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# THE BELL BEAKER TRANSITION IN EUROPE

MOBILITY AND LOCAL EVOLUTION  
DURING THE 3RD MILLENNIUM BC

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*edited by*

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*Front cover: All Over Cord Beaker from Bathgate, West Lothian, Scotland. Photo: © National Museums Scotland*

*Back cover: Cushion stones, gold ornaments and Beaker pottery in the artificial cave of São Pedro do Estoril, Portugal (Blech et al. 2001, pl. 70b; © P. Witte, Deutsches Archäologisches Institut, Madrid)*

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# EARLY GOLD TECHNOLOGY AS AN INDICATOR OF CIRCULATION PROCESSES IN ATLANTIC EUROPE

*Barbara Armbruster and Beatriz Comendador Rey*

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*This paper deals with goldworking technology, more precisely with the manufacturing processes and tools used in Atlantic Europe during the Copper Age and the beginning of the Early Bronze Age. It takes an interdisciplinary approach to the study of the technological aspects of early fine metalworking crafts.*

*Along with copper, gold was one of the first metals used by early metallurgists. Atlantic Europe is rich in gold artefacts attesting to the use of particular types of ornaments, from southern Portugal up to the north of Scotland. Precious metal objects are valuable goods with symbolic meaning used in rituals as well as in funerary contexts. They also had an important social function for gift exchange between elites and for demonstration of power. Gold artefacts can indicate cultural contact leading to the exchange of technological and artistic know-how.*

*One purpose of this paper is to investigate the traces of exchange and circulation processes in the archaeological record so as to be able to reconstruct the goldworking craftsmanship of the past.*

*The second purpose is to present an interdisciplinary approach to the analysis and definition of the early art of goldworking. Finally, the role of metal technology in tradition, innovation, contact and cultural change for understanding of early metal-using societies will be discussed.*

## **Phenomenology**

Early metallurgy in Atlantic Europe is rich in gold artefacts attesting to the use of particular types of ornaments, from southern Portugal up to the north of Scotland. This paper deals with early metal technology, in particular the manufacturing techniques, workshops and tool equipment of fine metalworking in Atlantic Europe during the Copper Age and Early Bronze Age. It focuses on the production of early sheet ornaments and takes an interdisciplinary approach to the study of the technological aspects of early fine metalworking crafts (Armbruster and Guerra 2003).

Gold is a rare metal, whose magical power derives from its shining, sunlike colour and its resistance to corrosion – its inalterability. The noble metal played an important role in all late prehistoric cultures (Bachmann 2006). The craft of goldworking and its products were anchored religiously, socially, and economically in Copper Age and Early Bronze

Age societies, of which some adopted Bell Beaker pottery while others did not. A considerable number of gold objects are known of from the beginning of metallurgy in the 3rd and 2nd millennia BC in western Europe, owing to the custom of depositing valuable things in graves. Even so, a precise estimation of the actual occurrence of gold is problematic, since we are aware of only part of early gold production. Most of the earliest artefacts made of gold from the Atlantic area were found in funerary contexts, predominantly in male inhumation graves. In these contexts they are usually associated with Beaker pottery, copper weapons and stone wrist-guards, as in the case of the Bell Beaker grave of Pago de la Peña (Zamora, Spain), which has gold strips, or in the artificial cave Gruta de São Pedro do Estoril (Portugal), where small gold wire spirals were found (Maluquer de Motes 1960; Gonçalves 2005). In some regions of Atlantic Europe metal appears in association with Bell Beaker pottery

in funerary contexts (Comendador 1998). But there are many other cases of isolated finds, which in some instances can be interpreted as intentional depositions.

The gold artefacts produced testify to a specialised craft with a considerable technical and aesthetic standard. The goldsmith, who knew how to work with valuable materials and whose task was to make important valuable goods and ritual objects, is therefore to be seen as a figure that stood out within society. Richly furnished graves of the Late Copper Age, like that of the aforementioned Amesbury Archer in Wiltshire in Britain, containing gold and bronze finds as well as stone metalworking tools, are considered proof of the high social esteem in which the early metallurgists were held (Fitzpatrick 2002).

