Experimental insights about giant core flaking *débitage*: The case of the late Acheulean of central Iberian Peninsula

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Abstract:

Traditionally, Acheulean assemblages are characterized by the presence of LCT (Large Cutting Tool) and particularly bifacial pieces. In this context, the existence of large flakes as blanks for those tools is the main criteria for a chrono-geographical approach of the variability inside this technocomplex. During the time span in which Acheulean occurs, a wide variety of systematized methods for blanks production were applied probably as a response to particular raw material constraints and even to cultural traditions or constraints.

In the case of the Iberian Peninsula, the quarries and workshops recently excavated in the region of Madrid, demonstrate the complexity of the flaking and shaping strategies during the second part of the Middle Pleistocene. Particularly, examples as Charco Hondo 2 (located in Los Ahijones area) or Cantera Vieja (located in Los Berrocales) both located in Madrid, demonstrate the existence of specific giant core flake exploitation, and exploitation adaptation to the blanks.

In this contribution, experiments based on archaeological materials from Charco Hondo 2, are produced and studied in order to understand the existence of particular strategies in the large flake production. Concepts as predetermination or just adaptation to particular raw material constrain (even the combination of both concepts) arise when experiments were produced. In any case, those tests provide us with an excellent tool for both quantitative and qualitative understanding of reductions sequences and human intentions.

Keywords: giant core; Acheulean; experimental archaeology; workshop site; *débitage*

1. Introduction

For many years, the research of the Acheulean techno-complexes in Europe has been focused on studies based on typological elements that characterize it (mainly handaxes and cleavers). However, the *débitage* models associated with the production of those large flakes within the European context have scarcely been defined and studied. The work of G. Sharon (2007) is a reference in this regard for African and Levantine Acheuleans, as it defined the principal methods and techniques related to the big cores exploitation (Sharon 2007; 2010; 2019).

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Independent of the shaping technologies applied to the biface production (Stout *et al.* 2014), function (Machin *et al.* 2007) and its chronological evolution (Iovita & McPherron 2011), large flake production for Large Cutting Tool (LCTs) blanks are described in Africa, Levant, and Iberian Peninsula (Arroyo & de la Torre 2013; Madsen & Goren-Inbar 2004; Rubio-Jara *et al.* 2016; Santonja & Pérez-González 2010), and the giant core perfectly described for the Levant case (Sharon 2009a). Similar "simple" methods have been described as natural back and transversal over-passed in the site of Bois-de-Riquet (France) in relation with giant cores in quarries contexts (Bourguignon *et al.* 2016a), or the site of Isampur (Paddayya *et al.* 2006; Petraglia *et al.* 1999) or La Noire (Moncel *et al.* 2013) with fracturing or flaking large slabs as a particular adaptation (Agarwal 2014; Bergman & Roberts 1988; Key 2023; Li *et al.* 2017; Méndez-Quintas *et al.* 2018; 2020; Moncel *et al.* 2019; Mussi *et al.* 2023; Ollé *et al.* 2016; Pope *et al.* 2006; Rubio-Jara *et al.* 2016; Santonja *et al.* 2018; 2022; Scerri *et al.* 2018; Sharon 2007; 2010). Here we present experimental insights based on the Charco Hondo 2 Large Flake production.

In the central Iberia context, sites as Pinedo (López-Recio *et al.* 2015), Puente Pino, San Isidro, Las Acacias, Valdocarros, Albalá, El Sotillo, etc. are examples of large flake industries produced by using several large flaking methods. However, only in a few cases, the first productional levels (Bourguignon *et al.* 2004) on a giant or big cores were studied. The lithic assemblage from Los Charco Hondo 2 (Los Ahijones, Madrid) provides good examples of these methods in very particular flint quarrying context. On this site, the initial morphologies are massive and have irregular qualities. The first stages produced manipulable nodules by using specific techniques, and with smaller blanks, several techniques and methods were applied. In all the examples, there is a *débitage* adaptation to the areas of the core with good quality. Taking into account these conditions, we pretend to evaluate if there are specific methods in the production of large flakes/fragments, and at the same time to describe the technical and technological variations produce along the reduction sequence of the flint blocks.

In this contribution, we had made several qualitative experiments based on the archaeological examples in order to understand the existence of a possible large flake predetermination and particular adaptations to particular raw materials characteristics. By using similar flint blocks from the site and a collection of techniques and gestures, we have conducted several experiments in order to understand raw material limitations, the possible technical organization of the reduction sequence, as well as to decipher the real meaning of a potential predetermination in this specific archaeological site. In any case, experiments provide us with an excellent tool for both quantitative and qualitative understanding of the reduction sequences and human intentions.

2. Material and methods

2.1. Archaeological sites and Archaeological materials (Charco Hondo 2, Los Ahijones Madrid, Spain)

The interfluvial plateau from Madrid includes several areas (El Cañaveral, Los Berrocales, and Los Ahijones) as part of the main drainage network of the Manzanares and Jarama rivers. Sites as Charco Hondo 2 at Los Ahijones, or the second example Cantera Vieja in Los Berrocales, are located close to flint primarily and secondary deposits (Baena Preysler *et al.* 2015; 2018; Bárez *et al.* 2016). The flint abundance of this region made of this area the right place to the people attraction. Catchment and tool production generated a great number of flint residues (Torres & Baena 2018) depending on the particular circumstances of the flint outcrop (Figure 1).

Figure 1. Madrid province and the location of the mentioned archaeological sites.

Karstic underlaying deformations had favored the creation of sedimentary depressions and the flint outcrops emergence helped by the drainage of the área. Later fluvial, Aeolian and colluvial deposits filled and preserved the archaeological testimonies in some cases with more than 5 meters of sandy clay deposits (Bárez & Pérez-González 2006; Bárez *et al*. 2011; 2016).

In this context, Charco Hondo 2 was excavated in a total surface of 70m2 showing the existence of intense large flake exploitation produced "*in situ*" on the flint outcrop blocks wich dimensions size exceeds the 1-meter length and 0,5-meter with (Figure 2). This catchment and transformation activities took place in the context of a small paleo-channel (Bárez *et al*. 2016).

Figure 2. A) Charco Hondo 2 (Los Ahijones, Madrid) archaeological site showing a giant core in the central place and the distribution of flakes and fragments around it. B) Cantera Vieja archaeological site with the natural flint blocks and the knapping residues around them.

Three main stratigraphical levels with Archaeological materials have been excavated G-1, G-2, and Ch, in a context of small stream that differentiated level G-1 lay on the river bank beneath the tertiary level, level G-2 upon G-1 sealing it in the slope and Ch corresponds to the filling of the river channel (Bárez *et al.* 2011; 2016).

