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The Atapuerca Sites and the Ibeas Hominids

The Atapuerca railway Trench and Ibeas sites near Burgos, Spain, are cave fillings that include a series of deposits ranging from below the Matuyama/Bruhnes reversal up to the end of Middle Pleistocene. The lowest fossil-bearing bed in the Trench contains an assemblage of large and small Mammals including *Mimomys savini, Pitymys gregaloides, Pliomys episcopalis, Crocuta crocuta, Dama* sp. and Megacerini; the uppermost assemblage includes *Canis lupus, Lynx spelaea, Panthera (Leo) fossilis, Felis sylvestris, Equus caballus steinheimensis, E.c. germanicus, Pitymys subterraneus, Microtus arvalis agrestis, Pliomys lenki,* and also *Panthera toscana, Dicerorhinus hemitoechus, Bison schoetensacki,* which are equally present in the lowest level. The biostratigraphic correlation and dates of the sites are briefly discussed, as are the paleoclimatic interpretation of the Trench sequences. Stone artifacts are found in several layers; the earliest occurrences correspond to the upper beds containing *Mimomys savini.* A set of preserved human occupation floors has been excavated in the top fossil-bearing beds. The stone-tool assemblages of the upper levels are of upper-medial Acheulean to Charentian tradition. The rich bone breccia SH, in the Cueva Mayor-Cueva del Silo, Ibeas de Juarros, is a derived deposit, due to a mud flow that dispersed and carried the skeletons of many carnivores and humans. The taxa represented are: *Ursus deningeri* (largely dominant), *Panthera (Leo) fossilis, Vulpes vulpes, Homo sapiens* var. Several traits of both mandibular and cranial remains are summarized. Preliminary attempts at dating suggest that the Ibeas fossil man is older than the Last Interglacial, or oxygen-isotope stage 5.

Introduction

In the dismantled railway trench of the Sierra de Atapuerca, near Burgos, Spain, there are fissure-fill deposits of three main karstic cavities which outcrop up to 13 m (TN) and 20 m (TD) in depth. Excavations were begun in 1976 at TD [locus IV-A-16 in the catalogue of natural cavities of Burgos province (MARTIN-MERINO *et al.*, 1981)] and TG, an exposed, almost filled gallery with a nearly horizontal roof, opening to a vertical duct, TN, on one side, and to an elliptical cave, TZ, on the other (IV-A-4 in the catalogue). Exploration sampling was started at TF (IV-A-10) and TP (IV-A-17) in 1986.

At TD, 12 m^2 have been excavated down to a depth of 5 m, the uppermost 4 m being sterile. At TG more than 25 m^2 were excavated to a depth of 4 m. A suspended square meter grid was established at each site. Preliminary sampling was performed at the TG-TN, TD and TF sections. Artifacts and fossils exposed by weathering have been recovered every year to prevent loss.

The Sima de los Huesos (SH), also in the Sierra de Atapuerca, and less than 1 Km from the T group of sites (*Figure 1*) is a crevice, nearly 15 m deep. It opens at the end of a side gallery, more than 400 m inside the Cueva Mayor, Ibeas de Juarros. The blind bottom of SH has a horizontal section of approximately 5×3 m^2; the height varies from 0 m to 3 m. Most of this room has been excavated over many decades by amateur speleologists, in search of bear canines. No less than 8 tons of bone bearing breccia were removed, and then left aside in the same place as a mass of bone fragments and mud debris (*Figure 2*).

The estimated 5 tons of discarded material, which have so far been evacuated, washed and sorted, contained nearly 9,000 identifiable fossils of carnivores, and more than 170 human remains. Initial excavation of undisturbed sedimentary material yielded seven pieces of fossil men. Profiles of the present cavity have been surveyed each 50 cm longitudinally and transversely.

ZAZO *et al.* (1983) studied the geological and geomorphological features and processes of the area, and made a geomorphic map.

Hundreds of cubic meters of sediment were washed and sifted in search of microvertebrates, and the main sections on the Trench were sampled for pollen analyses. Samples were also taken for paleomagnetic research at TD, and for isotopic dating at different levels in TG, as well as in SH.

Preliminary observations on geodynamics and stratigraphy

Atapuerca Hill consists of a monadnock of Cretaceous rocks, to the West of and detached from the main ranges of the Iberic System. It may have originated within the Oligocene, as the colluvial deposits of that age found on the slopes indicate. Peneplanation of the summit would have been completed sometime in the early Pliocene. Then the equilibrium thus established was disturbed by the Ibero-Manchega diastrophic phases I and II (AGUIRRE *et al.*, 1975). The last main prograding land-forms were followed by the highest terraces of the Duero river system near the base of the Pleistocene, as the Northern Meseta basin began drained into the Atlantic Ocean.

In the area of Atapuerca and the middle Arlanzón river valley no more than 4 terraces are attributed to the Early Pleistocene. ZAZO *et al.* (1983) assign the lowering of the water table, the exposure of the karst cavities and the beginning of the known depositional sequence in the Atopuerca Trench to the time of dissection of the 3rd terrace of the Arlanzón. The filling of that wide and important karst network ends nearly at the start of the Last Interglacial. Late Pleistocene and Recent activity in the Sierra de

