

The “Sima del Elefante” cave site at Atapuerca (Spain)

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To Loli Soria, *in memoriam*

ABSTRACT

The “Sima del Elefante” (TE site) (Atapuerca, Spain) is a major cave infill with a stratigraphic succession 25 m thick and 15 m wide, wealthy in animal bones and evidences of human occupation at different Pleistocene ages. TE site is under systematic excavation since 1996, and the inferior and superior levels are being dug up independently. The exposed section has been divided into 21 lito-stratigraphic units defined by major unconformities. Concerning the cave history, at least three main infill phases have been identified. The lower phase (TE8-TE14) is dated to Early Pleistocene (between 1.1 and 1.4 million years ago) on the basis of inverse paleomagnetism and belonging to the later Early Pleistocene on the basis of biochronology. The TE lower phase is providing a rich faunal assemblage, and shows evidence of human occupation. A set of stone tools of flint, and possibly, calcareous, is being found at these levels. Hence, the lower part of the TE section documents early presence of hominids in Europe and constituted an important element in the understanding of human dispersions out-of-Africa. The middle phase (TE15-TE19) dated to Middle Pleistocene and it is further subdivided into a basal part (TE15-TE17), still largely unexplored, but no vertebrate fossil record is present at this levels. Units TE18, and mainly TE19 unit, date to late Middle Pleistocene, and contain an abundant record of large mammals as well as stone tools included in calcareous breccias. The TE19 G level contains abundant pieces of charcoal, though verification of its anthropic character is pending. Finally, the third and last sedimentary phase (TE20 and TE21) date to Last Pleistocene and it defined the final infilling of the cavity and soil formation.

The chronological intervals represented in the fertile levels of the Sima del Elefante enlarge the temporal and biostratigraphic local succession at the Atapuerca Hill complex. The lower phase was deposited in a time previous to the lower levels from Gran Dolina site (TD4), whereas the TE upper levels possibly correspond to a moment later than the sedimentation of Galería GIII/GIV, and Gran Dolina TD10/TD11. In addition, the structural features of the TE site together with its sedimentary and archaeo-paleontological record allow the eventual exploration of problems that remain unresolved in other Atapuerca cave sites.

Key words: Early Pleistocene, Middle Pleistocene, Human occupation, Mediterranean ecosystem, Paleocology, Site formation.

RESUMEN

El yacimiento de la Sima del Elefante (TE) (Atapuerca, España) se localiza en el extremo sur de la trinchera del ferrocarril de la Sierra de Atapuerca. TE constituye una sección transversal de una antigua galería kárstica totalmente colmatada de sedimentos pleistocenos. La secuencia estratigráfica completa alcanza los 25 m de potencia y ha sido dividida en 21 unidades lito-estratigráficas delimitadas por discontinuidades mayores. La historia de la cavidad puede ordenarse en al menos tres fases. La fase inferior (niveles TE8 a TE14) data del tercio final del Pleistoceno Inferior, con una cronología entre 1.1 y 1.4

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millones de años. Es rica en registro arqueo-paleontológico y presenta claras evidencias de actividad antrópica. Dada su cronología, los niveles inferiores de TE representan un importante referente para la comprensión de la primera colonización humana de Europa. La fase intermedia la constituyen las unidades TE15 a TE19. El tramo basal de esta segunda fase de relleno (TE15 a TE17) hasta la fecha no ha deparado contenido fósil. El tramo superior (TE18 y TE19), cuya cronología parece corresponder a la parte final del Pleistoceno Medio, es rica en restos de grandes mamíferos e industria lítica sobre sílex y cuarcita. La unidad TE19 se caracteriza por una sucesión de coladas detríticas (“debris-flow”) (TE19A a TE19G), con matriz muy dura y carbonatada, rica en huesos de grandes mamíferos y ausencia de micromamíferos. El nivel TE19G contiene abundantes restos de carbón pendiente de verificar su posible carácter antrópico. Finalmente, la tercera y última fase de relleno (TE20 y TE21) corresponde al Pleistoceno superior y se define por la colmatación final de la cavidad y formación de un horizonte edáfico.

Los intervalos cronológicos representados en los niveles fértiles de la Sima del Elefante (TE) complementan la secuencia cronológica y bioestratigráfica local del complejo Atapuerca. La fase inferior de TE tuvo lugar en un tiempo anterior a los niveles inferiores de Gran Dolina (TD4), mientras que el relleno de las unidades superiores de TE corresponde a un momento posterior a la sedimentación de GIII/GIV de Galería y TD10/TD11 de Gran Dolina.

Palabras clave: Pleistoceno inferior, Pleistoceno medio, ocupación humana, ecosistemas mediterráneos, Paleoeología, formación del yacimiento.

Introduction

The Sima del Elefante (TE site), at Atapuerca Hill (Burgos, Spain), is currently providing solid confirmation of human settlement in the Iberian Peninsula much before 1 My ago. Such a circumstance, together with the rich faunal assemblage found at the same levels, makes of the TE site (TE9-TE14 units) a fundamental reference for the understanding of the physical, ecological and cultural factors that governed the initial dispersion of hominids into Europe (see Huguet, 2004). In addition, the upper lito-stratigraphic units of the Sima del Elefante (TE18-TE19) offer abundant arqueo-paleontological evidences that date from the late Middle Pleistocene. Eventual comparisons of the lower and upper TE site arqueo-paleontological record may contribute to the understanding of the taphonomy and the ecological evolution of the Mediterranean bioma in a restricted geographical area. This work is an updating of the previous papers published by the Atapuerca Research Team on the TE site (Rosas *et al.*, 2001, 2004; Huguet, 2004; Parés *et al.*, 2005).

Context and Background of the Sima del Elefante

The Atapuerca Hill contains a large number of cave sites, with a rich Pleistocene geo-arqueo-paleontological record (see Aguirre *et al.*, 1990; Car-

bonell *et al.*, 1998; Pérez-González *et al.*, 2001). Among these sites, the “Sima del Elefante” (TE site) is a major cave infill with a stratigraphic succession 25 m thick and 15m wide, wealthy in animal bones and evidences of human occupation at different Pleistocene ages (fig. 1). The site is catalogued as cavity IV-A-8, plan 6 (Martín-Merino *et al.*, 1981), and it is under systematic excavation since 1996. A large part of the cave infill outcropped after the construction of the railway cutting¹. The remaining 6 m are below the present Trinchera ground level.

Field operations

The investigation of the TE site started with a sampling of the sedimentary succession, and the description of the spatial heterogeneity of the infilling. Regular digging at the lower levels began in 1996, taking advance of a projection of the outcrop (~9m²). Excavation and processing of the archaeo-paleontological record is conducted following the methods described by Carbonell *et al.*, (1999a).

At the moment, upper TE levels have been only excavated at restricted areas, those projecting outside the section. These levels contain hard carbonated breccias that make the extraction of fossils difficult. Surface excavation is being planned, and new techniques might be implemented for bone extraction (e.g. electric drills).

¹ At the end of the 19th century a railway trench was opened by a British Mining Company in the south-western slope of the Atapuerca Hill. Along the nowadays abandoned railway trench some cave infillings are exposed, and they are systematically explored, sampled and excavated since 1978.



Fig. 1.—General view of the Sima del Elefante site (Atapuerca Hill).

Arqueo-paleontological levels are firstly identified on the ground of litho-stratigraphic units, denoted by numbers (e.g. TE19), and defined by major unconformities. Further subdivision of levels are denoted by letters (e.g. TE19C), and are based on matrix texture, composition as well as fossil content.

A systematic topography program is carry out since 1997 in the Atapuerca sites (Pérez Martínez, 2002). Maps and site sections refers to UTM coordinates, and include both the absolute height over the sea level and the archaeological 3D local coordinate reference system. Figure 2 shows a scale drawing of the TE site section.

Stratigraphical settings

The Sima del Elefante infill shows a high degree of tridimensional heterogeneity, with dramatic lateral changes in lithology and normal faults. At the

same time, a remarkable regularity is also present at some particular areas of the succession; a fact common in other sites from the Atapuerca railway. Attending to this particular areas, the TE section has been divided into 21 litho-stratigraphic units. A detailed description of the exposed stratigraphic succession, and unit's sediment composition can be found in Rosas *et al.*, (2001) (fig. 2).

