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A revolution in metalworking before the foundation of the Minoan palaces: special examples from the Petras necropolis

ABSTRACT

The excavation of the Pre- and Protopalatial necropolis of Petras continues to reveal exciting developments in metallurgy during the Early and Middle Bronze Age. Many artifacts from the rock shelter and house tombs have shown through careful examination and scientific analyses that their alloy composition and surface treatments greatly contribute to their dynamic—even magical—appearance. It is upon careful close examination and scientific analysis when the artifacts reveal the exciting technological advancements that, in turn, enable a more nuanced and vibrant interpretation of the Minoan culture.

New metalworking techniques in creating elite jewelry items begin to appear in Crete with imported objects like the “Embracing Kings Pendant” from an Early Minoan IIA context. This magnificent artifact is a small gold pendant with detailed and naturalistic iconography of two men embracing. It was paired with a tiny cast gold bead in the shape of a feline head, which displays silvery patches showing the animal to be a panther or leopard.

By the end of the Early Minoan period, the Cretan metalworkers were using complex techniques themselves. Some silver pendants contain high amounts of copper; they appeared pinkish in color after casting and necessitated special surface treatments to enhance the silver color. By Middle Minoan II metallurgists were formulating complex alloys like that used to make the “Astral Ring” with its Minoan hieroglyphic sign between the rays of an eight-pointed star. This silvery signet ring does not tarnish due to its unusual formulation that combines silver, gold, and arsenical copper.

KEYWORDS: archaeometallurgy, Bronze Age, complex alloys, Crete, Minoan metallurgy, southern Mesopotamia, Uruk

INTRODUCTION AND METHODOLOGY

The excavation of the Pre- and Protopalatial necropolis of Petras in eastern Crete continues to reveal exciting developments in metallurgy during the Early and Middle Bronze Age (for preliminary reports about the necropolis, see Tsipopoulou, ed., 2017; Tsipopoulou 2022b; 2024a, b; this volume; forthcoming a, b; Τσιποπούλου, Ισαακίδου, and Hall this volume; for the metallurgy, see esp. Brogan and Giumlia-Mair 2017; Giumlia-Mair et al. 2017; 2020; 2021; Giumlia-Mair,

Betancourt, and Ferrence 2018; Ferrence et al. 2022, 17-18, table 2.1). The multi-phased site of Petras was founded in the Final Neolithic period, and it grew into a thriving settlement with a palace in the Protopalatial period that continued into the Neopalatial period until its final destruction in Late Minoan (LM) IB (see Tsipopoulou and Hallager 2010; Tsipopoulou, ed., 2012; Tsipopoulou 2016; 2021). The LM III phase includes very interesting evidence for veneration of the ancestors buried in the Early and Middle Minoan necropolis (Tsipopoulou and Rupp 2019; Psychas 2022; Rupp and Tsipopoulou 2022). The many house tombs and other structures account for two millennia of stratigraphy from Early Minoan (EM) IB to LM IIIC (Tsipopoulou and Rupp 2019). Neopalatial phases are absent in the necropolis. The LM III buildings are not funerary; they seem to represent activities related to ancestor worship. Astonishingly, the EM IB-MM IIB burials have never been looted.

The contexts inside the rock shelter and house tombs are mostly secondary. A significant amount of metal artefacts have been recovered in the excavation, and they can be handed down from generation to generation. Their date of manufacture can be quite a long time before deposition in the necropolis, and so the dating for metal items can have a relatively wide range based on the morphological style, manufacturing processes, first use of the rock shelter or foundation time frame of the house tomb, and when the burial contexts went out of use.

Our thorough research methodology reveals exciting technological advancements by the Minoans that, in turn, enable a more nuanced and vibrant interpretation of their culture. The many metal artifacts from the rock shelter and house tombs have shown through careful microscopic examination and scientific analyses using X-ray fluorescence spectroscopy (XRF) that the alloy compositions and surface treatments greatly contribute to their dynamic—even magical—appearance, especially the jewelry (for the scientific methodology, see Giumlia-Mair et al. 2017, 204-205; Giumlia-Mair, Betancourt, and Ferrence 2018, 523-524; 2023, 14). Also, the methodology of the excavation of the Petras necropolis employed an unprecedented level of soil sampling in which practically 100% of burial contexts were water sieved (Giumlia-Mair et al. 2017, 56; Τσιποπούλου and Τσιμόγιαννη, this volume). This has resulted in the retrieval of the minutest metal artifacts, including tiny silver and gold beads as small as 1-2 mm in diameter that otherwise would have been lost to history due to their almost microscopic size (Fig. 1;

Giumlia-Mair et al. 2021, 411, fig. 8; Ferrence et al. 2022, 23, fig. 2.4).

