty-seven samples were taken in all. As a rule, except for the background of the figurative panels, each color follows the sculptural elements closely. Some fine details in black were also noted, such as the stripe on the parasol bearer's shirt. A map was created for each side with "flags" showing exactly where the samples had been taken. Another map, also for each side, was made to document precisely where pigments were still preserved. Pigments were sampled from both original surfaces and restored areas in order to determine whether modern materials differed from the ancient ones. The results also indicate that some colors were applied over original surface in modern times. Colorplate 1 shows, as far as can be determined, how the original polychromy looked on each side.

With the exception of Cesnola's *Cyprus,* most of the important earlier descriptions of the sarcophagus mention the polychromy, some with more accuracy than others. Describing the stone fragments in his *Handbook* of 1914, Myres wrote: "They were loaded originally with a hard limewash richly coloured with black, red, yellow, and blue. The last has mostly turned to green; but the green is so thick and loose that it may in part result from the decay of gilded copper-foil. Most of the colour which remains is ancient, except about the plastered fractures."[38] Myres correctly observed that black, red, and blue had originally been applied. He may have thought Cesnola's golden overall wash was at least partially ancient, and he was also mistaken about the reason behind the blue-to-green shift.

Tatton-Brown described the sarcophagus as originally painted with vivid colors; she mentioned in particular the "green" that could be observed on the lozenges ("scales") behind the figures, the beads of the Astartes' necklaces, the harnesses of the horses on the long sides, the chariots, and the parasol.[39] None of these details was originally meant to appear green, however; a color shift occurred over time that will be discussed below. Although Aupert characterizes the sarcophagus as richly decorated, he does not elaborate further on the polychromy.[40] Following are a description of the colors we found on the sarcophagus, an identification of the pigments used, and the conclusions we drew regarding the antiquity of the colors. The optical, elemental, and compositional analyses were carried out with polarizing light microscopy (PLM), X-ray fluorescence spectroscopy (XRF), Fourier-transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), and energy dispersive X-ray spectrometry (EDS). These techniques are briefly described in the Appendix.

Many of the decorative elements common to all four sides were painted the same color (see Table 1). Two different blues were used on the sarcophagus in antiquity: azurite, a strong medium-to-dark blue, and Egyptian blue, which is paler, and closer to a robin's egg in hue (see Colorplate 1). Azurite was chosen for most of the architectural elements; for example, in the ornamental frieze that runs around the top of the sarcophagus box every other cone in the upper band and every other ball in the lower is painted with azurite. Azurite was also used to decorate every other "egg" above and below the figurative panels on each of the four sides and as one of the two colors on the background scale pattern on each side. In addition, every other "plume," the central line of the arching motif, the curling elements, and the outer parts of the bud motif (but not the stems) on the piers that border the long sides were decorated in this color. The paler Egyptian blue was used to paint the vertical bands that frame the corner piers and the horizontal groundlines beneath the four figurative scenes.

A cooler, almost midnight blue was also found on the sarcophagus. This color, identified as Prussian blue, was first made in 1704 and in use by 1750, but it did not become common until the late eighteenth century.[41] We found that it had been consistently applied over the plaster restorations where blue was required by the design; it also served to enhance some of the original blue-painted areas, such as the horses' hooves (where azurite was also found) and some of the volutes on the piers. In addition, Prussian blue decorated some elements of the horse tack that had originally been painted red.

During the cleaning process it became apparent that red had been applied almost as generously as blue. The pigment was identified by PLM, XRD, XRF, and EDS as cinnabar, known to have been used in the

