El Mirador Cave (Sierra de Atapuerca, Burgos, Spain): a whole prespective.

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Abstract

The archaeological site of El Mirador is located in the southern slope of the Sierra de Atapuerca. The works developed at the site are providing a substantial set of data from the Upper Palaeolithic and Early Neolithic to the Middle Bronze Age. Throughout these at least about 4000 years of occupations, the cave was used for various activities, among burial, habitation and animal stalling. The practices related with this last use is at the moment, the main origin of the archaeological deposit, mainly composed by burnt animal dung with vegetal, potsherds, lithic and faunal remains. In addition, it is characterized by elevated high sedimentation rate that has enabled an individual and clear record of different episodes, providing a high chronological resolution data. Due to these particularities, it have been developed a specific methodology of excavation and interdisciplinary study of the archaeological data in order to understand the genesis of this archaeological sequence and, at the same time provide information about the introduction and development of the production economy in the Submeseta Norte region.

Keywords:

Livestock, pastoralism, *fumier*, Neolithic, Bronze Age, Iberian Peninsula

El Mirador cave

The cave of El Mirador (Ibeas de Juarros, Burgos) overlooks the southernmost flank of Sierra de Atapuerca at an altitude of 1.033 m asl, with commanding southerly views across the Arlanzón River valley (Figure 1). Now the mouth of this karst cavity is approximately 23 m wide and 4 high, penetrating some 15 m inwards. Its current shelter-like form is due to the collapse of part of the roof. It is part of the Sierra de Atapuerca karst system, although a possible connection to the Cueva Mayor system cavities along the Trinchera del Ferrocarril is yet to be confirmed.

Edelweiss Caving Group dug a small test pit in 1970 (Ortega et al, 2012) locating Bronze Age remains. This work was not continued, and poachers looted the site by in the following years. In 1999, the Atapuerca Research Team began the archaeological excavation at the site and it is still continuing.

Archaeological fieldwork and stratigraphic succession

In the first 10 years, the archaeological work was focused in the excavation of 6 m2 area test pit in the centre of the zone now sheltered by the roof, in order to ascertain the archaeological potential). In the 20 metre deep profile explored during these years are documented 14 metres of Pleistocene deposits and 6 metres of Holocene material. In 2009, fieldwork began in two new sectors, named 100 and 200, at the NW and NE ends of the cave respectively, in contact with the current wall. These sectors are not being dug vertically but in steps, following the line of the cave roof in order to document the inward retreat of the cave and also the stratigraphic variations between its different areas. The main aim of this work is to document the inward retreat of the cave and the stratigraphic variations between its different areas (Figure 2).

The Pleistocene deposit is composed by 14 metres of metric and decimetric limestone blocks with no sedimentary matrix in between. It is the result of the collapsed roof (MIR51/4 and MIR51/1) with two intercalated levels: MIR51/3, a shallow archaeological sterile level composed of wine-borne sediment, dated on 12480±40 BP (15.060-14.700 cal BP 95%) and MIR51/2, with the same sedimentary characteristics but with evidence of human activity: remains of a hearth, lithic and faunal materials. It has two dates, 11.470±40 BP (13.510-13.230 cal. BP 95%) and 11.610±40 BP (13.640-13.360 cal. BP 95%), from charcoal samples extracted from material burned in the hearth.

The 6 meters Holocene sedimentary layers rest directly on top of MIR51/. Four meters correspond to Neolithic occupations (levels MIR24 to MIR6) between the last third of the 6th millennium and the first half of the 4th cal BC, (Vergès et al, 2008) while the remaining two meters from the Middle Bronze Age (MIR4 and MIR3A), between the 2nd and 4th quarter of the 2nd millennium cal BP (Vergès et al, 2002) (Table 1).

These levels were essentially formed as a result of the use of the cave as a livestock pen. The activities related to animal husbandry left sedimentary layers, basically dung, which was piled together and burned at regular intervals in order to reduce the volume and eliminate parasites (Angelucci et al, 2009). These burned layers were alternate with partially burnt and unburned layers of manure and nodules of ash from burned dung. Artefactual record related to domestic occupations is often present in these levels. This kind of deposits is known as *fumier*.

