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## The Pleistocene site of Gran Dolina, Sierra de Atapuerca, Spain: a history of the archaeological investigations

Gran Dolina is part of an archaeological and paleontological complex located in the Sierra de Atapuerca karstic system (Burgos, Spain). The Trincheras del Ferrocarril sites were discovered as a consequence of the construction of a railway for the transport of minerals at the end of the nineteenth century. The systematic excavation of the upper Gran Dolina levels was initiated in 1981. In 1993, a 6 m<sup>2</sup> biostratigraphic survey pit was started, reaching level TD6 in 1994. This level was excavated during four consecutive years, yielding human fossils, identified as *Homo antecessor*, in association with lithic and faunal remains, dating to more than 0.78 m.y.a.

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### Location

The Sierra de Atapuerca is 14 km east of Burgos (Northern Spain) (Figure 1). This small mountain range has an area of 25 km<sup>2</sup> and a maximum altitude of 1082 m. The strategic location of the Sierra de Atapuerca may account for its regular occupation from

the early Pleistocene up to the present, as it is positioned between the basins of the river Duero to the southwest and the river Ebro to the northeast. To the northwest is the Cordillera Cantábrica (with peaks that reach 2600 m), and to the southeast there is the Sierra de la Demanda (the maximum altitude of which is 2262 m). Thus, the Sierra

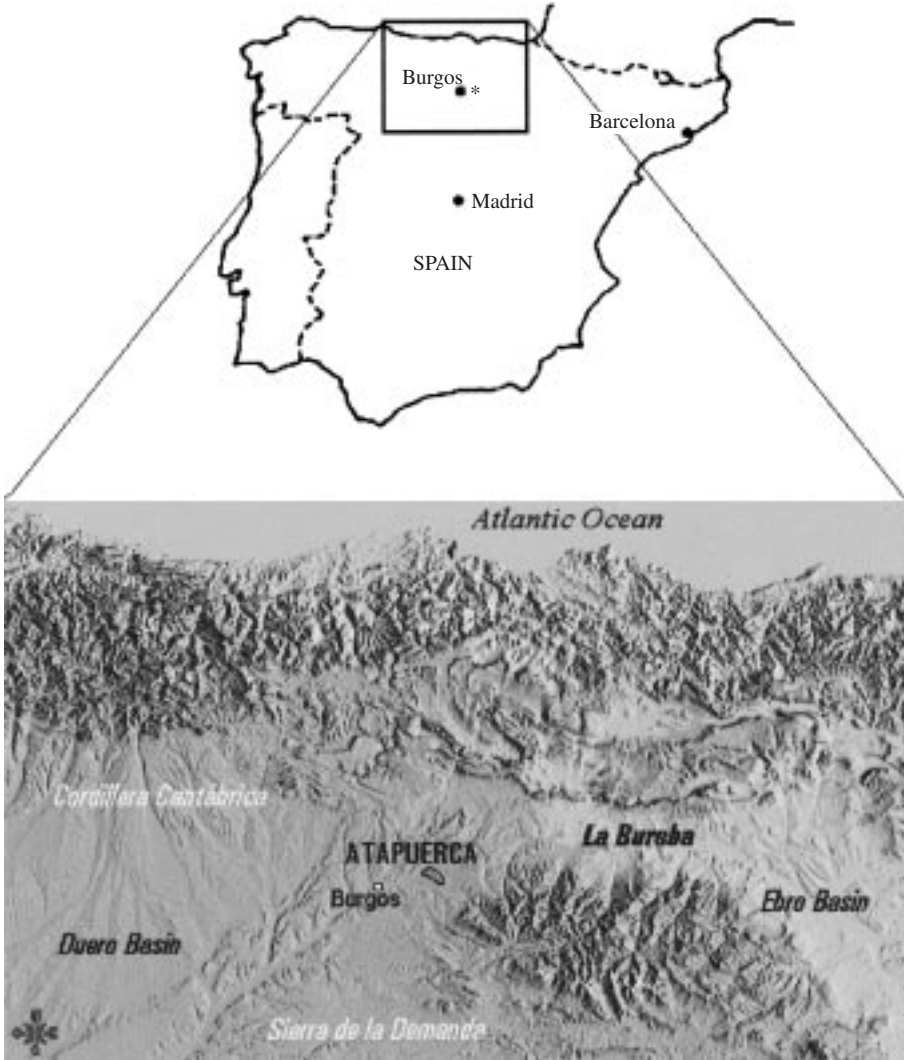


Figure 1. Map showing the location of the Sierra de Atapuerca (Extracted from Carta Digital de España. Servicio Cartográfico del Ejército).