The analysis of the lithic assemblages indicates that the activities focused mainly on the exploitation of flint blocks and the production of flakes for the later bifacial shaping (Table 1). The G-1 assemblage is mainly composed by a high proportion of natural fragments, large flakes, flake fragments, “misse en forme” shaping flakes, tested cores and flint blocks with a lower proportion of tested large flakes and bifacial preforms and finally a residual presence of small *débitage* and retouched elements. Generally, the *façonage* component dominates the documented lithic categories.

Table 1. Cores categories from Charco Hondo 2 (based and modify from Madsen & Goren-Inbar 2004).

Categories	Total	Total %
Small cores	43	75.44%
Big cores	8	14.04%
Giant cores	4	7.02%
Massive cores	2	3.51%
Total effective and percentage	**57**	**100.00%**

Charco Hondo 2 is not the unique example of the existence of giant cores for the production of large flakes. Cantera Vieja (Los Berrocales) is another example in which big cores and large flake production has been documented (Figure 2).

The identification in Charco Hondo 2 of large flakes up to 40 cm in length used as blanks for bifaces shaping (Figure 3) together with the presence of fractured blocks with controlled techniques offer us a referential framework to conduct the experimental analysis of techniques, methods and modalities applied on large blocks exploitation during the Acheulean in Iberia.

Level G-2 of Charco Hondo 2 shows a different strategy. In this case, the exclusive presence of flint slabs created a model in which bifacial pieces were made from singular slabs pieces broken by perpendicular percussion and no Large flake *débitage* is documented.

2.2. Raw material selection

The sedimentary context in which flint or silica rocks were formed corresponds to Miocene shallow lacustrine and palustrine system the raw material occurrence at Charco Hondo 2 in Los Ahijones area provide different models and sizes of blanks. This variability is in part a direct consequence of the changes in the host rocks. In the near Neolithic site of Casa Montero, four episodes of silicification have been differentiated associated with dolostones, and clays (Bustillo *et al.* 2009). Flint quality varies from chert to opaline chert varieties in the local context as a consequence of the recrystallization process consisting in the dissolution of the opal and the rapid precipitation of quartz (Bustillo *et al*. 2009). This dynamic produce important knapping quality changes inside the same block and thus an adaptation of flaking methods to this circumstance. In our study, evaluation of flint quality is based on the following criteria: quality assessment by 4 expert knappers, presence of cracks and internal alterations, crystallinity, surface aspect and sound (Torres 2022).

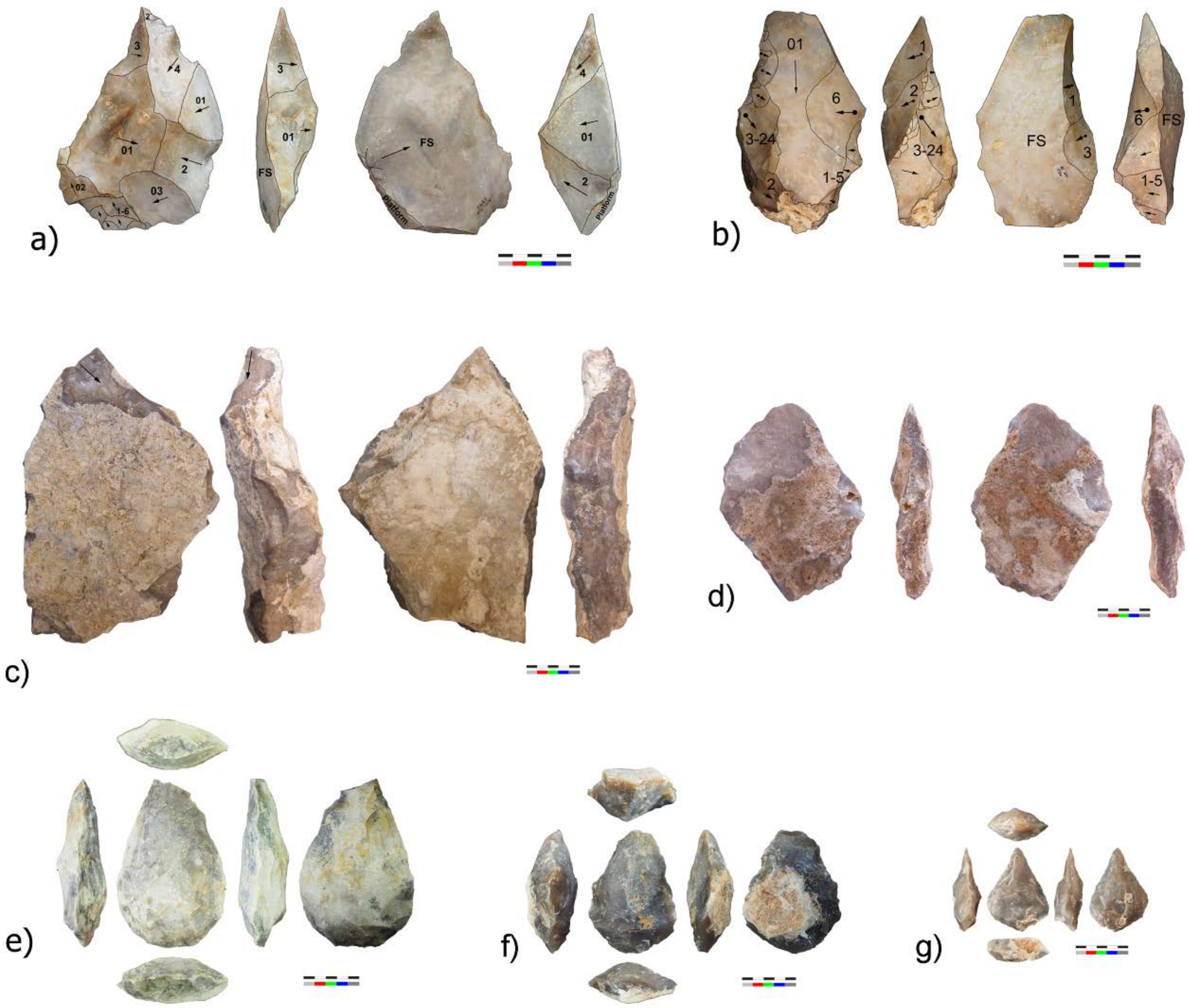

Figure 3. a and b) Bifacial preforms from the Charco Hondo 2 (level 2) archaeological site, made on a preconfigured large flakes; b) Biface made on slab (Charco Hondo 2, level 3; c) Tested slab supports from Charco Hondo 2 (level 3); f and g) Bifaces on large flakes from Cantera Vieja site. (The scale bar is 5 cm wide, divided into 1 cm sections.)

