



# POVOAMENTO E EXPLORAÇÃO DOS RECURSOS MINEIROS NA EUROPA ATLÂNTICA OCIDENTAL

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# FIRST BRONZES OF NORTH-WEST IBERIA: THE DATA FROM FRAGA DOS CORVOS HABITAT SITE

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## 1. LOCATION AND GEOGRAPHIC INTEGRATION

Fraga dos Corvos is a Bronze Age habitat site recently studied and located in the northwestern slope of Serra de Bornes, Eastern Trás-os-Montes (Macedo de Cavaleiros, Bragança). With an altitude of 870 m, it rises over the modern parish of Vilar do Monte which belongs to Macedo de Cavaleiros County, District of Bragança. The site geographical coordinates (Gauss) are 99.122,194 of longitude and 203.403,721 of latitude, sheet 78 of the 1:25 000 Portuguese Military Map (Fig. 1).

The hilltop of Fraga dos Corvos visually controls the Macedo de Cavaleiros basin. It is in the main traditional passes into and out of this basin that have been found the deposits of halberd copper blades (Abreiro, Carrapatos, Vale Benfeito

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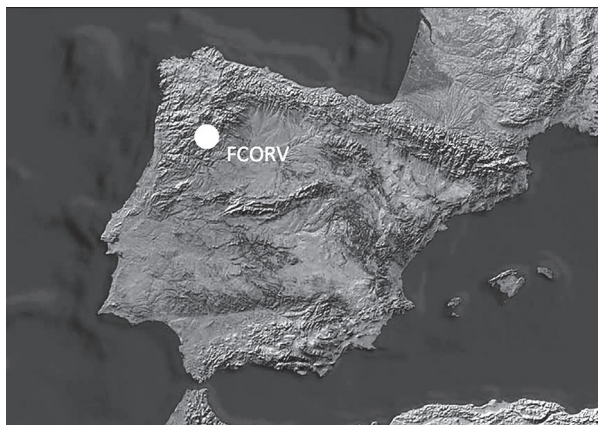
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**Figure 1.**  
Fraga dos Corvos  
in the Iberian Peninsula.

and Vimioso) which gave the name to the so called Carrapatas type of the Iberian Early Bronze Age Atlantic halberds (Bártholo 1959).

The regional bedrock consists mostly of metamorphic schist, with some quartz and greywacke veins, results in very acid soils, destroying most organic evidence in the archaeological record. In the region, there are also talc schist outcrops, used for making exceptional artefacts recovered in this archaeological site (e.g. a pendant with a horse head carved; or several rectangular shaped stones with one or two central perforations thought to have an ideotechnic function).

Some ore deposits also located in the Macedo de Cavaleiros region could have been the main source of the incipient metallurgy in regional Bronze Age. Although tin ores are very frequent in alluvial placers, copper ones are rare, mainly sulphides, carbonates and oxides. The last two might have been easily recognized by prehistoric communities for their bright and greenish tones.

Water sources are also very accessible, including the rivers Sabor and Azibo, their tributary rivers and riversides. In each side of the site we can find two streams, Vale de Nogueira and Ribeirinha, which should have been the main water sources for the archaeological site.

The main vegetation species are, *Quercus pyrenaica wild* (Pyrenean oak) and *Quercus ilex L. ssp. Rotundifolia* (Lam.) (holmoak).

## 2. STRATIGRAPHY AND OCCUPATION PHASES

Three diagnostic trial trenches were opened at the beginning of the excavation, on the northern platform of the hilltop (Sector A). The first one did not reveal any occupation evidence besides a few ceramic fragments. Therefore, all significant archaeological data come from enlarging Areas 2 and 3.



**Figure 2.**  
Fraga dos Corvos. Plan of Area 3  
with the structures excavated:  
A – Fire pit under the porch  
("Hut" 6);  
B – Sand-box.

