Quaternary International xxx (2014) 1–25

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

The earliest Acheulean technology at Atapuerca (Burgos, Spain): Oldest levels of the Galería site (GII Unit)

Paula García-Medrano [a,b,*], Andreu Ollé [b,c], Marina Mosquera [c,b], Isabel Cáceres [c,b], Carlos Díez [a], Eudald Carbonell [b,c,d]

[a] Laboratorio de Prehistoria, I+D+I, Universidad de Burgos, Pl. Misael Bañuelos s/n, 09001 Burgos, Spain
[b] Institut Català de Paleoecologia Humana i Evolució Social (IPHES), C/Marcel·lí Domingo s/n (EdificiW3), Campus Sescelades, 43007 Tarragona, Spain
[c] Àrea de Prehistòria, Universitat Rovira i Virgili (URV), av. Catalunya, 35, 43002 Tarragona, Spain
[d] Institute of Vertebrate Paleontology and Paleoanthropology, Beijing (IVPP), China

ARTICLE INFO

Article history:
Available online xxx

Keywords:
Middle Pleistocene
Lithic technology
Acheulean
Handaxes
Technological variability
Atapuerca

ABSTRACT

This work presents a study of the oldest Acheulean lithic assemblages from the Galería site, specifically the GIIa subunit, which has been dated to c. 503 ± 95 ka, and compares them with the subsequent subunit in the sequence, GIIb, dated to around 237–269 ka. The main goals of this study are to offer a detailed technological characterization of the earliest Acheulean presence in Atapuerca and to assess the elements determining the technological variability in a given site by studying the sequence, evaluating the concept of variability and defining the aspects which determine it. The Galería site does not display the features of a living space. It is a cave which was accessed by both humans and carnivores in order to obtain the animal biomass of the herbivores that had fallen down into the cave through a natural shaft. The archaeological record is therefore incomplete and fragmented, since it is the product of highly changeable occupational dynamics. In the lower Galería levels, we identified the development from an almost exclusive use of cobbles as blanks for knapping activities in the earliest periods to an increasing use of flakes. In terms of raw materials, the initially predominant use of Neogene chert and quartzite evolved towards a more balanced use of six raw materials. Furthermore, there was an increase in the size of the large tools. After comparing these two Acheulean assemblages, it is important to put them into context by taking into account a) the significance of cobbles and flakes as blanks; b) the significance of cleavers; and c) the use of raw materials such as quartzite, sandstone or chert. These aspects have traditionally been used to facilitate comparisons of the technologies used within the Iberian Peninsula, and comparisons between the Acheulean technology of the Iberian Peninsula and North Africa and the European (i.e. trans-Pyrenean) Acheulean technology.

1. Introduction

Atapuerca represents a continuous sequence of human occupation from 1.2 Ma to 250 ka, with the exception of a gap between *c.*900 ka and *c.*500 ka (represented by levels TD8 and TD8-9 of the Gran Dolina site) (Mosquera et al., 2013). Prior to 900 ka, the industry had the technological characteristics of a Late Mode 1 industry (TD6 remains) and is associated with *Homo antecessor*. After 500 ka, however, the industry corresponds to Acheulean technology (the Galería and Sima de los Huesos sites) and is associated with *Homo heidelbergensis*. The gap means that there is no continuity between the TD6 industries of Gran Dolina and the basall levels of the Galería site, from Mode 1 to Mode 2 technology at Atapuerca. The basal levels of the Galería site (the GIIa subunit) represent the first vestiges of *H. heidelbergensis*' activity in Atapuerca.

In this article we first present a general view of Galeria's geological and stratigraphical sequence, correlating the various excavated areas and providing contextual information on the fossil content and the patterns of human occupation identified to date. In the second section, we introduce the composition of the site's general lithic assemblage. In later sections, we focus our interest on the technological matters of exploitation methods and configuration processes, with special attention to the metrical and morphological characterization of large tools. Having presented the

* Corresponding author. Institut Català de Paleoecologia Humana i Evolució Social (IPHES), C/Marcel$lí Domingo s/n (EdificiW3), Campus Sescelades, 43007 Tarragona, Spain.
E-mail address: pgarciamedrano@gmail.com (P. García-Medrano).

http://dx.doi.org/10.1016/j.quaint.2014.03.053
1040-6182/

data, we finally assess the Galería record and put it into context, with reference to other sites on the Iberian Peninsula.

2. Archaeological context

The Sierra de Atapuerca is located on the northern part of the Iberian Meseta, 15 km east of Burgos (Fig. 1). It is a small Cenozoic limestone elevation that contains several caves (Pérez-González et al., 2001). Excavations at the numerous sites in Atapuerca have yielded a rich archaeological record spanning the last million years and including several items that have provided key information regarding our knowledge of Lower and Middle Pleistocene populations (Carbonell et al., 1995, 2008; Arsuaga et al., 1997b; Bermúdez de Castro et al., 1999; Rodríguez et al., 2011; Ollé et al., 2013).

The Galería complex is located in the western side of the Sierra. The cavity is roughly 14 m high and 18 m wide, developing inwards for over 12 m. The name Galería is used to refer to the complete cave system, which is composed of three different areas: a central area (TG), joined at the northern end to a small chamber (TZ) and containing a vertical shaft that rises to the surface at the southern end (TN). The following six main filling phases have been distinguished in Galería (Ollé and Huguet, 1999; Pérez-González et al., 1999; 2001; Vallverdú, 2002) (Fig. 2 and Table 1).

GI: A sterile unit formed by endokarstic detrital sediment. A speleothem at the top of this unit has been dated to >350 ka (U/Th) and 317 ± 60 ka (ESR) (Grün and Aguirre, 1987). The Matuyama–Brunhes boundary is less than 0.5 m below this (Fig. 2).

GII: All the lithic materials included in this study come from this Unit, which is the first one for which there is an archaeo-paleontological record. This deposit is separated into two subunits by a continuous organic layer. The earliest one, ***GIIa***, contains evidence of the cave's first exposure to the outside. This phase comprises archaeological levels TG7 to TG9, TN2/TN2A/TN2B to TN4 and TZ-GIId. This unit has been correlated with OIS11 (Aguirre, 2001). TL dates provide even older chronologies: 503 ± 95 ka for a sample just below Levels TG7-TN2, and 422 ± 55 ka for TG9 (Berger et al., 2008). The most recent ESR-US age data give new dates of 350–363 ka (Falguères et al., 2013). We can therefore define the chronological range of this subunit as between 450 and 350 ka.

The youngest subunit, ***GIIb***, comprises archaeological levels TG10D, TG10C and TG10B, TN5, TN6 and TN6DA and TZ-GIIb/c. This subunit has been recently dated by ESR-US at 237–269 ka (Falguères et al., 2013).

GIII: This unit is an archaeo-paleontological deposit that is also separated into two subunits. The first one, ***GIIIa***, corresponds to the lower part and comprises levels TG11 (from G.S.U.12 to G.S.U.07), TG10A, TN7, and TZ-GIIa. Two dates are available for the GIIIa subunit: a TL date of 466 ± 39 ka (Berger et al., 2008) and an ESR-US date of 221–280 ka (Falguères et al., 2013). The second subunit, ***GIIIb***, comprises levels TG11 (from G.S.U.06 to G.S.U.01), TN8, and TZ-GIII. A stalagmite from TN8 has been dated to 256 ± 33 (ESR) (Falguères et al., 2001). According to Berger et al. (2008), the upper part has a TL and IRSL date of 255 ± 26 ka, which agrees with the recently obtained ESR-US dates for this subunit of 221–269 ka (Falguères et al., 2013).

GIV to GVI: These represent, respectively, the last infill event and the edaphic relict formation that sealed the cave. A stalagmite from the top of GIV has been dated to 177 ± 23, 211 ± 32 ka and 222 ± 31 ka (ESR), and 87 ± 14 ka, 118 + 71/−49 ka, 135 ± 13 ka and 166 ± 25 ka (U/Th) (Grün and Aguirre, 1987; Pérez-González et al., 1999; Falguères et al., 2001, 2013). A new date from the base of GIV has yielded an IRSL date of 185 ± 26 ka (Berger et al., 2008). A

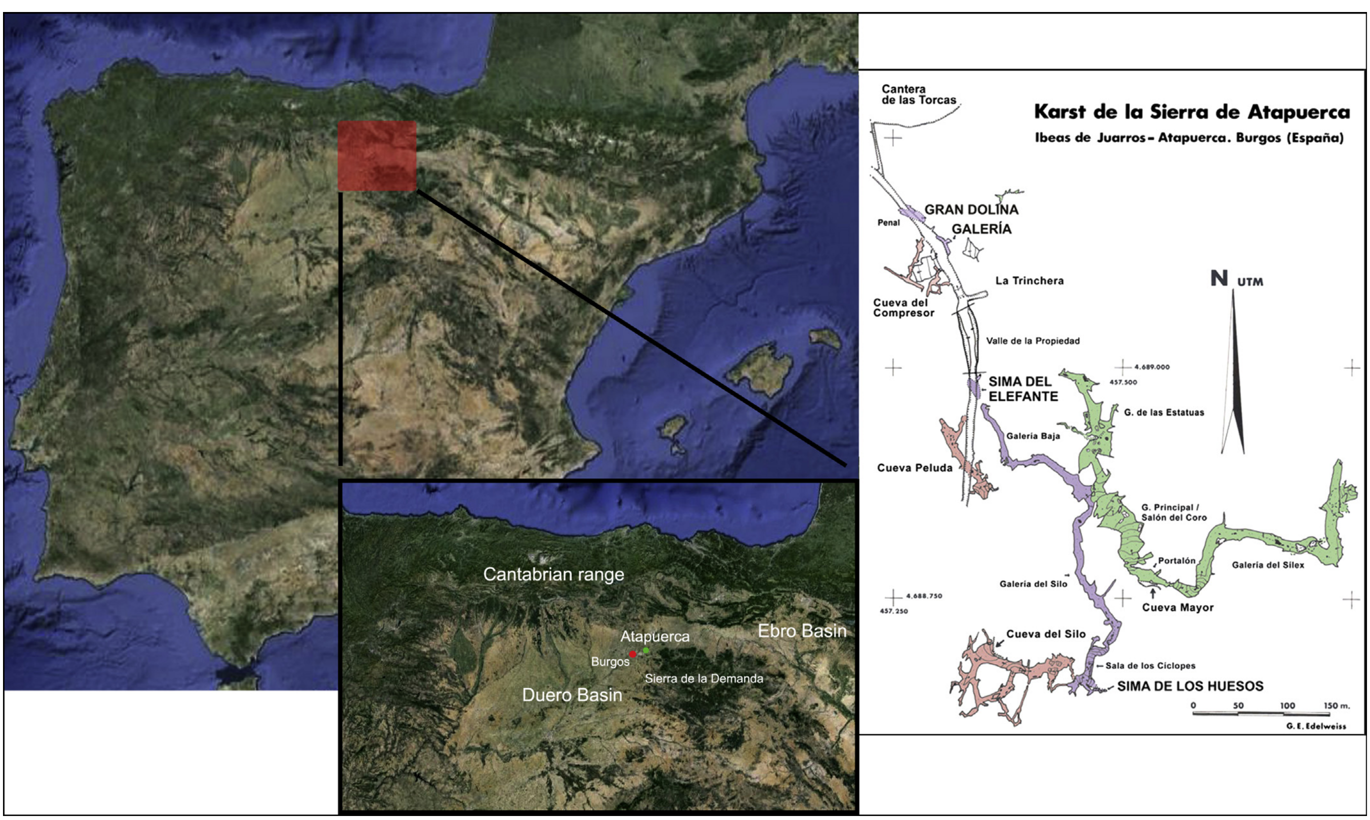

Fig. 1. Location of the Atapuerca sites. On the right, a map of the karst (adapted from Ortega, 2009). In green, the upper level of the karst; in purple, the middle level and in pink, the lower level. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

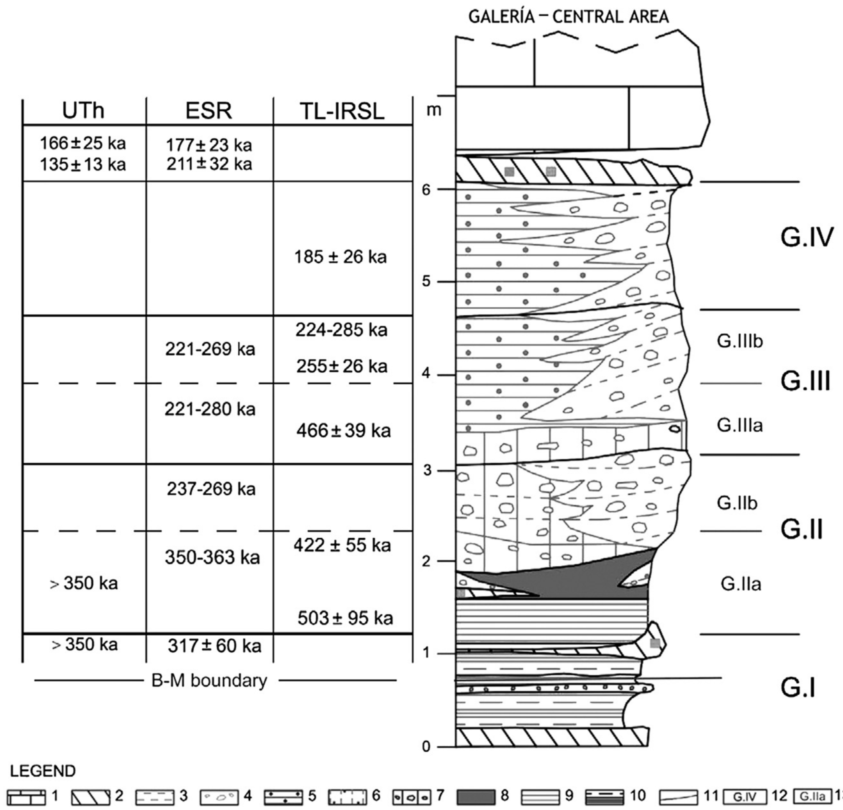

Fig. 2. Chronostratigraphic sequence of Galería and dating table (according to Grün and Aguirre, 1987; Pérez-González et al., 1999; Falguères et al., 2001, 2013; Berger et al., 2008). Caption: 1) Upper Cretaceous limestone and dolomite (cave wall and roof; 2) Speleothems; 3) Terra rossa; 4) Limestone blocks, cobbles and gravels; 5) Alternance of fine and medium pebbles and clay loam; 6) Lutites, clay loam; 7) Gravels and clay loam; 8) Bat guano and clay loam; 9) Laminated loamy clay; 10) Laminated sandy clay; 11) Main stratigraphical unconformities; 12) Main continuous archaeological levels; 13) Allostratigraphic units; 14) Archeo-paleontological levels (Modified from Falguères et al., 2013).

Table 1
Correspondence between the units, subunits and identified levels of the Galería site, detailing the three sectors (TZ–TG–TN), the dates and the methods used.

Unit	Subunit	COVACHA DE LOS ZARPAZOS (TZ)	GALERÍA (TG)		TRES SIMAS BOCA NORTE (TN)	Dates	Date Method and References
GIV	*Sterile Unit. Last infill event and edaphic relict formation*					135±13 211±32	**UTh** (Grün & Aguirre, 1987) **ESR** (Falguères *et al.*, 2001)
						185±26	**TL & IRSL** (Berger *et al.*, 2008)
GIII	**GIIIb**	GIII	TG11	GSU 01	TN8	221-269ka 256±33ka 255±26ka	**ESR-US** (Falguères *et al.*, 2013) **ESR** (Falguères *et al.*, 2001) **TL & IRSL** (Berger *et al.*, 2008)
				GSU 02			
				GSU 03			
				GSU 04			
				GSU 05			
				GSU 06			
	GIIIa			GSU 07		221-280ka 466±39ka	**ESR-US** (Falguères *et al.*, 2013) **TL** (Berger *et al.*, 2008)
				GSU 08			
				GSU 09			
				GSU 10			
				GSU 11			
				GSU 12			
		GIIa	TG10A		TN7		
GII	**GIIb**	GIIb/c	TG10CC	TG10B	TN6/6DA	237-269ka	**ESR-US** (Falguères *et al.*, 2013)
				TG10C	TN5		
				TG10D			
	GIIa	GIId		TG9	TN4	422±55ka 350-363ka	**TL** (Berger *et al.*, 2008) **ESR-US** (Falguères *et al.*, 2013)
				TG8	TN3		
				TG7	TN2A/TN2B	503±95 ka	**TL** (Berger *et al.*, 2008)
GI	*Sterile Unit. Cavernous detrital sediments*					317±60ka >350ka	**ESR** (Grün & Aguirre, 1987) **UTh** (Grün & Aguirre, 1987)
						MATUYAMA-BRHUNES BOUNDARY	

stalagmitic crust at the top of the sequence of TZ has also been dated to 135 ± 13 ka (U/Th) (Pérez-González et al., 1999).

Of the herbivore and carnivore remains found in the Galería site, the most abundant species are *Megaloceros solilhacus sspp*, *Hemitragus bonali*, *Dama dama clactoniana*, *Cervus elaphus priscus*, *Bison sp.* (small), *Stephanorhinus cf. hemitoechus*, *Equus ferus*, *Equus cf. hydruntinus Ursus deningeri*, *Panthera leo*, *Lynx pardinus spelaeus*, *Felis sylvestris*, *Cuon alpinus europaeus*, *Canis lupus*, *Vulpes vulpes*, *Meles meles*, *Mustela nivalis*, and *Mustela putorius* (Rodríguez et al., 2011). Additionally, the remains of micromammals (Rodríguez et al., 2011) and birds (Sanchez Marco, 1999) are well represented in the Galería site.

Two human remains, both recovered in TZ, are of particular note in the Galería's archaeo-paleontological record. The first (from Unit GII) is a right adult mandible fragment containing M2 and M3 (Bermudez de Castro and Rosas, 1992). The second specimen, from the base of GIII, is a neurocranial fragment from the lambdatic area of an adult individual (Arsuaga et al., 1999). As both remains have features in common with the fossils from the nearby Sima de los Huesos site (Arsuaga et al., 1997a), less than 2 km away from Galería (Fig. 2), they can be ascribed to the species *H. heidelbergensis*.