### Morphology and technology

There are several aspects involved in the creation and conceptualisation of the artefact: aesthetics, symbolism, and the technology used in its materialisation. The traditions of early goldwork started with two-dimensional sheet objects, but later developed into manufacturing techniques that included hammering to shape three-dimensional gold objects such as vessels and other objects. The earliest objects in the west are thin gold sheet artefacts crafted using a two-dimensional concept, as well as small wire spirals (Eluère 1977; Taylor 1980; Perea 1991). The predominant types of gold items associated with Bell Beaker are personal ornaments, such as ear pendants, diadems, neck ornaments, cylindrical wire spirals worn most probably in the hair and on a finger, and decorative sheet appliquéés. There are artefacts present in the archaeological record of early metalworking which have the same morphology and were made with the same techniques. This is the case of disappeared “sets” like the one from São Bento de Balugães (Barcelos, Braga, Portugal) which had a cylindrical collar with parallel bands cut in a flat gold sheet and Palmela points (Estacio da Veiga 1891, pl. 4, 2; Schubart 1971, fig. 86), or assemblages that have reappeared, like the one in Cícere (Santa Comba, A Coruña, Spain) with a similar ornament on which we can observe the marks made during the cutting of the parallel bands (Armbruster *et al.* 2004, fig. 4).

The technological study of the manufacture of certain objects can help to determine their chronological position. This is the case of the Urdiñeira assemblage (A Gudiña-Riós, Ourense) constituted by two gold bracelets and a “sun disc” in bronze. We suggest that this hoard could date from the Late Bronze Age, because it can be linked to a solid gold bracelet made using the lost-wax process technology (within the framework of the Villena-Estremoz technological domain system) and also due to the bronze composition of the sun disc (Comendador and Méndez 2008; Lackinger and Comendador 2013).

The exceptional physico-chemical properties of the metal played a decisive role in the development of early gold technology (Gmelin 1950–4). In early metallurgy native gold washed from alluvial deposits was used as raw material. This is a natural alloy of gold, with a tiny proportion of copper and, depending on the deposit, up to 50% silver. Deliberately made gold alloys did not appear in this early stage of gold metallurgy. Gold is a very dense precious metal (density 19.34), highly suitable for the manufacture of jewellery and ornamentation by means of casting or plastic shaping techniques. Its melting point is around 1000°C. To reach this temperature the charcoal furnace must be fitted with a bellows. Gold is very malleable and can be burnished to a high lustre. It is hardened in cold-working by hammering, chasing, punching or bending. To avoid cracking, gold is annealed at approximately 750°C. Annealing recrystallises the metal structure after it hardens or becomes brittle during plastic deformation. Goldworking took place in a cooled state, except for melting, casting, and annealing. As gold is resistant to most chemical influences its shining colour stays unchanged, even after millennia. Before any goldwork is begun, an idea of the form, decoration, and art of the technical realisation of the desired object is developed and the quantity of metal measured.

Most early gold artefacts are made of sheet with the exception of cast beads. Hammered gold objects were produced from a primary cast product, as large gold nuggets are extremely rare. The cast was made in moulds of charcoal, stone, metal, or clay, but unfortunately no casting moulds for goldworking are known from this period. For casting, the natural gold alloy had to be melted in a clay crucible in the blazing heat of the charcoal and then poured into the mould. The preliminary cast product was then worked by plastic shaping techniques such as hammering, chasing, punching or bending.

Hammering is the most common type of goldwork used during the Copper Age and Early Bronze Age. A thin sheet is hammered into shape by several consecutive steps of plastic shaping of a gold ingot using repeated annealing during the deformation process. Analogies from ethnoarchaeology and iconography give hints about the working position of early metallurgists as well as the tool equipment of the workshop. For instance, traditional goldsmiths from Mali, western Africa, sit on the ground while hammering (Armbruster 1993, fig. 6). A 16th century German chronicle, the *Hausbuch der Mendelschen Zwölfbrüder-Stiftung zu Nürnberg*, shows a craftsman producing large quantities of metal sheet strips while sitting on a stool (Treue *et al.* 1965).