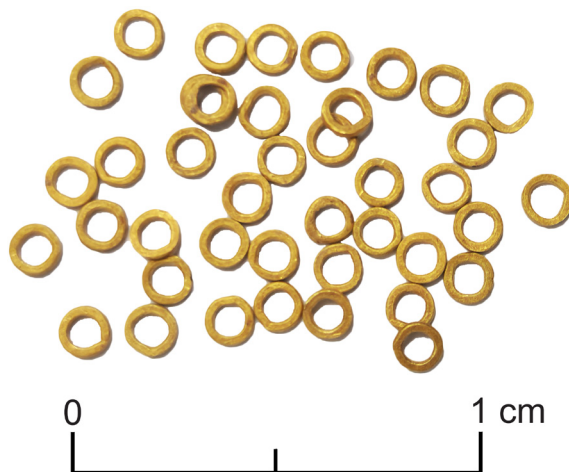


Fig. 1. Tiny cast ring-shaped beads (PTSK18-2305) made of pure gold from the MM IA Burial Structure 28 at Petras. Photo S. Ferrence.



Fig. 2. Four views of the gold pendant (PTSK18-1437A) depicting two men kneeling and embracing from an EM IIA primary burial of a young woman at Petras (Burial Structure 25 under House Tomb 2), likely imported from Uruk and manufactured ca. 3000 BC. Photos C. Papanikolopoulos.

EARLY BRONZE AGE IMPORTS FROM SOUTHERN MESOPOTAMIA

New metalworking techniques in creating elite jewelry items begin to appear in Crete with imported objects like the “Embracing Kings Pendant” that came from one of the few stratified burials in the Petras necropolis: an EM IIA grave of a young woman in the area of the Middle Minoan (MM) IB-IIB House Tomb 2, under the MM IA Burial Structure 29, and the EM IIA Burial Structure 24 (Fig. 2: PTSK18-1437A; Ferrence et al. 2024; forthcoming). The excavators have shown how the woman’s burial in a stone-built monument (Burial Structure 25) is unique for Crete at this early time period (Rupp and Tsiopoulou, forthcoming). The magnificent gold artifact is a very small pendant with detailed and naturalistic iconography of two men kneeling, kissing, and embracing. The pendant was cast then finished with fine tools and polished. Casting metal was a technologically advanced technique for the time period that made the piece stand out from other Cretan gold jewelry usually made of sheet or foil. For example, the famous gold jewelry from the house tombs of Mochlos is typical of Early Minoan goldwork (Seager 1912, fig. 8; for a survey of Prepalatial gold jewelry, see also Hickman 2008). The XRF analysis of the pendant revealed a gold alloy with approximately 6% silver (see Ferrence et al. 2024, 192, table 1). Adding silver to gold makes an alloy harder than gold alone and therefore the jewelry is more robust and less prone to damage. Silver also helps to facilitate the casting process by lowering the melting point of gold.

The pendant is a superbly detailed three-dimensional miniature image of two bearded men embracing each other as they kneel together. Their heads are in profile with their torsos facing each other, and they hug each other closely. They have detailed hairlines, beards, and eyes. Both men are dressed in kilts or skirts decorated with a cross-hatched pattern and hatches along the hemline, perhaps representing a fringe. Each man extends his right arm around the waist of the other, and their left arms each make a right angle with the bent elbow such that the fist rests on the back of the other man’s right shoulder. The fist of one man and the skirt of the other exhibit signs of wear, thus showing how the pendant rested on the body of the owner.

The image and artistic rendering are entirely unlike anything else from the Aegean in the Early Bronze Age (for surveys of Prepalatial figural art, see Immerwahr 1990, 21-34, figs. 6-11 and Cosmopoulos 1992; see also Ferrence 2017). After exhaustive iconographic research it has been



Fig. 3. Limestone cylinder seal with modern impression depicting a ritual scene involving a scribe, priests, and part of a boat. Note the distinctive net skirt worn by one of the standing men. From Iraq, Late Uruk to Jemdet Nasr periods (3350-2900 BC). Institute for the Study of Ancient Cultures, West Asia & North Africa at the University of Chicago, nos. A3616, C8906; purchased in Iraq in 1920. Photos S. Ferrence.

determined that its origin is the region of Uruk in southern Mesopotamia during the Jemdet Nasr period around 3000 BC (Ferrence et al. 2024, 186-190). The key is the emblematic net skirt, which is usually worn by the ruler and/or his attendants in the ceremonial imagery of Uruk. Several cylinder seals depict the Big Man of Uruk in various rituals and processions, sometimes including an attendant (Fig. 3; Speiser 1933, pl. IV; Frankfort 1954, 15-17, pl. 8D; Moortgat 1967, pl. A:5, 6; Orthmann 1975, 224, no. 126a, b, d; Feller 2019, 138, fig. 24.1; Vogel 2019, 124, fig. 20.5; Ferrence et al. 2024, 188, fig. 3).