de Atapuerca connects two large river basins through the so-called Corredor de la Bureba.

The proximity of the Sierra de la Demanda had great influence on the settlement of Atapuerca because it forms an ecosystem with considerable biodiversity. The Sierra de Atapuerca may have acted as a biological lure, attracting groups of settlers from the Sierra de la Demanda during crises. However, it is an attractive locus for

biotic communities. In this sense, the Sierra works as an ecotone, with water resources (the rivers Arlanzón, Pico and Vena) and with good prairie and low mountain vegetation (García Antón, 1995).

**Sites in the Sierra de Atapuerca**

Many archaeological and paleontological sites are located in the karst of the Sierra de

**Table 1** Archaeological and paleontological sites in the Sierra de Atapuerca

Site	Complex	Chronology	Type of investigation	Archaeological remains
Gran Dolina (TD)	Trinchera del Ferrocarril	LP, MP	Excavation and survey	A, B, C
Galería complex (TG-TZ-TN)	Trinchera del Ferrocarril	MP	Excavation	A, B, C
Penal (TP)	Trinchera del Ferrocarril	MP	Survey	A, B
Sima del Elefante (TE)	Trinchera del Ferrocarril	LP?, MP	Sampling	A, B
Sima de los Huesos (SH)	Cueva Mayor	MP	Excavation	B, C
Portalón	Cueva Mayor	UP?, H1, H2, H3, H4	Survey, excavation	A, B, C, D, E
Galería del Sílex	Cueva Mayor	H1, H2	Systematic studies	A, B, C, D, E
Galería Baja	Cueva Mayor	MP, H1, H2	—	A, B, D, F
Galería del Silo	Cueva Mayor	H1, H2	—	A, B, D, E
Galería de las Estatuas	Cueva Mayor	H1, H2	—	A, B, D
Cueva del Silo	Cueva del Silo	H1, H2	—	A, B, D, E
Cueva Peluda	Cueva Peluda	MP, H1/H2?	—	A, B, C, D
Cueva Ciega	Cueva Ciega	H1/H2?	—	C, D
Cueva del Mirador	Cueva del Mirador	UP?, H1	—	A, B, D

Chronology: LP=Lower Pleistocene, MP= Middle Pleistocene, UP=Upper Pleistocene, H1= Neolithic and Calcolithic, H2=Bronze age, H3=Iron age, H4= Roman epoch.

Archaeological remains: A=lithic industry, B= faunal remains, C=human fossils, D=ceramic, E=rock art.

Atapuerca (Table 1). Most of the sites are closely grouped in two sectors: the old Trinchera del Ferrocarril and the Cueva Mayor. Gran Dolina is the most important site in the first zone (Figure 2), whereas the Sima de los Huesos is the most outstanding one in the second zone.

The Trinchera forms a 500 m arch. Its maximum depth is 20 m. Several archaeological sites have been located besides Gran Dolina: Galería, Cueva de los Zarpazos, Penal and Sima del Elefante (Figure 3). Gran Dolina (3°31'08 W, 42°21'09 N; UTM coordinates: X=457279, Y=4689172) is located in the northern sector of the Trinchera del Ferrocarril.

In the Cueva Mayor, the Sima de los Huesos paleontological site is particularly noteworthy, but there is also a Neolithic site in the entrance of the Cueva (El Portalón), as well as Bronze Age funeral chambers in the Galería del Sílex.

On the southern slope of the Sierra there is another archaeological site, which has not been excavated yet; the Cueva del

Mirador. Here prehistoric remains have been discovered and Paleolithic remains might be preserved.