Area 3, with 36 m<sup>2</sup> opened between 2003 and 2006, revealed a single occupation phase integrating evidence for three housing structures (or "Huts"), defined by floors limited by postholes (Fig. 2):

- "Hut 2" is a small and sub-circular construction (about 3 m of diameter), limited by 13 postholes and with a central bigger one;
- "Hut 4" is bigger and ellipsoidal in shape, with axes of 4 m x 3,2 m, limited by 20 postholes and containing also a central bigger one (Senna-Martinez, Ventura & Carvalho 2005). In 2005 field season we finished digging the floor of Hut 4. To build the hut, the local schist substrate was artificially excavated in order to accommodate its southern end. This part of the hut floor contained a negative structure of oval configuration (Stratigraphic Unit 57 – UE.57



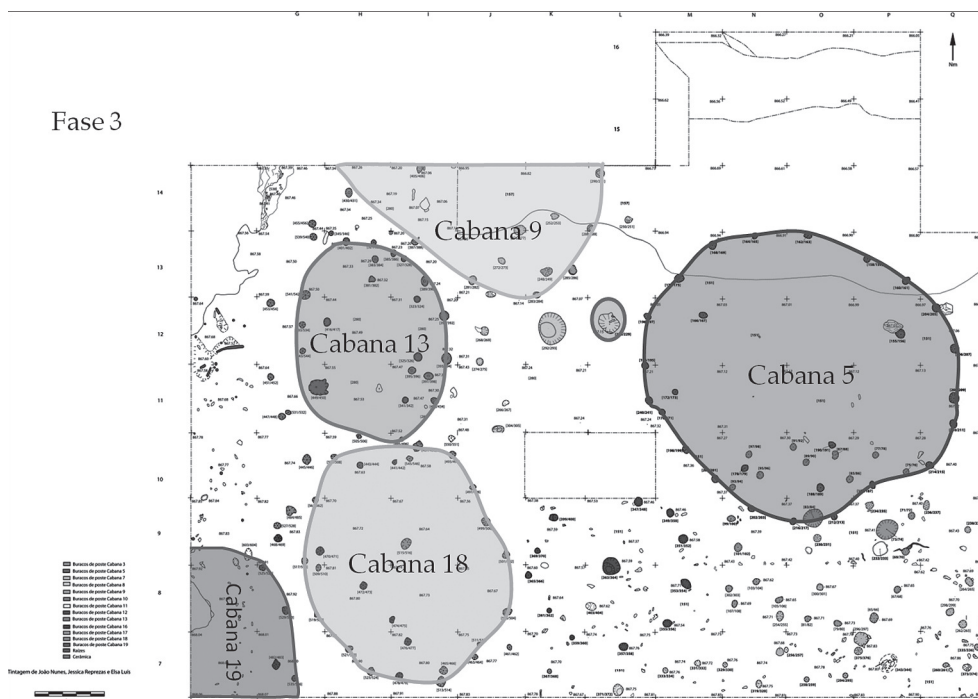


Figure 3. Fraga dos Corvos. Plan of the Phase 3 interface with the excavated structures.

- with axes measuring 88 cm x 77 cm and of about 20 cm of depth), filled with blackened sands, containing ashes (UE.58) and delimited by a ring of small stones (Fig. 2);
- What we designated as “Hut 6” (excavated in 2006 – Fig. 3) is a quadrangular structure (c. 4 m x 4 m), adjacent to the western limit of Hut 4, limited by four corner postholes and with a central ovoid depression filled with termoclasts, slag, some broken pottery sherds, tinny pieces of charcoal and the broken cover half of a mould in stone, thus configuring a very probable “fire pit”.

Around the oval negative structure of “Hut 4” northwestern side were found 3 smelting nodules (prills) of bronze, 71 non metallic vitrified fragments, 1 crucible fragment with traces of Cu and Sn, 2 fragments of stone moulds for awls, and 1 piece of bronze sheet. We think that this structure is what is left of a sand box to put moulds in to be filled with molten metal.

“Hut 6” is probably a porch giving protection from the elements to the fire pit under it. From the immediate surroundings of the fire pit come 3 pieces of vitrified non metallic elements and 2 other mould fragments.

All the other archaeological materials from the pavements of these 3 “Huts” are related to a domestic environment.

**Area 2**, with 103 m<sup>2</sup> opened between 2003 and 2010, allowed the identification of at least six occupation phases, integrating evidence of housing structures, defined by floors limited by postholes, in association with pits, fireplaces and archaeological materials related to domestic environments.

