Abstract

Bronze Age mining in the southeast of the Iberian Peninsula has been traditionally scarcely researched, but this frame has changed recently thanks to the identification of a great number of mining evidence identified during the fieldwork campaigns in the Rumblar and Jándula Valleys between 2009-2014. Specifically, in this paper we will be presenting the mining exploitations discovered during the archaeo-mining surveys carried out during the summer of 2014. During this campaign we have been able to identify a large assembly of material culture, mainly stone tools and ceramics that prove that these mines were exploited in Recent Prehistory. The analysis of the archaeological remains and the archaeometric data prove the importance of the mining and metallurgical activity carried out in eastern Sierra Morena by the communities that lived there between 2200-900 BC, revealing this area as one of the main production centers for copper and silver in the southeast of the Peninsula.

Key words: Prehistoric mines, copper, silver, stone tools, south of the Iberian Peninsula, Sierra Morena, Bronze Age, archaeological survey.

Resumen

La minería de la Edad del Bronce en el sur-este de la Península Ibérica ha sido escasamente tratada por la investigación. Este panorama ha cambiado recientemente gracias a la identificación de numerosas evidencias mineras durante los trabajos de campo realizados en los valles del Rumblar y Jándula entre 2009-2014. Concretamente, en este artículo analizamos las explotaciones mineras halladas en la prospección arqueominera realizada en los valles del Jándula-Yeguas en el verano de 2014. Esta actuación ha proporcionado una amplia gama de cultura material, fundamentalmente herramientas de piedra y cerámica, que evidencian que estas minas fueron laboreadas durante la Prehistoria Reciente. El análisis de los restos arqueológicos y los datos arqueométricos muestran la importancia de la actividad minera y metalúrgica llevada a cabo en Sierra Morena oriental por las comunidades entre el 2200-900 BC, situándose como uno de los principales centros productores de cobre y plata del sureste peninsular.

Palabras clave: Minas prehistóricas, cobre, plata, herramientas de piedra, sur de la Península Ibérica, Sierra Morena, Edad del Bronce, prospección arqueológica.

INTRODUCTION

The production of metals and their distribution has been a key element in the historical-
economic organization of III-II millennium B.C. communities of the south of the Iberian Peninsula. On one hand, since the decade of the 1970s different researchers have stressed that the process of metallurgical craft specialization was key in the social stratification of Bronze Age communities (Lull Santiago 1983; Lull Santiago et al. 2010; Moreno Onorato and Contreras Cortés 2010). On the other hand, some consider metallurgy to be a secondary element within this process that would not require a full time specialization; its development would be a consequence of social stratification and not a cause, and would be a part of the changes occurred in the organization of substantial production (Gilman 1987; Montero Ruiz and Murillo Barroso 2010).

But within the debate on the importance of metal production there is a substantial element that has been left out: mining. In the Iberian Peninsula, the studies centered on prehistoric mining have had a scarce development with the exception of the areas of Asturias-León and the province of Huelva (Blanco Freijeiro and Rothenberg 1981; Blás Cortina 2015). Until the publication of the ancient mines and foundries catalogue of the Iberian Peninsula, written by C. Domergue in 1987, the existing data on prehistoric mines on the southeast of the Peninsula was limited to sporadic and general information collected by mining engineers from the late XIX and early XX centuries, reports that usually lack archaeological information (Mesa y Álvarez 1890). Domergue documented 11 mining exploitations distributed throughout the whole Southeast with ofite and diorite stone hammers, which he considered belonged to Recent Prehistory. Eight of these eleven mines were concentrated in the Jándula basin—the mines of Navalasno, Los Escorialles or Artayo de Valquemado—(Domergue 1987: 254-261). His research was based on field work, unpublished reports from mining engineers from the Archive of S.M.M. Peñarroya, as well as the research carried out by M. Corchado y Soriaño (1962), mainly at the mine of Los Escorialles.

In the past few years, the panorama has changed thanks to the archaeological campaigns carried out by the Peñalosa Project in the eastern foothills of Sierra Morena (Contreras Cortés et al. 2005; Arboledas Martínez 2010; Arboledas Martínez et al. 2013; forthcoming) and the Bastida Project in the northern areas of the provinces of Almería and Murcia (Delgado Rack et al. 2014; Escanilla Artigas and Delgado Rack 2015).