### Metalworking tools

Direct proof of goldworking is exceedingly rare for the earliest gold metallurgy, because of the absence of any

features which would identify workshops, crucibles or casting moulds for precious metal. The metalworking tools needed in plastic shaping techniques are anvils and hammers, which, during this period, were made of stone. Cushion stones are stone tools with flat surfaces used in metalworking (Armbruster 2010, 14–16). The grave goods found in the artificial cave of São Pedro do Estoril (Portugal; Fig. 12.1), contain this kind of goldsmith's equipment: two cushion stones associated with gold wire spirals, stone wrist-guards, copper daggers and Bell Beaker pottery, interpreted as a tomb of an early metallurgist of high rank in society (Brandherm 2011, 319–321). A comparable set of cushion stones, other stone tools and copper objects, such as a flat axe and a Palmela point, were also found in the megalithic monument of Seixas (Viseu, Portugal; Fig. 12.1) (Armbruster 2006, 174; Brandherm 2011, 321).

We are familiar with these types of stone implements from ethno-archaeological studies carried out in Latin America and Africa. The stone tools used by the goldsmiths from mid-coast Peru include stones of various different shapes. Garcilaso de la Vega (ca. 1539–1615) describes stone hammers without handles used by the goldsmiths from Cuzco (Peru) (Lothrop 1950). Stones were used for hammering, held and guided directly by the hand without any hafting of the stone. One illustration shows a Peruvian goldsmith making a gold bowl using a stone hammer and a large stone anvil in the *Chronicle* of Girolamo Benzoni from the 16th century AD (Benzoni 1565) (Fig. 12.2). Working iron with these tools is historically documented in an ancient chronicle of the kings of Angola from the 17th century AD (Cavazzi 1687).

We can document the use of these stone tools in metallurgical workshops dating from the middle of the 3rd millennium BC (2500 BC), based on the iconographic information offered in the depictions of the Egyptian tombs of Ti and Mereruka: stones clutched in the hands, stones used to manipulate the crucible during the melting process, and stone hammers and anvils (Scheel 1989; Garenne-Marot 1985). Different metalworking tools and a group of goldsmiths are depicted on a wall painting at the tomb of Rehmire, near Thebes, dating from the middle of the 2nd millennium BC (1450 BC) (Fig. 12.2). The goldsmith's tools used in this Egyptian fine metalworking workshop are: furnace, blow-pipe, tweezers, anvils made of bronze (copper-based alloy) fixed in a block of wood, hammer stones and a copper-based punch or chisel. The techniques illustrated refer to the polishing and metal rising of a silver vessel, decoration by chasing and hammering for shaping metal sheets.

The functionality and effectiveness of metalworking stone tools can be verified by means of experimental archaeology (Armbruster 2006, 181; Freudenberg 2009). The working process leaves traces of metal on the surface of the tools, and hammering marks on the metal artefact. The

first work in experimental archaeology on stone tools for metalworking was carried out at the Römisch-Germanisches Zentralmuseum in Mainz (Germany) by H. J. Hundt, (Hundt 1975). He produced copper pins and daggers by hammering with stones fixed in wooden handles and a stone anvil.

In early metal production, we can find tools of different shapes, both wide and narrow, such as the stone hammers of Vaucluse and Belle Île (Morbihan, France), exhibited at the Musée d'Archéologie Nationale in Saint-Germain-en-Laye (Armbruster 2006, 176). Stone hammers are known to have existed all along the Atlantic shore, but no comprehensive study yet exists. Some regional studies offer a glimpse of the large quantity and variety of such early metallurgist's tools (Brandherm 2000; Boutoille 2012).

