Technological transfer of luxury craftsmanship between Crete and the Orient during the Bronze Age

Élise Morero, Romain Prévalet

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and Back Again – the Crossroads II

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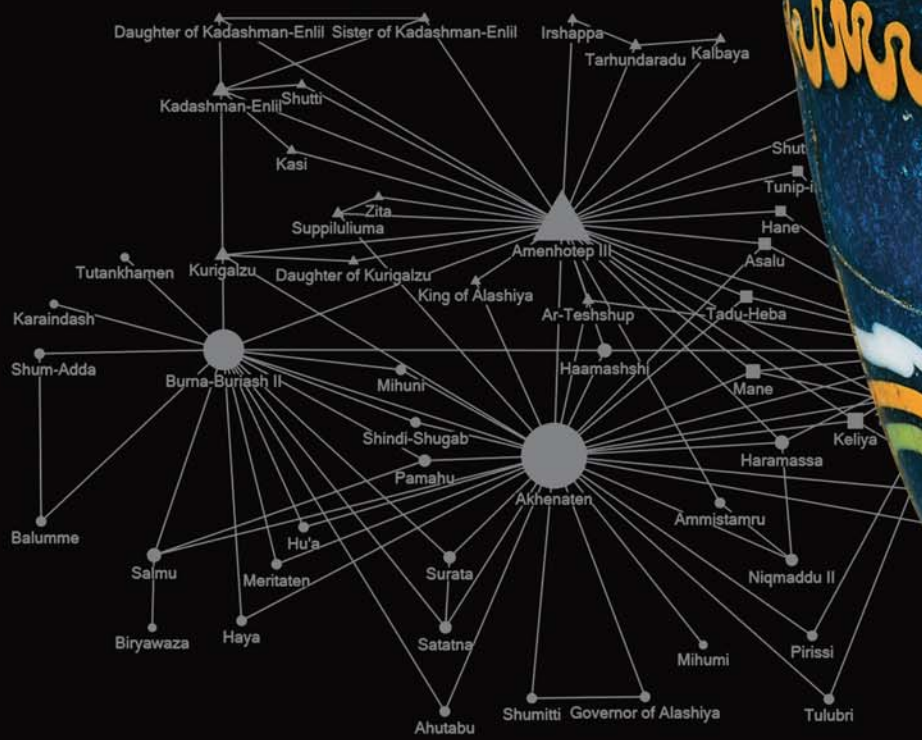

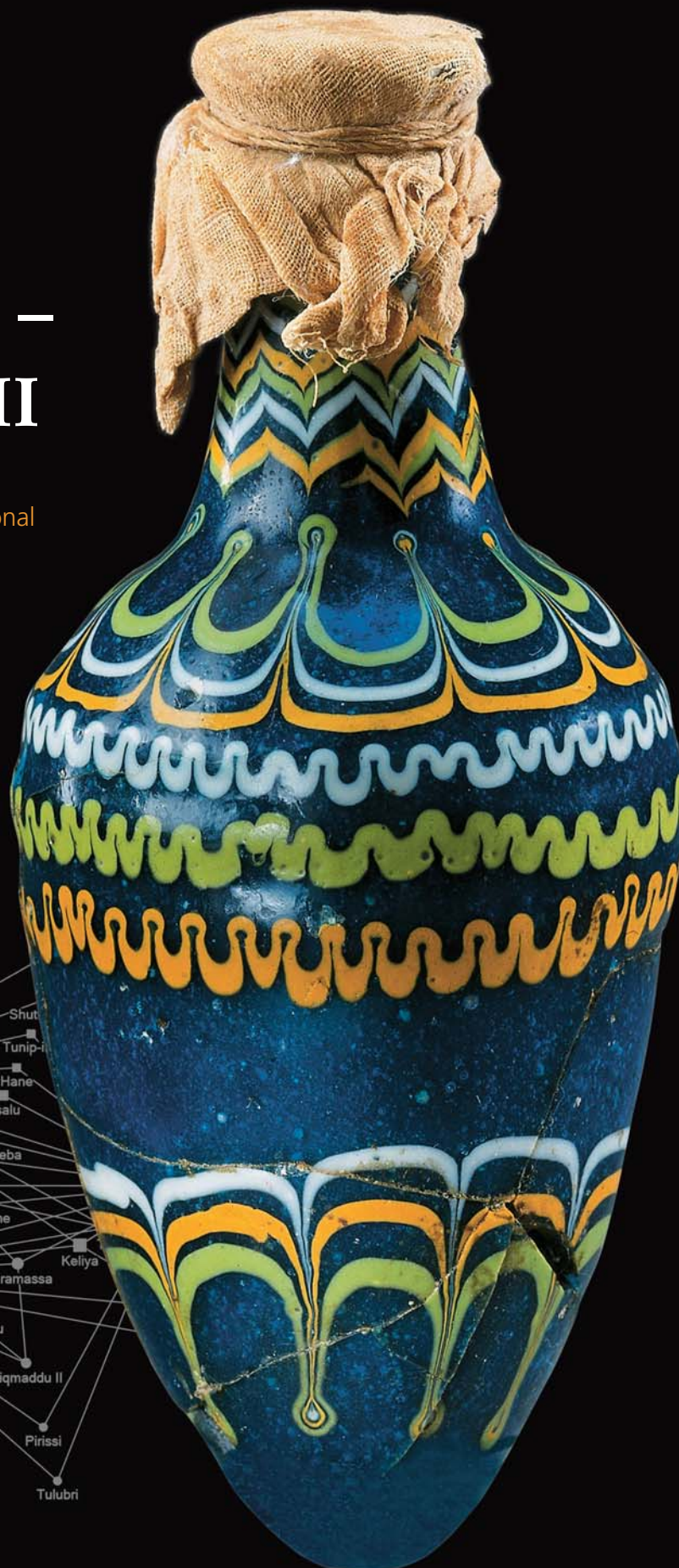

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Cover: Glass flask of Maiherperri from the Egyptian Museum in Cairo. Photo by Andreas F. Voeglin, Photographer Antikenmuseum Basel, Switzerland; the entire Social Network of the Amarna letters with four clusters (© D. H. Cline – E. H. Cline).

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TECHNOLOGICAL TRANSFER OF LUXURY CRAFTSMANSHIP BETWEEN CRETE AND THE ORIENT DURING THE BRONZE AGE

Elise Morero – Romain Prévalet

The 2nd millennium BCE is characterised in the Eastern Mediterranean (Aegean, Egypt, Levant) by the emergence of the palatial system, and the development of luxury craft productions. Goldwork, stone vases industry and the production of faience objects were some of the most flourishing. The growth of trade and contacts between the Aegean and the Orient, during the 2nd and 1st millennia, supported the spread of ideas and finished objects. However, people, especially craftsmen, have also travelled from one centre to another, bringing with them their tools, knowledge, and experience.

For several decades, a part of luxury goods in Crete were considered as exotic imports, and most of the technologies, styles, iconographies, and meanings were seen as transfers from the Orient. However, the two analyses presented in this paper, goldwork and stone vessels productions, show that Cretan technical processes were not exclusively the result of transfer. Indeed, the ancient techniques were also developed from a series of local innovations, craftsmanship stimulation through networking and reciprocal contacts.