In the young woman's burial, the pendant was found with other beads of stone and metal, including a tiny cast gold piece in the shape of a feline head that measures about 7 mm in length (Fig. 4: PTSK18-855). Upon careful magnified examination, it displays silvery patches on the surface that allow for the interpretation of the animal as a panther or leopard (Ferrence et al. 2024, 186, 192, table 1; forthcoming). The XRF analysis identified a gold alloy with 2.6% silver, and the silver content is markedly higher when the silvery surface areas are measured, but the tiny size of those spots inhibits a precise measurement. The feline bead is a tour de force of artistry because it was created with two views of the face that become obvious when the

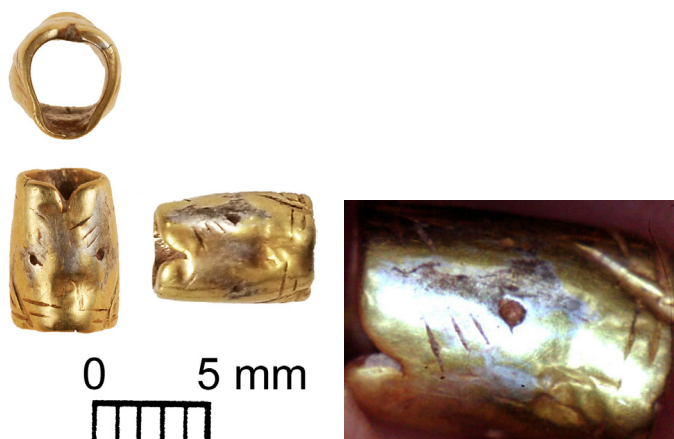


Fig. 4. Three views of the gold bead (PTSK18-855) depicting feline heads (left) from an EM IIA primary burial of a young woman at Petras (Burial Structure 25 under House Tomb 2), likely imported from Uruk and manufactured ca. 3000 BC. Detail at right under 50x magnification. Photos A. Giumlia-Mair and C. Papanikolopoulos.

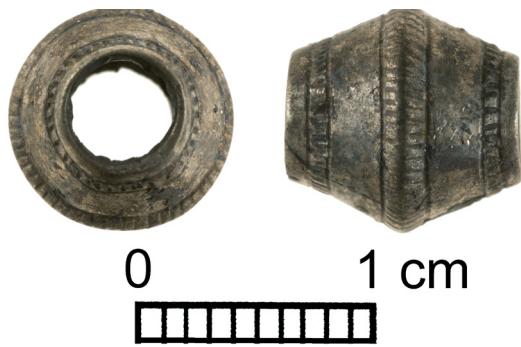


Fig. 5. Silvery biconical bead (PTSK18-1437B) with rope-pattern decoration from an EM IIA primary burial of a young woman at Petras (Burial Structure 25 under House Tomb 2), likely imported from Uruk and manufactured ca. 3000 BC. Photos C. Papanikolopoulos.

cylindrical bead is rotated on the string. Each view has a different set of facial features—eyes, ears, whiskers, and collar—and the two faces look in opposite directions. During rotation, one can always see the animal correctly.

A third cast metal item came from the same burial, this one a silver biconical bead with rope-patterned decoration (Fig. 5: PTSK18-1437B). A remarkable silver alloy with a high percentage of gold at 10% and also 0.5% copper helped to make the bead easier to work and more resistant to corrosion (Ferrence et al. 2024, 182, 192, table 1). Nevertheless, the low level of corrosion that did exist during XRF analysis inhibited precise results, and the amounts of 85% silver, 10% gold, and 0.5% copper are indicative only. The bead probably originally had a higher amount of copper when it was crafted. The biconical shape is certainly reminiscent of the many similarly shaped beads made of various stones and metals that have been found in Queen Puabi's and other tombs in the Royal Cemetery of Ur (Pittman 1998, 98, 101, 115-117, nos. 36, 42, 76, 78, 79, 81, 82 [bottom right]), although the rope decoration on the Petras bead seems to be a distinguishing feature.

All three items are most likely from Mesopotamia because they stand out from Cretan jewelry in their method of manufacture, their metallurgy, and their iconography (Ferrence et al. 2024). The pictorial depictions of the Big Man of Uruk include lions and other large cats as part of his ability to control the chaos of the animal world. The renowned Lion Hunt Stele dating to the Late Uruk (or perhaps Jemdet Nasr) period illustrates the supremacy of the Great Man over wild creatures and his symbolic control over disorder (Frankfort 1988, 33-34, fig. 24; Collon 1995, 50; Pollock 1999, 184-185, fig. 7.6; Hansen 2003, 22-23, fig. 5; Pongratz-Leisten 2019, 289-290, fig. 12.1).

The three Mesopotamian beads were buried as part of the jewelry suite worn by a young woman who was memorialized under a monumental structure in EM IIA (Rupp and Tsipopoulou, forthcoming). She was buried in a unique way compared to most other Early Minoan graves, and this also calls her own origin into question. Perhaps the pendant somehow signifies an agreement or royal relationship, possibly between “brother-kings” located somewhere in Mesopotamia from a time hundreds of years before the woman was interred at Petras, making her jewelry pieces heirlooms at the time they were buried with her (Ferrence et al. 2024, 194). It is also possible that she brought the antiques with her from her homeland in the East when she came to Crete as a bride of noble birth. We will never know the full story of the young woman's life and death. The iconography, microscopic examination, and scientific analyses, however, do reveal impressive details about the jewelry that she must have held so dearly.