Evidence for the first topmost occupation phase is scanty with only the lower part of the postholes of “Hut 7”, presenting no remains of any layer (or occupational floor) in association with them.

The second phase corresponds generically to stratigraphic unit (S.U.) [109=278] which is perforated by postholes delimiting six “Huts” (3, 8, 10, 12, 16 and 17). The drawing of a complete layout for these habitation structures was only possible in “Huts” 3, 12 and 10. The first two are sub-circular (“Hut 3” about 3 m in diameter, delimited by 16 postholes, while “Hut 12” is about 2,5 m in diameter with 11 postholes, both have a larger central posthole) and “Hut 10” is ellipsoidal (with 3,5 m x 2,5 m, delimited by 12 postholes and with two central ones).

The third occupation phase (Fig. 3) corresponds generically to S.U. [151=280] which is perforated by postholes delimiting another six “Huts” (5, 9, 11, 13, 18 and 19). An approximate plan was possible to reconstruct for three of them: “Huts” 5, 13 and 18. Between “Huts” 5 and 9 lie two small pits [292/293] and [228/229], the second one was full of vitrified items.

The fourth phase corresponds generically to S.U. [287], integrating just some individual postholes and a small pit [579/575].

The fifth occupation phase corresponds to S.U. [152], integrating a few individual postholes, a fireplace [437], a pit [590], being unclear the contemporaneity between their utilization and layer [152].

The stratigraphic sequence under this phase is still under study.

### 3. CULTURAL INTEGRATION

The cultural environment documented comprises a manual pottery industry with typical First Bronze Age types (sub-spherical bowls, conic open vessels with flat bottoms, carinated bowls, deep storage and cooking jars with everted rims and flat bottoms, etc.). A small part (between 2% and 16% in the several phases) of the vessels identified is decorated with a mixture of motifs of epi-bell-beaker geometric comb-stamped type and motifs of “Cogeces or Protocogotas type”. Sometimes both decoration types are combined both in the inside and the outside surfaces, with alternate metopas either with comb-stamped geometric motifs, or



with herringbone motifs incised or side punctuated, both types of decoration being sometimes incrustated with white burnt bone paste (Luís 2010, p. 55-61).

The lithic industry uses local rocks (mostly schist, quartz, quartzite and granite – Matos 2011) to produce a variety of denticulate sickle-blades, scrapers, borers, etc.

Mainly from the fifth stratigraphic phase, comes fragmented bone evidence of a macro fauna consumption, with preliminary evidence of the presence of bovinds, ovi-caprids, either pig or wild boar and deer.

The association, in all areas so far excavated, of pottery decorated in an epi-bell-beaker tradition with vessel types and decorations typical of the “Cogeces World” constitutes a strong argument to situate chronologically this habitat in a relatively early period of the First Bronze Age (approximately 1750-1250 BC).

#### 4. ARCHAEO-METALLURGICAL RESULTS<sup>7</sup>

##### 4.1. Area 3

The interpretation of “Huts” 4 and 6 as a melting area devoted to the production of artefacts made of binary bronze (Senna-Martinez *et al.* 2010) strongly suggested through the analysis of the archaeographic data is supported by the analytical results achieved. Table 1 (adapted from Figueiredo 2010) summarizes the results of EDXRF, Micro-EDXRF and OM analysis of the artefacts of this area.

Table 1

Nº	Item	Composition (wt.%)							Production method	Phases present
		Cu	Sn	Pb	As	Sb	Fe	Ni		
FCORV-194	Prill (?)	+++ 86.0±9.2	++ 13.9±9.1	Vest. 0.18±0.05	n.d. n.d.	n.d. -	+ <0.05	n.d. n.d.		α, δ↓
FCORV-660	Prill	+++ 88.9±0.7	++ 10.8±0.7	+ 0.25±0.02	n.d. <0.1	Vest. -	+ <0.05	n.d. n.d.		A
FCORV-781	Prill	+++ 88.2±2.1	++ 11.6±2.1	Vest. 0.18±0.05	n.d. n.d.	Vest. -	+ <0.05	n.d. n.d.		α, δ↓
FCORV-849	Blade frgm.	+++ 90.3±0.3	++ 9.1±0.3	+ 0.62±0.14	n.d. n.d.	Vest. -	+ <0.05	n.d. n.d.	C+D+T+D↓	A