The richest and most famous grave of its kind is the burial site of the Amesbury Archer (Wilshire, southern England), found in 2002 near Stonehenge (Fitzpatrick 2009). It is the earliest evidence that could be interpreted as a rich metallurgist's grave. Apart from the cushion stone, the funerary assemblage of the man from Amesbury contains a pair of gold earrings, wild boar tusks, flint arrowheads, a copper knife and dagger, several Bell Beakers, wrist-guards and other knapped stone objects, reflecting a wide range of valuable objects related to high status. Another rich assemblage that has been known of since the 1930s is the Kirkhaugh assemblage (Northumberland, UK), consisting of a gold earring, a stone hammer made from an axe, a cushion stone and a Bell Beaker, with other stone objects (Maryon 1936).

There are graves with implements of metallurgists who worked with copper and gold all along the Atlantic coast, including the Netherlands, dating from the period of the use of Bell Beakers. In Holland, in the 1960s, using a systematic approach, Jay Butler and Dideric van der Waals were the first archaeologists to define the term “cushion stones”, and to identify this kind of funerary context and the implements associated with it (Butler and van der Waals 1967). Based on the comparative study of these specialised stone tools, the Lunteren Bell Beaker assemblage was interpreted as the burial of a craftsman, a metallurgist.

### Form and function of early gold ornaments

The predominant morphologies of gold artefacts produced in early metal production were thin decorative sheet appliqué hammered to shape ornaments such as diadems and wire spirals. Holes were pushed through on the corners or ends of sheet ornaments with a conical metal point, serving as a means of fastening them onto cloth or other material.

A couple of gold sheet diadems are associated with a cylindrical collar with parallel bands cut in a flat gold sheet (so-called *gargantilla de tiras*) in the group from Cícere (Santa Comba, A Coruña, Spain) (Fig. 12.3). They were



Fig. 12.1. (Above) Cushion stones, gold ornaments and Beaker pottery in the artificial cave of São Pedro do Estoril, Portugal (Blech et al. 2001, pl. 70b; © P. Witte, Deutsches Archäologisches Institut, Madrid); (below) stone tools for metalworking in the megalithic monument of Seixas, Viseu, Portugal (Leisner 1998, pl. 3: 1, 3, 5, 12, 30, 31).