The 21 stratigraphic units are further grouped into three sedimentary phases. The lower phase (lower TE) ranges from the bottom of the sequence up to the unit TE-14. The middle phase is composed by TE15 to TE19 units. And, finally, the upper phase comprises the TE20 and TE21 litho-stratigraphic units.

The TE site: Phase I

In the exposed section, the lower phase comprises a series of strata embracing from the lowermost-



Fig. 2.—The topographic profile of the Sima del Elefante site (Atapuerca). Cave section at the level of railway-trench limestone cut. Main contact lines and stratigraphic units are indicated. At the bottom, below the present ground level, stratigraphic succession of non-exposed sediments coming from core samples. Scale indicates the heights on the sea level and the archaeological reference from the zero level chose for the excavation of the site.

outcropped unit (TE-8) to TE-14. Sediments composing these units are of an allochthonous origin, and they display marked inclination of the strata, more especially at TE9 and TE10. In fact, a clear angular unconformity is appreciated within this Early Pleistocene phase. The subset TE11-TE14 relays on a much slower bedding angle on the subset TE9-TE10. Patterns of sedimentation include mudflows at the bottom of the succession, and

hydraulic activation layers at the top of the succession, alternating with gravitational sediments (debris flows). The lower units show transport directions towards the NW in the central part of the locality and towards the south in its northern part, suggesting entries in the SE and N, respectively. In the exposed section, lateral continuity of the succession is partially broken up by a sort of cut-and-fill structure coupled to a set of local faults.

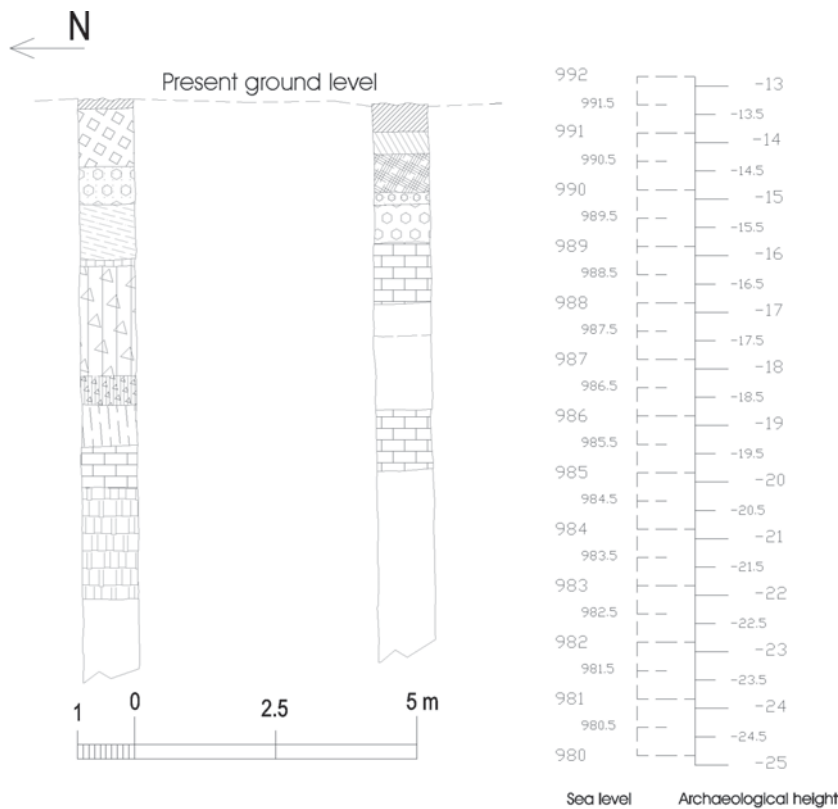


Fig. 3.—Stratigraphic columns resulting from the geologic drills performed at the Sima del Elefante base. The north drill shows that below the current Trincheras ground level there are 6 m of sedimentary succession. At this depth, cave's floor was identified by the presence of a 40 cm thick limestone layer, underneath of which lower karst level sediments were also found (see text).

Two hypotheses were advanced in order to account for the structure and present inclination of the strata from the lower phase. One of them maintains that the inclination of the whole series took place as a result of collapse of lower karst galleries. The other hypothesis holds that present inclination is sedimentary in origin. Several facts seem to support the latter.

Firstly, the inclination of the lower series decreases along the sequence from bottom to top. This feature is, moreover, coupled to a noticeable lateral change of facies. Proximal facies, located at the south end, are coarser than the distal ones, whose sediments increase in fine silt, and in cases laminated. This fact, in addition to the fossil preservation, allows hypothesising that the original entrance of the cavity during the Early Pleistocene was mostly of a fissure configuration better than a large cave entrance. Preserved sediments seem to enter the cavity by a talus cone.

The recent discovery of Early Pleistocene levels at the south and north end of the infill, acting as

perched terraces with sharp lateral erosive contacts, support the hypothesis that a major erosive process took place, washing away part of the Early Pleistocene sediments, and partially emptying the cavity. Therefore, the original Early Pleistocene sedimentary succession at the TE site was longer than it is today preserved, as it was cut by a noticeable erosive episode, well delimited by an erosive unconformity.

The lower limit of the Early Pleistocene sequence remained undefined as this part of the sequence does not outcrop. In order to know the length and composition of the sedimentary succession below the present ground level, two geologic drills were carried out during the 2001 field season, 5 m off the outcrop. Figure 3 shows the stratigraphic columns of the two drillings. A rough description of the north sequence drill, the longest of the two, is provided next.

Five different strata have been identified in the 6 m long sedimentary infill below the present ground

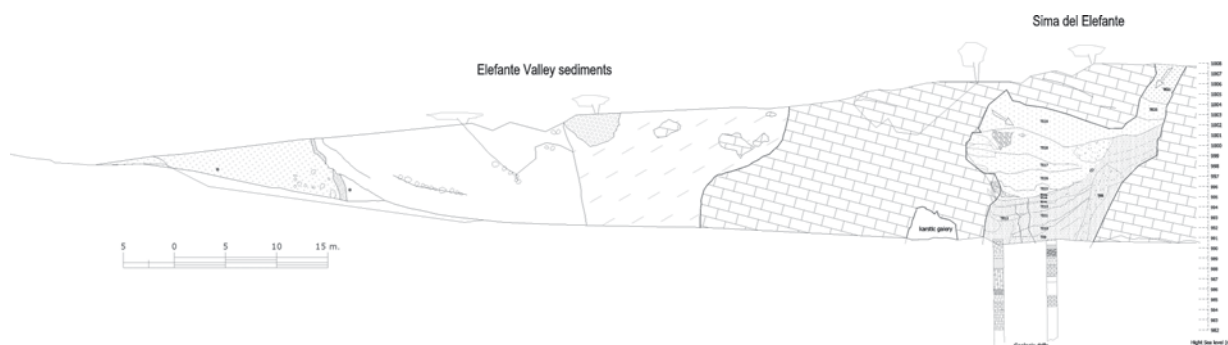


Fig. 4.—Profile of the south end railway-trench with a general outline of the sediments belonging to a nearby valley in-between the two areas of the Atapuerca Trench, and the topographic profile of the Sima del Elefante site.

level. At this depth, a limestone layer 60 cm thick was detected and interpreted as the floor of the cavity. From young to old these are composed as follow.

1. Brown silts with rock fragments.
2. Rock fragments with brown silts (7,5YR4/6).
3. Dark brown silts (7,5YR4/6).
4. Brown silt with rock fragments (2-4/10 cm) with fewer rock fragments at the base of this stratum.
5. A dark layer with brown silt and guano (7,5YR3,4/2 and 7,5YR5,6/8).

Underneath of this series of sediments, just below the limestone layer, a distinct set of sediments was found, which was interpreted to represent the infill of a cavity from a lower karst floor. Two strata have been distinguished. The uppermost is composed by clay with small clasts (1-2 cm), and manganese oxide. Below this, appears a stratum with rounded quartzite pebbles, which is interpreted as part of a terrace left by the Arlanzón river into the cave.

