The 'island of silver veins': an overview of the earliest metal and metalworking in Sardinia

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Sardinia; early metallurgy; copper; silver; lead

Abstract

This paper presents a review of our knowledge of the earliest phases of metal use and working in Sardinia, based where possible on radiocarbon chronology. It covers the cultural periods from the late Neolithic Ozieri to the Copper Age Monte Claro phase. I suggest that in contrast to continental Italy, the earliest metalwork in Sardinia seems to be used for display. It is striking that metal use and working seems to emerge in Sardinia later than in mainland Italy, despite the island's rich metal resources.

Introduction

The earliest metallurgy in Sardinia has been the subject of a number of syntheses (e.g. in particular: Lo Schiavo, 1989; Usai, 2005a). As we shall see, although the island is rich in ores, evidence for early metallurgy and metalwork is relatively rare in the archaeological record, indeed they do not become widespread until the Bronze Age. Much of our archaeological evidence for the later Neolithic and Copper Age comes from multiple burials in rock-cut tombs, which are locally known as *domus de janas*, and in megalithic tombs and cairns, so that it has been difficult for archaeologists to work out the material culture sequence. Tombs with multiple burials were regularly used into the Bronze Age, with previous interments being cleared out or moved to make room for new burials and their grave goods, so that it is often difficult to be sure about the chronological relationships among the material found in these tombs, and indeed their contents may only date to the final period of their use (Tanda, 2009, pp.67-68). Maria Grazia Melis (2000) has proposed a ceramic chrono-typology using a table of associations, which is helpful since many of the sites are not fully published, though of course it does not resolve matters for multi-phase contexts with insecure associations; unfortunately, her conclusions are difficult to verify from the limited supporting evidence she publishes, which is problematic when she disagrees with other scholars' dating.

Until very recently a secure radiocarbon chronology did not exist for Sardinia (and indeed radiometric dates for material found in multiple burials are sometimes of doubtful worth, since they likely date nothing other than the object that was determined), but an increase in the number of available dates means that we can now begin to understand the relationships between the various cultures of the late Neolithic and Copper Age and their chronology. Most recently, Melis (2013) has collated published determinations for the fourth and third millennia cal BC, but unfortunately she follows a restrictive criterion suggested by Martinelli and Valzogher (2011, p.37) and does not report all those dates with a standard deviation greater than ±100 years, an arbitrary cut-off which she applies as a 'chronometric hygiene protocol' (*sensu* Spriggs, 1989). In her paper, Melis (2013, fig.2) suggests that the classic Ozieri phase (which she calls Ozieri 1) should be dated to around 4000-3400 cal BC, and sub-Ozieri (her Ozieri 2) to around 3600-2800 cal BC; in the north of the island, Ozieri is followed by the Filigosa (about 3000-2400 cal BC) and Abealzu (c. 2600-2200 cal BC) phases, in the south the Monte Claro phase appears around 2900 cal BC, lasting until around 2100 cal BC. There are no radiocarbon dates for Monte Claro contexts in the north of the island (Melis, 2013, p.205), where it appears later. While much of this general scheme appears acceptable on present evidence, it should be noted that there are in fact fifth millennium cal BC dates for contexts described as Ozieri from Grotta di Filiestru (Mara SS) and Contraguda (Perfugas SS) (Table 1 and Figure 1), which Melis ignores in her 2013 publica-

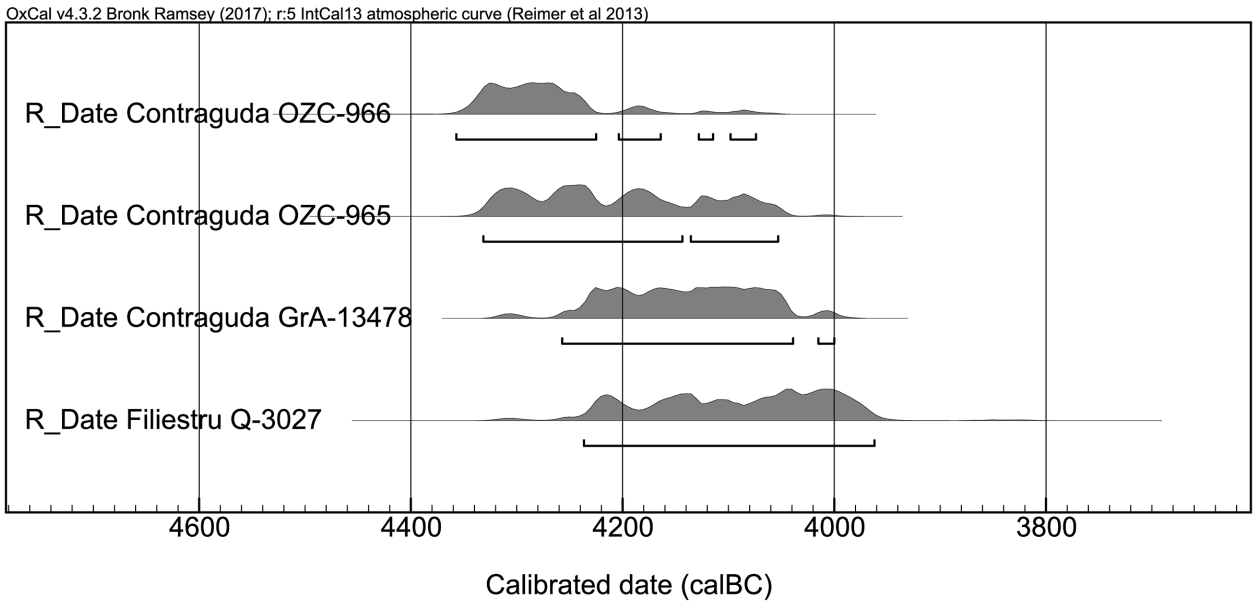

Figure 1. Fifth millennium cal BC radiocarbon dates for the classic Ozieri phase (calibrated with OxCal ver.4.3.2: Bronk Ramsey, 2009; Reimer, et al., 2013). Source: Costaguda (Perfugas SS) – Boschian, et al., 2001, p.256; Grotta di Filiestru (Mara SS) – Switsur and Trump, 1983, p.460; Trump, 1983, tab. 9.

tion. In an earlier paper, Melis, et al. (2007, p.191; tab.II) did take these earlier dates into consideration and dated the beginning of the Ozieri phase to around 4300 cal BC, though noting the presence of material with affinities with the San Ciriaco phase, which precedes Ozieri, in the layer at Contraguda with the earliest date (layer 4 – OZC-966: 5243±47, 4358-4075 cal BC; Boschian, et al., 2001, pp.256, 272, 285). It should be stressed, however, that the excavators themselves believe that Contraguda begins in an initial moment of the Ozieri phase (Boschian, et al., 2001, pp.272, 285). Although the samples from Contraguda are charcoal, and the exact cultural affinities of the context of the earliest date from Contraguda can only be verified when the site is fully published, on the basis of the dates from Contraguda and Grotta di Filiestru (Table 1 and Figure 1) it seems most likely that the Ozieri phase does in fact begin no later than the last quarter of the fifth millennium cal BC. Table 2 summarises the chronological framework that I am therefore adopting in this paper.

In this paper, in line with my usual practice, I report the commune and province for all sites mentioned (Pearce, 2007, p.109); this convention allows those unfamiliar with the geography of the island to locate them easily. I have chosen to use the traditional division of Sardinia into four provinces (Sassari, Nuoro, Oristano and Cagliari, abbreviated as SS, NU, OR and CA) rather than the eight provinces into which the island was briefly divided between 2005 and 2016, when the new provinces of Olbia-Tempio, Medio Campidano, Ogliastra and Carbonia-Iglesias were in existence, or the 2016 administrative division into Sassari, Nuoro, Oristano, Sud Sardegna and the Area metropolitana di Cagliari, as the traditional division is that most common in the archaeological liter-

Table 1. Fifth millennium cal BC radiocarbon dates for the classic Ozieri phase (calibrated with OxCal ver.4.3.2: Bronk Ramsey, 2009; Reimer, et al., 2013). Source: Costaguda (Perfugas SS) – Boschian, et al., 2001, p.256; Grotta di Filiestru (Mara SS) – Switsur and Trump, 1983, p.460; Trump, 1983, tab. 9.

Site	Context	Laboratory code	Determination bp	cal BC (95.4% probability)
Contraguda	Area 4, q.L12, layer 4, spit 12	OZC-966	5423±47	4358-4075
Contraguda	Area 3, q.V16, structure 200	OZC-965	5369±51	4332-4054
Contraguda	Area 19, q.FF2, structure 1901, layer B1	GrA-13478	5310±40	4258-4001
Filiestru	Trench B, layer 7	Q-3027	5250±60	4237-3963

Table 2. Chronological framework for the earliest phases of metal use and working in Sardinia

Ozieri	c. 4200-3400 cal BC
Sub-Ozieri	c. 3600-2800 cal BC
Filigosa	c. 3000-2400 cal BC
Abealzu	c. 2600-2200 cal BC
Monte Claro	c. 2900-2100 cal BC

ature, and it allows the reader to understand the rough geographical location of sites mentioned, Sassari corresponding to the north, Oristano the centre-west, Nuoro the centre-east and Cagliari the south of the island.