Between the second quarter of the 3rd millennium and the second quarter of the 2nd millennium cal BC, El Mirador was used as a burial cave. Group burial laid in a small natural chamber (sector 200, MIR203), cannibalised remains deposited in a hole at MIR4 and a single burial placed on one of the rocks ledges inside the cave have been documented. Extensive excavation will allow us to discover whether the differential treatment of the corpses and the different types of burial reflect different funeral traditions, or whether they evolved together.

Methodological remarks on the excavation and study of the *fumier* deposits: the *facies*

At El Mirador, the Holocene stratigraphic succession identified as a *fumier* presents a high complexity consequence of their remarkable lateral and vertical variability, in addition to a notable sedimentary discontinuity (Figure 2, right). This aspect along with logistics of the excavation process forced to refuse the use of major litostratigraphic units and to redefine the techniques and criteria employed during their excavation, sampling and analysis of the sediments.

At the field, it was decided to subdivide the succession in stratigraphic units in order to document no single events but complex events occurred in a chronological time relatively limited. The criteria of their identification were the existence of homogeneous and continuous surfaces in the whole excavation area. On the contrary, namely every single level implied a "divisionist" approach that would have confusing effects when the stratigraphic matrix was compiled, with thousands of units scattered within a few square metres (Angelucci *et al*, 2009). Likewise, it was important to document the internal variability of every stratigraphic ensemble. To cope with the complexity of *fumiers* structure and litology it was decided to use the concept of sedimentary facies. Therefore, each stratigraphic unit was subdivided into lithofacies according to sedimentary characteristics recognizable in the field, and all the lithofacies were individually excavated, sampled and three dimensionally mapped (Angelucci *et al*, 2009). In this sense it was created an open reference list of the lithofacies –specified with a small letter- used to deal with the excavation, description and interpretation of *fumiers* (Table 2).

Attending the complex formation and composition of the *fumiers,* as regards their study and interpretation, at El Mirador cave were applied two methodologies. On the one hand, taking in account that *fumiers* usually contains poor assemblages of cultural remains, but are very rich in products derived from stabling (coprolites and associated spherulites) and botanical remains (charcoals, seeds, pollen, phytoliths, etc.), all units and facies were floated, as well as, systematically sampled. On the other hand, the application of the soil micromorphology as a basic technique for the explanation of their formation processes. In this sense, some works on pastoral cave contexts has highlighted the importance of the integration of archaeobotanical (Cabanes *et al*. 2009; Dehlon *et al*, 2008) and archaeozoological data (Boschian and Miracle, 2008) in the interpretation of *fumiers* as indicators of cave and landscape use by prehistoric shepherds (Angelucci *et al* 2009).

At the same time, to meet with rigour the complexity in the study of these deposits, it has been considered necessary the development of experimental programs. These allow current reference data to be able to interpret more accurately the prehistoric archaeological records documented in these livestock areas. So far, it has been developed experimental works aimed at studying the processes of dung combustion (Vergès 2011) and how this processes can affect archaeological remains buried in, specially archaeobotanical and faunal ones (Vergès et al., this volume; Martín et al., this volume).

Archaeobotanical studies

The burnt dung accumulation of the uppermost layers from El Mirador cave during the Neolithic and Bronze Age produced an exceptional accumulation of archeobotanical microremains and macroremains including pollen, no pollen palynomorphs (NPP), phytoliths, charcoal and charred fruits and seeds. Specific methodological and technical approaches have been developed for each material that depends on accurate sampling and extraction processes. For macroremains all sediment has been water sieved using a flotation machine or bucket flotation and for microremains a systematic sampling has been carried out and pollen, NPP and phytoliths has been recovered in the laboratory using specific chemical and physical procedures. These evidences permit to explain the evolution of the vegetal cover and its transformation along the period that the cave was used at different scales. At the moment the data provides evidences of a mosaic landscape formed by crop fields, pastures, and forested areas locally represented by deciduous and evergreen oaks. At a regional scales other type of vegetation such as pine grooves or beech forests (overall during the Bronze Age) are also recorded. The sequence shows from the base to the top landscape transformations due to intensification of the human activity at the area and the influence of climatic changes occurred during the mid-Holocene (4.2 kyr cal BP event). Plant evidences are also important to understand human activities regarding crop plants, crop processing, plant food, fuel and fodder (Euba et al, this volume; Rodríguez et al., this volume). At El Mirador different archaeobotanical evidences show that crop fields were probably very close to the cave.