The TE site: Phase II

Middle sedimentary phase is dated to Early and Middle Pleistocene. The middle phase is a long sequence comprising from TE15 to TE19 units. Two distinct further sub-arrangements may be differentiated. The basal part of this sequence is characterized by a non-local sedimentary regime (TE15, TE16 and TE17). Bedding is mostly of hydrodynamic origin, and there is a recurrent pattern of speleothem formation along the sequence; specially in the TE17 unit where, at least, two solid stalagmite floors (of 20-30 cm thick) outcrop in the section. The sediments have light colours and are allochthonous, with few or no elements of the

immediate surroundings. Until present, no vertebrate fossil record has been recovered from TE15, TE16, and TE17 units, which seems to be sterile in macrofossils. We think that there was no nearby entry to the cave when these sediments were formed. These preliminary observations suggest that the nearby valley affected the sedimentation of the lower and middle units of TE (now on called Elefante Valley). This is evidenced by reworked Miocene and/or Cretaceous marls in the cave sediments, as well as by the similarity in texture and color of the sediments present in this nearby valley and those infilling the cavity (fig. 4).

The uppermost units within the middle phase (TE18 and TE19 units) are characteristic of allochthonous sedimentary input. Four different sectors have been distinguished, informally named: north tower (squares D-E-F-G), central sector (squares J-K-L), south sector (squares M-N-O) and south tower (squares P-Q-R-S). The latter sector is almost unexplored at present (see fig. 5 for the emplacement of the archaeological grid at the site).

TE18 unit is still largely unexplored. As a whole, it represents a stratified scree with marked lateral changes, and several erosive channels. A massive travertine concretion is located in the south end of the section, with evidences of later erosion and transport of travertine blocks and tuffs. A spring hole may be a reasonable interpretation of this structure.

TE19 is a large and complex stratigraphic unit (fig. 6). A succession of at least 5 debris flows (named by letters A to F) is located at the north tower and central sector of the section. These layers interfinger laterally with laminated silts, which define the south sector. The south tower sector records coarse sediments.

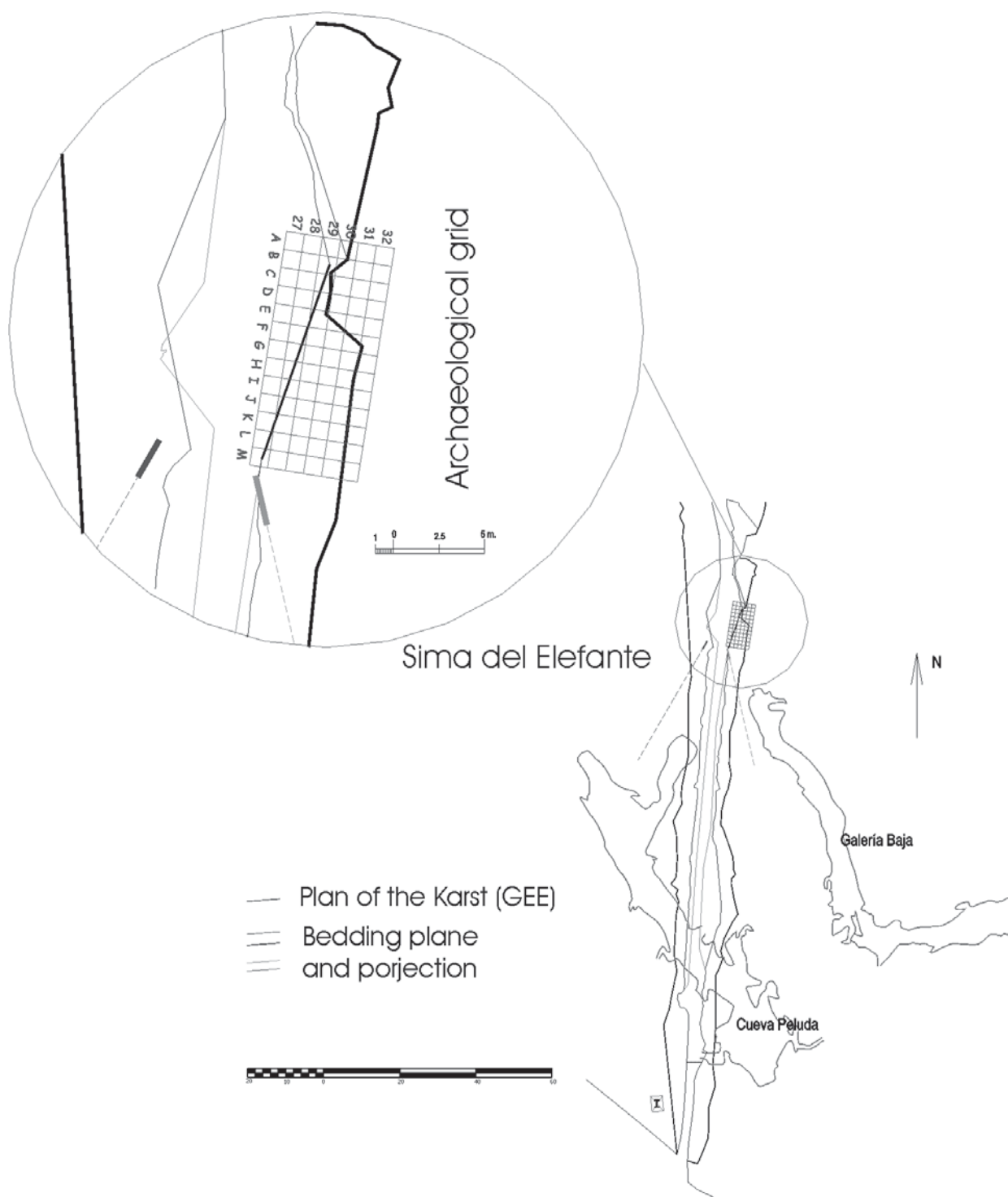


Fig. 5.—Plan of the railway trench and the TE site with the archaeological square grid. Superimposed on the surface site plan is of the longitudinal profile of Cueva Peluda (BU-IV-A-5) and Galeria Baja galleries at its distal end (speleo-topography after GEE; see Martín-Merino *et al.*, 1981). Dashed lines are calculated planes after measuring the limestone wall at the site, and its respective prolongation on the plan. Note the coincidence between limestone planes and axis of galleries.

According to this information, two distinct sedimentary regimes have been identified to occur in the TE19 unit. First, gravitational debris flows coming from the south and principally north cave entrances, and, second, sedimentation in a pond located at the south sector where the sediments are more finely bedded (fig. 6). Possibly debris flows and pond sedimentation alternates in time.

The TE site: Phase III

This is the shortest part of the sequence and is restricted to uppermost part of the section in the south. It is composed by pit fall debris (TE20), and Terra Rossa (TE21). Due to access difficulties, no excavation or sampling have been performed yet.

Chronological settings

The stratigraphic section of Sima del Elefante site has been sampled for dating by palaeomagnetism, U-series, and ESR. Geomorphology and reconstruction of the Sierra de Atapuerca landscape evolution support the hypothesis that railway cavities becomes opened—and, therefore, receiving allochthonous sediments—only after the dismantling of the Arlanzón terrace 3, dated by regional correlations to ~0.9 myr. (Benito y Pérez-González, 2002; Benito, 2004).

Paleomagnetic results obtained from the sedimentary fill at the Sima del Elefante site in Atapuerca, Spain, reveal a geomagnetic reversal, interpreted as the Matuyama-Brunhes boundary (0.78 Ma). The uppermost lithostratigraphic units (E17 through E19), which contain Mode II and III archaeological assemblages, display normal polarity magnetization, whereas the six lowermost units (E9 through E16) yield negative latitudinal virtual geomagnetic pole positions. Units E9 through E13, all of which display reverse magnetic polarity, contain Mode I (Oldowan) lithic tools, testifying to the presence of humans in the early Pleistocene (0.78e1.77 Ma) (Parés *et al.*, 2006).

Biostratigraphic data fully corroborate this assignation. The association of small and large mammals from the lower units is characteristic from the last third of the Iberian Early Pleistocene (Cuenca-Bescós and Rofes-Chávez, 2004, in press; Cuenca-Bescós *et al.*, 2004; Cuenca-Bescós and García, in press). The TE lower phase is biostrati-

graphically earlier than the lower levels of Gran Dolina site (TD4) and it is, therefore, the oldest record in the Sierra de Atapuerca. There is, however, an uncertainty on the precise timescale of the lower levels of TE. Further research is extremely needed.