The reconstruction of the techniques and tools used in the two industries was achieved by means of a multidisciplinary method, which combines archaeological data[1] from the Eastern Mediterranean centres with information from ethnoarchaeology, more particularly the studies of traditional workshops. First, a direct microscopic investigation of the objects was performed to construct a database of the manufacturing traces, which represent the signature of the use of a particular tool, process and technique. For the stone vessels productions, a more accurate microscopic observation and precise measurements of the technological micro-traces were performed by tribological analyses, in collaboration with the *Laboratoire de Tribologie et de Dynamique des Systèmes (LTDS) – École Centrale de Lyon*[2].

However, no tool has been discovered so far, which could be undoubtedly linked to these industries in Crete. Therefore, a series of hypotheses concerning the potential toolkits and know-how used by ancient craftsmen were formulated,

[1] For example: workshops excavations, occurrence of potential tools in the Eastern Mediterranean, waste materials linked to the manufacturing process, Egyptian bas-reliefs and paintings in tombs depicting craftsmen at work.

[2] For the working method see Vargiolu *et al*. 2007 and Morero 2009: 229–236.

based on the ethnographical studies of traditional workshops (especially from Africa, India, Egypt, and Iran),[3] which were then reconstructed and tested experimentally. Finally, the database of the technological traces, obtained through the experiments, was then compared with the database of the marks recorded on the archaeological objects to identify their origin, recognise the skills of the workers and finally characterise their productions.

1. Goldwork

1.1. The Technological Context of Goldwork in Crete

The beginnings of goldwork are well attested in Crete at the Early Bronze Age during the first part of the 3rd millennium BCE (Legarra Herrero 2014: fig. 2). The first gold items were recovered in the northern part of the island: at Pyrgos and Krasi (Xanthoudides 1918: 166; Branigan 1974: no. 3447), in the south: at Maronia and Platanos in the Messara (Branigan 1983: 17; Xanthoudides 1924: 110–111), and in eastern Crete: at Mochlos (Seager 1912).

Hundreds of gold jewellery pieces including bands, diadems, pins, pendants, rings and beads were discovered at Mochlos. That site represents one of the two main areas of the Minoan prepalatial gold production, together with the region of Messara (Legarra Herrero 2004: 40–41, fig. 9, tab. 3; Prévalet 2013: 352–353). More than 600 gold items have been discovered in Crete and at least half of them comes from the tombs of Mochlos, mostly dated to the Early Minoan II, around 2500 BCE (Hickmann 2012: pl. CXXXIII b). It has to be noted that the site has also provided evidence of the existence of an Early Minoan production (3rd millennium BCE) of stone vessels (see below), and as such has provided a volume of important data regarding the study of early craftsmanship in Crete and in the Aegean.

Indeed, the gold collection of Mochlos clearly shows all the features of local creation and tradition of the Minoan jewellery, which could be observed in the variety of the production, with the predominance of the floral and geometric styles and references to the animal repertoire (Davaras 1975: 102; Hickmann 2011). Admittedly, the early gold manufacture is quantitatively based on a set of hammering techniques in the whole Eastern Mediterranean and the Near East, but specific processes could also be recognised in the Minoan jewellery as a specific characteristic of the local gold-processing. Techniques like assisted cutting of hammering sheets for the bands and diadems production and *repoussé* for their dots-punctuated decoration, chain manufacture using the loop-in-loop method for the pen-

[3] For jewellery studies, see for example Armbruster 1999 (Africa) and Boyer 1995 (Asia). For the lapidary craftsmanship and stone vessels productions see studies on India (Roux 2000; Procopiou *et al*. 2013; Procopiou 2013), Egypt (Hester – Heizer 1981) and Iran (Wulff 1966).

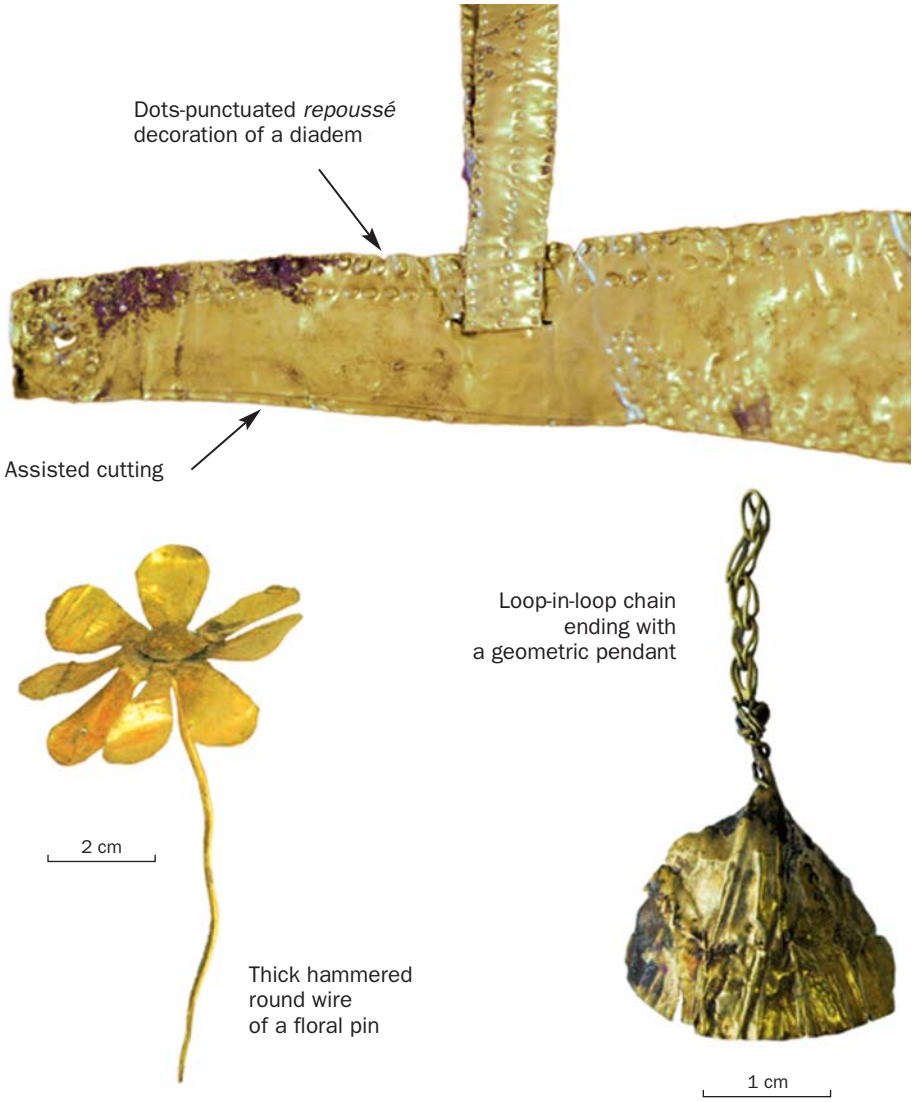


Fig. 1
Examples of gold technology features of Minoan production in Mochlos (© Romain Prévalet).

Archeological Museum of Agios Nikolaos (diadem and pendant)
Archeological Museum of Heraklion, 260 (pin)

dant suspension, and thick wire fabrication for the rod ending the floral pin, seems to have been more frequently used in Crete during the 3rd millennium BCE than in the Levant and Egypt (Fig. 1). Gold pieces, like diadems and pendants from Mochlos, well these local particularities. Furthermore, the lost-wax technique was still rare during the Bronze Age, but it was practiced in Crete and in other regions of the Eastern Mediterranean like Syria (Tell Banat for example) as early as the mid-3rd millennium BCE (Branigan 1983: 15; Prévalet 2013: 64–65, *id*. 2014: 256, fig. 9).