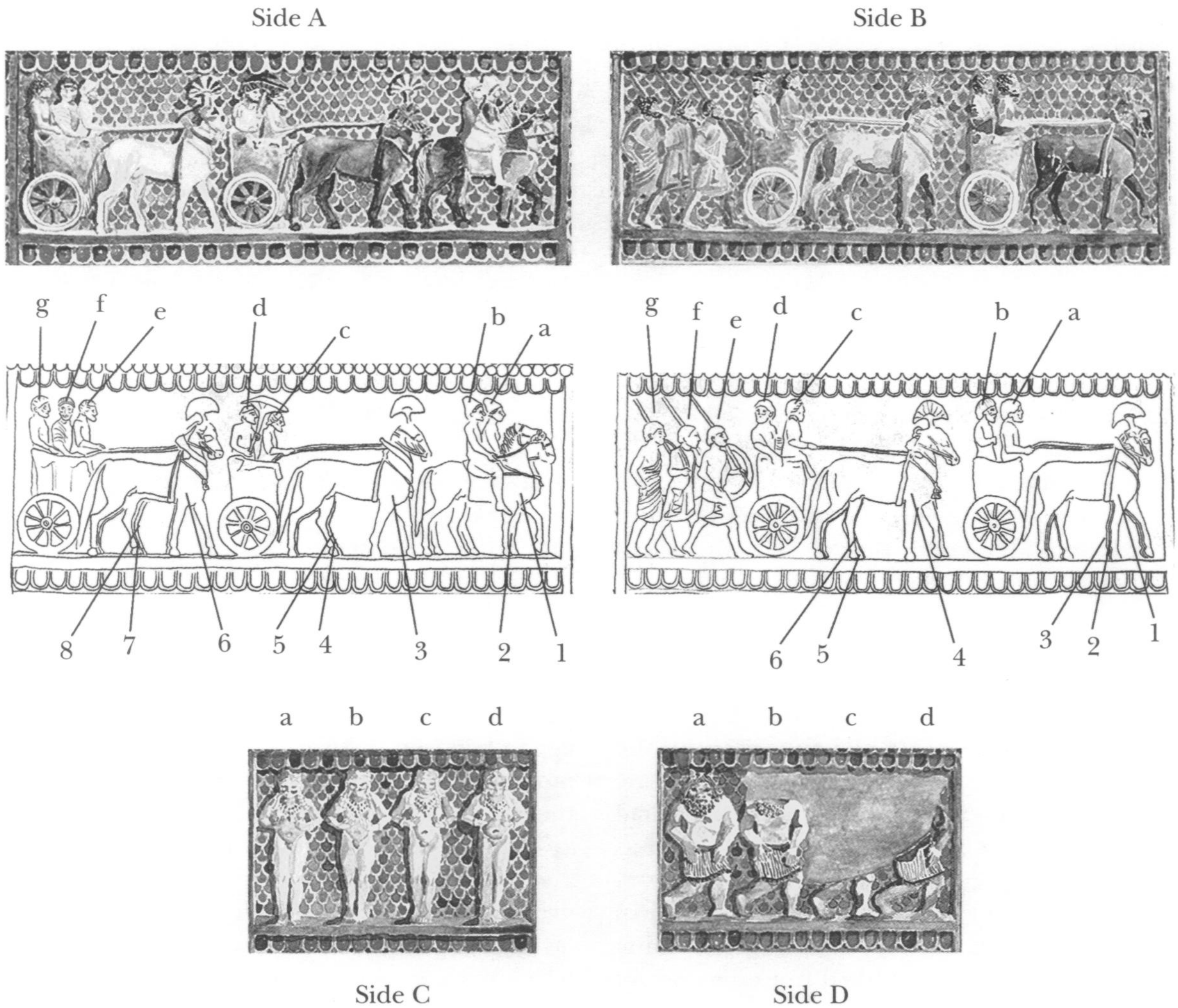

Figure 8. Detail of the figurative friezes on Sides A–D of the Amathus sarcophagus. The human figures are identified by lowercase letters and the horses by numbers (drawing: the author)

eastern Mediterranean since at least the Early Bronze Age.[42] The decorative motifs of the continuous frieze were colored with azurite, as we have seen, in alternation with cinnabar. In addition, the background of the lotus-blossom and lotus-bud band was painted with this vibrant red. Azurite and cinnabar were also alternated along the egg motif above and below the figurative panels on the long sides, and across the scale pattern on the background of all four sides. Relatively fewer details were picked out in red on the piers of the long sides: these include the alternating plumes, the arches, the bud centers, and the teardrop-shaped "tendrils" suspended from the curly vegetal forms. On the short sides, red was used as the background color on the vertical piers. Like the Prussian blue, a modern vermilion paint had been used to continue areas of the design covered by the plaster restoration. Because of the chemical similarity between cinnabar and vermilion (both are mercuric sulfides), it was difficult to determine whether vermilion had been applied over original stone in conjunction with the ancient cinnabar.[43]

A true green appears in the lotus band that encircles the sarcophagus (see Colorplate 1). The optical properties of the pigment are consistent with terre verte, "high-quality deposits" of which are still being exploited on Cyprus.[44] On the long sides, vestigial traces were found only on the vine at the base of the flowers, but on the short side with the Bes figures green was also located in the center of the blossoms and the buds. We are working under the assumption that green was used all the way around the sarcopha-

Table 1. Colors Used on Elements of the Amathus Sarcophagus
(for the colors, see Colorplate 1; for identification of the figures in the friezes, see Figure 8)

Elements on the sarcophagus	Blue	Red	Green	Black
Common to two or more sides				
alternating cone shapes at top of sarcophagus box	azurite	cinnabar		
alternating balls at bottom of frieze	azurite	cinnabar		
alternating egg shapes in horizontal bands above and below figurative panels	azurite	cinnabar		
alternating scales in backgrounds of figurative panels	azurite	cinnabar		
alternating plumes in piers flanking long sides	azurite	cinnabar		
alternating arches above "stretched" volutes in piers flanking long sides	azurite	cinnabar		
"stretched" and compact volutes, and buds in piers flanking long sides	azurite			
vertical borders of piers	Egyptian blue			
horizontal groundline in figurative panels	Egyptian blue			
background and vegetal ornaments on piers of short sides	Egyptian blue (vegetal motifs)	cinnabar (background)		
centers of buds and tendrils depending from "stretched" volutes in piers flanking long sides		cinnabar		
background of lotus-blossom and bud band in surrounding frieze		cinnabar		
center of and below lotus-blossom and bud motif			terre verte	
Side A				
incisions in horses' tails	azurite			
incisions in manes of horses A2, A6	azurite			
girth, yoke, and bridle side straps of horse A6	azurite			
girth of horse A3	azurite			
breast strap and most of bridle of horse A1	azurite			
hooves of horses A1, A3	azurite			
top of parasol	azurite			
stripes in horses' crests	Egyptian blue			
short-sleeved shirt of rider Ab and undergarment of rider Aa	Egyptian blue			
chariots	Egyptian blue			
hooves of horse A2		cinnabar		
tunic of rider Aa		cinnabar		
saddlecloth of horse A1		cinnabar		
yoke of horse A3	Prussian blue (modern overpaint)	cinnabar (below overpaint)		
spokes of parasol		cinnabar		
yoke pad of horse A6		cinnabar		
spaces between chariot-wheel spokes		cinnabar		
chariot cars	Egyptian blue (main part)	cinnabar (behind horses' tails)		
hair and beards of figures Ac, Ad, Af, Ag				charcoal
horses A1, A3				charcoal
thin lines around chariot wheels				charcoal
thin, seamlike lines in parasol bearer's shirt (figure Ad)				charcoal
Side B				
girth, tassels, bridle, blinker, and hooves of horse B4	azurite	cinnabar (edges of girth)		
stripes in horses' crests	Egyptian blue			
chariot cars	Egyptian blue (main part)	cinnabar (behind tail)		
tunic of shield-bearing soldier Be	Egyptian blue			
vertical element above yoke pad of horse B4		cinnabar		
spaces between chariot-wheel spokes		cinnabar		
shield interiors		cinnabar		
incisions in tail of horse B4		cinnabar		
horse B1				charcoal
hair and beards of all men				charcoal
Side C (Astarte figures)				
alternating beads of necklaces	azurite			
hair				charcoal
Side D (Bes figures)				
alternating fringe of Da's skirt	azurite	cinnabar		
interior of Da's ears		cinnabar		
hair and/or beard of Da, Db				charcoal
circles around irises of Da's eyes				charcoal
Lid				
alternating balls around base of gabled roof	azurite	cinnabar		
alternating vegetal motifs on preserved sculpted end above Side C	azurite	cinnabar		
alternating feathers of sphinxes, front and back	Egyptian blue	cinnabar		
circles around irises of sphinxes' eyes				charcoal