EARLY MINOAN SILVERY JEWELRY FROM THE ROCK SHELTER OF PETRAS

By the end of the Early Minoan period, the Cretan metalworkers themselves were using complex techniques as evidenced by the metal artifacts from the rock shelter in the Petras necropolis, which also produced a copious amount of well-preserved human skeletal remains: 77 almost complete crania, and another five fragmentary crania; the minimum number of individuals (MNI) from the rock shelter is 165 (Triantaphyllou 2012, 162-163, Τριανταφύλλου, Τσιποπούλου, and Betancourt 2018). The deposition in the rock shelter probably followed the cleaning of one of the house tombs (Tsipopoulou 2012b, 117). The many grave goods are of excellent quality, and they date to EM IB to MM IIA (Triantaphyllou 2012, 161). Pottery, stone vessels, jewelry, and seals were recovered (Tsipopoulou 2010). Significantly, many pieces of pottery from the rock shelter are in the Kampos style of the Early Cycladic islands but made of local clay (Tsipopoulou 2010, 132, fig. 6; 2012a, Tsipopoulou and Simandiraki-Grimshaw 2017), very similar to those excavated from the “Cycladic-type” rock-cut graves in the nearby cemetery of Hagia Photia (Davaras and Betancourt 2012). Other pottery types from the rock shelter include EM IIB Vasiliki Ware (Tsipopoulou 2010, 124, 133, fig. 7).

Good examples of the ancient metallurgy are pendants in the shape of rings, spades, and anchors among other enigmatic forms (Fig. 6; Giumlia-Mair et al. 2017, 205, fig. 1: PTSOU06-122, 06-217, 09-169; Giumlia-Mair and Ferrence 2019, 15, fig. 1). These metal artifacts are stylistically dated to EM I-IIA (Ferrence et al. 2022, 10-11, 19, fig. 204). The surface color and corrosion obscured their metal composition. The XRF analyses strikingly revealed on some of them that they are made of silver alloys that contain varying amounts of high levels of copper (Giumlia-Mair et al. 2017, 206a-206b, table 1: PTSOU06-122 [32% Cu], 06-139 [5% Cu], 06-217 [54% Cu], 06-240 [4% Cu], 09-170 [53% Cu]; Giumlia-Mair and Ferrence 2019, 14-15, fig. 1); this composition originally made them appear pinkish in color after casting. In order to eliminate the pink color, special treatments of strong acidic organic liquids, such as fruit or plant juices, dissolved the copper from the surface layer of each piece (Giumlia-Mair et al. 2017, 209). After treatment, the surface was porous and opaque, and they had to be consolidated and polished thus enhancing the silver color and making them sparkle. This methodology allowed the Cretan metalsmiths to create a larger number of silvery objects without using a commensurately large amount of the precious metal. They were able to maximize their supply of silver in this manner. The technology

is also found in the Early Minoan cemetery at Livari Skiadi in southeastern Crete where ring- and anchor-shaped pendants made of silver alloys were excavated (Papadatos 2015, 101-102, nos. J2, J4, J5, fig. 46; Ferrence et al. 2022, 16, 19-21, table 2.3, fig. 2.4:J2).



Fig. 6. Silvery pendants containing copper from the rock shelter at Petras: (a) ring PTSOU06-122, 32% Cu; (b) ring PTSOU09-170, 53% Cu; (c) unidentified type PTSOU06-139, 5% Cu; (d) anchor or wings PTSOU06-217, 54% Cu; (e) shovel PTSOU06-240, 4% Cu. Photos C. Papanikolopoulos.