Since 2001, our team is giving a strong impulse to the research on prehistoric and ancient mining and metallurgy in the south of the Peninsula (especially in the Upper Guadalquivir), adding new data to the information from the 1980s by carrying out a series of archaeological surveys in the Jándula, Rumblear, Guadiel and Guadalimar River Valleys, as well as the systematic excavation of the Bronze Age metallurgical settlement of Peñalosa (Baños de la Encina, Jaén) (Contreras Cortes 2000). The entire metallurgical production process for copper has been documented at this Argaric settlement with the exception of mining. Because of this, one of our main objectives was to locate and analyze the copper and silver mines in the region, and determine their influence on the territorial organization during the different periods of antiquity as well as their environmental impact. With this plan we prepared a series of interventions that united both fieldwork (archaeo-mining surveys of the eastern valleys of Sierra Morena, excavation of the Polígono and José Martín Palacios mines, etc.) and lab work (quantitative and qualitative archaeological analysis, provenance analysis, etc.) that are still being carried out (Arboledas Martínez y Contreras Cortés 2010; Arboledas Martínez et al. 2015; Bartheilme et al. 2012; Contreras Cortés et al. 2005; 2014; Moreno Onorato et al. 2010).

In this paper we will present and analyze the prehistoric mining evidence we have documented during the archaeological surveys carried out during the summer of 2014 and spring of 2015 in the Jándula and Yeguas Valleys (Natural Park of Sierra de Andújar) (Arboledas Martínez, forthcoming). These are the first mines from the Southeast, next to the Polígono and José Martín Palacios mines in Baños de la Encina (Jaén) and Cerro Minado in Huercal-Overa (Almería), that can clearly be ascribed to Recent Prehistory1 (Arboledas Martínez and Contreras Cortés 2010; Arboledas Martínez et al. 2015; Escanilla Artigas and Delgado Rack 2015).

MINERAL RESOURCES IN THE AREA OF INTEREST

The surveyed mining area is located within the Natural Park of Sierra de Andújar, in the eastern part of Sierra Morena, in the northeast quadrant of the Province of Jaén. The park includes more than 40 private and public estates with an extension of over 70,000 hectares. At the moment we have surveyed the public estates of Lugar Nuevo, Selladores-Contadero, Valquemado and the private estates of La Lastrilla and El Poyuelo, which all adds up to approximately 7% of the total extension of the Park. These mining areas correspond to the middle and upper Yeguas and Jándula River Valleys, tributaries to the Guadalquivir River, and belong to the municipalities of Marmolejo and Andújar (Jaén) (Fig. 1).

1 In the summery presented at the IV Archeometallurgy in Europe Conference we indicated that the intention was to present the results from the lead isotope analysis that are being carried out on the mineral samples that were recover from this mines with the objective of characterizing their isotopic range and determining their distribution, but it has been impossible to obtain the results before the presentation of this paper.
Geologically speaking, this area is characterized by two well differentiated stratigraphic and tectonic units that are extended in parallel bands from West to East. The first one corresponds to two deep strands of the Paleozoic bedrock, to the north and south of the granite outcrops, represented by sedimentary material (slate, graywakes, etc.) that have been folded and transformed by regional metamorphism and granite intrusions during the variscian orogeny. The second is related to the intrusion of plutonic rocks –mainly granites, diorites, granodiorites and adamellite– corresponding to the Pedroche batholiths which follows an approximate direction of NW-SE (IGME 1971:14).

The mineral veins are usually located in the granitic areas and in some slate areas of the inter-carboniferous. The main mineralizations are copper, lead/silver and uranium. Most of the copper veins cross the granitic mass in direction E-W and NE-SW. Some stretch out more than 10km and penetrate into the slate terrains, as is the case of the vein of Los Escoriales. These mineralizations are formed in columns of 50 to 200 m long, with superficial quartzite and iron-rich crests. These superficial outcrops are rich in copper oxides and carbonates and would have been the preferential points for prehistoric miners.

These veins contain chalcopyrites, pyrites, azurite, malachite... In the metamorphic contacts these mineralizations are mainly galena, malachite and iron oxides (goethite, hematite, etc.). The main minerals in these Valleys are cupferiferous with exception of lead-rich levels in the district of Linares (Azcarate 1972).
During the first stages regarding mining in eastern Sierra Morena, mainly copper minerals were exploited, both in the form of simple minerals as well as in the form of native metal or polymetallic minerals located at the crests of the mineral veins. At the settlement of Peñalosa, thanks to bulk composition analysis, we can certify that the minerals obtained belonged to two different polymetallic mine groups: one with cupriferous ores (José Martín Palacios) and another with lead-copper ores (Polígono) (Moreno Onorato et al. 2010; Moreno Onorato and Contreras Cortés 2010: 60). In these superficial oxidized levels there is also a possibility of obtaining native copper and silver (Tamain 1972). At a certain depth, non altered cupriferous minerals and complex sulfates linked to iron, such as pyrites, have also been identified, and would have been exploited during Roman times.

**NEW PREHISTORIC MINES IN THE JÁNDULA VALLEY**

The main problem we stumble upon when trying to study prehistoric mines, as occurs in other mining areas in Europe, is the capability of distinguishing and identifying the oldest exploitation phases of mining activity. In most cases, subsequent mining activities, especially after the industrial revolution, have hidden or destroyed previous evidence. Fortunately, in this area a great amount of ancient mining remains have been untouched, mainly due to the low profitability of many of the mineral veins with scarce lead mineralizations, objective of contemporary mining interests in the area.