A useful outline of the mineral resources of the island is given by Valera and Valera (2005) and by Valera, Valera and Rivoldini (2005), which are revisions of earlier papers (Valera and Valera, 2003; Valera, Valera and Rivoldini, 2003). Briefer syntheses are also provided by Arca and Tuveri (1993) and Giardino (1995, pp.140-150; 308-309). When reading modern ore geologies, it must be borne in mind that they often concentrate on outcrops considered to be of present-day economic interest and that deep mineralisations might not have been detectable or easily accessible in prehistoric times. Small outcrops of easily winnable ore are likely to have been much more important in the past than they are in today's economic conditions (Pearce, 2007, p.54).

The most important metal resources available in Sardinia (Figure 2) are its outcrops of argentiferous lead ore, found in particular in the Iglesiente in the south west: the Cambrian 'Metalliferous Ring' focused on Monteponi (Iglesias CA) (Valera and Valera, 2005, p.38; Valera, Valera and Rivoldini, 2005, pp.60, 85). The other main outcrops of lead and hence silver are found at Montevecchio (Guspini CA) in the south west, at Baccu Locci (Villaputzu CA) and the 'Sarrabus silver lode' in the south east (though this latter may not have been easily accessible at the surface), at Correboi (Villagrande Strisaili NU) in the Barbagia, at Sos Enattos and perhaps Guzzurra (Lula NU) in the north east, and at Argentiera (Sassari SS) in the Nurra area in the north west (*ibid*., pp.68-70, fig.17). Copper could be easily extracted at Sa Duchessa (Domusnovas CA) and perhaps at Rosas, Sa Marchesa and Barisonis (Narcao CA) in the Iglesiente, at Baccu Locci (Villaputzu CA), Talentino (Tertenia NU) and perhaps in the area of Monte Nieddu (Esterzili and Orroli NU) in the south east, in the area of Funtana Raminosa (Gadoni NU) and at Correboi (Villagrande Strisaili NU) in the Barbagia, at Val Barisone (Torpé NU) in the north east and at Calabona (Alghero SS) in the north west (*ibid*., pp.65-66, fig.64).

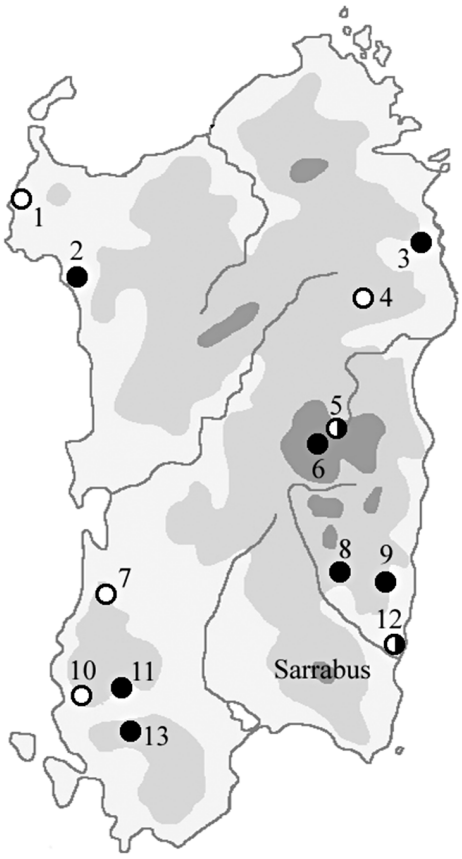

Figure 2. Ore resources in Sardinia. Open circles: lead and silver, closed circles: copper. 1. Argentiera (Sassari SS); 2. Calabona (Alghero SS); 3. Val Barisone (Torpé NU); 4. Sos Enattos and Guzzurra (Lula NU); 5. Correboi (Villagrande Strisaili NU); 6. Funtana Raminosa (Gadoni NU); 7. Montevecchio (Guspini CA); 8. Monte Nieddu (Esterzili and Orroli NU); 9. Talentino (Tertenia NU); 10. Monteponi (Iglesias CA); 11. Sa Duchessa (Domusnovas CA); 12. Baccu Locci (Villaputzu CA); 13. Rosas, Sa Marchesa and Barisonis (Narcao CA).

In considering the source of the silver found in the archaeological record from the earliest phases of metallurgy in Sardinia onwards, it is worth thinking about the nature of a galena (PbS) ore body: as we have seen, lead ores predominate in Sardinia (Valera and Valera 2005, p.38). The secondary (supergene, oxidation) zone of a galena ore body will contain native silver, acanthite (known as argentite in older literature, silver sulphide, Ag_2S) and cerargyrite (silver chloride, AgCl), as well as argentiferous cerussite (lead carbonate, $PbCO_3$). The silver minerals, acanthite and cerargyrite, are easily smelted to produce silver (Patterson, 1971, p.304; Craddock, 1995, p.212) and although acanthite resembles galena, the two minerals can be easily distinguished as acanthite deforms while galena breaks when hammered (Agricola, 1955 [1546], p.204). Craddock (1994, p.212) suggests that native silver may have been more significant in prehistoric times than it now seems (see also Patterson 1971)

and it is also likely that in early prehistoric times silver was extracted from the supergene acanthite, cerargyrite and argentiferous cerussite rather than the hypogene galena (Craddock, 1994, pp.213-214; *pace* Valera, Valera and Rivoldini, 2005, pp.44, 60). Cerussite is relatively simple to smelt to lead at temperatures of 300-400°C (Atzeni, et al., 2003, p.109) and while galena is also easy to smelt, the procedure requires higher temperatures (Hetherington, 1980; Tylecote, 1986, pp.54-58; see also Craddock, 1995, pp.205-206). However, it is not clear from the evidence presently available when extraction by cupellation of silver from the argentiferous lead ores, cerussite and galena, began in Sardinia (for cupellation, see Tylecote, 1986, pp.58-61). Cupellation of cerussite (or cerussite-rich jarosite) is documented at Fatmalı-Kalecik in eastern Anatolia in the early third millennium BC (Hess, et al., 1998).

Ozieri (c. 4200-3400 cal BC) and sub-Ozieri (c. 3600-2800 cal BC)

The earliest metalwork, and perhaps metallurgy, appears in contexts dated to the classic Ozieri phase: both in the north in the Sa Korona di Monte Majore (Thiesi SS) cave, and in the south at tomb 5 in the Pranu Mutteddu (Goni CA) cemetery and in the large settlement at Su Coddu (Selargius CA). It is worth noting that both copper and silver are found in the Ozieri phase, and that the working of both metals, perhaps smelting, seems to be attested. Metalworking and metal objects are also documented in the sub-Ozieri phase, at the Cuccuru Is Arrius (Cabras OR) settlement in the centre-west of the island and at the settlements at Su Coddu-Cannelles (Selargius CA) and Terramaini (Pirri, Cagliari CA) and at the Montessu (Villaperuccio CA) cemetery in the south. Reports of Ozieri and sub-Ozieri metalwork at the ritual site at Monte d'Accoddi (Sassari SS) in the north are less secure. Webster and Webster provide generic distribution maps for sites of the Ozieri (2017, fig.2) and sub-Ozieri (2017, fig.25) phases; Figure 3 shows the sites where metalwork is attested.

Giovanni Lilliu (1967, p.46) reports finding metal artefacts in Ozieri levels in the Sa Korona cave: copper artefacts (he does not specify how many) in his lower layer, a copper bead and copper staining on a bone in the upper layer. Later excavations found three periods of use of the cave, Impressed Ware, Bonu Ighinu and Ozieri (Nieddu Foschi, 1989, p.145). The cave seems to have been inhabited, though Foschi (1984, p.322) argues that the presence of statuettes means that a ritual function cannot be ruled out.

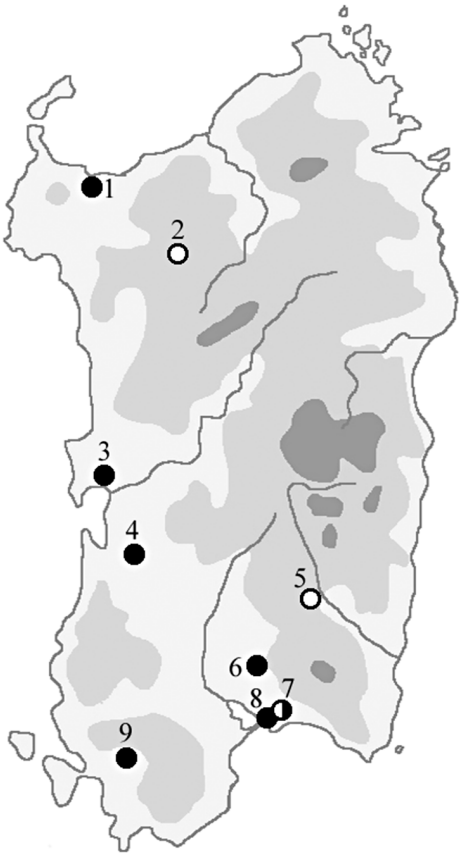

Figure 3. Ozieri and sub-Ozieri. Open circles: Ozieri, closed circles: sub-Ozieri. 1. Monte d'Accoddi (Sassari SS); 2. Sa Korona di Monte Majore (Thiesi SS); 3. Cuccuru Is Arrius (Cabras OR); 4. Puisteris (Mogoro OR); 5. Pranu Mutteddu (Goni CA); 6. Monte Olladiri (Monastir CA); 7. Su Coddu and Cannelles (Selargius CA); 8. Terramaini (Pirri, Cagliari CA); 9. Montessu (Villaperuccio CA).

