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Arsenical copper and bronze in Middle Bronze Age burial sites of southern Portugal: the first bronzes in Southwestern Iberia

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ABSTRACT

Middle Bronze Age was a transition period in Iberia, characterised by the emergence of bronzes after more than a millennium of a conservative metallurgy of copper with arsenic. Despite its importance there are no relevant studies on MBA metallurgy in Southwestern Iberia due to the absence, until recently, of known settlements and the scarcity of metals. However, recent archaeological excavations have brought to light important finds dated to the SW Iberian Bronze Age such as new burial monuments and open settlements. About 50 artefacts from hypogea, cists and domestic contexts (pits) from Torre Velha 3 (Serpa) and Monte da Cabida 3 (Évora) were analysed by micro-EDXRF, reflected light microscopy, SEM–EDS and Vickers microhardness testing. Radiocarbon dating of their archaeological contexts established a chronology of ~1900–1300 cal BC. Despite presenting different burial practices both sites share the almost exclusive use of arsenical coppers (4.1 ± 1.0 and 4.2 ± 1.5 wt.% As, respectively). However, few awls and a dagger from Torre Velha 3 are among the earliest evidence of bronze in SW Iberia, being dated to the second quarter of the 2nd Millennium BC. These bronzes are similar (9.6 ± 1.2 wt.% Sn) to LBA alloys suggesting trade with a region with a developed bronze metallurgy. The emergence of bronze in SW Iberia during the first half of the 2nd Millennium BC points to an earlier introduction or a more rapid expansion than initially assumed. Nevertheless, these arsenical coppers and bronzes display a similar manufacture involving hammering and annealing cycles. A final hammering increased the hardness, which could be higher for bronzes. Arsenical coppers display variable operational conditions often with poorer thermomechanical work as expected from a prehistoric technology. A bronze dagger with silver rivets evidences the prestige value of early bronzes to MBA communities. Similarly, an arsenical copper dagger with silver coloured rivets shows the ability of MBA metallurgists to replicate prestige objects with indigenous knowledge.

1. Introduction

The development of prehistoric metallurgy was often a very slow process, being heavily dependent on technological knowledge and availability of metallic ores (Craddock, 1995). Early metals from Iberia were composed of copper with varying amounts of arsenic, a feature that persisted for more than a millennium, ~3000–1200 BC (Rovira, 2002). The true meaning of arsenical copper alloys (copper with more than 2 wt.% As) among ancient communities is still unclear. Arsenical copper does not seem to be an evolution in copper metallurgy since in some regions it is present among the first contexts with evidences of metals (Ruíz-Taboada and Montero-Ruíz, 1999). However, the possibility of attaining higher hardness or different colours was certainly among the first characteristics recognized by metallurgists. For instance, certain typologies at the Chalcolithic settlement of Zambujal (Torres Vedras), namely Palmela points, saws, long awls and tanged daggers, have higher arsenic content (Müller et al., 2007). In another example, a relation between arsenical coppers and tools/weapons has been identified at the Chalcolithic settlement of Castro de Vila Nova de São Pedro (Azambuja) pointing to a deliberate selection of alloys (Pereira

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et al., 2013). This work also suggested that colour, and not hardness, was the objective behind the production of those arsenical coppers. Later on, Middle Bronze Age (MBA) artefacts from Southwestern Iberia still have highly variable contents of arsenic. However, the limited number of studied examples inhibits a clear trend, with the exception of swords that show higher amounts of arsenic (Hunt Ortiz, 2003).

The conservative metallurgy of copper was slowly but progressively replaced by bronze (copper with more than 2 wt.% Sn). In Europe, very few bronzes can be securely dated to the 1st half of the 3rd Millennium BC. A double-edged knife from a 3080 to 2880 cal BC burial at Velika Gruda (Montenegro) is one of them, being considered to be an importation from the Near Eastern region (Primas, 2003). The earliest bronzes in the Atlantic region already belong to the 2nd half of the 2nd Millenium BC, such as a few burial offerings from 2580 to 1890 cal BC at Saint Lude 2, Bretagne (Briard, 1984). Likewise, the first true metalworking tradition in Britain belongs to 2300–2200 cal BC (Needham, 1996). Curiously, the only bronzes among the metallic collection from the 2300 to 2000 cal BC burial of Singen (Germany) have Atlantic typologies (Fernandez-Miranda et al., 1995). This evidences the complex pathways of the spread of bronze in prehistoric Europe. In the Western Mediterranean region bronze arises during almost the same period. In Italy, for instance, the bronze alloy becomes regular during the Early Bronze Age, 2200–1800 BC (Eaton, 1980), period after which the first bronzes appear in Sardinia, namely during 1800–1600 BC (Lo Schiavo, 1997).