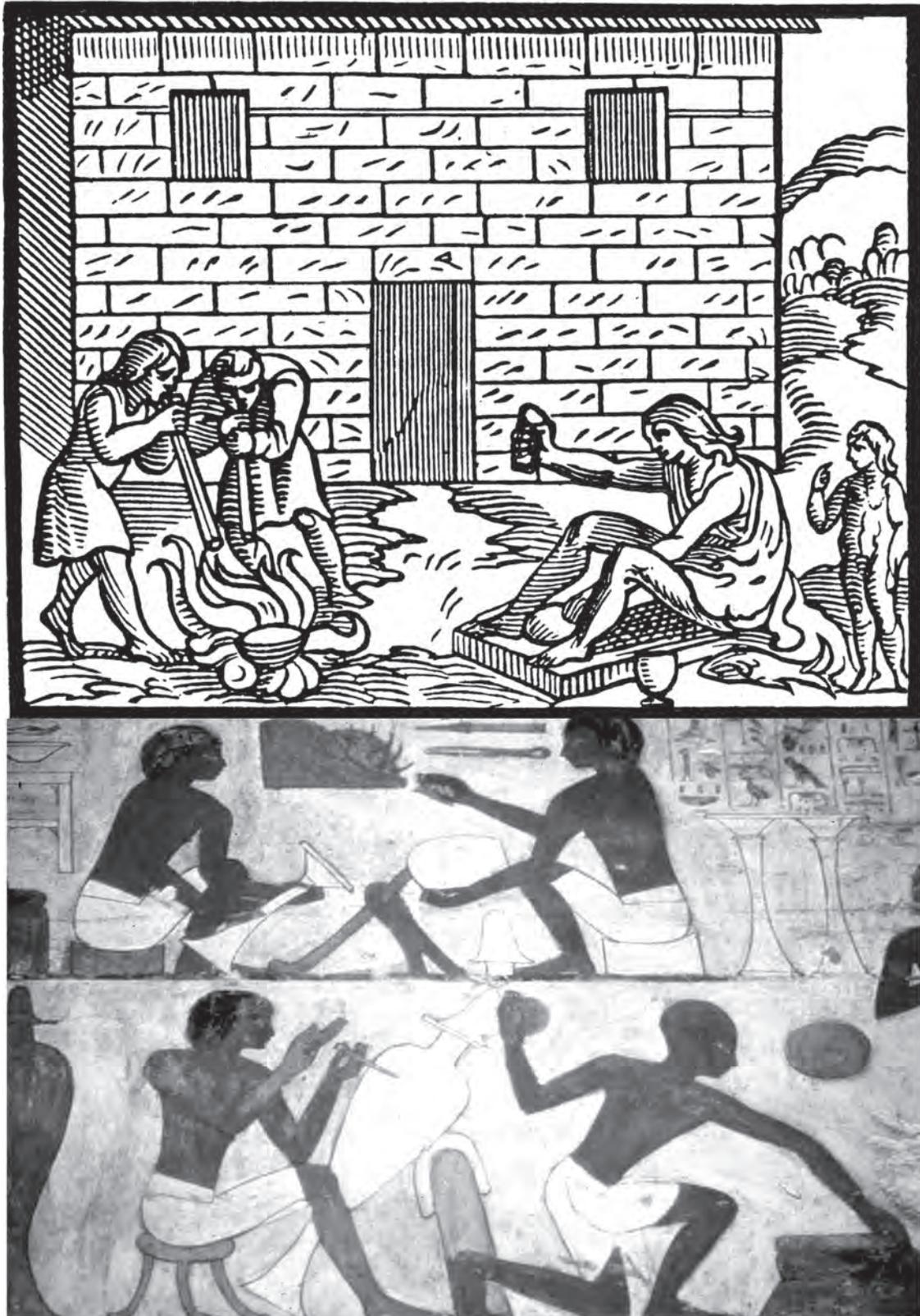


Fig. 12.2. (Above) Depiction of Peruvian goldsmiths making a gold bowl using a stone hammer and a large stone anvil from the *Chronicle of Girolamo Benzoni*, 16th century AD (Benzoni 1565); (below) depiction of stone tools and metallurgical workshops in the Egyptian tomb of Rehmire (© B. Armbruster).



Fig. 12.3. (Above) Gold sheet diadems; (below) cylindrical collar with parallel bands cut in a flat gold sheet (so-called *gargantilla de tiras*) from Cicere, Santa Comba, A Coruña, Spain (© B. Armbruster).

made from a rectangular hammered gold sheet. A part of the long sheet has parallel bands that were cut in a flat gold sheet before it was bent into a cylindrical shape. This particular design exists in several comparable items of distinct size (collars, bracelets, rings), with a distribution ranging from Portugal, throughout Spain, to France (Armbruster *et al.* 2004). One *gargantilla de tiras* is associated with two solid gold bracelets in the group of A Golada (Pontevedra, Spain), pointing to a relation with later artefacts, comparable to the As Silgadas assemblage (Caldas de Reis, Pontevedra, Spain) (Comendador Rey 1998a). The Caldas de Reis hoard represents the heaviest late prehistoric gold hoard from Atlantic Europe ever found. It contains small fragments of this type of ornament.

There is some controversy as to the chronology of the hoard of As Silgadas. We believe that the assemblage comprises artefacts from different chronologies (Comendador Rey 1998b; 2010). Fragments of a cylindrical collar with parallel bands cut in a flat gold sheet are dated to the Chalcolithic or Early Bronze Age. However, the three solid gold bowls were made with the lost-wax process, although their shapes, as well as the comb, remind us of ancient models (Armbruster 1996). The decoration of the bowls is considered to have been made with a lathe. However, the parallel lines of the

decoration could have been made with a metallic point fixed to a marking gauge. With regard to the lost-wax process, it had been widely introduced in the Iberian Peninsula during the Late Bronze Age, but the existence of this technique was known previously in the eastern Mediterranean, and not only for vessel production. So, until the new review comes out, we would propose that the chronology of the hoard to be around 1400–1000 BC.