The ritual site at Monte d'Accoddi (Sassari SS) is sometimes confusingly referred to as a 'ziggurat'; this term, whilst accurately describing its form, is misleading as there is no demonstrable derivation from Mesopotamian structures (though some argue for Mesopotamian parallels: Webster and Webster 2017, pp. X, 24-25). The excavations are still largely unpublished, so that the metal finds cannot be precisely dated. Melis (2011b, p.215) suggested that '33 metal artefacts and fragments … were present in the most ancient layers beneath the ramp, correlated with finds from the Ozieri phase'. She reported that '[t]he objects were predominantly made of copper: point-making tools (45%), several small axes (12%), laminae (6%), an awl, a fishhook, a dagger, and a pendant. Added to these were a small silver disc and several fragments of lead'. This dating has been followed by Webster and Webster (2017, p.12). However, in a later paper Melis (2014, p.484) notes that the contexts of these objects are not secure, and the artefact classes she reported do not all fit the pattern of Ozieri and sub-Ozieri metalwork;

perhaps we might accept the awl, which she assigns to the late Ozieri phase (Melis, et al., 2012, p.15, fig.4:1b), but its context too provides no secure dating (see below).

Giovanni Ugas (1993a, p.26) argues that Ozieri period sherds found at Puisteris (Mogoro OR) and Monte Olladiri (Monastir CA), which had been drilled for repairs, provide proxy evidence for the use of lead, otherwise unknown in Ozieri contexts. This is plausible, if the early silver was extracted by cupellation from argentiferous cerussite (lead carbonate) or galena (lead sulphide) so that lead was also produced, and lead is certainly used for such repairs in later phases (see below). However, as we have seen, Ozieri phase silver artefacts could have been produced from native silver, acanthite (silver sulphide) or cerargyrite (silver chloride), and pottery repairs were not necessarily carried out using lead and could have been made with leather or another organic binding, so the use of lead to repair pottery in this early phase remains to be demonstrated.

Two small silver rings, probably beads, were found with Ozieri material close to the chambered-cairn tomb 5 at Pranu Mutteddu, which is known as "Su Nuraxeddu" (Atzeni, 1981, p.XL, fig.N107; Atzeni and Cocco, 1989, pp. 201, 212, fig.3:4-5; Lo Schiavo, 1989, p.282; Usai, 2005a, fig.4).

Su Coddu is a large prehistoric village with Ozieri and sub-Ozieri phases, excavated by a number of different teams in advance of the expansion of the suburbs of Selargius. Giovanni Ugas and his colleagues report metal artefacts and copper- and silver-working slag from structures 21, 36 and 67, datable to the Ozieri phase of the site, and from structures 42, 65 and 51, datable to the later sub-Ozieri phase; a 'pin' with a rhomboid section was found in structure 32 and a fragment of silver sheet in structure 51, both sub-Ozieri contexts (Ugas, Lai and Usai, 1985, pp.13, 19, 22; Ugas, et al., 1989, p.255; Ugas, 1997, pp.53, 56, fig.42). There are no analyses available for the slags reported nor delucidation of what is precisely meant by 'silver-working slag' ('scorie di fusione d'argento e rame': Ugas, Lai and Usai, 1985, p.13); unfortunately Italian archaeologists' usage of the word 'fusione' does not always distinguish between smelting and the more general working of molten metal. Cupellation, if it were practised this early in Sardinia, would produce litharge (lead oxide; Tylecote, 1986, pp.59; 70), which might possibly be what is meant. Obsidian, and lithic tools generally, become less common and metalworking more common in the sub-Ozieri phase (Ugas, 1997, pp.56-57), when awls appear at the site (Manunza, 2006, p.37). Manunza and colleagues (2007, pp.5, 7-11, figs 1-7) found ceramic material that had been subject to temperatures in excess of 1100-1200°C in their structure B.

Metallurgy is also documented in the sub-Ozieri settlement of Canelles (Selargius CA), a southwestwards extension of Su Coddu. Manunza (2005, p.35) reports a tubular bead, perhaps in silver, and a fragmentary crucible with slaggy incrustations. Finds also include an unspecified number of copper points and awls; a burnt mud brick, found in the same context as the crucible fragments, may be part of a furnace or other pyrotechnological structure (Manunza, 2013a, p.11, tav.VII:5; cf. Manunza, et al., 2012, p.1268, fig.3I:1 & 2). Melis (2005, pp.556-558, fig.4; Melis, et al., 2007, fig.3:6) reports the finding of a copper punch, an awl and fragment of wire in the sector she excavated at Canelles; preliminary analysis of fragments she had identified as slag (mainly from her structure 39) suggested that they were not the result of metallurgy (Melis, 2005, p.558, fig.3:2), though this needs specialist verification. A radiocarbon date is available for bone from the layer in which the awl was found, LTL-295A: 4554±45 (Melis, et al., 2007, p.187, figs 1 & 3:6, tab.III); unfortunately, the determination calibrates at a point where the calibration curve is relatively flat, to 3490-3100 cal BC at 95.4% (calibrated with OxCal 4.3: Bronk Ramsey, 2009; Reimer, et al., 2013). In a later paper, Melis (2014, p.484, fig.6:3 & 4) reports two silver rings from context 1058 (Badas sector) in the fill of a cylindrical storage pit, structure 47: one was similar to one of the rings from Pranu Muteddu and is likely to be a bead. A radiocarbon determination is available for an 'underlying level', LTL-1105A: 4345 ± 40 BP (Melis, 2014, p.487), which calibrates as 3090-2890 cal BC at 95.4%. Melis (2014, p.487, tab.1) also reports XRF analyses of the rings, which are highly oxidised.

According to Melis (2009, p.516) there are 12 metal objects from Su Coddu and Cannelles, just one datable to Ozieri, the others all sub-Ozieri. Lo Schiavo (1989, pp.283, 288, note 35) reports, on the basis of a public lecture by Giovanni Ugas, a fragment of a (presumably copper) flat axe from structure 4 at Su Coddu; if confirmed, this would be the earliest metal axe known to date in Sardinia.

As well as at the Canelles settlement, metalwork was also found in the sub-Ozieri settlement of Cuccuru Is Arrius (Cabras OR) in the centre-west of the island by the Cabras lagoon: square-sectioned awls and fragments of a dagger blade in sector F (Atzeni, 1981, p.XL, fig.N105) and a further square-sectioned copper awl in structure ('*sacca*') 38 in sector A (Santoni, 1992, p.33, tav.III:3); eight awls are on display in Cabras Museum. Slag is reported from the settlement of Terramaini (Pirri, Cagliari CA), as well as an amorphous fragment of copper found in a sherd of a coarse clay vessel, which has been tentatively identified as a crucible, suggesting that metallurgy

was practised at the site (Usai, L. 1987, pp.181, 188 note 18; 2005a, p.260).

A megalithic *allée* at the Montessu (Villaperuccio CA) cemetery of rock-cut *domus de janas* has yielded two rings, one made of copper band, the other of silver wire, associated with sub-Ozieri pottery (Atzeni, Contu and Ferrarese Ceruti, 1989, p.450; Atzeni, 1996, p.220; Lo Schiavo, 1989, p.283; Usai 2005a, pp.259-260). A dagger from the cemetery on display at Santadi Museum is assigned to the Monte Claro phase (see below).

Because of imprecisions in the literature and incomplete publication of sites, it is difficult to quantify the number of metal artefacts found in the Ozieri and sub-Ozieri phases, but they comprise copper points, rings and beads, a dagger blade, and perhaps an axe. The copper points are variously described as punches, pins or awls, probably on the grounds of their relative thickness, and we might suppose that they comprise a single artefact class; if we disregard the awl from Monte d'Accoddi, whose context is not secure, copper points do not occur until the sub-Ozieri phase. It is worth noting that silver is initially only attested in the south of the island, but is present as far north as the Cabras lagoon in the sub-Ozieri phase.

Filigosa (c. 3000-2400 cal BC)

Whilst silver metalwork appears in both funerary and settlement contexts in the Ozieri and sub-Ozieri phases, in the following Filigosa and Abealzu phases it is only found in funerary contexts, apart from a disk-shaped ring from Monte d'Accoddi (see below), which might relate to a disturbed burial (Melis, 2014, p.484). The two phases are not always distinguished in the literature, (e.g. Webster and Webster, 2017, p.45; see their fig.32 for a generic distribution map of the combined phases), but I have attempted to isolate those contexts published as pertaining to one or other of the two phases; the sites with metalwork are shown in Figure 4. The metalwork is again difficult to quantify exactly from the information published.