A similar situation is found in the TE19 unit. No radiometric dating is presently available. In spite of the several attempts, the low uranium content in the sediments of the TE site has precluded any dating with this technique (Bishoff, pers. com.). New assays with new samples are, however, underway. Likewise, ESR analyses on enamel teeth are in progress by C. Falgueres. On the other side, the scarce record of small mammals makes a biochronologic assignation difficult. The large mammal assemblage is typical for the final third of the Middle Pleistocene (0.35-0.15 Myr), but a more accurate estimation is at present difficult. Additionally, advanced technical features of the stone tools from this unit may fit a final Middle Pleistocene age for the TE19 unit. The ongoing dating program on the site may eventually refine this approximation.

Three-dimensional geometry of the Sima del Elefante site. Background.

Available information on the geological background of the Sierra de Atapuerca may be found in Aguirre *et al.*, (1990); Carbonell *et al.*, (1998); Parés and Pérez-González (1999); Pérez-González *et al.*, (2001); Benito and Pérez-González (2002). Likewise, Atapuerca caves topography and speleologic field research is provided by Grupo Espeleológico Edelweiss (GEE) (see Martín-Merino *et al.*, 1981; Martín-Merino and Ortega, 2003; Martín-Merino, 2002).

As a summary, the Atapuerca karst is of phreatic origin, which evolved throughout the formation of the three floors: upper, middle, and lower floors respectively (Martín-Merino and Ortega, 2003). The cave pattern is geographically organised in two independent systems. The larger of them is formed by the Cueva Mayor-Cueva del Silo galleries network, further subdivided into Cueva Mayor and Cueva del Silo subsystems with two distinct current openings (see Martín-Merino *et al.*, 1981; fig. 7). The other set of cavities is located at the western end of the Atapuerca railway cutting, and it outcrops in series of independent caves and fissures sections (e.g. Gran Dolina (TD) site and Galería/Covacha (TG/TZ) site, among several others).

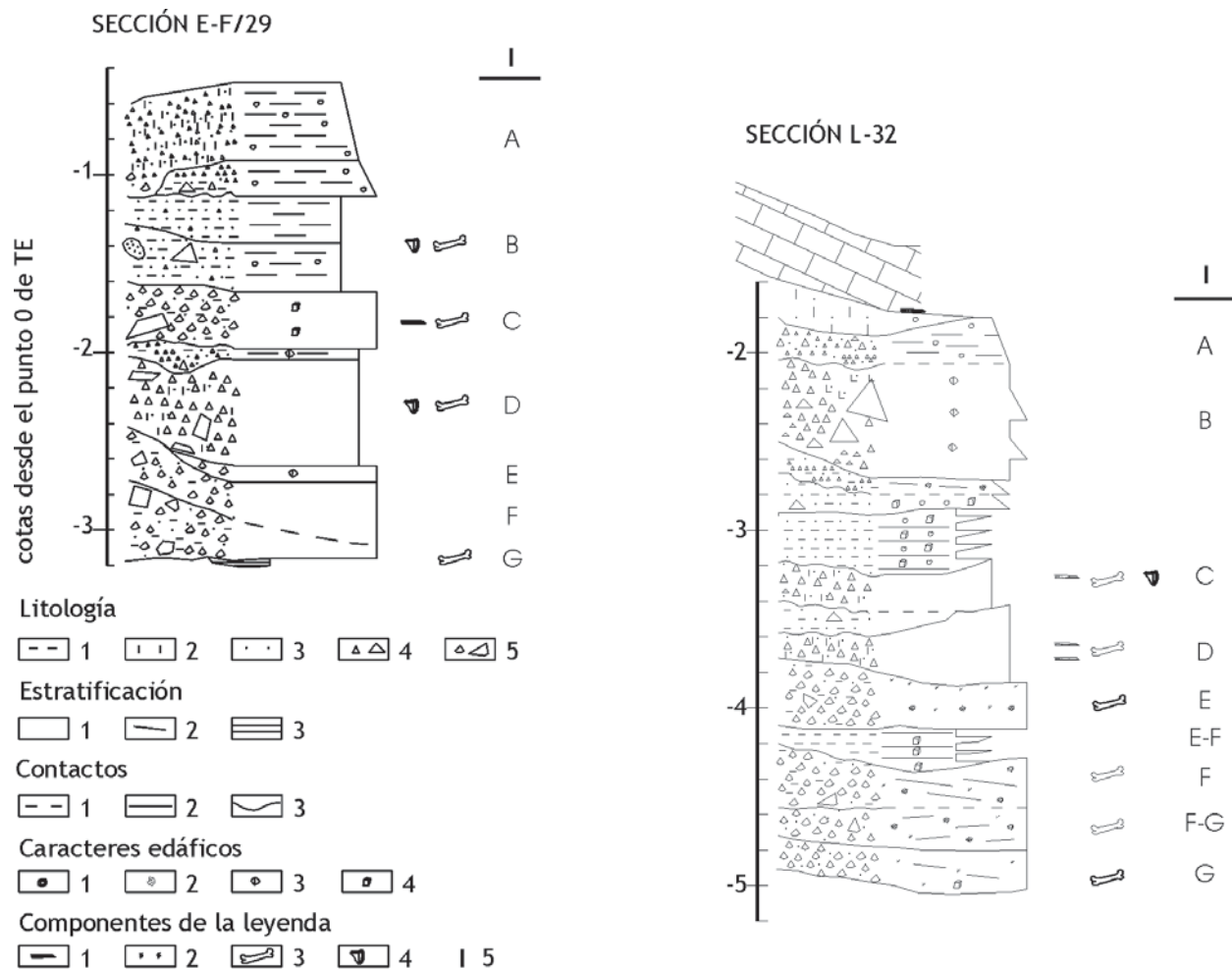


Fig. 6.—Stratigraphic columns of the Sima del Elefante TE19 unit. Perfiles sintéticos del nivel 19 de Trinchera Elefante. Litología: 1, arcillas; 2, limos; 3, arenas; 4, gravas angulares; 5, gravas subangulares. Estratificación interna: 1, masiva; 2, discontinua; 3, laminar. Contactos: 1, gradual; 2, recto claro; 3, ondulado claro. Caracteres edáficos: 1, nódulos carbonatados; 2, microagregado (grumo); 3, agregado poliédrico; 4, agregado prismático. Componentes de la leyenda: 1, espeleotema; 2, microcarbones; 3, restos óseos; 4, industria lítica; 5, niveles arqueopaleontológicos de la unidad estratigráfica 19.

As far as free galleries allow to explore, these latter cavities present a much more local extension, without connections among them. Yet, according to Eraso *et al.*, (1998a and b), the Gran Dolina site is a large karstic conduit fully filled. A small valley separates geographically both cave systems (fig. 7; see also fig. 4). The geomorphological evolution of this nowadays dry valley seems to have had a significantly influenced the infilling of the Sima del Elefante. A large amount of sediments from the TE cave, and more especially those corresponding to the phase II, may have had a fluvial origin closely related to this valley.

Topography and fieldwork investigations carried out by the Grupo Espeleológico Edelweiss (GEE) (see Martín-Merino *et al.*, 1981; Martín-Merino and Ortega, 2003) led to propose the hypothesis that TE site represents an old entrance to a branch of the Cueva Mayor karts subsystem. Superposition of surface and cave topography locates the TE site at a short distance of the end of the longitudinal axis of the Galería Baja. Thus, on the grounds of the GEE's field studies, Arsuaga *et al.*, (1997) claim that "the Sima del Elefante site belongs to the Cueva Mayor karst subsystem, representing an ancient opening, now completely filled by sediment".



Fig. 7.—Plan of the Atapuerca karst system after G. E. Edelweiss (Martín Merino *et al.*, 1981). Superimposed on it, lines defining the planes measured on the Sima del Elefante limestone walls has been drawn. Also, several parallel lines to those planes has been recorded on the plan. Also, an extra set of parallel lines following the axis main galleries has been put on the plan. Structural features of the Sima del Elefante and its development may be initially understood in the context of the major structural features of the Atapuerca cave network. Note, for instance, that cave entrances are located at joint points of major structural planes; the TE site being an example of this pattern.