In fact, the abundance of cereal pollen grains and the presence of spikelet forks in some samples are clear evidences of the development of crop processing activities (Expósito et al., this volume; Rodríguez et al., this volume). The existence of agricultural and livestock practices along the entire sequence and its clear antropozoogenic origin also implies the proliferation of coprophilous and carbonicola fungi. In addittion, the important values of deciduous and evergreen oaks and their dendrological characterization are indicating the importance of these species that were probably used as wood fodder (Euba et al., this volume).

Archaeomagnetism studies

An innovative line of research that we are carrying out at El Mirador Cave is archaeomagnetism. The numerous burning episodes (ash – carbonaceous couplets) documented along the Holocene stratigraphy, radiometrically well-dated (C^{14}), and in a very good state of preservation, provide a suitable context to reconstruct the directional variations of the Earth´s magnetic field in the past. This information has interest both from the geophysical and archaeological point of view. From the geophysical perspective, 15 isolated directions of the Earth´s magnetic field were obtained from 15 different burning features ranging from 5500 to 4000 yr cal. BC (Carrancho et al. 2013). Sampling was performed with the aim of a cylindrical non-magnetic device, which incorporates a built-in orientating system to allow a precise geographical orientation of the samples. Despite this device is not the standard sampling technique, we designed it due to the non-consolidated nature of these sediments. Certainly, the difficulty in collecting oriented samples with precision has prevented archaeomagnetic research in this type of contexts before.

A comprehensive rock-magnetic study demonstrated that these fires are mostly dominated by low-Ti titanomagnetite as main magnetic mineral carrying a thermoremanence (TRM) (Carrancho *et al*. 2009). Thus, these burnt sediments prove to be suitable directional geomagnetic field recorders fulfilling the necessary requirements for archaeomagnetic analyses. The obtained data represent the oldest archaeomagnetic directions currently existing in Western Europe. The directions obtained here combined with data from other mid-Holocene sites in Eastern Europe, allowed us to design the first European directional Palaeosecular Variation (PSV) curve of the geomagnetic field (6000 – 1000 yr BC) which can already be used as dating method (Carrancho *et al*. 2013). This new curve has a dating resolution similar to radiocarbon (± 30 to ± 200 yr). More importantly, it shows the potential of this type of sediments to extend back in time the archaeomagnetism as a dating method.

On the other hand, the versatility of archaeomagnetism and mineral magnetism to the study of burnt anthropogenic cave sediments has yielded useful archaeological information such as determination of palaeotemperatures or evaluation of post-depositional mechanical alterations, among others. The magnetic results obtained at the site indicate that the ashes reached heating temperatures > 700 ºC and the subjacent carbonaceous facies underwent heating temperatures up to 350 – 450 ºC. Likewise, magnetic analyses (i.e., anisotropy of magnetic susceptibility) successfully determined the absence of fluids flow (i.e., water currents) that might disturb the preservation of the ashes in these burning events (Carrancho *et al*, 2013; Carrancho, this volume). Certainly, this information has important implications in the cultural interpretation of the sequence. Nowadays, the research is focused on obtaining additional archaeomagnetic (directional) determinations from new survey pits recently opened at the site as well as absolute palaeointensity data from well-dated pottery fragments. All these data will contribute to design a full vector (directional and intensity) master PSV record, which will be used as reference for archaeomagnetic dating in Western Europe until Mid-Holocene times.

Zooarcheological studies

Macromammals remains were very abundant in El Mirador cave. The Neolithic and Bronze Age levels have yielded 9372 remains recovered from the central test trench and sector 100. Faunal assemblage conservation is very good but anthropic index of bone breakage is high, which difficult taxonomical identification. The number of identified specimens (NISP) was 3643.

Faunal study consisted in taxonomical, anatomical and taphonomic analysis. Death age of domestic animals was calculated and experimental works were realized in order to study faunal assemblage formation and taphonomic modifications.