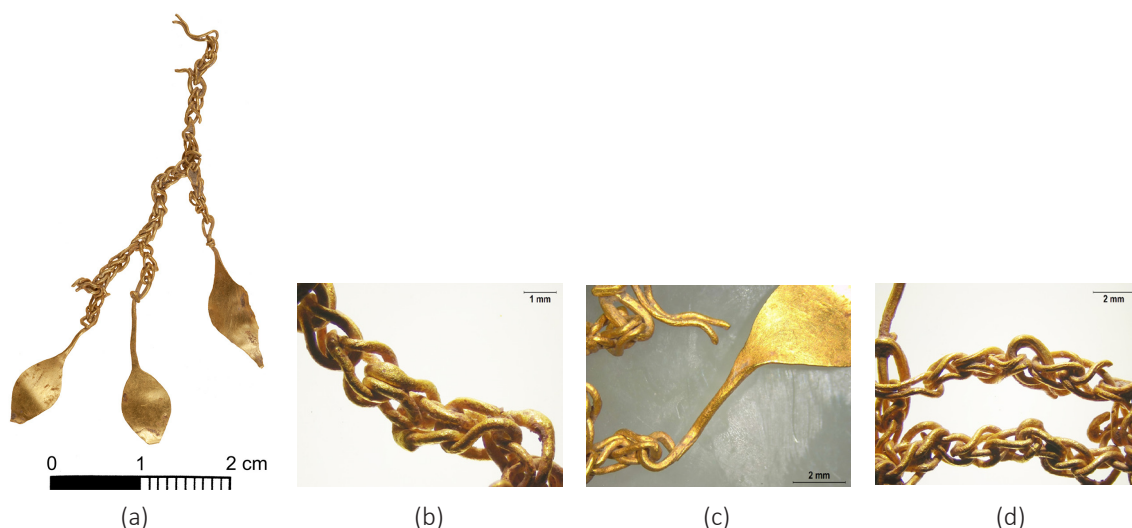


Fig. 7. Gold chain with three leaf-shaped pendants (PTSK15-1258) from an EM IIA house tomb at Petras: (a) general view; (b) detail showing three rings with visible bulbous places where solder was applied to join the ends of the twisted wire to create each ring; (c) detail showing evidence of hammering the stem of one of the leaves; (d) detail showing folded rings with helicoidal lines from twisting the wires to create the rings. Photos K. Hall and C. Papanikolopoulos.

EARLY AND MIDDLE MINOAN GOLDWORK AT PETRAS

The use of microscopy in our examination of the metal jewelry has revealed the goldworking techniques that were employed at Petras (Giumlia-Mair et al. 2021). An EM IIA example of a gold chain from House Tomb 17 was made of twisted wires that were soldered into rings to form the loop-in-loop chain (Fig. 7; Giumlia-Mair et al. 2021, 409-410, no. PTSK15-1258, figs. 4a, 4b; Tsiopoulou 2022a, 55, 57, 65, figs. 5.11, 5.12). This piece also had three leaf-shaped pendants made of gold foil that were cut into the leaf shape with a short strip on one end that was hammered and annealed into the stem, which, in turn, forms the loop for attaching the leaf to the chain. Another leaf-and-chain piece of jewelry was excavated in House Tomb 6 along with Vasiliki ware pottery and dated to EM IIB: a sheet hammered into the shape of a leaf was annealed at the loop where the leaf was attached to a gold chain (Fig. 8; Giumlia-Mair et al. 2021, 409, no. PTSK06-150, fig. 3a). This time the chain was made of cast rings that were then folded

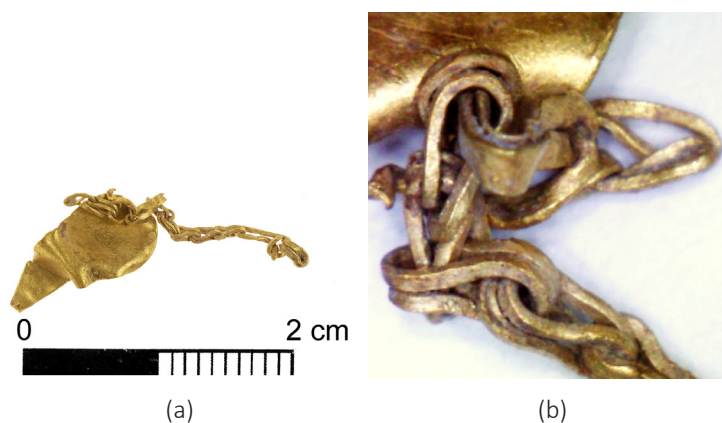


Fig. 8. Gold chain with a leaf-shaped pendant (PTSK06-150) from an EM IIB house tomb at Petras: (a) general view; (b) detail showing squared edges of the rings indicating their cast form before folding (50x magnification). Photos A. Giumlia-Mair and C. Papanikolopoulos.

and linked with each other using the loop-in-loop method (Giumlia-Mair et al. 2021, 409, no. PTSK06-150, fig. 3b). Parallels for gold chains with leaf pendants occur at several sites in Crete, including for example Mochlos (Seager 1912, fig. 10:II.35).

One example of a gold strip or diadem from MM II House Tomb 2, Room 3, has one side that was polished—presumably the outward-facing side—because the difference in the surface treatment is obvious (Giumlia-Mair et al. 2021, 408, fig. 1: PTSK05-263). This simple piece has a wide date range of EM II-MM II because parallels from earlier tomb contexts in Crete show that the type has a long history, and this one from House Tomb 2 could very well have been an heirloom when it was deposited in the necropolis. Sometimes the pattern of the leather employed as a cushion for the fragile gold sheets can be seen on the side that was unpolished. The metallurgist would have polished the strip while it rested on the soft leather. Under microscopy, small holes in the strips and diadems were identified showing that many of the items made of gold foil and sheet were attached with a thread to garments of different materials like fabric or leather, for example a strip of foil from House Tomb 3, Room 1, dated to EM III-MM IA (Giumlia-Mair et al. 2021, 408-409, no. PTSK06-88, figs. 2a, 2b).