gus both in the heart of the flowers and on the band that links the vine with the flowers. It seems safe to do this because as a general rule details in the figurative elements were colored with some consistency from side to side.

Carbon black (charcoal) seems not to have been used on the areas of the sarcophagus decorated with architectural and vegetal motifs. Black does appear, however, in the four figurative panels, whose polychromy will be described fully below for each side. These descriptions will mention only what our analyses suggest were the original colors, not modern pigments.

Side A, one of the long sides, depicts a procession of two chariots led by two equestrian figures (see Figures 3, 8; Table 1). By counting the legs, one can determine that three horses were meant to be depicted as drawing each chariot, with another for each rider, totaling eight on this side. The incised lines in the tails of all the horses and the manes of horses A2 and A6 were painted azurite blue, as were the girth, yoke, and side straps of the bridle of horse A6, the girth of horse A3, and the breast strap and most of the bridle of horse A1. Azurite was used for the top of the parasol and for the hooves of horses A1 and A3.

Egyptian blue was identified on the short-sleeved shirt of the equestrian figure Ab, and on the undergarment of Aa. The chariots were painted Egyptian blue, as were the stripes on the horses' crests.

The hooves of horse A2 were red, as were the tunic of the equestrian figure Aa, the saddlecloth of horse A1, the yoke of horse A3, the spokes of the parasol, the yoke pad of horse A6, the spaces in between the spokes of the chariot wheels, and those parts of the chariot cars directly in back of the team. All samples of this color could be identified as cinnabar.

Black pigment (charcoal) was found in the hair and beards of figures Ac, Ad, Af, and Ag. Traces were also found on horses A1 and A3, suggesting that the coats of these animals were originally black. Thin lines of black filled the light incisions encircling the chariot wheels, and also described seams on the shirt of the parasol bearer.

The other long side of the sarcophagus, Side B, shows a similar procession, with two chariots preceding a group of foot soldiers bearing shields (see Figures 4, 8; Table 1). There are six horses on this side: two teams of three, each team drawing a chariot. Azurite blue decorated the girth, tassels, bridle, blinker, and hooves of horse B4. As on Side A, Egyptian blue was used to delineate the chariot cars and the stripes on the crests fanning above the horses' bridles. The tunic of the leading shield bearer, Be, was once also Egyptian blue.

Red (cinnabar) was painted on the front of the chariot directly behind the first team of horses, the edges of the blue girth of horse B4, the vertical element on top of the yoke pad of horse B4, and the spaces in between the spokes of the chariot wheels. The shield interiors, too, are red—as are those depicted in reliefs at the Siphnian Treasury at Delphi and at Building G at Xanthus.[45] Red was also used, interestingly enough, in the incisions defining the strands of the tail of B4 (perhaps indicating that this horse was chestnut-colored).

Charcoal black was identified on the hair and beards of all the figures on this side, as well as on most of horse B1.

The Astarte figures of Side C seem to have had relatively few painted details; there may have been a conscious choice to leave the stone as naked as the subject (see Figures 5, 8; Table 1). Azurite was used to color every other bead of the necklaces on each figure, and although no traces of cinnabar have been found, it would be consistent with the rest of the color scheme if red beads had alternated with the blue ones. Traces of black remain on the hair of the Astarte figures, but no color, if there ever was any, is left on the bracelets.

Nor does much color remain on the figures of the god Bes depicted on Side D (see Figures 6, 8; Table 1). Cinnabar red was found on every other string of Da's skirt, and in his ears. Carbon black (charcoal) was identified on the hair and beard of figure Da and the beard of figure Db (the upper part of the head is not preserved) and was used to describe the fine circles outlining the irises of Da's eyes.