Regarding "sophisticated" techniques like filigree and granulation, Messara is considered as an innovative place. These two techniques of decoration consist in fixing wires and tiny granules arrangements on a gold surface by a soldering process. The anteriority of Levantine and Egyptian techniques is not well established. Although the chronological data do not allow to give a precise localisation of the first places of innovation, it seems that filigree was practiced in Crete during the second part of the 3rd millennium BCE (Early Minoan II–III?) in Platanos, Khalatiana and Mochlos, whereas it does not exist in the Levant before the beginning of the 2nd millennium BCE[4] (Middle Bronze I). Moreover, the granulation appeared most probably simultaneously in Crete, the Levant, and Egypt at the early beginning of the 2nd millennium BCE (Middle Minoan IA in Crete, Prévalet 2013: 343).

Filigree and granulation are always considered as exotic imports from Egypt or/and the Levant (Colburn 2003: 50, 165–66; *id.* 2008), whether by exchange of finished goods or transfer of technologies. However, the transfer of the gold processing technology induces a direct contact between at least two crafsmen and probably a mechanism of apprenticeship. In comparison, the simple observation of finished exotic goods, circulating in the Eastern Mediterranean, is basically not sufficient to initiate a transfer and acquire the neecessary skills. Observation of people working is the first step in the transfer of knowledge but is still not enough; practice and experiments are required.

1.2 Gold Technology Transfers: The Case of Filigree and Granulation

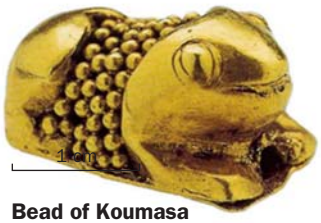
A technological study of archaeological gold pieces is clearly necessary in order to make any suggestions about the identification, nature and frequency of transfer, diffusion, or the imports of artefacts. This study points out that the process features and means of consumption of either technique in Crete are not similar to the Levantine or Egyptian techniques at the early beginning of the 2nd millennium BCE, even if they carry comparable aspects. For instance, the granulation of Koumasa (Middle Minoan IA) is probably contemporaneous with the granulation of Byblos (early Middle Bronze I) and the Egyptian 12th Dynasty of the Middle Kingdom (Dahshur for example; Fig. 2). Experimental tests compared with the results of a microscopic investigation conclude that different processes of granules fabrication may be selected according to several criteria—depending on the technical skills but also socio-economic and technical choices:[5] the size, number, and surface of the granules needed. In addition, although granules can be produced with the same melting process in a reduced atmosphere, the practice of the tech-

[4] But the filigree is attested in Mesopotamia and Syria as early as the mid-3rd millennium BCE. See more recently Nicolini 2010: 70–71; Prévalet 2014: 254–255.

[5] This point is precisely argued in Prévalet 2013: 317–321.

Fig. 2
Examples of gold granulation evidence in the Eastern Mediterranean at the beginning of the 2nd millennium BCE (© Romain Prévalet).

Necklaces of the Princess Khnemet, Dahshur
National Museum of Cairo
(after Aruz *et al.* 2008)



Bead of Koumasa
Archaeological Museum of Heraklion (386)
(after Karetsou & Andreadaki-Vlazaki 2000)

Double Axe of Byblos
National Museum of Beyrouth (DGA 16132)
(after Aruz *et al.* 2008)

niques could take place using different tools—the blowpipe or the brazier. Therefore, we must consider that different know-how is sometimes required for a single technical sequence.

The granules from Koumasa are only attested on two artefacts: the "frog" bead and a bead cap. The granules decorate the edges of the cap while they completely fill the dot-punctuated back part of the Cretan frog. The microscopic examination of the cap element provides accurate technical information (actually unpublished) about the early Minoan granulation (Fig. 3). The granules are characterised by a large calibration of 1 mm diameter (in comparison with a medium calibration used for the "frog" bead after measurements on a scale picture). The morphology of the granules is very regular (although some facets appear, probably caused by the melting process on a flat surface), and the surface is clean and quite smooth. The joints of soldering are thin, almost invisible (even with a magnification of 120x), and certainly the result of copper salt soldering.[6] This technique of soldering, based on the diffusion of copper salts in the gold elements during heating, is particularly suitable for granulation; this soldering process is already known at Troy and in Syria (Tell Banat, Mari) since the second

[6] This process could not be recognised on the "frog" bead without a direct examination.

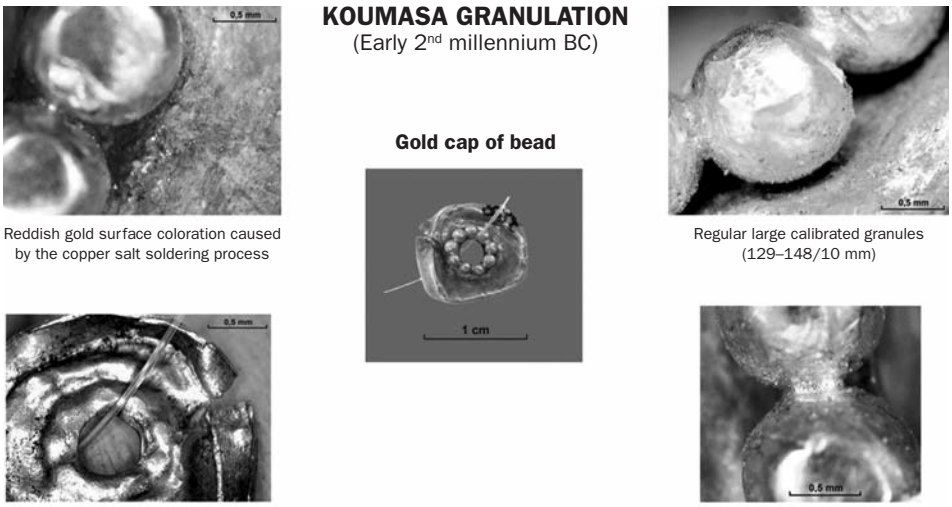


Fig. 3
Microscopic examination of an early Minoan granulated item (© Romain Prévalet).

half of the 3rd millennium BCE (Born *et al*. 2009; Nicolini 2010: 74; Prévalet 2014: 253, fig. 7).

On the contrary, the early Levantine granulation from Byblos is mainly characterised by the use of thousands of granules for the decoration of luxury weaponry elements which are arranged in a linear and geometric pattern; then, the granules are mostly medium-calibrated, around 0.5 mm in diameter, with regular morphology and surface (Fig. 4). The copper salt soldering seems to have been normalised at Byblos while brazing is still employed separately or with the inner process. Finally, another difference occurs with the almost systematic association of granulation and filigree for luxury gold decoration. This Levantine feature does not appear in Crete before 1800–1700 BCE (Middle Minoan II) where it occurs for the first time on the bee pendant of Malia (see the picture in Aruz *et al*. 2008: fig. 32).