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1 The initials used to identify these sites correspond to the initials of the municipalities of the province of Jaén where they are located: A (Andújar), M (Marmolejo) and VR (Villanueva de la Reina); and are accompanied by a correlative number assigned to each site.

### Table 1. Mining exploitations from the Jandula and Yeguas Valleys. Mining evidence: T = trench, P = mining shaft, S = survey/pit, G = Gallery, E = mining dump. Material Culture: Mi = Mineral, Mar = Hammer, ML = Lithic material, CP = Prehistoric ceramic, CR = Roman ceramic, CPR = Protohistoric ceramic, CMP = Prehistoric metallurgical ceramic, CMPR = Protohistoric metallurgical ceramic, CMR = Roman metallurgical ceramic, EPR = Recent Prehistoric slag, ER = Roman slag. Chronology: PR-C = Recent Prehistory, Copper Age, PR-EB = Recent Prehistory, Bronze Age, PRO = Protohistory and R = Roman.

<table>
<thead>
<tr>
<th>Nº</th>
<th>Acronym</th>
<th>Name</th>
<th>Evidence mining</th>
<th>Material Culture</th>
<th>Cronology</th>
</tr>
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<tr>
<td>02</td>
<td>J-A71</td>
<td>Piedra del Águila</td>
<td>T, P, G, E</td>
<td>Mi, CMPR, ML</td>
<td>PR y PRO</td>
</tr>
<tr>
<td>03</td>
<td>J-M5</td>
<td>Barranco Valpeñoso</td>
<td>S, E, P</td>
<td>Mi, Mar, CR, ER</td>
<td>PR-EB, R</td>
</tr>
<tr>
<td>04</td>
<td>J-M6</td>
<td>Revuelta Molinicos</td>
<td>T, E</td>
<td>Mi, Mar, ML</td>
<td>PR</td>
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<tr>
<td>05</td>
<td>J-A62</td>
<td>Los Castellones</td>
<td>T, E</td>
<td>Mi, Mar</td>
<td>PR</td>
</tr>
<tr>
<td>06</td>
<td>J-A65</td>
<td>Arroyo de la Grieta</td>
<td>T, E</td>
<td>Mi, Mar, EP</td>
<td>PR</td>
</tr>
<tr>
<td>07</td>
<td>J-A65</td>
<td>Mingorramos</td>
<td>T, E, G</td>
<td>Mi, Mar, CR</td>
<td>PR, R</td>
</tr>
<tr>
<td>08</td>
<td>J-A69</td>
<td>Navalasno</td>
<td>T, E</td>
<td>Mi, Mar, ER</td>
<td>PR, R</td>
</tr>
<tr>
<td>09</td>
<td>J-M9</td>
<td>Nava de la Cabrera</td>
<td>T, E</td>
<td>Mi, Mar</td>
<td>PR</td>
</tr>
<tr>
<td>10</td>
<td>J-A75</td>
<td>Las Minetas</td>
<td>T, E</td>
<td>Mi, Mar</td>
<td>PR</td>
</tr>
<tr>
<td>11</td>
<td>J-A75</td>
<td>Las Minetas II</td>
<td>T, E, S</td>
<td>Mar</td>
<td>PR</td>
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<tr>
<td>12</td>
<td>J-A84</td>
<td>Laguna de los Llanillos</td>
<td>T, E</td>
<td>Mi, Mar</td>
<td>PR</td>
</tr>
<tr>
<td>13</td>
<td>J-A86</td>
<td>Casa mina de Valquemado</td>
<td>T, E</td>
<td>Mi, Mar</td>
<td>PR</td>
</tr>
<tr>
<td>14</td>
<td>J-A87</td>
<td>Casa vieja de Valquemado</td>
<td>T, E</td>
<td>Mi, Mar</td>
<td>PR</td>
</tr>
<tr>
<td>15</td>
<td>J-A85</td>
<td>Cerro de los Venados</td>
<td>T, E</td>
<td>Mar</td>
<td>PR</td>
</tr>
<tr>
<td>16</td>
<td>J-A8</td>
<td>Los Escoriales</td>
<td>T, E, Es, P, S</td>
<td>Mi, Mar, ER, CR</td>
<td>PR, R</td>
</tr>
<tr>
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<td>T, E</td>
<td>Mi, Mar</td>
<td>PR</td>
<td></td>
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<tr>
<td>18</td>
<td>Arroyo Fresnecillo</td>
<td>T, E</td>
<td>Mi, Mar</td>
<td>PR</td>
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<tr>
<td>19</td>
<td>El Polígono</td>
<td>T, E, S, P</td>
<td>Mi, Mar, ML</td>
<td>PR-C, PR-EB</td>
<td></td>
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<tr>
<td>20</td>
<td>J-BE84</td>
<td>José Palacios-Dña Eva</td>
<td>T, P, G, E</td>
<td>Mi, Mar, CMP, CPR-EB, CR</td>
<td>PR-EB, PROT, R</td>
</tr>
<tr>
<td>21</td>
<td>Mina Arrayanes</td>
<td>T, E</td>
<td>Mi, Mar, CR</td>
<td>PR, R</td>
<td></td>
</tr>
</tbody>
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Despite certain limitations, the survey has allowed us to identify 52 unknown archaeological sites and mines, with the exception of the eight mines mentioned by C. Domergue (1987) and the four settlements documented during the first stages of the Peñalosa Project in this valley (Pérez Barea et al. 1992). Half of the sites, 25, are mines that were exploited at different moments in history, of which 20 are ancient exploitations. In some cases we have been able to identify two exploitation phases, one during Prehistoric times and the other during the Roman period, as are the cases of Barranco de Valpeñoso and Los Candalares.