The Galería assemblage lacks the characteristic features of a home base, such as a high degree of anthropization on the faunal remains, abundant and complete lithic reduction sequences or a certain degree of spatial organization. In addition, the taphonomic data suggest conditions of waterlogged ground and semi-darkness that can, to some extent, explain the relatively limited domestic activities documented. The occupational model thus infers repeated low intensity visits for the purpose of obtaining the animals that had fallen into the natural trap created by the TN shaft, in successful competition with carnivores (Díez and Moreno, 1994; Huguet et al., 2001; Cáceres, 2002; Ollé et al., 2005; Cáceres et al., 2010). Human and carnivore access to Galería was sporadic but repeated. These visits did not correspond to significant occupations but rather to intermittent visits for obtaining animal resources. These biological agents developed different strategies for obtaining the animal resources. Hominins visited the site for the purpose of preparing foodstuffs and transporting them out of the Galería. Cut marks, principally on axial elements, but also on appendicular elements present in the cave show that humans had primary access to the carcasses. The limited evidence of bone breakage by humans (1.2%) corroborates the low level of *in situ* consumption of food (Cáceres, 2002). However, carnivores, mainly canids and (more sporadically) hyaenids or felids, prioritized *in situ* consumption of carcasses, and sometimes accessed skeletons abandoned by hominins, as indicated by the evidence of carnivore activity overlapping human activity (Cáceres, 2002; Ollé et al., 2005; Cáceres et al., 2010).

The activity in Galería correlates with the functionality and effectiveness of the natural trap. The lower levels -GII Unit- show higher levels of human and carnivore activity than the upper levels, where a smaller quantity of animal remains has been documented. The gradual reduction in the meat supply must have led to a loss of interest in this cave, which thus became of marginal interest to both humans and carnivores in Sierra Atapuerca.

According to this model, the Galería site would have been a complementary settlement area to which hominins in the complex karst network of the Sierra de Atapuerca made occasional planned visits (Ollé et al., 2013). This type of strategy suggests that those groups of hominins had a high degree of knowledge of the environment and good planning and organization abilities.

Use-wear studies of the Galería stone tools were mainly conducted using SEM (Márquez et al., 2001; Ollé, 2003; Ollé et al., 2005) and yielded valuable functional information. Although artefacts from all size groups were used, small-sized ones were predominant. The highest usage rate was identified on retouched flakes, regardless of the raw material. The type of action identified is closely related to butchery. Most of the use-wear traces result from cutting animal tissue, and appear on low- and medium-angled edges. There is also evidence of hide scraping on the more abrupt edges. Woodworking has been documented at all archaeological levels, but always less frequently than butchery.

3. Methodology

The lithic technology from the Galería site has been studied on several previous works (Mosquera, 1995; Márquez, 1998; Carbonell et al., 1999; Ollé, 2003; Ollé et al., 2005; Terradillos, 2010; García-Medrano, 2011; Terradillos-Bernal and Rodríguez, 2012; García-Medrano et al., 2013; Ollé et al., 2013). Fieldwork has been conducted over an extended period, specifically from 1981 to 1996 and from 2001 to 2010. This work presents all the finds from the GII Unit, and covers the whole area of the Galería site (including the three sectors, TZ–TG–TN). We will also make a brief reference to the handaxe recovered at Sima de los Huesos (Carbonell et al., 2003; Carbonell and Mosquera, 2006).

The main aim of this study is to describe and interpret the lithic remains found in the GIIa subunit, which includes the following levels: GIId-TZ; TG7, TG8, TG9; TN2A, TN2B, TN3, TN4). We will then compare that assemblage with the GIIb subunit, which includes the immediately higher levels: GIIb-TZ, GIIc-TZ; TG10D, TG10C, TG10B; TN5, TN6, TN6DA (Ollé and Huguet, 1999). The Galería's infill was deposited through several entrances. Within each entrance, different synchronically and diachronically related levels have been identified. In some cases, the relationships between levels have been considerably erosive, which makes the levels appear and disappear (Fig. 3). This makes it difficult to consider each one independently. We have plotted the faunal and lithic remains found at the Galería site in order to understand the stratigraphical relationships between levels (García-Medrano, 2011).

The Atapuerca lithic assemblage has been analysed using the Logical Analytical System, LAS (Carbonell et al., 1983, 1992, 1999; Rodríguez, 2004). In this study, we combine different methodological approaches in order to complement the LAS' processual and not typological view. Knapping methods are defined by means of faciality (number of flaked faces), direction of removals and arrangement of striking platforms. The methods considered can be summarized as follows (Ollé et al., 2013):

- Unipolar longitudinal: knapping is typically performed on a single surface, and the flake scars run unidirectionally along the thickness of the blank. At Atapuerca, this flaking method was very commonly used on pebbles and cobbles, leading to products with a significant amount of cortex on their sides.
- Multifacial multipolar: this strategy is based on continuously creating surfaces that will be used as both striking and removal platforms. The angles between these surfaces tend to be close to 90° (orthogonal).
- Centripetal: this can be unifacial or bifacial, although the latter dominates. It involves recurrent knapping around the edge of a blank.
- Large tool preconfiguration: here a given morphology is configured on the blank' surface before the flake is produced, in order to guarantee a specific technical feature in the future product.

The following size classes are used to provide a basic metric description: micro (≤20 mm), small (21–60 mm), medium (61–100 mm) and large (>100 mm) (Carbonell et al., 1999).

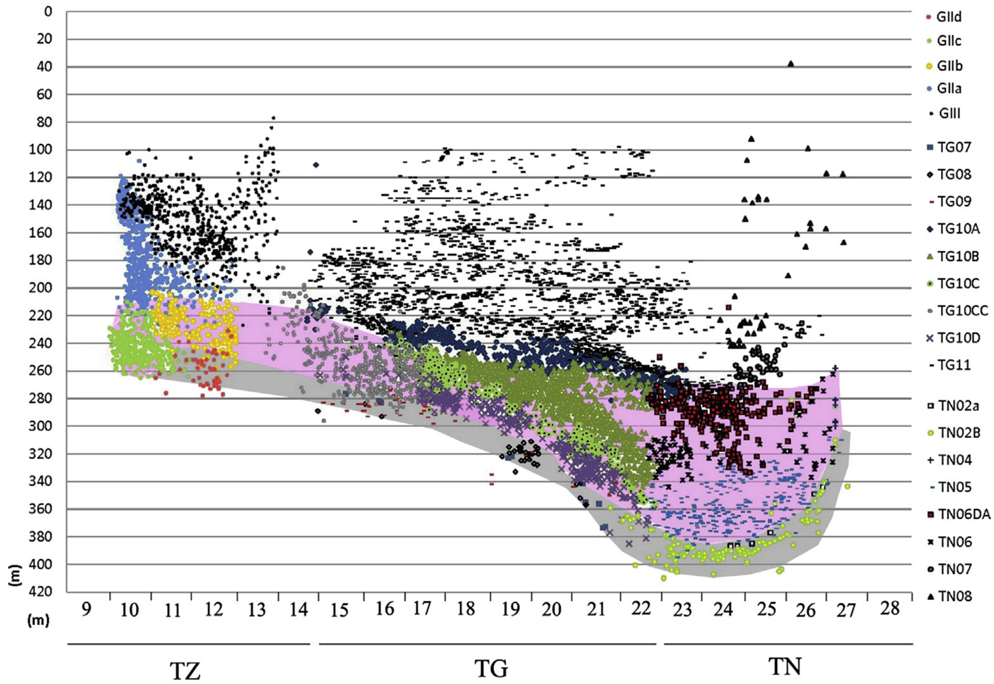

Fig. 3. Longitudinal projection of all the faunal and lithic remains from the Galería site and detail of the ground. The GIIa levels have been marked in grey and the GIIb levels have been marked in pink. The remains plotted come from **Line G** of the TG and TN areas and **Line N** of the TZ area (Modified from García-Medrano, 2011: 72). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Having characterized the unknapped cobbles, cores and flakes, we will then make a more detailed study of the large tools, due to the significance of these tools in Acheulean contexts. In order to better address this goal, the description of the configuration sequence defined by the British research tradition (Newcomer, 1971; Wenban-Smith, 1989; Wenban-Smith and Ashton, 1998) has been adapted. This method establishes several phases in the shaping process: Test, Rough-out, Shaping and Finishing. The tools have been assigned to a stage on the basis of their technological characteristics, such as the amount of cortex, the distribution, size and shape of the removals, the use of a hard or soft-hammer or a combination of both, the type of retouch, the angle between the two faces of the tool, etc. During the Shaping phase, the objects receive their general morphology from large removals which considerably modify the original bases, so the configuring affects 30–50% of the object. The Finishing phase implies more attention to edges and surfaces, and the configuring affects 50–100% of the object. Here, we are referring to the standardized large cutting tools, such as bifaces, including both handaxes and cleavers.

The shaping processes have been studied, focussing on faciality, percentage of perimeter modified by configuring, extent, direction and delineation (Rodríguez, 2004). However, to give a more detailed description of the shaping strategies, we have counted the number of scars per face and defined ten models of large tools, depending on where the presence of cortex was documented (Fig. 4).

This basic analysis has been completed by the use of several measurements that have traditionally been used in the study of the variability of large tools (Fig. 5) (Bordes, 1961; Roe, 1968, 1981). These measurements complement the information about morphologies and variations in size and shape (García-Medrano, 2011). These measurements have been combined into three main indices: Elongation (ratio of total length to maximum width), Refinement (ratio of maximum width to maximum thickness) and Planform (ratio of total length to base length). To complete our analysis of the technological strategies carried out inside the cave, we have performed refits and spatial analyses, which will be explained below.

4. Results

4.1. Raw materials and assemblage composition

Seven main types of raw materials were identified in the Galería's archaeological record, all of which are available in the direct surroundings of Sierra de Atapuerca, within a 2–5 km radius of the sites (García-Antón et al., 2002; García-Antón and Mosquera 2007. Neogene chert is the most abundant material in the Atapuerca record. This rock was formed during the Astaracian (Middle Miocene). It is extremely abundant in the Atapuerca area, and is available in the form of large blocks around the caves. It has a cryptocrystalline texture and flakes easily, although the irregularities in the texture and quality, even within the same blank, limit its workability. Cretaceous chert, from the Middle-Late Turonian, appears in two areas less than 2 km from the site: inside the karst, and in the highest part of the Sierra. This material, also cryptocrystalline, is more homogeneous and hence easier to flake, but of limited use due to the small size of its nodules (less than 15 cm). There were some cases in which the variety of chert (Neogene or Cretaceous) could not be defined. This was either because the chert has been considerably modified, or in other cases the specimens show no features that are clear enough to define them.

The other principal materials such as quartzite, quartz, sandstone and schist are of Palaeozoic origin, and appear in the form of medium to small cobbles. The main potential source areas of these materials are the Quaternary Arlanzón river terraces, but specific varieties of quartzite and quartz can also be found in formations such as Utrillas facies, exposed a few km from the sites. These materials flake easily to moderately

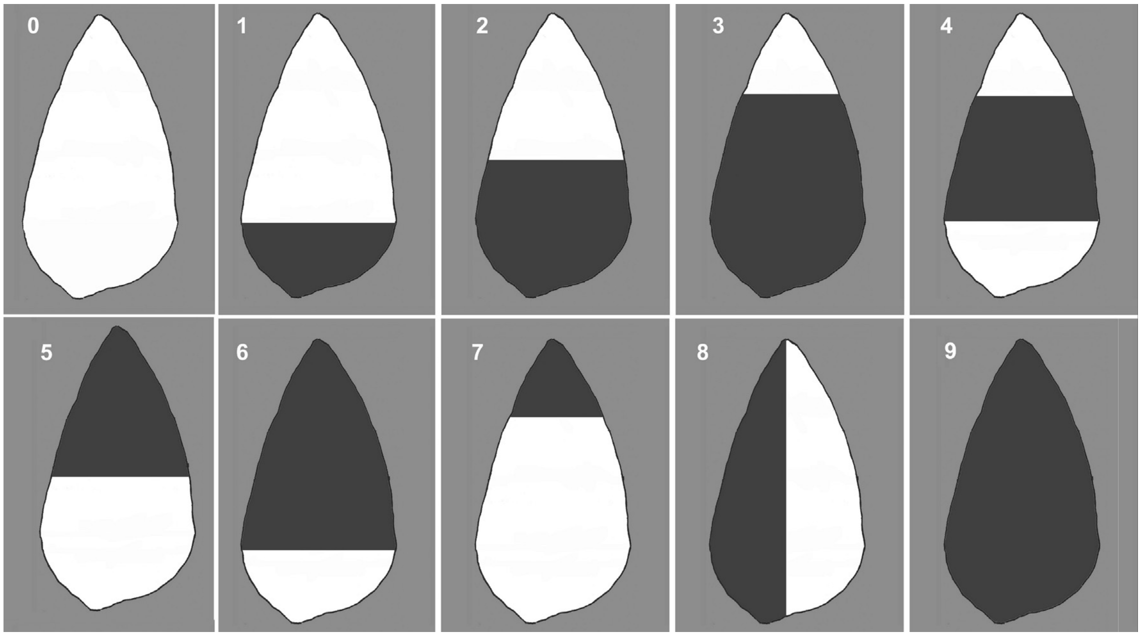

Fig. 4. Models of large tools, depending on where the cortical surface was located. Type 0 is non-cortical and Type 9 is completely cortical (he cortical surface is shown in grey and the non-cortical part is shown in white).

easily, depending on the homogeneity and grain size of each variety.

Finally, the limestone comes from the Cretaceous substrate of the Sierra. It appears in all formats (mainly in blocks but also in cobbles), with fine to coarse grain sizes, and with limited flaking properties.

The initial period of Acheulean technology in Atapuerca (the GIIa subunit in the Galería site) involved the use of six raw materials, of which Neogene chert (around 50%) and quartzite (33.57%) were the most heavily used. The group of materials of secondary importance includes sandstone (8.3%) and Cretaceous chert (6.5%). The third group includes materials with a marginal presence, such as limestone and quartz (Table 2).

Flakes are the main structural category (52.7%), followed by shaped tools (24%) and unknapped cobbles (here we refer to all those cobbles undoubtedly carried to the cave, with our without marks; 18%). The small tools were basically made of Neogene chert and quartzite. The large tools are, in more than the 58% of cases, made of quartzite. There are very few cores (2.53%), and they are basically made of chert (Neogene or Cretaceous) (Table 2).

However, the GIIa subunit has a unique characteristic, which is not found in the rest of the Galería site or in other Atapuerca sites.

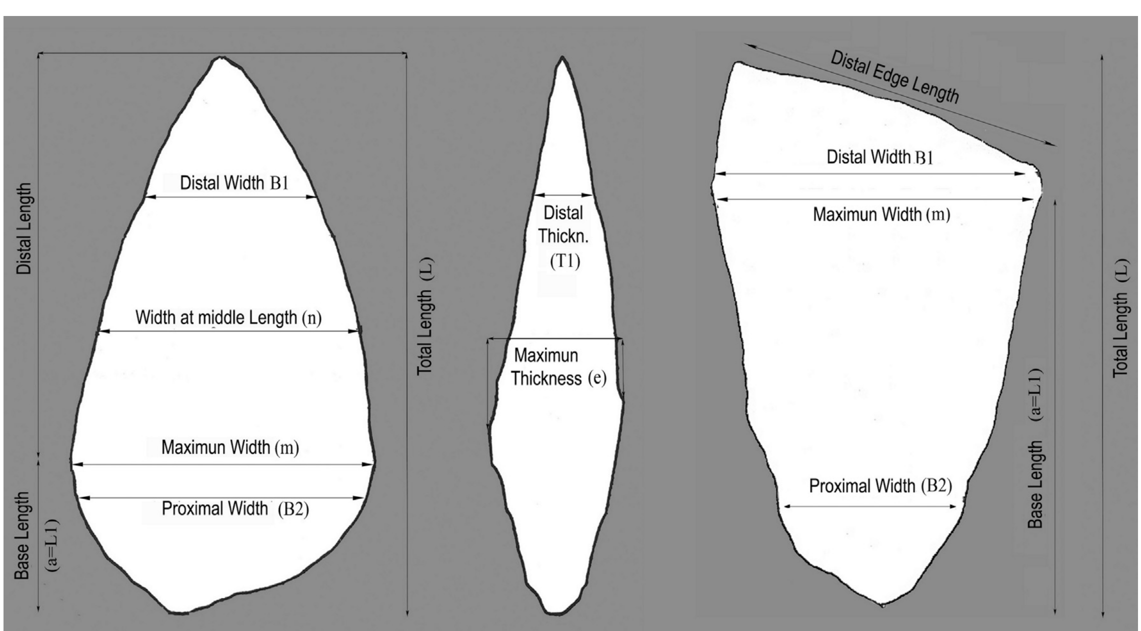

Fig. 5. Measurements taken from handaxes and cleavers, expressed as name and initials. Modified from García-Medrano (2011).

Table 2
All the lithic remains from the GIIa subunit, by raw materials and six general categories of tools. We found 55 indeterminate pieces of Neogene chert, which have been not included due to their poor conservation status and the loss of any technological characteristics. We have not counted these remains.

	Cobbles		Cores		Big tools		Small tools		Flakes		Fragments		Total	
Sandstone	5	*9.80*	–	–	3	*17.65*	3	*5.88*	12	*8.22*	–	–	23	*8.30*
Limestone	–	–	–	–	1	*5.88*	–	–	1	*0.68*	1	*20.00*	3	*1.08*
Quartzite	45	*88.24*	1	*14.29*	10	*58.82*	14	*27.45*	23	*15.75*	–	–	93	*33.57*
Quartz	1	*1.96*	–	–	–	–	1	*1.96*	–	–	–	–	2	*0.72*
Cretac.Ch.	–	–	3	*42.86*	–	–	6	*11.76*	9	*6.16*	–	–	18	*6.50*
Neog.Ch.	–	–	3	*42.86*	3	*17.65*	27	*52.94*	101	*69.18*	4	*80.00*	138	*49.82*
Total	**51**	*18.41*	**7**	*2.53*	**17**	*6.14*	**51**	*18.41*	**146**	*52.71*	**5**	*1.81*	**277**	

Bold represents the total number of tool category and italics for the % of this total with respect to the global total of the assemblage.

This is the substantial use of cobbles for knapping: in over 50% of cases, the configuration was produced on cobbles (García-Medrano, 2011: 218).

The GIIb subunit represents a major change. Firstly, there was a diversification in terms of the raw materials used. Quartzite was used less, dropping to 18.51%, and sandstone, Cretaceous chert and limestone were used more extensively, increasing to 9.62%, 8.41% and 7.21% respectively, as measured by the number of remains (Table 3). In this subunit, the cores were not only knapped of chert but also of quartzite. Secondly, the exclusive use of quartzite for making handaxes and cleavers had come to an end, and a combination of 6 raw materials were used, of which sandstone was most frequently used (36.84%). For the small toolkit a wider variety of raw materials were used, and sandstone represents 24% of the assemblage. Thirdly, knapping was performed on large flakes, which required considerable planning of the knapping sequences and a different level of resource management.

of quartzite and sandstone are 60–170 mm long and 15–60 mm thick. The dimensions of cores are very similar to those of the larger cobbles (Fig. 6). In a small number of cases, therefore, the largest cobbles could have been used as improvised cores. These are at a very early stage of the knapping process and were basically exploited using longitudinal methods (García-Medrano, 2011). This aspect does not explain the significant accumulation of cobbles inside the cave. These have traditionally been interpreted as cobbles collected to provide for possible lithic knapping or bone breakage requirements (Mosquera, 1995).