These technical differences between the Koumasa and Byblos granulation techniques demonstrate that the technology was not applied in a similar way (in terms of skills and designs) over the Eastern Mediterranean. This does not allow us to conclude that Minoan granulation is an imitation, and even less an import from the Levant. Nevertheless, the existence of Minoan granulation in Crete might have been influenced and stimulated by previous Trojan and Near Eastern granulation as well as the contemporaneous Levantine and Egyptian prototypes.

A comparable point of view could be demonstrated with the techniques of the early Minoan filigree. Gold technology studies and experimental work show that several types of wire were produced during the Bronze Age: round, square, flat, ornamental, plain or not (Oddy 1977, Nicolini 1990: pls. 219–220). Then, a wire

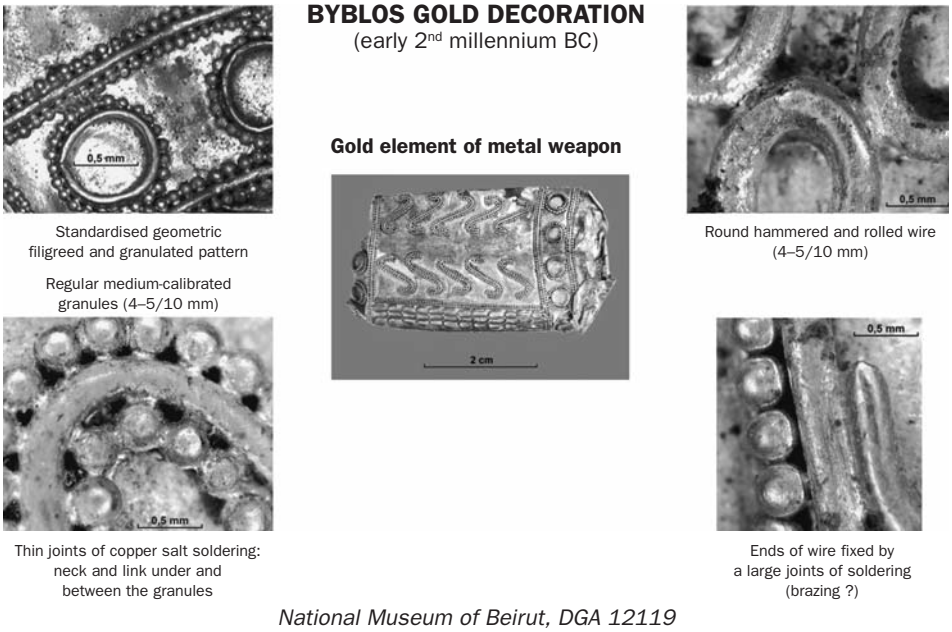


Fig. 4
Microscopic examination of a Levantine granulated item (© Romain Prévalet).

like the round one can be obtained with several techniques that may be identified according to the diagnostic micro-traces on the surface (Prévalet 2013: 94–152). In Crete, the first evidence of filigree, at Platanos and Kalathiana (Fig. 5), shows the use of the round wire in S-spiral shaped on globular or cylindrical beads whereas this pattern does not exist in the Levant and is rare in Egypt. Furthermore, this type of Minoan wire seems to be hollow-twisted—illustrated by large helicoidal seams and flattened surfaces.[7] However, comparison with the early Levantine filigree from Byblos, employed at the beginning of the 2nd millennium BCE, indicates that the round wire is very often used for decorative purposes but it is always plain. During the Middle Bronze Age, filigree is normalised in the Levant at Byblos and Ebla, and is frequently associated with granulation. The filigree is frequently employed to create a framework for granulation designs or a set for stone incrustations on the surface of luxury weaponry or jewellery elements. In Crete, filigree is still rare during the same period and the filigree-granulation association is uncommon.

1.3. Final Remarks on the Identification of Technology Transfer and Knowledge Diffusion

Many other examples can demonstrate that full transfer of gold technology is not attested in Crete whereas stylistic and technological similarities in the Eastern

[7] This technical identification is hypothetical, as I did not directly examine these items at a microscopic scale.

Fig. 5
Evidence of an early Minoan filigree bead (© modified by Romain-Prévalet, after Karetsou – Andreadaki-Vlazaki 2000).

Mediterranean clearly emerged through the 2nd millennium BCE (Prévalet 2013: 343–348). This is particularly recognisable in the decorative techniques and geometric patterns of the bee pendant from Malia which is strongly comparable with the Levantine, Egyptian and Mesopotamian elements (the granulated concentric circle or the three pendants outlined with lines of a thick round wire and granules), or in the treasure of Aegina which is characterised by multiple influences—local, Aegean, Egyptian and Eastern (Fitton 2009). From the mid-2nd millennium BCE, the gold jewellery in Crete shows also fashionable elements of the Mycenaean jewellery like the standardised production of embossed beads (in gold and in glass as well), and the development of natural and animal motifs, both already present in the Minoan gold jewellery tradition.

To conclude on the techniques of filigree and granulation, it could be suggested that these techniques started to be used through different steps: two consecutive periods of innovation (first filigree, then granulation) for Crete and Egypt from the second part of the 3rd millennium BCE to the beginning of the 2nd millennium BCE; a single one in the Levant during the Middle Bronze Age. Although these three regions use both techniques for gold decoration, they are executed through several processes and different methods; the selection of technical sequences depends, therefore, on the technological knowledge of the craftspeople, their experience and know-how, and their specific choices. Furthermore, the *chaîne opératoire* of elaboration of these techniques can strongly differ from one object to another, even within the same region or workshop. The North-Eastern Aegean gold production of the Early Bronze Age (from Troy and Poliochni) must be thoroughly considered in the mechanisms of technological transfer and knowledge diffusion. This is especially the case of the prepalatial Minoan gold jewellery that displays common stylistic and functional features with the North-Eastern Anegean production, as well as the use of similar decorative techniques like *repoussé*, filigree, and granulation. The discussion on the first innovative places (Early Bronze

Age) is essential for the understanding of the technological development and the diffusion of ideas through the Bronze Age. Moreover, the Trojan gold jewellery provides fundamental clues about the technological innovation of gold craftsmanship (filigree, granulation, copper-salt soldering) that make it a rule to globally tackle the questions of invention, production, and transmission throughout the Near East and the Eastern Mediterranean (Prévalet 2014: 254–257).

Thus, the technological study of these gold collections underlines that Crete does not have to be regarded only as a receptive path of foreign knowledge but also as a centre of local and regional artistic creativity and a place of influence for the whole Eastern Mediterranean. Even if the divers centres of production of the Eastern Mediterranean have probably shared similar sources of raw materials, common meanings, socio-economic system, iconographic repertoires, and standardised technologies, the new data on Minoan gold technology reveal that full technological transfers cannot be considered. Indeed, technical elements potentially transferred cannot be precisely and systematically recognised. Finally, it is more likely today to consider several places of production and an Eastern Mediterranean-scale diffusion of some gold techniques, processes, and know-how through external stimulation and various influences, and reciprocal exchanges between the regional centres leading to local creation, development and adaptation.