In the case, Charco Hondo 2 (level G-1), flint blanks appear in massive blocks and frequently on blocks with sized higher than 40 cm. and thin cortical surfaces and rounded morphologies. On the contrary, tabular morphologies were exploited in Charco Hondo (level G-2) level in a very adaptive way. Both levels present a bifacial segmented *chaîne opératoire* strategy (Bárez *et al.* 2016) in very different flint qualities. The other example until now, Cantera Vieja site presents similar rounded morphologies with nodule sizes around 50 cm. and with a good workable raw material.

Due to the wide variation of morphologies and qualities, the raw material selection was mainly based on this last aspect and technical and flaking methods were adapted to this constraint.

2.3. Large Flake production methods documented in the Acheulean from central Iberia

2.3.1. Large flake production techniques

Large flake production is commonly related to techniques that require the use of hard and heavy hammers. Particular morphologies of hammers and maces (Figure 4) are essential for the opening and exploitation of big cores. The selection of those hammers responds to a proportional rule of about 1/3 of hammer and core volume and weight (Baena 1998). An excess in the hammerstones volume of weight produce the flake fragmentation (frequently *siret* fractures) and the lack derives on crushing of the platforms and no flake production. The techniques used will vary in relation to the flaking methods, although in general, throwing percussion is associated with the opening of large siliceous blocks, while not launched direct percussion are related with the exploitation of manipulable cores (Figure 5).

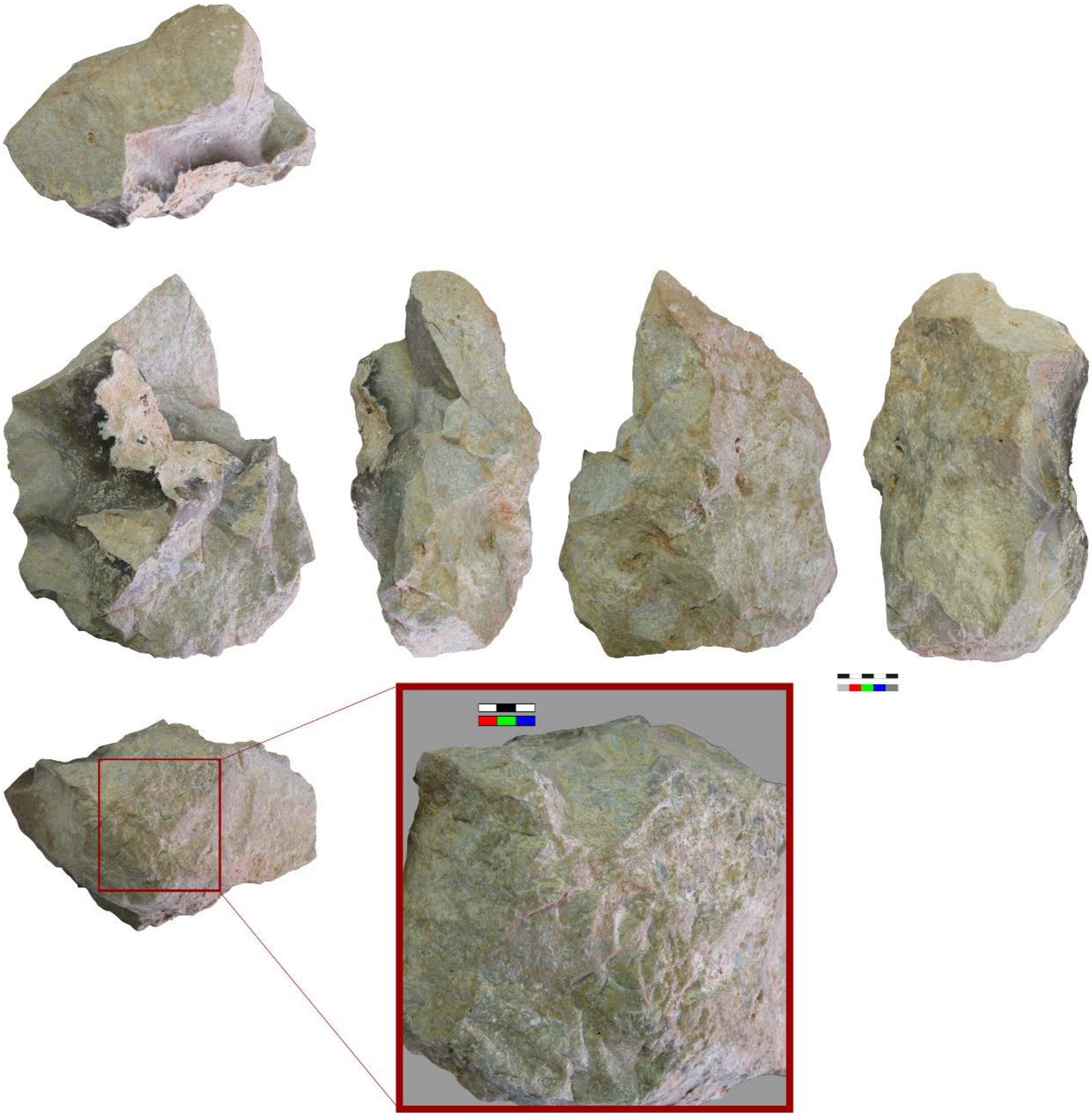

Figure 4. Big mace in flint found in the Charco Hondo 2 archaeological site. (The scale bar is 5 cm wide, divided into 1 cm sections.)

Figure 5. Different large flaking techniques. a) Throwing technique. Experimental throwing from an elevation technique for massive flint block breakage using a quartzite hammer; b) “Percussion lancée”. Experimental technique throwing percussion on massive flint block using a flint hammerstone; c) “Two hands” percussion; Experimental percussion technique on the ground on giant flint core with a flint hammer; d) “On the floor” percussion. Experimental percussion technique on the ground applied on giant flint core using a quartzite hammer (see Supplementary files 1 and 2).

a) Throwing technique and “percussion lancée”

Traditionally, throwing percussion techniques have been associated by some authors with the early stages of lithic knapping when the human hand was not perfectly adapted to the grip, considering the most primitive techniques from a cognitive point of view (Marzke & Marzke 2000; Marzke *et al.* 1992).

However, these opening blocks techniques are used throughout the Pleistocene because it is an effective system for the initial divisions or flaking of large flint volumes. They are techniques that although they do not require much precision in the beginning, have the advantage of the fast production and the application of higher impact forces (Baena 1998; Leroi-Gourhan 1943; Schick & Toth 1993).