Of the 20 ancient mines, 15 have been cataloged as belonging to Recent Prehistory, and some specifically to the Bronze Age, as are for example, Los Candalares and Arroyo de la Grieta. In this valley, C. Domergue (1987) mentioned another three mines that we have not been able to identify: Los Escoriales, Aliseda and Arroyo Fresnillo. We must also add the two mines documented in the Rumblar Valley and one documented in Linares (Arboledas Martínez and Contreras Cortés 2010; Arboledas Martínez et al. 2015). Up till now we have been able to identify 21 prehistoric mines in eastern Sierra Morena with evidence of material culture, especially lithic tools and ceramics linked to Recent Prehistory (Bronze Age) (Tab. 1) (Fig. 1).

The mines documented in Sierra de Andújar are open-cast, same as in the cases of the Linares-La Carolina district, in the form of trenches-shafts or shallow pits that exploited the superficial veins and outcrops rich in mineral copper oxides and carbonates and probably native metals. Prehistoric miners would easily recognise the outcrops by the white quartzite with azurite (blue) and malachite (green) or native copper veins. The walls of many trenches, for example in the case of Los Candalares, still preserve many copper mineralizations, mainly malachite.

Mining works present an irregular layout and variable dimensions due to the extraction of the richest areas of the veins, characteristic of a selective and non-systematized mining tradition, common in Prehistory. Therefore, the most important veins of the area, which stretch out many kilometres, present massive mining areas at certain points and no mining activities at others. This exploitation system would have survived throughout great part of antiquity. The morphology and dimensions of the trenches depend on the direction and depth of the veins, the location of the mineral, their quality and other physical or geological conditions. To this sense, in the area we have documented large trenches (more than 50 m long), as are the cases of Los Candalares, Navalasno and Mingorramos, and other smaller ones such as the survey/pit at the mine of Barranco de Valpeñoso (fig. 2-4).

These exploitations are part of the mining activities–trenches and pits–as well as the dumps, which in occasions can be very large or are camou-

Figure 2. Trench in the NE sector of the Mingorramos/Humilladero mine (Mingorramos estate, Andújar).
flaged in the surrounding landscape. Both within the mines and in the dumps Argaric ceramics and a great amount of lithic tools linked to the extraction and beneficiation of the mineral have been identified. Of the 15 prehistoric mines, we have selectively recovered over 80 tools (both complete and fragmented tools). Most are oñite and diorite hammers/maces, adzes, milling stones and hand mills. In some mines, such as Los Candalares or Barranco de Valpeñosos, we have also recovered Roman ceramics (common and amphorae).

All the hammer-maces recovered at the mines in Sierra de Andújar (41) (fig. 5), present grooves or slots to for fitting. Their shape and dimensions are substantially different from one another. The morphological and weight differences must be considered when interpreting the functionality of these objects. Hammers that would weigh between 0.5 and 5 kg would be used both for direct and indirect percussion. Their typology responds to the characteristics of other mining hammers documented in the Peninsula, such as those located in the southwest, or in Asturias (Hunt Ortiz 2003; Blas Cortina 2007-2008). Larger hammers (more than 5 kg) are thought to have been used as part of slings placed in front of the surface of the rock (Blas Cortina 2007-2008). The mace would be suspended and would be swung in pendulum movements against the surface of the vein. Extraction experiments using these dispositives hanging directly from the shoulder have also proven to be effective (Pickin and Timberlake 1988: fig. 2a). But these large maces could have also been used for a first beneficiation of the minerals extracted with help of a lever system or crank, similar to those used to extract water.