However, the discrepancy between the 90% of the unknapped cobbles' shapes and sizes and the dimensions of the large tools and cores (Fig. 6) indicate that these cobbles were not stored to be exploited. These show a tendency to spherical shapes and the large tools are longer and have flatter bases. Having the same length as a large tool, the cobble is between 15 and 20 mm thicker than it. In addition, most of the cobbles have percussion marks and fractures

Table 3
Lithic remains from the GIIb subunit, by raw materials and six general categories types of tools. We found 260 indeterminate pieces of Neogene chert; in most cases, they were indeterminate due to their poor conservation status. We have not used these remains.

	Cobbles		Cores		Big tools		Small tools		Flakes		Fragments		Total	
Sandstone	6	*12.50*	1	*9.09*	7	*36.84*	5	*4.95*	19	*8.26*	2	*28.57*	40	*9.62*
Limestone	12	*25.00*	1	*9.09*	1	*5.26*	5	*4.95*	10	*4.35*	1	*14.29*	30	*7.21*
Quartzite	29	*60.42*	4	*36.36*	4	*21.05*	16	*15.84*	24	*10.43*	3	*42.86*	77	*18.51*
Quartz	1	*2.08*	–	–	–	–	3	*2.97*	8	*3.48*	–	–	15	*3.61*
Schiste	–	–	–	–	–	–	–	–	2	*0.87*	–	–	2	*0.48*
Indet Ch.	–	–	–	–	1	*5.26*	–	–	–	–	–	–	1	*0.24*
Cretac.Ch.	–	–	2	*18.18*	1	*5.26*	11	*10.89*	21	*9.13*	–	–	35	*8.41*
Neog. Ch.	–	–	3	*27.27*	5	*26.32*	61	*60.40*	146	*63.48*	1	*14.29*	216	*51.92*
Total	**48**	*11.54*	**11**	*2.64*	**19**	*4.57*	**101**	*24.28*	**230**	*55.29*	**7**	*1.68*	**416**	

Bold represents the total number of tool category and italics for the % of this total with respect to the global total of the assemblage.

4.2. Exploitation processes

Unknapped cobbles have a significant presence in these levels of the Galería site. In the GIIa subunit, they represent the 18.41% and over 88% are quartzite cobbles. In the GIIb subunit, these continue to be significant, 11.54% of the whole sample. In this case, most of the cobbles are quartzite (over 60%), but there is an increased presence of both limestone (25%) and sandstone cobbles (over 12%). In both subunits, most cobbles show marks, or associated marks and fractures, resulting from percussion activities.

Two trends are observed when the length and thickness of cobbles are compared with the dimensions of cores and large tools (both quartzite and sandstone). Firstly, the unknapped are 45–120 mm long and 10–70 mm thick. Secondly, the large tools made

on their surfaces (Fig. 7), and the typology of these marks is clearly related to the use of those cobbles as hammerstones. Therefore, in spite of the scarcity of refittings and the fragmentation of the operational chains, there must have been more knapping activity inside the cave than has been documented.

None of the subunits contained many cores, and in GIIa, there were only 7 (2.53%). The production techniques were basically carried out on Neogene and Cretaceous chert cores. In 60% of cases, cobbles were used as blanks, with Cretaceous chert cobbles predominating (Fig. 8). The Unipolar Longitudinal method was most commonly used, and it was applied to Neogene chert and quartzite cores. Multipolar methods were used on the small Cretaceous chert cobbles, focused to the production of small and thick flakes. These would, in most cases, be retouched to produce small tools.

Please cite this article in press as: García-Medrano, P., et al., The earliest Acheulean technology at Atapuerca (Burgos, Spain): Oldest levels of the Galería site (GII Unit), Quaternary International (2014), http://dx.doi.org/10.1016/j.quaint.2014.03.053

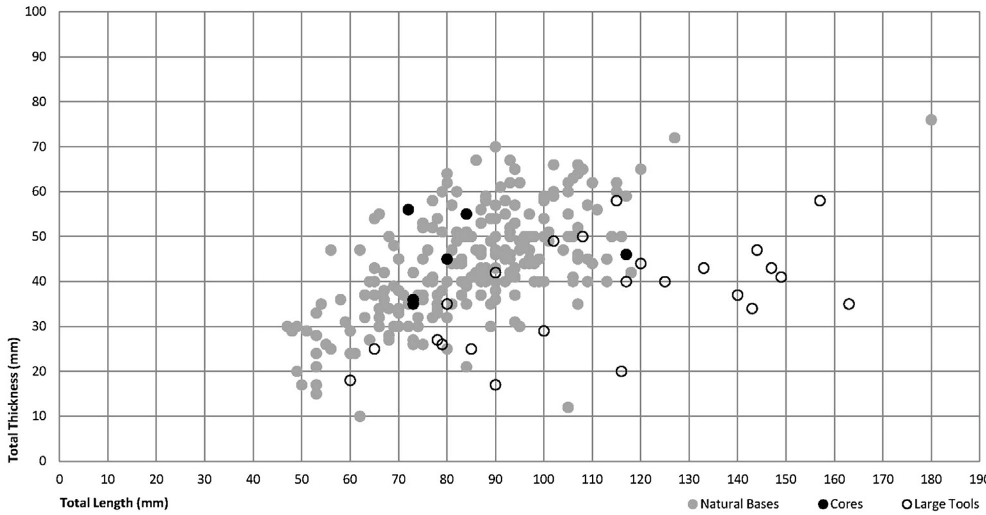

Fig. 6. Metrical comparison of the total length and the total thickness of unknapped cobbles and quartzite and sandstone cores and large tools.

The GIIb subunit (11 cores, 2.64%) represents an important change in exploitation techniques. In 50% of cases, the blanks are flakes. Additionally, the range of raw materials used increases from three types to five, with the appearance of sandstone and limestone (Fig. 8). The techniques are the same, but they are performed differently: the centripetal strategy appears to have been the most common technique and it was applied to cobbles or flakes and to very different materials such as sandstone, quartzite and Neogene chert. The exploitation in the Galería site therefore started with a simple use of raw materials with more expeditive methods, independently of the raw material. The GIIb subunit, however, shows a high level of knowledge of knapping techniques and raw materials.

The cores exploited by longitudinal methods are in an early stage of the exploitation process, but those knapped by centripetal and multipolar methods are in a very advanced stage. Most of them have been introduced to the cave after being knapped outside, which indicates a high degree of mobility and probably an "outside-inside-outside" route. In addition, the physical characteristics of cores and flakes are very different in terms of raw material quality. The products show more regular textures and in general a better workability than the cores. This implies that either the best quality cores were brought into the cave and then transported back outside, leaving the products inside after their use, or the best quality flakes were selected to be brought into the cave and then left inside it.

However, we have documented three refitting groups of production sequences from the GIIa subunit (A, B and C in Fig. 9) and four from the GIIb subunit (D, E, F and G of Fig. 9) (García-Medrano, 2011). The Cretaceous chert core (A) has been exploited by the multipolar method and the Neogene chert (E), by a longitudinal method. Both are exhausted. The quartzite and sandstone cores (F, G), however, exploited by the centripetal method, are in a medium stage in the production. They do not

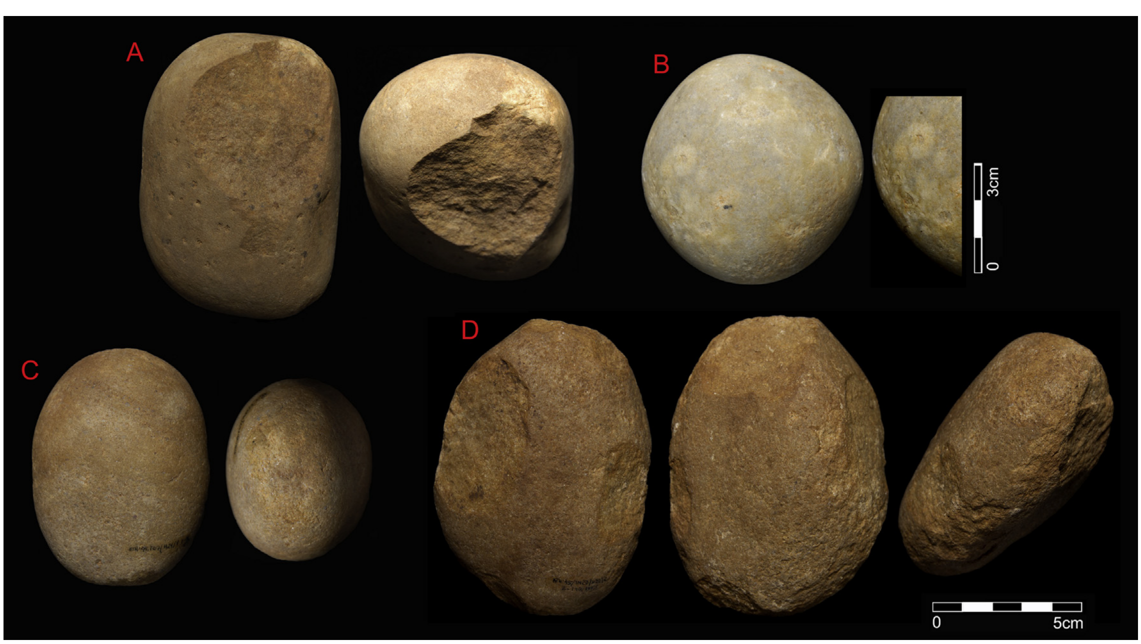

Fig. 7. Quartzite hammerstones from the GIIa subunit. **A**, ATA'94 TN2B F22, 2; **B**, ATA'95 TN2A F28, 9; **C**, ATA'95 TG7 H21, 1; **D**, ATA'95 TN2B H22, 2.

Please cite this article in press as: García-Medrano, P., et al., The earliest Acheulean technology at Atapuerca (Burgos, Spain): Oldest levels of the Galería site (GII Unit), Quaternary International (2014), http://dx.doi.org/10.1016/j.quaint.2014.03.053

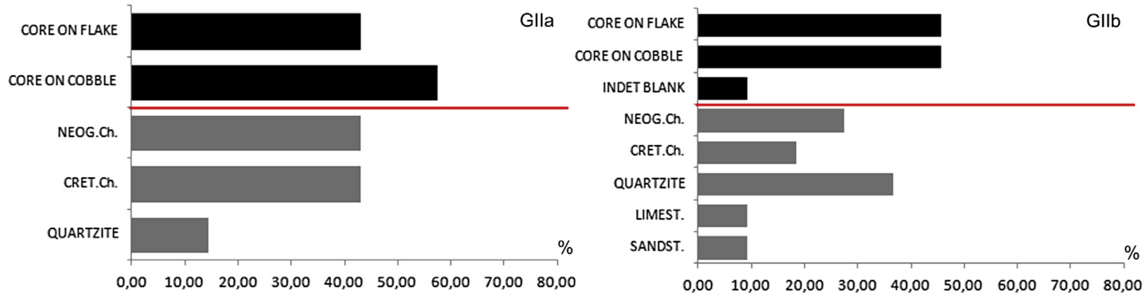

Fig. 8. Cores by raw materials (grey) and by generation (black). GIIa cores are on the left; GIIb cores are on the right.

indicate long knapping sequences but do prove the existence of knapping activities inside the cave, mainly aimed at providing for immediate needs, by detaching flakes that were probably used to meet these immediate needs.

In both subunits, the flakes are basically Neogene chert, quartzite and Cretaceous chert. In most cases, these are in micro and small formats and they are basically the result of longitudinal and centripetal methods. The ones resulting from longitudinal methods have cortical platforms and only one or two previous removals. They are quadrangular. The flakes derived from centripetal cores have non-cortical and bifaceted platforms and a considerable variety of planforms. In addition, we have documented three large Neogene chert flakes and one limestone flake, over 100 mm long (Fig. 10), which were probably brought into the cave in order to make large tools. This implies that the original block was prepared in order for these flakes to be detached in the desired manner. In GIIb, the presence of medium-sized flakes is greater, both because centripetal techniques were used more extensively and due to the blanks being larger. Additionally, new materials appear, such as limestone, schist and quartz. No schist or quartz cores have been found, so these flakes must have been detached from cores outside the cave.

There is a selection of small and medium flakes to be retouched, basically Neogene chert and quartzite. This retouch process was mainly used to make marginal scrapers and denticulated edges (Tables 4 and 5).

4.3. *Large tools' shaping processes*

The lower levels of the Galería Complex (GIIa subunit) contained a group of 17 large tools (6.14%) including choppers, chopping-tools, handaxes and cleavers. Over 70% were made from cobbles, of which around 60% were made of quartzite (Table 2), and the rest in sandstone and Neogene chert (Table 6). These proportions are exclusively of these lower levels of the Galería site. Subunit GIIb, however, represents an important change. Firstly, the presence of large tools drops from 25% to 16%, and that of small tools increases from 75% to 84%. Secondly, the configuration on flake amounts to 50%. Thirdly, quartzite is replaced by sandstone as the material most frequently used for large tools (Table 7).

The large tools made from cobbles represent a wide variety of tool types, such as handaxes, cleavers, choppers and chopping-tools. On the other hand, the only large tools made from flakes were handaxes and cleavers. Cobbles were therefore used intensively, flexibly and expeditiously, while large flakes were systematically used to produce more standardized large tools (Fig. 10). Additionally, the configuration strategies on flakes were more highly developed and defined than those used on cobbles.

The choppers and chopping-tools retain most of the original shape of the cobble and its cortical portion. The configuration is aimed at producing convex and irregular distal edges by means of large removals, obtained by hard-hammer percussion. Compared

Table 4
Small tools from the GIIa subunit by raw material and type.

	Marginal		Denticulates		Notch		Point		Scraper		Endscraper		Indet.		Total	
Sandstone	–	–	–	–	–	–	1	*33.33*	2	*66.67*	–	–	–	–	3	*5.88*
Quartzite	2	*14.29*	1	*7.14*	2	*14.29*	2	*14.29*	5	*35.71*	1	*7.14*	1	*7.14*	14	*27.45*
Quartz	–	–	–	–	–	–	–	–	1	*100.00*	–	–	–	–	1	*1.96*
Cret.Ch.	–	–	–	–	–	–	–	–	4	*66.67*	2	*33.33*	–	–	6	*11.76*
Neog.Ch.	1	*3.70*	11	*40.74*	1	*3.70*	6	*22.22*	3	*11.11*	2	*7.41*	3	*11.11*	27	*52.94*
Total	3	*5.88*	12	*23.53*	3	*5.88*	9	*17.65*	15	*29.41*	5	*9.80*	4		51	

Italic represents the value of tool type per raw material, we show in italics the % with respect to the total of small tools per raw material.

Table 5
Small tools from the GIIb subunit by raw material and type.

	Marginal		Denticulates		Notch		Point		Scraper		Endscraper		Indet.		Total	
Sandstone	–	–	2	*40.00*	–	–	–	–	3	*60.00*	–	–	–	–	5	*4.95*
Limestone	2	*40.00*	1	*20.00*	1	*20.00*	–	–	1	*20.00*	–	–	–	–	5	*4.95*
Quartzite	3	*18.75*	4	*25.00*	2	*12.50*	1	*6.25*	5	*31.25*	1	*6.25*	–	–	16	*15.84*
Quartz	1	*33.33*	1	*33.33*	–	–	–	–	1	*33.33*	–	–	–	–	3	*2.97*
Cret.Ch.	5	*45.45*	4	*36.36*	1	*9.09*	–	–	1	*9.09*	–	–	–	–	11	*10.89*
Neog.Ch.	18	*29.51*	17	*27.87*	2	*3.28*	4	*6.56*	15	*24.59*	–	–	5	*8.20*	61	*60.40*
Total	29	*28.71*	29	*28.71*	6	*5.94*	5	*4.95*	26	*25.74*	1	*0.99*	5		101	

Italic represents the value of tool type per raw material, we show in italics the % with respect to the total of small tools per raw material.

Please cite this article in press as: García-Medrano, P., et al., The earliest Acheulean technology at Atapuerca (Burgos, Spain): Oldest levels of the Galería site (GII Unit), Quaternary International (2014), http://dx.doi.org/10.1016/j.quaint.2014.03.053

Table 6
Large tools from the GIIa subunit by type of tool (Handaxe in the Shaping phase, Handaxe in the Finishing phase, Cleaver and Chopper), type of blank and raw material (sandstone, limestone, quartzite and Neogene chert). The percentages for each group are shown in italics.

	Shaped tools from cobble						Shaped tools from flake				Total	
	Sandstone	Limestone	Quartzite	Neo. Ch.	Total		Quartzite	Neo.Ch.	Total			
Handaxe Shap.	3	–	1	–	4	*33.33*	1	2	3	*60.00*	7	*41.18*
Handaxe Fin.	–	–	1	–	1	*8.33*	–	–	–	–	1	*5.88*
Cleavers	–	–	2	–	2	*16.67*	2	–	2	*40.00*	4	*23.53*
Choppers	–	1	3	1	5	*41.67*	–	–	–	–	5	*29.41*
Total	3	1	7	1	**12**		3	2	**5**		**17**	
	25.00	*8.33*	*58.33*	*8.33*	***70.59***		*60.00*	*40.00*	***29.41***			

Table 7
Large tools from the GIIb subunit by type of tool (Handaxe in the Shaping phase, Handaxe in the Finishing phase, Cleaver and Chopper), type of blank and raw material (sandstone, limestone, quartzite and Neogene chert). The percentages for each group are shown in italics.

	Indet blank						Shaped tools from cobble				Shaped tools from flake					Total	
	Limestone	Quartzite	Cretac.Ch.	Indet Ch.	Total		Sandstone	Quartzite	Total		Sandstone	Limestone	Neog.Ch.	Total			
Handaxe Shap.	–	–	–	–	–	–	1	–	1	*16.67*	1	1	1	3	*33.33*	4	*21.05*
Handaxe Fin.	1	1	1	–	3	*75.00*	–	–	–	–	1	–	2	3	*33.33*	6	*31.58*
Cleavers	–	–	–	1	1	*25.00*	2	1	3	*50.00*	–	1	2	3	*33.33*	7	*36.84*
Choppers	–	–	–	–	–	–	2	–	2	*33.33*	–	–	–	–	–	2	*10.52*
Total	1	1	1	1	**4**		5	1	**6**		2	2	5	**9**		**19**	
	25.00	*25.00*	*25.00*	*25.00*	***21.05***		*83.33*	*16.67*	***31.58***		*22.22*	*22.22*	*55.56*	***47.37***			

with the other types of large tools, these tools are significantly smaller. Their presence seems to correspond to immediate use of the cobbles available in the cave. Their presence drops from 30% of large tools in GIIa to 10% in GIIb.