Tubular beads, decorative appliqués and ear ornaments are other characteristic shapes of early gold sheet work (Hernando 1983; Eluère 1977; Armbruster and Parreira 1993, 176–179 and 206–211). Massive olive-shaped or bi-conical beads and small wire spirals also figure in gold assemblages from graves with Bell Beaker vessels.

Ear pendants are found from Portugal to the British Isles. This is a very characteristic piece of jewellery of the early metal production of western Europe, dating from the period of use of Bell Beakers or the Early Bronze Age in the British Isles according to the regional chronology. For example, the pair of leaf-shaped ear pendants from Emergeira (Torres Vedras, Lisbon, Portugal; Fig. 12.4) is stylistically and technologically very close to an Irish sample, considered to proceed from Castletreasure (Cork, Ireland) (Armbruster and Parreira 1993, 154–157; Taylor 1980, pl. 3). They are made of hammered sheet with a hook-like appendix, made of one gold piece. There are flat oval or leaf-shaped examples and also partly rolled examples, the so-called basket earrings. These ear ornaments decorated with punched geometric motifs are mainly found in pairs (Russel 1990). This kind of rolled sheet earring continued to exist until the Late Bronze Age in Belgium (Warmenbol 2004). In the British Isles there are examples of rather large ear ornaments made from a thin oval gold sheet, such as the one from Orbliston, Moray (Fig. 12.4) (O'Connor 2004, 206 fig. 18.1).

Another characteristic artefact type from Beaker and Early Bronze Age contexts are the archers' wrist-guards (Fokkens *et al.* 2008). Most of them are made of stone, bearing holes for fastening the plate onto the arm. Others were fixed with rivets, most probably on a leather band. We know of rare examples with gold rivets or, to be more precise, copper rivets covered with thin gold sheet, like the wrist-guard from Culduthel (Inverness, Scotland; Fig. 12.5) (Ritchie and Ritchie 1985, 64 fig. 41). In this case the rivets are clearly ornamental elements besides being functional. The only gold specimen known is the one from Vila Nova da Cerveira (Portugal; Fig. 12.5) (Armbruster and Parreira 1993, 148–151). This gold wrist-guard is a purely decorative prestige object, with no practical function. It is made from a thick gold plate decorated with four chased pseudo-rivets, which have no practical purpose. Rivets are generally functional elements on stone wrist-guards serving to hold the plate in place. The gold specimen bears two perforations that could be used to fasten it.

The last gold sheet ornaments that we consider here are



Fig. 12.4. Earpendants: (above) Emergeira, Torres Vedras, Lisbon, and Estremoz, Evora, Portugal; (below) Orbliston, Moray, Scotland (© B. Armbruster).

