

# La Mina El Cerro de San Cristobal: a Bronze Age tin mine (Extremadura, Spain)

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Figure 1 The location of Logrosan - El Cerro de San Cristobal (LaLaguna, 1990, 2)

## Introduction

This paper is a short synopsis of the discussion relating to the Logrosan mines contained in my PhD thesis (Merideth 1998), which reviewed the evidence for ancient tin mining and smelting sites in Spain and Portugal.

The area in which I undertook my survey work, Mid-Central Western Iberia, had not been surveyed for Late Bronze Age remains until the late 1980's and early 1990's. In Portugal, current survey and excavation work for this period is being undertaken by Raquel Vilaca of the Department of Archaeology, University of Coimbra (Vilaca 1995), whilst in the Spanish province of Extremadura, current Late Bronze Age survey and excavation work is being undertaken by Ignacio Pavon Soldevia, of the Department of Archaeology, University of Extremadura, (Soldevia 1998).

My PhD project which I started in the summer of 1992, was based on a survey of the cassiterite mine areas which I was able to locate and visit within my chosen geographical region. Of all the sites (42 in total) which I surveyed, the Logrosan mine area produced the largest quantity of archaeological surface evidence for ancient mining and settlement activity and was, accordingly, selected for more detailed investigation.

Unfortunately, our knowledge of early cassiterite mining and ore preparation in the Iberian peninsula is extremely limited and there is little in the way of comparanda that can offer a realistic basis for the interpretation of the site. It is to be hoped that with further fieldwork, the evidence for ancient tin mining and processing will also be forthcoming within Zamora province and the regions of Asturias and Galicia (the other main cassiterite mineralization areas of Spain).

### **Geographical Setting of El Cerro de San Cristobal**

The mountain of El Cerro de San Cristobal is a solitary granite batholith oriented on a slight SW-NE axis, located approximately 3-4 kilometres from the southern slope of the Sierra de Los Poyales and the Sierra de Las Paredes, which form part of the central region of the larger Sierra de Guadalupe mountain range.

El Cerro de San Cristobal stands out very singularly in the Meseta, the flat low rolling hill region which runs southward from the Sierra de Guadalupe mountain range to the Guadiana river valley. The small Ginjal river runs directly along the northern and western flank of the Cerro de San Cristobal. The mountain is approximately two thousand five hundred meters long north-east to south-west and approximately one thousand meters wide north to south. El Cerro de San Cristobal has a long summit which has two geophysical survey points one at 681 meters on the eastern side and the other at 679 meters at the western side (Sos Baynat 1967: 14), from which there are panoramic perspectives of the Meseta and the neighbouring mountains.

The village of Logrosan is sited on the lower north east slope of the Cerro, the central plaza of the village is located approximately 200 meters below the summit of the Cerro (Calles, Pena, Jimenez 1994: 3).

### **Geology of El Cerro de San Cristobal**

Vicente Sos Baynat (1902-1995), a respected Spanish geologist, studied the geology and geography of the area during the 1950's and 1960's and his treatise on the geology, mineralogy and mineral genesis of El Cerro de San Cristobal (Sos Baynat 1967) is very informative. Further references to the geology and mineralogy of the Cerro can be found in various publications produced by the Junta de Extremadura (*La Minería En Extremadura* 1987: 73-75 and *La Minería En Extremadura* 1993: 107-108) whilst (Dallmeyer and Garcia 1990: 212-219) discuss the formation process of the ore deposits at the site.

Sos Baynat considered the granite intrusion and mineralization which formed El Cerro de San Cristobal to have taken place in three separate phases: first during the Hercynian mountain building period approximately 250 million years ago, and again during a post Hercynian period and finally during the Alpine mountain building period approximately 50 million years ago (Sos Baynat 1967: 50-61).