The gold beads from the necropolis are many and varied in their shape, decoration, and method of manufacture. There are fewer cast pieces compared to the number of those that were hammered because casting needs more gold. Small thin cylindrical beads from an EM IIA primary burial (Structure 24; located under Space 9 of the later House Tomb 2, which was founded in MM IB; Tsipopoulou and Rupp 2019, 82, 83, pls. XXIX-XXXI; Rupp and Tsipopoulou, forthcoming) were made with rolled gold sheet that has 4-5% silver content, depending on the alteration of the alloy (Fig. 9; Giumlia-Mair et al. 2021, 410, fig. 5: PTSK17-991, 17-1170, 17-1503, 17-1530, 17-1720, 17-1556, 17-1684). A few of the examples are very thin at only 1-2 mm in diameter. Other gold beads from Burial Structure 25—also of EM IIA date, situated above Burial Structure 25 (where the gold pendant from Uruk was excavated), and also containing a female primary burial—were made by wrapping foil around a core of organic material, such as wood, that has long since decomposed (Fig. 10; Giumlia-Mair et al. 2021, 410, fig. 6: PTSK18-1096, 18-1249, 18-1328, 18-1356; for the context, see Rupp and Tsipopoulou, forthcoming). Other



Fig. 9. EM IIA thin cylindrical beads made of rolled gold sheet (PTSK17-991, 17-1170, 17-1503, 17-1530, 17-1720, 17-1556, 17-1684).

Photo C. Papanikolopoulos.



Fig. 10. EM IIA beads originally made of a wooden(?) core with gold sheet wrapped around it (PTSK18-1096, 18-1249, 18-1328, 18-1356).

Photo S. Ferrence.



Fig. 11. EM III-MM IA biconical electrum bead (PTSK13-1237) with seam evident at right under 50x magnification. Photos S. Ferrence and A. Giumlia-Mair.

metal beads have hot hammered joins that are only detectable under microscopy, for example a very well-made electrum bead from Room 4 in the EM III-MM IA House Tomb 3 (Fig. 11; Giumlia-Mair et al. 2021, 410-411, figs. 7a, 7b: PTSK13-1237). The XRF analyses showed ca. 10% silver in the gold alloy, which is apparent in its lighter color. This biconical bead was made from thicker cast sheet, which was hammered with small tools (probably made of copper-based alloys) on a rounded form of some sort to create the distinctive shape. The seam was then heated and hammered to attain a strong join. The bead is extremely well made, otherwise the seam would have opened and corroded at some point in the last 4,000 years. To achieve this type of durable bond, the metal had to be perfectly cleaned and degreased with a substance such as, for example, strong vinegar or alum. These different ways of manufacturing gold jewelry maximized the available precious raw material.

Three tiny decorated cast gold beads have come to light from the exhaustive water-sieving program of the excavation of the necropolis. One example comes from Burial Structure 25 under House Tomb 2 (Fig. 12a: PTSK18-2198; for the context, see Tsipopoulou and Rupp 2019, 84 and Rupp and Tsipopoulou, forthcoming), the same EM IIA context as the gold pendant described above imported from Uruk. This spherical bead is ca. 98% gold with 1.1% silver and 0.4% copper, the latter two of which were possibly natural impurities in the gold. It has a diameter of 6 mm, and it was well-made by casting it with a detailed rope-pattern around the equator and rims around the holes of the bead on its sides/ends. The rope pattern was cold worked, and the piece was finished by polishing. Its weight and morphology set it apart from the other gold jewelry, and it probably also came from southern Mesopotamia like the gold pendant of two men and the gold bead in the shape of a feline head (see above). Another cast bead, this time from MM IA Burial Structure 28 under Room 1 of House Tomb 2 (Fig. 12b: PTSK18-2188; for the context, see Tsipopoulou and Rupp 2019, 84 and Rupp and Tsipopoulou, forthcoming) is 92% gold with 6.3% silver and 0.3% copper, and it measures 5 mm in diameter. It was cast from a model of wax that was a square sheet pierced in the center and folded under on the sides to create the unique shape with incurved sides thus making a four-pointed star. The gold alloy with added silver helped to make the piece resistant to damage, especially around the four points of the star where the bead is most delicate. The low amount of copper may have been an impurity in the silver. A third example from Room 1 in MM IB-II B House Tomb 11 (Fig. 12c: PTSK17-2079) is a cast