EDXRF results +++ >50%; ++ 10-50%; + 1-10%; vest. (Vestiges) <1%; n.d. not detected  
C cast; D deformation/forged; T heat treatment/annealed; ↓ low amount; ↑ high amount

<sup>7</sup> The entire field recovered archaeometallurgical data (up to 2009) was studied by the METABRONZE Project (*Metallurgy and Society in Central Portugal Late Bronze Age* – POCTI/HAR/58678/2004), current studies (from 2010) are being carried out under the EARLYMETAL Project (*Early Metallurgy in the Portuguese Territory* – PTDC/HIS-ARQ/110442/2008) both financed by the Portuguese Foundation for Science and Technology (FCT).

The smelting nodules or prills (FCORV-194, FCORV-660 and FCORV-781) show deep intergranular corrosion as well as coarse microstructure which developed under slow cooling rates. The deeper intergranular corrosion observed in these nodules when compared to the other metallic items of Fraga dos Corvos is most likely related to a less homogenised microstructure, a result of absence of thermo-mechanical processing. Their composition and structure militates in favour of their possible production through a co-smelting process.

All the artefacts are made of binary bronze, with an average for Sn content of  $11.9 \pm 2.1\%$ . As previously brought up by the study of the nodules from *Baiões* (Figueiredo *et al.* 2010), the regularity of Sn content in the prills (in the range of the metal artefacts and fragments analysed, as in the blade fragment FCORV-849) would not be expected if the prills were a result from a primitive co-smelting operation. However, on the other hand, the coarse microstructures of the prills, which resulted from slow cooling rates, do suggest a product of such a smelting operation.

The crucible fragment (FCORV-691) EDXRF analyses results showed strong peaks of Cu, Pb and Sn, indicating that it was used for metallurgical activities.

The vitrified products show evidences that they have been submitted to high temperatures. Thermodynamic calculations, by Filipa Geirinhas and Miguel Gaspar (Geirinhas *et al.* in press), using *Quilf* 95, based on the chemical composition of spinels and olivines, showed melting temperatures above 1100°C, compatible with the presumed metallurgical processes.

The contextual dispersing of all the analysed elements in the area between the sand box of “Hut 4” and the fire pit (under its porch) does strongly support the interpretation of these structures as a melting area dedicated to the production of binary bronze artefacts.

#### 4.2. Area 2

In Area 2 there is archaeometallurgical evidence in contexts from phases 2, 3 and 5. Table 2 (adapted from Figueiredo 2010) shows the results of EDXRF, Micro-EDXRF and OM analysis of the artefacts of this area (Fig. 4).

Table 2

Phase	Nº	Item	Composition (wt.%)							Production method	Phases present
			Cu	Sn	Pb	As	Sb	Fe	Ni		
2	FCORV-1517	Bar frgm.	++ 84.4±2.7	++ 13.9±2.4	++ 1.6±0.6	n.d. n.d.	Vest. -	+ <0.05	n.d. n.d.	C+D+T+D↑	α
3	FCORV-1381	Undeterm. frgm.	+++	++	n.d.	Vest.	n.d.	+	n.d.		
3	FCORV-1407	Wire (?) frgm.	+++ 98.7±0.7	+ 1.3±0.2	Vest. n.d.	+ 0.50±0.3	Vest. -	+ <0.05	n.d. n.d.	C+D+T	α-copper
5	FCORV-1807	Spatula (?)	++	++	++	n.d.	vest.	++	n.d.	C+D+T+D	α

EDXRF results +++ >50%; ++ 10-50%; + 1-10%; vest. (Vestiges) <1%; n.d. not detected  
C cast; D deformation/forged; T heat treatment/annealed; ↓ low amount; ↑ high amount