The presence of cleavers in these base levels of the Galería complex is significant and varied, increasing from the lower to the upper levels. In GIIa they therefore represent over 23% of the large tools, and all are made of quartzite. In the GIIb subunit however, they account for almost 37% of the large tools, and are made of sandstone, quartzite or Neogene chert. In general, equal numbers of cleavers were made from flakes and from cobbles. In this analysis, we have considered the "classic" cleavers made from flakes (Tixier, 1956) together with those made from cobbles, paying more attention to the final tool outline (namely the transversal distal edge) and to their hypothetical use than to the reduction sequence required to obtain the blank.

These tools reflect a wide range of variability and differences both in size and in type of configuration. They correspond to Types 0, 1, 2 and 5 (Tixier, 1956). The largest ones have been made from large cobbles and the smallest from small flakes, retaining a high proportion of the original cortex in their medium-proximal portion (cleaver made from a cobble, B in Fig. 21; cleavers made from flakes, C and D in Fig. 21). The Neogene chert cleavers are made from large flakes, with lateral striking platforms, and with a clear tendency to have quadrangular shapes and an unretouched transversal edge (B and C of Fig. 23). Some quartzite cleavers are examples of the tendency to create the transverse edge by means of a large removal (Fig. 11). Some small, plane and marginal scars can be identified on this removal. These are probably related to the final use of these instruments. The concave profile of the distal edge may also be the product of a loss of material due to the tool being used. This has been noticed in some of the cleavers studied for use-wear traces, in which clear evidence of forceful hitting actions (Fig. 11.1) has been recorded. This characteristic edge fracturing points to chopping actions, although it is difficult to identify the worked material because the fracturing process itself restricts the formation of more diagnostic wear features as rounding and polishes (Fig. 11.2) (Ollé, 2003). We therefore seem to have evidence of the last moments in the useful life of these tools, after which they would have been abandoned inside the cave.

Handaxes are the commonest type of large tool found in both subunits. In GIIa they represent more than 45% of the large tools. In over 60% of cases, they were made from quartzite or sandstone cobbles (B, E and G of Fig. 20); the rest were made from flakes of Neogene chert or quartzite (A, C, D and F of Fig. 20). In the GIIb subunit, these proportions change, since over 60% of the handaxes were made using flakes (A, B, C, D and H of Fig. 22), and they were made from a wider variety of raw materials. Handaxes clearly made from cobbles represent only 10%, while in 30% of cases the shaping process was so extensive that it has been impossible to identify the type of blank (E, F, and G of Fig. 22).

All the handaxes found in the Galería base levels belong to the final phases in this operational chain: the Shaping and Finishing phases. There are no rough-outs or pre-shapes, although some of the large Neogene chert flakes were probably intended to be used for making these large tools (Fig. 10). The large tools from the Galería base levels are finished tools (García-Medrano, 2011). In the GIIa subunit, handaxes mostly belong to the Shaping phase. During this phase, the tools receive their general morphology from large removals and short operative chains. The configuring affects 30–50% of the object, retaining an important part of the blank's shape. In GIIb, however, the handaxes mainly belong to the Finishing phase. This phase implies more attention paid to edges and surfaces, and the configuring affects 50–100% of the object. The shapes of the blanks have therefore been more extensively modified.

Within the GII Unit, there is little evidence of several phases of retouching and, as mentioned above, retouching was mainly effected by means of hardhammer percussion. Overall, this has resulted in wavy edges and a certain lack of attention, so it is often possible to identify the general features of the original blank: a significant part of the cortex in one or both faces, the original thickness of the base, or the original ventral face in the case of a flake. The fact that no special attention was paid to specific details points to the idea that the general shape of these tools was the main goal of the production processes.

Please cite this article in press as: García-Medrano, P., et al., The earliest Acheulean technology at Atapuerca (Burgos, Spain): Oldest levels of the Galería site (GII Unit), Quaternary International (2014), http://dx.doi.org/10.1016/j.quaint.2014.03.053

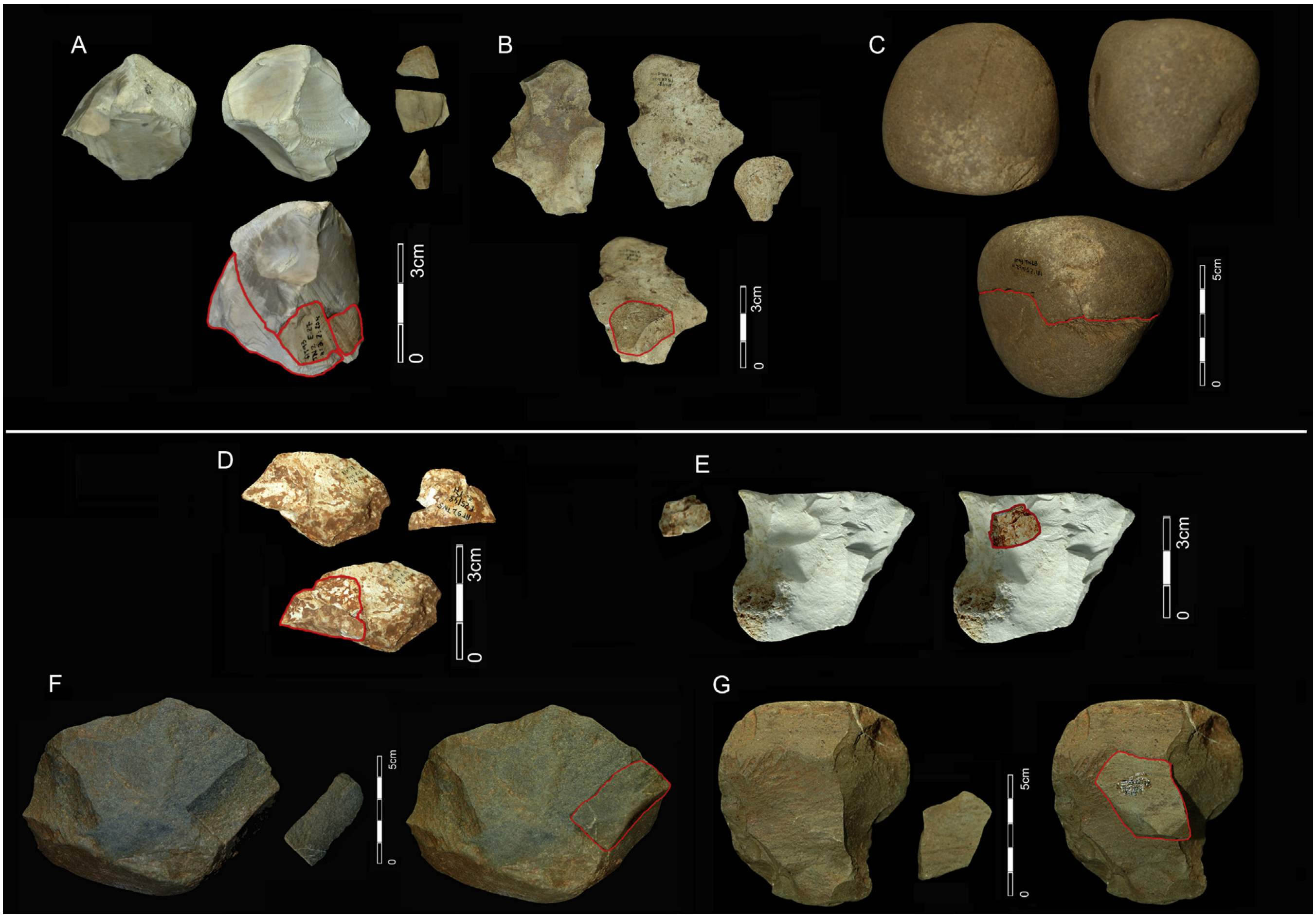

Fig. 9. Refittings of the production sequences from the *GIIa subunit* (**A**: Ata'93 TN2B E27,1 – Ata'93 TN2B E27,2 – Ata'93 TN2B E27,3 – Ata'93 TN2B E27,4 – Ata'93 TN2B E27,5; **B**: Ata'95 TN2B G25,1 – Ata'95 TN2B G25,2; **C**: Ata'93 TN2B H23,1 – Ata'94 TN2B F22,6) and the *GIIb subunit* (**D**: Ata'92 TN5 F25,48 – Ata'93 TN5 E24,6; **E**: Ata'92 TN5 G26,72 – Ata'92 TN5 G26,74; **F**: Ata'92 TG10B G18,78 – Ata'92 TG10B G20,125; **G**: Ata'92 TG10B F19,334 – Ata'92 TG10B G20,19).

4.3.1. Morphological variability within the large tools sample

Morphological variability among handaxes and cleavers has been explained as due to a variety or combination of factors. The "raw material model" explains that the original blank shape determines the final morphology of the tools (White, 1995; Ashton and White, 2003). The "reduction sequence model" describes how successive reduction stages explain the morphological variations of stone tools in the course of the sequence (Dibble, 1995; McPherron, 2006). A greater distal length is therefore linked to triangular/pointed shapes. On the other hand, a shorter distal length must be associated with oval shapes, due to the more extensive configuration process or to re-sharpening. Other authors, however, state that these differences can simply be explained by cultural traditions (Boëda, 1995; Sharon, 2008).

Roe (1968) was one of the first researchers to define handaxe types in terms of the shapes of the large tools: the pointed, oval and cleaver traditions. These morphologies were defined by the position of the maximum width with respect to the total length. Roe found no sites in Great Britain where the cleaver was the predominant type of tool. The dichotomy between the oval and pointed traditions was therefore the focus of the British Acheulean discussion.

Taking into account Roe's morphological definitions, the bifaces from the Galería base levels are mostly oval in shape (Fig. 12) and there is a strong homogeneity throughout the archaeological sequence (García-Medrano, 2011). A considerable number of

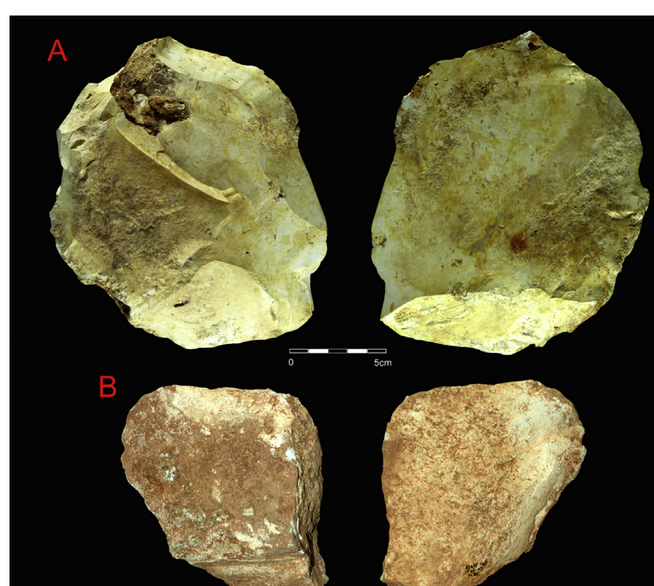

Fig. 10. Large Neogene chert flakes from the GIIa subunit (**A**: Ata'95 TN2B E27,1; **B**: Ata'95 TN5 F28, 1). Modified from García-Medrano (2011).

Please cite this article in press as: García-Medrano, P., et al., The earliest Acheulean technology at Atapuerca (Burgos, Spain): Oldest levels of the Galería site (GII Unit), Quaternary International (2014), http://dx.doi.org/10.1016/j.quaint.2014.03.053

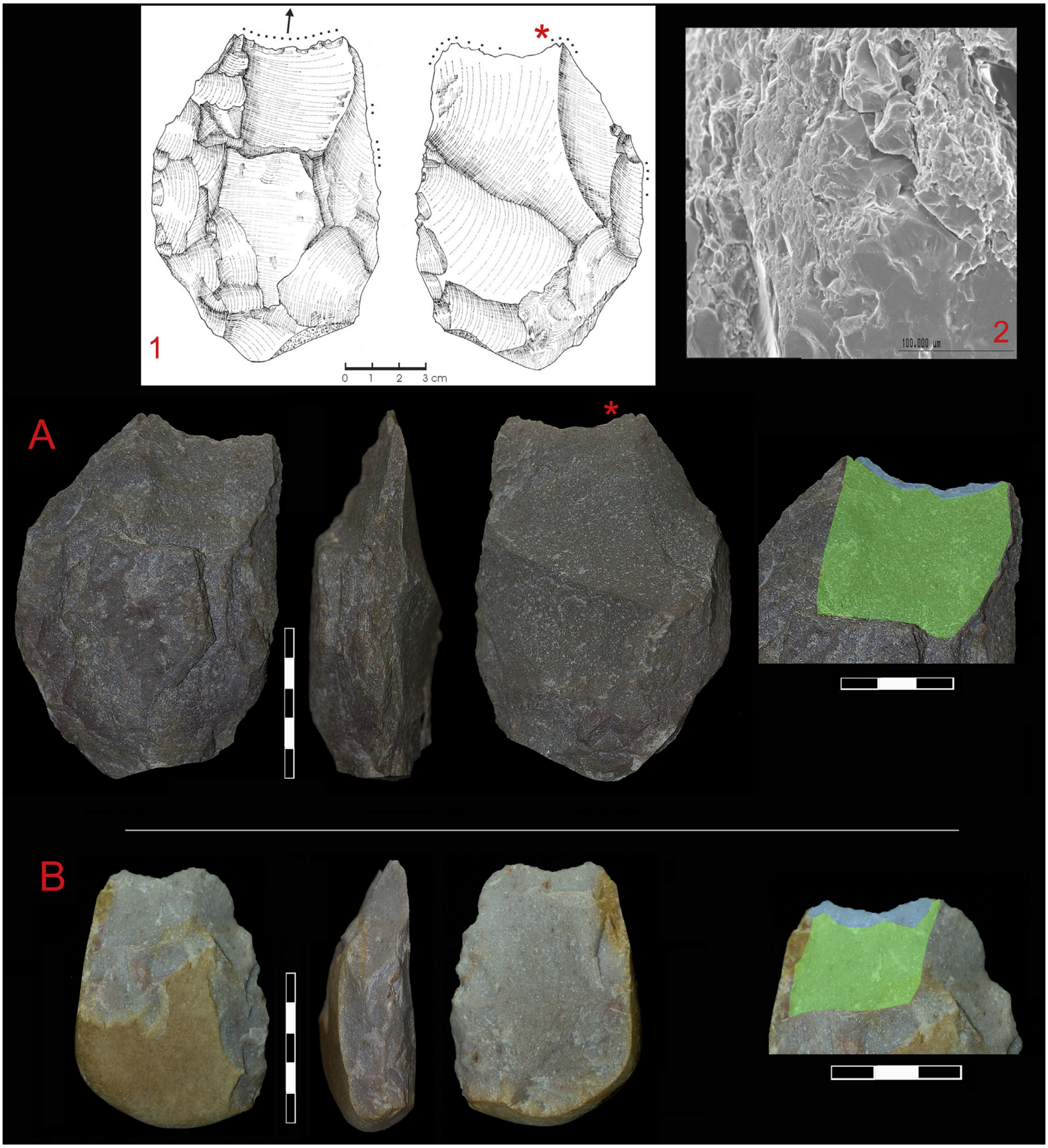

Fig. 11. Two quartzite cleavers from the GIIa subunit and detail of the distal end (**A**: Ata′94 TN2B F22 n.3; **B**: Ata′95 TN2B G28 n.4). In green, a large removal to produce the transverse edge and in blue, scars probably produced by using the tool. 1) Quartzite cleaver (A) used by its transversal edge in a chopping action against a non identified material. Also the side edges (especially the right one) show evidences of use (dotted line). 2) Wear traces recorded under the SEM, in form of edge rounding and only initial polish of the quartz crystals. Asterisk (*) shows the location of the SEM micrographs. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

handaxes present convex proximal butts. In the case of tools made from cobbles, the striking platforms are usually cortical. In general, these tools have narrow outlines and a clear tendency to pointed distal ends. The handaxes having pointed shapes are also the widest and have the shortest butts. There is an invariable tendency to thicker, elongated tools, but in the most recent GII levels there is a less variability in shape and the assemblage becomes more homogenous (Fig. 13).

There is a significant increase in the large tool dimensions from the GIIa to the GIIb assemblages but, as in the case of the shapes, the sample from the GIIb subunit is more homogenous (Fig. 14). In the GIIa subunit, the pointed handaxes are the shortest. The "reduction sequence" pattern does not, therefore, seem to work. Nevertheless, at that time the degree of configuring was very limited and the knappers aimed to configure the middle-distal portion and retained the original morphology of the proximal end. The results from the GIIb subunit were very different. The pointed handaxes are the longest, and the oval ones are the shortest. Thus, when the configuring process is more intense (Fig. 15), the "reduction sequence" model works. If we compare the percentage of the

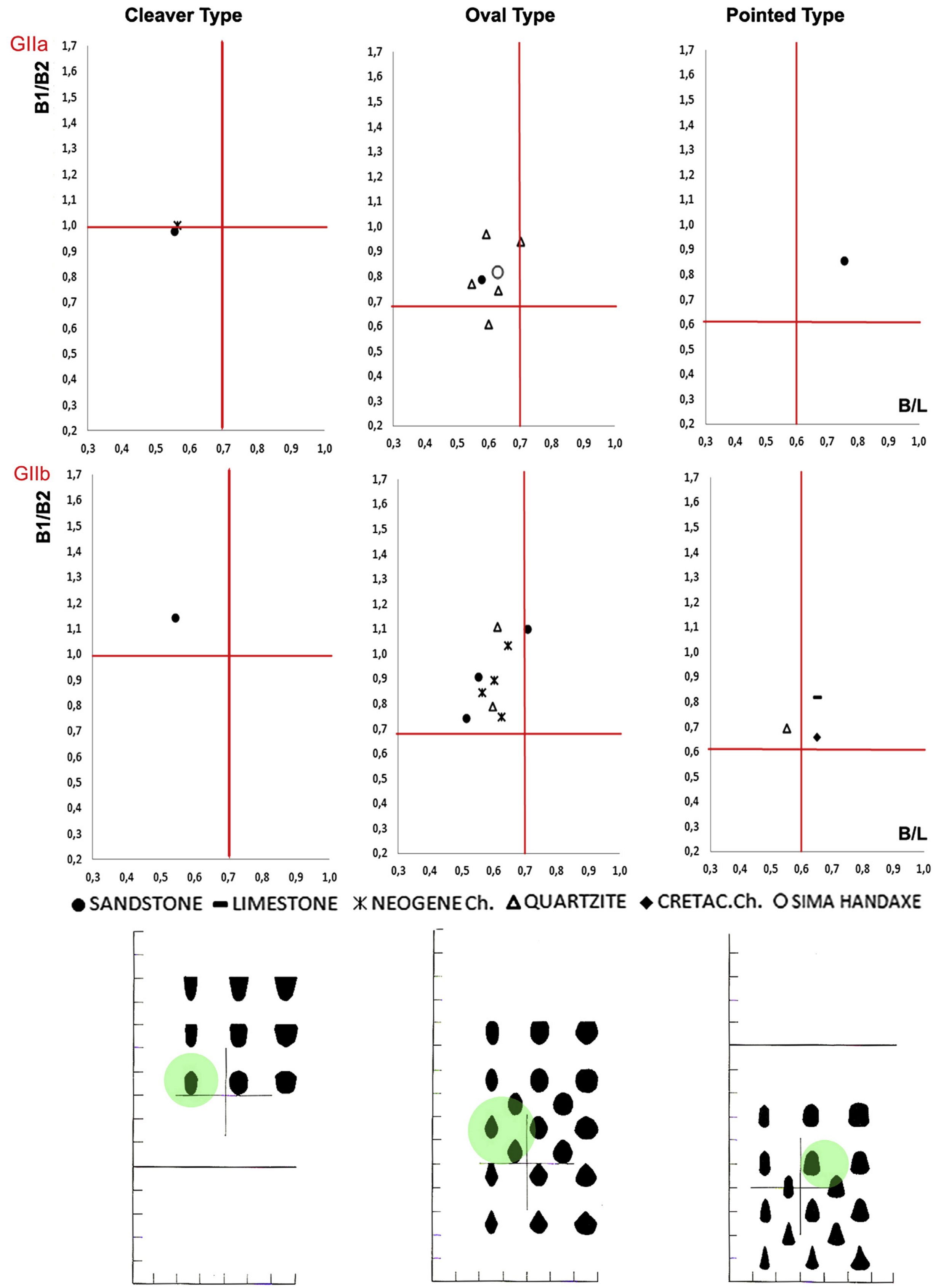

Fig. 12. Morphologies of bifaces from the base levels of the Galería site, in relation to the location of the maximum width. From left to right, cleaver type, oval type and pointed type. All the handaxes and the cleavers, including the Sima de los Huesos' handaxe have been taken into consideration.