Though currently the petrographic study of the hammers is being carried out, we can already observe a clear preference in the raw material, with a clear predilection of intrusive igneous rocks such as diorites. This type of material is very frequent in Sierra Morena with a large presence of granitic batholiths. All the tools present polished surfaces, common in riverbeds. Therefore, they would obtain the raw material from secondary deposits from nearby rivers and streams (such as the Yegüas or Cabrera). The identification of a grooved hammer near the riverbed of the Cabrera River (Andújar) confirms the origin of the raw material used for the creation of these objects (fig. 5.2).
During the extraction of the mineral, bone/antler tools were probably used, though no mine in the South has preserved any evidences of these elements. We only have the testimony of E. Hernández, who indicated the presence of some deer antlers next to stone hammers and human remains located at the Preciosa mine (Seville) (Hernández Pacheco 1907: 288). Nevertheless, there is evidence and traces of other extraction methods, such as fire-setting, that appear both on the minerals recovered at the site of Peñalosa and at two of the mines in the Rumblar Valley, the mines of José Martín Palacios and Polígono (Arboledas Martínez et al. 2015: 150; Moreno Onorato et al. 2010).

CHRONOLOGY OF THE MINING EXPLOITATIONS

Another important question regarding the study of mining exploitations is their chronological frame. The chronological adscription to Recent Prehistory (Copper and Bronze Age) of the 15 identified mines from Sierra de Andújar, next to the previous 3 identified by C. Domergue, has been carried out taking into consideration a series of archaeological evidences: the typology of the mines, the existence of certain traces, such as vaulted and blackened surfaces due to the presence of fire, stratigraphy, the level of integration of labour, dumps, the distance to prehistoric settlements and, above all, as also occurred in other mining areas of the Peninsula, the presence of material culture in the dumps and inside the mines. The most significant elements are lithic artefacts, especially mining hammers, and ceramics. The identification of only one of these remains does not make a chronological adscription per se, and only if many different aspects meet or are ratified by archaeological excavation or lead isotope analysis, can we certify the chrono-cultural moment in which the mining-metallurgical activity was carried out.

As we can see, most of the evidence that has been documented allows us only to make a general classification of these mines as belonging to Recent Prehistory or Protohistory, without any further precision. Stone tools, mainly hammers, are the most abundant materials found at mines that are used as chronological indicators. Unfortunately, these tools only allow a general adscription: prehistoric; given the fact that these elements can be found since the Copper Age up until the Late Bronze Age both in the Iberian Peninsula and Europe, as for example at the Chalcolithic mines of Cabrières (Herault) (Amébert et al. 2009) and El Aramo (Asturias) (Blas Cortina et al. 2013), or the Bronze age mines of Mitterberg (Salzburg) (Stöllner et al. 2004) and Copa Hill (Wales) (Timberlake 1990), and the Late Bronze Age mines of Chinflon (Huelva) (Blanco Freijeiro and Rothenberg, 1981: fig. 30). Therefore, these elements cannot be exclusively linked to a certain period and the variations in typology usually do not respond to chronological criteria (Gale 1995; Hunt Ortiz 2003).

Nevertheless, the presence of handmade burnished ceramics, characteristic of the Bronze Age (Argaric culture), fragments of reduction vessels and immature slag (fig. 6) with the same characteristics as those indentured in other Argaric settlements in the region, have been identified in three mines –Los Candalares, Arroyo la Grieta and Peñón del Águila-, and are irrefutable indicators for the Argaric Bronze Age exploitation of these mines. Furthermore, at the mines of Polígono and José Martín Palacios flint objects and adzes belonging to the Copper Age and Early Bronze Age have also been identified (Arboledas Martínez et al. 2015; Arboledas Martínez and Contreras Contreras 2010).

At these two mines located in the neighboring Rumblar Valley, Bronze Age exploitation has also been identified through lead isotope analysis.
Figure 5. Mining maces and hammers with a central groove from the prehistoric mines of Sierra de Andújar. 1 and 3. Arroyo de la Grieta, 2. Río Yeguas, 4. Revuelta de Molínicos, 5 and 7. Los Candalares, 6. Working area Los Candalares.
The results indicate that these two mines were exploited by the inhabitants of the metallurgical Bronze Age settlement of Peñalosa (Hunt Ortiz et al. 2011: 198-201). In the case of the José Martín Palacios mine, the results of the excavation of 5 sectors and \( ^{14}C \) dating of three samples confirm the results obtained during previous archaeological surveys and lead isotope analysis. Therefore, a first exploitation of this mine would have begun at the end of the III mil. B.C. and throughout the Bronze Age and a second moment during Roman times (Arboledas Martínez et al. 2015).

Until now, these are the only two mines of the the southeast of the Iberian Peninsula where we have clearly documented Bronze Age exploitation thanks to the archaeological record (survey and excavation), radiocarbon dating, and lead isotope analysis. The other mine of the southeast dated by \( ^{14}C \) is Cerro Minado (Huercal Ovra, Almería) with a late Copper Age chronology (Delgado Rack et al. 2014). Other cases from the Peninsula can be added, such as the mines of Moçissos in Portugal (Hanning et al. 2010: 289) or Sa Mitja Lluna in Illa de Colom (Menorca) (Hunt Ortiz et al. 2014). Out of the Peninsula we must highlight the prehistoric mines of Kargaly (Martínez and Rovira 2005) and Ross Island (O’Brien 2004).