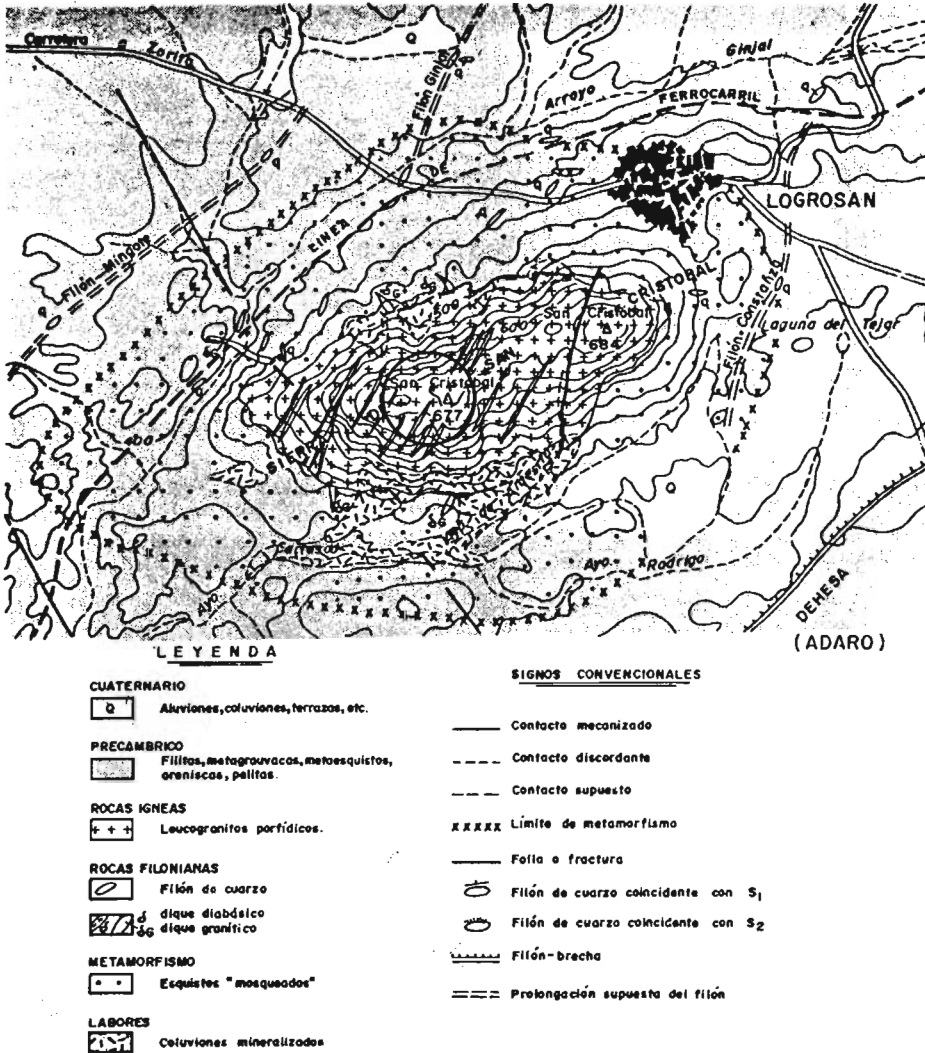


Figure 2 The Mountain of El Cerro de San Cristobal (Barrena & Isidro 1987: 74)

The Logrosan granite is classified as a leucogranite porphyry with two micas and made up of quartz phenocryst and small amounts of feldspar, biotite, apatite, and rutile with some iron oxide present. There are three areas on the northern slopes and one area on the western slope of the Cerro consisting of kaolinized granite (Sos Baynat 1967: 329-30). This granite is completely enclosed by slate and sedimentary structure rocks, the slate being thought to be of pre-Cambrian origin, approximately 700 million years old (Calles, Pena, Jimenez 1994: 5). A metamorphic aureole was created when the granite intrusion which formed the Cerro de San Cristobal, came into contact with the surrounding slate rock. The nearest large granite region is approximately 20 kilometres to the west of Logrosan near the town of Zorita.

Cassiterite, the major tin ore used in antiquity, appears almost exclusively within the Centro-Iberian Zone granites within the Iberian Peninsula. These granites run in a curved arc from the North West corner of the Iberian Massif in the province of Galicia down to the Andalusian province of Jaen. The Central-Iberian granite zone contains important mineralizations of Sn, W, U, Cu, P, Li, Zn, Sb, and Au (Dallmeyer and Garcia 1990: 212). The majority of these cassiterite deposits contain cassiterite and wolframite mixed together within the same veins or in very close proximity. The exception to this, are the mines of Calabor and Arcillera, Zamora province and the mines of Telba and Logrosan, Caceres province which consist principally of cassiterite veins (Dallmeyer and Garcia 1990: 216-217).

Within the district of Logrosan both the slate and granite are veined with quartz, in formations that range in size from a centimetre up to a meter wide and running in some instances for several kilometres. Not all of the quartz veins located in the Logrosan district are mineralized (Barrena and Isidro 1987: 73).