The earlier, Filigosa phase sees an increase in the quantity of metalwork, in both silver and copper. This is particularly true in the south of the island. Here, the *domus de janas* tomb 2, at Cungiau 'e Sa Tutta (or Su Tuttùi) (Piscinas CA) seems to be exceptionally rich, despite having been partly plundered by *tombaroli*. Ten silver rings, three spiral bracelets, four silver disk beads and a fragment of silver sheet wrapping a stone bead were found in the rock-cut chamber, along with four copper artefacts interpreted by the excavator as spearheads or miniature

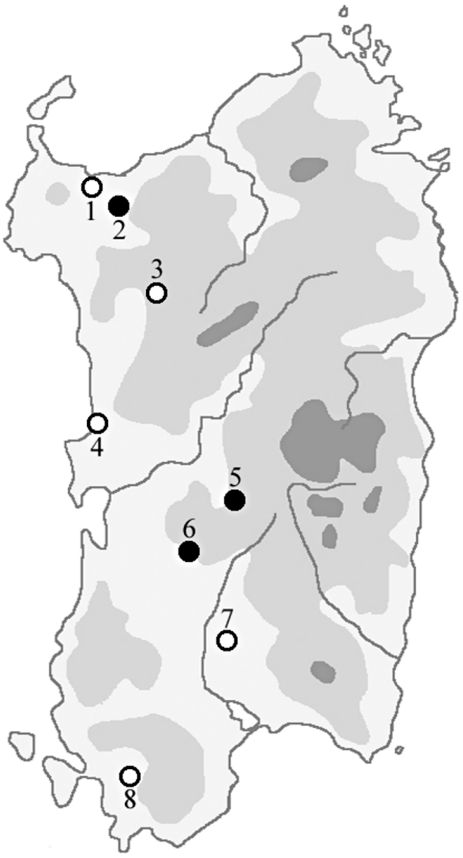

Figure 4. Filigosa and Abealzu. Open circles: Filigosa, closed circles: Abealzu. 1. Monte d'Accoddi (Sassari SS); 2. Cabula Muntones (Sassari SS); 3. Filigosa (Macomer NU); 4. Santa Caterina di Pittinuri (Cuglieri OR); 5. Sa Corte di Noa (Laconi NU); 6. Scaba 'e Arriu (Siddi CA); 7. Serra de is Cannigas (Villagreca CA); 8. Cungiau 'e Sa Tutta (or Su Tuttùi) (Piscinas CA).

daggers and a copper dagger and an awl or pin (Usai, 1996, p.243, fig.38; 1998, p.222, figs 23.5:C & D, 23.6: 3-6; 2000, pp.878-879, figs 3 & 4; Melis, 2014, p.485). In the megalithic enclosure in front of the chamber, two copper axes were found along with further copper spearheads or daggers, silver and copper rings, and copper bracelets (Usai, 1996, p.243; 2000, p.879; 2005b, figs 8 & 9). Examination of metallographic sections, scanning electron microscopy – energy dispersive spectroscopy (SEM-EDS) and atomic absorption spectroscopy (AAS) on two silver rings and the silver sheet wrapping the stone bead found them to be heavily corroded (analyses reported by Atzeni, et al., 2003, p.102, tab.4; Atzeni, Massidda and Sanna, 2005, pp.173-174, 248, tab.36).

Serra de is Cannigas (Villagreca CA), a plough-damaged *domus de janas* of the '*a forno*' type, was also rich in metal finds. Atzeni (1985, pp.14-35, note 11, fig.7:13-20, tav.IV:1, 3-6) publishes two spiral copper rings and one spiral silver ring, a quadrangular-sectioned copper awl, and four copper daggers, plus a photograph of ten

other similar copper and silver rings (two of which were soldered or welded, the rest spirals), and reports that five further daggers were lost. The pottery from the tomb is datable to the Filigosa phase (Lo Schiavo, 1989, pp.283-284; Melis, 2000, pp.54, 61).

In contrast, tombs in the centre and north of the island contain fewer artefacts. A single silver spiral ring was found at *domus de janas* 3 at Filigosa (Macomer NU; Foschi, 1983; Foschi Nieddu, 1985a). The *domus de janas* at Santa Caterina di Pittinuri (Cuglieri OR) was used in the Filigosa and Abealzu phases for multiple secondary burial and showed no signs of later disturbance (Cocco and Usai, 1988). Two silver rings, which are too large to be finger rings and may have been hair ornaments, were found in chamber C associated with Filigosa pottery and two further silver rings come from chamber D, one of which may have been a link from a chain (Cocco and Usai, 1988, p.17, figs 13 & 14; Usai, 2005a, fig.6).

As we have already noted, the excavations at the ritual site at Monte d'Accoddi (Sassari SS) are still largely unpublished, so that the metal finds cannot be precisely dated. Two fragments of socketed crucibles are published and are assigned to a late Filigosa context ('A partire dal momento finale di Filigosa si hanno a Monte d'Accoddi dei crogioli a cucchiaione fittili identici a quelli trovati … [a] Terrina …' – Contu, 1983, p.100, note 16; Lo Schiavo, 1986, p.232, fig.16:1; 2000, pp.27-28; according to Melis, 2009, p.517 there are three crucibles from the site, though only two are on display at Sassari Museum). It should be noted that a drawing published by Camps (1988, fig.101) mistakenly shows the crucibles as having quadrangular sockets like those from Terrina IV (Aléria, Haute-Corse) in Corsica, dated to *3250-2400 cal BC* (Pearce 2013), whereas in fact their sockets are elliptical (as correctly shown e.g. by Lo Schiavo, 1986, fig.16:1). Webster and Webster (2017, p.50) use the difference in socket form to argue for a later date for the Monte d'Accoddi crucibles, as a Bronze Age crucible from Iloi (Sedilo OR) has an elliptical socket (Depalmas 2012, p.872, fig.2:29), but this does not seem to fit with the data for Monte d'Accoddi. Metalworking hammerstones, mortars and perhaps a fragment of slag were also found, though their contexts are not yet published (Melis, 2011a, p.362; 2011b, p.215). As we have seen, Melis (*ibid*.; cf. 2014, p.484) reports that 33 metal objects were found at the site in the excavations by Ercole Contu, from the Ozieri levels onwards: of these most were of copper, 45% 'point-making tools', 12% small axes and 6% sheet-metal, plus an awl, a fishhook, a dagger, and a pendant; there was also a small silver disc-shaped ring and an unspecified number of lead fragments. The silver disc-shaped ring, perhaps a bead, was found in spit 6 of sector X-S, close to the ramp, as was the copper pendant: the artificial spit contains mostly Ozieri and sub-Ozieri material but the presence of later material makes it safer to assign the ring and the pendant to the Filigosa phase (cf. Melis, 2014, p.484). The awl was discovered in a hole in the large perforated limestone slab found to the east of the ramp (Contu, 1992, pp.32-33). Freund and colleagues publish portable XRF analyses for 14 artefacts from the site, comprising 9 awls or pins, 4 daggers and an axe. They found that 11 of the artefacts had compositions of 95% or more copper, and that three artefacts had 'significant proportions of silver': a pin (3.90%), an axe (3.30%) and a dagger (13.10%) (Freund, et al., 2016a; 2016b). Melis (2014, p.488) also discusses unpublished XRF analyses of copper artefacts from the site, in which silver was determined in some artefacts as ranging from 2.5%-13%; she suggests that two artefacts in which silver was measured as 8% and 13% were perhaps deliberately alloyed to give them a silvery colour (*ibid*., citing C. Giardino pers. comm.). However, some caution is required in interpreting these findings, since XRF is a surface analysis, silver may have been deliberately enriched and corrosion may induce enrichment (or depletion) in copper-based metals, so that the bulk silver composition of the artefacts could be lower (Beck, et al., 2004). Moreover, copper-silver alloys only begin to have a distinctly silvery appearance above 50% silver (Leuser, 1949; Cretu and van der Lingen, 1999), so that depletion silvering would have been necessary to produce any noticeable colour change in these artefacts. Until depletion silvering can be demonstrated metallographically, we cannot exclude the possibility that such amounts of silver were not perceivable by ancient metallurgists and are simply the product of the smelting of mixed copper-silver ore.

Abealzu (c. 2600-2200 cal BC)

A small silver ring (probably a necklace bead) was found in the Filigosa-Abealzu layers of reuse of the *domus de janas* at Scaba 'e Arriu (Siddi CA), whose earliest phases are Ozieri in date (Badas and Usai, 1989; Usai, 1999, p.28; Ragucci and Usai, 1999, p.178); some 99 individuals were buried in the Filigosa-Abealzu phase (Lai, et al., 2011, p.402) and the tomb was disturbed by later, Monte Claro use, when a megalithic structure was built within it.

The *allée couverte* at Sa Corte di Noa (Laconi NU) was disturbed. There is a small amount of Ozieri and Filigosa pottery, but most of the material seems to date to the Abealzu phase (Atzeni, 1984, p.336; 1989, p.526). The metalwork consist of unspecified number of copper

rings and spirals, at least five small flat and round section silver rings and a silver spiral, and some small scraps of lead (Atzeni, 1984, p.337; 1989, p.526, fig.3; Lo Schiavo, 1989, p.283). In an early reference to the tomb, Lilliu (1980, p.8) suggested that the rings were Ozieri, but the excavator, Atzeni (1989, p.526), believes that the metalwork is likely to be Abealzu in date.

A few small fragments of copper were found in layers rich in burnt material at the cult area around a megalith at the village of Cabula Muntones (Sassari SS) (Basoli, 1989, p.32; 2011, pp.772-773); these layers, probably documenting ritual activity centred on the menhir, which originally stood over 4.5 m high, are dated by the presence of Abealzu-type pottery.

Monte Claro (c. 2900-2100 cal BC)

Although the conflation of archaeological cultures with peoples is methodologically problematic, Monte Claro is generally considered to be intrusive, as it represents a break with the ceramic traditions of Ozieri, Filigosa and Abealzu (e.g. Melis, et al., 2007, pp.185-186); on the other hand, Webster and Webster (2017, p.76) prefer to see it as 'an indigenously created culture of alterity' with East Mediterranean ties. Monte Claro certainly seems to appear earlier in the south of the island, where it immediately follows on from sub-Ozieri levels. The phase sees much more widespread use of metal, and the first well-dated use of lead. Metalwork is present in both funerary and domestic contexts, and consists mostly of copper daggers (17 are documented) and awls (10 are documented) and lead pottery repair-clamps. The only site to have yielded ornaments to date is tomb 14 at Su Fraigu (San Sperate CA), with silver and copper grave goods (Webster and Webster, 2017, p.87). A generic distribution map of Monte Claro phase sites is provided by Webster and Webster (2017, fig.55); Figure 5 shows the sites where metalwork has been found.