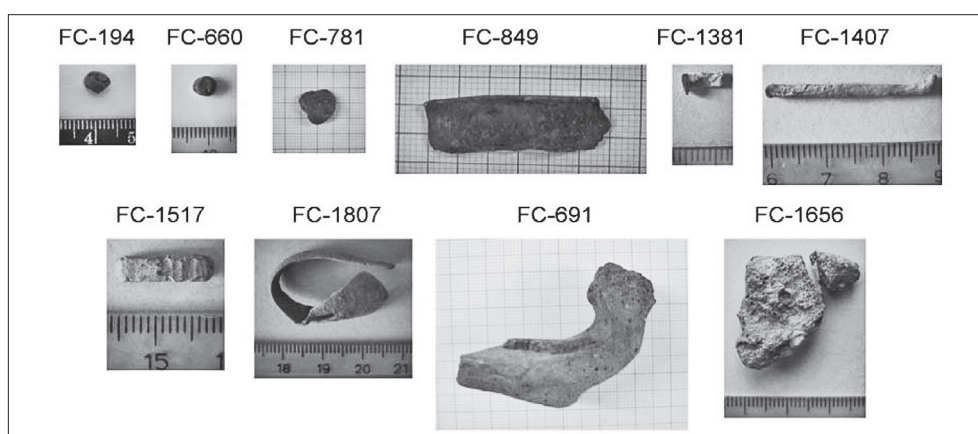


Figure 4. Some of the studied artefacts from Fraga dos Corvos (Figueiredo 2010, fig. 3.73 adapted).

Phase 2 besides a small bar fragment of binary bronze obtained by forging a cast element, revealed a rim fragment from a vessel with adherent slag (FCORV-1656). The EDXRF analysis of this fragment showed strong peaks of Cu, Pb and Sn, indicating that it was used for metallurgical activities. Typological analysis of the rim strongly suggests that it is not part of a crucible, as in the case of FCORV-691, but it probably belonged to an open vessel like a bowl.

Otherwise, from Phase 3 comes an unidentified fragment of binary bronze, a bit of wire made of Cu with impurities<sup>8</sup>, another vessel rim (FCORV-1706 – probably

<sup>8</sup> That could have been used to be cut to produce rivets, as documented in LBA Baiões/Santa Luzia metallurgy (Senna-Martinez *et al.* this volume).

a bowl) with vitrified adherences and several other vitrified elements (Fig. 5).

Finally from phase 5 comes a probable spatula of bronze and a fragment of a stone mould half made of talc schist, very much similar to a complete mould from Corga da Mela (Erosa, A Gudiña, Ourense) (Taboada Chivite 1973) both for axes of Bujões type and chisels.

As in Area 3, the vitrified elements and the bowl rim with adherences document melting temperatures above 1100°C.

The two rim fragments from phases 2 and 3 can be perceived as fragments of open-vessels used to co-smelt Cu and Sn ores, probably with Pb as one of the impurities, as suggested by the compositional analysis of the metal artefacts from Fraga dos Corvos.



Figure 5. Fraga dos Corvos. Cut profile of bowl rim fragment with vitrified adherences (FCORV-1706).

#### 4.3. Ore Provenance

A preliminary study on determination of the possible origin of the copper ores used in Fraga dos Corvos metal artefacts was developed in 2007/2008 (Geirinhas *et al.* in press).

As referred above, tin is not a problem as it abounds locally. Copper, however, is a different question. Taking in consideration that in the First Bronze Age of Iberia there is no evidence for the processing of copper sulphides, which knowhow seems to be introduced by the Phoenicians, the only source regionally available of copper carbonates and oxides would have been secondary copper enriched gossans which might have been easily recognized by prehistoric communities for their bright and greenish tones.

Two geological formations were sampled: “*In the Junqueira area outcrops the Pombais Unit characterized by basic metavolcanic rocks and greenschists affected by internal thrusting. The thrusts are often underlined by well developed gossans (20-50 cm). Cu mineralization occurs as fine disseminated chalcopyrite or as malachite filling the gossan pores and the greenschists foliation, and copper sulphates along fault planes*”; “*Ponte do Azibo is a wedge-shaped outcrop of garnet-rich amphibolites, 3 to 4 m wide and a few dozens of meters long, mineralized with chalcopyrite, pyrite and marcasite*” (Geirinhas *et al.* in press).

