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## A Prehistoric Copper Mine and Smelter in South-East Andalusia (Spain) – First Discovery by IAMS Survey Team

After more than ten years of intensive research in the region of the huge ancient mining site of Rio Tinto, Southern Spain, IAMS's Southern Iberia Archaeo-Metallurgy Project has lately shifted the emphasis of its fieldwork to the south-eastern provinces of Andalusia (Granada and Almeria), where large, fortified urban settlements of the Spanish Copper Age appeared closely connected with the beginnings of copper extraction and working. The current programme is centred on the major Copper Age sites of Los Millares and El Malegon which have been systematically excavated for a number of years by the Department of Prehistory, University of Granada, under the co-directorship of Professor Antonio Arribas, Professor Fernando Molina and Dr Francisco de la Torre.

The IAMS archaeo-metallurgical research group, directed by Professor Beno Rothenberg, included scientific colleagues from Mainz University (Professor I. Keemann), the British Museum Research Laboratory (Dr M. Tite, Dr I. Freestone and Dr D. Hook), and Oxford University (Dr N. Gale). Its programme included the scientific investigation of the metallurgical remains uncovered at Los Millares and Malegon as well as systematic archaeo-metallurgical explorations in the region adjacent to these sites, the latter in close collaboration with archaeologists from the University of Granada. This programme is sponsored by the Volkswagen Foundation.

IAMS Newsletter publishes here the first report on the archaeo-metallurgical survey in Almeria, carried out in September 1988, which discovered a prehistoric copper mining and smelting site, apparently of the Copper Age, in the high mountain range of the Sierra de Alhamilla, east of Los Millares – the earliest of its kind ever found in Western Europe.

### The Copper Age Site of Los Millares and the Emergence of Metallurgy

The coming of the Copper Age in Spain, evidenced by fortified urban settlements, complex megalithic tombs and the first substantial use of copper, is named the 'Millaran culture', after the type-site Los Millares in the province of Almeria (Fig. 1).

The settlement of Los Millares, with its adjacent corbel-vaulted megalithic tombs, is located on the tip of the spur between the Andarax river valley and the Rambla de Huechar, about 2km. from the modern village of Gador. After the discovery and first investigations of the site in 1891-2 by Belgian engineers, the brothers Henri and Louis Siret, and the first modern excavations during 1953-8, by Professor M. Almagro and Professor A. Arribas, the Department for Prehistory, University of Granada, began a long-term systematic excavation programme at Los Millares in 1978, directed by Professor A. Arribas and Professor F. Molina.

These excavations, continued almost annually, have already created a detailed picture of a huge urban

settlement, occupying an area of c. two hectares (five acres) and defended by three roughly concentric stone walls (Fig. 2). The external wall, which is the major defence of the settlement, is over 300m. long and c. 2m. thick. Semicircular and square bastions were built against the outside of this wall at intervals of 11-15m.

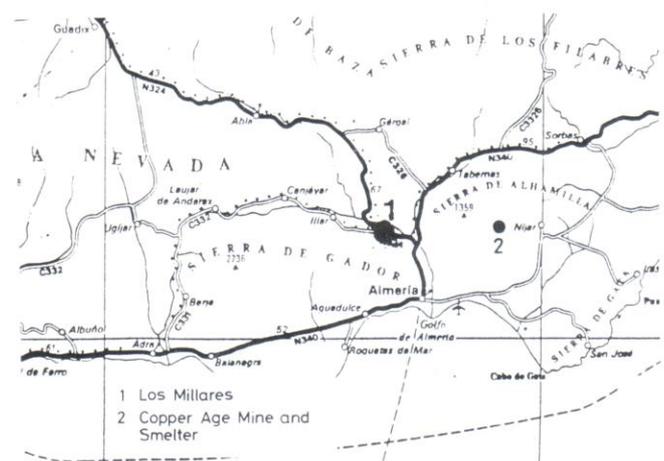


Fig. 1. Map of the region of Los Millares.