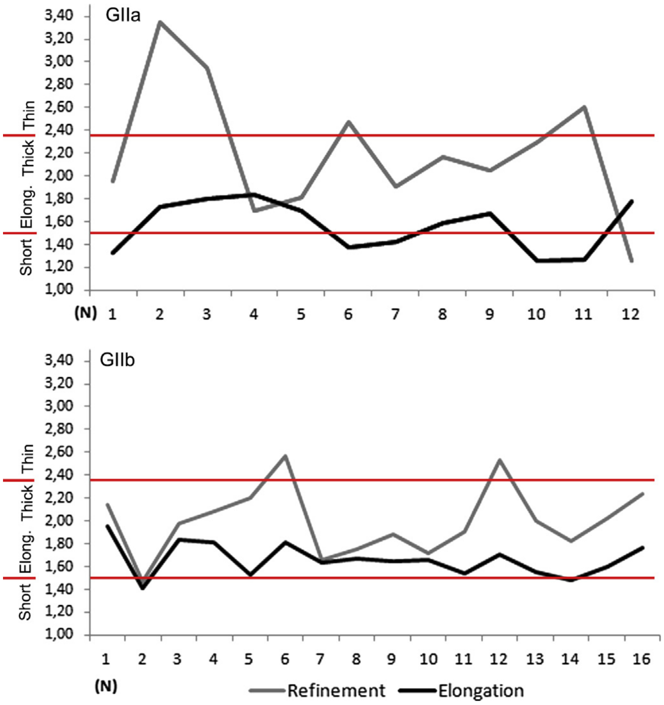

Fig. 13. Metrical Indices. The horizontal axis represents the number of cases (N), and the vertical axis represents the values of the indices: Refinement (ratio of maximum width to maximum thickness, shown as a grey line) and Elongation (ratio of total length of tools to maximum width, shown as a black line). The red lines represent the midpoint in the boundaries of the indices (1.5, in the case of Elongation and 2.35 in the case of Refinement). These figures include only handaxes and cleavers, and exclude choppers and chopping-tools. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

surface affected by knapping, the GIIa subunit is characterized by tools for which up to 60% of the surface has been affected by the shaping processes. In the GIIb, however, most of the large tools have had between 40% and 100% of their surfaces transformed by the configuring process.

A similar pattern of configuration has been found in both subunits. The knapping is concentrated on the middle-distal end (Fig. 16). This fact has also been corroborated through the use-wear studies. The analysed handaxes concentrate the use-wear traces along the lateral edges, especially on their end portions. The proximal ends, more abrupt, less shaped and quite often presenting cortical surfaces, seem to have worked as prehensile surfaces. The actions identified are those of cutting, and when the wear features are developed enough, the worked material has been identified as soft animal matter (clearly pointing to butchery activities) (Fig. 17).

Most of the variability in terms of intensity of shaping appears in GIIa, where the configuring strategies are less well-defined and are characterized by a limited number of scars, arbitrarily distributed over the surface. In the GIIb subunit, however, the greater homogeneity in terms of shapes and the more extensive shaping processes are accompanied by an increase in the number of scars per face. The GIIa assemblage presents up to 20 scars per face, and in GIIb the tools have been configured with between 5 and 50 scars in most cases. An exception was found in the GIIa subunit, a quartzite handaxe-pick (Fig. 20) which is in the Finishing stage of configuration. It represents a very extensive configuration, restricted to the middle-distal part and especially on the edges.

The differences between handaxes in the Shaping and Finishing stages are a constant feature of the GII unit. The handaxes in the Shaping stage show a smaller surface area affected by the knapping process and fewer scars (between 5 and 30) than the handaxes in the Finishing stage (between 10 and 70) (Fig. 18). On the tools made from cobbles, most of these scars are related to the process of configuring with the tool, but when the blanks were large flakes of Neogene chert, there are many scars that actually correspond to the previous task of detaching the flake. In spite of these technological

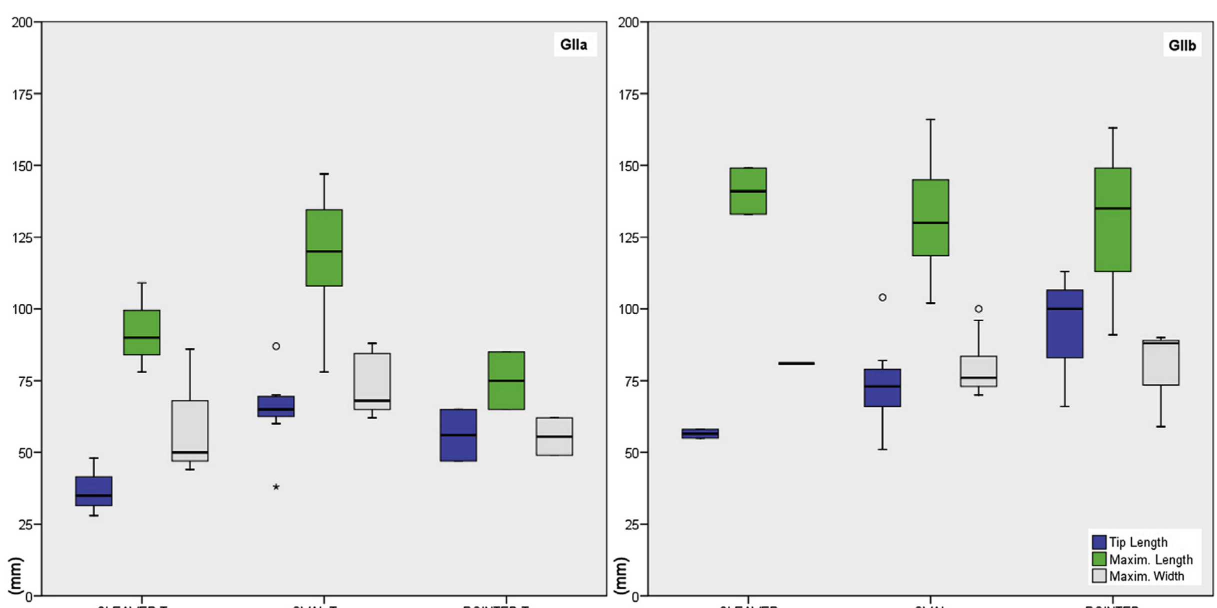

Fig. 14. Metrical Comparison between the handaxes in their three different morphological groups (Roe, 1968): Pointed, Cleaver and Oval Morphological Types. In blue, Tip Length; in green, Total Length; in grey, Maximum Width. The box plots diagram is essentially a summary plot based on the median, quartiles, and extreme values. Boxes represent the interquartile range that contains 50% of the values (the range from the 25th to the 75th percentile). The line across the box indicates the median. The whiskers represent maximum and minimum values, excluding outliers (which are indicated by circles, at least 1.5 times the interquartile range) and extremes (indicated by asterisks, at least 3 times the interquartile range). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

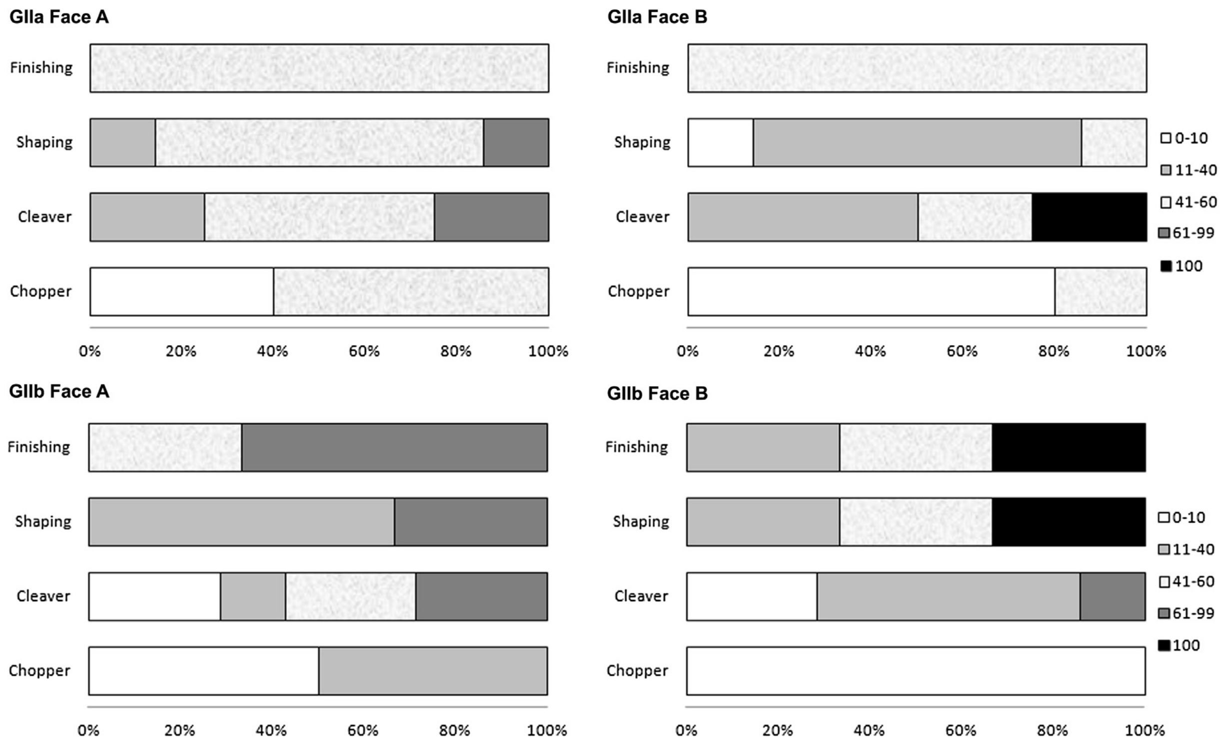

Fig. 15. Percentage of surface (dorsal on the left, and ventral face on the right) affected by the configuration. The data is shown by subunit (GIIa above and GIIb below), and by faces.

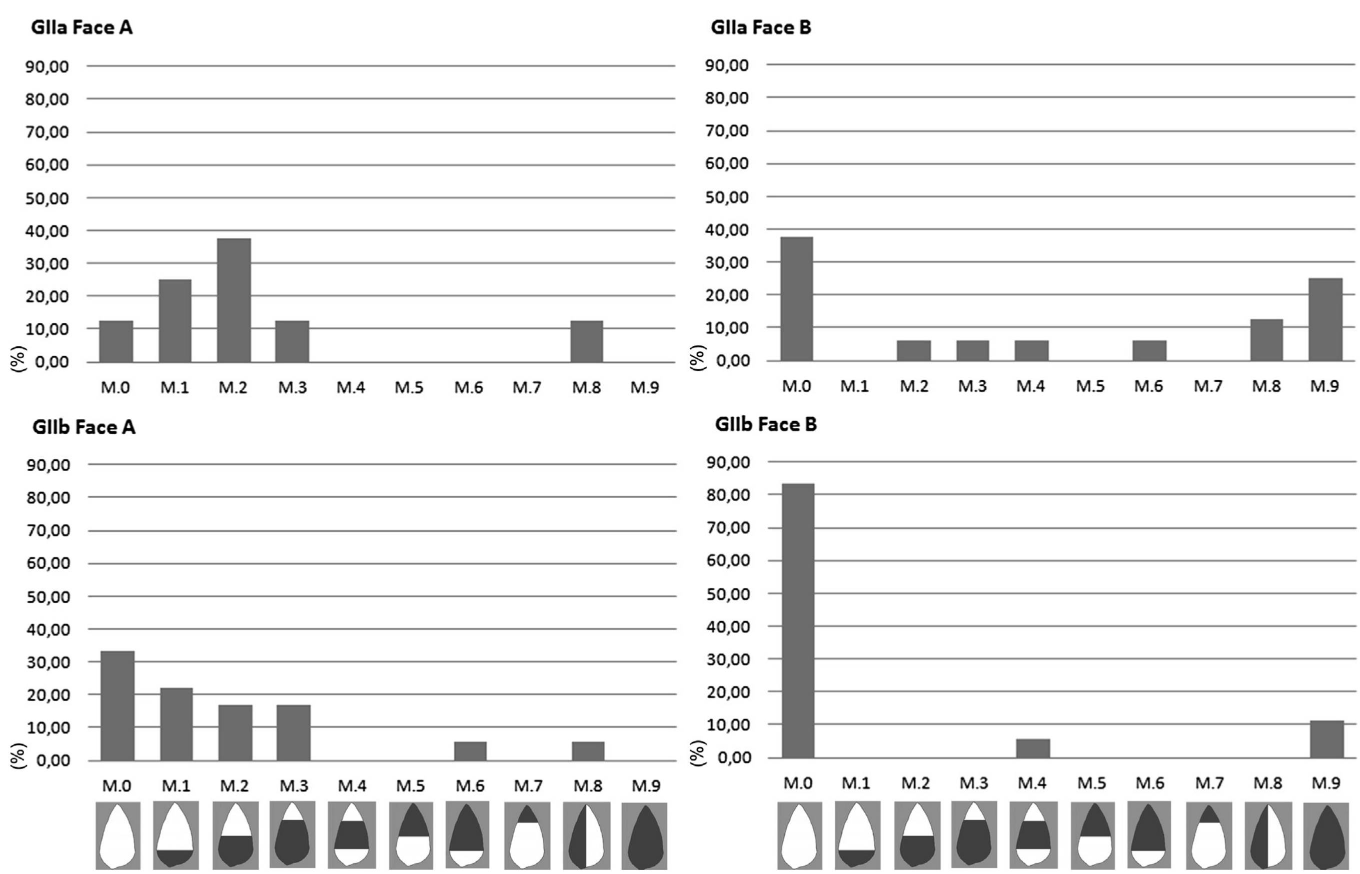

Fig. 16. Biface Models (from 0 to 9, taking into account cleavers and handaxes), depending on the location of the cortex. Type 0 is a non-cortical tool and Type 9 is completely cortical. The data is shown by subunit (GIIa above and GIIb below), and by faces.

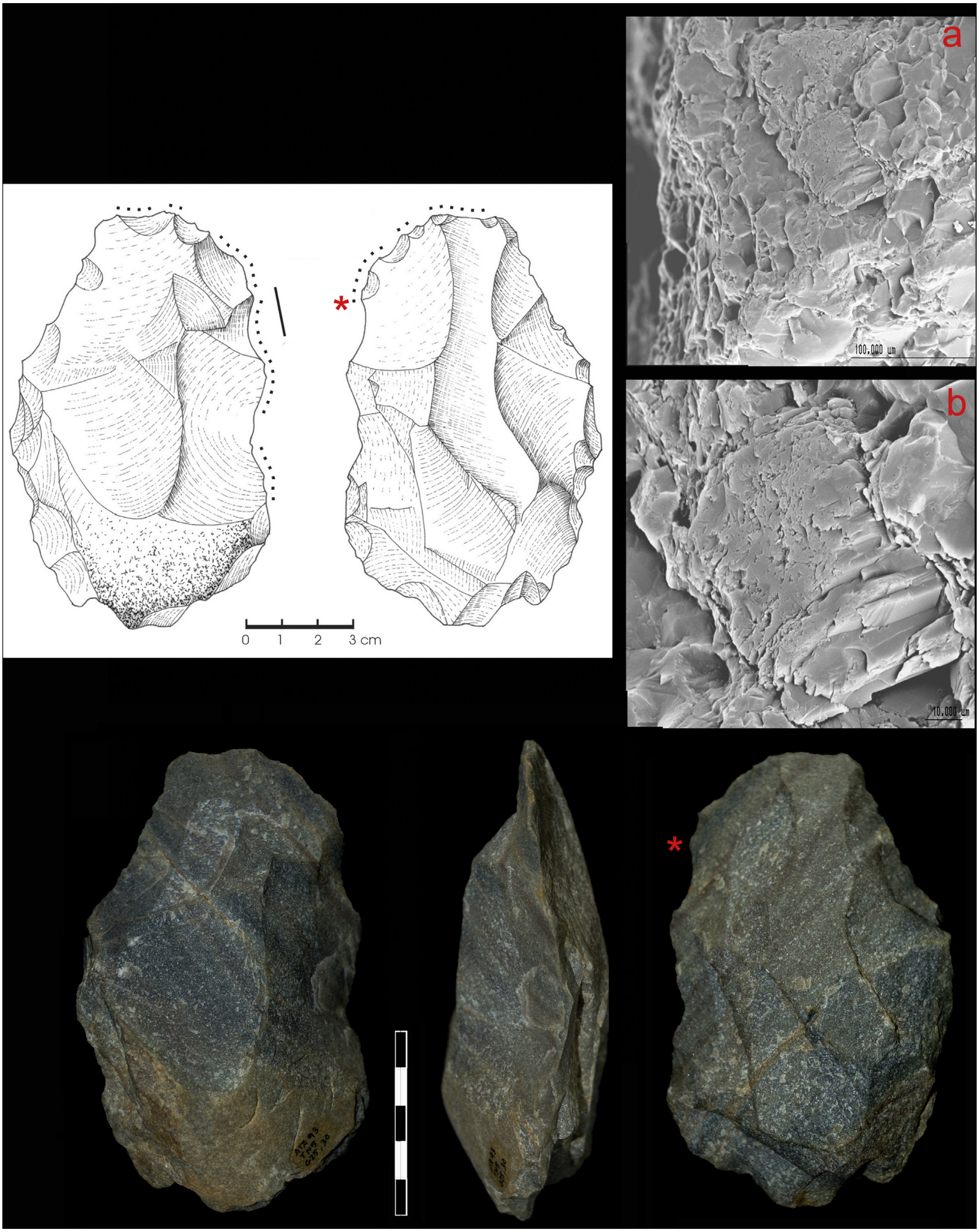

Fig. 17. Quartzite handaxe (ATA93-TN5, G25,30) used by its right lateral and distal edges in a cutting action. a) Wear traces recorded under the SEM, in form of well developed polish on the ridges of the microscars. b) Detail of the spot of maximum wear development, where soft linear features parallel to the edge can be observed. Asterisk (*) shows the location of the SEM micrographs.

characteristics, the handaxes in the Shaping stage are smaller than those in the Finishing stage (Fig. 19). The tools that were more extensively configured are bigger. There is therefore not a direct relationship between the intensity of the configuring process and the dimensions of the final objects; their size is affected by other variables, such as the features of the original blank.