In order to test this proposal, three limestone planes were measured on the TE site cave walls (fig. 5). Projection of these planes on the Atapuerca karst map allows to corroborate how the direction of the south wall of the TE site perfectly fit the major axis of the Galería Baja, fully supporting the GEE's hypothesis.

Similarly, Cueva Peluda develops in a parallel direction to the Galería Baja axis, but at the lowest level of the karst system, at a similar deepness as that of Cueva del Silo. Figure 8 shows a profile of the south end railway-trench on which it has been projected the longitudinal sections of the

Cueva Peluda karst gallery (BU-IV-A-5; see Martín-Merino, 1981). It is highly likely that a lateral branch of Cueva Peluda cave reach the bottom of the Sima del Elefante site. The aforementioned geologic drills performed at the base of the TE site detect both an empty cavity as well as fluvial terrace sediments also present in Peluda and Silo caves (GEE: Martín-Merino *et al.*, 1981). Therefore, the 3D configuration of the Sima del Elefante seems to be structurally linked to the evolution of the Cueva Mayor/Cueva del Silo cave system, and its functioning as an old entrance to the Galería Baja.

Arqueo-Paleontological Record of the Sima del Elefante

In general terms, fossil documentation coming from the lower and the upper levels present a different profile. Up to the 2005 field season, TE lower levels have delivered ~2500 bone remains larger than 2 cm, thousands of small vertebrate remains, ~50 flint fragments (21 stone tools), ~100 pieces of charcoal, among other items. The mentioned record has been recovered along 7 years of systematic excavation (~20m³). The TE19 unit has delivered during 2 years of restricted area excavation (~4m³), ~1637 bones, 39 stone tools on quartzite (15), sandstone (14) and flint (14), dozens of snail shells, and abundant pieces of charcoal. A synopsis of the arqueo-paleontological record of the TE site is given in table 1.

Taphonomic profile

Regarding TE inf., the homogeneity in small mammal species, with slight changes in species abundance, seems to indicate that the lower units were laid down in a "relatively" short time-interval. Other taphonomic features may also reinforce this conclusion. The arqueo-paleontological record of the successive units of the TE lower phase present the following characteristics:

1. Occurrence of abundant small mammals remains, as well as lagomorphs and *Corvidae* and *Columbidae* remains. That gives a certain taphonomic homogeneity to the distinct sedimentological beds.

2. A certain individualization of the levels when attending to the presence of specific taxa or frequency of them (e.g. turtle, fishing eagle, fragment of antlers, among other, taxa, moles, rabbits).

3. Regular presence of fossils in anatomical connection. These are frequent in bird's wings, legs of rabbits and distal legs of large mammals. Additionally, a nearly complete skeleton of a beaver and a fishing eagle were found at TE10.

4. Herbivore and carnivore species present a different pattern of representation. It is relatively frequent to find complete skulls of carnivores (fig. 9), including the lower jaws. Herbivores, by contrast, appear heavily fragmented.

5. Large mammal remains rarely appear complete, fragments of bones are the most usual way of appearance.

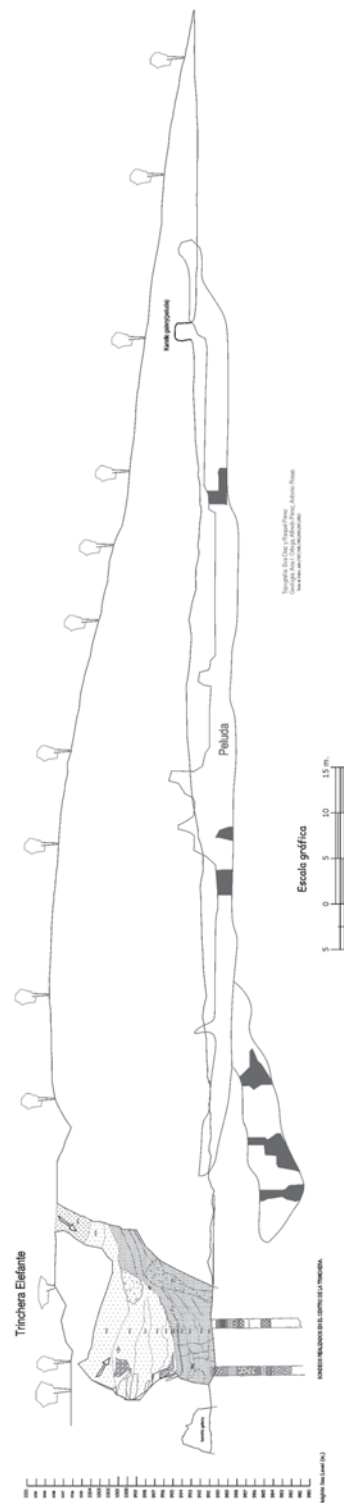


Fig. 8.—Profile of the south end of the railway-trench on which it has been projected the longitudinal section of the Cueva Peluda (BU-IV-A-5) karst gallery (see Martín Merino, 1981). It is highly likely that a lateral branch of Cueva Peluda cave reach the bottom of the Sima del Elefante site.

Table 1

Unit	Level	Large Mammals		Medium size mammals		Small mammals	Birds	Other taxa	Vegetal and other remains	Human evidence/stone tools
		Herbivores	Carnivores							
TE21	No explorado									
TE20	No explorado									
ET19*	A to F	Stephanorhinus hoemithecus Bovini indet Bison sp. Megacerini indet. Cervidae indet. Cervus elaphus Dama dama aff. clactoniana Suidae indet. Proboscidea indet.	Ursus denengeri Vulpes vulpes Canidae indet. Crocuta crocuta.	Lagomorpha indet. Erinaceus sp.	Arvolidae indet	Ave indet.	Rana sp. Gastropods	Pinus silvestres/nigra Angiosperma indet., Charcoal	Mode III Flint, Quartzite, Snadstone	
		Equus caballus								
TE18	Sterile									
TE17-15	Sterile									
TE14	Sup.	Equus sp. Bovidae indet.		Castor fiber						
	A	Hippopotamus sp. Stephanorhinus etruscus, Bison sp. Equus (estenoniano)	Canis cf. C. arnensis/mosbachensis	Lepus sp. Oryctolagus sp.			Quelonia	Carbón	Mode I Flint	
	B	Stephanorhinus etruscus	Vulpes cf. V. alopecoides Canis cf. C. arnensis/mosbachensis	Oryctolagus sp.		Quelonia				
C	Equus (estenoniano)	Felidae indet Vulpes cf. V. alopecoides Ursus dolinensis Mustelidae indet.	Castor fiber		Quelonia					
TE13		Equus (estenoniano) Cervidae indet.	Canis cf. C. arnensis/mosbachensis Felidae indet.	Castor fiber Erinaceus sp. Talpa cf. europeans		Desmaninae indet. Beremendia fissidens Asoriculus gibberodon Crocidura cf. russula Crocidura aff. C. korfeldti Allophaiomys lavocati Castillomys rivas Allophaiomys nutensis Elionys quercinus Ct. Minomys Sciurus sp. Ungaromys sp. Myotis sp. Rhinolophus sp. Miniopterus schreibersii	Quelonia Avian egg shells		Mode I Flint	
TE12	A	Eucladoceros giulii/ Megaloceros savinii	Vulpes cf. V. alopecoides Lynx cf. Lynx cf. L. isadorensis Ursus dolinensis Panhiera gombaszoegensis Canis cf. C. arnensis/mosbachensis Cf. Barangele antiqua	Lepus sp Oryctolagus sp Talpa cf. europeans		Corvus antecorax		Quelonia Gastropods Salmonidae Avian egg shells		
	B	Equus (estenoniano) Eucladoceros giulii/ Megaloceros savinii	Canidae indet.	Oryctolagus sp.			Bufo calamita			
	C		Carnivora indet.							
	TE12N	Bovidae indet	Lynx cf. L. isodorensis Ursus dolinensis							

Table 1. (continuación)