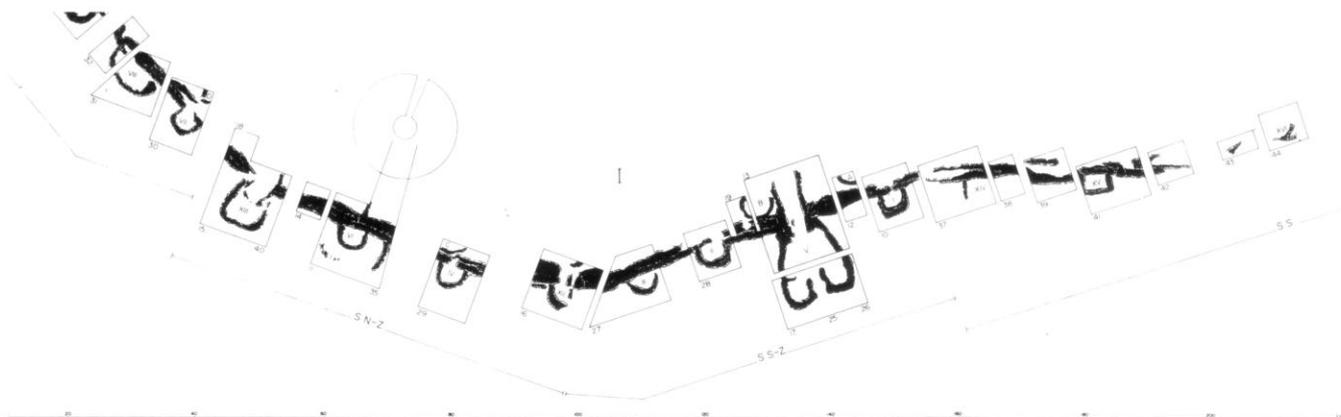


Fig. 2. Los Millares. Section of the outer bastioned defensive wall with the main gate.

Its main entrance, 4.6m. wide, was protected by a 'Barbican'-shaped main gate, projecting c. 12.5m. from the exterior of the wall. The excavations have also uncovered a number of round, stone built habitations of the typical Millaran house type. In several of these structures remains of metalworking were uncovered.

A chain of more than ten hilltop 'forts', located in a large semi-circle at some distance from the main settlement, was partly excavated by Granada University. The excavated 'fort' No. 1 was protected by concentric massive stone walls with outside bastions, encircled by a deep moat.

The most impressive archaeo-metallurgical discovery in the 1985 season of excavations was a large rectangular building built against the interior side of the third defensive wall. It contained a mass of metallurgical debris and, in its centre, a small round installation, apparently a metallurgical furnace (still to be investigated in detail). This is the first Millaran metallurgical workshop to be found and it testifies to a well-organized metallurgical industry at Los Millares.

The very appearance of such huge fortified urban settlements with a rich late neolithic-tradition material culture, now rightly named 'Copper Age' because of the presence of copper working, has naturally created a whole complex of pertinent questions: Where did these settlers come from? Where was the origin of their metallurgical know-how, which was obviously a newcomer of great economic importance into the country? And the basic question: Why did they have to build such huge defences and against whom?

#### Diffusion against local, autochthonous emergence

Since the late nineteenth century, and until quite recently, the 'diffusionist' idea of the arrival of 'colonists' from the eastern Mediterranean, who settled on the Almerian coast as well as on the Tajo estuary (now Portugal), had become generally accepted. These intruding newcomers brought with them the knowledge of metallurgy, together with the bastioned defence wall technique, megalithic burial practices and the correlated cult of a Mother Goddess (schist plaques with carvings of the Millaran 'Eye Goddess' in the tombs).

The most popular view, stated in 1961 by Beatrice Blance, saw the Millaran settlers as colonists who came directly from the Aegean. However, others, like H. N.

Savory (1968), suggested the Levant, in particular Palestine, with its semi-circular bastioned sites of Jericho, Ai and Arad, rather than the Aegean, as the region of origin of the Millaran newcomers. According to A.-W. Schuele (1976), it was the large increase in the demand for copper in the market places of the Near East which triggered off this large-scale colonization.

These comparisons of Millaran settlements and culture with Aegean and Levantine parallels obviously implied the acceptance of the related chronologies, which dated the beginning of Millaran settlements and metallurgy to approximately 2300 B.C. A number of C14 dates, obtained from archaeological samples from Millaran sites, e.g. 2340 ± 85 B.C. (H-284/247), or 2200 ± 120 B.C. (KN-73), were quoted as implying confirmation of the diffusionist view (Savory, 1968, p. 155).

Against this 'short chronology' and, consequently, against the diffusionist view of the origin of Millaran metalworking culture from the eastern or southern Mediterranean, speak the impressive number of recent calibrated C14 dates from Millaran contexts, which date these settlements and tombs to the late fourth to early third millennium B.C., i.e. long before the Aegean or Palestinian sites came into being. Professor Colin Renfrew, the chief exponent of this anti-diffusionist view, (1973, p. 91), lists the following relevant calibrated radiocarbon dates for Los Millares samples:

Collapse of fortification wall:

<i>C14 date b.c.</i>	<i>Approx. mean calibrated date B.C.</i>
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2345 ± 85 (H-204)	c. 2950
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Passage grave 19:

2430 ± 120 (KN-72)	c. 3300-3000
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Following up the consequences of this revision of dates and their culture-historical interpretation, which obviously negates any idea of direct Aegean or Levantine influence on the Iberian developments, Renfrew proposes an independent local, autochthonous beginning for Iberian metallurgy.