These techniques, with no precise impact point and fracture trajectory control, are associated with the “block-on-block” method for opening massive blocks that require the use of large hammers or maces, held with both hands to hit directly on the nodules (Figure 5a and Figure 5b). Through this technique of throwing percussion, blocks and also the hammers were fractured (see Table 2), and when the same raw material (flint) is used, makes it difficult to discriminate their role in the archaeological record (Bourguignon *et al.* 2016b).

Table 2. Experiments performed with throwing techniques.

Experiments	Flaking method	Technique	Result
10(A)	Unipolar	Throwing	Opening and initial breakage of the block.
11(B)	Unipolar	Throwing	Opening and initial breakage of the block.
12 (C)	Unipolar	Throwing	Blank division with hammerstone fracture.
13(D)	Unipolar	Throwing	Blank division with hammerstone fracture.
14(E)	Unipolar	Throwing from an elevation	Blank division with hammerstone fracture.

b) “Two hands” percussion and “on the floor” percussion

The “two hands” and “on the floor” percussion techniques are associated with alternant, bifacial, orthogonal and “debordant” methods, in all cases, related to manipulated core volumes that allow the selection of suitable and better-quality percussion surfaces. In opposition to throwing techniques, it is possible to control the location of the impact points more accurately (Figure 5c).

Experimental replication of these techniques clearly demonstrates that the productiveness (number of flakes obtained per volume units) of the “on the floor” is clearly higher that the rest. Equally, the “predetermination” of the resulting large flake is higher in the application of controlled techniques with alternant, bifacial and orthogonal methods (see Table 3). Although flint hammerstones are effective enough for these percussion techniques, the effectiveness of quartzite hammerstones is much bigger.

Table 3. Experiment to produce large flakes. Throwing experiments produced very few large flakes.

Experiments	Products	% flakes made into bifaces	Length mean of flakes in cm	Knapping methods	Techniques
1	11 flakes	10 bifaces	18,36	Orthogonal	On the floor
2	7 flakes	5 bifaces	24,11	Orthogonal	On the floor
3	16 flakes	10 bifaces	19.42	Orthogonal	On the floor
4	1 flake	1 biface	19,3	Unipolar	Two hands
5	1 flake	1 biface	17,3	Unipolar	Two hands
6	3 flakes	1 biface	13,93	Unipolar	On the floor
7	4 flakes	4 bifaces	13,8	Unipolar	On the floor
8	1 flakes	1 biface	19,4	Unipolar	Two hands
9	6 flakes	4 bifaces	22,05	Unipolar	On the floor
10 (A)	1 flake and 4 fragments	-	11,5	Unipolar	Throwing
11 (B)	2 flakes and 5 fragments	1 biface	9,6	Unipolar	Throwing
12 (C)	2 blocks	-	-	Unipolar	Throwing
13 (D)	2 blocks	-	-	Unipolar	Throwing
14 (E)	2 blocks	-	-	Unipolar	Throwing from an elevation

2.3.2. Large Flake *débitage* methods

The general *Chaîne Operatoire* is the basic framework for the study of the giant core flaking (Figure 6). Depending on the particular characteristic of the archaeological site, it may include the whole *chaîne* or a fragmented sequence with some of the steps only. The existence of an organized productive sequence is mainly documented during the middle Paleolithic (Turq *et al.* 2013) and can even include ramification of small products (Rios-Garaizar *et al.* 2015; Romagnoli *et al.* 2018).

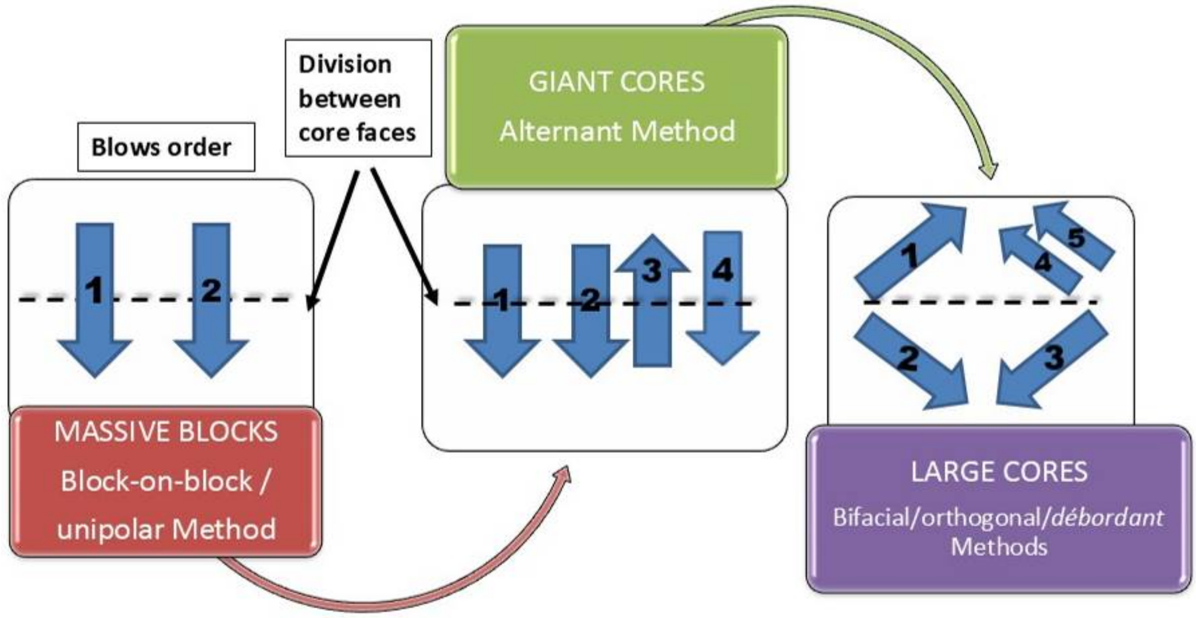

Figure 6. Adaptative methods for large flake production depending on the core size from Charco Hondo 2, Los Ahijones sites (Spain) (in Torres 2022).

The archaeological sites of the interfluvial area of Madrid as Charco Hondo 2 or Cantera Vieja are knapping areas with initial reduction sequences but also with the beginning of the bifacial reduction sequences. These circumstances facilitate the reconstruction of the giant *débitage* methods, poorly represented in the Acheulean assemblages and also the recognition of the large flaking methods in large and big cores.

Overall it is characterized by the following steps: 1) Extraction and a later division of giant blocks into manageable sizes taking advantage of the pre-existing flaws and fissures and by using adaptive knapping techniques; 2) Production of large flakes from giant/big cores by applying organized *débitage* methods and modalities; 3) Test and initial shaping of bifacial preforms (Callahan 1979; Newcomer 1971); 4) Discard of invalid products or failures (Bárez *et al.* 2016).