Macromammals management in El Mirador cave was based on complementary stockbreeding and hunting practices (Martín et al., this volume). Mixed goat (*Capra hircus*) and sheep (*Ovis aries*) flocks breeding was the most important practice during Neolithic and Bronze Age. Immature individuals of sheep and goat were very abundant, specially fetal and neonatal inviduals. El Mirador Cave was employed like breeding cave for pregnant ewes (Martín et al., this volume).

Cattle (*Bos Taurus*) breeding was complementary but its importance increased towards the Bronze Age in parallel with wild taxa increase This fact could be linked with the diversification of faunal sources exploitation and with the intensification with the human activity documented by archaeobotanical analysis.

Dogs (*Canis familiaris*) and pigs (*Sus domesticus)* were part of domestic group too. However domestic horses (*Equus caballus*) determination is difficult. Horses NMI was higher during Bronze Age, they could be domestic horses or wild horses monitored by human community (Martín et al., 2014).

Wild consumed animals were: deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), several small carnivore (*Meles meles, Felis silvestris, Vulpes vulpes*), lagomorphs and birds. Wild Carnivore consumption is punctual and could be linked with hunting practices of these animals to flocks protection or with accidentally hunting (Martín et al., 2014).

Most of identified taphonomic modifications were anthropic (cut marks, tooth marks, fracturing, culinary alterations). Domestic dogs and suid modifications (tooth marks and fracturing) were also identified. Fossildiagenetic alterations were scarce, identifying trampling, manganese root etching. Finally, bone tools were scarce, 10 remains with anthropic abrasion were identified.

Human remains and DNA studies

In the final third of the 3rd millennium cal BC, i.e., at MIR4 level, was documented start of the Bronze Age skeletal remains of six individuals deposited in a small hole. They bear evidences of having been defleshed, fractured, cooked and eaten (Cáceres *et al.*, 2007) and certainly they were collected and buried hundreds of years after by the farmers that occupied the cave. Experimental works (Saladié et al, 2015) support the study of these cannibalized human remains.

At 200 pit test have been identified at least 23 individuals laid (MIR203) in a small natural chamber. Two of them were dated in 4.100±30 BP (4.810 - 4.520 cal. BP 95%) and 4.220±30 BP (4.850 - 4.660 cal. BP 95%), locating the burial episode along the Chalcolithic. The final's stage of this site's use as a burial cave is documented at 100 pit test and it is marked by a single burial (MIR106) of a young male who was placed on one of the rocks ledges inside the cave. Their radiocarbon age is 3.430±30 BP (3.820 – 3.620 cal. BP 95%), corresponding at the Middle Bronze Age.

In the sector 200 of the cave, a collective burial with a minimum number of 23 individuals was found (Figure 3). The collective burial was dated in 4,760-4,200 years BP. The analysis of these human remains are still ongoing, however some finished works contributed with results related to dental morphology and pathology, and DNA analyses.

Dental analyses show some bucco-dental pathologies and abnormalities associated with one of the buried individuals. This is the case of Individual 4 who suffered several oral pathologies and shows the ancient published case of supernumerary molar in her mandible (Ceperuelo et al., 2015). The analysis of the morphological characterization of the inner anatomy of the root canals of permanent molars of these human fossils using cone-beam computed tomography determined that the shape and disposition of the root canals show the same diversity since Chalcolithic populations until nowadays (Ceperuelo et al. 2014). Recently, it has been determined the presence of dental wear related to cultural uses of teeth on the occlusal surfaces of two of the 23 individuals (Lozano et al., in press).

On the other hand, the analysis of mitochondrial DNA of these individuals has provided important information about this human group and its relationships with other contemporary and previous groups. The mitochondrial DNA sequence and the haplogroup composition from 19 individuals from the collective burial has been obtained (Gómez-Sanchez et al., 2014). This work is related to the analysis of the current distribution of haplogroup H that was modeled by the expansion of the Bell Beaker culture (4,500-4,050 BP) out of Iberian Peninsula during the Chalcolithic period. However, little is known on the genetic composition of other contemporary populations lacking of the archaeological traits of the Bell Beaker culture.

The specific mtDNA composition of El Mirador group is different to other contemporaneous Bell Beaker populations and to present-day Iberians. El Mirador shares affinities with Near Eastern groups and gathers the Middle and Late Neolithic populations from Germany (Rössen, Salzmünde and Baalberge archaeological cultures). However, El Mirador is not clustered with contemporaneous Bell Beakers.