The cassiterite mineral veins on El Cerro de San Cristobal are only found within the granite and run in a N30E/50SW direction and are almost always accompanied by quartz and in some instances also tourmaline. (Barrena and Isidro 1987: 73). These cassiterite mineral veins (according to Sos Baynat) were formed as the result of three distinct geological phases, that can be characterized as the consequence of epithermal, pneumatolysis and hydrothermal action, all of which resulted from the cooling of the San Cristobal granite (Sos Baynat 1967: 58-61). Present also in the Logrosan granite in varying amounts are the minerals stannite ( $\text{Cu}_2\text{FeSn}_4$ ) and arsenopyrite ( $\text{FeAsS}$ ) accompanied by smaller amounts of chalcopyrite ( $\text{CuFeS}_2$ ), pyrite ( $\text{FeS}_2$ ) and sphalerite ( $\text{ZnS}$ ) (Barrena and Isidro 1987: 74).

Wolframite ( $\text{Fe,Mn}(\text{WO}_4)$ ) which normally appears in association with cassiterite ( $\text{SnO}_2$ ) seems only to be present on the Cerro in very small amounts (Sos Baynat 1967: 94-95). However wolframite does occur on the hill of Cerro del Serranillo, located about three kilometres to the northeast of the village of Logrosan. So far I have not come across any information on the mining activities which took place on the Cerro del Serranillo, but it is clear that these Wolframite deposits have been commercially mined, using open cast mining methods, most probably during the 1950's and 1960's. Wolframite, the principal ore of tungsten, was however not a metal that was used in antiquity due to its very high melting point, which would have required a temperature that could not have been achieved using prehistoric furnace structures and tuyere air supply technology.

### **Phosphate Mining at Logrosan**

The Logrosan area has been the site of intermittently important Spanish phosphate mining and production (1775-1946). The former phosphate vein mines at Logrosan, are located approximately 300 meters below the summit of El Cerro de San Cristobal and consist of the west filon, Mingote, north filon, Ginjal and east filon, Constanza. The Ginjal filon was the most productive of the three mined phosphate veins, being approximately 2.5 m meters in width and extending for five kilometres containing ore of 70% richness (Calles, Pena, Jimenez 1994: 7).

The Logrosan phosphate veins were located primarily in the metamorphically formed slate which surrounds the granite of the Cerro de San Cristobal, though two of the

phosphate veins (Constanza and Ginjal) are present for a short part of their total length within the metamorphic aureole of Logrosan.

During the period 1917-1921, the phosphate veins at Logrosan produced 90,000 tons of phosphate, which at that time was half of the national phosphate production for Spain (Molero 1993: 106). It should be noted that during the duration that the Logrosan area was a major phosphate production area no written evidence has been found that acknowledges Logrosan as having been a major cassiterite production area in antiquity.

### **Modern mining activity on El Cerro de San Cristobal**

In 1949, exploratory mining activity undertaken by migrant miners and local Logrosan residents searching for gold in the Logrosan area, led to the discovery of the fact that cassiterite was present in large amounts on the mountain of El Cerro de San Cristobal. From 1949, until the mid 1960's, a very chaotic system of exploration and mining of the cassiterite veins and the elluvial and alluvial deposits took place on the western end of the Cerro on both its lower slopes and western summit area. It is not exactly clear whether these modern mining workings were solely concerned with the quartz/cassiterite veins or the elluvial and alluvial deposits, which must have been very extensive. From Sos Baynat's description of the cassiterite mineralization on El Cerro de San Cristobal, it is quite probable that all three types of cassiterite deposits were being mined at Logrosan (Sos Baynat 1967: 40-61).

It has been stated in some publications that gold was found and mined at Logrosan during modern mining operations (Calles, Pena, Jimenez 1994: 7). There is a very small sample of gold in the Logrosan mineral collection at the geological museum in Merdia and I assume that this gold fragment had been collected by Sos Baynat during one of his visits to the San Cristobal mine workings during the 1950's.

The volume of modern cassiterite production which must have been considerable and the (probably much smaller) volume of gold production can not be ascertained as no proper records of the mining activities of the period seem to have been kept for the Logrosan district (Town Hall Official, Logrosan 1995). The chaotic nature of the unsystematic mining techniques undertaken at the Cerro de San Cristobal, has resulted in numerous worked out cassiterite mineral veins and in very roughly dug out surface working areas and dumps over most of the western Cerro summit and the lower western slopes on both its north, south and west sides.

### **Archaeometallurgical Survey work done on the Cerro 1992-1996**

My first visit to Logrosan, and El Cerro de San Cristobal (Survey site No 4) took place in August 1992, as part of an archaeometallurgical survey based on site surface walking to try and find firm archaeometallurgical evidence of prehistoric tin mining and tin production sites.