### **Trinchera del Ferrocarril. Its discovery and the first archaeological and paleontological investigations**

The first published account of the existence of archaeological occurrences in the Sierra de Atapuerca cave sites goes back to 1863. On 20 May, the local newspaper *El Eco Burgalés* reported the discovery of human remains found in the Cueva Ciega (on the southern slope of the Sierra, near Cueva del Mirador). Later, in 1868, these finds were included in a monograph entitled “Descripción con planos de la Cueva llamada de Atapuerca” published by two engineers, P. Sampayo and M. Zuaznavar. It is likely that these are the finds referred to by Lagasca in 1875 as paleontological remains and Cuveiro (in 1891) as human remains associated with ceramics.

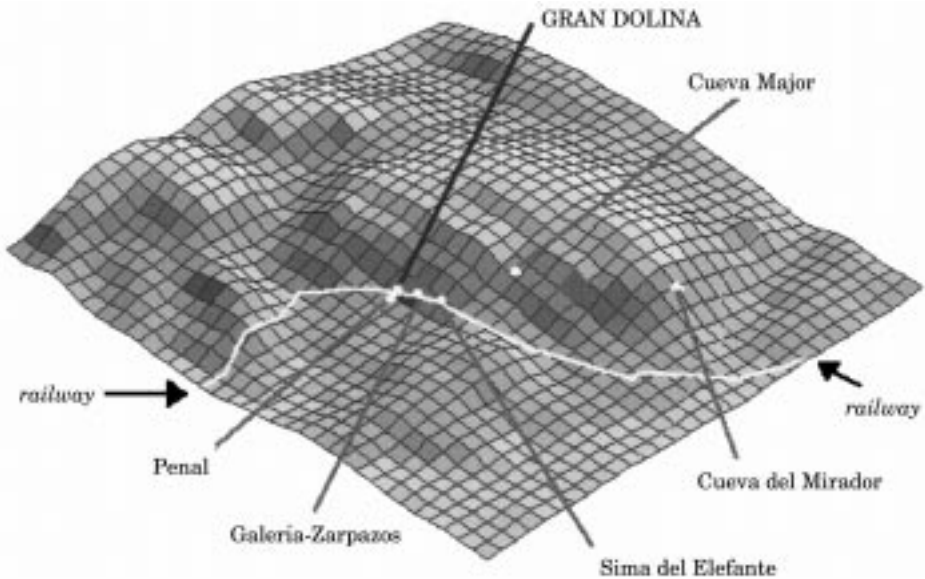


Figure 2. Tridimensional projection of the Sierra de Atapuerca showing the location of the most significant sites.

At the end of the last century a British mining company created “The Sierra Company Limited”, which was to lay a narrow-gauge railway between Monterrubio de la Demanda and Villafraía. The railway was to cross the southwest area of Sierra de Atapuerca, for which it was necessary to excavate a trench in Cretaceous limestone (Figure 4). The railway worked for a short time but was soon abandoned.

The Trinchera del Ferrocarril (TF) had in its walls some karst fissures, filled with sediments. Many years later it was proved that these sediments contained important archaeological and paleontological materials. However, before recognizing the archaeological importance of the TF, the Cueva Mayor had become a site of interest. Carballo (1910) makes reference to the existence of a Bronze Age site in the Cueva Mayor entrance. Soon after, probably in 1912, Obermaier and Breuil visited the cave and analyzed the cave paintings of Cueva Mayor and Cueva del Silo (Breuil, 1933; Breuil & Obermaier, 1913; Obermaier,

1925). At about that time, Martínez Santaolalla (1926) made reference to the Cueva Mayor in his study of the Neolithic in the Burgos area.

Although the construction of the Trinchera del Ferrocarril allowed the discovery of a series of caves, their existence was not revealed until 1962. In that year, Uribarri, a member of the Edelweiss Speleological Group (which had been discovering fossils since 1954), notified the Museum of Burgos of the presence of fossil bones in the locality presently known as Galería. Encouraged by this discovery, on 15 April 1963 B. Osaba, Director of the Museum of Burgos, visited the Trinchera, accompanied by members of the Edelweiss Group and the Association “Amigos de Burgos”. During this visit Acheulean artefacts were also found.