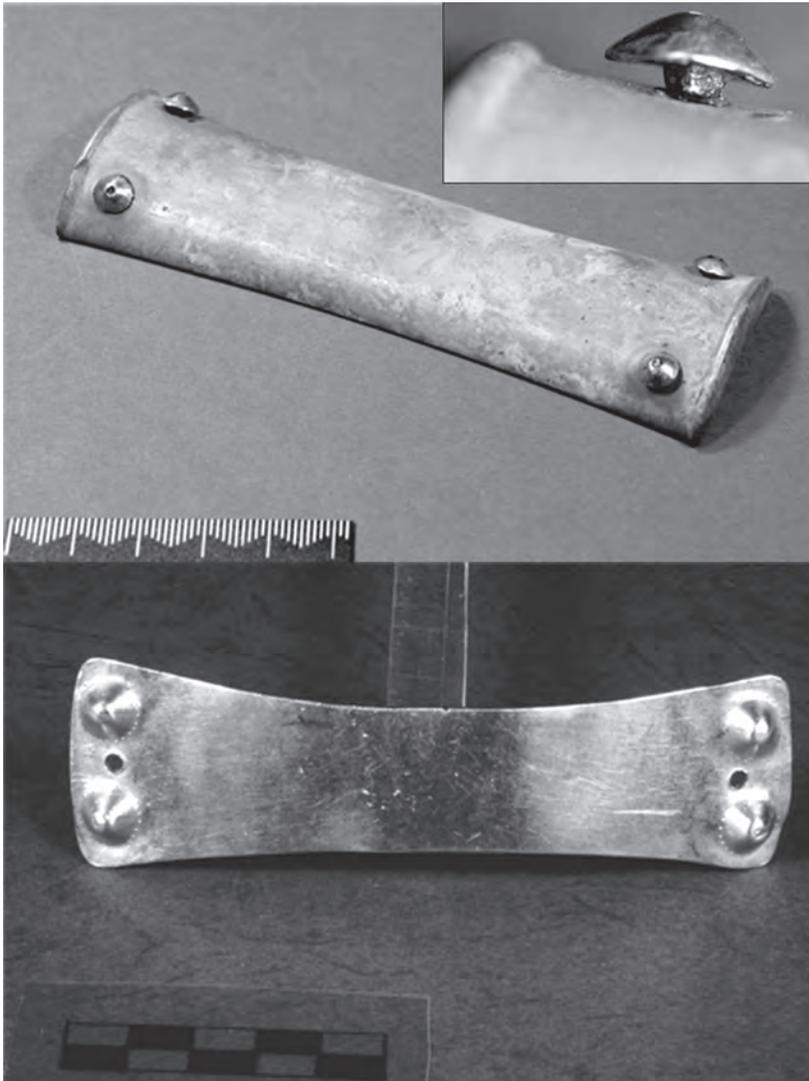


Fig. 12.5. (Above) Wrist-guard with copper rivets covered with gold sheet from Culduthel, Inverness, Scotland; (below) gold specimen from Vila Nova da Cerveira Portugal (© B. Armbruster).