Finally, we must also imagine the lid with its corner sphinxes brightly painted (see Figures 3–6; Table 1). The balls running in a band around the foot of the lid were done in azurite and cinnabar; but unlike those at the base of the frieze on the sarcophagus proper, the ones at either end of Side C are not both blue, but blue on the left and red on the right. This anomaly cannot be ascribed to erroneous restoration, since the lid is well preserved on this side. The face of the gable was in all likelihood painted over the entire decorated surface. Only a few of the elements preserve any pigment, but where there is color, azurite alternates with cinnabar on the vegetal motifs. The sphinxes were also painted. The creatures' wing feathers were colored front and back with alternating cinnabar and Egyptian blue, and the irises of their eyes were defined by thin black circles, as on the Bes figures. Since nothing original remains from the long sides of the lid, or from Side D save the damaged sphinxes (which preserve enough traces to show that they were painted in a way similar to the better-preserved examples), it is not possible to know how these sides may have been colored.

Discussion of the Color Shifts in Azurite and Cinnabar

Among the many questions raised during our examination of the sarcophagus were why the pigment identified as azurite often appears green and why the pigment identified as cinnabar sometimes appears black. In the case of azurite, the greenish hue associated with much of this blue can be explained by the presence of malachite, a pigment that has been used since antiquity in its own right. Under the microscope, at 400x magnification, the most predominant characteristic of the green particles after the hue is the fibrous or broken structure typical of malachite,[46] whereas the azurite particles are blue with a clean concoidal fracture. Were these two colors deliberately mixed together in varying proportions on the sarcophagus to create a graded color effect? We noticed that the greenest blue-green was often found in deeply cut areas of the stone while the bluest shade tended to predominate on the high relief. This suggested that the artist might have been trying to achieve a special effect with the color application. However, blue-green could sometimes be found in a random distribution, such as on some parts of the vegetal motifs on the piers of the long sides. Furthermore, true azurite blue was occasionally preserved over an entire surface, whether flat or three-dimensional, and so we finally concluded that the two-color effect was accidental, the result of weathering or other natural conditions rather than of human agency.

The explanation for this color shift on the sarcophagus seems to lie in the chemical similarity between azurite and malachite. Water collected in the crevices of broken chunks of the sarcophagus or mere dampness in the tomb could have hydrated the copper carbonate of the azurite, transforming it directly into malachite. Gettens and Fitzhugh, who have published studies on both pigments, indicate that such shifts are common in old paintings kept in damp conditions: "There is hardly a medieval Italian church where azurite in mural paintings does not show evidence of being transformed to malachite."[47]

Earlier, I described the ancient red pigment on the sarcophagus as capricious. Chemical and compositional analyses by powder XRD, XRF, and EDS have identified the red as mercuric sulfide, or cinnabar/vermilion, and PLM has confirmed the optical properties of cinnabar. However, XRD and XRF analyses have also identified as cinnabar a black pigment that occurs on some of the patterns that appear red elsewhere on the sarcophagus, such as the scales that alternate with blue in the figurative panels.

More surprisingly, we noticed that the red we were revealing underneath the thick modern limewash coating became gradually darker if it was left unconsolidated after cleaning. Why was the color turning now, after existing for thousands of years as a brilliant cherry red? The answer to this question, we think, is that for the first time in the long life of the sarcophagus, its surfaces were being exposed to light without protection. The sarcophagus was probably shut up in the dark tomb chamber soon after it was sculpted and painted. Whoever smashed it to pieces, perhaps in medieval times, apparently did so without removing the roof of the tomb, so the painted surfaces were exposed to daylight only in the nineteenth century, when Cesnola removed the fragments from their original context. Within a relatively short time, evidently before the sarcophagus left the island, Cesnola had it skim-coated with the yellow-toned limewash that has frequently been mentioned above. This covered stone, polychromy, and plaster restoration about equally. In addition, the hard gypsum deposit that we found on some areas of the surface must have kept the underlying paint from direct contact with daylight. This crust could have formed before the sarcophagus was broken, if water was able to seep through the calcareous walls of the tomb chamber and drip onto the lid or stone fragments. It may also have formed later, if the pieces were in direct contact with moisture, causing the calcium from the limestone to leach out of the fragments, combine with sulfur in the atmosphere, and form calcium sulfate (gypsum) on some surfaces.

This brief digression provides the background for our attempt to explain the shift that has occurred in the cinnabar. The darkened form of this red pigment, referred to as metacinnabarite or metacinnabar, was described as early as the first century B.C. by the Roman architect Vitruvius:

> Though it keeps its colour perfectly when applied in the polished stucco finish of closed apartments, yet in open apartments, such as peristyles or exedrae or other places of the sort, where the bright rays of the sun and moon can penetrate, it is spoiled by contact with them, loses the strength of its colour, and turns black. Among many others, the secretary Faberius, who wished to have his house on the Avetine finished in elegant style, applied vermilion to all the walls of the peristyle; but after thirty days they turned to an ugly and mottled colour. He therefore made a contract to have other colours applied instead of vermilion.
>
> But anybody who is more particular, and who wants a polished finish of vermilion that will keep its proper colour, should, after the wall has been polished and is dry, apply with a brush Pontic wax melted over a fire

> and mixed with a little oil; then after this he should bring the wax to a sweat by warming it and the wall at close quarters with charcoal enclosed in an iron vessel; and finally he should smooth it all off by rubbing it down with a wax candle and clean linen cloths, just as naked marble statues are treated.
>
> This process is termed *ganosis* in Greek. The protecting coat of Pontic wax prevents the light of the moon and the rays of the sun from licking up and drawing the colour out of such polished finishing.[48]

We may gather from this text that the presence of a barrier layer can in some cases prevent the darkening of cinnabar and also that heat apparently does not affect the color adversely.