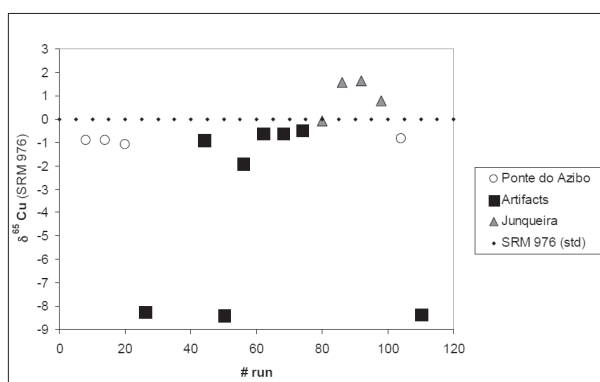
The artefacts sampled where the three prills and blade fragment from Area 3 (FCORV-194, 660, 781 and 849) and the bar and wire fragments from Area 2 (FCORV-1517 from phase 2 and 1407 from phase 3).

“The Cu isotopic signature of copper mineral separates, from Junqueira and Ponte do Azibo, and Fraga dos Corvos metallic artefacts was measured at University of Bristol by high-resolution Multi-Collector ICP-MS (MC-ICPMS), after acid digestion and Cu chromatography following the procedures of Archer (2007)” (Geirinhas *et al.* in press). Table 3 resumes the results.

Table 3  
(Geirinhas *et al.* in press)

Sample	Material	$\delta^{65}\text{Cu}^*$
<b>Archaeological materials</b>		
FCORV-194	Bronze nodule	-8,26
FCORV-781	Bronze nodule	-8,37
FCORV-781 repeat	Bronze nodule	-8,34
FCORV-660	Bronze nodule	-0,90
FCORV-849	Bronze Blade Fragment	-1,91
FCORV-1517	Bronze Bar Fragment	-0,46
FCORV-1407	Cu String Fragment	-0,61
FCORV-1407 (duplicate)	Cu String Fragment	-0,63
<b>Ponte do Azibo</b>		
FA-03	Chalcopryite	-0,89
FA-03 (duplicate)	Chalcopryite	-0,90
FA-03 repeat	Chalcopryite	-0,85
FA-04	Chalcopryite	-1,09
<b>Junqueira</b>		
JQ-01B	Cu-sulfate	-0,08
JQ-03-02A	Malachite	1,56
JQ-03-02A (duplicate)	Malachite	1,65
JQ-03-10	Malachite	0,79
* Analysis precision of 0.08‰		

Figure 6.  
Cu isotopes of Fraga dos Corvos artefacts and mineral separates from nearby Cu occurrences (Geirinhas *et al.* in press).



Archaeological materials show a large spread in Cu isotopic ratios ( $\delta^{65}\text{Cu}$  from  $-8.37$  to  $-0.46$  –Table 3). The clustering of the  $\delta^{65}\text{Cu}$  values suggests at least a couple of Cu sources and/or mixing of ore materials (Fig. 6).

The  $\delta^{65}\text{Cu}$  values for the copper ore samples from Junqueira are heavier than the studied archaeological materials and therefore unlikely to be a local ore source. The  $\delta^{65}\text{Cu}$  values for the samples from Ponte do Azibo partially overlap some of the artefacts but cannot account for their entire Cu isotopic range. These results seem to reveal a foreign copper source, at least for the artefacts group with the lowest Cu ratios.

## 5. CONCLUSIONS

The archaeological data from Fraga dos Corvos, namely the characteristics of the studied structures, the small amount of melting leftovers recovered, the even smaller amount of metal so far recovered in the excavated areas, all point towards a very small operational scale for metal production within the site. All this takes place in a cultural environment chronologically compatible with the dissemination of the axes of Bujões/Barcelos type (c. 1750-1500 BC) for which the mould fragment FCORV-2220 documents a very probable local production.

Otherwise, the published data for the grossly contemporary site of Sola (Braga, Minho) (Bettencourt 2000), as well as what is known for Galicia (Comendador 1997, 2008), shows that the inception of binary bronze production was a larger phenomenon taking place in all of Northwest Iberia within the above mentioned chronological frame.