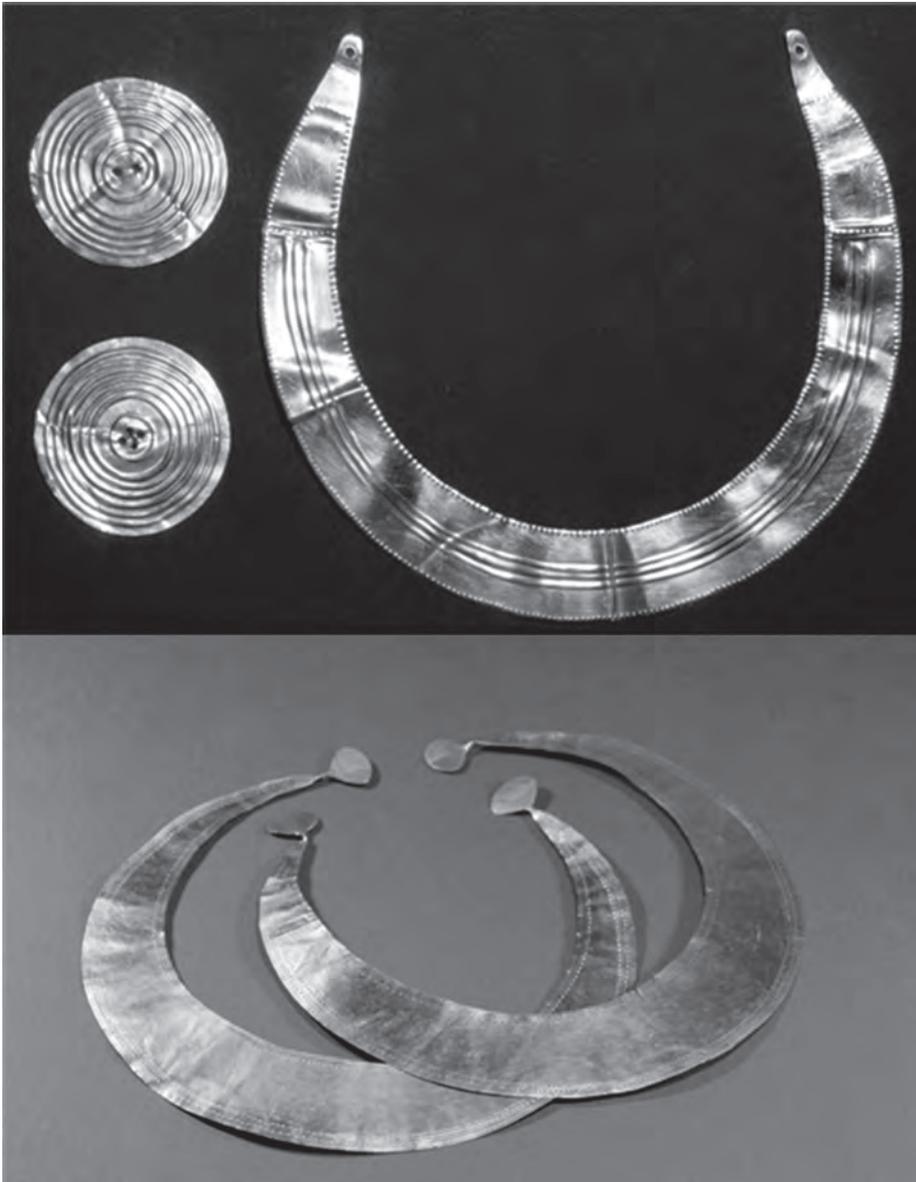


Fig. 12.6. (Above) Lunulae. Cabeceira de Basto, Portugal; (below) Coulter, Pebbleshire, Scotland (© Armbruster).

Early Bronze Age lunulae and discoid appliqués (Taylor 1980; Eogan 1994). The lunulae are decorated with punched and chased geometric motives (Fig. 12.6). No lunula has ever been found in a funerary context. The discoid sheet appliqués often bear a concentric decoration as well as cross and zigzag motives. They are perforated for sewing onto cloth. It is very rare to see an association between lunula and disc. For a long period the only case known was the lunula with a pair of discs from Cabeceiras do Basto (Fafe, Portugal) (Armbruster and Parreira 1993, 56–59). Recently the new discovery of such an ensemble from Ireland documents the same grouping of gold jewellery (Kelly and Cahill 2010). The bent ends of certain lunulae are the only concession to three-dimensional design on these flat sheet ornaments.

The large crescent-shaped neck ornaments and the discoid appliqués are interpreted as symbols of a moon or sun cult. From the Neolithic period on we can see diachronic and interregional symbols on all different kinds of materials throughout Atlantic Europe (Gessner 2005).

### Conclusions

To conclude we will discuss the following aspects related to early goldwork production in Atlantic Europe. Firstly, goldwork manifestations spread across the entire Atlantic shore, from the south of Portugal, passing through the north of Scotland, to Denmark. It is interesting to note the similarities not only of morphologies, but also of the

technological system domains (working practices, design concepts ...) and symbolism.

Bell Beaker and Early Bronze Age goldwork probably never had a purely decorative character; rather, above all else, it acquired a ritual and social function as a symbol of status and power. For the elites, gold objects served to represent, legitimise, and preserve their power, authority, and identity (Clarke *et al.* 1985). As in many traditional cultures even today, gold objects have been enveloped in a system of symbols, coded sign language, and religious or social values, which are conveyed through their ownership, accumulation, categorisation, or exchange. In prehistory gold was symbolic of the life-dispensing sun and thus embodied fertility, well-being, and permanence, to which can be added an apotropaic quality.

In the area of Atlantic Europe as a whole there are indications of interrelationships and a “common sense” between geographically distant regions, not only with regard to the custom of depositing valuable luxury goods in graves, but also in terms of their morphological and technological characteristics. This might reflect contact and exchange on an interregional level.

The finds of goldworking assemblages such as grave goods in funerary contexts raises questions as to the social status of these individuals, and in general about the social model of early metallurgy groups. By means of this multidisciplinary approach based on archaeology, materials science, ethno-archaeology and experimental archaeology, it is possible to propose early goldwork as an indicator of processes of interaction and exchange and the dissemination of know-how and metallurgical knowledge in the Atlantic area.

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