Descriptions in Dana's *System of Mineralogy* (compiled between 1837 and 1892) indicate that small amounts of zinc and selenium may substitute for mercury and sulfur, respectively, in naturally occurring samples of metacinnabar.[49] Since EDS analysis of samples taken from the sarcophagus did not identify either zinc or selenium,[50] substitution by these elements in the original ore is not the reason we have metacinnabar here. The pigment was applied in its red form and was meant to be red, never black (important when considering the red hooves and tail incisions).

Besides mercury and sulfur, we identified traces of iron in a sample taken from a restored section of the decoration, which may indicate that an iron oxide was used to extend the red pigment. No iron was found in the samples taken from areas that we judged were ancient (either because they were under a gypsum crust or because they were part of the original pattern overlaying intact stone). On the other hand, traces of silver, in one case significant, were found in the three ancient samples analyzed by EDS but not in the restoration sample. As silver sulfides and mercury sulfides can occur together, the explanation for this discovery may lie in the composition of the ore from which our cinnabar came.

The darkened form of cinnabar has the same chemical elements as the red variety, but a different crystal structure. Because the change from one form to the other takes place on the surface of a sample, XRD, which analyzes the bulk of the material, is not able to detect metacinnabar on samples that have not thoroughly converted.[51] Feller, in his "Studies on the Darkening of Vermilion by Light" (1967), measured the rate of darkening with an instrument designed to detect changes in the wavelength absorbed by the pigment, rather than reflected by it.[52] When absorption was measured against time in a carbon-arc Fade-Ometer, the resulting straight line showed that the rate of formation of metacinnabar is directly related to time of exposure to light. Changes in the rate of darkening could be manipulated, however, by changing the medium in which the cinnabar was suspended, a relationship that Vitruvius had already noted. The early studies of Alexander Eibner, which had inspired Feller to look into this phenomenon, were confirmed by Feller's own work, which showed that cinnabar darkened more quickly in oil than in watercolor (presumably gum arabic was the binder) or acrylic emulsion. One implication is that the absence of medium of any sort leaves the pigment most vulnerable of all to darkening in the presence of light. The procedures we devised for treating areas of red paint on the sarcophagus (see above, pp. 49–52) are based on Feller's conclusions.

The kinetics of this color shift are not well understood; however, a recent study of the effects of light-aging on samples of cinnabar and two forms of synthetic vermilion has been undertaken at the Courtauld Institute in London by Rachel Grout and Aviva Burnstock.[53] Their study confirmed the conclusions of Eibner and Feller but also suggested that impurities in the pigment may affect darkening by altering the way light energy is absorbed in localized points.

The recent course of treatment in the Sherman Fairchild Center for Objects Conservation has restored to the carving on the Amathus sarcophagus something of its original character, now that the coating of plaster and limewash has in some areas been removed and in others diminished. In addition, the long and careful examination of the polychromy has made it possible to create a watercolor reconstruction of each side, reproductions of which hang on the wall opposite the sarcophagus in the Museum's new permanent installation of Cypriot art. With these nearby, the viewer can appreciate how astonishingly rich was the full effect and with careful inspection can find more than a little of the evidence for the reconstruction still visible on the stone.

APPENDIX: ANALYTICAL METHODS USED ON THE AMATHUS SARCOPHAGUS DURING THE 1999–2000 CONSERVATION CAMPAIGN AT THE METROPOLITAN MUSEUM

Polarizing Light Microscopy (PLM)

With its high magnification capability (100x–400x), the polarizing light microscope has made it possible to identify the morphological and optical properties of a pigment and thereby gain valuable information about the manufacture and even the origin of a given sample. When an unidentified pigment is examined by PLM, the following properties are observed: (1) the sample's color/transparency in plane polarized light; (2) its color/transparency when polars are crossed; (3) its extinction characteristics under crossed polars; (4) its shape; (5) the sizes of its particles (average, plus smallest and largest); (6) its aspect ratio (long axis relative to short axis); and (7) its refractive index relative to the mount medium. PLM can also help determine whether or not the sample is still associated with particles that suggest its geological source.[54]

Under low magnification (8x–20x), samples are prepared by removing a few particles with a scalpel and placing them between two glass microscope slides. The slides are pressed together, crushing the particles. The particles are then scraped onto one of the slides and sealed with a cover slip to which a droplet of a mounting medium of known refractive index has been applied (the mounting medium fixes the particles between the glass slide and the cover slip). The mounted sample is then ready for examination under the higher-powered polarizing light microscope. The instrument utilized for the Amathus sarcophagus pigment analyses at the Sherman Fairchild Center for Objects Conservation was a Zeiss Axioplan 2; the mounting medium was Aroclor, with a refractive index of 1.66.

X-Ray Fluorescence Spectroscopy (XRF)

XRF is used to identify the elements that make up a sample of inorganic material, such as mineral pigments, metals, or salts. A beam of X rays is fired at the sample, causing atoms at the surface to emit fluorescent X rays (also called secondary-emission X rays). The particular wavelengths of the fluorescent X rays correspond to specific elements. A detector converts these X rays into electric pulses, which can be analyzed by software in the instrument's computer. The X-ray spectrometer at the Sherman Fairchild Center is set up in a lead-lined room, where even very large objects can be analyzed without removing a sample; a video camera reveals a tiny area that contains the target location.

A database in the instrument's computer contains known emission lines of the chemical elements, from the heaviest down to potassium (atomic number 19), the present limit of the detector; elements lighter than potassium, such as sulfur, will not be detected. As sulfur is one of the elements constituting the red pigment cinnabar (or vermilion), it is important to remember when interpreting the results of XRF analysis that the absence of sulfur in the analysis does not preclude the presence of cinnabar in the sample. Since no other red pigments contain the element mercury (atomic number 80), its detection is sufficient for an identification of cinnabar or vermilion. Hematite, an iron oxide, and red ocher, composed of silicates and iron oxides, will yield very similar results by XRF analysis; red lead, however, will produce clear peaks corresponding to the lead component.