This first survey visit to the western summit of El Cerro de San Cristobal was fortunate in its timing as it took place soon after an area of the same just to the north west of the 679 survey marker, had been cleared of all vegetation by a brush fire. This fire-cleared area, although not large, proved to be very rich in visible surface archaeological remains: pottery fragments, stone loom weights, hammers/crushing stone fragments and what seemed to be the remains of stone wall foundations for

round structures. Also an extensive terraced area of the northwestern summit of the Cerro was covered with numerous fragmented pottery surface remains.

The strong primary archaeological surface evidence viewed and collected in 1992 seemed to suggest that the Cerro de San Cristobal had been possibly used as a settlement and maybe also as a tin mining site sometime during antiquity. Further survey walking on the upper south western summit area of the Cerro de San Cristobal led to the finding of a grooved stone mining hammer fragment (Fig. 3), which demonstrates a similarity in the grooving, pecking technique to the mining hammers that have been found in the Chinflon and Rio Tinto mine areas of Huelva (Rothenberg and Blanco-Freijeiro 1981: 33-182). Several areas on the southwest upper slope below the 679 survey marker of the Cerro, were extensively covered with crushed quartz heaps, intermixed with crushing-grinding stones and numerous pottery fragments.

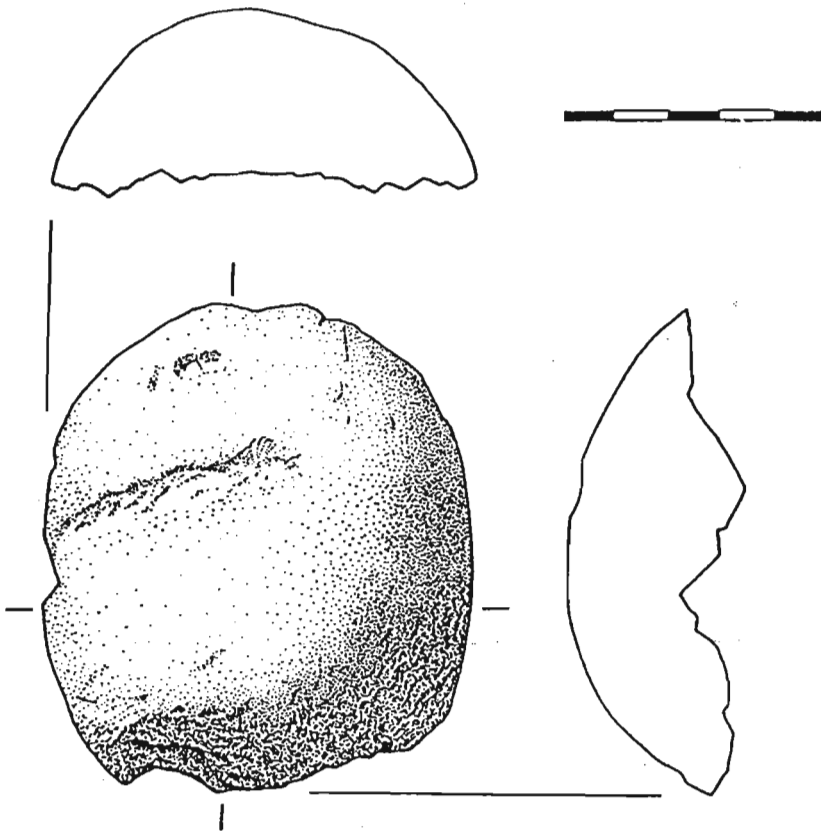


Figure 3 Logrosan hammer fragment

The exact archaeological date of the majority of the surface pottery finds (Late Bronze Age) was not established until some of the collected pottery had been examined by Alonso Rodriguez Diaz and Ignacio Pavon Soldevia of the Prehistoric Department of the University of Extremadura, Caceres.

I returned to El Cerro De San Cristobal in 1993, 1994 and again in 1995. Each visit provided more surface evidence that the cassiterite mine site on the San Cristobal mountain would possibly be one of the most interesting and rewarding of the candidates identified in the course of my survey work.

A large percentage of the stone hammers/crushers found on the surface during later survey seasons (1993, 1994, 1995, 1996) at El Cerro de San Cristobal came from slate rocks that had been geologically altered in the lower slope metamorphic aureole. This metamorphized spotted slate rock is extremely hard and durable. Furthermore a large percentage of the used aureole hammer/crushers had also been shaped and smoothed by water action in the seasonal Ginjal river which flows to the north and west of El Cerro de San Cristobal. Similar shaped hammer stones can still be found today in the Ginjal and Arroyo Grande riverbeds within the Logrosan area.