Unit	Level	Large Mammals		Medium size mammals	Small mammals	Birds	Other taxa	Vegetal and other remains	Human evidence/stone tools
		Herbivores	Carnivores						
TE11		<i>Bison</i> sp. <i>Cervidae</i> indet.	<i>Mustela</i> cf. <i>palerminae/praeivalis</i> <i>Felidae</i> indet. <i>Canidae</i> indet.	<i>Castor fiber</i> <i>Talpa</i> cf. <i>europeans</i>			Gastropods	<i>Angiosperma</i> indet. Charcoal	Mode I Flint
TE10		<i>Eucladoceros giulii</i> <i>Megaloceros savini</i> <i>Equus</i> (estenoniano)	Cf. <i>Pannonicetus</i> sp. <i>Canis</i> cf. <i>C. arvensis/mosbachensis</i> <i>Vulpes</i> cf. <i>V. alpeccoides</i>	<i>Castor fiber</i> <i>Erinaceus</i> sp. <i>Talpa</i> cf. <i>europeans</i> <i>Dryctolagus</i> sp.	<i>Desmaninae</i> indet. <i>Berenimys fissidens</i> <i>Asoriculus gibberodon</i> <i>Crocidura</i> cf. <i>ruscula</i> <i>Crocidura</i> aff. <i>C. korngeldi</i> <i>Allophaiomys lavocati</i> <i>Castellomys rivas</i> <i>Allophaiomys nutensis</i>	<i>Anas</i> sp. <i>Perdix paleopendix</i> <i>Pyrrhocorax pyrrhocorax</i> <i>Columba livia olmos</i> <i>Falco tinnunculus</i> <i>Corvus corax s. frugilegus</i> <i>Lagopus mutus</i> <i>Phoenicurus ochruros</i> <i>Turdus</i> spp. <i>Vanellus vanellus</i> <i>Acanthis flammea</i>	<i>Bubo</i> <i>bubo</i>		
TE9	A+	<i>Rhinocerotidae</i> indet.	<i>Canis</i> cf. <i>C. arvensis/mosbachensis</i> <i>Lynx issodorensis</i> cf. <i>Pannonicetus</i> sp.	<i>Erinaceus</i> sp.	<i>Eliomys quercinus</i> Cf. <i>Minomys</i> <i>Sciurus</i> sp. <i>Ungaromys</i> sp. <i>Myotis</i> sp.	<i>Corvus antecorax</i>			
	A	<i>Bison</i> sp. <i>Equus</i> (estenoniano) <i>Suidae</i> indet.	<i>Mustela</i> <i>Panthera gombaszeensis</i>	<i>Macaca</i> sp. <i>Castor fiber</i> <i>Talpa</i> cf. <i>europeans</i>			<i>Salmonidae</i> <i>Egagropila</i> Avian egg shells	Conifer indet., <i>Acer</i> sp. <i>Quercus</i> sp. deciduos	
	B	<i>Bovidae</i> indet <i>Equus</i> (estenoniano) <i>Rhinocerotidae</i> indet <i>Eucladoceros giulii</i> <i>Megaloceros savini</i>	Cf. <i>Barangale antiqua</i> <i>Felidae</i> indet.		<i>Rhinolophus</i> sp. <i>Miniopterus schreibersii</i>				Mode I Flint
	C	<i>Cervidae</i> indet	<i>Canidae</i> indet. <i>Lynx</i> sp.						Mode I Flint

Mustelidae indet. 1 small size
Mustelidae indet. 2 intermediate size

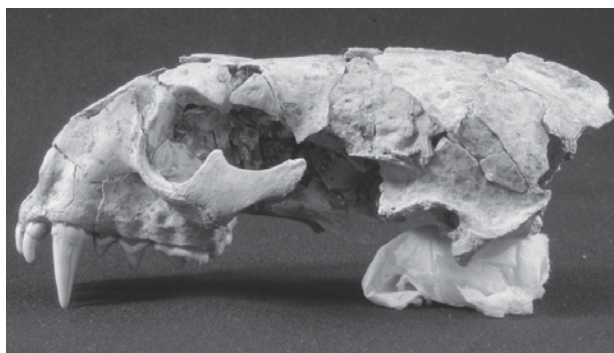


Fig. 9.—Complete skull of a large mustelid (cf *Pannonictis* sp.) coming from the TE9 unit (Early Pleistocene).

Lower TE is mainly characterised by the presence of cave dwelling animals and their rests of food. In this line, even though taphonomy of small mammals has not been studied yet, owls and other bird-prey pellet dropping is a reasonable explanation for this assemblage; some complete pellets have been also recovered. Besides, birds nesting or living at the cave threshold and limestone walls, such as crows and pigeons, are systematically found in the site. In the case of rabbits, their abundance, state of preservation and bone-traceology indicate a possible double accumulation origin: natural death at dwelling and predation. A wide range of predators on rabbits may be preliminary proposed.

Richness and diversity of the fossil record varies among the different sublevels of the TE19 unit, with TE19C preserving the most abundant and diverse record.

The following features can be identified in TE19:

1. Among the species, there is a significant size biased representation. Small animals are very rarely found, whereas large mammal remains are quite abundant.

2. Within the vertebrate community, almost only mammals are preserved, with very few avian remains. Among the mammals, the horse is the best-represented species, with the 50% of the total sample. Bears are also well represented.

3. There is a differential representation of skeletal elements by species. Most of the species are represented by teeth and distal leg elements (phalanges, carpal and tarsal bones). By contrast, most of the skeletal parts are preserved in the case of the horse.

4. Frequency of appearance is quite different between herbivore and carnivore guilds. While herbivore guild is well documented, presence of carnivores is sporadic, evidenced by isolated remains.

Cluster analysis -calculated with Euclidean distances and complete agglomeration- were employed for the analyses. Statistical procedures were performed with Statistica Software (Statsoft, 1996). As far the reduced recovered sample allows to say, there is no reason to suppose significant differences in taphonomic sampling or ecological differences acting on the TE19 fossil assemblage formation. Homogeneous environmental conditions seem to have prevailed during the deposition of the TE19 unit.

Upper TE may have functioned as a spring-hole, and animals went there, either for water or fresh grass. They died around a “water-hole trap”. Bear presence may be easily assign to hibernation or cave bearing activities. The high number of horses is still unexplained. Two gross hypothesis may be considered: 1) horses were the most abundant large mammal species in the original paleoecosystem; 2) humans or any other predator is the selective action responsible of such a number. Also, the absence of birds and small mammal remains unexplained.

Evidence of human presence

At present, no human remains have been found at the Sima del Elefante. However, several other evidences testified the presence of humans at different Pleistocene ages in the site (table 1).

Stone tools

Three different technological complexes are represented at the different levels of the TE site (table 1). Stone tools of Mode I, II and III have been recovered at TE inf. (TE9-14), TE18, and TE19, respectively. Raw materials include Cretaceous flint, sandstone, and quartzite. Industry from TE inf. is mostly made on flint (fig. 10), but knapping on calcareous rocks is also possible. Several flakes on micrite limestone have been recovered at these levels. Distinction between natural fractures and human activity is difficult, but technical and functional analyses are underway.

Zoo-archaeology

Even though carnivore/hominid interaction processes are still under analysis (Huguët, 2007), it may be advanced that these processes are a plausible agent responsible for part of the fossil assemblage. Attending to traces on bone surfaces and bone fracture patterns, carnivore activities co-occur with human presence. On the one hand, biting marks and fresh fracture occur. On the other, a number of cut marks have been recognised. The specific pattern of interaction still has to be resolved.

The study of the biostratigraphic agents is of large difficulty in TE19. Most of the bone surfaces are lost because they remain attached to the sediment matrix. No information is currently available on this aspect.

Biological assemblages

Table 1 shows the taxa identified along the Sima del Elefante succession. Additionally, table 2 gives taxa and number of skeletal elements recovered at the TE19 unit. On the whole, sediments from the TE inf. levels contain a diverse though scarce assemblage of large mammals, but is very rich in small mammals, lagomorphs, and avian remains. By contrast, TE19 provides an abundant fossil record of large herbivores, few carnivores and very scarce small mammals documentation.