The first publications referring to archaeological findings in the Trinchera appeared in the 1960s (Jordá, 1965; Palol, 1969a,b). In 1964 a prospecting campaign was carried out. It demonstrated the

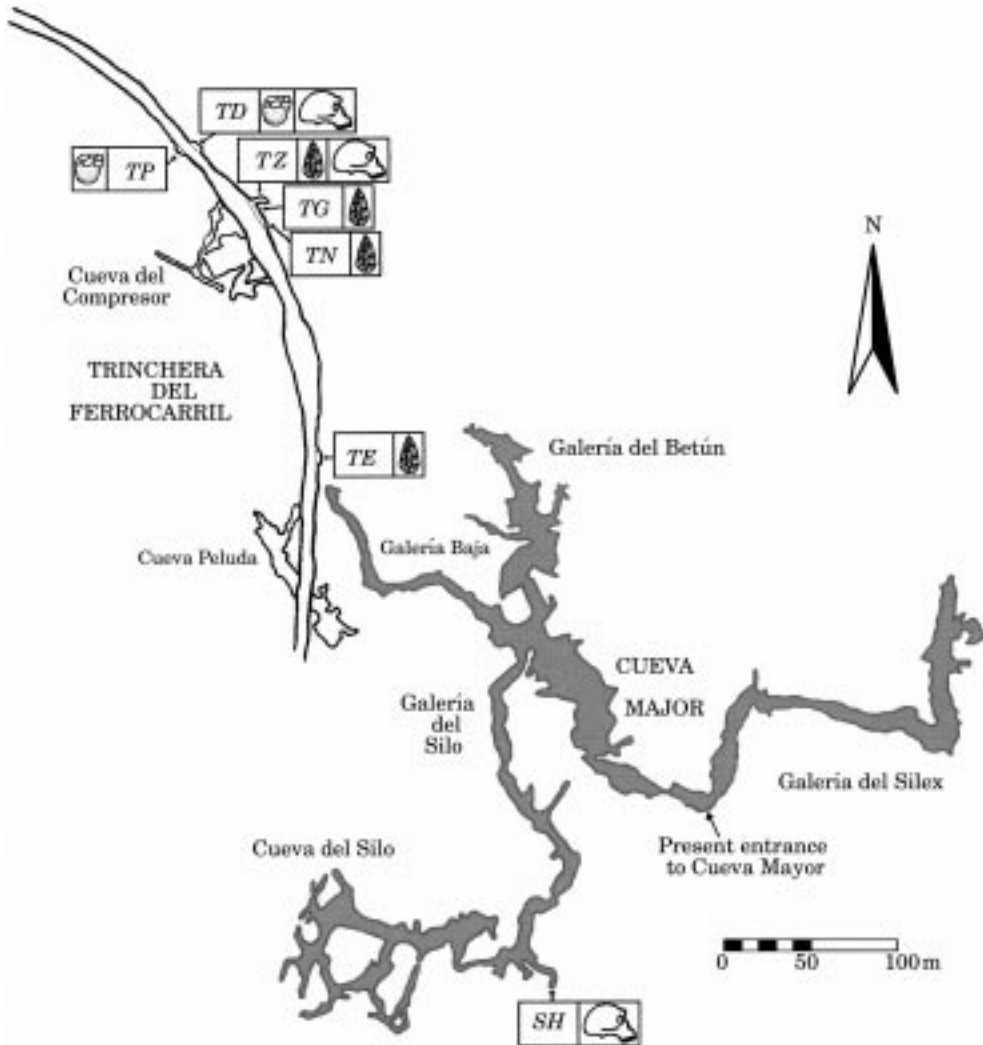


Figure 3. Plan of Trinchera del Ferrocarril and Cueva Mayor. TD=Gran Dolina, TP=Penal, TZ=Cueva de los Zarpazos, TG=Galería, TN=Trinchera Norte, TE=Sima del Elefante, SH=Sima de los Huesos (based on [Martín Merino et al. 1981](#)).

importance of these karstic infillings for the recovery of faunal remains and their associated industries. In 1966 an excavation campaign was carried out which led to the discovery of a lot of fauna, but scarcely any lithic material ([Palol, 1969b](#)).