Almost all of the San Cristobal summit hammer stones (Fig. 4) have been slightly notched by pecking with another stone in the central area of the hammer, this pecked notching would probably have allowed for the fixing of some form of a handle. Stone tools used solely for crushing purposes were not grooved or notched but seem to have been chosen for shapes that could be easily hand held.

In the 1994 survey visit to San Cristobal I was accompanied by a two, person site planning team (Brenda Craddock and Anthony Bridgeman) in order to undertake a site plan and a contour plan both on a 1:500 scale. A standard Hilger Watts ST156 manual theodolite was used during the first year's survey. The area to be mapped centred on the western summit of El Cerro De San Cristobal, this area I believed to contain the location of the largest (and final) prehistoric settlement and, most probably, contained some of the prehistoric mining site areas.

It was not possible to finish the site and contour plan of the western summit area of El Cerro de San Cristobal in 1994, due to the large area that the proposed Late Bronze Age settlement/mine site covered, (approximately 500 meters east to west and 150 meters north to south). The complexity of the geographical setting including what was possibly more recent historic stone quarrying sites and the modern mining chaos of the site presented many problems for the planning team. The weather also proved variable with some extremely cold and wet days which restricted the scope of the planning work.

I returned in April-May 1995 to the Cerro with the same planning team, with the main aim of finishing the basic planning survey started in 1994. With better weather and the use of a modern electronic surveying equipment (Nikon DMT 20, Total Station) the basic western summit primary site and contour survey maps were finished. Many more surface and mining details remain to be added to both the plans in future survey work seasons.