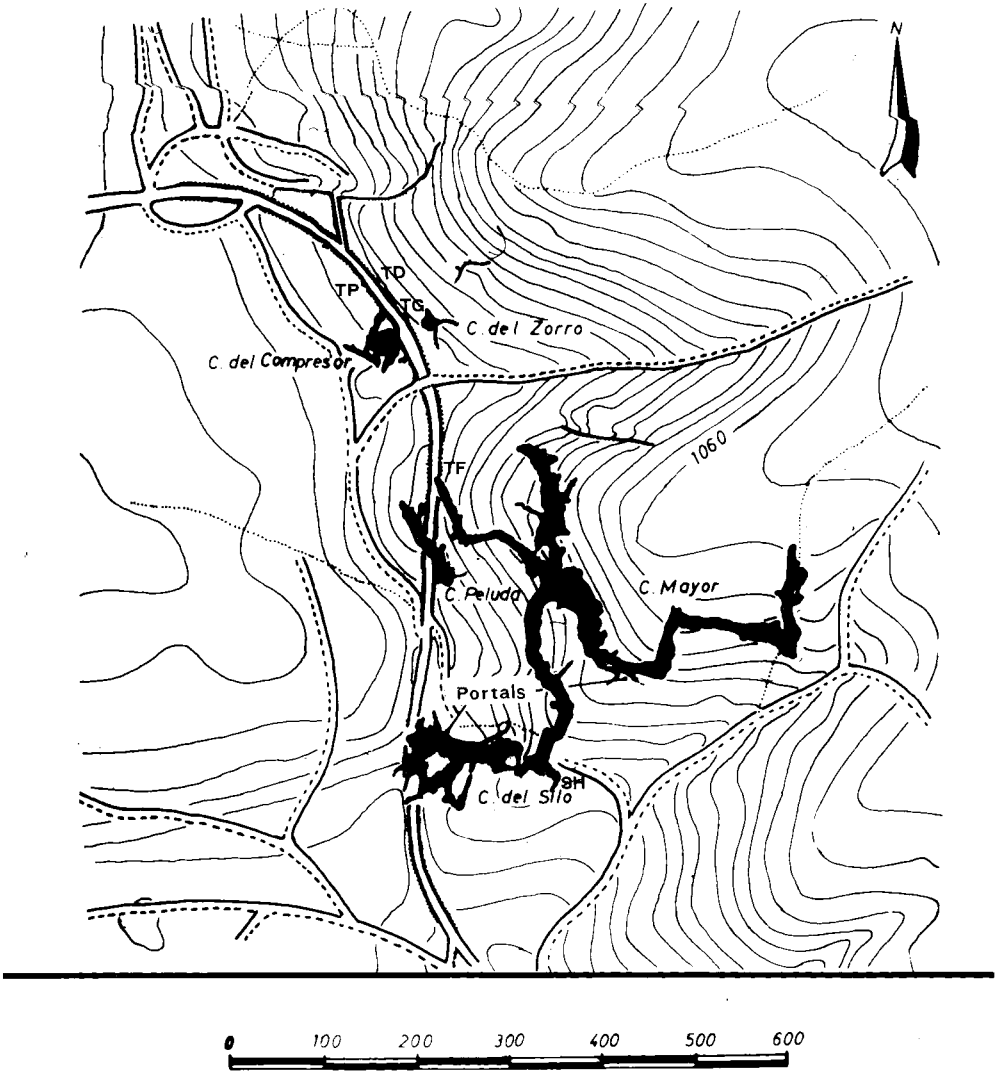

Figure 1. — Map of the present cavities (black) of Sierra de Atapuerca, plotted on a topographic map, in which the sites TD, TP, TG, TF and SH are located. The Trench can be seen running from South to Northwest. Courtesy of the Grupo Espeleológico Edelweiss.

Atapuerca slopes consisted of heavy erosion affecting not only the Sierra and cave roof materials, but the former karst filling as well; a great portion of the former cave roof corresponding to TD-TP sites was eroded away and the infilling exposed. New cavities were opened in the recent karst cycle, and part of the old karst was reworked. The filling deposits of the ancient karst are bracketed, all or almost all, within the limits of the Middle Pleistocene as currently understood; that is including the Cromerian stage at its base , and the climatic amelioration corresponding to Shackleton and Opdyke's episode 5

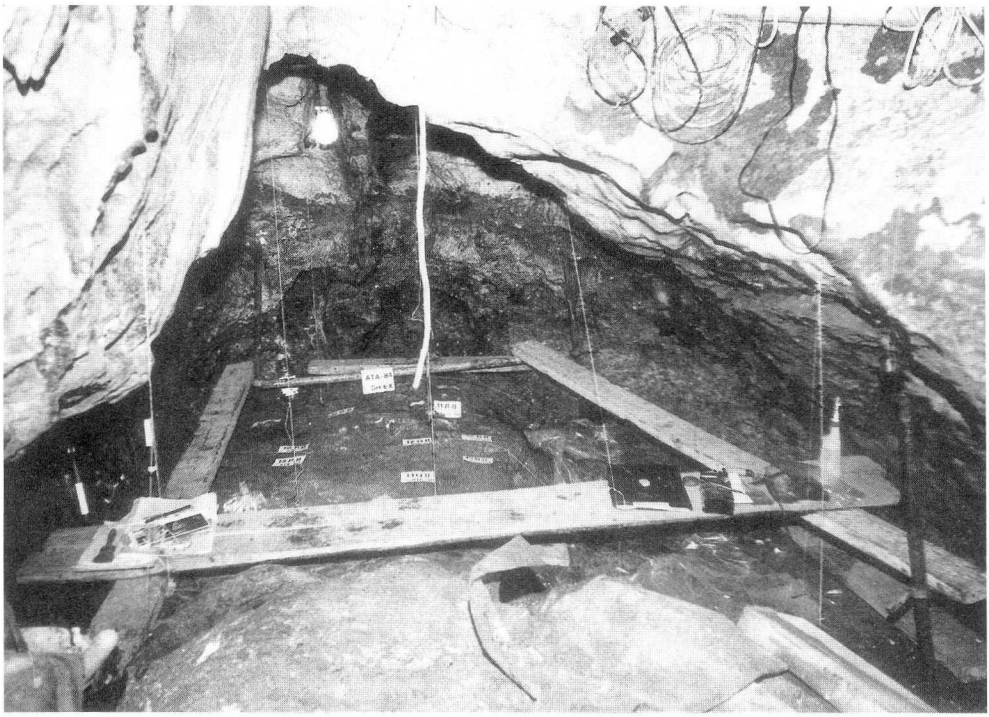

Figure 2. — Deepest end of Sima de los Huesos in Cueva Mayor, Ibeas: part of the excursionists overburden is seen in the foreground; part of exposed deposit SH in the center. Season 1984.

on top. Caliche crusts, developed at the top of these depositional series, constitute the floor of many present residual cavities. At many other places the infilling sediments reach the cavity roof, as can be seen in TD, and partially in TG.

The most comprehensive site from the viewpoint of the stratigraphical record is TD (*Figure 3*). Four main units are distinguished. Unit TD-I is a very complex one; it is 10 m thick, and is further divided into 6 beds, including at least three warm and three cold episodes. Unit TD-II consists of a set of beds corresponding to high energy water transport (Bed 7). It is followed by a sequence of breccias, TD-III, from which the matrix has been washed out and replaced by carbonate crust (Bed 8). Unit TD-IV starts with a thin regular silt bed (Bed 9) laying unconformably on TD-III. A cave breccia (Bed 10) with a red, fine silt to clay matrix, follows. Bed 10 is affected by a deformation at least in part contemporary with its deposition, and is overlaid unconformably by Bed 11, which partially reworks materials from the preceding breccia at its base. Bed 11 ends with a thick caliche; it partially reaches the cave roof. Laterally it was washed out by Late Pleistocene erosion and is disconformably overlain by recent colluvia.

The TG site (*Figure 4*) is the filling of a lateral, subhorizontal conduit. Its section includes a breccia and a crust attached to the cave limestone on the floor; these are followed by Beds TG 3 and 4. These consist of silts, preserving finely laminate stratification. At the top of each, TG 3 and TG 4, discontinuous lime crusts are seen; the crust at