On the other hand, Narciso Sánchez, led by the paleontologist Miquel Crusafont, director of the Paleontology Institute of

Sabadell, recovered many fossils in the sites of the Trinchera, especially in the Galería-Cueva de los Zarpazos. In 1972, a team of American archaeologists prospected in the Trinchera del Ferrocarril and drilled into the Cueva Mayor entrance. The work, directed by Geoffrey A. Clark and Lawrence G. Strauss, showed the existence of abundant fauna in two infillings in the Trinchera

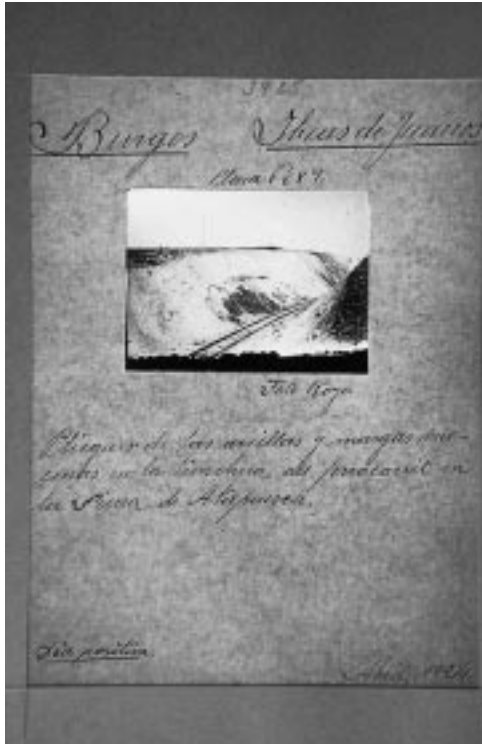


Figure 4. Image of the old mining railway passing through the Sierra de Atapuerca.



Figure 5. General view of Gran Dolina (in the background) and Galería, both found in the Trinchera del Ferrocarril.

del Ferrocarril (Clark *et al.*, 1979). Clark & Strauss also mentioned the presence of engravings in the Cueva del Silo entrance, which might be Calcolithic according to Breuil (Breuil, 1952). The materials recovered when drilling in July 1972 were studied by Apellániz (1979), who excavated in the same place in 1973. Apellániz found Calcolithic, Bronze Age and late Roman (fourth and fifth centuries AD) occupation sites in the Portalón de Cueva Mayor (Apellániz & Domingo, 1987). The American researchers also identified an open-air site located close to the Cueva Mayor entrance, probably linked to this cave, and another surface site with few materials. This last one is about 200 m north of the N120 road, on the east side of the path leading to the Trinchera del Ferrocarril, “at the top of the Arlanzón

river’s second terrace” (Clark *et al.*, 1979).

In 1972 the Edelweiss Speleological Team discovered a new gallery in the karstic system of the Cueva Mayor, known since then as the Galería del Sílex (Martín Merino *et al.*, 1981). This is an interesting site with Neolithic, Calcolithic and Bronze Age materials (Apellániz & Uribarri, 1976; Uribarri & Apellániz, 1975).

Trinidad Torres excavated in the Trinchera del Ferrocarril in 1976 with the aim of finding cave bear (*Ursus*) remains for his doctoral thesis. Given the scarcity of remains discovered in the infillings that Torres named Gran Dolina (where he excavated in the western side of levels TD4 and TD5) (Figure 5) and Galería, new excavations were begun in the Cueva Mayor.