Apart from the conspicuous presence of small mammals (see Laplana and Cuenca-Bescós, 2000), birds are the best represented animals in the lower levels. *Corvus antecorax*, and in lesser degree, pigeons (*Columba livia/oenas*) are present in almost every sublevel. The presence of *Haliaeetus albicilla* is a significant finding. Lagomorphs (*Lepus* sp. and *Oryctolagus* sp.) are also quite abundant at the TE inf. levels. Among the large mammals species, the most abundant taxa are the Cervidae, and more specifically the fallow deer (genus *Dama*). Other large herbivores cover a wide range of animals including rhinos, hippos, large Bovids, Equids, and omnivores like *Sus* sp. Also, the presence of *Macaca* may be attributed to this latter category. Along with the carnivores, specimens attributed to the genus *Canis* (e.g. *Canis arnensis/mosbachensis*) are the carnivores more frequently found at these levels. The small size felid *Lynx* is also reasonably well preserved. In this

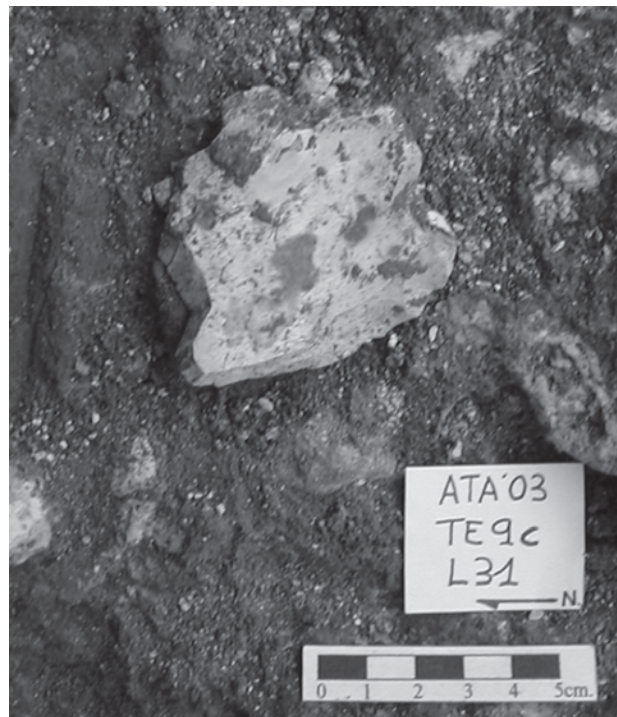


Fig. 10.—Flake of Cretaceous flint found *in situ* at the lower levels of the Sima del Elefante site (Atapuerca) during the 2003 field season.

line, and with the exception of the leopard-size felid, the absence of large carnivores stands out (large felids and hyenas), usually present at other South European sites of a roughly similar age (Le Vallonnet, Fuente Nueva-3, Barranco León). By contrast, the presence of at least three species of mustelids (small, intermediate, and large) at these levels is notable.

A foremost characteristic of TE inf. is the relative abundance of vertebrate species linked to inland water biotopes e.g. hippopotamus, beaver, fishing eagle, otter-like mustelid (this latter, however, pending of further studies), and others.

Concerning the TE19 unit, very few small mammals and bird remains have been recovered. Among the large mammals, the Equidae (genus *Equus*) is the most represented taxa. Likewise, the diversity of bovinii seems to be higher than at lower levels. The presence of these species together with elephant, rhinos, and deer testified a high large herbivore diversity. By contrast, *Ursus* sp. is the most frequently found carnivore species, combined with sporadic finding of felids, hyenas and canid specimens.

Snail shells are uncommon in the Atapuerca cave sites. As an exception, gasteropods are occasionally found at TE19, most of the cases concentrated in particular areas of the site.

Charcoal evidence

Small bits of charcoal appear at several levels in the succession (table 1). Charcoal recovery was made manually, as any other archaeological record. However, a flotation procedure was attempted in the 2003 field season with good results for the fine fraction (sieve 0.5 mm). Both the small size and bad preservation permit the identification of just a few number of species. Among the tree species *Acer sp.* and deciduous *Quercus sp.* are present in TE9, which may indicate a certain degree of environmental humidity. By contrast, *Pinus silvestris/nigra* is the most abundant taxa in TE19 from which cold climatic conditions may be inferred at this unit.

With regards to the origin of charcoal at the site two different possible explanations are given. Natural fires are fairly common in Pleistocene sites (Scarascia-Mugnozza *et al.*, 2000), and this is accepted as the most reasonable explanation for the charcoal remains found at the TE lower phase. A regular presence of charcoal in the TE inf. units, if evidence of natural fires, may suggest a dry season or periods of drought during the time of TE inf. accumulation.

Level TE19G contains abundant pieces of charcoal disposed in a well defined archaeological horizon in close association to possibly burned bones. An anthropic origin of this evidences is a feasible hypothesis, but human use of fire cannot be confirmed at the moment. The charcoal has been identified as belonging to the *Pinus silvestris/nigra* group species.

Paleoecology Settings

Several indicators point to clear differences in the environmental conditions prevailing at the time of TE inf. and TE19 sedimentation, respectively. Also, soil formation recorded at TE21 grants certain climatic information. Different signals seem to indicate that both humidity and temperature have varied along the succession.

Humid environmental conditions are detected in TE inf. by the relative abundance of vertebrate

species linked to inland water biotopes e.g. hippo, fishing eagle, beaver. This strongly suggests the existence of permanent and extensive water layers at a short distance from the site (the hippos need permanent water with a minimum depth of 1.5 m). Evidence from small mammals, specifically from the insectivore assemblage, also support wetter condition (Cuenca-Bescós and Rofes-Chávez, 2004). Arboreal species such as *Acer sp.*, and deciduous *Quercus sp.* reinforce this proposal. Also, Sánchez-Marco (1999, 2002, 2004) stated that more open country and wetter conditions prevailed during the early Pleistocene than previously inferred.

Temperature indicators come mostly from field observation of sedimentary matrices, which indicates a warm environment. Besides, the existence of possible systemic natural fires also point to such a set of physical environmental conditions. This pattern coincides with those found in other sites of similar age; Sierra de Quibas (Murcia) dated between 1.3 and 1.0 (Montoya *et al.*, 2001), and Fuente Nueva-3 and Barranco León (Granada) (Oms *et al.*, 2000). Casablanca 3 also indicates warm and wetter conditions as compared with the present time. Therefore, the interval between 1.3 and 1.0 myr ago was a warm and humid period. According to this, TE inf. would correspond to a period prevailing wetter and warmer conditions than present, before the cooling recorded at the Jaramillo sub chron, as evidenced in Untermassfeld, and Le Vallonnet, both date to around 1.0 myr, and corresponding to OIS 30 (de Lumley *et al.*, 1988).

A distinct situation is found in TE18 and TE19. Both units seem to indicate cold conditions. TE18 presents stratified slope deposits (scree) which may be associated with glacial conditions. On the other side, TE19 unit displays conditions of elevated carbonate precipitation. Besides, the appearance at these levels of *Pinus silvestris/nigra* is also an indicator of colder conditions. Also, the relative frequency of *Equidae* vs *Cervidae* is also a potential indicator for environmental conditions. Among the large mammals the more represented species at the lower units is *Dama dama vallonnetensis*. Conversely, the genus *Equus* is poorly represented. By contrast, the upper phase present a high representation of *Equus caballus*. A preponderance of horses may indicate more open landscapes, and hence dry/cold climate conditions. An example of this situation was also detected in Atapuerca-Galería site, in the transition from GII to GIII units (Rosas *et al.*, 1999).

Discussion and Conclusions

Chronology

A program of chronometric analyses is still pending on the Sima del Elefante site. Unfortunately, essays on U-series already have failed to provide valid datings (Bishoff, pers. comun.). Chronological information available comes from sampling in paleomagnetism and biostratigraphy, as well as from correlation with fluvial terraces from the surrounding fluvial systems (Zazo *et al.*, 1983; Benito and Pérez-González, 2002; Benito, 2004).

From a chronological viewpoint, the small rodents association is characteristic from the later part of the Early Pleistocene, and an age close to that of the French site Les Vallerots (~1.1. myr) was proposed by Laplana & Cuenca-Bescós (2000; in Rosas *et al.*, 2001). However, López-Martínez (pers. comun.) found a larger similarity of the lagomorphs with the Italian site of Monte Peglia (Maul *et al.*, 1998), dated to 1.3-1.1 myr. New data on small mammals biostratigraphy can be seen in (Cuenca-Bescós and García, in press).