In the Iglesiente district of the south-west, caves were used for multiple burials. A Monte Claro phase decorated bowl, found in the burial cave of Cùccuru Tirìa or San Lorenzo (Iglesias CA), had been repaired with lead clamps (Atzeni, 1978, p.20, tav.IV:A; 1981, p.XLIII, figs 22 & N124; 2001, fig.4). The cave contained disturbed burials, with Monte Claro, Beaker and Bonnanaro material (Alba, 1996a, pp.36, 41); three copper awls may perhaps also be attributed to the Monte Claro phase (Atzeni, 1978, p.20, tav.IV:B; 1981, p.XLIII). Three copper awls and a copper fragment, interpreted as a dagger, found in the nearby Grotta della Volpe (Iglesias CA) disturbed burial cave, have also been assigned to the Monte Claro

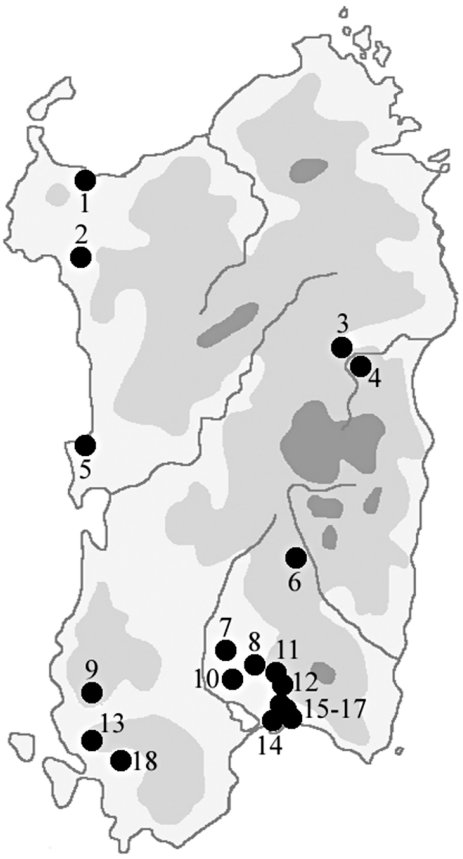

Figure 5. Monte Claro. 1. Su Crucifissu Mannu (Portotorres SS); 2. Monte Baranta (Olmedo SS); Janna Ventosa (Nuoro NU); 4. Sa Sedda de Biriai (Oliena NU); 5. Serra Is Araus (San Vero Milis OR); 6. Su Monti or Su Motti (Orroli NU); 7. Sa Corona (Villagreca CA); 8. Cresia Is Cùccurus (Monastir CA); 9. Cùccuru Tirìa or San Lorenzo, Grotta della Volpe, Su Mrajani di Monte Casula and Crabì (Iglesias CA); 10. Su Fraigu (San Sperate CA); 11. Bau su Matutzu (Serdiana CA); 12. Is Calitas (Soleminis CA); 13. Carbonia (CA); 14. Via Basilicata and Sa Duchessa (Cagliari CA); 15. Su Coddu (Selargius CA); 16. Gannì (Quartucciu CA); 17. Simbirizzi and Basciu 'e Serra (Quartu Sant'Elena CA); 18. Montessu (Villaperuccio CA).

phase (Atzeni, 2001, p.32, fig.7A: 1-4), though the dagger does not resemble more common Monte Claro types (Usai, 2005a, p.263). A lead repair-clamp was also found and is argued to be Monte Claro in date (Alba, 1996a, p.41; 1996b, p.23, fig.1:1). The cave contained disturbed burials dating to the Monte Claro, Beaker and Bonnanaro phases (Alba, 1996a, p.41). A lead repair-clamp has also been found attached to a Monte Claro sherd at the cave of Su Mrajani di Monte Casula (Iglesias CA), which has material dating from the early Neolithic onwards (Alba, 1996a, p.41; 1996b, pp.23-24, fig.1:2; 2012, fig.2:1.a-c), and numerous lead repair-clamps are reported from the Crabì burial cave (Iglesias CA) (Alba, 2012, p.1248, note 5).

A copper dagger in Carbonia (CA) museum from the Doneddu Collection (Marras, 1998, p.46, fig.41)

may have a local provenance and may be assigned to the Monte Claro phase on typological grounds (Manunza, 2010, p.76; 2013b, p.55).

A copper dagger from the Montessu (Villaperuccio CA) cemetery of rock-cut *domus de janas* may be assigned to the Monte Claro culture according to the Santadi Museum website (http://www.museoarcheologicosantadi.it/percorso-espositivo/reperti/pugnale-in-rame, see also http://www.museoarcheologicosantadi.it/galleria-immagini/zoom-immagine?b_start=6&indice=0; accessed 5 February 2018), though no evidence for this dating is provided.

Atzeni reports a tanged dagger with a leaf-shaped blade, found in tomb IV at Via Basilicata, Cagliari (CA), a shaft tomb ('*a forno*'), which contained Monte Claro pottery (Figure 7:8; Atzeni, 1981, p.XLIII, fig.24:b). A later photo published by Atzeni (1986, tav.XXVI:2) actually shows two daggers and indeed Lo Schiavo (1989, p.284, fig.1:6) mentions a second, smaller, dagger as being found in the grave. A group of Monte Claro tombs ('*a fossa*') containing single and multiple burials were found about 320 metres away in 1956 at Sa Duchessa (Cagliari CA) (Lilliu and Ferrarese Ceruti, 1960, pp.12-15) but unfortunately the grave assemblages were not kept separate. A small copper dagger was found in one of the tombs; it has a leaf-shaped blade and a tang with a quadrangular cross-section (Figure 7:7; Lilliu and Ferrarese Ceruti, 1960, pp.36-37, tav.XXV:2 – the text implies, but does not explicitly say, that the dagger was analysed; Atzeni, 1968, p.177, note 14 also implies that the dagger was analysed; Lo Schiavo, 1989, fig.1:5).

A copper awl was found in tomb 3 at Simbirizzi (Quartu Sant'Elena CA), a shaft tomb ('*a forno*') with Monte Claro pottery (Usai, E. 1987, pp.153, 156; 1989). Another copper awl was found in chamber T2 of shaft tomb 1 at Gannì (Quartucciu CA) which contained what has been interpreted as a family group of two adults and three children (Manunza, 2013b, pp.44, 60, tav.7:18), while a further copper awl was found associated with Monte Claro pottery at Is Calitas (Soleminis CA) in the fill of a large pit ('*sacca*' VI) (Manunza and Usai 2005, pp.83-84).

Atzeni (1968, p.177) reports the finding of a 'pure copper' dagger at Su Coddu (Selargius CA) in a pit ('*sacca*') that had been cut during road building; it was associated with Monte Claro type pottery and perhaps also Ozieri material so that its dating is not secure, though the lack of daggers in Ozieri contexts might suggest that a dating to the Monte Claro phase is more likely. No details of the analytical technique used to determine its composition or further results are given.

The shaft tomb, a multiple burial, found at Bau su Matutzu (Serdiana CA) contained a copper dagger (Manunza, 2010, pp.76-77, 110, fig.63b; 2013b, pp.44, 53, tav.VII:18) and a small copper dagger was found together with Monte Claro material at the Cresia Is Cùccurus (Monastir CA) shaft tomb, also a multiple burial (Figure 7:9; Atzeni, 1981, p.XLIII, fig.24:a; Lo Schiavo, 1989, p.284, fig.1:7), while tomb 14 at Su Fraigu (San Sperate CA) contained a single inhumation with silver and copper grave goods: a tubular silver bead, from a necklace or bracelet, a twisted copper wire pendant, from a necklace or earring, plus two copper beads and one silver bead (Ugas, 1987, p.118; 1993b, p.100, tav.LIV).

A copper dagger found at Basciu 'e Serra (Quartu Sant'Elena CA) may relate to a settlement, but it had no secure context (Atzeni, 2010, fig.3c; Manunza, 2013b, p.55).

A dagger was found in the tower building at the Monte Claro settlement of Sa Corona (Villagreca CA) and may be of Monte Claro date, but the publication does not give enough information to know whether this association is certain (Atzeni, 1967, fig.11b; cf. 1981, p.XLV). For Usai (2005a, p.270) one of the daggers from Serra de is Cannigas (Villagreca CA), which is probably Filigosa in date, has a similar form to the Sa Corona dagger and indeed Filigosa-Abealzu material is present at Sa Corona (as is sub-Ozieri/Filigosa transitional material according to Melis' [2000, pp.52, 61, 115-116] chrono-typological analysis), which may support an earlier date for this dagger.

Two copper daggers were found in *domus de janas* VII at Serra Is Araus (San Vero Milis OR), a tomb which had been partly disturbed by *tombaroli*; the daggers were found in a Monte Claro level, and have a leaf-shaped blade and a tang with a rectangular cross-section (Figures 7:5 and 6; Atzeni, 1975, pp.22-23, tav.XXIX:3; 1981, p.XLIX, fig.24:c & d; Lo Schiavo, 1989, p.284, fig.1:2 & 3).

Su Monti or Su Motti (Orroli NU) is a cemetery of six *domus de janas*. Pottery, collected out of context, is mostly Ozieri, some Monte Claro and Beaker. A copper dagger with a leaf-shaped blade was found associated with the Monte Claro pottery and may therefore be attributed to that horizon (Sanges, 1989; Lo Schiavo, 2005b, p.192, fig.2). Semi-quantitative SEM-EDS analysis suggested it is made of pure copper (Cincotti, Demurtas and Lo Schiavo, 1998, tab.1; Demurtas, 1999, p.2, tab.1).