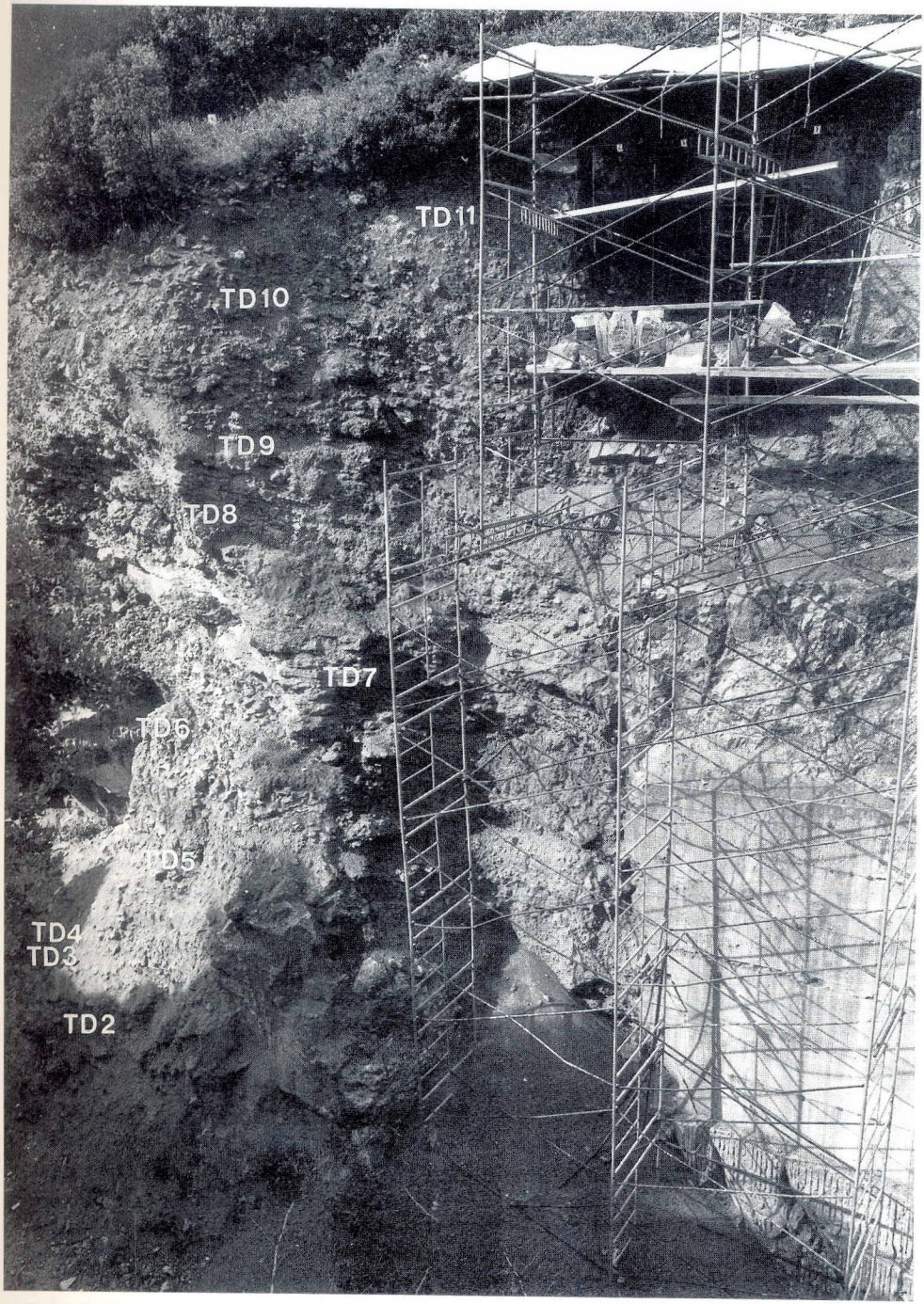

Figure 3. — Section of TD site in the Atapuerca Trench. Excavations 1982.

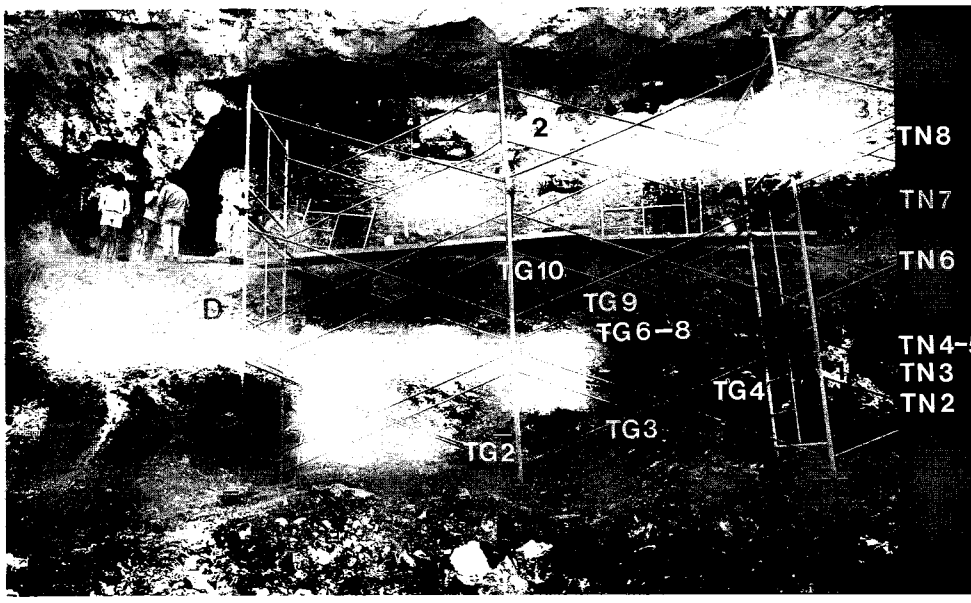

Figure 4. — Section of TG site, with part of TN (right edge). Dated horizons (in black): lower speleothem (1), upper crust (2), and cemented breccia of TN 8 (3). Debris of digging before 1977 (D).

the top of Bed 4 is considerably developed as an extensive stalagmitic-stalactitic construction. TG 5 consists of finely laminated silt ending with a blackish horizon composed almost exclusively of bat faeces, and overlaid by pockets of reddish clay and silt beds in turn, including tracts of a discontinuous crust, TG 6-8; this complex sequence represents a time of cave opening and karst construction. It is followed by the upper TG unit, that is equivalent to TD IV: TG 9 is a fine sandy to silty bed with limestone blocks at its base; TG 10 is a cave breccia with heterometric blocks in a brown silty matrix below and a more red, clayish matrix above; TG 11 laying unconformably on TG 10, consists of a homometric breccia of small, angular limestone pieces cyclically interfingering with pink silts. The sequence ends with caliche horizons and a stalagmitic floor. The TG cut opens on one side to the elliptical cavity TZ, where the equivalent of TG-11 is a layer, up to 2 m thick, of fine, laminated silts. On the other side, TG ends on the vertical duct TN.

Faunal record

The oldest known faunal assemblage in the Atapuerca Trench is that of the lower unit at TD. It includes *Talpa* cf. *europaea,* a large *Hystrix* sp., *Eliomys quercinus, Allocricetus bursae, Pitymys gregaloides, Microtus brecciensis, Pliomys episcopalis, Mimomys savini, Allophaiomys chalinei, Apodemus* sp., *Ursus praearctos, Crocuta crocuta intermedia, Panthera toscana, Dicerorhinus hemiteochus, Bison schoetensacki voigstedtensis, Cervus elaphus, Dama* sp., *Megaceros* sp. cf. *antecedens, Megaceros (Praemegaceros)* sp. Near the top of this Unit TD I, in bed 6, there is an occurrence of *Marmota marmota.*

The intermediate units at TD (bed 7, and Bed 8), and the lower beds of TG are quite poor in fossils. An intermediate sequence appearing in TN, Beds 4 to 6, is again

fossiliferous. It follows the end of an important karst constructive phase. Its provisional faunal list includes *Eliomys quercinus, Allocricetus bursae, Pitymys subterraneus, Microtus brecciensis, Microtus arvalis-agrestis, Pliomys lenki, Arvicola* sp. (size of A. *sapidus*) and *Apodemus* sp. There is an occurrence of *Marmota marmota* in Bed 4. Assemblages similar to each other occur in upper beds of both series, TD 10-11, and TG 10-11. In these, systematic excavations have yielded a remarkable faunal representation. The macrofauna includes *Ursus spelaeus, Canis lupus, Lynx spelaea, Panthera (Leo) fossilis, Panthera toscana, Felis sylvestris, Dicerorhinus hemitoechus, Equus caballus steinheimensis, Equus c. germanicus, Cervus elaphus, Bison schoetensacki.* Birds are frequent, with 27 taxa represented of this class (A. SÁNCHEZ, in AGUIRRE *et al.*, 1987).

It has been recognized, since the earliest studies on SH that this site is a derived one, originating as a mud flow that washed out an amount of skeletons of carnivores, carrying the pieces to deeper cavities. Thousands of bones or bony fragments were dispersed and, to some extent, sorted according to size and shape by successive, seasonal water-and-mud sheets.