The Galería base levels clearly show that the knapping was adapted to suit the selected blank. We have documented two

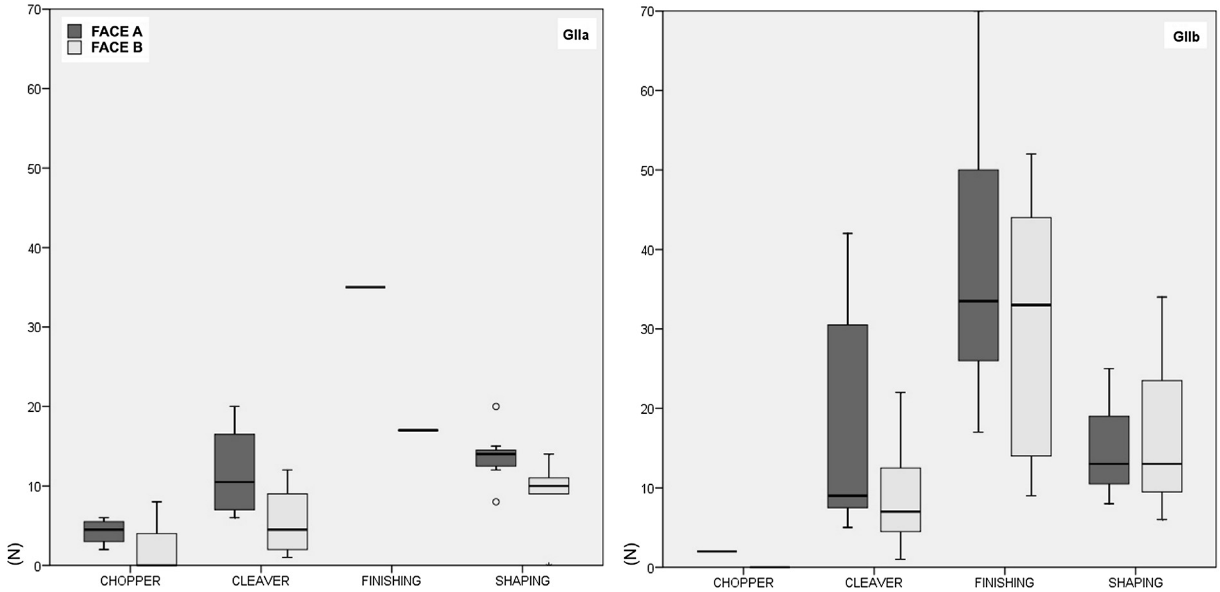

Fig. 18. Comparison between the number of scars by type of tool and by faces. Boxes, lines, whiskers, outliers, and extremes are as described in Fig. 14.

different types of configuration. The first one is related to those handaxes in the Shaping phase. These are basically made from sandstone or quartzite cobbles. They retain a significant part of the original blank's technical and physical characteristics (such as the cortical surface or the thickness). This configuration is made by removing large amounts of material, which significantly modifies the edges and generates a wide variability in shape, with just a few blows. This is the type of handaxe that predominates in the GIIa subunit. The second type is represented by handaxes in the Finishing stage of configuration, and is well defined in the GIIb subunit. In this case, the blanks selected are larger bases, the majority of them flakes. In spite of having been more extensively configured, these tools are the longest, as the knapping aimed to modify their middle-distal portion. At the proximal end most of the configuration seems to be basically oriented to solving problems with holding the object (and sometimes the original surface was kept unaltered).

5. Discussion: the Acheulean technology of Galería and the Iberian Peninsula

Acheulean technology originated in East Africa, around 1.7 Ma (Isaac and Curtis, 1974; Dominguez-Rodrigo et al., 2002; Lepre et al., 2011; Beyene et al., 2013), and was then dispersed across Africa, Europe and western and south Asia (Bar-Yosef, 2006). In Europe, Acheulean technology is documented around 500 ka and suddenly appears at dozens of sites. There are, however, very few sites dated to between 0.9 and 0.5 Ma, leading some authors to

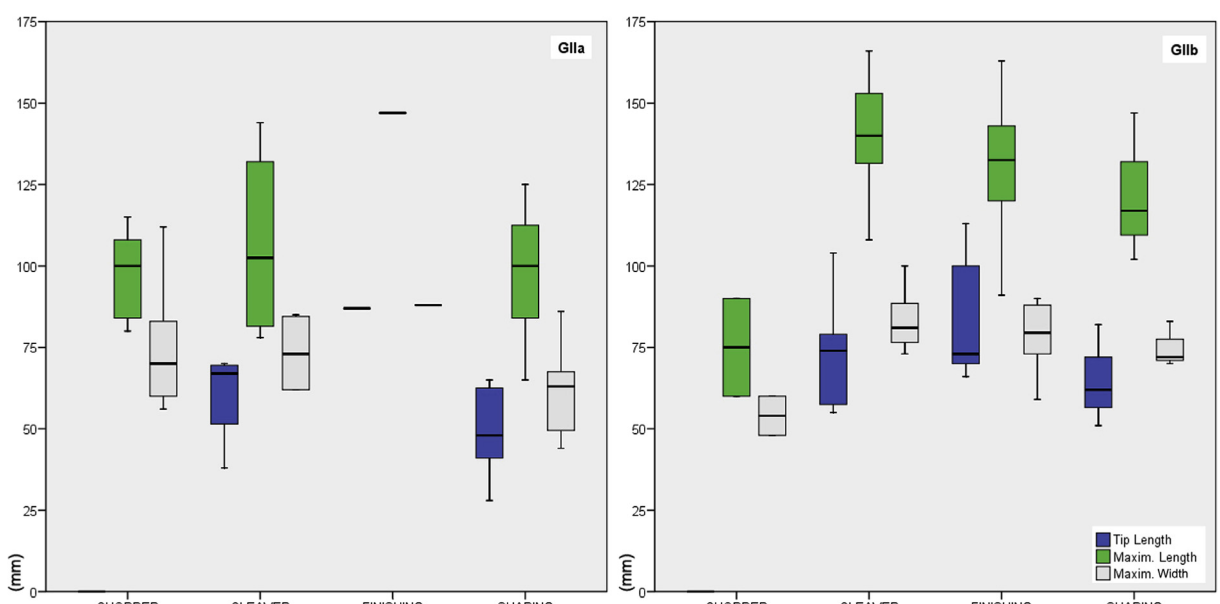

Fig. 19. Metrical comparison between Choppers/Chopping tools, Cleavers and Handaxes (in the Shaping and Finishing stages of configuration). In blue, Tip Length; in green, Total Length; in grey, Maximum Width. Boxes, lines, whiskers, outliers, and extremes are as described in Fig. 14. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

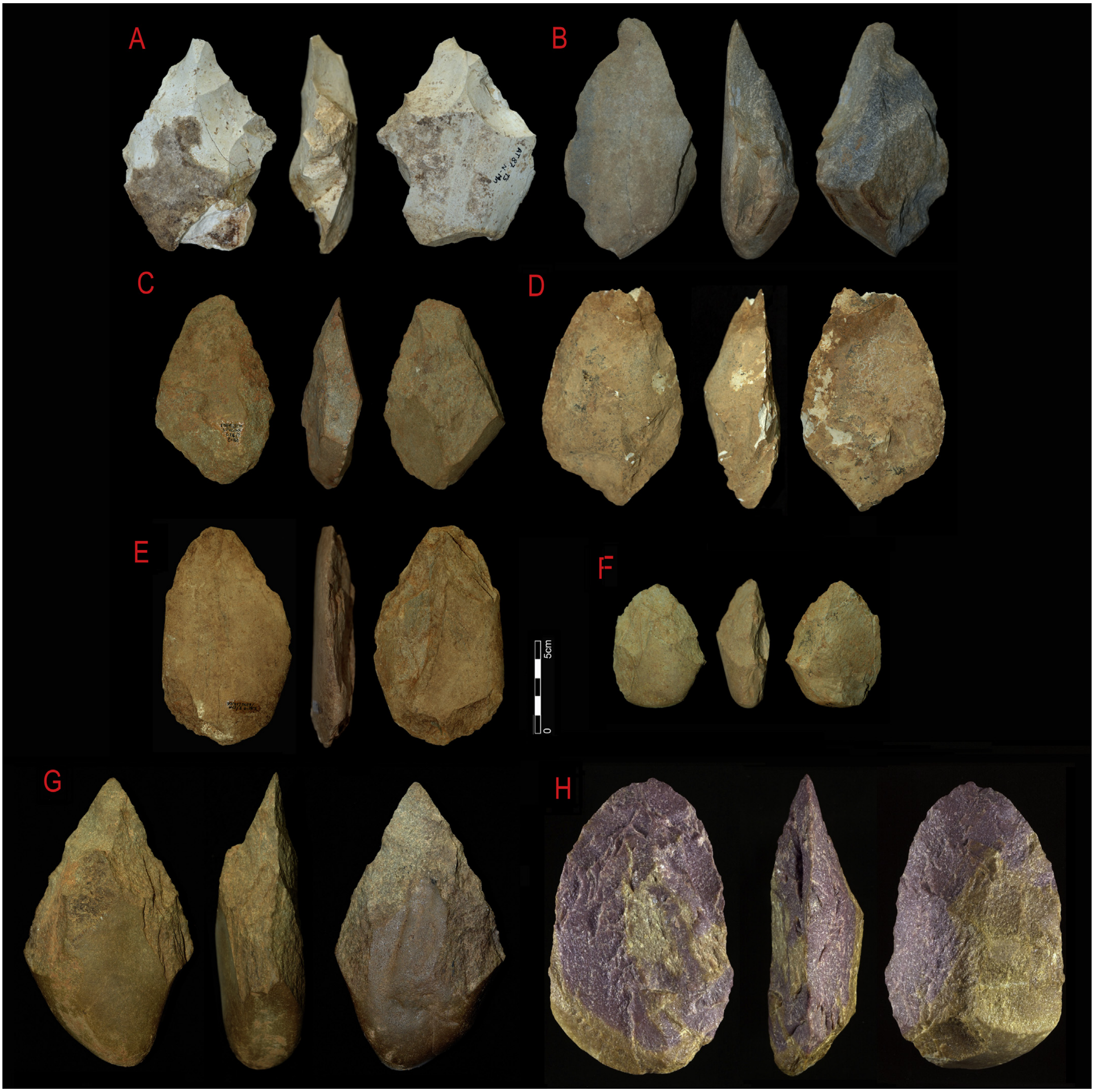

Fig. 20. Handaxes from the GIIa subunit. (**A**: Ata′87 TN2 S/C; **B**: Ata′94 TN2B G22,5; **C**: Ata′95 TN4 G28,3; **D**: Ata′96 TG GIId H12,10; **E**: Ata′95 TN2B H23,1; **F**: Ata′95 TN2B G28,3; **G**: Ata′94 TG7 F20,4; **H**: Sima de los Huesos quartzite handaxe).

suggest that the population of Europe may have decreased or nearly disappeared at that time (Mosquera et al., 2013). In recent years, new lithic assemblages with Early Acheulean features have been appearing dispersed around Europe which, for the first time, date to the end of the Lower Pleistocene. In Spain, the Solana del Zamborino (Guadix-Baza, Granada) and Quípar (Murcia) have been dated to 900 ka (these dates being debatable, Scott and Gibert, 2009; Jiménez-Arenas et al., 2011) and La Boella, Tarragona, has been dated to around 700 ka (Saladié et al., 2008; Vallverdú et al., 2009). In France, La Noira has been dated to 700 ka (Moncel et al., 2013) and there is also level P of L'Arago (570 ka) (Barsky and de Lumley, 2010). Other examples have been found at Notarchiricco in Italy, dated to 650 ka (Piperno and Tagliacozzo, 2001).

Multiple sites have been found in Europe that date to 500 ka, such as Boxgrove (in England, Roberts and Parfitt, 1999), Galería in Atapuerca (Berger et al., 2008; Falguères et al., 2013), Cageny-la-Garenne (in France, Bahain et al., 2001) and others (see Santonja and Villa, 2006). The discontinuity between the Mode 1 and Mode 2 occupations has also been observed in the hominin fossil record, between 600 and 500 ka (MacDonald et al., 2012). *H. antecessor* was replaced by an immigrant population represented by the hominins of Galería and Sima de los Huesos, *H. heidelbergensis* (Arsuaga et al., 1997a).

Please cite this article in press as: García-Medrano, P., et al., The earliest Acheulean technology at Atapuerca (Burgos, Spain): Oldest levels of the Galería site (GII Unit), Quaternary International (2014), http://dx.doi.org/10.1016/j.quaint.2014.03.053

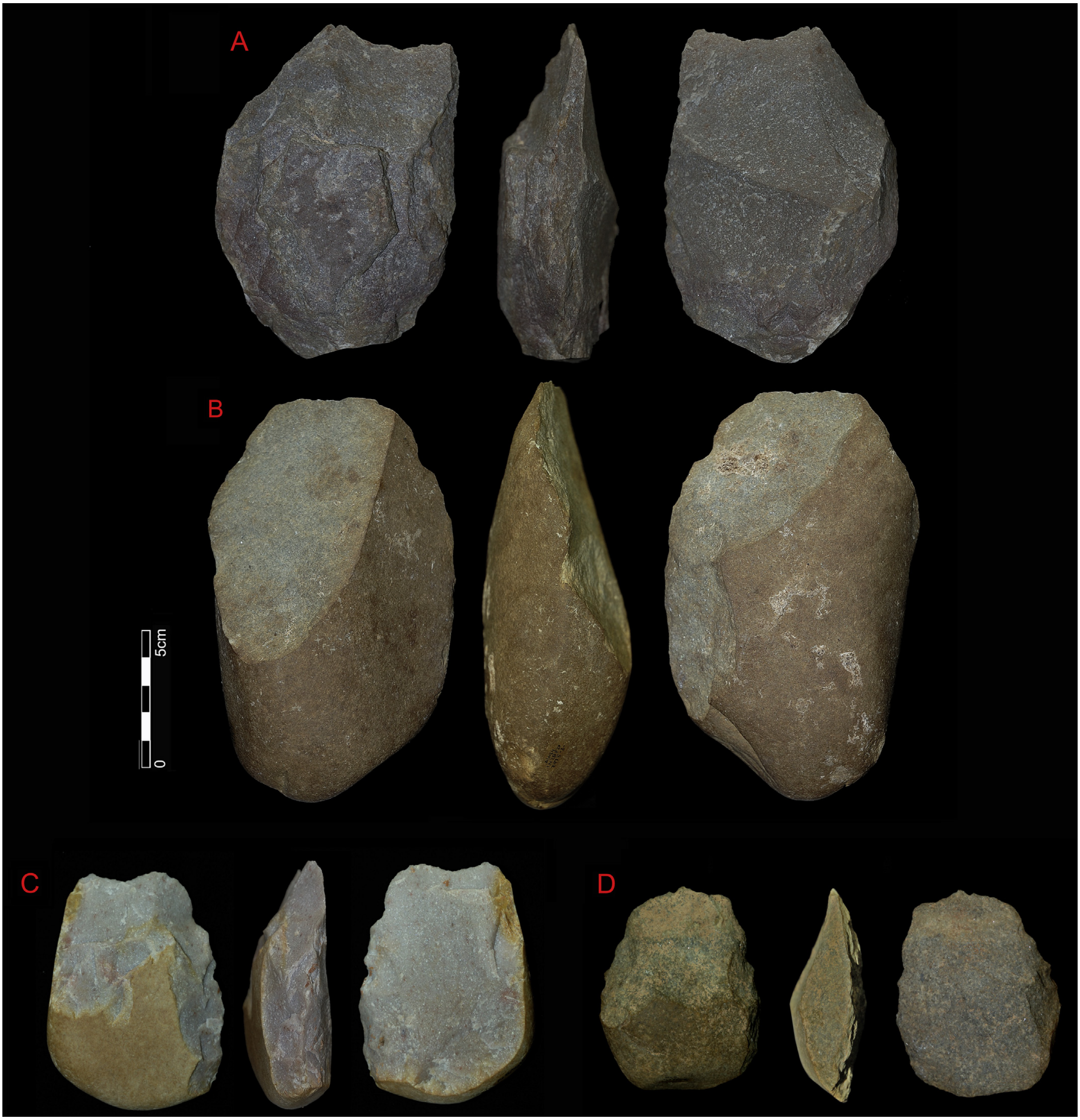

Fig. 21. Cleavers from the GIIa subunit. (**A**: Ata′94 TN2B F22,3; **B**: Ata′94 TN2B F27,2; **C**: Ata′94 TG7 F20,2; **D**: Ata′95 TN2B G28,4).