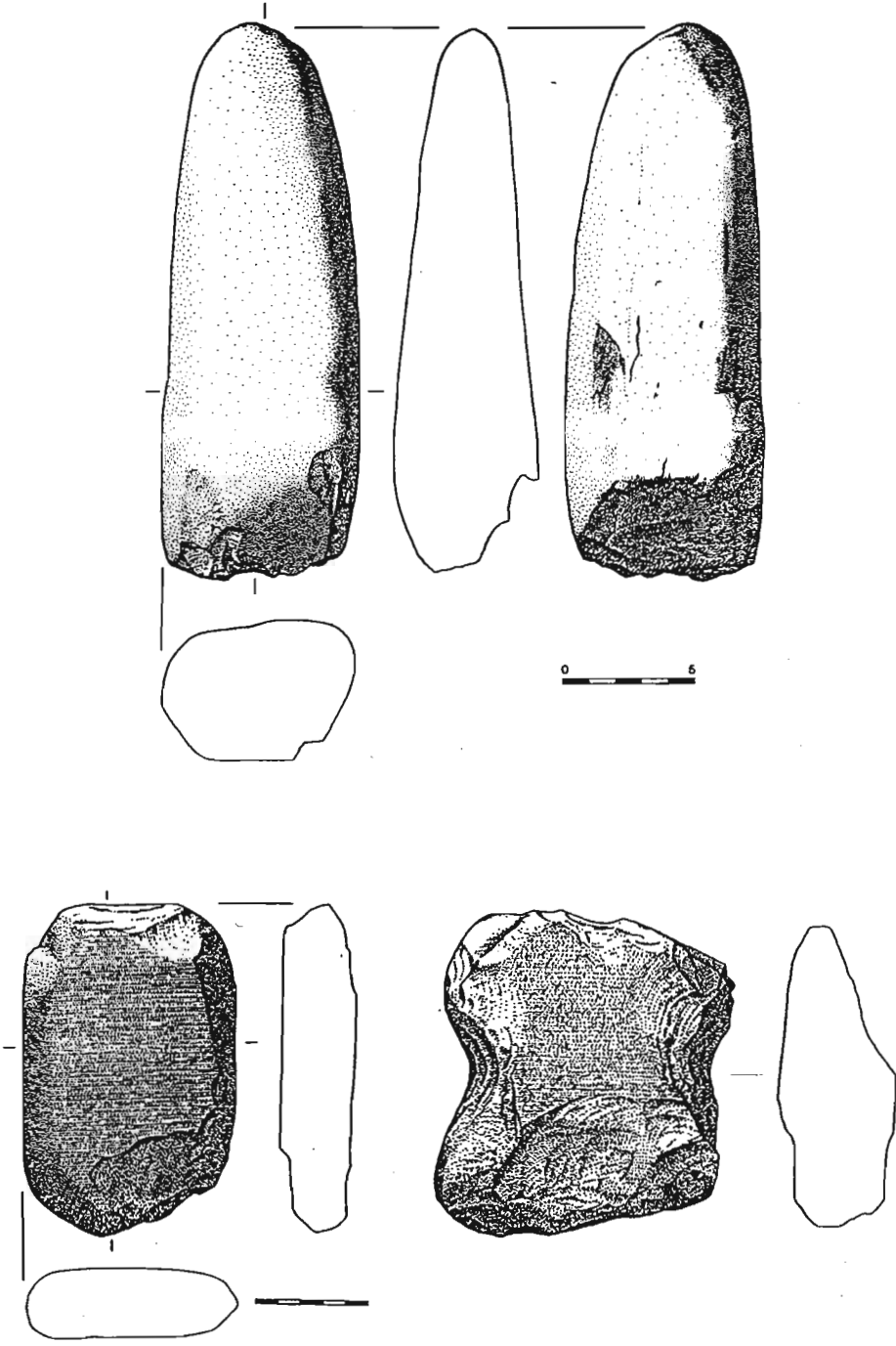


Figure 4 Hammer stones from the Cerro de San Cristobal



During the 1994 and 1995 seasons at Logrosan more surface archaeological evidence, mostly hammers and crushers, was noted and collected. These tools continue to support the view that the complete western end of the Cerro De San Cristobal summit contained the debris of a walled Late Bronze Age settlement site and mining area. However, at present it would be premature to consider the numerous stone wall remains on the western end of the Cerro, as having a defensive function,, and a more general hypothesis of the use of these stone walls as containment or boundary markers seem preferable.

During the prehistoric period, both within and outside the walled settlement area, there would have occurred large areas of veined and elluvial cassiterite deposits. One important question that has yet to be answered unequivocally, is whether this cassiterite ore was mined and worked during the Late Bronze Age.

The next stage of work at Logrosan, in the near future, will be to further plan and map more precisely, the location of the former quartz bearing tin veins and all remaining mine galleries and surface mine workings, both ancient and modern, on the both western end of the Cerro summit and on the lower north-western slope. The reason for undertaking a more precise mapping and planning of the mined out veins and surface workings would be to try and ascertain exactly which mine areas might have been worked in antiquity and those that had been only worked in the modern phase of mining. A critical question remains unresolved: are there mineralized areas containing a clear-cut division of ancient and modern mine workings on the western summit and lower slopes? It is possible that all the existing ancient cassiterite vein mine workings were reworked during the modern exploration period in which case, it is likely that all traces of ancient mining would have been obliterated. It is however difficult to believe, given the quantities and size of cassiterite veins and elluvial working remains still visible on the Cerro, that all ancient mine workings would have been reworked and destroyed during the modern period. It is to be hoped that some ancient mine workings displaying early mining tool marks may still be located somewhere on the western Cerro. (Craddock, 1995, 37-58, for comparanda).

It would also be rewarding to undertake the excavation of trenches within the putative upper settlement area of the western summit in order to try and locate proper archaeological stratified sequences within the proposed settlement. These should then allow a more definite reconstruction of the date and phasing of the prehistoric remains, the mine workings and metal production activities which I believe were taking place on El Cerro de San Cristobal in antiquity.

#### **Vicente Sos Baynat Archaeological Artefacts from the Cerro**

During the 1994 survey season, I was able to find (with the help of Tomas Porro Mayo the custodian of the Museo De Geologica De Extremadura) the location of the archaeological finds which Sos Baynat had personally collected or had been given by the miners from the Logrosan mining operation in the 1950s and 1960s. With the help of Augustin Velazquez Jimenez, the secretary of the Museo Nacional De Arte Romano, Merida, it was possible to view, photograph and have the Baynat Logrosan collection drawn by Josefina Molina Garcia.

The finds collected by Sos Baynat (comprising flint, stone tools, stone grinders and crushers, casting moulds, escoria or casting waste, pottery, metal, beads, and gold

fragments) seem to point to a much wider archaeological sequence than the existing western Cerro surface pottery suggests, the majority of which seem to belong only to the Late Bronze Age.

Some of the Baynat collected material clearly point to a earlier Copper Age date with the remote possibility that some of the artefacts were deposited on the Cerro even earlier. There are also one or two possible Roman artefacts and two definite bell beaker artefacts, an arsenical copper Pamela point and a stone archery wrist guard.