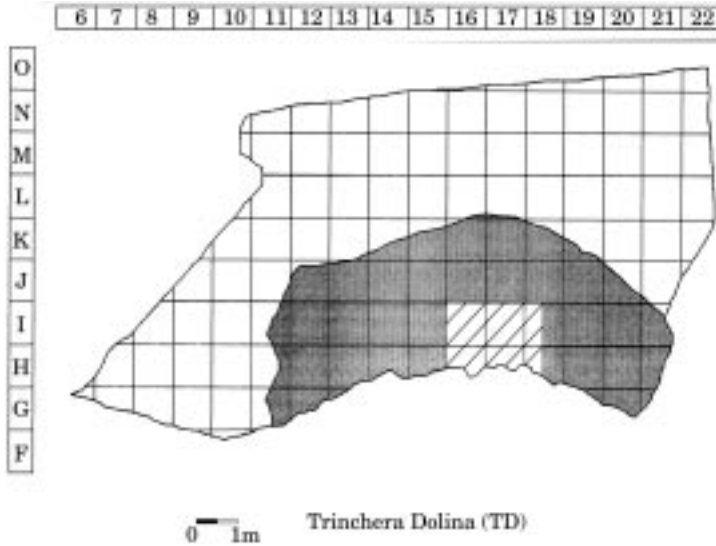


Figure 6. Schematic plan of Gran Dolina comprising the excavated zones: squares excavated between 1996 and 1997 in white, and squares excavated between 1981 and 1989, shaded. The diagonal lines indicate the location of the biostratigraphic survey pit, which was excavated between 1993 and 1997.

Torres decided to excavate in the Sima de los Huesos in which a great abundance of bones had been reported. During the excavation in the Sima de los Huesos he discovered a large amount of *Ursus* remains and human fossils, including a complete mandible. These fossils were studied by Aguirre and Lumley (Aguirre, 1977; Aguirre *et al.*, 1976; Aguirre & Lumley, 1977), who classified them as Pre-Neanderthal, chronologically Middle Pleistocene.

Due to the unquestionable interest that Sierra de Atapuerca sites merited, Aguirre requested a research project to undertake its systematic study. This project started in 1978, and Aguirre led the excavations himself (Aguirre, 1995).

#### Archaeological investigations in Gran Dolina between 1978 and 1997

There have been 19 excavation campaigns in the sites of the Sierra de Atapuerca between 1978 and 1997 (Figure 6). Until 1990 the director was Emiliano Aguirre, whereas from 1991 the directors of the

research project and of the excavations have been Juan Luis Arsuaga, José María Bermúdez de Castro and Eudald Carbonell.

The excavation of Gran Dolina, as well as the other infillings of the Trincheras del Ferrocarril, presents some major logistical problems. In the first place, access to the archaeological levels required the adaptation of a path and assembly of scaffolding. In the second place, the lack of electricity made it necessary to use generators, and the absence of water meant moving sediments for washing to the Alarzón river, 2 km away. Even more serious have been the problems associated with the poor condition of the findings. Some flint objects are damaged, to the point of making their recovery impossible (Carbonell *et al.*, this volume).

#### *Phase one: setting up the project and 1978–1989 field work*

In 1978, the sites were prepared for excavation; the vegetation at the uppermost part of Gran Dolina was cleared and paleontological and sedimentological samples were collected. In 1981, the unproductive levels

of the uppermost part of Trinchera Dolina were removed, and then excavation by layers started. In 1982, the uppermost part of Dolina was excavated, palynological samples were collected, and a provisional stratigraphy was developed (Gil *et al.*, 1987). In 1983, the excavation area was enlarged and during the 1984 campaign the excavation at the top level continued (TD11).

In 1985, preliminary paleomagnetic data were obtained (Carracedo *et al.*, 1987), and palynological analyses and stratigraphic sections were carried out, while still excavating a 20 m<sup>2</sup> area in the TD11 level.

In 1986, uncontrolled blasting carried out by the army (which was using the zone as a training ground) made it necessary to collect archaeological and paleontological material given up by the stratigraphic cutting of Dolina. Material was recovered directly from the cutting itself in view of the danger of a cave-in. During this campaign, the vegetation in the area opposite Dolina (on the other side of the Trinchera del Ferrocarril) was cleared, yielding some stone tools. This area was referred to as the Trinchera Penal (TP).