Blue pigments cannot always be identified by this technique with certainty. The silicon and aluminum that occur as impurities in most samples of azurite will not be detected by XRF analysis, although the major element, copper, will be.[55] Egyptian blue, which is a mixture of calcium-copper silicates,[56] might be confused with azurite on a calcitic substrate if analyzed by XRF alone, as would the modern pigment phthalocyanine blue, which also contains copper. Lapis lazuli, a silicate containing sodium (atomic number 11) and/or potassium, and rich in sulfur, will be essentially invisible to XRF. The presence of cobalt blue, on the other hand, will be detected (as the element cobalt), and modern pigments such as Prussian blue, which contains iron, can also be spotted in XRF analysis.

The detection limits in XRF need to be considered when interpreting the results of analysis. The absence of certain elements may be a function of the instrument capabilities, or it may reflect the composition of the sample. Other questions must therefore be raised when a sample is analyzed—primarily, which elements are likely to be present, and which are not?

Energy Dispersive X-Ray Spectrometry (EDS)

As in XRF analysis, a beam of X rays is aimed at a sample and the specific photons thus emitted are collected and analyzed. When electrons of a certain energy strike electrons in the inner shells, or orbitals, of atoms in a specific element of the sample, the inner shell electrons will be displaced. Electrons from the next orbital will drop down to fill the vacancies. Since they are dropping to a lower energy level, they give off excess energy in the form of X rays, emitted at specific energies corresponding to the difference in energy between the shells; these energies are characteristic for each element. Thus, measurements of the energies of the X rays enable the identification of the element(s) from which they derive. A semiconductor detector captures the energy emitted by each X ray, then converts the energy to a voltage pulse and finally to a digital signal that is saved and plotted in a computer. The source for the impinging electron in the Sherman Fairchild Center is a scanning electron microscope outfitted with a Kevex Model Delta IV EDS instrument operated by Mark T. Wypyski.

Fourier-Transform Infrared Spectroscopy (FTIR)

The component atoms of a molecule exist in states of vibrational motion with respect to each other. These modes of vibration are distinguished according to their spatial geometry and frequency, which are determined by the relative masses of the atoms and their arrangement in the molecular structure. Infrared spectroscopy is based on the principle that molecular vibrations can absorb energy from incident electromagnetic radiation having the same frequencies as the vibrational modes in the molecule; many of the vibrational modes occurring in materials comprising works of art have frequencies that occur in the infrared region of the electromagnetic spectrum, and so it is this region that is found to be specifically diagnostic.

In general, when infrared radiation is passed through an unknown sample, selective absorption by the many different molecular groups produces a spectrum of bands that can either be identified individually as to the specific molecular components that they represent or compared as an assemblage to spectra of known compounds in an effort to find an acceptable match.

FTIR permits all frequencies of absorption to be measured simultaneously—thus, much more quickly and efficiently than a so-called dispersive instrument, which measures frequencies in sequence. The FTIR instrument operated at the Museum by Dora Henel, a volunteer research scientist in the Sherman Fairchild Center, is a BIO-RAD FTS-40 spectrometer. The samples were mounted in a Spectra-Tech diamond cell and placed in a BIO-RAD UMA 500 infrared microscope. The spectra were collected at four wavenumber resolution, with a total of fifty scans each.

X-Ray Diffraction (XRD)

Most ancient pigments are minerals, naturally occurring crystalline materials composed of atoms arranged periodically in three dimensions. Such arrangements define sets of parallel lattice planes that have the property of being able to diffract X rays at specific angles according to the wavelength of the impinging radiation and the spacing of the lattice planes in the sample. A crystalline material such as a mineral pigment is characterized by the spacings between its lattice planes; the pattern formed by the impinging X rays, as recorded on film or with an instrument detector, can be used to determine these spacings and thereby identify the mineral itself. This method is particularly useful when combined with XRF or other analytical means that can identify the elemental composition of an unknown sample. Ground pigment samples and film were loaded into a Philips Debye-Scherrer powder camera, mounted on a Philips PW 1840 X-ray diffractometer, and exposed for three hours at 35 KV, 20 ma. The results were interpreted using Micro Powder Diffraction Search/Match software (PSI International) on a Gateway 2000 GP5-200 Personal Computer.