The mtDNA of El Mirador is related to the hypothesis of the continuity of the previous Middle Neolithic genetic composition into the Chalcolithic.

Ceramic remains studies.

The ceramic equipping of the site is studying with a double aim: (a) to determinate the type and measurement of ceramic vessels to establish functional possibilities and (b) to initiate the decorative-formal study of the remains to establish a cultural affiliation of each chronological phase.

The Bronze Age (c. 594 fragments) and Neolithic (c.2300 fragments) ceramic record obtained from the test pit have been analysed to establish the minimum number of vessels (plain and decorated). From a macroscopic analysis, type of finished, mineral inclusions and cooking have been studied. Furthermore, decorative matrices of the available sample have been analysed.

The analysis of Bronze Age ceramics shows the lack of the Classic Cogotas I motifs. This characteristic has let it to question the inclusion of El Mirador in the heart of the development of the Cogotas I material horizon, considering most successful include the area of the Sierra de Atapuerca in the so-called Contact Zone, where the decorated pottery style away from the Cogotas I (Moral, 2002). In this regard it is noteworthy not only the relationship of these materials with those found at the nearby Valle del Ebro, but the presence of a number of materials that could be described as with "outside influence" (Moral et al, 2003-2004).

Greater number of ceramic vessels have been observed in the layers of Early Neolithic and Late Neolithic than the intermediate phase. Also subtle differences in the volumes between the phases and morphologies have been observed. This would imply the possibility that the occupations had unequal intensities and at the same time, the duration was also different. In turn, the decorations are documented mostly in the earliest levels (Moral et al, 2006), while they are anecdotal from the Middle Neolithic. This fact indicates that the same tendency is followed in the peninsular Neolithic than the centre of the Iberian Peninsula sites (Oms et al, 2014).

Discussion

The study of prehistoric societies requires singular records that take us beyond the outline of processes, providing data that allow them to draw details. This degree of definition is achieved by having continuous stratigraphic successions with a long-haul chronology and preserved records obtained from well-distinguished archaeological units allowing to document the small changes and put them chronologically.

When the subject of study is the implementation and expansion of farming societies, this is the case of the records preserved in so-called pen-caves. In the context of the interior of the Iberian Peninsula Los Husos I and II y San Cristobal (Fernández-Eraso, 2008, Polo and Fernández-Eraso, 2010), El Portalón (Galindo, 2014) y El Mirador (Vergès et al., 2002, 2008) are outstanding archaeological sites.

El Mirador has over five meters of Holocene stratigraphic sequence, ranging from the Neolithic to the Middle Bronze Age, with a sedimentation rate corresponding to the Neolithic period of 1mm/year. It is an extraordinary deposit to get the cultural, economic and environmental changes. Proof of their potential are the innovative studies on archaeomagnetism that are being carried out (Carrancho et al., 2009, 2013, this volume).

Likewise, the excellent conditions of its archaeological record, even at the level of genetic material, as testify the studies carried out to date (Gomez-Sanchez et al., 2014), allowing it to carry out all the studies are nowadays possible in archeology.

The results of the studies developed until today and that are currently in process, some of them included in the articles of this volume, place El Mirador archaeological site as a reference in the study of the process of Neolithisation in the Iberian Peninsula and Mediterranean pen-caves.

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Figure Captions

Figure 1. Location of El Mirador cave.

Figure 2. Upper left: aerial view of El Mirador cave (J.Mestre/IPHES). Lower left: Plant of the cave of El Mirador where were indicated the three archaeological areas and the direction of the section. Right: N-S section of the cave and stratigraphical profile from the Holocene south section of the test pit.

Figure 3. Chalcolithic collective burial (MIR203)

Table 1. 1. Archaeological level; 2. Material; 3. Identification; 4. Laboratory number; 5 y 6. Measured Radiocarbon Age (5) and conventional (6), in years ^{14}C BP; 7 y 8. 2σ calibrated results, in cal BP years (7) and in cal BC years (8); 9. 13C/12C ratio (Vergès *et al*, 2008).

Table 2. Sedimentary characteristics of the different lithofacies identified in the Holocene Series (Angelucci *et al*, 2009).