The excavators of Los Millares, in a recent publication (A. Arribas and F. Molina, 1982, p. 30), propose a rather more moderate approach, which seems to be more in line with recent archaeological research. The

large number of settlements with bastioned defence walls and round towers, recently discovered in the eastern Mediterranean region, and especially in Palestine, as well as in the West (in southern France at Lebous, Boussargues, Camp de Laure), can, in some instances be dated as far back as the early third millennium B.C. This appears to make it difficult to accept the view of such multiple, parallel emergence of the same ideas of defence systems. It therefore seems to be preferable to consider their gradual diffusion throughout the entire Mediterranean region, together with the metallurgical know-how, which apparently appears contemporaneously. According to Arribas and Molina, such a process would not require any direct contact between the eastern Mediterranean and the Iberian peninsula.

Arribas and Molina (1982, p. 32) also indicated a possible solution to the basic question concerning the need for the strong defences of the Millaran settlements. There is archaeological evidence for the contemporaneous existence in the same narrow geographical region of two different groups of inhabitants with different cultural traditions, i.e. besides the Millaran people with their corbel-vaulted tombs, there was a widespread shepherd population with a megalithic tradition of Passage-graves with rectangular or trapezoid burial chambers. It is significant that a large group of the latter 'strange' tombs was located c. 3km. southwest of Los Millares. The detailed study of this intriguing situation is one of the major objectives of the Almerian research project, together with the intensive study of any metallurgy involved.

### Problems of Millaran metallurgy

For the archaeo-metallurgists participating in the Los Millares research programme, the metallurgical finds from the site present a picture of an advanced copper-working technology, including the working, and perhaps even the deliberate production, of arsenical copper. The pertinent question to be asked in this context, which is also frequently discussed in recent archaeo-metallurgical publications in connection with other sites and regions (Rothenberg and Blanco, 1981, p. 169) can be formulated as following: Was arsenic an intentional addition to copper to improve its metallurgical properties and applications, or was it an ingredient of the original copper ore as mined? In other words: was arsenical copper a 'natural alloy', the appearance of which in metal history is but a fortuitous 'accident' of mining history, or was arsenical ore brought to the copper-smelters or to the workshops to be used as an intentional additive to the copper in order to make 'arsenical bronze'? Was arsenic present in some of the ores mined at the period and not in others, and did the Millaran metallurgist recognize the difference in quality between the copper produced, therefore choosing the ores and/or copper best suiting his particular needs in the manufacture of different types of tools and objects?

These are basic questions of great significance in this very early prehistoric context. They relate to the overall understanding of the metallurgical processes –

smelting as well as the manufacture of metal objects – and demand not only detailed metallurgical laboratory investigation of the finds from Los Millares, but also the search for the Copper Age mining and primary smelting sites in the area adjacent to the site.

### A Prehistoric Copper Mine and Smelter in the Sierra de Alhamilla (Almeria) – Site ALS 2

Four high mountain ranges – Sierra de Gador, Sierra de Alhamilla, Sierra de Gata and Sierra de los Filabres – recorded as old and recent mining areas with documented copper mineralization, could all be considered likely mineral resources for the Millaran metallurgist. The first survey season in September 1988 was intended to establish the ancient mining potential of these mountains, to study their mineral deposits and the suitability of their minerals for ancient smelting.

The results of this survey will be forthcoming as soon as the many samples, collected at over twenty mining sites of different ages, have been scientifically investigated by Professor I. Keesmann, Mainz University. One of the outstanding results of this survey, breaking new ground in survey methodology, was the realisation that it was not only the presence of suitable ores which made the ancient miner decide where to work and build his smelting furnace; no less important were the environmental factors, geological and geographical, involved and the availability of fluxes, fuel and water.

This preliminary report concentrates on the discovery of an ancient mine and smelter in the Sierra de Alhamilla – Site ALS 2 on the survey map, G.R. UTM 620/893 (Fig. 3).