**CONTROL AND EXPLOITATION OF THE TERRITORY: LABOUR AREAS OR CAMPS?**

The exploitation of mining resources in eastern Sierra Morena has been directly and indirectly conditioned throughout history by both its landscape and by settlement patterns. The first important evidence of occupation of this territory has been documented as belonging to the Copper Age, moment in which the first copper...
mines of Sierra Morena would have begun to be exploited.

During the archaeological surveys carried out in the Jándula Valley during the late 1980’s only two sites belonging to the Copper Age were documented (A-26 and A-30). This hampered any attempt to carry out spatial analysis or to try and establish any kind of settlement pattern. Both sites share common characteristics such as their reduced size, the inexistence of fortifications and the scarce entity of their households, as well as a limited sequential development as is indicated by the superficial material that was recovered. In both cases, the location of the settlement seems to be conditioned by the exploitation of local resources. The first site (A-26) is located in an area that seems to be related to stockbreeding and gathering activities. The second site (A-30), known as Los Santos, on the other hand seems to be related to raw material exploitation, especially flint and copper minerals, since the site is located in a flat meadow area with flint outcrops situated near the mines of Los Candalares and Las Minetas. The recovery of crucible fragments on the surface of the site reveals the existence of metallurgical activities, as happens in other Copper Age sites of the Rumblar Valley such as in Cerro del Tambor (Pérez Bareas et al. 1992). Isotope analysis of the mineral samples from both mines and the crucible can confirm the relation between the mines and the site (fig. 1).

It is during the Bronze Age when we can observe, as is also the case of the Rumblar Valley and the Linares-Bailén depression, an authentic colonization of the Jándula Valley with the ex novo foundation of new, medium sized, settlements that occupy different strategic points with a great territorial control. Next to these settlements we can also identify different enclosures or small forts with the objective of having a better control over the natural mountain passes form the Guadalquivir Valley towards the interior of Sierra Morena as well as facilitating the inter-connection between sites. Within this settlement pattern we must highlight the site of Las Cabreras (M-1) located in a strategic point, controlling the mouth of the Jándula River, tributary of the Guadalquivir. Its geostrategic location is incremented by a complex fortification system composed of various walls and a tower placed at the easiest access point. We must also take into account its large extension of over 4 hectares. Therefore, this would be the most important site in the Jándula basin, and possibly the centre of this complex settlement pattern (Pérez Bareas et al. 1992).

The intense occupation of this area was intimately linked to the existence of important mineral resources since it is a natural pass that connects the Central Plateau and the Guadalquivir Valley. Though the location of sites, as is the case of the Jándula Valley, does not seem to be directly linked to the spatial distribution of mines and their exploitation, but rather seems to be related to natural passes that act as routes for the beneficiation and distribution of metal.

The excavation of Argaric sites such as Penañalosa and Castillo de Baños de la Encina, in the neighboring Rumblar Valley has allowed us to archaeologically document the total production process of copper metallurgy. Metallurgical activities have been documented in most of the structures of the settlement (slags, mineral, crucibles, etc.), in opened areas, coexisting and sharing the same spaces as other productive activities and daily tasks (Alarcón García 2010; Moreno Onorato and Contreras Cortés 2010: 58-59). During the most recent campaigns at Penañalosa, a metallurgical dump (slags, crucibles, etc) has been documented outside the settlement precinct. This is the first case in which this has been documented in any Recent Prehistoric settlement of the Iberian Peninsula, which proves the importance of this activity within the life of this site (Contreras Cortés et al. 2014).

Nevertheless, more recent investigations—the excavation of the José Martín Palacios mine and the survey of the Sierra de Andújar—have revealed new relevant data on the existence of possible labor sites areas next to the mines with evidence of metallurgical activity, completing the settlement pattern. This has been documented at the mines of Los Candalares (fig. 7) and Arroyo de la Grieta, in the Upper Valley of the Yegüas-Cabrera River. Due to the dimensions these do not seem to be settlements such as the ones documented in other areas of the Jándula or the Rumblar, but seem to be workshops or camps with a multifunctional character, where miners would carry out activities related to the extraction and beneficiation of the mineral. The identification of immature slags, milling stones and grooved hammers in both these sites indicates the existence of these workshops or metallurgical spaces next to the mines (Arboledas Martínez et al. in press). This type of settlements have certain parallels, always considering the geographic, temporal and cultural differences, with the camps documented at Loma de Tejerías (Albarracín) (Montero Ruiz and Rodríguez de la Esperanza 2008) and Les Campa de Mines (Sierra del Aramo) (Blas Cortina et al. 2013).