### **The present archaeological position on the Cerro**

The two main areas that seem to have prehistoric activity are the western and eastern summits of El Cerro de San Cristobal. My archaeometallurgical survey and planning work has concentrated mostly on the western summit area and on some of the lower north western and south western slope areas, which also contain some of the more surface visible modern mine working debris and dumps.

The eastern side of the Cerro summit has substantial stone ruin remnants, which consist mostly of fallen stone wall debris and remaining foundations of earlier stone walls. Some of the stone debris located on the eastern end of the summit by survey point 681 seem to lie on man-made levelled areas. There is surface indication that some of this stone debris on the eastern summit might represent remains of a defence wall with accompanying turret towers (Calles, Pena, Jimenez, 1994, 10-14). However a good, 1:500 plan of the eastern summit stone debris and levelled off areas needs to be drawn in order to provide a better understanding of the true building and wall layouts in this area.

Today, the only water to be found on the Cerro is a small spring located on the eastern side of the eastern summit. This small spring still functions today, even in high summer, though the flow of water is no more than a small trickle. This would not have been a strong enough flow to have supported what seems to have been a major Late Bronze Age settlement site, but it is quite probable that the hydrological conditions would have been different in the past.

A small amount of surface pottery was collected within the eastern summit stone debris area but none of the collected pottery was absolutely dateable, having no distinguishable shape, although the fabric of some of the sherds suggested possible Late Bronze Age origins. Other fragments of the pottery collected on the eastern summit could possibly be post-Roman or even medieval in origin. It is possible that the majority of the pottery that must accompany the stone structures of the eastern Cerro summit area still remains buried.

A small number of trenches have been randomly dug on the eastern summit area within the stone debris, which have the appearance of robber trenches, possibly trying to locate archaeological remains or artefacts, I would not consider them to be modern mining works.

Although at present it is generally thought that the ruins on the eastern side of the Cerro represent a phase of the development of the Logrosan before the modern town was founded (1545 A.D.) lower down on the north eastern slope of the Cerro (Sos Baynat, 1977, 26-27) there is a reasonable probability that some Late Bronze Age

remains may still survive on the eastern summit of the Cerro. However detailed excavation of the extensive stone debris currently in situ will be necessary in order to provide precise evidence for the dating of the existing ruins, and to try and locate any earlier settlement that might appear beneath or within the same.

The area between the high eastern and western summits contains a small amount of surface scattered pottery, but again it is difficult to date as the collected pottery is very fragmented, shapeless and in poor physical condition. Within this central summit area on the upper south side is a granite area which has been used to quarry millstones, a couple of which are partially cut out and still remain in their original settings. The granite millstone quarrying area is probably medieval or later in date.

The western Cerro de San Cristobal appears to have been settled in prehistory (and possibly more recently) on both its summit area and the north/western slope up to 150 m below it judging by the Baynat artefacts and the survey work. It is the western end of the summit with its significant number of surface archaeological and archaeometallurgical remains that represents the most promising primary area for future archaeological - archaeometallurgical excavation work. The probable reason behind so much Late Bronze Age pottery being visible on the western summit surface is due to the digging up or turning over of large areas of the summit during the modern prospection and mining operations. It is quite possible that one is looking at a reverse archaeological stratigraphy (personal comment, Katrina Gibson, 1995) in this area, albeit that this very disturbed landscape could not provide any really good archaeological stratigraphy.

Part of the north western summit area of the Cerro seems to have been levelled into a series of terraces, which might be attributed to the last phase of the western Late Bronze Age settlement. The terraces run in a slight north east to south west direction from just below the summit to the final north stone containment wall on the upper northern slope. The terraces cover an area of approximately 100 meters north to south and 150 meters east to west.

There is the very real possibility that further planning and survey work at the Cerro would stand a good chance of actually locating ancient tin mine workings. A major problem which still remains today, is that none of the stone hammers collected during the survey were found near the lower north slope worked-out quartz-cassiterite veins, although some of the Sos Baynat collected stone hammers came from this area (Sos Baynat, 1977, 8-17). It is possible that the absence of stone mining hammers is the result of the numerous mine dumps and general surface chaos left by the modern workings in this area.

Few sites in the archaeological world offer the prospect of containing both Late Bronze Age cassiterite vein mine workings and with what would seem to be an accompanying mining settlement. In this sense, El Cerro de San Cristobal demands sustained investigation in order that its rich archaeological, mining and metallurgical potential can be realised.