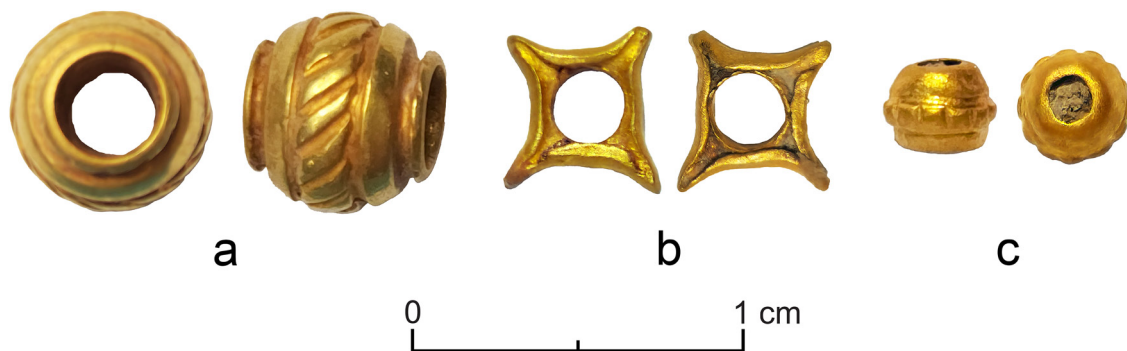


Fig. 12. Two views each of three cast gold beads from the necropolis of Petras: (a) spherical bead with rope-pattern banded decoration (PTSK18-2198) from an EM IIA burial, probably imported from southern Mesopotamia; (b) flat bead in the shape of a four-pointed star (PTSK18-2188) from a MM IA burial; (c) globular bead with square-pattern banded decoration (PTSK17-2079) from a MM IB–IIB house tomb. Photos S. Ferrence.

globular bead made of gold with 0.3% silver and 0.2% copper, the latter two elements possibly being impurities. The bead was cast with a square-pattern banded decoration around its equator. It measures only 3 mm in diameter, and the decoration is almost invisible to the naked eye. After casting, the bead was finished by cold working and polishing. The tiny size of these beads begs the question of why go to the trouble of decorating them with such details like a rope pattern when it would not easily be discernable by an onlooker? One theory is that the decoration would make the gold jewelry sparkle more than if it was undecorated thereby amplifying the effect of wearing the gold, which in turn is another way of maximizing the investment in manufacturing the precious items.

INCREASINGLY COMPLEX MIDDLE MINOAN II METALLURGY

There are also examples of diffusion bonding in the metal artifacts from the Petras necropolis as identified by the XRF analyses. So far the earliest example of this metallurgical technique comes from the Troad in Early Bronze II (Betancourt 2006). Copper traces at 2% were detected on the surface of a gold ring from Room 2 in MM IB–IIB House Tomb 10, and a seam was also identified under microscopy (Fig. 13a; Giumlia-Mair et al. 2021, 414, figs. 15a: PTSK12-1280). The gold also contained 3% silver. The location of the copper is where the two ends of the rod were joined to create the ring. Copper salts were applied to the gold and heated to join the ends together securely.

Cast tweezers made of arsenical copper with silver-capped rivets also show the use of copper salts to adhere silver foil onto the copper heads of the rivets (Fig. 13b: PTSK05-141, 05-124). These two examples come from Rooms 1 and 2 from Middle Minoan IB–IIB House Tomb 2 (Ferrence, Muhly, and Betancourt 2012, fig. 5:a; Giumlia-Mair et al. 2017, 205, 206b, table 1, fig. 1). Silver plating on rivets of daggers and tweezers has a long tradition in Minoan Crete (for a discussion, see Betancourt, Ferrence, and Giumlia-Mair 2023, 64-65).

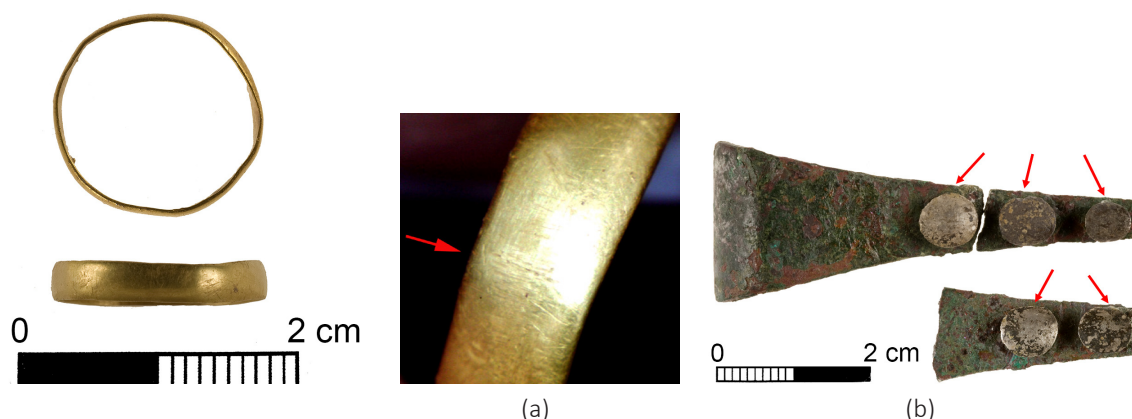


Fig. 13. Examples of diffusion bonding (red arrows) in metal artifacts from MM IB-IIB house tombs in the Petras necropolis: (a) copper traces detected at the seam on the surface of a gold ring (PTSK12-1280); (b) tweezers with silver-capped rivets (PTSK05-141, 05-124).