2. Stone Vessels Industries

The main centres of stone vessel production in the Eastern Mediterranean were located in Egypt, Aegean, Cyprus, Anatolia and the Levant, but during the 2nd millennium BCE, the industry was particularly important in Egypt and Crete. The vases were exported throughout the Eastern Mediterranean, sometimes as diplomatic gifts. This phenomenon, associated with the strong influence of Egypt on the diplomacy and economy of the whole region, suggests that techniques followed the same path: from Egypt to Crete (and by extension from Egypt to the rest of the Eastern Mediterranean). However, such as in the case of goldwork, the technological study of a sample of 469 pieces (Fig. 6) from Crete, the Cyclades, Greek mainland, Egypt, Cyprus and the Levant indicates the coexistence of more complex systems of diffusion and reception of the new techniques.

In order to distinguish these technological transfers from the local innovations, and to reconstruct how the transmissions (and the selection of techniques) were realised, this study focuses on the best-documented part of the manufacturing sequence: the techniques used to hollow out the cavity of the vases.[8]

[8] For example, the traces generated by the drilling (annular grooves, Figs. 8 and 11) or carving (chisel marks, Fig. 16b) processes were often preserved and not erased by polishing, as it is frequently the case with the manufacturing traces on the outside walls of the vessels.

Fig. 6
Examples of Eastern Mediterranean stone vessel productions of the 2nd millennium BCE: a) Vase in shape of a triton shell from Malia, Crete (Aghios Nikolas Museum); b) Jar from Mycenae – mainland Greece (Mycenae Museum); c) Egyptian jar (Petrie Museum, London).

2.1 The Technological Context in the Eastern Mediterranean: Identification of Different Technical Traditions in the Stone Vessels Industries

The reconstruction and comparison of the drilling techniques used in the principal centres of the Eastern Mediterranean indicate, mainly, the development of local knowledge during the Bronze Age. Consequently, the common picture of a technological *koine* really needs to be reconsidered, especially concerning the Minoan and Egyptian industries (Morero 2009; *id*. 2011; *id*. 2013c). Indeed, the Egyptian drilling processes were largely based upon the use of stone borers (Figs. 7a–b). The working of hard stones began with the Predynastic time (5th to 4th millennium BCE).

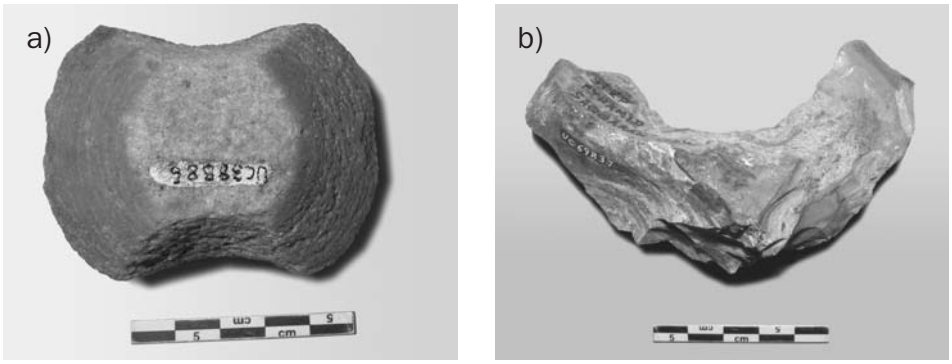


Fig. 7a, b
Egyptian stone borers (Petrie Museum, London): a) figure of eight shaped stone borers b) crescent flint.

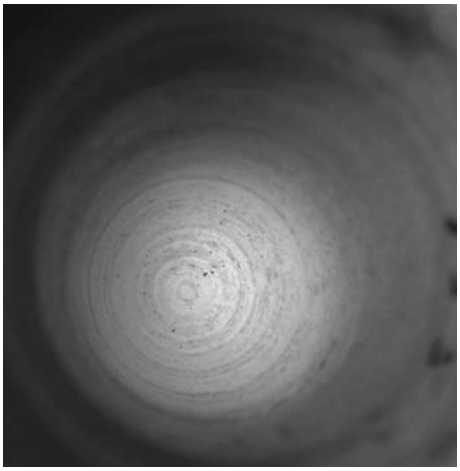


Fig. 8
Annular grooves related to the drilling process in the cavity of an Egyptian jar (Petrie Museum, London).

The traces recorded on stone vases (Fig. 8), and the occurrence in Pre-Protodynastic contexts, such as in the workshop of Hierakonpolis (Quibell – Green 1898: 6), indicate the use of a figure-of-eight-shaped stone borers (Fig. 7a) for the enlargement of the interior space (Stocks 2003), run by a crank borer (Fig. 9). During the Protodynastic phase (end of the 4th millennium BCE) the crescents flint (Fig. 7b) appeared barely for working soft stones such as limestone or calcite (Caneva 1970). According to our tests, series of stone borers, of different sizes, were used successively to enlarge the cavity in a globular shape, or simply to hollow out open conical cavities (Fig. 9).

However, the Minoan workshops reveal the use of a different technology. At the beginning of the industry, during the Early Bronze Age (the first half of the 3rd millennium BCE; Warren 1969: 9 and 182; Evely 1993: 172), the Minoan craftsmen demonstrated their independence by developing their own range of local shapes and manufacturing techniques. More than a specific manufacturing sequence, the originality of the Cretan production consists in the employment of particular drilling tools. Indeed, unlike in other centres of the Eastern Mediterranean, the

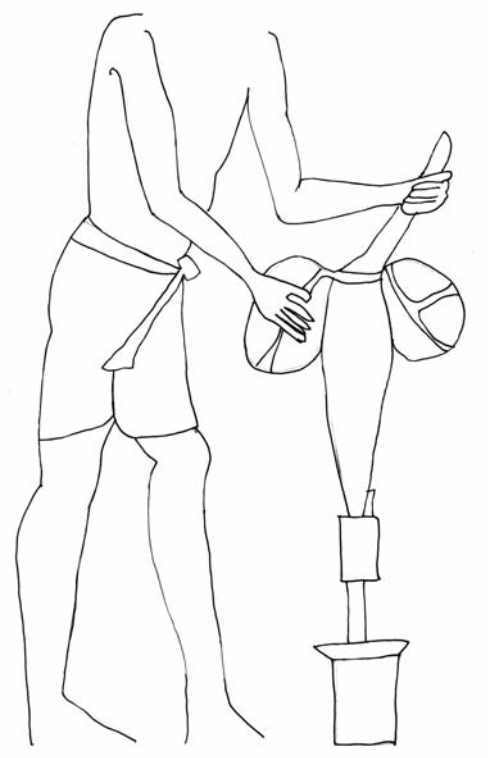


Fig. 9
Drawing of an Egyptian bas-relief (tomb in Saqqara, 2500 BCE) depicting a craftsman with a crank borer (after Caldwell 1967).

hollowing techniques are largely based on the use of solid wooden borers, with a lubricant (water) and abrasives (corundum, sand, etc.).

Plain wooden drill bits (Fig. 10) were employed for the creation of conical open shapes (Fig. 11). A type of elongated wooden borer (Fig. 12), close to the Egyptian figure-of-eight-shaped stone borer morphology, was also used in series for the enlargement of globular shapes. The use of different sorts of tubular drilling could also be identified, depending on the nature of the stone (Morero 2009): stones harder than limestone (e.g. serpentine) were probably drilled with a hollow reed (Fig. 13) or with a copper tube coated with wax, an abrasive and water (Morero 2013a). However, for the drilling of soft rocks (such as soft limestone, for example), the use of a copper tube (Fig. 14) and an abrasive paste, made of grounded corundum and calcite (Lazzarini 2001), is the most probable hypothesis. Unlike the Egyptian workshops, the Minoans used the bow drill to put in motion the various drill bits (Fig. 14).