These are the first testimonies of workshops and metallurgical activities carried out next to mines that have been documented in the south of the Iberian Peninsula, sites that would complement the metallurgical activities that were carried out at the main settlements such as Penañalosa (Contreras Cortés 2000). To explain the presence of slags and reduction vessels we pro-
pose two hypotheses taking into account the small extension excavated until now at the José Palacios mine and the superficial data recovered during the surveys. The first one regards the evidence as metallurgical tests with the objective of estimating the quality of the mineral. The second one considers that metallurgical activities next to mines would be quite frequent, especially in the case of Los Candalares mine. In any case, both metallurgical activities and the existence of workshops next to the mines would be conditioned by a series of factors such as the location of a mine and its proximity to a settlement.

Other testimonies of metallurgical activities during Recent Prehistory in the Iberian Peninsula have been documented at the Moçissos mine (Portugal) (Hanning, Gaub and Goldenberg, 2010: 289) and the mining-metallurgical camps at Les Campa de Mines in the Sierra del Aramo (Riosa, Asturias) (Blas Cortina et al. 2013), and at Loma de Tejerías in Albarracín (Montero and Rodríguez de la Esperanza 2008: 163). In the last two cases, the mines are located in isolated mountainous regions, far from the main settlements, fact that would explain the location of these work spaces near the mines, especially in the case of Les Campa de Mines, located at more than 2000 m.a.s.l. As is proven by the existence of metallurgical remains, reduction processes and beneficiation of the mineral would be carried out at these sites in order to facilitate the transportation to the settlements.

Nevertheless, the settlement pattern in the areas of the two mentioned camps is very different from the one documented in the Rumblar and Jándula Valleys. For example, in the Rumblar, the existence of a large amount of Argaric settlements near mines (less that 3 km) renders the existence of situational camps useless since the miners could go to the mine and return in the same day. This does not discard in any case that during certain moments some people may stay during many days near the mine, leaving behind some remains evidencing occupation, as is the case of the José Palacios mine (Baños de la Encina).

In the case of the Sierra de Andújar (Jándula and Yegüas Valleys), most of the mines are located in isolated areas that are hard to access, far from any Bronze Age settlements documented until now in the area. This isolation can justify or explain, among other questions, the existence of the workshops-camps. Nonetheless there is still much to investigate in the Yegüas-Cabrera Valley to be able to present strong hypothesis since we still only have partial data. Furthermore, this
area has traditionally been considered as the NW «border» between the Argaric Bronze Age and the Bronze Age of the Guadalquivir (Contreras 2000). Therefore, despite being in the initial stages of our research, the new data reveals that we are facing a more complex reality regarding the control and territorial structure than the one in the Rumberal Valley or the Linares-Bailén depression published in previous papers (Contreras Cortés 2000; Arboledas Martínez et al. 2014).

The intense control over these mining valleys (Jándula, Rumberal, Guadiel and Guarrazas) is a clear symptom of the intensification and a certain specialization of copper and silver metal production in eastern Sierra Morena, within the territory culturally defined as the Argar Culture. The Upper Guadalquivir, as is proposed by some researchers (Contreras and Cámara, 2002), forms a geographic and cultural entity related to other Argaric areas, controlled by social elites, probably located in the main settlements of the Guadalquivir Valley, that would politically and economically control the production and distribution of metals, which must have been one of the key factors, but not the only one, in the asymmetry and social differentiation of the population (Moreno Onorato and Contreras Cortés, 2010).

CONCLUSIONS

As we have seen, the research we have been carrying out in the mining districts of Sierra Morena have revealed novel data that allows us to obtain a better image of the role of metal production within the prehistoric communities of the southeast of the Iberian Peninsula. The archaeo-mining surveys in the Sierra de Andújar have allowed us to identify and analyze 15 mining exploitations related to Recent Prehistory based on the material culture located at each mine, especially lithics and ceramics. We must also add the other three mines identified by C. Domergue (1987) in his mine catalogue of the Peninsula. Therefore, up until now, 18 prehistoric mines have been documented in the Yeguías and Jándula River Valleys, and when adding the mines of José Palacios and Polígono in Baños de la Encina, and Arrayanes in Linares, we obtain a total of 21 mines located in eastern Sierra Morena.

Quantitatively, this group of prehistoric mines, especially those in the Jándula basin, are the most numerous and important in the whole peninsular southeast. Within the Iberian Peninsula they can only be compared to the important mining exploitations identified in the areas of Asturias and León (Sierra del Aramo, La Profunda, etc.) (Blas Cortina 2007-2008; Blas Cortina et al. 2013), or, if regarding typology, with those documented in the province of Huelva (Blanco Freijerio and Rothenberg 1981). This concentration of mines united to the amount of metallurgical remains and the existence of copper ingots documented at the Argaric site of Peñaolosa, analyzed in another paper in this monograph, indicate that the scale of production reached within these communities are well above the need of the population of the mining valleys of Sierra Morena.