The taxa represented, other than man, are *Ursus deningeri,* largely dominant, cf. *Cuon* sp., *Vulpes vulpes, Panthera* cf. *toscana, Panthera* (*Leo*) *fossilis.*

The faunal list of the beds

TD 3-4 (*Figure 3*) is similar to those of West Runton, Voigsted, and Gombaszek. Also TD 6 contains *Mimomys savini.* The genus *Mimomys* is still present at Süssenborn and Konépusy 7-18; it is absent in fossil assemblages of Europe younger than these. Therefore, the faunal evidence suggests that the beds TD 3 to 6 must be included within the Cromerian *sensu lato* (that is in the sense of Dutch stratigraphers) with exclusion of the warm phase Cromer IV. On the other hand, a warm episode is indicated by the crusts developing in TD 2 and the silt deposition of TD 3 without blocks; the falling of blocks from the cave roof in TD 4 may indicate a cooling, and the red clayish matrix to the top of this level would indicate more temperate, humid conditions.In bed TD 5 the homometric, centimetric, angular blocks of limestone coming from outside the cave, as well as the silt interbedded and constituting the matrix indicate severe cold, dry, periglacial conditions; also the blocks fallen from the cave roof. The horizon of red, prismatic clays at the top of TD 5 (5a) represent another warm oscillation. Cold conditions with some seasonal moist use can be indicated in TD 6 by the coarse silt containing short flows of blocks from cave walls and roof, and sand lenses laterally; also by the presence of *Marmota.* In consequence, according to the most likely correlation of Cromerian to the oxygen isotope curves of ocean paleotemperatures (SHACKLETON & OPDYKE, 1976) TD 3 could correspond to either episodes 19 or 17, TD 5 to oscillations 16-15, and TG 6 to episode 14. The faunal content of TD 8 is but very poor.

The faunal assemblage recorded in beds TD 10-11 and in TG 10-11 still contains several large mammals, which have never been found in Late Pleistocene — *Panthera toscana, Dicerorhinus hemitoechus, Bison shoetensacki* and *E.c. steinheimensis* — with an association of rodents similar to that of La Fage. The equids are also represented by the subspecies *Equus caballus germanicus*, whose type locality is Taubach-Ehringsdorf. Therefore, the upper part of the Atapuerca Trench sites TD, TG-TN is assigned to late Middle Pleistocene or, in other terms, to the Saalian. The sequential beds TN 3-6 are older than TG 10-11 whose lateral equivalents are TN 7-9; they are underlaid by the crusts and speleothems of lower TG. The microfauna represented in TN 4-6 does not differ significantly from that of the overlaying beds; it can therefore be considered post-

Holsteinian. As a working hypothesis for correlating this sequence to the oxygen isotope ocean paleotemperature curve, it is suggested that the intermediate beds TN 2-6 may correspond to episodes 9-7, and the terminal TG 10-11 to episode 6.

On the other side, the faunal list of the SH secondary deposit, in which the human fossils of Ibeas are included, contains no ungulate remains; consequently, correlation must be based only on carnivores. A few fossil micromammals have also been identified from samples of the uppermost laminated silts. The presence of *Panthera cf. toscana* should not be taken into consideration, being based only on a metapodial. Otherwise, the identification of *Ursus deningeri* is based on the study by two of us (T. Torres first, Torres, 1985, continued after with M. Ceballos) of some 9.000 fossils, and offers no doubt, notwithstanding the observed variability including the presence of progressive morphotypes. The species *U. deningeri* is known since the late Early Pleistocene; it occurs commonly in Middle Pleistocene, and has never been reported in beds attributed to the Late Pleistocene, where it is replaced by *Ursus spelaeus*. The materials which have been taken into consideration as representing *Ursus deningeri* for comparative study are from Süssenborn (SOERGEL, 1940), Mauer (RUGER, in ZAPFE, 1946) Mosbach and Hundsheim (Zapfe, 1946), L'Escale (BONIFAY, 1971), Petralona (KURTÉN & POULIANOS, 1977) and Taubach (KURTÉN, 1977).

Magnetic stratigraphy

Preliminary sampling and analysis for the paleomagnetic record was conducted in 1984, in the lower half of TD (TD I). A total of 31 samples were taken, at irregular intervals, within the lowest 10 m of the section.

Changing of polarity was noticed in samples from Bed TD 2 (CARRACEDO et al. in AGUIRRE et al., eds., 1987): it can be influenced by the fact, that sedimentation in TD 2 is somewhat chaotic. Part of the sedimentary materials of TD 2 are derived from earlier deposits. New sampling was done in 1987, this in columnar, overlapping sections. This way an almost continuous sample was obtained, from which more than 100 fractions were analyzed in the Estacíon Vulcanológica de Canarias — obviously there are the gaps due to sedimentary hiatuses. Reverse polarity was found for the most basal horizons of TD 3, only. From lower TD 3 upwards, all the samples have normal polarity (J.C. CARRACEDO, V. SOLER, P. CHICHARRO, personal commun.). This evidence suggests that the basal levels of TD 3 correspond to the latest Matuyama magnetochron. On the other hand, TD 3 yields, from its very base, faunal remains: these are abundant and constitute a typical «Cromerian» assemblage, more precisely early Cromerian. This fact can also be retained as a support for identifying as the Matuyama/Brunhes the reversal that occurred near the begining of deposition of sedimentary materials and faunals remains in TD 3.

Geochronometric dating

The work for dating the fossils and events at different levels in the sites of Atapuerca Trench and in the SH site of Cueva Mayor (Ibeas) is still very incomplete. Several dates have nevertheless been reported by various scholars. No dating has yet been attempted on the crusts nor on speleothemes in the TD section.

In TG, dating of the top stalagmitic crust and of the complex speleothems in the lower part of the section (TG 4) was conducted by R. Grün (in AGUIRRE *et al.*, 1987: 201-204). Independently, samples were taken and analyzed by Ch. FALGUÈRES (1986) from the same top crust of TG and from a heavily carbonated breccia within TN 8, in the

Laboratoire de Faible Radiactivité, Gif-sur-Yvette, France, by the ESR method. Falguères finds for TN 8 an ESR age of 256 ± 23 Ky (*Fig. 4, 3*) and for the top crust (*Fig. 4, 2*) of TG section, 211 ± 32 Ky. GRÜN *et al.*, in AGUIRRE *et al.*, eds., (1987) obtain for the lower speleothem TG 4 (*Fig. 4, 1*) a ESR age of 317.6 ± 60 Ky and a U-series age >350 Ky; for the top crust (*Fig. 4, 2*) the ESR age 177.3 ± 23 Ky and a U-series age of 118 + 71, −49 Ky. The dates obtained by Grün for the main speleothem and crust formation in lower TG, bed TG 4, are with ESR 317 ± 60 Ky, with U-series more than 350 Ky. Thus,the epoch of concealed cavity without fossils in TG-TN should have been pre-Holsteinian. The end of that period and the successive construction of carbonate crusts and stalagmites are most likely correlated to oxygen isotope oceanic paleotemperatur episodes 9 to 11, partially at least to the Holsteinian warm phase (however it may be correlated to the former). The two subsequent sedimentary cycles — TN 3 to 6, and TN 7 to 8 (and their equivalent TG 10 to 11) — are then correlated to two Saale oscillations, quite likely including the cold episodes 8 and 6. The warm episode represented by the lime crusts at the top of TG-TZ and pedogenetic processes at top of TD and TN would then be the same as the Shackleton episode 5. This interpretation is more consistent with the U-series date and with biostratigraphic evidence; the ESR dates, on the contrary, point independently to episode 7 as the age of the crust and the ending of the Trench series.