Previous experimental works (Madsen & Goren-Inbar 2004; Sharon 2007; 2009), have provided an important basis for the understanding of the *chaîne opératoire* from the giant cores. Although we do not have detailed comparative studies of these methods, the studied in near-eastern areas (Barkai *et al.* 2002; Ghoper & Barkai 2006) or in later periods of supply areas of lithic resources in Argentina (Bobillo 2017; Bobillo & Hocsman 2015) are good comparative models, since they reflect knapping activities focused on the reduction of cores to obtain blanks.

In general, the flaking methods employed for the production of LCT are based on the systematic production of large flakes from primary or secondary aggregated sources of raw material. The production is aimed at the exploitation of high-quality raw rocks from a technical and functional point of view. The predetermination of the final large flake morphology in the extraction methods and the temporal and spatial fragmentation in the operative chain indicate that the whole strategy was perfectly anticipated (Bárez *et al.* 2016; Gallotti 2016; Panera *et al.* 2011; Pappu & Akhilesh 2019; de la Torre *et al.* 2014).

The studies by Madsen and Goren-Inbar (Madsen & Goren-Inbar 2004) establish a size differentiation between giant cores (maximum length> 25 cm, maximum width> 20 cm) and big or large cores (maximum length 15-25 cm, maximum width 8-20 cm). We have included in this categorization by size, obtained by the characteristics of the lithic record of the Charco Hondo 2, a third size dimension to refer to the massive blocks separate from the giant cores defined by Madsen and Goren-Inbar (see Table 1). This distinction establishes differences in the reduction methods applied depending on the block dimensions.

Thus, for the analysis of the different methods to produce large flakes we have differentiated:

1) Massive cores (maximum length> 50 cm, maximum width> 30 cm).
2) Giant cores (maximum length of 25-50 cm, maximum width of 20-30 cm).
3) Big or large cores (maximum length of 15-25 cm, maximum width of 8-20 cm).

The methods and techniques that have been documented in the Acheulean sites of the region of Madrid, follow criteria of volume, quality, and predetermination in the final morphology of large flakes. Thus the modalities documented and tested experimentally are:

a) Block-on-block or unipolar method

Some publications allude to this knapping method in relation to the first phases of the production of large flakes from giant cores (Kleindienst & Keller 1976). Sharon (2009) indicates that the term “block-on-block” technique describes an “archaic” method, whereby two large blocks collide each other without any platform preparation or control over the resulting flake morphology.

In the case of Charco Hondo 2, the evidence refers to the use of a unipolar modality related to the fragmentation of massive blocks. The experimentation also suggests the use of large maces or hammers. Generally, it is a method that opens large masses and obtains prominent platforms (Sharon 2009) for later knapping strategies. The use of large pebbles (quartzite) of high density facilitates the fragmentation and the large flake production.

In essence, it allows us to test and transform non-manipulable siliceous blocks into manageable fragments that will be discarded or used as giant or big cores. The dimensions of the massive blocks (Figure 7) documented in Charco Hondo 2 suggest the cooperative manipulation of the group of knappers for their fragmentation and block/core mobilization. Although their large dimensions do not allow developing a constant rotation of it, occasionally and after several unipolar percussion, the massive blocks would be moved and turned to obtain fragments of the highest quality in all their surfaces. The concentration of percussion impact traces on the surface of blocks suggests some control in the percussion.

The massive blocks were abandoned after the stage in which the quality of the raw materials does not offer high quality or fragmentation of the block was not possible. The analysis of the stigmas and worked surfaces in each nodule confirms the existence of a clear adaptation of the knapping methods to the possibility or not of the three-dimensional manipulation of them. The inability to rotate or have a total vision of the block leads to unipolar methods (Figure 8).

This method produced a high volume of discarded block fragments due to the low quality of the flint, and only a specific proportion of blocks that will be selected for a new fragmentation and exploitation.

With smaller dimensions (Figure 9) and frequently by taking advantage of the existence of wide flat surfaces in one of the block faces, the unipolar method is a highly productive procedure. Large flakes trend to present one or two backed sides in series that requires almost no maintenance or core rotation. This method, if required, can be easily modified into an alternant method.