We have also documented this hiatus between 900 ka and 500 ka in the occupation of the Sierra de Atapuerca (Mosquera et al., 2013). In Galería we have an occupational sequence running from 500 ka to 250 ka, which offers us the chance to analyze the local evolution of the Acheulean technology. The GIIa Unit represents the first documented evidence of human presence in the Atapuerca sequence after this hiatus. This technology reflects the use of six main raw materials, predominantly Neogene chert and quartzite. The flaked blanks are basically quartzite cobbles. The Neogene chert was mainly used in producing small flakes and small retouched tools. The exploitation techniques are characterized by limited development of the production sequences and by their simplicity, with the Longitudinal and Orthogonal methods being represented. The operational chains are very fragmented and most of the knapping work was carried out outside the cave. The large tools include choppers, chopping-tools, and especially, cleavers and handaxes. These were basically made from quartzite cobbles, taking advantage of the originals' morphology and often retaining a significant part of the original shape. The configuration was obtained through a limited number of removals, which were dispersed and non-systematic, and little care was taken with the edges. These aspects lead us to mention maximization of effort. By using

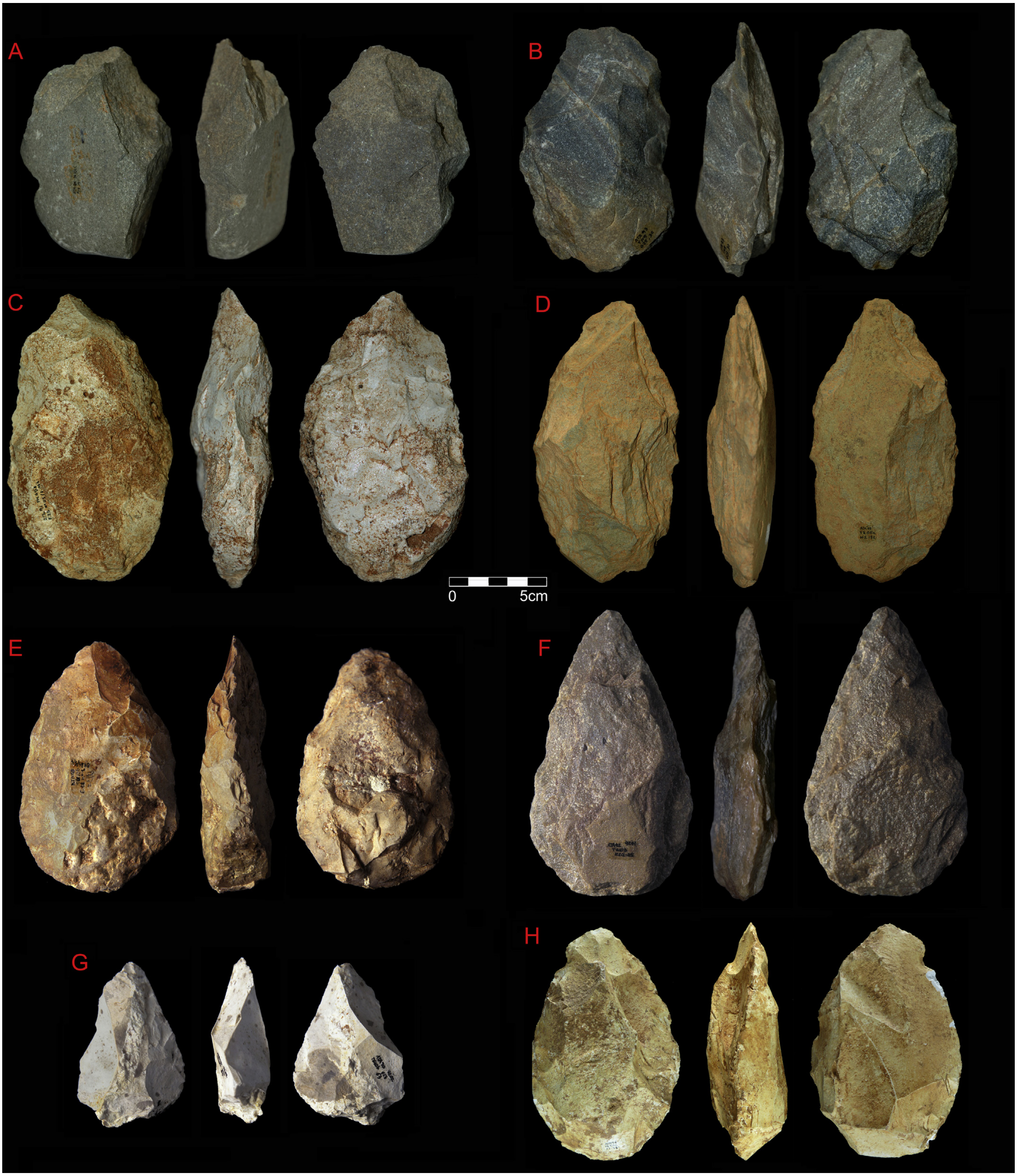

Fig. 22. Handaxes from the GIIb subunit. (**A**: Ata'89 TG10C F15,15; **B**: Ata'93 TN5 G25,30; **C**: Ata'91 TN6DA F25,115; **D**: Ata'08 TZ GIIc N2,152; **E**: Ata'88 TG10B E18,1; **F**: Ata'92 TG10B H20,25; **G**: Ata'90 TG10B F17,63; **H**: Ata'96 TZ GIIc L2,48).

minimum effort and short operational chains, these populations produced efficient lithic tools. The predominant use of quartzite for producing large tools can been related to this material's versatility and greater durability. These aspects gave the populations of Atapuerca a significant degree of economical adaptability (Mosquera, 1998).

The handaxe from the Sima de los Huesos site fits into the general features of the quartzite handaxes from the GIIa subunit. It

Fig. 23. Cleavers from the GIIb subunit. (**A**: Ata′92 TG10c G18,1; **B**: Ata′91 TG10B F20,53; **C**: Ata′08 TZ GIIc N2,14; **D**: Ata′93 TN5 F25,32; **E**: Ata′96 GIIc H13,17; **F**: Ata′92 TG10c G17,1).

Please cite this article in press as: García-Medrano, P., et al., The earliest Acheulean technology at Atapuerca (Burgos, Spain): Oldest levels of the Galería site (GII Unit), Quaternary International (2014), http://dx.doi.org/10.1016/j.quaint.2014.03.053

is an oval handaxe made from quartzite and measures 154 × 97 × 48 mm (Fig. 12 and 20). This handaxe is in the Finishing stage of configuration. It shows two configuration series: an initial series during which it was shaped by large invasive removals that were probably made by hardhammer percussion, and a second one, during which the configuring process was focused on the edges and on the convex distal end (Carbonell et al., 2003; Ollé et al., 2013).

The GIIb subunit (237–269 ka) shows some significant technological changes. Although the same raw materials were used, their proportions are quite different. Neogene chert continues to be the main material, but quartzite loses its predominance, and sandstone becomes the third most important lithic resource. In this subunit the knapping was mainly carried out on flakes, and there was a significant increase in sizes. Centripetal exploitation became the main technique. The large tools are made from flakes, with sandstone becoming the most heavily used material. In this case, there is a certain degree of standardization in the way the shaping process was carried out. The operational chains are longer than in the GIIa below it. These result in a greater modification of the blank, as seen from the increased number of scars.

Throughout the sequence, the pattern of hominin benefit of the herbivores that fell into the cave was homogeneous. This consists of transporting complete small animals or selectively transporting the most nutritious segments of medium or large animals (Cáceres, 2002; Ollé et al., 2005). The main difference within the sequence is the scarcity of bone remains in the GIIa subunit. This does not reflect a lower level of human activity in the Galería site. Rather, it reflects the poor conservation of remains in the GIIa subunit, due to the influence of organic sediments (Huguet et al., 1999; Ollé and Huguet et al., 1999). Nor was there any change in the raw materials available and used by humans. So, this change must therefore be interpreted as an evolution of the local Acheulean traditions.

Clark (1994) and Santonja and Villa (1990) noted the progressive loss of the archaic characteristics in favour of Mode 2 characteristics of refining morphologies and taking more care over the configuration of the tools. These authors analyzed the Acheulean technology of the Iberian Peninsula and described three phases. The known Middle Pleistocene sites of the Iberian Peninsula almost invariably appear in fluvial deposits of middle river terraces (Santonja and Villa, 2006) .The initial phase of Acheulean technology on the Iberian Peninsula involved the use of hard-hammers to create irregular handaxes, a large number of cleavers, and the use of cobbles as blanks for knapping. Secondary retouching is almost absent. This phase also retained Oldowan techniques and technological characteristics. Santonja and Villa (2006) included the Pinedo (Toledo) and La Maya III (Salamanca, +50 m terrace in the Tormes terrace) sites in this phase. During the second phase, handaxes and cleavers continued to have irregular morphologies, but the centripetal technique spreads and evolves, and the first stages of the Levallois technique appear. The La Maya II and I (Salamanca, +30/+12 terraces in the Tormes river) and the Manzanares and Tagus basin sites (such as El Sartalejo in Cáceres province, +28 m terrace in the Alagón river) have been included in this phase. In the third phase, the handaxes were nearly symmetrical, with micoquian morphologies, the cleavers had undergone bifacial retouching and the picks were well defined. This is the case of the El Basalito (Salamanca, +20 m terrace in Yeltes river) and Porzuna (Cuidad Real, +5 m terrace in Bullarque river) sites. The soft-hammer was included progressively throughout the evolution of Acheulean technology, and this led to greater control over the configuration.

The technological changes seen throughout the lower levels of the Galería site seem to be coherent with these global characteristics. The lithic technology of Galería is similar to that of other Iberian sites such as Torralba and Ambrona, El Sartalejo, the Terraces of Manzanares and the Duero basin sites, among others. These sites show a technology characterized by the use of quartzite cobbles and an abundance of cleavers and irregular and thick handaxes. The differences between sites have traditionally been linked to the differences in the raw materials available (Mosquera, 1998; Santonja and Villa, 2006). The knapping seems basically to have been carried out using hardhammers.

The features that are common to the Iberian Acheulean technology and its similarities with the North African Acheulean assemblages have led some authors to propose the Strait of Gibraltar as route by which this technological complex reached southern Europe around 500 ka (Santonja and Pérez-González, 2010; Sharon, 2011). Furthermore, the technological characteristics of the central and northern European Acheulean industries, such as the predominant use of flint, the long shaping sequences, the reshaping of edges, and the scarcity of cleavers, seems to distance these industries considerably from those used on the Iberian Peninsula and in North Africa. These differences have traditionally been linked to the technology used in the latter zones having a different origin (Moloney et al., 1996; Santonja, 1996; Sharon, 2009, 2011).

6. Conclusions

The appearance of Acheulean technology in Atapuerca has been documented to around 450–350 ka in Sima de los Huesos and in the GIIa subunit of the Galería site. In spite of the scarcity of remains and the significant degree of fragmentation in the operational chains, the Galería site has given us the chance to document the appearance of the technology and some important changes within this assemblage. The initial Acheulean technology in Atapuerca is characterized by the use of a wide range of raw materials as well as the overwhelming use of cobbles for knapping. The exploitation techniques are very simple, being basically longitudinal and multipolar, mainly applied to Neogene and Cretaceous chert cores. Shaping activities are important in this assemblage, and in most cases the handaxes, cleavers and choppers were made from quartzite cobbles. The shaping sequences are simple, aiming to generate a general shape but without much care being taken over the edges or to create symmetry. Most of the handaxes are in the Shaping stage of configuration, retaining remains of the cortex on the surfaces, principally in the proximal part.

The type of occupation had a considerable effect on the technological assemblage. As a result, the operational chains are very fragmented and there is a significant degree of transfer from outside the cave to inside it and then back out again. However, the large number of cobbles with marks and fractures associated with knapping activities and the documented refits seem to testify to certain knapping activities having taken place inside the cave, aimed at resolving specific problems.

The GIIb subunit represents a technological change that occurred around 250 ka. Cobbles and quartzite blanks lose their predominance, in favour of the use of flakes as blanks. Knapping on cobble is mainly replaced by knapping on flake, and there is an increase in the size of blanks. The centripetal method is most commonly used and it is applied to a wide variety of raw materials. The predominance of quartzite is replaced by sandstone and Neogene chert. The more extensive configuration documented in the GIIb subunit resulted in greater technological and morphological homogeneity in this assemblage. In this case, more care was taken over edges, and in most cases the handaxes are in the Finishing stage of configuration.

Although future work with larger samples are needed, Galería seems to reflect a technological evolution from a more expeditious, flexible and less curated technological knowledge to a lithic assemblage characterized by longer operative chains and the use of centripetal techniques to maximize the exploitation of cores, more care taken over tools, longer operative chains, and tools predominantly in the Finishing stage of configuration processes. These technological characteristics result in a more standardized assemblage. The technology may have went from a more expeditious technological base to a compacter technology with a “mental template” that was well defined and assimilated in the minds of *H. heidelbergensis*. Larger blanks were chosen for making these tools. In this case, curation refers to a tool that was made, transported, used, transported again and perhaps used and transported several times (Ashton and McNabb, 1994). At that period, the “mental construct” defined by Ashton and McNabb (1994) seems therefore to have existed as a prior idea that went further than the changes in the types of raw materials used.

We have defined some technological changes that may imply that technological evolution took place within this Acheulean context. However, due to the characteristics of the Galería record (the limited number of remains, the important influence of the type of occupation and the high level of fragmentation of the operational chains) it is difficult to extrapolate this data to other Acheulean sites. The technological change between the two periods in the Galería site could be corroborated by the finds during the new fieldwork, beginning in 2010.

Acknowledgements

This research is part of the MINECO Project *Comportamiento ecosocial de los homínidos de la Sierra de Atapuerca durante el Cuaternario III* (CGL2012-38434-C03-03) and the AGAUR project *Desenvolupament social i tecnològic al Plistocè inferior i mitjà* (2009SGR-000188). The fieldwork is sponsored by the Junta de Castilla y León. We are deeply grateful to Fundación Atapuerca and to all the members of the Atapuerca team involved in the recovery and study of the archaeological and paleontological record from the Galería site. P.G. benefited from a predoctoral research grant from the Fundación Siglo para las Artes en Castilla y León.

References

Aguirre, E., 2001. Dépôts fossilifères du karst de Atapuerca, premiers 20 ans. L'Anthropologie 105 (1), 13–26.

Arsuaga, J.L., Bermúdez de Castro, J.M., Carbonell, E. (Eds.), 1997a. The Sima de los Huesos Hominid Site. Journal of Human Evolution 33 (2/3 Special Issue), 105–421.

Arsuaga, J.L., Martínez, I., Gracia, A., Carretero, J.M., Lorenzo, C., García, N., Ortega, A.I., 1997b. Sima de los Huesos (Sierra de Atapuerca, Spain). The site. Journal of Human Evolution 33, 109–127.

Arsuaga, J.L., Gracia, A., Lorenzo, C., Martínez, I., Julia Pérez, P., 1999. Resto craneal humano de Galería/Cueva de los Zarpazos (Sierra de Atapuerca). In: Carbonell, E., Rosas, A., Díez Fernández-Lomana, J.C. (Eds.), Atapuerca: Ocupaciones humanas y paleoecología del yacimiento de Galería. Junta de Castilla y León. Conserjería de Educación y Cultura, pp. 233–236.

Ashton, N., McNabb, J., 1994. Bifaces in perspective. In: Ashton, N., David, A. (Eds.), Stories in Stone. Lithic Studies Society, London, pp. 182–191. Occasional Paper.

Ashton, N., White, M.J., 2003. Bifaces and raw materials: flexible flaking in the British Early Paleolithic. In: Soressi, M., Dibble, H.L. (Eds.), Multiple Approaches to the Study of Bifacial Technologies. University of Pennsylvania, Museum of Archaeology and Anthropology, pp. 109–123.

Bahain, J.-J., Falguères, C., Laurent, M., 2001. Datation par résonance paramagnétique électronique (RPE) de sédiments et par combination des méthodes RPE/U-Th de restes paléontologiques (provenant des sites paléolithiques de Cagny). Publications du CERP 6. Université des Sciences et Technologies de Lille, Lille.

Bar-Yosef, O., 2006. The known and unknown about the Acheulian. In: Goren-Inbar, N., Sharon, G. (Eds.), Axe Age. Acheulian Tool-Making from Quarry to Discard. Equinox, London, pp. 479–494.

Barsky, D., de Lumley, H., 2010. Early European mode 2 and the stone industry from the Caune de l'Arago's archeostratigraphical levels “P”. Quaternary International 223–224, 71–86.

Berger, G.W., Pérez-González, A., Carbonell, E., Arsuaga, J.L., Bermúdez de Castro, J.M., Ku, T.-L., 2008. Luminescence chronology of cave sediments at the Atapuerca paleoanthropological site, Spain. Journal of Human Evolution 55 (2), 300–311.

Bermudez de Castro, J.M., Rosas, A., 1992. A human mandibular fragment from the Atapuerca Trench (Burgos, Spain). Journal of Human Evolution 22, 41–46.

Beyene, Y., Katohc, S.,G.,W., Harte, W.K., Utof, K., Sudog, M., Kondoh, M., Hyodoi, M., Rennej, P.R., Suwal, G., Asfaw, M., 2013. The characteristics and chronology of the earliest Acheulean at Konso, Ethiopia. Proceedings, National Academy of Science 110 (5), 1584–1591.

Boëda, E., 1995. Levallois: a volumetric construction, methods, a technique. In: The Definition and Interpretation of Levallois Technology. Prehistory Press, Madison, pp. 41–68.

Bordes, F., 1961. Typologie du Paléolithique Acient et Moyen. Centre National de la Recherche Scientifique, Paris.

Cáceres, I., 2002. Tafonomía de yacimientos antrópicos en karst. Complejo Galería (Sierra de Atapuerca, Burgos), Vanguard Cave (Gibraltar) y Abric Romaní (Capellades). Ph.D. thesis, Universitat Rovira i Virgili. Departament de Història i Geografía.

Cáceres, I., Huguet, R., Rosell, J., Esteban Nadal, M., Saladié, P., Díez, J.C., Ollé, A., Vallverdú, J., García, P., Carbonell, E., 2010. El yacimiento de Galería (Sierra de Atapuerca, Burgos, España): un enclave para la obtención de recursos cárnicos en el Pleistoceno Medio. In: 1ª Reunión de científicos sobre cubiles de hiena (y otros grandes carnívoros) en los yacimientos arqueológicos de la Península Ibérica. Zona Arqueológica, Alcalá de Henares, pp. 157–165.

Carbonell, E., Rodríguez Alvarez, X.P., Sala i Ramos, R., Vaquero, M., 1992. New elements of the logical analitic system. Cahier Noir 6.

Carbonell, E., Mosquera, M., 2006. The emergence of a symbolic behaviour: a sepulchral pit of Sima de los Huesos, Sierra de Atapuerca, Burgos, Spain. Comptes Rendues Paleovol 5, 155–160.

Carbonell, E., Guibaud, M., Mora, R., 1983. Utilización de la lógica analítica para el estudio de los tecnocomplejos de cantos tallados. Cahier Noir 1, 3–79.

Carbonell, E., Bermudez de Castro, J.M., Arsuaga, J.L., Díez, J.C., Rosas, A., Cuenca-Bescos, G., Sala, R., Mosquera, M., Rodriguez, X.P., 1995. Lower Pleistocene hominids and artefacts from Atapuerca-TD6 (Spain). Science 269, 826–830.

Carbonell, E., Márquez, B., Mosquera, M., Ollé, A., Rodríguez Alvarez, X.P., Sala, R., Vergès, J.M., 1999. El Modo 2 en Galería. Análisis de la industria lítica y sus procesos técnicos. In: Carbonell, E., Rosas, A., Díez Fernández-Lomana, J.C. (Eds.), Atapuerca: ocupaciones humanas y paleoecología del yacimiento de Galería. Junta de Castilla y León. Consejería de Educación y Cultura, pp. 299–352.