The first bronzes in Iberia made their appearance in the northeastern region during the Early Bronze Age, perhaps due to the existence of exchange networks with other regions of Western Europe (Fernandez-Miranda et al., 1995). Archaeological works at Bauma del Serrat del Pont (Girona) recovered a bronze awl/needle and a bronze rod dated to 2560–1975 cal BC (Alcalde et al., 1998). According to this paper, however, the premature appearance of bronze in this settlement could be related with copper ores with high amounts of tin. These ores were already smelted during the Chalcolithic occupation of the site, but often failed to produce bronze due to unsuitable reducing conditions. Also in the northeastern region, namely at Monte Aguilar (Navarra) two bronze awls belonging to contexts dated to 1890–1750 BC were recorded (Sesma and García, 1994). During the second quarter of the 2nd Millennium BC bronzes arrived at the central and southeastern regions, namely at La Mancha, Levant and the Argaric region (Fernandez-Miranda et al., 1995). From northern Portugal, two metallic prills and a bronze bar suggesting the bronze production at the Bronze Age settlement of Sola (Braga) were also dated to the second quarter of the 2nd Millennium BC (Bettencourt, 2000). Until recently, the single securely dated context with early bronzes in Southwestern Iberia was the funerary hypogeum from Belmeque (Serpa), located in the southern Portuguese territory and dated to 1670–1390 cal BC (Soares, 1994; Alves et al., 2010). Nevertheless, the first evidence of bronze production in the region is attested by a mould for flat axes from Casarão da Mesquita 3 (Évora) exhibiting a later date of 1120–900 cal BC (Soares et al., 2007; Mataloto et al., 2013). Additionally, metallurgical production contexts from Entre Águas 5 (Serpa), dated to the first quarter of the 1st Millennium BC, point to the co-smelting of oxide copper ores with cassiterite (Valério et al., 2013).

The early bronzes in most of Western Europe exhibit variable concentrations of tin, but there was an alloy regularisation during the MBA, suggesting a regular trade of tin to areas without tin ores (Fernandez-Miranda et al., 1995). The diffusion of bronze artefacts was probably much faster than the spread of the technology itself, but in spite of arsenical copper and bronze being certainly distinguishable by colour, some technological expertise would be essential to locally produce the new alloy. Furthermore, the recently arrived bronze artefacts should reveal a clear mechanical or aesthetical benefit in order to instigate the replacement of the long established technology of arsenical coppers. Consequently, the MBA was an important period of slow but crucial metallurgical developments.

Despite the obvious importance of the MBA, there are no relevant studies on the coeval metallurgy in Southwestern Iberia. However, recently discovered MBA burial sites exhibiting numerous metallic artefacts have been providing a significant number of materials for study. Two of these archaeological sites are Torre Velha 3, located in the Portuguese left bank of the Guadiana River, and Monte da Cabida 3, situated not far from the city of Évora. Most of the artefacts are tools/weapons and ornaments from burial monuments, such as hypogea at Torre Velha 3 and cists at Monte da Cabida 3. Other metals belong to non-funerary contexts located in both sites. These distinct archaeological contexts were radiocarbon dated to get a precise and reliable chronology for the artefacts. Afterwards, it was possible to make an elemental and microstructural characterisation of the artefacts, thus providing for the first time an accurate comprehension on the MBA metallurgy in the region. Different alloys could be identified, while the manufacture of several typologies and alloys was compared, thus establishing the use and value of metal to those ancient communities inhabiting the Southwestern Iberia.

2. Archaeological background

2.1. Torre Velha 3 – metals from hypogea and pits

During 2008 the area directly affected by the upcoming construction of the Laje Dam (Serpa), included in an irrigation project connected with the Alqueva Dam, was subject to an archaeological survey (14 ha), followed by archaeological excavations of the structures and contexts that had been identified. Archaeological works exposed tens of negative structures containing artefacts and other materials that cover a large diachrony ranging from the Chalcolithic to the Late Antiquity (Alves et al., 2012). Nevertheless, the Bronze Age is the chronological period better represented at Torre Velha 3 comprising negative structures of different typologies such as hypogea and pits (Fig. 1).

Undoubtedly, a group of 25 hypogea are the most relevant archaeological structures recorded at Torre Velha 3 (Alves et al., 2010). These hypogea are MBA funerary structures (see Fig. 1) composed of an atrium and an underground burial chamber dug in the soil (Alves et al., 2010). At Torre Velha 3 these funerary monuments seem to have been grouped in two clusters plus an isolated hypogeum located approximately 40 m south of the main group. The set of burial offerings varies from one hypogeum to another but is mainly composed of ceramic vessels, metallic artefacts and meat offerings. About half of the hypogea of this necropolis include metals totalling about 20 artefacts. Most of the tombs exhibited an awl, while hypogeum [2215]–[2231] contained a dagger and a ring. Hypogea [1267]–[1792], [1298]–[1695] and [2417]–[2418] exhibited each one an awl and a dagger. These awls are thin bars with a rounded section opposite to a quadrangular section both ending with a sharp edge (Fig. 1). These offerings are typically associated to the gender of the buried individual (Castro-Martínez et al., 2006). Awls and small daggers (knives?) arise in female burials on both Southwestern Iberia (Pavón Soldevila, 2008) and Argaric region (Lull et al., 2011). The dagger from hypogeum [1267]–[1792] is an exceptional specimen since it has two rivets of silver attached to a small blade. Silver was also present among the grave goods from hypogeum [2550]–[2551] comprising a necklace with two silver beads, two copper beads plus a pair of beads made