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NOTES

1. Luigi Palma di Cesnola, *Cyprus: Its Ancient Cities, Tombs, and Temples,* 1877, reprint ed. with foreword by Stuart Swiny (Limassol, 1991), p. 41. Once established, he took on additional consulships—for Russia, Greece, and an unspecified country—in order to supplement his income (p. 2).
2. John L. Myres, *Handbook of the Cesnola Collection of Antiquities from Cyprus* (New York, 1914), pp. xiii–xiv.
3. Pierre-Yves Péchoux, "La situation géographique," in Pierre Aupert, *Guide d'Amathonte,* École française d'Athènes, Sites et monuments 15 (Paris, 1996), p. 9.
4. Cesnola, *Cyprus,* pp. 249, 251; Aupert, *Guide d'Amathonte,* pp. 24, 39.
5. Cesnola, *Cyprus,* p. 5; see also Aupert, *Guide d'Amathonte,* p. 19, n. 6.
6. On the disposition of tombs, and dates of the Cypro-Geometric and Classical periods, see Aupert, *Guide d'Amathonte,* pp. 23, 41–43, 46, 151.
7. Ibid., pp. 14, 46, 151. See also Elizabeth McFadden, *The Glitter and the Gold: A Spirited Account of The Metropolitan Museum of Art's First Director, the Audacious and High-Handed Luigi Palma di Cesnola* (New York, 1971), pp. 143ff.
8. Cesnola, *Cyprus,* p. 256.
9. Ibid., p. 255.
10. Myres, *Handbook,* p. 228.
11. Since there is no marble on Cyprus, the sarcophagi of this material must have been carved locally from imported stone or manufactured elsewhere and brought to the island. See Joan B. Connelly, *Votive Sculpture of Hellenistic Cyprus* (Nicosia, 1988), p. 3.
12. Cesnola, *Cyprus,* p. 259, and see pp. 256, 260, for plans and elevations.
13. Ibid., p. 269. The king of Cyprus joined the Fifth Crusade of A.D. 1218, and throughout that century Cyprus was an important rallying point for the Latin knights; it is possible that this is the period Cesnola was thinking about. See Maurice Keen, *The Pelican History of Medieval Europe* (London, 1968), pp. 179–81.
14. Henri Metzger, *L'acropole lycienne,* Fouilles de Xanthos 2 (Paris, 1963), pp. 60–61. Frederick N. Pryce gave a somewhat earlier date for the Xanthus reliefs, of ca. 500 B.C. in his *Catalogue of Sculpture in the Department of Greek and Roman Antiquities of the British Museum,* vol. 1, pt. 2, *Cypriote and Etruscan* (London, 1931), pp. 118, 144–46. This may have been the approximate date Cesnola had in mind for the sarcophagus. See also William A. P. Childs, "Lycian Relations with Persians and Greeks in the Fifth and Fourth Centuries Reexamined," *Anatolian Studies* 31 (1981), pp. 55–80.
15. Cesnola, *Cyprus,* p. 264. Pryce also compares the horses' crests on the Lycian monument to the horses' gear at Persepolis; see Pryce, *Catalogue,* p. 145, and, for an illustration of the horse harness on the Lycian frieze, pl. 30.
16. Myres, *Handbook,* p. 233.
17. Veronica Tatton-Brown, "Le 'sarcophage d'Amathonte,'" in Antoine Hermary, *Amathonte II: Les sculptures découvertes avant 1975,* Recherche sur les grandes civilizations, Mémoire 10; Études chypriotes 5 (Paris, 1981), pp. 81–83.
18. Aupert, *Guide d'Amathonte,* pp. 41–46.
19. Vassos Karageorghis, in collaboration with Joan R. Mertens and Marice E. Rose, *Ancient Art from Cyprus: The Cesnola Collection in The Metropolitan Museum of Art* (New York, 2000), p. 201.
20. Herodotus, *The Histories,* ca. 425 B.C., 5.104 (trans. Aubrey de Sélincourt, rev. with introductory matter and notes by John Marincola [London, 1996], p. 319).
21. Aupert, *Guide d'Amathonte,* p. 36; see also pp. 41–43. Herodotus (*Histories,* 5.114 [trans., 1996, pp. 319–22]) tells of a Cypriot soldier named Onesilus who laid siege to Amathus for siding with the Persians (and Phoenicians) against the rest of the Cypriots (allied with the Ionians and the Athenians). After Onesilus fell, his head was hung in triumph over the city gates. In time, bees colonized the head and filled it with honey. An oracle advised the people of Amathus to bury the head and worship Onesilus thenceforth. It seems that Herodotus's legend attempts to account for Amathus's traditional alliance with the East as well as its more recent ties to people west of Cyprus.
22. Pierre Amiet, *Art of the Ancient Near East* (Paris 1977; New York, 1980), pl. 120; see also the procession relief at Persepolis, built by Darius and his son Xerxes at about the same time as the Amathus sarcophagus was carved, pls. 684–91.
23. Hermary, *Amathonte II,* pls. 2, 3, 7.
24. John Boardman, *Greek Sculpture, the Archaic Period: A Handbook* (New York, 1978). pls. 151–53, 166.
25. For the ivory carving of two sphinxes from Arslan Tash/Hadatu, of ca. 850–800 B.C., see Harvey Weiss, ed., *Ebla to Damascus: Art and Archaeology of Ancient Syria. An Exhibition from the Directorate-General of Antiquities and Museums, Syrian Arab Republic,* Smithsonian Institution Traveling Exhibition Service, in association with the J. Paul Getty Trust (Washington, D.C., and Malibu, 1985), no. 175; see, in the same catalogue, fig. 67, and "ivory bed or chair panel from Nimrud, 8th–7th c. B.C."
26. Cesnola, *Cyprus,* p. 260.
27. See Amiet, *Ancient Near East,* pl. 120, top register, "Assyrian general leads Ummanigash, the new king imposed on Elamites, by the hand."
28. See William A. P. Childs and Pierre Demargne, *Le monument des Néréides: Le décor sculpté,* Fouilles de Xanthos 8 (Paris, 1989), vol. 1, pp. 263, 265–66, vol. 2, pl. 57.2 (British Museum 879).
29. Hermary, *Amathonte II,* p. 12; Aupert, *Guide d'Amathonte,* p. 46.
30. Tatton-Brown, "Le 'sarcophage d'Amathonte,'" p. 78. See also Aupert, *Guide d'Amathonte,* p. 36.
31. Aupert, *Guide d'Amathonte,* p. 39.
32. The possible apotropaic function of the Bes figures on the sarcophagus is mentioned in Aupert, *Guide d'Amathonte,* p. 37.
33. Ibid., p. 41.
34. Myres, *Handbook,* p. 228.
35. A thin section taken from the mortar lining of the sarcophagus shows stressed feldspar, schist, and brownish, grainy, hornblende aggregate in a micrite cement (lime-rich matrix). The proportion of aggregate to binder—about two to one—is common in restoration mortars (personal communication, George Wheeler, April 2000). The aggregate is very heterogeneous in both particle size and composition, and there are indications that some of it may have come from a volcanic source. The fact that it contains a few marine shells and other fossils increases the likelihood that it was obtained in a marine environment, such as Cyprus's. A thin section of the stone shows about 40% porosity; the rest is calcitic and fossiliferous—there are no noncarbonaceous inclusions. "Thin sections" are samples of material ground exactly 30 μm (0.000003 m) thick and mounted on glass microscope slides. The optical properties of minerals at a known thickness are diagnostic. My thanks are due to Leonard Cannone for preparing the thin sections of the mortar and stone of the Amathus sarcophagus.