Carbonell, E., Mosquera, M., Ollé, A., Rodríguez, X.P., Sala, R., Vergès, J.M., Arsuaga, J.L., Bermúdez de Castro, J.M., 2003. Les premiers comportements funéraires auraient-ils pris place à Atapuerca, il y a 350 000 ans? Did the earliest mortuary practices take place more than 350 000 years ago at Atapuerca? L'Anthropologie 107, 1–14.

Carbonell, E., Bermudez de Castro, J.M., Pares, J.M., Perez-Gonzalez, A., Cuenca-Bescos, G., Olle, A., Mosquera, M., Huguet, R., van der Made, J., Rosas, A., Sala, R., Vallverdu, J., Garcia, N., Granger, D.E., Martinon-Torres, M., Rodriguez, X.P., Stock, G.M., Verges, J.M., Allue, E., Burjachs, F., Caceres, I., Canals, A., Benito, A., Diez, C., Lozano, M., Mateos, A., Navazo, M., Rodriguez, J., Rosell, J., Arsuaga, J.L., 2008. The first hominin of Europe. Nature 452 (7186), 465–469.

Bermúdez de Castro, J.M., Carbonell, E., Arsuaga, J.L. (Eds.), 1999. Gran Dolina site: TD6 Aurora stratum (Burgos, Spain). Journal of Human Evolution 37, 309–700.

Clark, J.D., 1994. The Acheulian industrial complex in Africa and elsewhere. In: Corrucini, R.S., Ciochon, R.L. (Eds.), Integrative Paths to the Past. Paleoanthropology Advances in Honor of F. Clark Howell. Prentice-Hall, New Jersey, pp. 451–469.

Dibble, H.L., 1995. Raw material availability, intensity of utilization, and middle paleolithic assemblage variability. In: Dibble, H.L., Lenoir, M. (Eds.), The Middle Paleolithic Site of Combe-Capelle Bas (France). University Museum Monograph, Pennsylvania, pp. 289–315.

Díez, C., Moreno, V., 1994. El yacimiento Galería (Atapuerca, Burgos): evolución de un espacio en el Pleistoceno Medio, vol. 60. Boletín del Seminario de Estudios de Arte y Arqueología, pp. 9–24.

Domínguez-Rodrigo, M., Torre, I.D.L., Luque, L.D., Alcalá, L., Serrallonga, J., Medina, V., 2002. The ST complex at Peninj, West Lake Natron, Tanzania: implications for early hominid behavioural models. Journal of Archaeological Science 29, 639–665.

Falguères, C., Bahain, J.-J., Yokoyama, Y., Bischoff, J., Arsuaga, J.-L., Bermudez de Castro, J.M., Carbonell, E., Dolo, J.M., 2001. Datation patir RPE et U-Th des sites pléistocènes d'Atapuerca: Sima de los Huesos, Trinchera Dolina et Trinchera Galería. Bilan géochronologique. L'Anthropologie 105 (1), 71–81.

Falguères, C., Bahain, J.-J., Bischoff, J.L., Pérez-González, A., Ortega, A.I., Ollé, A., Quiles, A., Ghaleb, B., Moreno, D., Dolo, J.-M., Shao, Q., Vallverdú, J., Carbonell, E., Bermúdez de Castro, J.M., Arsuaga, J.L., 2013. Combined ESR/U-series chronology of Acheulian hominid-bearing layers at Trinchera Galería site, Atapuerca, Spain. Journal of Human Evolution 65 (2), 168–184.

García-Antón, M.D., Mosquera, M., 2007. Donées préliminaires sur des aires d'approvisionement et de selection des matières premières lithiques dans les occupations du Pléistocene Moyen du niveu TD10-1. In: Moncel, M.-H., Moigne, A.-M., Arzarello, M., Peretto, C. (Eds.), Aires d'approvisionement en matières premières et aires d'approvisionement en resources alimentaires. Approche intégrée des comportements-UISPP. Actes du XV Congrès Mondial (Lisbonne, 4–9 Septembre 2006). British Archaeological Research International Series 1725. Archaeopress, Oxford, pp. 171–185.

García-Antón, M.D., Morant, N., Mallol, C., 2002. L'approvisionnement en matières premières lithiques au Pléistocène inférieur et moyen dans la Sierra de Atapuerca, Burgos (Espagne). L'Anthropologie 106, 41–55.
García-Medrano, P., 2011. Los sistemas técnicos del Pleistoceno Medio en el Oeste de Europa. Cadenas operativas y procesos de configuración en los conjuntos líticos de Galería y Gran Dolina-TD10-1 (Sierra de Atapuerca, Burgos, España) y Boxgrove (Sussex, Inglaterra). Ph.D. thesis, Universidad de Burgos. Departamento de Ciencias Históricas y Geografía. Área de Prehistoria, 496.
García-Medrano, P., Ollé, A., Díez, C., Carbonell, E., 2013. Les matières premières, la technologie lithique et les stratégies d'occupation dans le site du Pléistocène moyen de Covacha de los Zarpazos (gisement de Galería, Sierra de Atapuerca, Espagne). L'Anthropologie 117, 515–540.
Grün, R., Aguirre, E., 1987. Datación por ESR y por la serie del U, en los depósitos cársticos de Atapuerca. In: Aguirre, E., Carbonell, E., Bermúdez de Castro, J.M. (Eds.), El hombre fósil de Ibeas y el Pleistoceno de la Sierra de Atapuerca. Junta de Castilla y León, Valladolid, pp. 201–204.
Huguet, R., Cáceres, I., Díez Fernández-Lomana, J.C., Rosell, J., 1999. Estudio tafonómico y zooarqueológico de los restos óseos de macromamíferos de la Unidad GII de Galería (Sierra de Atapuerca). In: Carbonell, E., Rosas, A., Díez Fernández-Lomana, J.C. (Eds.), Atapuerca: Ocupaciones humanas y paleoecología del yacimiento de Galería. Junta de Castilla y León, Valladolid, pp. 245–264.
Huguet, R., Díez Fernández-Lomana, J.C., Rossell, J., Cáceres, I., Moreno Lara, V., Ibáñez, N., Saladié, P., 2001. Le gisement de Galería (Sierra de Atapuerca, Burgos, Espagne): un modèle archéozoologique de gestion du territoire durant le Pléistocene. L'Anthropologie 105 (1), 237–258.
Isaac, G., Curtis, G.H., 1974. Age of early Acheulian industries from the Peninj Group, Tanzania. Nature 249, 624–627.
Jiménez-Arenas, J.M., Santonja, M., Botella, M., Palmqvist, P., 2011. The oldest handaxes in Europe: fact or artefact? Journal of Archaeological Science 38, 3340–3349.
Lepre, C.J., Roche, H., Kent, D.V., Harmand, S., Quinn, R.L., Brugal, J.-P., Texier, P.-J., Lenoble, A., Feibel, C.S., 2011. An earlier origin for the Acheulian. Nature 477, 82–85.
MacDonald, K., Martinón-Torres, M., Dennell, R.W., Bermúdez de Castro, J.M., 2012. Discontinuity in the record for hominin occupation in south-western Europe: implications for occupation of the middle latitudes of Europe. Quaternary International 271, 84–97.
Márquez, B., 1998. Galería (Atapuerca, Burgos), Nivel TG10: Aplicación de un programa experimental para el estudio traceológico de conjuntos líticos del Pleistoceno Medio (Tesis de Licenciatura). Universidad Complutense de Madrid. Facultad de Geografía e Historia. Departamento de Prehistoria y Etnología, p. 393.
Márquez, B., Ollé, A., Sala i Ramos, R., Vergès, J.M., 2001. Perspectives méthodologiques de l'analyse functionnelle des ensembles lithiques du Pléistocène Inférieur et Moyen d'Atapuerca (Burgos, Espagne). L'Anthropologie 105 (1), 281–299.
McPherron, S.P., 2006. What typology can tell us about Acheulian handaxe production. In: Goren-Inbar, N., Sharon, G. (Eds.), Axe Age. Acheulian Tool-Making from Quarry to Discard. Equinox, London, pp. 267–285.
Moloney, N., Raposo, L., Santonja, M., 1996. Non-flint Stone Tools and the Paleolithic Occupation of the Iberian Peninsula. British Archaeological Research International Series, Oxford.
Moncel, M.-H., Despriée, J., Voinchet, P., Tissoux, H., Moreno, D., Bahain, J.-J., Courcimault, G., Falguères, C., 2013. Early evidence of Acheulean settlement in Northwestern europe – La Noira Site, a 700 000 Year-Old Occupation in the Center of France. PLoS One 8 (11), e75529.
Mosquera, M., 1995. Procesos técnicos y variabilidad en la industria lítica del Pleistoceno Medio en la Meseta: Sierra de Atapuerca, Torralba, Ambrona y Áridos (Tesis Doctoral). Ph.D. thesis, Universidad Complutense de Madrid. Departamento de Prehistoria y Etnología, p. 370.
Mosquera, M., 1998. Differential raw material use in the Middle Pleistocene of Spain: evidence from Sierra de Atapuerca, Torralba, Ambrona and Aridos. Cambridge Archaeological Journal 8 (1), 15–28.
Mosquera, M., Ollé, A., Rodríguez, X.P., 2013. From Atapuerca to Europe: tracing the earliest peopling of Europe. Quaternary International 295, 130–137.
Newcomer, M.H., 1971. Some quantitative experiments in handaxe manufacture. World Archaeology 3, 85–93.
Ollé, A., 2003. Variabilitat i patrons funcionals en els sistemes tècnics de Mode 2. Anàlisi de les deformacions d'ús en els conjunts lítics del Riparo Esterno de Grotta Paglicci (Rignano Garganico, Foggia), Áridos (Arganda, Madrid) i Galería-TN (Sierra de Atapuerca, Burgos). Ph.D. thesis, Universitat Rovira i Virgili. Dept. d'Història i Geografia, Tarragona, p. 589.
Ollé, A., Huguet, R., 1999. La secuencia arqueoestratigráfica del yacimiento de Galería, Atapuerca. In: Carbonell, E., Rosas, A., Díez, J.C. (Eds.), Atapuerca: ocupaciones humanas y paleoecología del yacimiento de Galería. Junta de Castilla y León, Zamora, pp. 55–62.
Ollé, A., Cáceres, I., Vergès, J.M., 2005. Human occupations at Galería site (Sierra de Atapuerca, Burgos, Spain) after the technological and taphonomical data. In: Molines, N., Moncel, M.-H., Monnier, J.-L. (Eds.), Les premiers peuplements en Europe. Colloque international: Données récentes sur les modalités de peuplement et sur le cadre chronostratigraphique, géologique et paléogéographique des industries du Paléolithique ancien et moyen en Europe (Rennes, 22–25 septembre 2003). John and Erika Hedges Ltd., Oxford, pp. 269–280.
Ollé, A., Mosquera, M., Rodríguez, X.P., de Lombera-Hermida, A., García-Antón, M.D., García-Medrano, P., Peña, L., Menéndez, L., Navazo, M., Terradillos, M., Bargalló, A., Márquez, B., Sala, R., Carbonell, E., 2013. The Early and Middle Pleistocene technological record from Sierra de Atapuerca (Burgos, Spain). Quaternary International 295, 138–167.
Ortega, A.I., 2009. La evolución geomorfológica del karst de la Sierra de Atapuerca (Burgos) y su relación con los yacimientos pleistocenos que contiene. Ph.D. thesis, Universidad de Burgos. Departamento de Ciencias Históricas y Geografía, Burgos.
Pérez-González, A., Parés, J.M., Gallardo, J., Aleixandre, T., Ortega, A.I., Pinilla, A., 1999. Geología y estratigrafía del relleno de Galería de la Sierra de Atapuerca (Burgos). In: Carbonell, E., Rosas, A., Díez Fernández-Lomana, J.C. (Eds.), Atapuerca: Ocupaciones humanas y paleoecología del yacimiento de Galería. Junta de Castilla y León, Zamora, pp. 31–42.
Pérez-González, A., Parés, J.M., Carbonell, E., Aleixandre, T., Ortega, A.I., Benito Calvo, A., Martín Merino, M.A., 2001. Géologie de la Sierra de Atapuerca et stratigraphie des remplissages karstiques de Galería et Dolina (Burgos, Espagne). L'Anthropologie 105 (1), 24–43.
Piperno, M., Tagliacozzo, A., 2001. The Elephant butchery area at the Middle Pleistocene site of Notarchirico (Venosa, Basilicata, Italy). In: The World of Elephants – International Congress. Rome, pp. 230–236.
Roberts, M., Parfitt, S., 1999. Boxgrove. A Middle Pleistocene hominid site at Eartham Quarry, Boxgrove, West Sussex. Archaeological report. English Heritage, London.
Rodríguez, X.P., 2004. Technical systems of lithic production in the Lower and Middle Pleistocene of the Iberian Peninsula. Technological variability between north-eastern sites and the Sierra de Atapuerca sites. BAR Internationa Series (British Arhaeological Reports), Oxford, England.
Rodríguez, J., Burjachs, F., Cuenca-Bescós, G., García, N., Van der Made, J., Pérez González, A., Blain, H.A., Expósito, I., López-García, J.M., García Antón, M., Allué, E., Cáceres, I., Huguet, R., Mosquera, M., Ollé, A., Rosell, J., Parés, J.M., Rodríguez, X.P., Díez, C., Rofes, J., Sala, R., Saladié, P., Vallverdú, J., Bennasar, M.L., Blasco, R., Bermúdez de Castro, J.M., Carbonell, E., 2011. One million years of cultural evolution in a stable environment at Atapuerca (Burgos, Spain). Quaternary Science Review 30 (11–12), 1396–1412.
Roe, D., 1968. British Lower and Middle Palaeolithic handaxe groups. Proceedings of the Prehistoric Society 34, 1–82.
Roe, D., 1981. The Lower and Middle Palaeolithic Periods in Britain. RKP, London.
Saladié, P., Vallverdú, J., Bennàsar, L., Cabanes, D., Mancha, E., Menéndez, L., Blain, H., Ollé, A., Mosquera, M., Vilalta, J., Cáceres, I., Expósito, I., Estéban, M., Huguet, R., Rosas, A., Solé, A., López-Polín, L., García, A.B., Martínez, B., Carbonell, E., Capdevila, R., 2008. Resultats preliminars del nivell 2 del sodenig al Centre de Convencions del barranc de la Boella. Cota Zero 23, 13–19.
Sanchez Marco, A., 1999. Aves del yacimiento mesopleistoceno de Galería, Sierra de Atapuerca. Patrones ecológicos en el Pleistoceno medio. In: Carbonell, E., Rosas, A., Díez Fernández-Lomana, J.C. (Eds.), Atapuerca: Ocupaciones humanas y paleoecología del yacimiento de Galería. Junta de Castilla y León, Valladolid, pp. 211–224.
Santonja, M., 1996. The lower Paleolithic in Spain: sites, raw material and occupation of the land. In: Moloney, N., Raposo, L., Santonja, M. (Eds.), Non-flint Stone Tools and the Palaeolithic Occupation of the Iberian Peninsula. B.A.R. International Series, Oxford, pp. 1–20.
Santonja, M., Pérez-González, A., 2010. Mid-Pleistocene Acheulean industrial complex in the Iberian Peninsula. Quaternary International 223–224, 154–161.
Santonja, M., Villa, P., 1990. The Lower Paleolithic of Spain and Portugal. Journal of World Prehistory 4, 45–94.
Santonja, M., Villa, P., 2006. The Acheulian of Western Europe. In: Goren-Inbar, N., Sharon, G. (Eds.), Axe Age. Acheulian Tool-Making from Quarry to Discard. Equinox, London, pp. 429–478.
Scott, G.R., Gibert, L., 2009. The oldest hand-axes in Europe. Nature 461 (3), 82–85.
Sharon, G., 2008. The impact of raw material on Acheulian large flake production. Journal of Archaeological Science 35 (5), 1329–1344.
Sharon, G., 2009. Acheulian giant-core technology. Current Anthropology 50 (3), 335–367.
Sharon, G., 2011. Flakes crossing the straits? Entame flakes and Northern Africae Iberia contact during the Acheulean. African Archaeological Review 28 (2), 125–140.
Terradillos, M., 2010. El Paleolítico inferior en la Meseta Norte: Sierra de Atapuerca, La Maya, El Basalito, San Quirce y Ambrona. Estudio tecnológico y experimental. Universidad de Burgos. Dpto. Ciencias Históricas y Geografía.
Terradillos-Bernal, M., Rodríguez, X.-P., 2012. The Lower Palaeolithic on the northern plateau of the Iberian Peninsula (Sierra de Atapuerca, Ambrona and La Maya I): a technological analysis of the cutting edge and weight of artefacts. Developing an hypothetical model. Journal of Archaeological Science 39 (5), 1467–1479.
Tixier, J., 1956. Le hachereau dans l'Acheuléen Nord-Africain. In: Notes typologiques. Congrès préhistorique de France, pp. 914–923.
Vallverdú, J., 2002. Micromorfología de las facies sedimentarias de la Sierra de Atapuerca y del nivel J del Abric Romaní. Ph.D. thesis, Universitat Rovira i Virgili. Departament d'Història i Geografia.
Vallverdú, J., Saladié, P., Bennàsar, L., Cabanes, D., Mancha, E., Menéndez, L., Blain, H., Ollé, A., Vilalta, J., Mosquera, M., Cáceres, I., Expósito, I., Esteban, M., Huguet, R., Rosas, A., Solé, À., López-Polín, L., Martinell, J., García-Garbo, A., Martínez-, Navarro, B., Agustí, J., Ros-Montoya, S., Carbonell, E., Capdevila, R., 2009. El barranc de la Boella de la Canonja (Tarragonès) revisitat en la intervenció

arqueològica preventiva de l'any 2007. Tribuna d'Arqueologia, 7–28, 2008–2009.

Wenban-Smith, F.F., 1989. The use of canonical variates for determination of biface manufacturing technology at Boxgrove Lower Paleolithic site and the behavioural implications af this technology. Journal of Archaeological Science 16, 17–26.

Wenban-Smith, F.F., Ashton, N., 1998. Raw material and lithic technology. Occasional Paper. In: Ashton, N., Lewis, S., Parfitt, Simon A. (Eds.), Excavations at the Lower Palaeolithic Site at East Farm, Barnham, Suffolk 1989–94. British Museum, London, pp. 237–244.

White, M.J., 1995. Raw materials and biface variability in Southern Britain: a preliminary examination. Lithics 15, 1–20.

Please cite this article in press as: García-Medrano, P., et al., The earliest Acheulean technology at Atapuerca (Burgos, Spain): Oldest levels of the Galería site (GII Unit), Quaternary International (2014), http://dx.doi.org/10.1016/j.quaint.2014.03.053