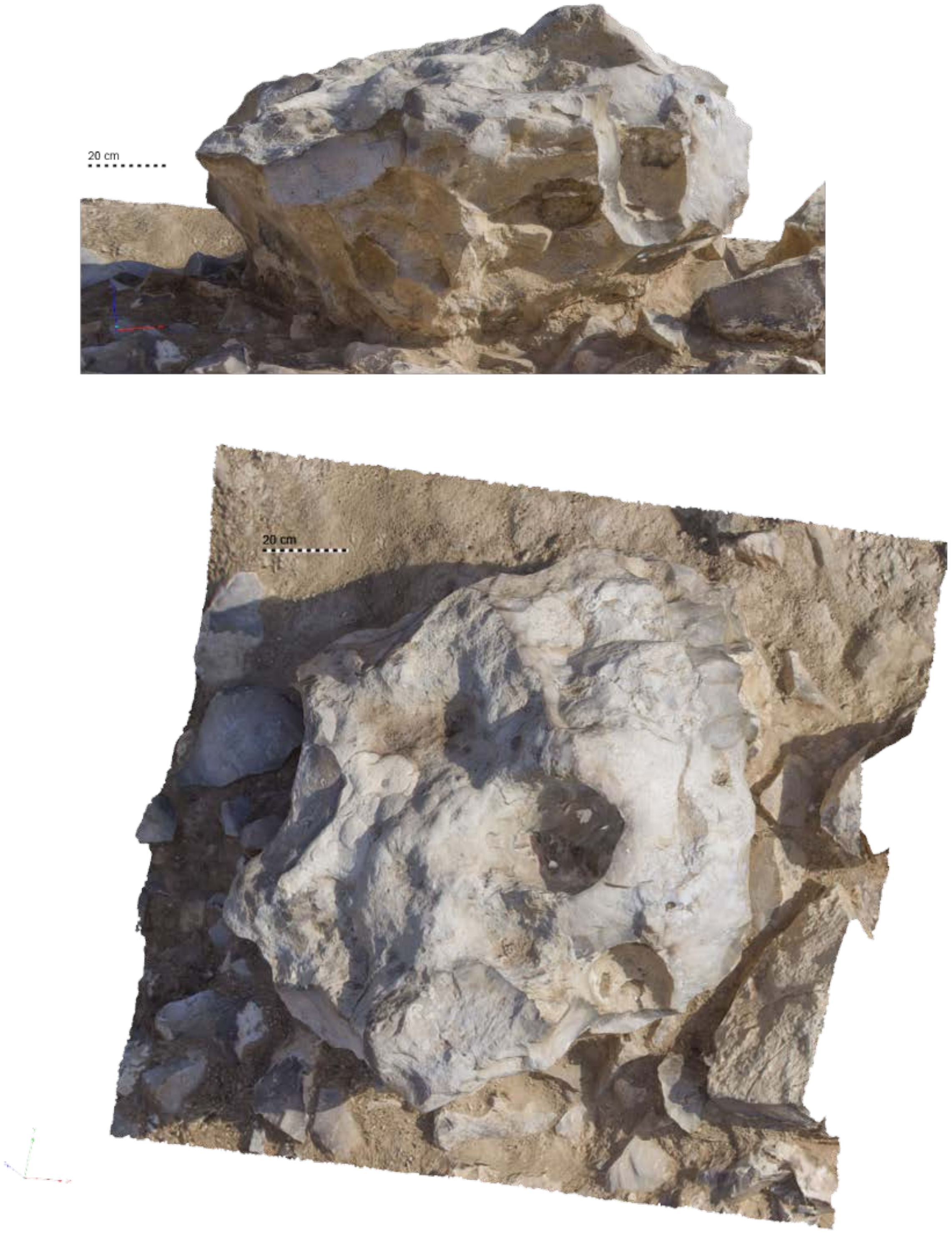

Figure 7. Archaeological massive Flint core higher than 1-meter length and width with knapping traces documented at Charco Hondo 2 archaeological site.

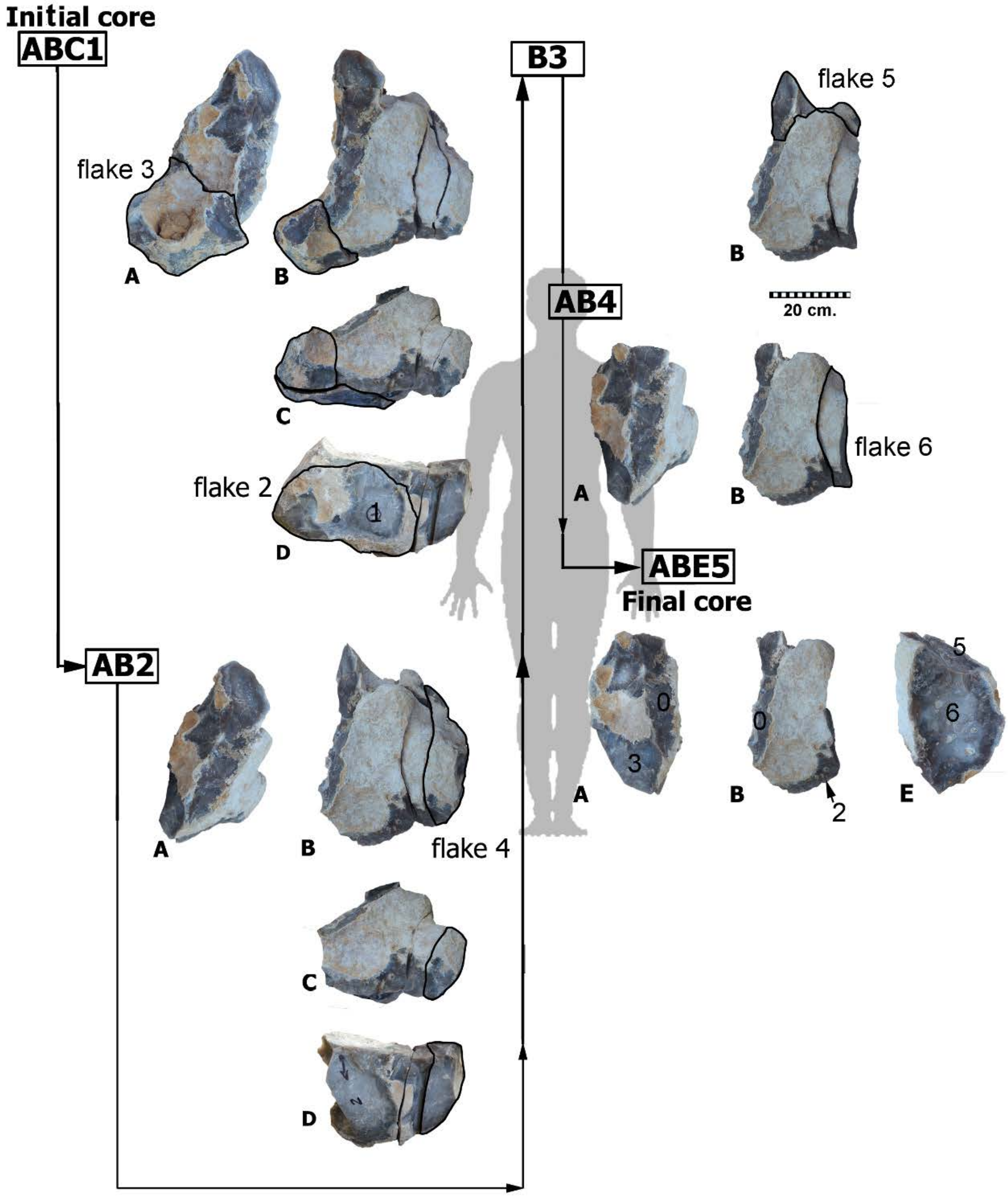

Figure 8. Experimental unipolar debitage (experiment 9).