36. The yellow pigment was identified by PLM and FTIR as raw sienna.

37. Myres, *Handbook,* p. 228.

38. Ibid.

39. Tatton-Brown, "Le 'sarcophage d'Amathonte,'" p. 76. The scale pattern on certain areas of the west frieze of the Siphnian Treasury at Delphi provides another datable parallel to the Amathus sarcophagus; see Vinzenz Brinkmann, *Beobachtungen zum formalen Aufbau und zum Sinngehalt der Friese des Siphnierschatzhauses* (Ennepetal, 1994), pls. 142, 143. Brinkmann (p. 73) dates the sculpture on the treasury to just after 480 B.C. The pattern appears on the mantle of Athena, and it is made by alternating blue and red, with green interspersed. Brinkmann does not identify the pigments definitively but mentions (pp. 49, 51) azurite, red ocher or cinnabar, and malachite green as likely pigments.

40. Aupert, *Guide d'Amathonte,* pp. 45–46.

41. Rutherford J. Gettens and George L. Stout, *Painting Materials: A Short Encyclopedia* (1942; corrected republication, New York, 1966), pp. 149–51.

42. Elizabeth Hendrix, "Painted Ladies of the Early Bronze Age," *MMAB* 55 (Winter 1997–98), p. 8.

43. See Rutherford J. Gettens, Robert L. Feller, and W. Thomas Chase, "Vermilion and Cinnabar," *Studies in Conservation* 17, no. 2 (1972), pp. 45–69, esp. pp. 50–52, where the similarity in appearance between ground natural cinnabar and dry-processed vermilion, even under very high magnifications, is discussed.

44. Carol A. Grissom, "Green Earth," *Artists' Pigments: A Handbook of Their History and Characteristics,* vol. 1, ed. Robert L. Feller (Washington, D.C., 1986), p. 141.

45. Pryce, *Catalogue,* p. 127.

46. Rutherford J. Gettens and Elisabeth W. Fitzhugh, "Malachite and Green Verditer," in *Artists' Pigments: A Handbook of Their History and Characteristics,* vol. 2, ed. Ashok Roy (New York, 1993), p. 186.

47. Rutherford J. Gettens and Elisabeth W. Fitzhugh, "Azurite and Blue Verditer," *Artists' Pigments,* vol. 2, p. 27. For example, Gettens and Fitzhugh ascribe changes in Cimabue's fresco on the ceiling of the Upper Church of Saint Francis, Assisi, to the transformation of azurite to malachite.

48. Vitruvius, *The Ten Books on Architecture,* 1st century B.C., 9.2–4 (trans. Morris Hicky Morgan [Cambridge, Mass., 1914; New York, 1960], pp. 216–17).

49. *The System of Mineralogy of James Dwight Dana and Edward Salisbury Dana, Yale University, 1837–1892,* vol. 1, *Elements, Sulfides, Sulfosalts, Oxides,* 7th ed., rewritten and enlarged by Charles Palache, Harry Berman, and Clifford Frondel (New York and London, 1944), pp. 215–17, 251–54.

50. Performed by Mark T. Wypyski in the Sherman Fairchild Center for Objects Conservation.

51. Alternatively, an amorphous form of metacinnabar may be responsible for the darkening. This form would not be detected by XRD. See Rachel Grout and Aviva Burnstock, "A Study of the Blackening of Vermilion," *Zeitschrift für Kunsttechnologie und Konservierung* 14, no. 1 (2000), pp. 15–22.

52. Robert L. Feller, "Studies on the Darkening of Vermilion by Light," *National Gallery of Art: Report and Studies in the History of Art* (Washington, D.C., 1967), p. 99, with reference to Alexander Eibner, *Über lichtechte Zinnober* (Munich, 1914).

53. Grout and Burnstock, "Study of the Darkening of Vermilion," pp. 15–22.

54. For minerals associated with naturally occurring cinnabar, for example, see Gettens, Feller, and Chase, "Vermilion and Cinnabar," p. 46.

55. For the composition of azurite and its history as a pigment, see Gettens and Fitzhugh, "Azurite and Blue Verditer" (and bibliography therein).

56. W. Thomas Chase, "Egyptian Blue as a Pigment and Ceramic Material," in *Science and Archaeology,* ed. Robert H. Brill (Cambridge, Mass., 1971), p. 80.