2.2 The Technological Transfers: The Case of the Tubular Drilling Technique

However, several centres of the region share some techniques and tools, which indicates the existence of transfers. One of the most important was certainly the diffusion of the tubular drilling (Fig. 14). Indeed, this tool presents a number

Fig. 10
Experimental reconstruction of a Minoan wooden drill bit.

of technical advantages. Unlike the solid drill bits, the tube surface, in contact with the rock is much more reduced, limiting the effects of friction that slow the drilling operation. Thus the tube allows to hollow out hard stones faster.

In Crete, soon after the beginning of the industry, a group of new techniques emerged during the Early Minoan II (second half of the 2nd millennium BCE), accompanied by the creation of new shapes. The use of the mechanical drilling process appeared for the first time in connection with the small funerary vases of Mochlos and Archanes. The use of a solid drill bit and tube emerged simultaneously on the island during the Early Minoan II–IIB/III (Evely 1993: 84, 188). A transmission from Egypt, where the technique was already applied in the stone vessel industry, can be assumed and supported by the attested contacts between the two regions during this early period. The hypothesis of an Egyptian diffusion is reinforced by the morphological similarities between the discovered at Mochlos and the early Egyptian vases. The Minoan shapes are inspired by (but are not exact replicas of) the Egyptian ones. Furthermore, small Egyptian vases were often hollowed out with a single tubular drilling operation, as observed in a miniature amphora from Mochlos (Warren 1969: fig. D199). At present, if Egypt appears to be the first centre of the Eastern Mediterranean area to employ the tubular drill for hollowing out stone vases, Egyptian workshops were also the first to use an interior enlargement method which does not require the division of the vase in

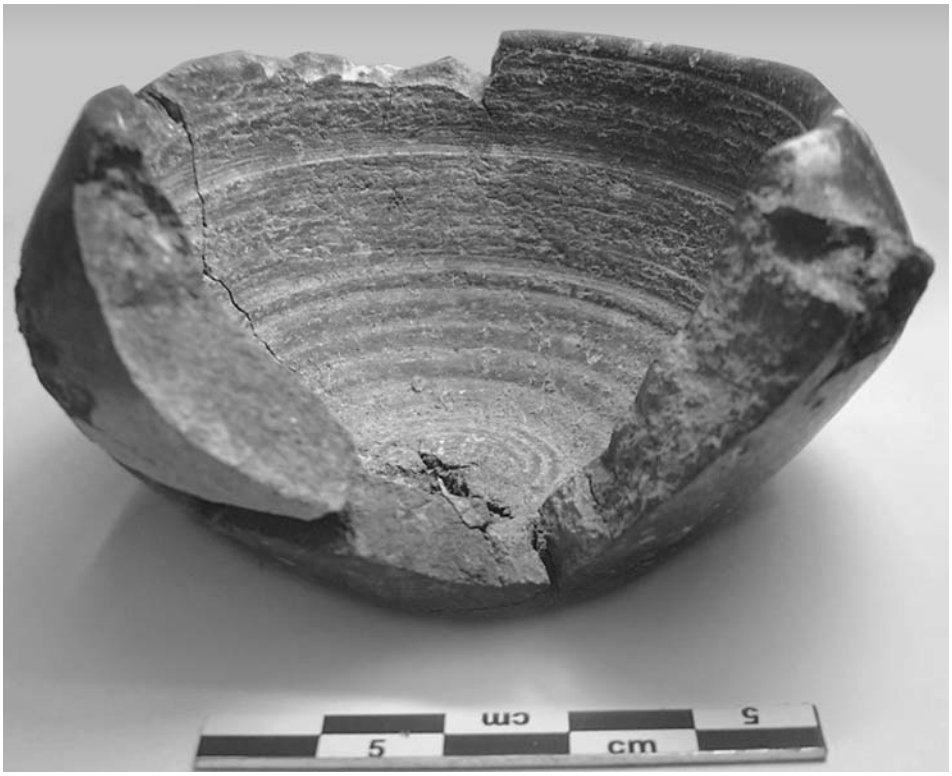


Fig. 11
Minoan vase with annular grooves created by using a plain wooden drill bit (Malia, Crete).

two parts. If the enlargement method seems to have been adopted by the Minoans as well as the tube, the Egyptian tools employed in this operation (stone drill bits) were ignored and were never adopted. The Cretan craftsmen preferred a type of wooden eight-shaped borer (Morero 2009; *id*. 2013a; Morero *et al*. 2008). Only specific technical elements were introduced and not the totality of the Egyptian manufacturing sequences and techniques.

These elements were then shortly employed for producing purely Minoan shapes and style. Thereafter, the use of the tubular drill spreads, as perfectly illustrated by the production of the protopalatial period (Midle Minoan II), which can be characterised as a phase of maturation and diffusion of the new technologies in Crete itself (like the metallic tubular drill coated with beeswax, see Morero 2009; *id*. 2013a; *id*. 2013c). During the first palatial period, the manufacturing sequences and processes were also systematised and spread by contact between craftsmen, which would certainly have been encouraged by the palatial system. Furthermore, the establishment of what can be seen as "technical territories" is observed at that period (Morero *forthcoming*).[9]

Then, with the emergence of the new palaces, stone vessels produced by highly skilled craftsmen begin to appear in Minoan Crete, sometimes requiring complex techniques, which seem predominantly locally developed. These facts indicate a strong

Fig. 12
Experimental reconstruction of an elongated wooden borer.

technical tradition during the neopalatial period and the existence of skilled craftsmen, sometimes inspired by Egyptian forms or iconography (adapted to Minoan taste),[10] but using Minoan technology. This phenomenon also occurred in the neopalatial industry of transformation of Egyptian stone vessels in artefacts of Minoan style, especially visible at Knossos, Zakros and Malia (Warren 1969: types 19B, 43 A3 and A8).

Minoan know-how was also transmitted and adopted in the Cyclades and mainland Greece during the 2nd millennium BCE, especially the tubular drilling, applied in the manufacture of stone vases (Morero 2011a; *id.* 2015). However, the system of introduction followed by the new techniques seems to be different. The workshops in the Cyclades adopted at the same time the whole Minoan repertoire of techniques and shapes. This radical mutation of the production in the Cyclades during the 2nd millennium BCE was certainly connected to the establishment of Minoan craftsmen, producing for a local Minoan clientele (Morero 2013a; *id.* 2013c). On the other hand, on the Greek mainland, a Mycenaean industry appeared in the LH III period, which

[9] A technological preference (or tradition) in certain regions was also recognised for the protopalatial period regarding the ceramic production (see for example, Knappett 1999).

[10] For example, a Minoan plaque from Malia, with a sphinx molted in relief (HM 19818) is a Minoan imitation of an Egyptian motif (Poursat 1980: 116–118; Warren 2005: 221–226); however, the craftsman has adapted the Egyptian symbol in a local style with a new Minoan meaning (Poursat 2000: 29).