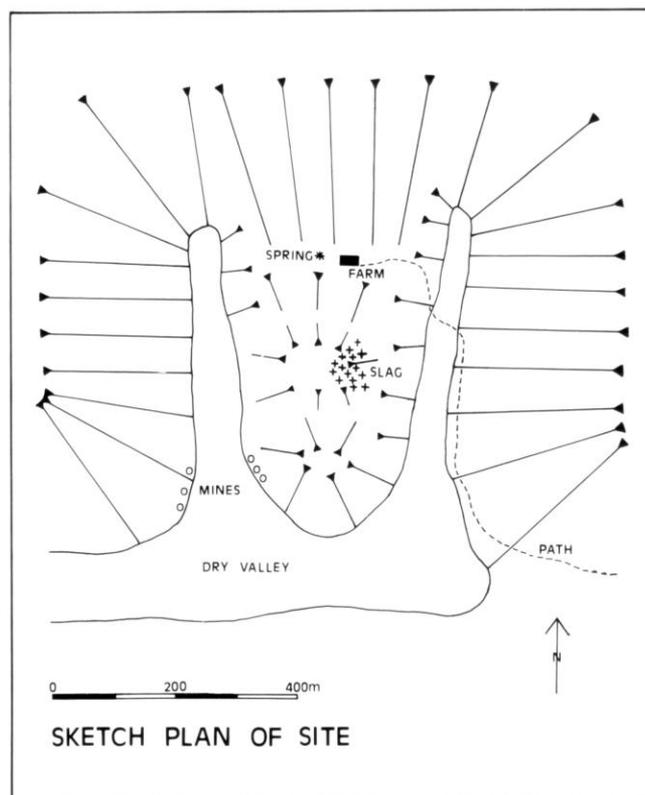


Fig. 3 Sketch plan of site ALS 2.

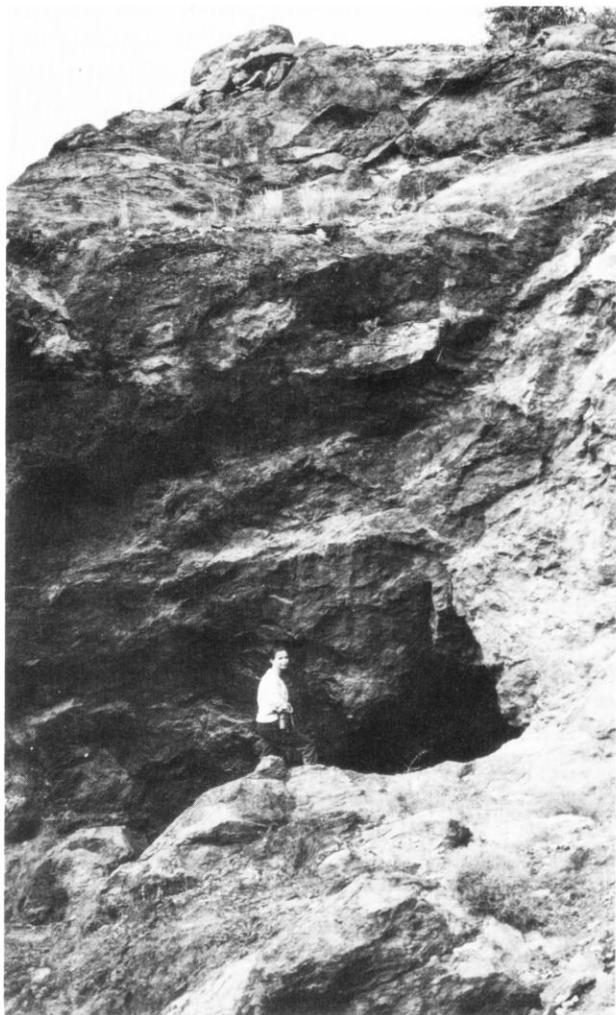


Fig. 4. Mine workings, probably nineteenth century, with dump in front.

The site was reached by a rather precarious path through rugged mountains, approximately 3km. from the village Las Cuevas de las Ubedas. Here, a large uninhabited farmhouse (built in 1955) stands at the head of a narrow, steep valley where a spring, located in the nearby hills, still provides good drinking water. The valley below the farmhouse (which is marked but not named on the official map), has been thoroughly terraced and there was very little left for our archaeological team to investigate.

The terracing ends towards the lower, rugged part of the valley where, and also along the steep slope of the adjacent high mountain to the west, numerous mine workings are visible. These exhibit rather different mining techniques, though most of the work is obviously late nineteenth or early twentieth century. At the very bottom of the small valley, where the slopes accelerate into rocky cliffs descending to the dry riverbed below, there are some very rough entrances to underground horizontal workings. In front of them are recent looking mining dumps (Fig. 4) which contain some copper minerals (chalcocite, chrysocolla, and others). Two shafts located on the slopes above these workings seemed to belong to this rather rough, but obviously late, mining enterprise.