The *domus de janas* Tomb 1 at Janna Ventosa (Nuoro NU) was probably built in the sub-Ozieri phase (Foschi Nieddu, 1998, pp.277-279). A dagger was found in the antechamber associated with Monte Claro phase pottery: it has a leaf shaped blade and a tang with a quadrangular section (Foschi Nieddu, 1985b; 1998, fig.26:9; Lo Schiavo, 1989, fig.1:1; 2005a, p.190, fig.2). Semi-quantitative SEM-EDS analysis found it to be made of arsenical cop-

per (Copper 95-93%, Arsenic 5-7% - Cincotti, Demurtas and Lo Schiavo, 1998, tabs 1 & 2; Demurtas, 1999, pp.2-4, fig.2, tabs 1 & 2); AAS on a shaving taken at the point where the tang joins the blade found Fe 330 ppm, Pb 100 ppm, Zn 80 ppm, Ag 900 ppm, Bi 440 ppm and Ni 80 ppm (Atzeni, et al., 2003: tab.2; Atzeni, Massidda and Sanna 2005: tab.2).

A copper (?) awl or punch was found in room B of hut 8 at Sa Sedda de Biriai (Oliena NU), a Monte Claro phase hilltop village associated with a sanctuary (Castaldi, 1987, p.130, fig.5:2; 1999, pp.104, 124, tav.IX:1). Two pottery funnels found in room B of hut 10 have been plausibly interpreted as possible *tuyères*, but show no signs of having been used (Castaldi, 1999, pp.110, 140, tav. XXII:2 & 3, tav.LXVII:15), which leaves open the possibility that metallurgy was practised at the site.

At the walled promontory settlement of Monte Baranta (Olmedo SS), a copper (?) blade was found in sector C of the enclosure-tower; Monte Claro pottery sherds were found in the same layer, but its dating is not certain (Moravetti, 2004, pp.95-96, 243, fig.166:9). The form resembles a spatula (Usai, 2005a, p.271) and there are no known parallels (Lo Schiavo, 1989, p.284).

A dagger tip was found associated with Monte Claro material in layer 2 of chamber e of tomb XVI at Su Crucifissu Mannu (Portotorres SS); the tomb had been reused, with both Beaker and Bonnanaro material present, so the dating of the object is not secure, though no Bonnanaro material was found in chamber e (Ferrarese Ceruti, 1976, pp.133, 191).

Finally, Melis, et al. (2012, p.17) report a crucible from an unnamed Monte Claro settlement.

Uncertain dating

As previously mentioned, much of our evidence from this period comes from multiple burial contexts in *domus de janas* rock-cut tombs, and a number of metal artefacts and a probable *tuyère* cannot be precisely dated but are discussed in the literature. I shall outline the salient points below; the sites locations are shown on Figure 6.

The cemetery at Anghelu Ruju (Alghero SS) consists of 38 *domus de janas* containing multiple burials (Demartis, 1986). A number of these contain metal artefacts, but these are difficult to date because of the long periods over which the tombs were used, many continuing to receive burials into the Early Bronze Age Bonnanaro phase. Moreover, many of the tombs were robbed in antiquity, so that it is likely that the metal assemblages found only partially reflect the original grave goods (Taramelli,

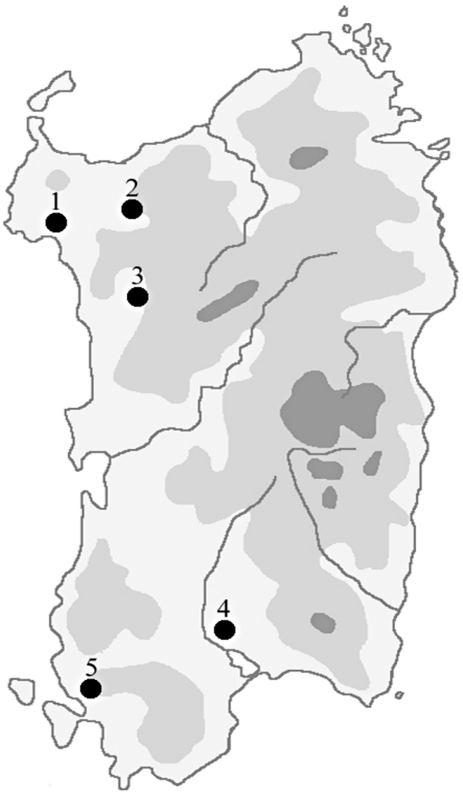

Figure 6. Uncertain dating. 1. Anghelu Ruju (Alghero SS); 2. Mesu 'e Montes (Ossi SS); 3. Sa 'ucca de su Tintirriòlu (Mara SS); 4. Sant'Iroxi (Decimoputzu CA); 5. Cannas di Sotto (Carbonia CA).

1909, col.520). Tomb I has material dating from the Ozieri to the Beaker phase (Demartis, 1986, pp.33-35): a dagger was found by the head of a burial in chamber a (Taramelli, 1904, p.304, fig.7:2; Colini, 1905, p.184, tav.V:2), and two quadrangular-sectioned awls in chamber i (Taramelli, 1904, p.321, fig.7:1 & 3; Colini, 1905, p.184, tav.V:1 & 3). Tomb III likewise contained material dating from the Ozieri to the Beaker phase (Demartis, 1986, p.28): a quadrangular-sectioned awl was found in chamber b (Taramelli, 1904, p.326), and another in chamber d (*ibid*., p.330; Colini, 1905, tav.V:5 illustrates an awl from this tomb, without specifying the chamber it was found in). A quadrangular-sectioned awl was also found in chamber b of tomb XII (Taramelli, 1909, col.411, fig.31:8), while tomb XIII, which contained beakers and brassards (*ibid*., cols 424-425, figs 13 & 18; Demartis, 1986, p.29), had two silver beads in antechamber a and three quadrangular-sectioned copper awls in chamber b (Taramelli, 1909, cols 421-422, figs 11:2, 31:3 & 5-6). Tomb XVII, which contained material dating from the sub-Ozieri to the Bonnanaro phases (Demartis, 1986, p.23; Melis, 2000, pp.54-55), had a dagger in chamber b and 3 quadrangular-section awls in chamber c (Taramelli, 1909, col.445, fig.31:7, 9 &13). Tomb XVIII, which

Table 3. SAM analyses of copper artefacts from Anghelu Ruju cemetery (Junghans, Sangmeister and Schröder, 1960, pp.106, 126, Taf. 20, nos 556-565); Tr = Traces.

Tomb		N.	Sn	Pb	As	Sb	Ag	Ni	Bi	Au	Zn	Co	Fe
I	Tanged dagger	556	0	0	0.11	0.17	<0.01	Tr	0	0	0	0	0.04
I	Awl	557	0	0	0.07	0.2	<0.01	Tr	0	0	0	Tr	0.05
I	Awl	558	0.01	0	0.02	0.95	1.4	0.01	0	0	0	0	0.02
XIII	Awl	559	0	<0.01	0.3	0.4	0.09	0.01	0.003	0	0	0	0.01
XIII	Awl	560	Tr	Tr	0.11	0	< 0.01	Tr	0.01	0	0.41	< 0.1	0.6
XVIII	Open bracelet	561	0	0.34	0.05	Tr	0.01	0.02	0.003	0	0.09	0	0.5
XX	Awl	562	0.2	0.3	1.7	0	0.34	Tr	0.03	0	0	0	0.04
XX	Awl	563	0.05	0.18	1.3	0	0.30	0	0.01	0	0	0	0.12
XXX	Flat axe	564	0	Tr	0.78	1.55	0.12	Tr	0.025	0	0	0	0.03
XXX	Tanged dagger	565	0	0.02	0.05	0.76	0.15	0.01	0.009	0	0	Tr	0.02

had material dating from Ozieri to the Early Bronze Age Bonnanaro phase (Demartis, 1986, p.32), contained a silver ring, and a copper bracelet plus two decorated fragments which might be late in date (Taramelli, 1909, cols 447, 450-451, figs 31:15 & 18, 32). Tomb XX also continued in use into the Early Bronze Age Bonnanaro phase (Demartis, 1986, p.44). Two of its chambers contained copper grave goods: three awls (one described as a needle) in chamber c and an arrowhead in chamber e (Taramelli, 1909, cols 465-466, figs 31:10-12 & 16, 42); for Ferrarese Ceruti (1976, p.139) the grave goods date to the Bonnanaro phase – certainly the analytical data for an awl and the dagger, which are in arsenical copper, suggest that they are later in date (Tab.3; Junghans, Sangmeister and Schröder, 1960, pp.106, 126, Taf.20, nos 556-565). In Tomb XXbis, a small niche, chamber d, had a single burial with rich grave goods, including two silver beads which are described as being similar to those found in Tomb XIII (Taramelli, 1909, col.478); the material in the tomb ranges from the Ozieri phase to the Beaker phase (Demartis, 1986, p.44). Finally, a dagger, a flat axe, beads and three spirals were found in chamber d of tomb XXX (Taramelli, 1909, cols 510-512, 514, fig.31:1, 14 & 17); this grave was in use from the Ozieri phase to the Beaker phase (Demartis, 1986, pp.37-38).

A *tuyère* was recognised by Ronald Tylecote among the material from chamber d of *domus de janas* XIV at Anghelu Ruju (Taramelli, 1909, cols 434-435, figs 14:2 & 23; Tylecote, Balmuth and Massoli-Novelli, 1984a, p.125, fig.6:2; 1984b, p.66, fig.1). The material from the tomb, a multiple grave with a long history of burials, ranges from Ozieri to Abealzu, so the *tuyère* cannot be precisely dated (Lo Schiavo, 1984, p.22, note 4).