Dating of fossil men from Ibeas, SH site, has been approached in two ways. The results are quite inconsistent. First, Y. Yokoyama employed his non-destructive method directly on a human mandibular fragment, AT-75, recovered from undisturbed silt at the bottom of SH. This author finds more than 175 Ky according to the 231-Pa/235-U ratio, and 320 + 233, −73 Ky according to the 230-Th/234-U ratio (in Falguères 1986). Samples were taken by R. Grün in the SH cavity: one (sample 117) from a thick speleothem, one more (118) from a needle on 117, one (120) from a thin crust covering the needle 118; two more (121, 122) from a crust covering the wall in front of the former samples; still one sample was taken from a calcite layer (142) on a bear tooth; the last two samples were enamel fragments of bear teeth (168 b,c). The analyses were done by R. Grün at the Department of Geology, McMaster University, Hamilton, Ontario, Canada. The dates obtained from this set of samples, with two different methods, are summarized below (personal communication):

Sample	U-series age (in Ky)	ESR age (in Ky)
121	350	240-360
122	$256\ ^{+93}_{-54}$	268-316
117	333 ±50	260-306
118	280 ±60	260-308
120	—	133-141
142	—	119-143
168b	—	105-115
168c	—	112-126

Ages of 260/300 Ky correspond to a phase of karst construction which ended most likely with episode 9 of the oceanic paleotemperature curve. The date resulting for late crust on calcite needles, and the one on the teeth, around 137 Ky and 131 Ky respectively, can be that of the beginning episode 5. The date of the bear remains can not be younger than the crust deposit on them. Something should therefore be revised on the methodical

procedures of these dating techniques. New samples of a calcite crust enclosing a mass of bones uncovered in the last season (1987), is being analyzed at present. This crust certainly originated after the secondary deposition of fossils.

The Ibeas fossil man

Human fossils were first noticed among the SH debris by T. TORRES and cols. in 1976, and published preliminarily by AGUIRRE *et al.* (1976). Other papers followed (AGUIRRE & DE LUMLEY, 1977; AGUIRRE & ROSAS, 1985; AGUIRRE *et al.*, 1987). There were three mandibular remains, twelve isolated teeth, two cranial fragments and part of a tibia. From 1984 to 1987, cleaning out the debris left by excursionists was conducted and part of the untouched sedimentary deposit tested.

The present collection of human fossils from SH includes; 65 cranial fragments; 6 major mandibular remains (AT-1, with both molar series: AT-2, with 4 teeth, C-M1; AT-3 with the P4; AT-75 with M2 and M3; AT-83 is an ascending ramus; AT-172 was found without any tooth crown); 66 isolated teeth (maxillary: 9 incisors, 4 canines, 4 premolars and 12 molars; mandibular: 8 incisors, 6 canines, 10 premolars and 13 molars); 2 partial humeri, AT-25 and AT-93; 4 fragments of tibiae, AT-19, AT-85 and AT-91 + AT-119. The sample of phalanges totals 37 specimens. There are some other fragmentary postcranial remains of still dubious identification.

Considering the mandibular remains and the isolated teeth, it was possible to estimate that at least eleven individuals are represented in the Ibeas hypodigm (see BERMÚDEZ DE CASTRO, 1986; 1988 for determination of MNI). In these papers the teeth recovered until 1986 were described in detail.

The cranial remains are generally fractured and split. In spite of this, the most complete pieces permit morphoscopic and metrical studies of the frontal, parietal, temporal and occipital bones.

Two frontal remains have been retrieved. AT-129 is a small fragment of frontal squama, showing a great thickness and a clear vermiculate pattern (TAPPEN, 1973; 1978; 1980) on the exocranial surface (*Figure 5*). The frontal fragment AT-121 (left side) consists of a great portion of the orbital segment (as defined by SMITH & RANYARD, 1980) of the supraorbital torus, the totality of the lateral segment of the torus with the frontozygomatic suture and small parts of the orbital roof, frontal squama and temporal line (*Figure 6.1*). The endocranial surface is also represented in AT-121 and exposure (by fracturing) of the internal aspect of the torus shows coarse cancellous bone and a small evidence of the frontal sinus lateral lobe. A vermiculate surface pattern is clearly seen in the anterior torus surface (in the points where it is preserved) and in the superior torus surface, especially on the lateral area and grading out medially. The metrical study shows that AT-121 torus is similar in thickness and projection to the homologous segment of Arago 21, and thicker than Steinheim. The region of the trigonum supraorbitale of AT-121 also appears morphologically and metrically similar to that of Arago 21.

Four fragments of temporal bone have been recovered so far. AT-125 corresponds to the asterionic angle of a left temporal. AT-124 represents a small portion of a left temporal basal region, with the glenoid fossa completely preserved and showing the effects of a temporomandibular arthritis. In the right temporal bone AT-86 the mastoid process, external auditory meatus and the petrous part are in good condition. AT-84 consists of almost the homologous region on the left side, and comes from another individual. Both AT-84 and AT-86 exhibit, unlike the Neandertals, a developed and projecting mastoid process (MARTINEZ & ARSUAGA, 1985) (*Figure 6,4*). In AT-84 the following characters can

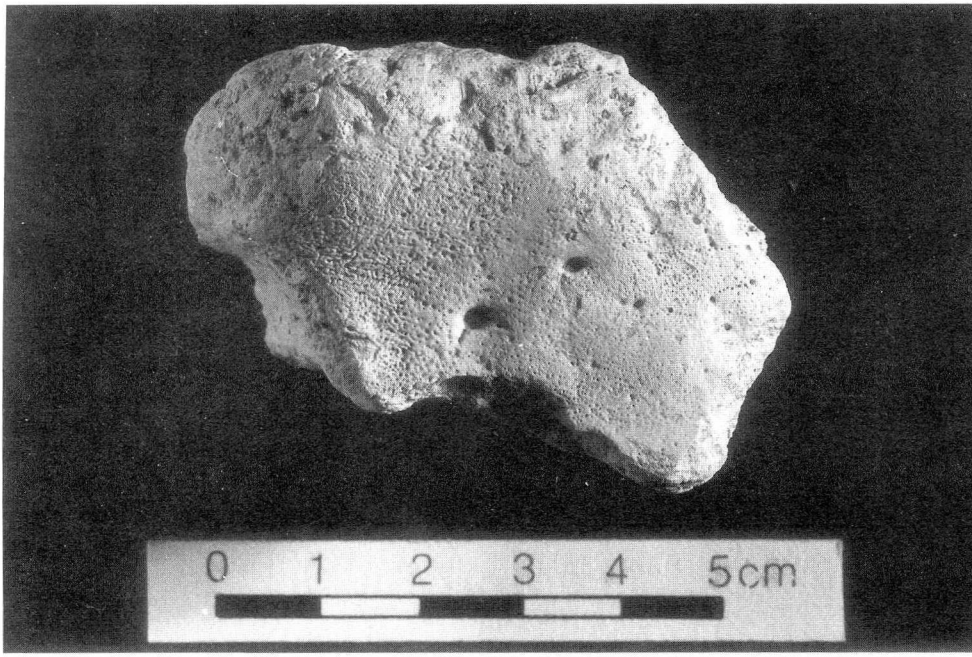

Figure 5. — Vermiculate pattern in the fragment of frontal squama AT-121.

be well established: (1) The mastoid crest runs on the lateral side of the mastoid process till its apex, (2) there is definitively no anterior mastoid tubercle, and (3) there is not an occipitomastoid crest, large compared with the mastoid process (*Figure 6,4*). Thus, in these three traits AT-84 does not present the Neandertal autapomorphies proposed by HUBLIN (1978), SANTA LUCA (1978) and STRINGER *et al.* (1984).