The first archaeological excavation on the Cerro de San Cristobal took place at the end of August and early September 1998 and it is hoped that a full excavation report will be ready by the Spring of 1999.

Artefact illustrations by B. Craddock

### References

- Barrena, M.A. & Isidro, P.D. 1987. *La Minera En Extremadura*. Merida: Junta De Extremadura.
- Calles, A.P., Pena, A.M. & Jimenez, S.G. 1994. *Logrosan: Naturaleza y Arte Publica*. Excelentísimo Ayuntamiento de Logrosan.
- Consejeria de Economia y Hacienda/ Castilla y Leon 1988. *Los Recursos Minerales de Castilla y Leon NO 2 Estano*. Valladolid: Junta de Castilla y Leon.
- Craddock, P.T. 1995. *Early Metal Mining and Production*. Edinburgh: Edinburgh University Press.
- Dallmeyer, R.D. & Garcia, M.E. (eds) 1990. *Pre-Mesozoic Geology of Iberia*. Berlin: Springer-Verlag.
- Diaz, A.R. (ed), 1998. *Extremadura Protohistorica: Paleoambiente, Economia y Poblamiento*. Caceres: Universidad de Extremadura.
- Ferandez, J.A. (Direccion) 1996. *Atlas de Extremadura y de Espana*. Madrid: Grupo Anaya S.A.
- Guzman, F.V. 1983. *Depositos Minerales de Espana*. Madrid: Instituto Geologico y Minero de Espana.
- Instituto Geologico y Minero de Espana, 1988. *Monografias De Sustancias Minerales-Estano*. Madrid: Servicio De Publicaciones Ministerio De Industria.
- Jorda Cerda, F., Pellicer Catalan, M., Acosta Martinez, P. & Almagro-Gorbea, M. 1989. *Historia De Espana Prehistoria I*. Madrid: Editorial Gredos S.A.
- Junta De Extremadura, 1993. *Minerales Gemologicos De Extremadura*. Merida: Consejeria de Industria y Turismo.
- LaLaguna, J. 1990. *A Traveller's History of Spain*. Adlestrop: Windrush Press.
- Lehmann, B. 1990. Metallogeny of Tin/Lecture Notes. *Earth Sciences* 32.
- Merideth, C. 1998. *An Archaeometallurgical Survey for Ancient Tin Mines and Smelting Sites in Spain and Portugal, Mid- Central Western Iberian Geographical Region, 1990-1995*. Oxford: Archaeopress.
- Molero, C.A. 1993. *La Minera en Extremadura*. Merida: Junta De Extremadura.
- Navascues, J.E. & Diaz, A.R. (eds) 1995. *Extremadura Arqueologica V*. Caceres: Junta De Extremadura.
- Ochoa, C.Q. 1987. *Mapa Geologico De Extremadura*. Merida: Junta De Extremadura.
- Penhallurick, R.D. 1986. *Tin in Antiquity*. London: Institute of Metals.
- Roso De Luna, M. 1898 (1982 reprint). *Logrosan (Legajo Historico)*. Caceres: Institucion Cultural "El Brocense".
- Rothenburg, B. & Blanco-Freijeiro, A. 1981. *Ancient Mining and Metallurgy in South-West Spain*. London: Institute for Archaeo-Metallurgical Studies.
- Soldevia, I. P. 1998. *El Transito del II al Milenio A.C. en las Cuencas Medias de los Rios Tajo y Guadiana: la Edad del Bronce*. Caceres: Universidad de Extremadura.
- Sos Baynat, V. 1967. *Geologia, Mineralogia y Mineralogenia de la Sierra de San Cristobal, Logrosan (Caceres)*. Madrid: Real Academia De Ciencias-Exactas, Fisicas y Naturales.
- Sos Baynat, V. 1977. *Los hallazgos prehistoricos de Logrosan (Caceres)*. Badajoz, Spain: Diputacion Provincial De Badajoz.

- Sos Baynat, V. 1980-1981. Sobre la Edad Geologica de las Casiteritas de Extremadura, Espana. *Sociedade Geologica de Portugal Boletim* 22.
- Sos Baynat, V. 1981. *Museo De Geologia De Extremadura*. Merida: Excmo Ayuntamiento de Merida.
- Tylecote, R.F. 1992. *A History of Metallurgy*. London: Institute of Materials.
- Vilaca, R.1995. *Aspectos do Provamento da Beira Interior (Centro e Sul) nos Finais da Idade do Bronze* (two volumes). Lisboa: Departamento de Arqueologia.