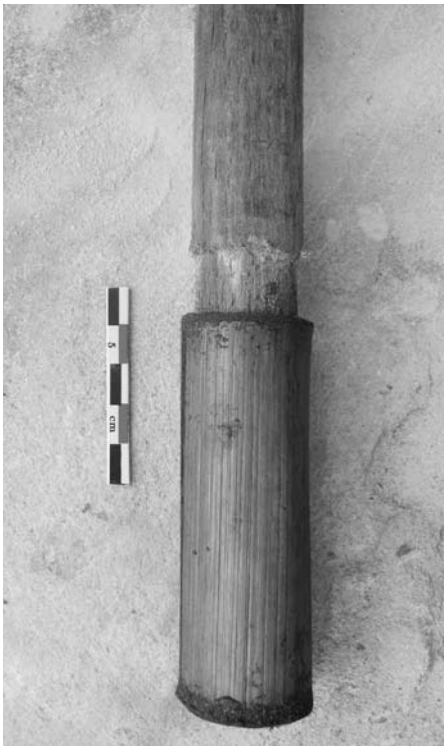


Fig. 13
Hollow reed used in experimental reconstruction of the drilling process.

suggests a link with Minoan technology. A great part of the Mycenaean know-how derives from contact with Minoan craftsmanship. However, if a large number of technical elements (use of tubular drilling for the hollowing process, production of vessels in several parts) may come from a Minoan heritage, the Mycenaeans developed, soon after, their own approach—with their own technological emphases, serving purely Mycenaean forms (Morero 2015).

The transmission of a Minoan tool to the Egyptian workshops seems also to occur. Indeed, after the 4th Dynasty (second half of the 3rd millennium BCE), the flint crescents and the stone borers seem to disappear in Egypt, to reappear only during the Ptolemaic period. However, the marks observed in several stone vases suggest a generalisation of a drill bit, morphologically close to the figure-of-eight-shaped borer, for working both soft and hard stones. But the complete absence of occurrence suggests the use of tools made of a perishable material such as wood. The employ of this process in Crete, as soon as the Early Bronze Age, and the attested contact with Egypt at this time, might infer the transmission of this Minoan tool to the Egyptian workshops.

2.3 The Production of Imitations of Egyptian or Egyptianizing Vessels

More generally, two groups of vessels can be distinguished in the Eastern Mediterranean during the 2nd millennium BCE: 1) stone vases of local forms and style and

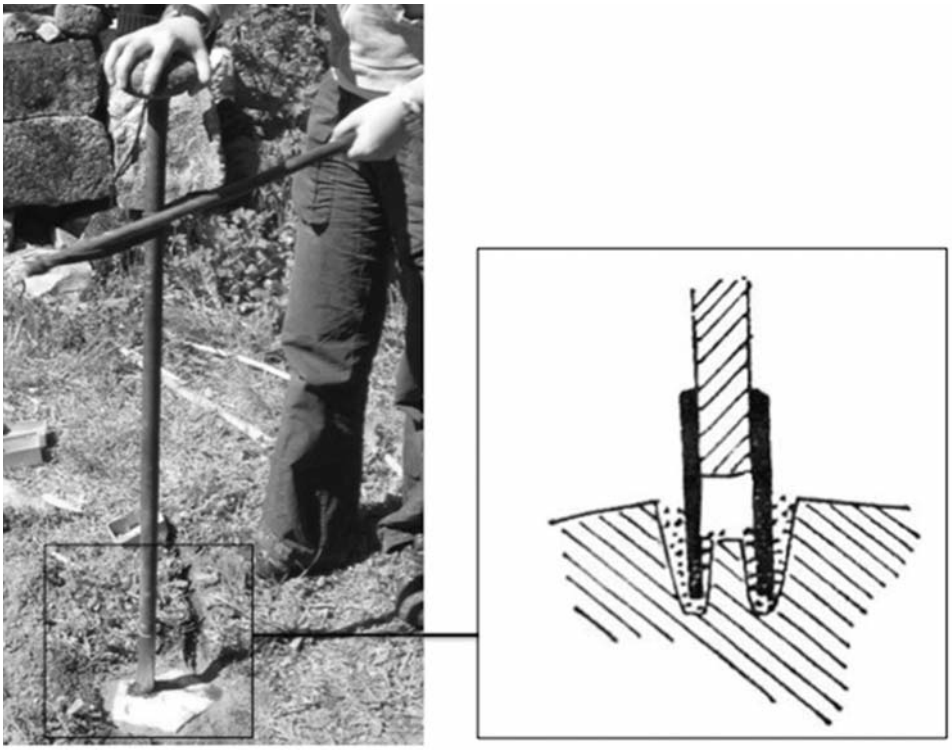


Fig. 14
Experimental reconstruction of tubular drilling, with a copper tube.

2) copies of Egyptian or Egyptianizing forms and style. The industries of imitation existed especially in the North and South Levant, Cyprus and Crete. If this last group clearly reflects the high prestige of Egyptian culture during the Middle and Late Bronze Age, what do the techniques of production reveal?

In the Levant, the products of local morphologies were usually carved in soft greenstone like chlorite, serpentine or soapstone (Caubet 1991: 206). At least a part of this production was hollowed applying mechanical drilling techniques (Woolley 1955: 293). The group of Egyptian/Egyptianizing shapes of vessels is more complicated to interpret and the identification of the manufacturing techniques is one of the reliable criterions to find the provenance of the piece (Ben Dor 1945; Lilyquist 1996). Thus, Egyptian or Egyptianizing vases are divided into three groups: 1) vases with Egyptian shapes and technology, 2) vessels with Egyptianizing shapes and Egyptian manufacturing techniques, and 3) objects with Egyptianizing morphologies but a non-Egyptian know-how.

The employment of Egyptian manufacturing techniques is specific to the workshops of the North Levant (groups 1 and 2), as indicated by the morphology of the drilling traces on the stone vessels from Qatna or Ras Shamra (Morero 2011a; 2011b). The observed recurrent shape variations (some small jars are often oval in plan in the Levant and circular in Egypt), or the drilling sequences, provide strong evidence of a Levantine origin of these objects. The production was probably con-

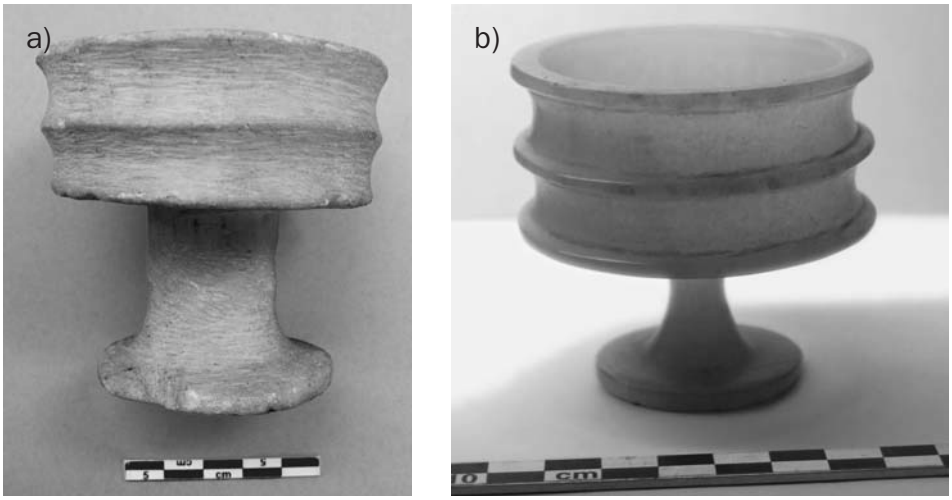


Fig. 15
a) Copy on an Egyptian tazza from the South Levant (University College London, Petrie Collection); b) Egyptian tazza (Louvre Museum, Paris).