A fragment of a copper (?) blade was found in room 3 of *domus de janas* II at Mesu 'e Montes (Ossi SS). The tomb, built in the Ozieri period, had been disturbed and contained material from the Filigosa, Abealzu, Monte Claro and Bonnanaro phases, as well as Medieval artefacts, but the excavators suggest on typological grounds that the blade is likely to be pre-Beaker in date (Demartis and Canalis, 1985, pp.64, 66, 68, fig.19:5).

It has been claimed (e.g. Melis, 2000, p.84, tav.110:8 & 9; Webster and Webster, 2017, p.16) that the metal finds from the cave of Sa 'ucca de su Tintirriòlu (Mara SS), excavated by Renato Lorìa and David Trump in 1971, also document Ozieri metalwork (Lorìa and Trump, 1978, p.50). Close reading of the (admittedly confused) account of the stratigraphy, and the form of the objects themselves, suggests that this is unlikely. Two conjoining fragments of what is described as sheet metal ('*lamina*': *ibid*., p.50, fig.37:18, tav.XXXIX:15) were found in the second 'level' of trench G, which pertains to a mound also containing Monte Claro and Roman material, clearly heaped up long after the Ozieri phase of use of the cave (*ibid*., p.11, fig.5). The fragments therefore cannot be dated by their context. A further fragment, which resembles the handle of a metal vessel and so is *prima facie* later in date (*ibid*., p.50, fig.37:19, tav.XXXIX:19), was found in a layer without any diagnostic material that lay between 'level' 1 (which was disturbed) and 'level' 2

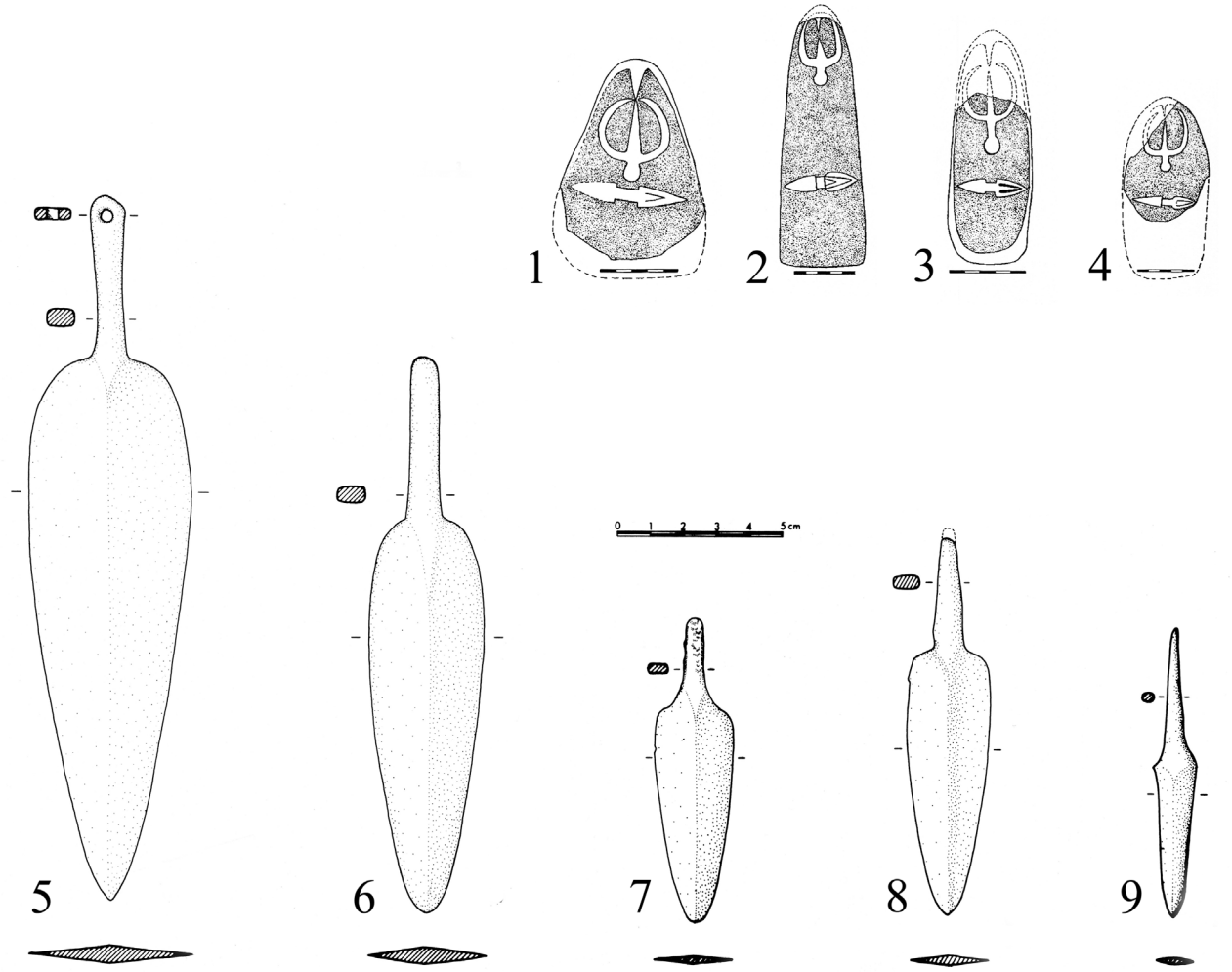

Figure 7. 1-4, Statue-menhirs, Laconi (NU), scale bar 50 cm (after Atzeni 1998, fig. 6: 8 & 9, fig. 7: 12 & 16): 1. Piscina 'e Sali II; 2. Piscina 'e Sali I; 3. Piscina 'e Sali V; 4. Piscina 'e Sali VIII. 5-9, Copper daggers (after Lo Schiavo 1989, figs 1: 2, 3, 5-7): 5 & 6. Serra is Araus (San Vero Milis OR); 7. Sa Duchessa (Cagliari CA); 8. Via Basilicata (Cagliari CA); 9. Cresia is Cùccurus (Monastir CA).

(assigned to Ozieri) in trench F (*ibid*., pp.55, 84), so that it too is unlikely to be Ozieri in date. Thus we may agree with the excavators that the metal finds from the cave are 'stratigraphically unreliable' ('stratigraficamente poco attendibili' – *ibid*., p.92).

The *domus de janas* at Sant'Iroxi (Decimoputzu CA) is known as the '*tomba dei guerrieri*' or tomb of the warriors. An awl or punch was found in chamber A in an Ozieri context (layer 11), but the excavator thinks it may be intrusive as it is of a similar form to the Bronze Age, Bonnanaro, examples also found in the chamber (Ugas, 1990, pp.75, 96).

A brief interim report of the excavation of chamber 2 of *domus de janas* 12 at Cannas di Sotto (Carbonia CA) reports silver and 'bronze' (more likely copper) rings in association with atypical pottery and an Ozieri-style sherd (Salis, 2013) – their dating may become clearer when the context is fully published.

Statue-menhirs

Monolithic statue-menhirs, concentrated around the area of Laconi (NU) and most likely datable to the Filigosa and Abealzu phases (Atzeni, 1998, p.65), offer proxy evidence for the importance of metal daggers in the construction of Copper Age male identity (Figure 7). They are classified into two types, the Samugheo type and the Laconi type (Webster and Webster, 2017, pp.56, 65-66). The Samugheo type sometimes depict copper daggers that show affinities with Remedello style daggers (Atzeni, 1980, pp.39-40; 1998, p.71), shown also on Ligurian statue-menhirs and the rock-carvings at Mont Bego (Barfield and Chippindale, 1997); interestingly, Remedello-style copper daggers are not known in archaeological contexts in Sardinia (Lo Schiavo 2000, p.30) (nor indeed in Liguria or around Mont Bego). The Laconi type statue-menhirs sometimes depict a 'double dagger'

variously interpreted as a copper dagger with a large (organic) pommel or an opposing pair of daggers, the second perhaps in lithic material or bone (Figures 7:1-4; Atzeni, 1980, p.39; 1998, p.63).

Discussion

Perhaps the most striking aspect of the evidence for the earliest metallurgy in Sardinia is its paucity, at least until the Monte Claro phase, especially given the presence of abundant metal resources on the island. However, one of the key affordances of metal as a material is the ease with which it can be recycled, so the archaeological adage that absence of evidence is not evidence of absence is best kept in mind when assessing the incidence of metal finds, especially as it is precisely in those phases when metal was most rare that it is most likely to have been recycled.

Sardinian metallurgy seems to begin in the Ozieri phase, which we have seen starts in the last quarter of the fifth millennium, with the succeeding sub-Ozieri phase beginning around 3600 cal BC. Until dated contexts for the earliest metalwork are available, the parsimonious hypothesis is that the scarce evidence for Ozieri metalwork is likely to date to later in the timespan covered by the phase. On present evidence, and *pace* Melis (2014, p.488), this suggests that metallurgy in Sardinia appears somewhat later than in continental Italy, where metalworking first appears around 4300 cal BC (Pearce, 2015, pp.48-51). Since in the second half of the fifth to the later fourth millennium cal BC Sardinia was at the centre of a flourishing central Mediterranean obsidian trade, with its long distance networks (Tanda, 2009, p.64), it seems odd that metalwork arrives late and develops slowly in Sardinia, and we must ask why this might have been so.