In 1987, the scaffolding was assembled and the transition area between TD11 and TD10 was excavated. In 1988, microfauna and many stone tools were found. In the same year, all the excavations had reached level TD10. Throughout 1989, the top of level TD10 was also excavated, yielding many stone tools.

#### *Phase two: 1990–1992 field work*

In 1990, no field work was carried out in the uppermost part of TD, only at its base (level TDW4, 25 m<sup>2</sup> excavated), which yielded important remains of macrofauna and few, though nonetheless significant, remains of lithic industry. They are the most ancient evidence of human presence in the Sierra de Atapuerca (Carbonell & Rodríguez, 1994). In the Trinchera Penal, samples of the section were collected and at the upper-

most part, the level covered by the tangled vegetation was surveyed.

In 1991 the operation at the base of TD (TDW4) was completed, yielding new finds of macrofauna, but not of stone tools. New stratigraphic studies of this site were also carried out.

An operation was carried out in the Trinchera Penal in 1992, with two test trenches being made in order to evaluate the site's archaeological potential. As the fauna and stone tool remains were scarce, it was decided not to continue the operation. TD was not excavated, but samples of microfauna were taken from the stratigraphic section and the excavation areas were expanded, clearing the entrance to the upper part of the infilling.

#### *Third phase: excavations carried out since 1993*

Although in each phase of the excavation we found ourselves working on a research programme on the development of Iberian settlement in the Pleistocene, in 1993 it was decided to initiate a new strategy for the excavation of Gran Dolina. Three factors motivated the change: we were sure that archaeological materials could be discovered in the upper part of the infilling on the TD10 and 11 levels; good results had been obtained from the excavation at the base of Dolina (TD4) and it had been confirmed that abundant material could be recovered in TD5 and TD6.

A biostratigraphic test pit was begun in view of the need to obtain systematic knowledge of the records of the whole series and to determine the excavation method to be applied when extensive operations were to be started (Figure 7).

The excavation of Gran Dolina at the beginning of the 1990s was fundamental to the development of our research programme, since it yielded the findings with the greatest potential of all those known in the Trinchera del Ferrocarril complex.





Figure 7. Excavation of the Gran Dolina biostratigraphic test pit at level TD6, in the 1994 field season.

In order to proceed with the fieldwork, we discussed several key points. First, we had to determine in which part of the section the test pit should be constructed; second, we needed to decide which area should be excavated in order to obtain significant data; and third, a specialized interdisciplinary team for the sounding test had to be organized.

The 6 m<sup>2</sup> test pit had to cover Gran Dolina's 18 m of stratigraphic potential. The excavation of the test pit would provide a diachronic sample of the deposit, which could guide us in the future extensive excavation of the site. In this first year, the sounding test was in TD10 (which contained abundant lithic artefacts and fauna) and TD9 (which was barren).

In May 1994 an article on the British site of Boxgrove was published in *Nature*

(Roberts *et al.*, 1994). The authors suggested that the human remains found in Boxgrove might correspond to the first inhabitants of Europe. The suggested chronology did not go beyond 500,000 years. In his comments on the Boxgrove findings, Gamble (1994) proposed that no humans existed in Europe prior to that time. Three main arguments were put forward. First, the absence of human remains prior to 500 ka. Second, the anthropic origin of stone tools dated at more than 500 ka was doubtful. Third, the artefacts thought to belong to the oldest chronological periods came from sites which lacked stratigraphic context. In fact, this hypothesis had already been put forward (Roebroeks *et al.*, 1992) and reasserted in various publications (Roebroeks, 1994; Roebroeks & Tuffreau, 1995; Roebroeks & van Kolfschoten, 1994). This paradigm was incompatible with our thinking about the period of the first European settlement. Indeed, the hypothesis of a recent European settlement became so increasingly preponderant that we decided to vary our strategy for the Gran Dolina test pit. Going beyond mere reference sampling for the future excavation of the site, we widened the aims of the test pit in order to turn it into a tool that would allow us to develop a new paradigm. Thus, the basic goal of the test pit became to reach the oldest levels of Gran Dolina in order to obtain material that would back up our arguments in favour of an earlier settlement of Europe (around 1 m.y.a.). A meeting took place in June 1994 at which it was decided to speed up the test pit in order to reach these oldest levels. At that moment we knew that there should be lithic industry and fauna in TD6 because some pieces had been recovered from the stratigraphic section before falling. Although we did not know the chronology of TD6 with any degree of accuracy, we thought it could be about 500 ka or slightly older. In fact, the decision to carry out systematic paleomagnetic datings of the site had already been made some months

before: it was during the 1994 campaign that Josep María Parés began to take samples for dating.