Photos A. Giumlia-Mair and C. Papanikolopoulos.

By the Middle Bronze Age, Minoan metallurgists were formulating quite complex alloys. An excellent example is the MM II “Astral Ring” from Room 5 in House Tomb 9; it is decorated with a Minoan hieroglyphic sign repeated among the rays of an eight-pointed star (Fig. 14; Ferrence, Betancourt, Muhly 2020). This silvery signet ring did not tarnish due to its unusual composition; the XRF results identified an exceptional alloy with 84% silver combined with arsenical copper—meaning 3% Cu and trace amounts of As—and, meaningfully, 10% gold (Giumlia-Mair et al. 2017, 206b, table 1, fig. 1: PTSK12-199). Arsenical copper has a silvery appearance that was further enhanced when combined with silver. Arsenical copper also lowers the melting point of the alloy, and it helps to make the metal harder and thus less likely to be damaged. The gold in the alloy prevents the ring from tarnishing. Ancient people might have called the fact that it looks silvery and never tarnishes a magical property of the jewelry. Perhaps the Minoans thought the magic was also conferred upon the person who wore the ring. The ring also may have had a ritual or religious meaning. Due to gold’s never-ending pristine condition, ancient peoples thought it was a divine element that protected the owner and provided good fortune. For example, the Egyptians added gold and silver to copper-based alloys for special reasons (see, e.g., Bernstein 2000, 12; Giumlia-Mair 2002, 317-320). Sacred symbols that include gold and silver are widespread throughout time and cultures. This astral ring from Petras was an extraordinarily important piece of personal adornment that was also utilized as a seal by its owner who would have known the meaning of the star motif.



Fig. 14. MM II “Astral Ring” (PTSK12-199) from House Tomb 9 at Petras made of a complex silver alloy and decorated with a star motif and a Minoan hieroglyphic sign (red circle) repeated among the points of the star.

Photos C. Papanikolopoulos.

The iconography of the astral ring with the Minoan hieroglyphic symbol has been previously discussed in detail (Ferrence, Betancourt, and Muhly 2020). The eight-pointed star has been shown to be linked to the Near Eastern goddess Ištar, the Egyptian goddess Hathor, and the Greek goddess Aphrodite. The branch-like Minoan hieroglyphic sign has been linked to the imagery of the “tree of life,” which, in turn, is iconographically related to the Minoan goddess. Ištar was an Akkadian goddess of love and war, and she was also known as a mother and fertility goddess. Her earlier Sumerian counterpart was Inanna. Thanks to the writings of Enheduanna—the daughter of the Akkadian king Sargon and high priestess of her father’s empire—we know that “during the Akkadian period Inanna merged with Ištar” (Lovisetto 2022, 56). “By illustrating the attributes of the two goddesses in her literary works, Enheduanna promoted their identification as a single deity” (Dajani 2022, 85). Inanna and Ištar were the names in different languages and regions of Mesopotamia for essentially the same deity (Babcock and Tamur 2022, 21; Dajani 2022; 85; Foreman 2022, 28). The Egyptian goddess Hathor was associated with a tree, and she was sometimes called the Lady of the Sycamore. She was known as the patroness of love, fertility, childbirth, and motherhood. Ištar and Hathor had a strong presence in the Levant, and it is very difficult to disentangle their iconography and meaning in that region. Further, Aphrodite, Ištar, Hathor, and the Minoan goddess seem to have the same iconographic symbols of trees and stars or suns. In the Aegean the star motif dates back to Early Cycladic imagery on ceramic frying pans, some depicting a pubic triangle as well. The star motif on the silver seal ring from Petras strongly indicates its relationship to the Near East. The Minoan hieroglyphic symbol on the ring, however, demonstrates that its origin is in Crete.

CONCLUSION

The metal artifacts from the necropolis of Petras, especially the very small ones, perhaps at first glance, may not convey the level of metallurgical mastery of the Minoans during the Early and Middle Bronze Age. It is only after careful microscopic examination and elemental analysis that the skill and know-how of the metal artisans of this time can be revealed. They were clearly influenced by the technology and imagery coming from the Near East and Mesopotamia starting in Early Minoan II. They knew how to stretch their precious metal resources to maximum effect for personal adornment and conspicuous display of affluence in the burial realm of Petras. The people interred were certainly elites, and perhaps one noble woman even had a royal connection to southern Mesopotamia.

Until the excavation of the necropolis at Petras, the archaeological record of Prepalatial cemeteries has been quite limited due to looting, older excavation methodologies, and the lack of stratigraphy in communal burial contexts (Legarra Herrero 2004, 30, 32). The systematic stratigraphic excavation of the unlooted Pre- and Protopalatial necropolis at Petras and the ongoing study of its metal artifacts will show the types of metal objects that have been missing from other Prepalatial burial contexts and which metal items from those contexts could be assigned to more secure chronological time periods.

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