Joining parietal fragments, three sets have been composed. P.I. (AT-31a + AT-31b + AT-17) represents most of a left parietal containing the parietomastoid suture and brief segments of the lambdoidal and temporal borders (MARTINEZ & ARSUAGA, 1985) (*Figures 6,2* and *7*). The bone is very thick, especially in the parietal boss (*Figure 8*). No angular torus is present in P.I. The curvatures of the rest are regular, that is, without strong angulation between the temporal and superior planes. The parietal protuberance, located above the superior temporal line, can be identified as the point of maximum curvature of the bone. Unfortunately, in the absence of any sign of saggital suture, the transversal contour of the complete biparietal vault cannot be satisfactorily determinated, but the curvatures of P.I. closely resemble those of Swanscombe. P.II (AT-61 + AT-33) corresponds to the anterior half of a left parietal, with remains of the saggital and coronal borders, and certainly comes from another individual. P. III (AT-63 + AT-65) belongs to a right parietal posterior region, where the asterion, parietomastoid suture and a long segment of the lambdoidal border can be identified (*Figure 6,3*). There is no angular torus in P. III, but the asterionic region appears thick. P. III can be anatomically conected with the occipital fragment AT-122 and the right temporal AT-86 in a set called Cr. 1 (*Figure 6,3*). These, and other well identified parietal fragments, display clear impressions of

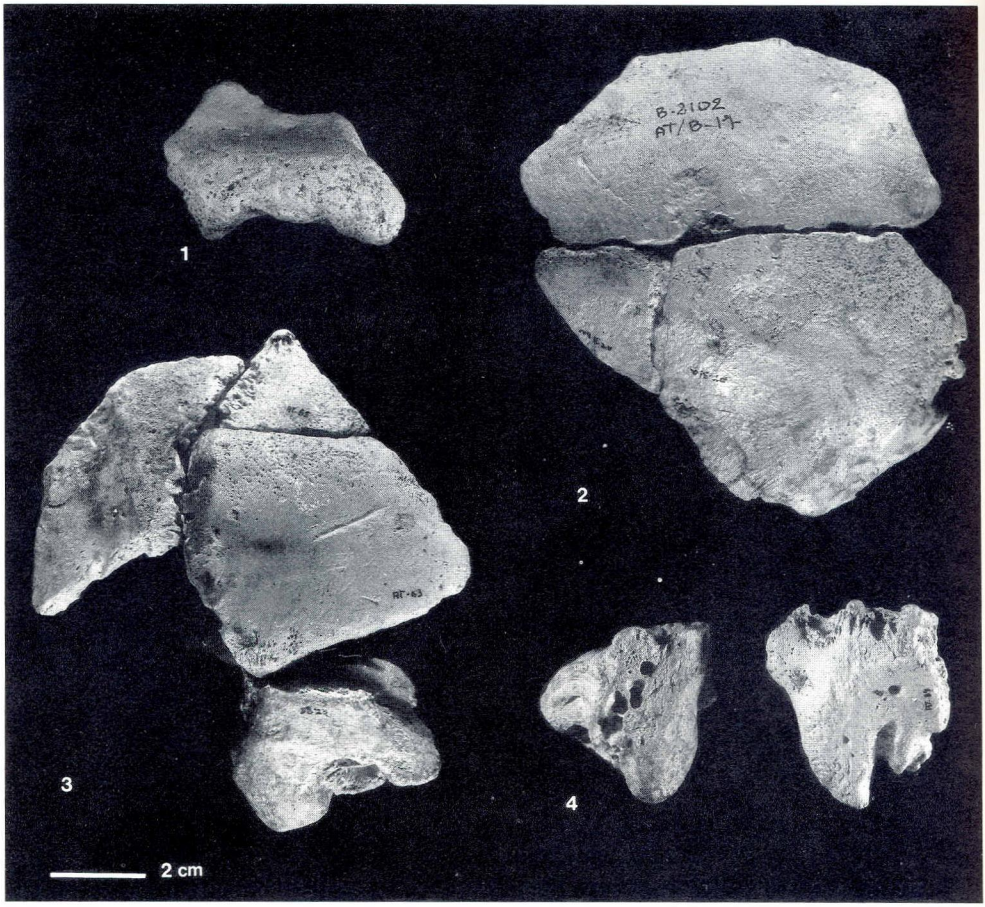

Figure 6. — Some neurocranial remains from Ibeas. 1: Anterior view of the frontal fragment AT-121; 2: Exocranial surface of the left parietal P.I (AT - 31a + AT - 31B + AT - 17); 3: Aspect of the set of articulated fragments Cr. 1 (AT-63 + AT-65 + AT-86 + AT-122); 4: Mastoid processes of AT-86 (left) and AT-84 (right). All photographs were taken on the originals, except AT-17 (cast).

meningeal vessels. Neither in P. I nor in P. III can be found the groove of the *sinus lateralis,* that in modern populations is often described as crossing the asterionic region of the parietal bone on its way from the occipital to the temporal bone.

Fragments of occipital bone currently known correspond to asterionic region: O. I (AT-105, AT-106, AT-132), O. II (AT-45, AT-56), AT-122 (Cr. 1), AT-39 and AT-140. In all of them, the *sinus lateralis* runs directly from the occipital to the temporal bone, inferiorly to the asterion position. In the last, a clear exocranial butressing (lateral portion of the occipital torus) can be observed.

The mandibular remains AT-1, AT-2 and AT-3 have been revised and the new ones, AT-75 and AT-83, described by Rosas (1987). Among the observed traits, some may deserve particular mention for their phylogenetic significance, in our opinion: All the

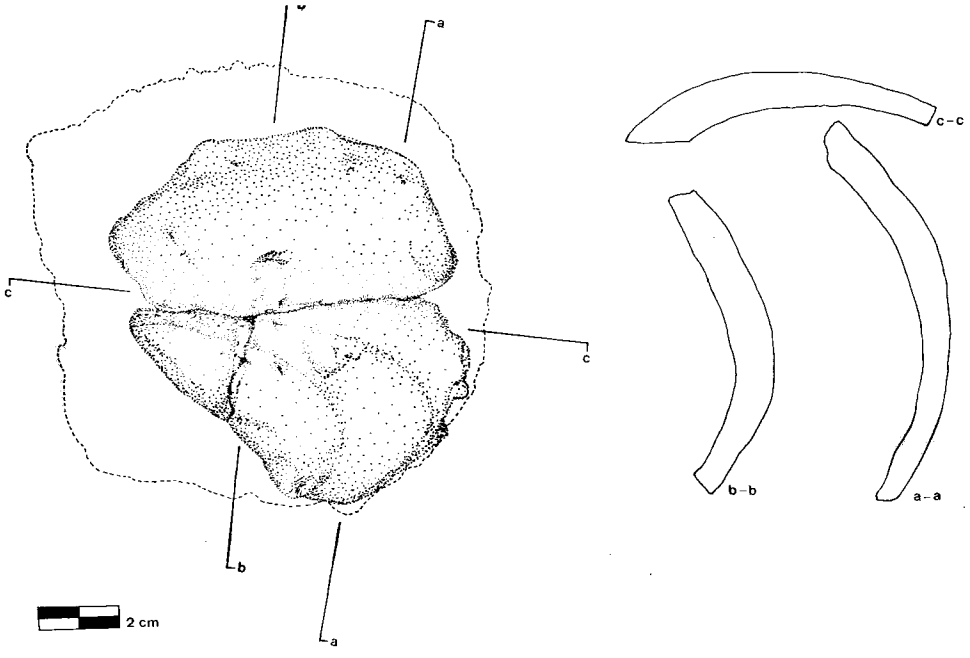

Figure 7. — Drawing of Ibeas P. I, outlined on the Swanscombe left parietal profile. Three sections have been made at different levels to show thickness and curvature of P.I.

human mandibles of Ibeas are robust, with a regularly thick jawbone; the mandibular body is in all observed cases low, with parallel alveolar and basilar edges. The symphyseal profile is extremely inclined backwards and downwards. A wide, shallow anterior notch is present in AT-1. The *impressiones digastricae* are looking inferiorly, nearly horizontal, as in OH 22, Mauer, Arago XIII. The *eminentiae laterales* are located in a forward position; a *triangulum retromolare* is well developed in two of the three fossils in which this trait can be observed. A *torus marginalis inferior* is prominent externally in all the specimens; also the *tuberculum marginale anterius* is strongly bulging. The *linea mylohyoidea* is represented by a sharp edge, long and in a low position in all the preserved fragments of mandibular body. The ascending ramus AT 83 is thick, with a straight, thick anterior edge, a robust coronoid apophysis looking upwards, and a shallow sigmoid notch. Many apomorphic traits are shared with the mandibles of Arago, Mauer and Montmaurin, and also with OH 22 and OH 23 from Olduvai IV, while other are characteristic of Neandertal.