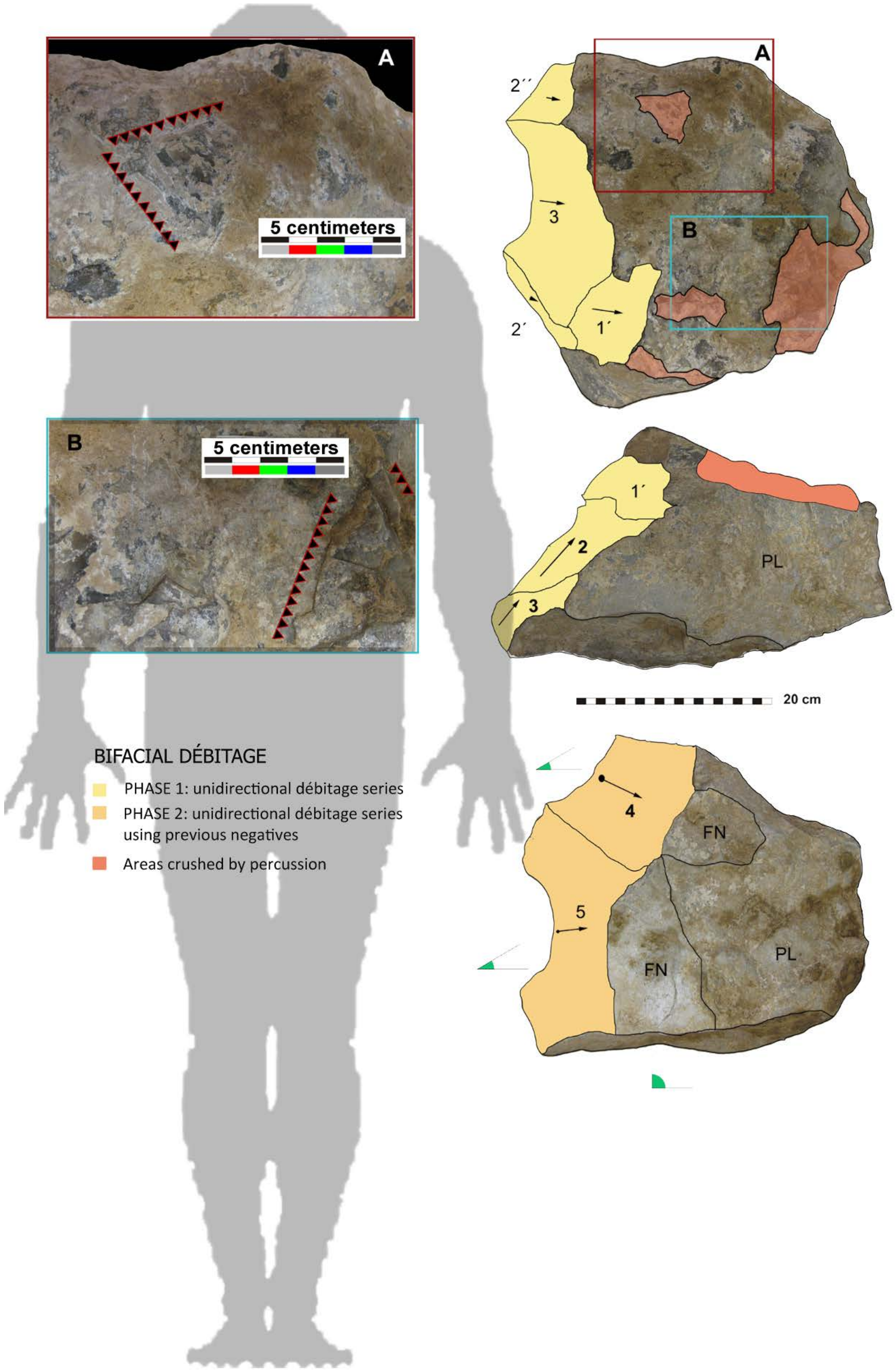

Figure 9. Archaeological bifacial giant core *débitage* from Charco Hondo 2 (Los Ahijones).

b) Bifacial method

The bifacial exploitation method is frequently used in the Charco Hondo 2 assemblage. Notably amongst giant and big cores. The dimensions of these cores make them be manageable elements and allow controlling the knapping process. This method starts with unipolar sequences and if there is a wide surface, flaking can be limited to it. But occasionally after a sequence of unipolar detaches, the use of those negatives as platforms produced a bifacial (but no alternant) reduction. With this method, the knapper will take advantage of the flat surfaces of the previous negatives to obtain thick enough flakes to develop the bifacial shaping or depending on the volumes used, large fragments and after performing a more organized *débitage* (orthogonal and “debordant” methods).

Figure 9 shows the bifacial exploitation sequence in two faces of a giant core documented in Charco Hondo 2. Large flake *débitage* is produced on the surfaces with the better flint quality, avoiding the most irregular areas where raw material loses crystallinity. The core surface, preserve crushed areas produced by repetitive percussion. These areas with multiple impact stigmas may be the result of a previous attempt or tested areas before the final exploitation, or part of the early phase where the siliceous mass was fragmented to make the block manipulable.

The diachritic model of Figure 10 clearly presents a first unipolar scars (flakes 1 to 3) of medium dimensions that works as future platforms for the second unipolar productive sequence. Finally, unipolar methods rarely facilitate cores that permit the shaping of bifacial pieces (*façonage*) on them. However, bifacial methods can provide core morphologies that can be used as blanks for a latter shaping of bifacial pieces on original large flake cores.

c) Orthogonal and “débordant” methods

All the knapping methods in giant and big cores are destined to generate specific flakes in terms of dimensions and morphologies. The existence of different methods as the bifacial, orthogonal and “*débordant*” methods is the result of a clear adaptation of the knapper to the raw material constraints and limitation.

The analysis of big core size sequences of Charco Hondo 2 and the flakes indicate that the *débitage* of these large flakes usually take advantage of flat surfaces to produce by previous negatives avoiding the existence of bad quality areas. This is the case of the cores presented in Figure 11. The orthogonal conception of the flaking method is in some examples limited to the areas of the core where the good quality is located and then, series of orthogonal flakes can be superimpose each other in the same face. When the flint quality is not zoned a 3 dimensional orthogonal method can be applied by implementing an algorithm (denominated as “concavity algorithm”) that consists on the use of the lateral or distal part of the previous concave negative as the knapping platform for the next flake (see Supplementary files 1 and 2). The morphology of this flat and slightly concave areas favors the production of clean large flakes with convex dorsal areas and lateral backed sides (Figure 12), and their slightly concave negatives facilitate the creation of next large flakes. Final cores trend to present cubic or pyramidall morphologies that do not allow the shaping of bifaces on them.