The 1994 fieldwork on Gran Dolina was thus started with a fresh outlook. Excavations began at TD8 (with fauna, but without lithic industry) and TD7 (with abundant fauna and one object of lithic industry). The TD6 level, where abundant fauna, lithic industry and human remains were found, was reached at the beginning of July (Carbonell *et al.*, 1995). The microfauna indicate a minimum age of 500 ka (due to the presence of *Mimomys savini*), but the results of the paleomagnetic analyses, which had been undertaken at the beginning of the campaign, gave an age older than 780 ka (Parés & Pérez-González, 1995). The site was covered and thus protected from natural deterioration.

In 1995 the biostratigraphic column of Gran Dolina continued to yield material, including human remains. Meanwhile, the upper part of Gran Dolina was prepared for extensive future excavation. In 1996 the excavation of the test column was still concentrated on level 6, although it had gone beyond the layer with human remains. Simultaneously, extensive excavation of the upper part of Dolina was begun, initiating operations at level TD11. In 1997 the biostratigraphic test column reached level 5, while extensive excavation continued at level 11.

The study of human fossils from TD6 culminated in the naming of a new species *Homo antecessor* (Bermúdez de Castro *et al.*, 1997).

### Conclusions and future perspectives

The discoveries made in 1994 and in subsequent years have allowed us to refute the hypothesis that humans reached Europe less than 500 ka ago (Dennell & Roebroeks, 1996). We have been able to counter all the arguments put forward by the proponents of

a so-called “young Europe”. Human fossils and lithic industry have been found in association with fauna (including *Mimomys savini*) at a level dated at more than 780 ka. All these remains were found in stratigraphic context, with the refittings of lithic industry, fauna and human remains indicating hardly any signs of the findings having been displaced. We have thus been able to reinforce the hypothesis that the first human settlement of Europe occurred at least 780 ka ago (Carbonell *et al.*, 1996). Other recent finds (in Fuente Nueva 3, Dmanisi and Monte Poggiolo) further support this theory. The scientific confrontation of two research projects (Boxgrove and Atapuerca) has thus resulted in a change of paradigm with respect to the first settlement of Europe, constituting what is perhaps an example of the Kuhnian view of the philosophy of science (Kuhn, 1962).

The Atapuerca investigations are part of an expanding scientific research programme organized in such a way as to optimize operations, in the epistemological sense proposed by Lakatos (Lakatos, 1978), and to yield progressively greater knowledge about human evolution in the Pleistocene period in Europe. This has allowed us to formulate future perspectives on the basis of specific operational strategies. Thus, in 1995 work was begun on extensive excavation of an area of some 80 m<sup>2</sup>, reaching level TD10 in 1998. At the current rate it will take about nine years to reach level TD6 again. We should then be able to considerably increase our knowledge of the paleobiology of *H. antecessor*.

It should also be borne in mind that Sierra de Atapuerca is a karstic complex with more than 4 km of caves. Cave entrances such as Portalón de Cueva Mayor, Cueva Ciega and Mirador are as yet of unknown potential. Although the surface sediments are Holocene in age, the structure of the cavities suggests they may have levels dating to the Upper Pleistocene. This hypothesis is supported by results from nondestructive

electromagnetic surveys carried out in 1998, as well as by a mechanical sounding test project. If the hypothesis is correct, the Atapuerca project will have information on human evolution and ecosystems from the second half of the Lower Pleistocene, the Mid Pleistocene and the Upper Pleistocene.

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