Human occupation of the Trench sites and tool-making

Stone artifacts occur in the Trench sites TD, beds 6, 10 and 11; TN, beds 4 to 8; TG 9-11. Only TD 10-11 and TG 10-11 have been excavated, and TN 8; stone tools from other levels outcrop on the section by weathering. Artifacts are particularly abundant in beds TD 10 and TG 10. These beds are tilted with deformation and sliding; indications of definite fertile horizons can still be seen in TD 10; the original situation was other than

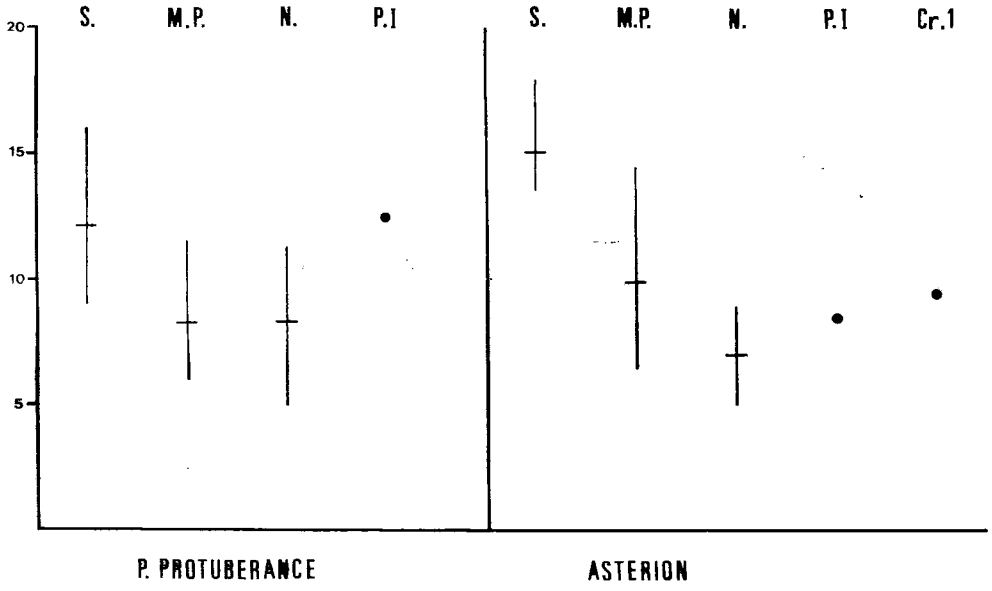

Figure 8. — Parietal thickness at asterion and parietal protuberance. Vertical lines = range of variation. Horizontal bars = averages.

S = Zhoukoudian; data from skulls 3, 5, 10, 11 and 12 (Wolpoff, 1980). M.P. European Middle Pleistocene fossils; data from La Chaise (Suard) 1 (Piveteau, 1970), Steinheim, Swanscombe (Wolpoff, 1980), Biache-Saint-Vaast (Vandermeersch, 1982), Fontéchevade (Vallois, 1958), Castel di Guido (Mallegni *et al.*, 1983) and Arago 47 (Authors on cast). N = Central and Western European Neandertals (Wolpoff, 1980). P. I = Ibeas P. I; Cr 1 = Ibeas cranium 1.

present. Only the lower horizons of TD11 are tool-bearing; TD 11 is tilted, not deformed. There is a discomformity between bed TD 10 and TD 11; evidences of human occupation are better preserved in between: trimming flakes were found in two square meter around a quarzite core, to which they fitted.

Also TG 11 overlies TG 10 discomformably. The layers of TG 11 are almost horizontal. Sedimentation in TD was rythmic, with low energy; microconglomerates of homometric, angular fragments of cryoclastic limestone from outside the cave with pink silty matrix and dispersed blocks of cave roof; these are interfingering with layers of silt. Most of the bones are found in horizons of definite depth, commonly upon layers of conglomerate, below layers of silt, that is strata deposited of times of decreasing energy. Among the skeletal remains in the floor GSu-1, the proximal part of a fallen antler of a red deer was found; transportation with the sedimentary materials is excluded in this case. Stone tools occur associated in low number. Only bones of birds, carnivores, rodents, and rare fragments of large mammals occur between the main fertile horizons. These were therefore interpreted as preserved records of human activity, and designed by figures 1 to 10, from top to bottom, after label GSu (*Figures 10* and *11*).

In TD 10, more than 250 tools were recovered in less than 10 m^2, and barely more than 1 m depth. Nearly 2/3 of the stone artifacts recovered are made of flint and an

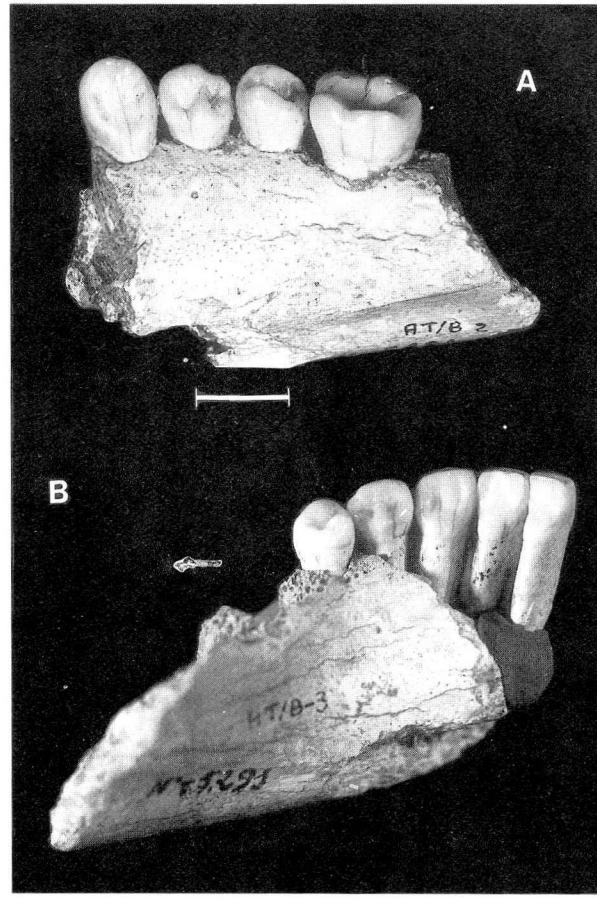

Figure 9. — a) AT-2, internal side; b) AT-3, with other teeth fitted; internal side. Scale bar 1 cm.

additional 25% of green or greyish quartzite. A poor, foliate, fine grained, green quarzite intermittently occurs, as does vein quartz. Unretouched flakes are dominant (47%). The morphological spectrum of flakes in TD 10 and TD 11 is large; denticulates (c. 45%) and side scrapers (*Figure 12*) are fairly dominant. Only 10% of the pebbles are worked out, almost all of these bifacially, with centripetal, flattish removal surfaces, sinuous edges, resulting in an overall convex or angular shape. Most of them are simply cores from which flakes were obtained; others yielded bifaces and cleavers. On the other side many cleavers and bifacials are second generation tools, that is derived from flakes.

According to the evidence summarily exposed in the preceding paragraphs, the TD cavity may have been occupied, at the time of TD 10 breccia, but not continuously. This area may have been used, at least ocasionally as a camp and workshop. There are not very many skeletal remains found in these horizons; their association to the artifacts can be viewed as either original or due to redeposition.