Early metalwork in continental Italy is characterised by copper awls, with copper axes then appearing in the north-east around 4000-3800 cal BC, on the fringes of a network covering the eastern Alps, the middle Danube and the Carpathian basin; it is also possible that copper axes appear in northern and west central Italy around the mid fifth millennium, though this latter hypothesis is controversial (Pearce, 2015, p. 51). The Ozieri metalwork of Sardinia, on the other hand, is characterised by ornaments (beads and rings). Awls (a class of object that is variously described in the literature as points, pins, awls or punches) seem to only appear in sub-Ozieri times, when they become the most common artefact class. The first dagger is attested in sub-Ozieri times, while the report of an axe at Su Coddu remains to be confirmed (and dated). Daggers and axes are certainly documented later, in the third millennium BC Filigosa phase. The different pattern of incidence of artefact classes, with ornaments having an important early role on the island, may indicate that in Sardinia display was an important factor in the adoption of metalwork, unlike continental Italy (Pearce, 2007, pp.37-51). Indeed, it is interesting to note that after the sub-Ozieri awls become less common relative to other artefact classes, only increasing again in the Monte Claro phase; Monte Claro metalwork is dominated by daggers and awls, with few ornaments, suggesting a new social role for metalwork. Melis (2009, p.517) suggests that awls only become common again in the Beaker period, but this is clearly wrong as the high relative number of Monte Claro awls shows. The production of long blades by pressure flaking with copper points, documented in layers dated to the end of the fourth / early third millennium BC at Contraguda (Perfugas SS), provides useful proxy evidence for the specialist use of copper points (Costa and Pelegrin, 2004; cf. Pearce, 2000; 2007, pp.48-51). Finally, it must also be noted that since there is cultural continuity from Ozieri through to Abealzu, with Monte Claro appearing perhaps to be intrusive, the introduction of metal-use and working does not seem to be associated with any major cultural change.

Both copper and silver artefacts and working occur from the Ozieri phase, silver initially in the south of the island, and the early attestation of silver may be explained by Sardinia's rich silver resources, comprising outcrops of acanthite, cerargyrite and argentiferous cerussite and galena ore, as well as the likely presence of native silver. It is noteworthy that silver artefacts are also concentrated in the Copper Age Rinaldone culture of west-central Italy, particularly in northern Latium and in the Rome area (Bergonzi, 2012). For example, a silver bead was found in the multiple burial rock-cut tomb 23 at Selvicciola (Ischia di Castro VT), which has radiocarbon dates in the mid fourth millennium cal BC, though its final phase of use remains undated, so in the absence of a secure association we must remain sceptical about its dating (Petitti, et al., 2002; Petitti, Persiani and Conti 2016: 182-184, tab.2). Bergonzi (2012, pp.573-574) notes that silver artefacts in Sardinia and the Rinaldone culture do not share strong formal similarities implying that while contacts between the two zones are likely, they may not have been strong. Based on lead isotope analysis, Carboni, et al., (2016) suggest that a fragment of silver sheet found in tomb 12 at Osteria del Curato – via Cinquefrondi (Rome) was made of metal from the Iglesiente in Sardinia.

It is striking that metallurgy in Sardinia seems much earlier than that of Corsica, where the pit at Terrina IV

(Aléria, Haute-Corse), with the earliest radiocarbon-dated evidence for metalworking on that island, was filled around *3250-2400 cal BC* (Pearce, 2013; cf. Camps, 1988, pp.82-85, tab.VIII, fig.33; 1992, tab.5). Moreover, silver metallurgy does not appear to be attested in Corsica, despite the fact that the island had functioned in the Neolithic as a stepping-stone between Sardinia and the Italian mainland (Melis, 2014, p.490). In Corsica local rhyolite seems to be preferred to Sardinian obsidian as a raw material during the Copper Age Terrinien phase, perhaps a further indication of the dropping off of contacts between the islands (Melis, 2014, p.490) or simply of the decline of obsidian, replaced on the circuits of Mediterranean trade by metal. Certainly Sardinian obsidian begins to become rarer from the first quarter of the fourth millennium at the settlement of Neto – via Verga (Sesto Fiorentino FI) and in Tuscany more generally (Baglioni, Martini and Volante, 2008, pp.102, 105-106, 115, 122). All this suggests that any contacts between Sardinia and northern Latium and the Rome area may have been based on sailing directly across the Tyrrhenian Sea rather than island hopping.

The contexts of metal finds also show variation through time, with silver occurring in both funerary and domestic contexts in the Ozieri and sub-Ozieri phases and then only in funerary contexts in the Filigosa and Abealzu phases (except perhaps for the silver disk-shaped ring from Monte d'Accoddi [Sassari SS], by any measure an exceptional site, which may be from the Filigosa phase). Metalwork more generally seems restricted to funerary contexts in the Filigosa and Abealzu phases, except for the Abealzu ritual context of Cabula Montones (Sassari SS). It is worth noting that both Monte d'Accoddi and Cabula Montones are situated in the north of the island, whereas metalwork is largely attested further south, suggesting differences in practice across the island; certainly, tombs in the south seem much richer in metal finds in the Filigosa phase. In the Monte Claro phase, metalwork is again attested at settlements in the south, at Sa Corona (Villagreca CA) and Su Monti (Orroli NU), and in the north, at Monte Baranta (Olmedo SS). The concentration of sites of the phase with metalwork in the south of the island may simply reflect the fact that the Monte Claro phase lasted longer in this part of Sardinia, appearing later in the centre and north, and indeed a similar pattern is seen in the distribution map of Monte Claro sites more generally (Webster and Webster, 2017, fig.55). This phase also sees the first well-dated use of lead for repairing pottery, which may provide proxy evidence that silver is now being extracted from argentiferous lead ores by cupellation. Despite the presence of many Monte Claro sites in the silver-rich Iglesiente, silver artefacts are very rare in contexts of this phase, being attested so far only at rock-cut tomb 14 at Su Fraigu (San Sperate CA), suggesting that silver played a very different role in the intrusive Monte Claro group as opposed to the Filigosa and Abealzu societies, where it is much more common (Melis, 2014, p.491).

A difficult question to resolve regards how metal use and working originated in Sardinia. It seems unlikely to have developed autonomously, but given the extensive trade in Sardinian obsidian in the second half of the fifth to the later fourth millennium cal BC (Tanda 2009, p.64), it is more likely the result of transmission of know-how, perhaps even by metal prospectors, but the archaeological record provides no real evidence as to where these may have come from. Traffic in Sardinian obsidian was directed towards central and northern Italy and southern France (Tykot 2004, fig. 11; Lugliè 2012, fig.1), which may provide an indication of the areas from which knowledge of metallurgy is most likely to have originated. Southern France is unlikely to be the source of such know-how, as here too metallurgy developed quite late (in the late fourth/early third millennium BC in the Languedoc, later in Provence: Bartelheim and Pearce 2015, p. 703), so northern or north-central Italy (Pearce 2015) seem the most likely candidates, though the lack of attestations of early metalworking in Corsica may make the central Italian hypothesis less likely, as the island traditionally acted as a 'stepping stone' between Sardinia and peninsular Italy.

Conclusions

An anonymous scholiast to Plato's *Timaeus* (25, B; Greene 1938: 287) tells us that Sardinia was once called 'the island of silver veins' (ἡ ἀργυρόφλεψ νῆσος) and silver is certainly an important feature of the early metallurgy of the island. In this paper I have provided an overview of our knowledge of metal use and working from the Ozieri to Monte Claro phases, attempting to establish some order in the data, notwithstanding the many difficulties caused by the lack of a secure radiocarbon chronology for early metallurgy, and the fact that most early metal artefacts were found in multi-period, multiple burial tombs. What emerges is that metallurgy seems to appear rather later than in continental Italy, and has a distinct character, being used for display. What is now needed is a programme of analysis, and in particular lead isotope analysis, so that we can learn more about the character of the early metallurgy and the likely ore sources.

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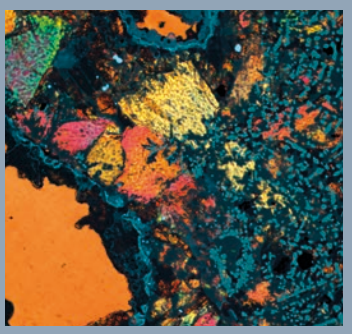

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Cover Images

1: An antique shrine with the partly molten religious objects made of silver and copper alloys at the palace of Dedoplis Gora, in Georgia. The contribution of Parjanadze and Bode investigates these silver objects and other Roman period silver from Georgia through elemental and lead isotope analysis. Photo: L. Gagoshidze.

2: Micrograph of wüstite-rich iron smithing slag adhering to forsterite-bearing basalt. The contribution of Güder, Gates and Yalçın investigates iron smithing technology through metallography and slag analysis from the Iron Age period at Kinet Höyük, Turkey. Photo: Ü. Güder.

3: Underground in an ancient copper mine at Lāghe Morād in the Veshnaveh mining area in central Iran. Recent research on the geology of the copper deposit and archaeological connections to key Bronze and Iron-Age settlements and workshops in central Iran are presented in the contribution of Nezafati and Stöllner. Photo: K. Stange.

4: The prehistoric tomb structure of Nuraghe Losa (Abbasanta OR), west-central Sardinia. The contribution of Pearce reviews the evidence of the earliest use of metals and metallurgy from settlements and tombs on this island, renowned for its rich copper and silver resources. Photo: M. Pearce.

metallum, i, n:
Mine (often pl.)
Metal, also stone, mineral

μεταλλον, το:
Mine, shaft, gallery;
esp. a) Mine (usually pl.)
b) Quarry

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