The surplus of produced metals would be used as trading goods with other regions of the south of the Iberian Peninsula, either as finished objects or as ingots, such as the ones documented at Peñaolosa. To this sense, the lead isotope analysis of silver and copper objects from Argaric sites, especially funerary contexts (Stos-Gale 2001; OXALID; Murillo Barroso et al. 2015; Bartelheim et al. 2012; Murillo Barroso 2013), shows that on one hand copper and silver from eastern Sierra Morena was distributed throughout the whole Southeast. On the other hand, they reveal a great diversity and dispersion of the mineral sources for copper, which does not occur in the case of silver, mainly produced in the mining districts of central and eastern Sierra Morena (Bartelheim et al. 2012).

Regarding copper, around 70 analyses have been carried out only being able to determine their provenance in 32% of the cases. Within these cases an important amount belong to the areas of Linares (eight elements), followed by Los Pedroches (four elements) and the Alcudia Valley (two elements) (Montero Ruiz and Murillo Barroso 2010: 44-46; Murillo Barroso et al. 2015). In total, these mining districts of central and eastern Sierra Morena add up to 82.3% of the total amount of objects whose provenance has been identified, being the mining district of Linares-La Carolina the most important one. Though this data can constantly vary when further research is published and more analytical results are obtained, until now it seems that Sierra Morena was the main copper producer of the southeast of the Iberian Peninsula. This fact however, is not at all contradictory to the coexistence of other mineral sources.

Field work in the area of Sierra de Andújar has also allowed us to identify the existence of labor spaces and metallurgical remains at the mines for the first time in three cases, and can be added to the case documented at the José Martín Palacios mine in the Rumberal Valley. The presence of these remains has been interpreted as metallurgical experiments to test the quality of the mineral or as timely reductions carried out at the mining sites. In some cases, such as in Los Candales or Arroyo de la Grieta, this could have been a normal practice with the intention
of transporting reduced mineral to the large settlements located further from the mines, contrary to the cases documented in the Rumbler Valley. The presence of immature slag, milling stones, hand mills and hammers evidence that these spaces would be related to extraction and beneficiation of minerals. In any case, we have obtained novel information that has changed the existing vision we had of the metallurgical process in this area, which considered that the whole metallurgical process, from beneficiation to the final object or ingot was exclusively carried out at the settlements, and not next to the mines.

The identification of labor spaces next to the mines can be justified due to the fact of their distance regarding the settlements located in this area (around the Jandula River). We must also consider that these types of settlements are located on the limits of Argaric influence and could respond to a different reality, structure and territorial exploitation that those documented in the Rumbler Valley or the Linares-Bailén basin. In the Jándula Valley, we have also been able to see a colonization of the area thanks to the huge increment in the number of settlements regarding previous periods. These settlements are located on hilltops which are extremely hard to access that are visually connected with one another directly or by means of small forts, such as Piedras Bermejas in the Rumbler Valley. Their locations would be directly linked to territorial control, natural passes and exploitation of natural resources, including copper.

Definitively, both the archaeological evidence of the Sierra de Andújar and the ones documented in the district of Linares-La Carolina and the archaeometric provenance analysis evidence that eastern Sierra Morena would have been the main focal point for copper and silver production in the peninsular southeast during Recent Prehistory, especially during the Argaric Bronze Age. It would not be the exclusive production area but it would be the most important one based on the results of lead isotope analysis, which have also determined the existence of other mines that still have not been identified. Therefore the two traditional hypothesis regarding Argaric metallurgy should be nuanced since the archaeological and analytical evidence reveal a more complex reality. In this case, large specialized production centers, such as the ones in eastern Sierra Morena, would coexist with other exploitation areas.

In the future it will be necessary to continue carrying out field work in order to locate new prehistoric mining exploitations not only in Sierra Morena, but also in the provinces of Granada, Almería and Murcia. This will also help in completing the isotopic characterization of the mines in the south and southeast of the Iberian Peninsula. Furthermore, the number of lead isotope analysis of copper and silver objects from Argaric sites must also increase to be able to identify the different commerce routes and the provenance of metal to further understand their circulation and distribution and to see if Sierra Morena still acts as the main production area. Currently, both lines of research are a priority in the research projects that we are carrying out in the provinces of Jaén and Granada.

ACKNOWLEDGMENTS

This work is inscribed within the following Research Projects: «La minería romana en Sierra Morena oriental: formas de estructuración de un territorio a partir de la producción, consumo y distribución de los metales» (PGI of the Junta de Andalucía 2012-2017) directed by Luis Arboledas; «La minería en el Alto Guadalquivir. Formas de construcción histórica en la antigüedad a partir de la producción, consumo y distribución de los metales» (I+D+i, Ministerio de Ciencia, HAR2011-30131-C02-01) directed by F. Contreras, and «Proyecto minería metálica en la Sierras Andaluces orientales. Desde los orígenes hasta inicios de la Edad Moderna» (HUM-7764, Proyecto de Excelencia of the Junta de Andalucía) also directed by F. Contreras. Furthermore we must also thank the Public Institutions, land owners, forest guards and land management employees for the help and permission and without whom this research could not have been possible.

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