On the other side of the narrow and very steep



Fig. 5. Small, primitive mine workings in the rock face of the mountain west of the smelter.

riverbed, numerous small mine workings are visible all over the rockface of the mountain (Fig. 5); most of them were shallow and primitive workings to dig out small pockets of outcropping ores. The latter showed some traces of oxidized copper ore (malachite and azurite), also found by us at the smelting spot of the site. These workings are now almost obliterated by collapse and erosion and, at this stage of our investigation, cannot be dated. Some of them could well be ancient, though the recent mine operation is obvious everywhere and it is quite apparent that at least two different mining techniques are represented on this mountainside.

Further up the valley, a bare, roundish, hillock, approximately 20m. across, crops out of the surrounding terraced farming terrain, overlooking the whole area (Fig. 6). Although the terracing has in fact removed parts of this hillock, some of its original surface remained untouched – and on its eastern side, a quantity of small slag pieces was found. It was a concentration of rather coarse small pieces of the kind often called ‘furnace slag’, typical of many very early smelting sites. It was obviously not a tapped slag, but had been left to cool inside the smelting hearth, subsequently being removed as a large lump and broken up in order to extract the copper prills – the actual product of this still very primitive smelting process.

Amongst the slag dispersed on the top (east side only) of the hillock, and also all over its eastern slope, were numerous lumps of slagged rock and ceramic furnace fragments, which can be taken as evidence for copper smelting activities at this location. Also amongst the slag were numerous fragments of oxidized, carbonate copper ore of the same appearance as the mineralization observed in the shallow mine workings in the face of the mountain across the riverbed. It is quite obvious that the ancient metallurgists intentionally chose this type of minerals for their copper smelting.

A number of handmade potsherds were collected as surface finds amongst the slag and on the slope of the smelting site. Although insufficient and not typical enough, they are probably fragments of Copper Age



Fig. 6. Site ALS 2, from the north, with the hill of the smelter outcropping in the centre.

pottery. The set up of the smelter, the furnace fragments, the type of copper ore and, especially, the rough crushed slag and the pottery mixed with these finds, can be taken as indications of Copper Age mining and smelting at Site ALS 2, the only copper production site of such early date so far discovered in Spain, indeed, in Western Europe.

Because of the uniqueness and metal-historical importance of Site ALS 2, and because much more evidence will be required to accurately date its mine workings and smelter, proper excavations are planned for the near future. Analytical work on the samples taken at the site, and their comparison with the metallurgical debris from Los Millares, will provide the data for the understanding and experimental reconstruction of the metallurgical processes used here during the Copper Age.

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Auxilio Moreno and Valentino Merida*

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## From the Director's Desk

### Archaeo-Metallurgy in Jerusalem

The Dean of the Faculty of Humanities at the Hebrew University, Jerusalem, recently invited the Director of IAMS to set up a course of archaeo-metallurgy at the Institute of Archaeology, Jerusalem, in the next academic year (1988/9).

In spite of an already overloaded schedule and many obligations in different parts of the world, including a comprehensive programme of fieldwork in the Iberian peninsula, it was felt that this invitation should be taken up in order to introduce archaeo-metallurgical teaching and studies into Israel's academic establishment.

Since this forthcoming course is the first of its kind at any Israeli university, we need to prepare an archaeo-metallurgical study collection as well as to assemble a study library of the relevant archaeo-metallurgical literature. We would be most grateful for any contributions, books as well as offprints of papers. These may be addressed to the Director, c/o Faculty of Humanities (Archaeo-metallurgy), The Hebrew University, Jerusalem, Israel.

### Radiocarbon's reply to our appeal in IAMS Newsletter 10/11

In our previous issue of the *Newsletter* the Director appealed to the Editor of Radiocarbon, 'not to publish dates of samples taken from excavations unless their stratigraphic context is confirmed by the archaeologist responsible for that excavation. If for some reason such confirmation is not available, it should be explicitly stated.'

We quote here the main points of the reply to our appeal made by Renee Kra, the Managing Editor and Director, IRDB (International Radiocarbon Data Base), dated 19 January, 1988:

'You bring up a philosophical question on responsibility. Surely, you do not expect an editor to be responsible for archaeological material submitted to a highly reputable radiocarbon dating laboratory (such as the British Museum)! We are not in the business of researching every date that is submitted to this office for publication. However, we do review very carefully every manuscript and data list and we