Artifacts have also been recovered from Bed TD 6, by salvage, when seen outcropping on the section. Two large cores of flint, of no less than 30 cm on the main axis, were found, one in 1980, the other in 1986, along with some other artifacts and large mammal

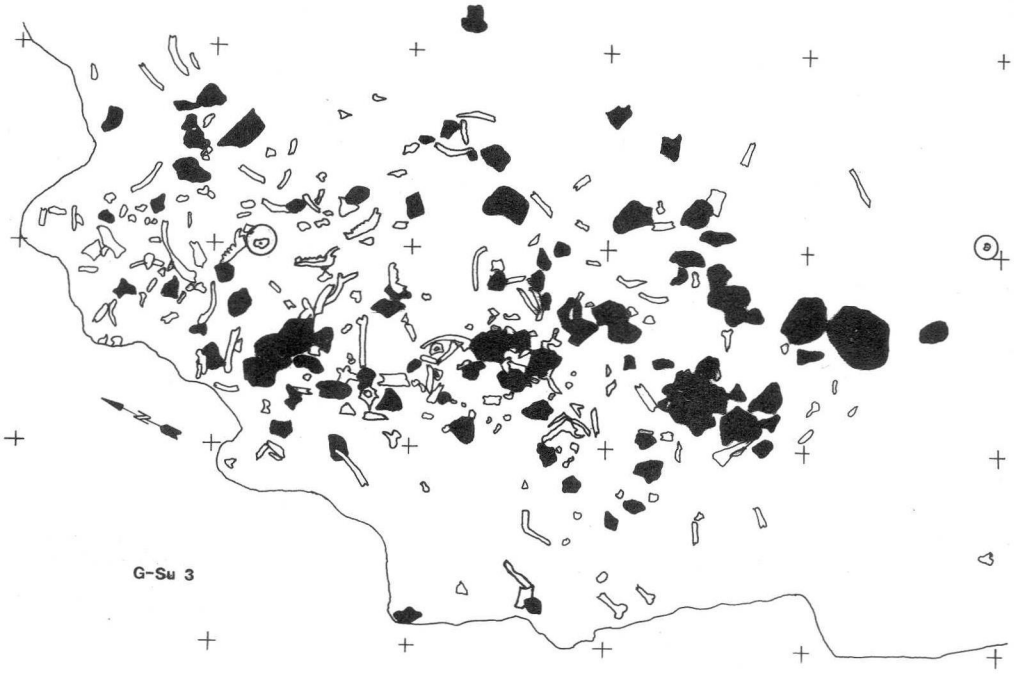

Figure 10. — TG site, map of occupation floor GSu 3 in upper Bed 11. The tools are encircled.

Figure 11. — TG site, occupation floor GSu 9 in upper Bed TG 11, partial view. 1983.

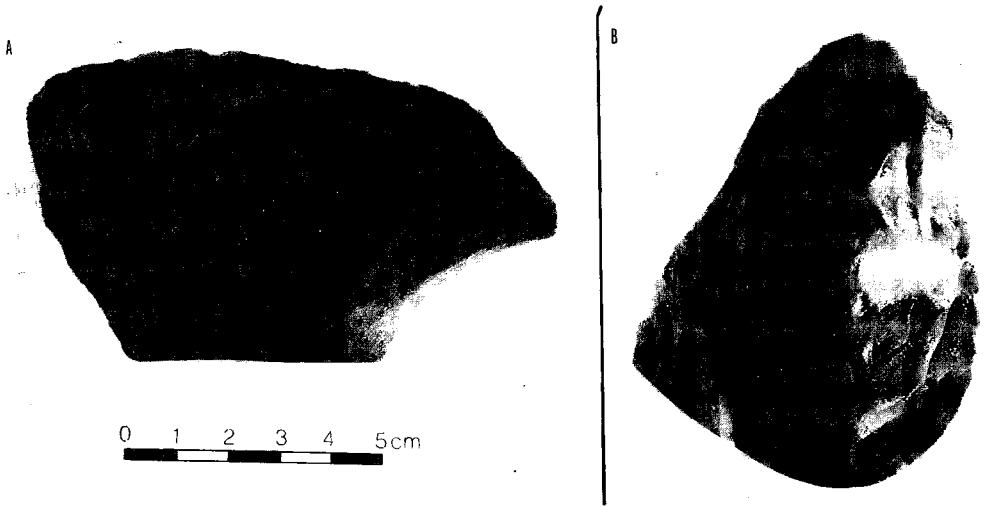

Figure 12. — A) BN2G. Transversal side-scrapers made of a quartzite flake, R22 (Spd c X tr. dist.). B) BN2G. Bifacial tool made of a quartzite flake, with a secondary left side-scraper retouch, B (4C Pt 1a = RS (P) mm lat. izq. /2C Sat 1a/ sin si.

remains. These findings may represent an important human occupation near the beginning of the Middle Pleistocene according to faunal evidence (see above).

TG locus can be considered as an access to the more interior room TZ. The number of allochtonous stones in TG 10-11 is small; flint dominates as raw material (64%) and quartzite is second. Cortical heels are absent from both positive bases and negative bases of the second generation. This evidence is interpreted as indicating allochtonous origin for the artifacts found at TG.

Two different operational sequences are inferred: on one side, entire bases -quartzite pebbles- are transported and utilized without any trimming, apparently for breaking skeletal pieces; on the other, tools elaborated elsewhere, mostly of flint, were selectively introduced. The last show a high degree of specialization, morphotypically: there are denticulates, side scrapers, many on trapezoidal flakes; the latter frequently show long and sharp cutting edges, like cleavers.

The human occupations at TG 11 show that deer and horses were hunted almost exclusively. Bison is also represented by some remains; in GSu-4, the bones of a forward extremity of a bison were found in anatomic connection: this part of the animal was buried here (squares F16 - G16) with flesh and skin; several artifacts occur in the same horizon. Rhinos are only found in TG 10; their last appearances occurring at the top of this bed. Deer carcasses were carried whole to the site and butchered there: all parts of their skeletons are present, but most of the antlers and feet are missing. The skeletal representation of horses is quite selective. Two adult mandibles and a few teeth were recovered from the eight floors of TG 11, against more than 20 mandibular series or hemimandibles of colts. No arrangement of the space is ascertained in these occupational floors, but some rather poor indications are seen in GSu-3. A feature found in several floors, for which we do not have an explanation, is that of a well elaborated tool laying on

a corner (Southeast), near the vertical duct TN, out of the area covered with bone remains. There are traces of fire using, but no hearths are preserved. The biomass represented in the richest floor stays under 1.500 Kg. The excavated remnant extension of these soils is less than 24 m^2. They were destroyed, partly by the railway cut, partly by amateur collecting.

We may infer that the successive occupations of TG were ephemeral, with occasional use of ungulate food and that they were marginal, that is depending on other «centers». The human groups successively using the TG room were small.

A flint implement with retouch on one face was found in the top horizon of the TZ bed, associated with deer, horse, and large bovine remains. Spacial arrangement may be inferred from the stone and bone distribution; these are concentrated in two main definite areas, while there are only two patches with limited overlapping, one of the stones the other of scattered bone splinters. Several flint and quartzite artifacts were recovered from TN section at levels TN 4,5 and 6.

The sampling started in 1986 at TF site has yielded, near the top of the depositional series , an assemblage of three finely elaborated tools — 1 on flint, 2 on quartzite — of Charentian types associated with fauna.

No tools were found at SH, and only one phalanx of a rhino together with the several thousands of fossil remains of carnivores. The human group, whose remains are being recovered from SH, apparently did not use that part of the cave as a camp, nor for any activity related to food producing or consuming, nor to tool-making or tool-using (DIEZ *et al.*, 1986). Instead their remains were transported there by underground mud flows.

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