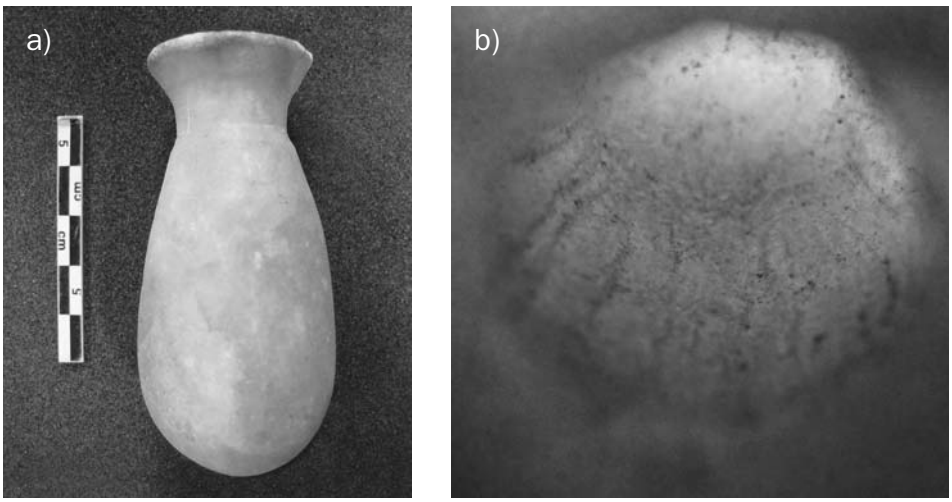


Fig. 16
a) South Levantine copy of an Egyptian jar from Jericho (Ashmolean Museum, Oxford);
b) Chisel traces inside the jar cavity.

sidered as a luxury one. Indeed, copying Egyptian shapes and techniques, as well as using Egyptian stones,[11] should add a certain value to the object (Figs. 15a–b). However, apart from these local imitations, the stones, shapes and drilling techniques of some stone vases found in the region also indicate a genuine Egyptian origin.

The South Levantine industry is mainly known from highly standardised gypsum copies (Figs. 15a and 16), produced in a very limited range of shapes (ovoid jars and *tazze* especially), with radically different types of techniques (Ben Dor

[11] The small jars with a collar, the ovoidal or baggy jars, and the small juglets were generally carved into white stones imitating the Egyptian calcite vessels. The Levantine craftsmen employed local limestone or calcite blocks imported from Egypt. The use of gypsum is rare.

1945; Sparks 2007). Indeed, the chisel is the only tool used for hollowing out the vases (Fig. 16b). It is therefore the demonstration of a technical and cognitive scheme which is totally different. In this case, the separation between the copy of a shape (or a part of the shape) and the techniques used for its realisation can be observed.

The stone vessel production in Cyprus is relatively limited in the Bronze Age and appears mainly during the Late Bronze Age. The majority of the vases is Egyptian/Egyptianizing in type and was carved in poor quality local gypsum. The techniques used are, as in the South Levant, different from those identified on the Egyptian material. The chisel seems to be used particularly, but sometimes a kind of hybrid technique, based on the employment of chisel and drilling processes (Bevan 2007), was identified.

Thus, the production of imitations of Egyptian or Egyptianizing vessels revealed two different ways of dealing with foreign techniques, which uphold the distinction between morphology and technology. How to interpret this diversity?

2.4 The Means of Transfers in the Stone Vessel Industries

As previously mentioned in connection with the goldwork industry, the introduction of foreign processes required direct contacts between craftsmen and a system of apprenticeship. At least for the stone vessel production, the observation of an operator at work is required. Contacts between craftsmen in the Eastern Mediterranean are attested by textual evidence, indicating the presence, permanent or temporary, of royal craftsmen sent to other courts (Zaccagnini 1983). The presence of Egyptian lapidary craftsmen was also possible for Minoan sites like Malia (Morero 2009: 446–447; *id*. 2013b: 11). Similarly, the presence of Minoan craftsmen in the production of stone vases appears in the Near East, at Alalakh (Woolley 1955: 294),[12] in the Cyclades or on the Greek mainland. This suggests the possibility of direct transfers of technology.

The introduction of foreign know-how did not necessarily follow the traditional scheme of transmission: from a dominant centre to a more modest one. If the diffusion of Egyptian techniques to Crete and other regions of the Aegean world is attested, Crete also transmitted processes to the flourishing Egyptian workshops, such as the figure-of-eight-shaped wooden drill bits. But if the techniques were not necessarily intended as a direct mark of prestige, the style and shapes, however, were the first elements for the expression of the symbolic value. As a matter of fact, the vessels made in Egypt were placed in royal tombs in Crete and the Levant, and were also, as we have seen, imitated.

[12] The presence of Minoan craftsmen in the Levant and Egypt is also attested by the frescoes (Niemeier 1991: 196, 199; Bietak 2000).

The industry of copies involved several questions concerning the technical transfers. Indeed, different ways of dealing with the foreign techniques were identified. Why did the North Levant adopt in the same time techniques and shapes wholesale but not the South Levant or Cyprus? This is perhaps the result of the permanent or temporary settlement of Egyptian craftsmen at Ras Shamra or Qatna who made these products or at least ensured the transmission of the technological knowledge. Indeed, the migration of Minoan craftsmen seems also to be at the origin of the radical mutation of the Cycladic production during the Late Bronze Age (Morero 2011a). Similarly, if a technique can be adopted for its efficiency (gain of time, energy invested, raw materials, etc.), its introduction reflects the existence of a favourable technical environment. On the contrary, when the technique is rejected, this environment does not yet have the means to receive the new process (Leroi-Gourhan 1945). Indeed, the tubular drilling is extremely convenient, as it allows working hard rocks in a minimum of time. It is also quite simple and quick to learn. However, if Crete, the Cyclades and the Greek mainland adopted this technique, the South and North Levant, as well as Cyprus, seem to ignore it completely for both local and imitation industries.[13] Thus, other constraints need to be investigated and the rejection of certain know-how could rather be related to the existence of a strong local technical tradition.

Conclusion

The gold working and stone vessel industries reveal a picture that is more complex than the traditional scheme of the wholesale transmission of techniques from the dominant centre (Egypt) to the dominated periphery (Crete and the Levant).

The technical processes applied in Crete are not only the result of transfer and adaptation of foreign processes (stone vessels) or diffusion of knowledge (gold) but also of local innovation and stimulation of craftsmanship through networking and reciprocal contacts between Mediterranean centres (as attested by archaeological evidence and by texts).

The transmission of foreign techniques required direct contact, and the ways in which local craftsmen dealt with them were strongly connected to the socio-political context. It is possible that the development and maintenance of local processes of production had, for a part, a political meaning. We need to consider the possibility that technological choices could have been the expression of strong (and independent) power, a demonstration by local elites that they owned skilled and inventive craftsmen.

[13] The exception is perhaps the North Levant, where some examples of Egyptian imitations may suggest its use. Similarly, an unachieved lamp of Minoan shape at Alalakh (North Levant) represents an isolated occurrence of the use of the tube and could be the work of a Minoan craftsman.

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