The probable melting work area for binary bronzes represented by the contexts of “Huts 4 and 6” (Area 3) is complemented by the data from phases 2, 3 and 5 of Area 2, allowing us to put forward the possibility of local smelting by co-reduction of copper and tin ores in open-vessel to produce binary bronze prills. To this we must also add the possibility of the importing of bronze prills, as source material for local melting as suggested by the results of the copper provenance analysis.

The regularity of Sn content, both in prills and artefacts, is remarkable taking into consideration the very simple technology used and the empirical constraints on copper ore selection (that we supposed was made mainly by colour).

For now, all the archaeological and archaeometallurgical data from Fraga dos Corvos are consistent with a very small scale of production performed inside the settlements, at a “domestic” and “part time” level, thus reinforcing our previously suggested uneconomic nature of metal production during the regional First Bronze Age (Senna-Martinez *et al.* 2010).

The early production of binary bronze attested for Northwestern Iberia is compatible with a technological introduction from northwest to southeast of the



Iberian Peninsula as proposed by Fernández-Miranda, Montero Ruiz and Rovira Llorens (1995), as well as allowing us to propose a western route for its diffusion southwards that will probably reach Portuguese areas south of the Tagus river basin only at the beginning of the Late Bronze Age (Senna-Martinez *et al.* this volume).

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**Abstract:** The evidences of binary bronze production, recently stated for domestic contexts in two sites of Northern Portugal, dated of the second millennium's second quarter, provoked an important change in our comprehension of its origins and dispersal in the western Iberian seaboard (Comendador *et al.* 2008; Bettencourt 2000; Senna-Martinez 2007).

The Fraga dos Corvos habitat excavation and study (8 field seasons, 2003/2010, with 137 m<sup>2</sup> of open area) allowed the identification of binary bronze foundry areas (melting and probably smelting as well – Senna-Martinez *et al.* 2010), including metallurgical leftovers, a crucible and molds.

The data obtained, together with the study of the 19 domestic structures ("huts") distributed among five stratigraphic phases all attributed to a second phase of the First Bronze Age (c. 1750-1250 a.C.), allow us to perspective the metallurgical production in its technical and social context.

The metallurgical working areas of Fraga dos Corvos, together with the data from Sola habitat (Braga) and their probable association to the production of axes of Bujões/Barcelos type allow us to consider the processes of dispersal of bronze artefacts production southwards from their northern prototypes.

**Key-words:** Fraga dos Corvos, Northern Portugal, First bronze artefacts, Archaeometallurgy.

**Resumo:** A descoberta e estudo, em dois arqueosítios do Norte Português, de evidências de produção de bronzes binários em contextos domésticos, datados do segundo quartel do 2º milénio cal a.C., veio provocar uma mudança importante na perspetivação da origem e difusão da respectiva tecnologia no território hoje português (Comendador *et al.* 2008; Bettencourt 2000; Senna-Martinez 2007).

A escavação e estudo do arqueosítio da Fraga dos Corvos (8 campanhas, 2003/2010, com 137 m<sup>2</sup> de área aberta) permitiram identificar áreas de fundição de bronze (e, possivelmente, de redução – Senna-Martinez *et al.* 2010), com os respectivos restos de fundição, de cadinho e moldes. Em conjunto com o estudo das 19 estruturas habitacionais ("cabanas") até hoje identificadas no conjunto de cinco fases estratigraficamente reconhecíveis, todas atribuíveis a uma segunda etapa da Primeira Idade do Bronze (c. 1750-1250 cal AC), tais evidências arqueometalúrgicas permitem inserir a produção metalúrgica nos respectivos contextos tecnológico e social.

As "áreas de fundição" da Fraga dos Corvos, juntamente com os dados obtidos no habitat da Sola (Braga), e a sua provável associação à produção de machados do Tipo "Bujões/Barcelos" permitem agora encarar a produção dos primeiros bronzes do Centro e Sul portugueses a partir dos seus protótipos "Transmontanos e Minhotos".

**Palavras-Chave:** Fraga dos Corvos, Norte de Portugal, Primeiros bronzes, Arqueometalurgia.