Large mammals, on the other side, provide the following information. The remains of the ungulates from the lower part of the TE section tend to be scarce and fragmented, which limits their value for biostratigraphy. Some bovine remains are larger than their homologues in *Leptobos*, but are in the ranges for *Bison*. *Leptobos* was the only west European Bovine at the beginning of the Pleistocene, but was replaced by two lineages of *Bison* at the end of the Early Pleistocene: the *Bison deguiulii* - *B. s. lagenocornis* - *B. s. schoetensacki* lineage (first in Pirro Nord, about 1.2 Ma) and the *B. menneri* - *B. voigtstedtensis* group or lineage (first in Untermassfeld, about 1.07-0.99 Ma) (Masini, 1989; Sher, 1997; Van der Made, 1999a, 2001). The material from the lower part of TE seems to belong to *Bison*, and though it is too poor to be assigned to species, seems to suggest an age younger than 1.2 Ma.

Some remains belong to *Dama*. *Dama*-like deer arrived in western Europe during the latest Pliocene. Recent studies suggest that those deer should be placed in a single genus (Pfeiffer, 1999) and can be seen as a single lineage with gradual changes in morphology and size (Van der Made, 1998, 1999b, 2001, 2003). From about 1.4 Ma the size increased till about 0.4 Ma ago, after which size decreased. A P₂ from TE14 is interesting in that

it is larger than those of *Dama nestii vallonnetensis* from Untermassfeld and Vallonnet, while another specimen from TE10 is in the upper ranges of those samples. These samples are very large and date from the Jaramillo. This would suggest that TE10-14 is younger than the Jaramillo event. The other ungulates are even less indicative.

The carnivores are represented by much better material and offer a more accurate information. Interesting is a large mustelid, which seems to represent the genus *Pannonictis*. The latest presence of *Pannonictis nestii* correspond to the Italian site of Pietrafitta from the Late Villafrankian (Rook, 1995), with an age around 1.3-1.4 myr (Ambrosetti *et al.*, 1989). Likewise, cf. *Baranogale antiqua*, *Mustela* cf. *palermineae/praeivalis*, *Vulpes* cf. *alopeoides* and cf. *Lynx issodorensis* are typical from the Middle-Late Villafrankian (MNQ16 a,b, 17, 18). Therefore, in a preliminary study of the carnivorous association from the TE inferior levels (TE9-TE14), a minimum age of 1.3-1.4 myr can be proposed.

In sort, the large mammals suggests an Early Pleistocene age for TE9-14. Palaeomagnetism with its normal polarity indicates that the lower part of the TE sequence is Matuyama, and within that chron either above or below the Jaramillo. However, the herbivorous fauna is not conclusive in whether these units are just below, or above the Jaramillo, but suggests that, in any case, they are close to the Jaramillo. In a sharp contrast, carnivorous seem solidly indicate an older age for TE inf., well into the Early Pleistocene.

Upper units of the TE site are much younger, and, as far as local correlation and large mammal assemblage indicate, date to late Middle Pleistocene. In addition, there is a speleogenesis phase formation at TE17, which may be tentatively correlated with those found at TD8 unit (Gran Dolina site), and GIA unit (Galería site). In both cases, dating of this layers gives an age of ~0.4 myr, corresponding to a warm stage. Such a correlation would establish a post-Cromer date for the TE upper levels, with a tentative assignation to the Saalian period (9/8/7 OSI curves). In addition, TE18 and TE19 units record cold conditions, what fits the proposed hypothesis.

From the large mammals information the following can be said. Many of the specimens of TE19 that were studied are not very indicative (carpals, sesamoids etc.), and are often broken or not yet prepared. This limits the reliability of the

results. The more indicative taxa are briefly discussed here. Correlations to the oxygen isotope stages (OIS) as by van der Made (2001) and van der Made *et al.* (in press).

There is a small *Cervus elaphus*. *Cervus elaphus* is present in western Europe since some 0.9-0.8 Ma or the end of the Early Pleistocene and various chronosubspecies can be recognised on the basis of morphology and size (Van der Made, 2001; Van der Made *et al.*, in press). Small subspecies are *Cervus elaphus priscus* (first in Mauer, OIS13, 500 ka and last in Grotte des Cèdres, OIS 8, 250 ka) and the form of OIS 3-4 and the recent red deer *Cervus elaphus elaphus* (OIS1). The small sized material from TE19 seems to belong to one of these taxa, and to one of these periods.

There is some material of *Dama* that is large compared to recent *Dama dama dama* from Spain, well within the ranges for *Dama dama geisalana* from Neumark Nord, and in the lower range of *Dama* from Atapuerca TG (van der Made, 1999c). The *Dama*-like deer were common in Europe from the latest Pliocene onwards. Recent studies assign them all to a single genus *Dama* (Pfeiffer, 1999) and the west European samples can be arranged according to age and morphology from old with simple antlers to recent with more complex palmate antlers, showing size increase during most of the Pleistocene till some 400 ka (Bilzingsleben and Petralona), after which size decreased (Van der Made, 1999a, 2001). The remains from TE19 would fit any subspecies of *Dama* that lived in western Europe between some 300 ka and the Late Pleistocene.

Some large cervid remains might either belong to a not very large form of *Megaloceros giganteus* or to *Megaloceros solilhacus*. The smaller and earlier *M. g. antedecens* is known from about OIS9-7, its direct ancestor is still older and *M. solilhacus* still occurs in OIS 10-11 (Van der Made, 2001, in press).

The remains attributable to *Stephanorhinus hemitoechus* are not particularly large, nor robust. *Stephanorhinus hemitoechus* appeared in western Europe in OIS12, initially it had slender limb bones (as in Bilzingsleben, OIS 11), but later (as in Neumark Nord, OIS7) it had more robust metapodials (van der Made, 1999b).

At the first sight, the large mammals suggest a correlation of TE19 to OIS 8-9. This suggests that TE19 is younger than TG10-11 and TD10-11. But it should be stressed that this is based on the study of too few specimens to be very reliable.

Human presence

The Sima del Elefante is providing essential information on human presence at the Sierra de Atapuerca. TE inf. units are providing information of early colonization of Europe, and a warm period seems to have been the background for those early occupations. Besides, TE site upper levels match the time when classic Neandertals were living. At present, no human remains have been found at the Sima del Elefante.

Human remains recovered at European late Early Pleistocene sites are currently ascribed to *Homo antecessor* (Bermúdez de Castro *et al.*, 1997), represented by Atapuerca-TD6 sample, dated to 0.8 myr (Carbonell *et al.*, 1995), and Ceprano (Italy) calotte, dated to 0.9 myr (Manzi *et al.*, 2001). These two samples, in principle, illustrate the anatomy of the first incomers. As long as the available evidence can be considered, the first human species arriving to the west end of the Palaeolithic realm was *Homo antecessor*. According to the proposed scenario, *H. antecessor* were the inhabitants of Europe during the Early Pleistocene, and time of speciation of this species was predicted to have happened in Africa at ~1 myr B.P. But, if hominids came to Europe at 1.3 myr ago, who were they? Were they *H. antecessor*? To hold the model the speciation time should be sent back at least 0.3 million years. There is another possibility, however. A different wave of incomers of a different species (*H. erectus*?) inhabited Europe before *H. antecessor* came into place. Future findings from this period, being TE site a potential candidate, will or will not support this statement.

European hominids after ~0.5 myr are generally named *Homo heidelbergensis*; a species which evolved into the classic Neandertals (see Rosas, 2001). As mentioned, TE site upper levels match the time when classic Neandertals were living. In principle, eventual findings of human remains will correspond to *H. neanderthalensis*; a species still not found in any of the Atapuerca sites. The potential finding of human remains at these levels will enrich the sequence of human evolution in a single region, and eventually will greatly help to solve some of the biological questions set down on the evolutionary processes acting on the European hominid lineages. As an example, the pattern of features evolution (e.g. mosaic or integrated) could be eventually approached (Rosas, 2001). With luck, we might ask and answer these and other questions in a near future.

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