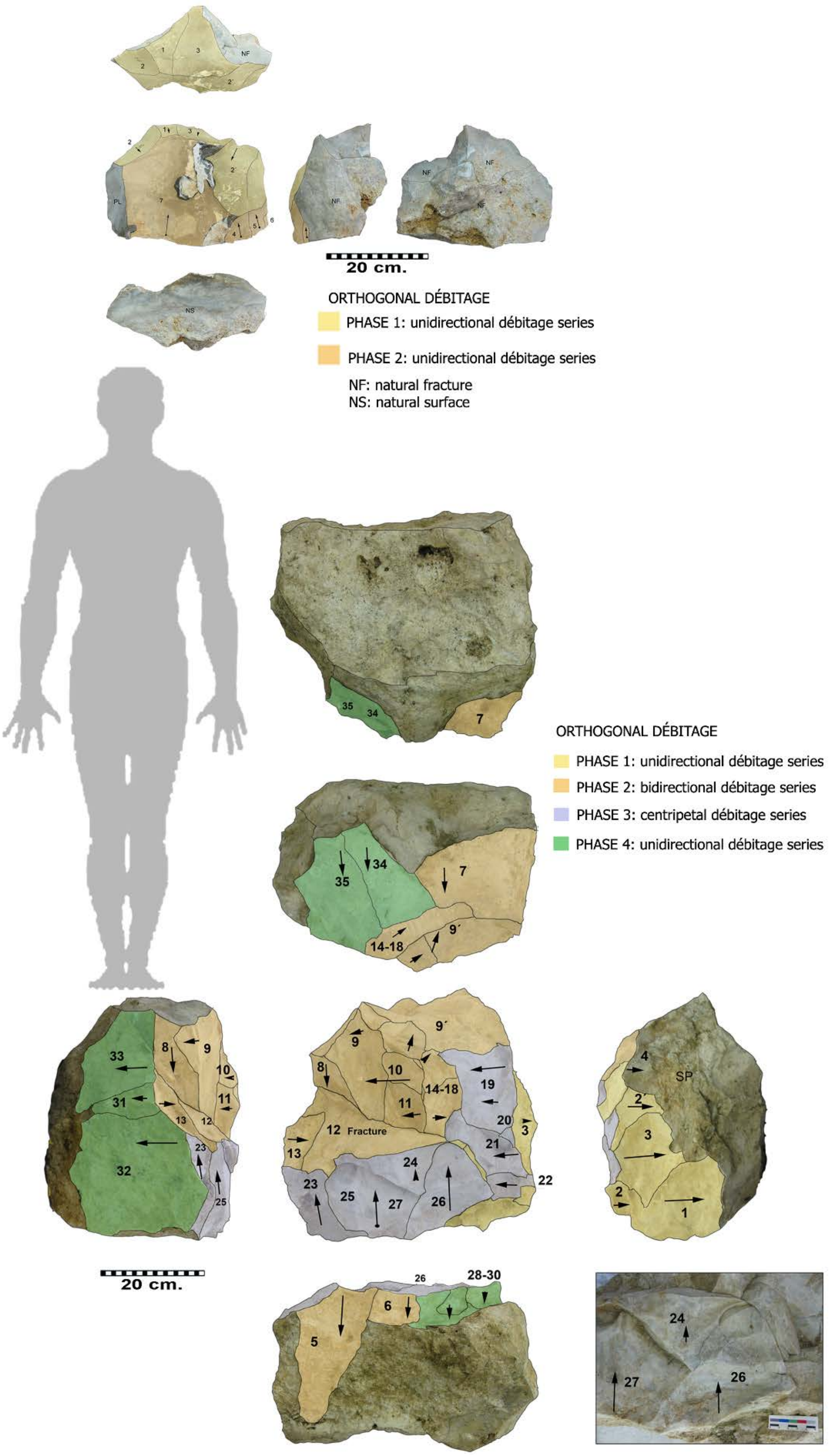

Figure 10. Archaeological orthogonal *débitage* in big cores. Charco Hondo 2.

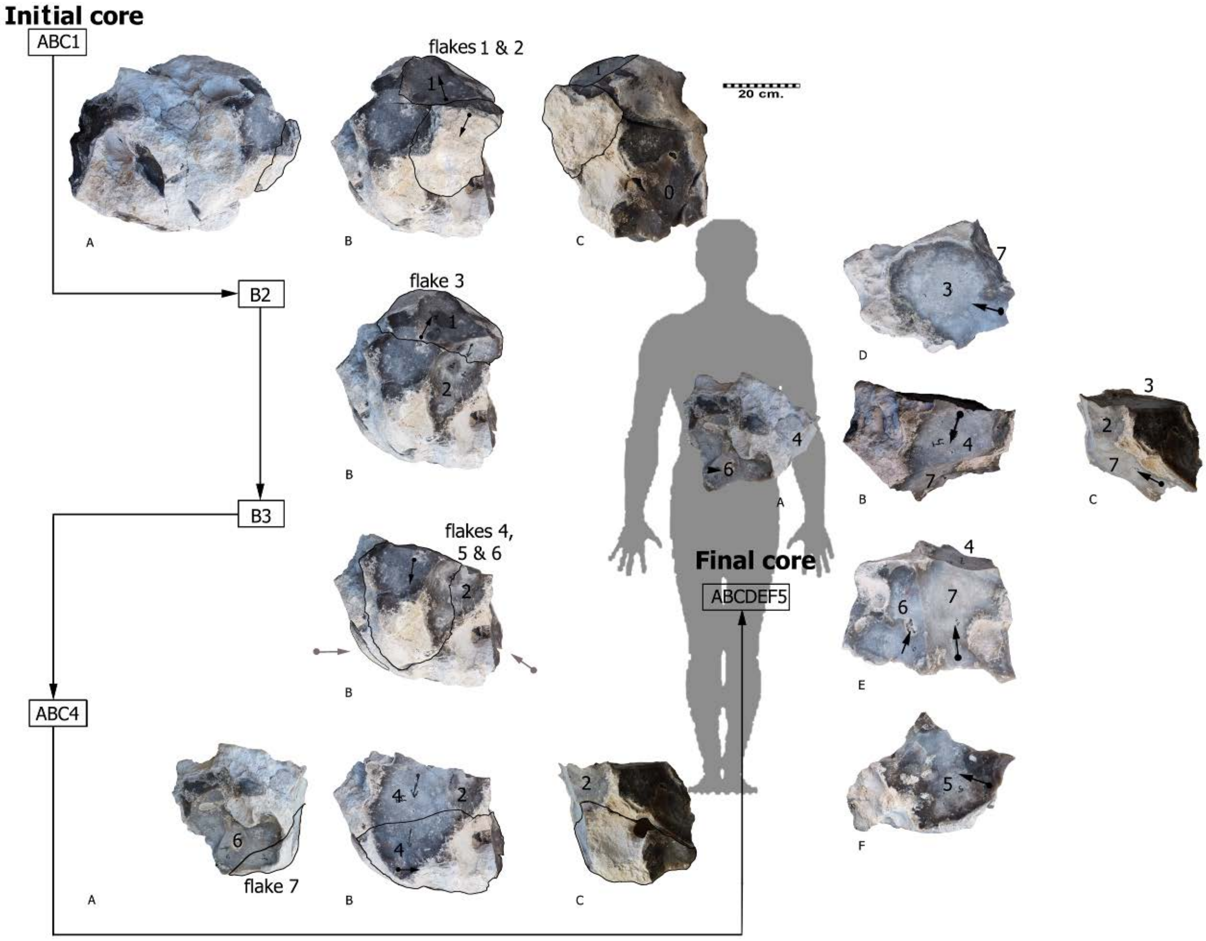

Figure 11. Experimental orthogonal method (experiment 2).

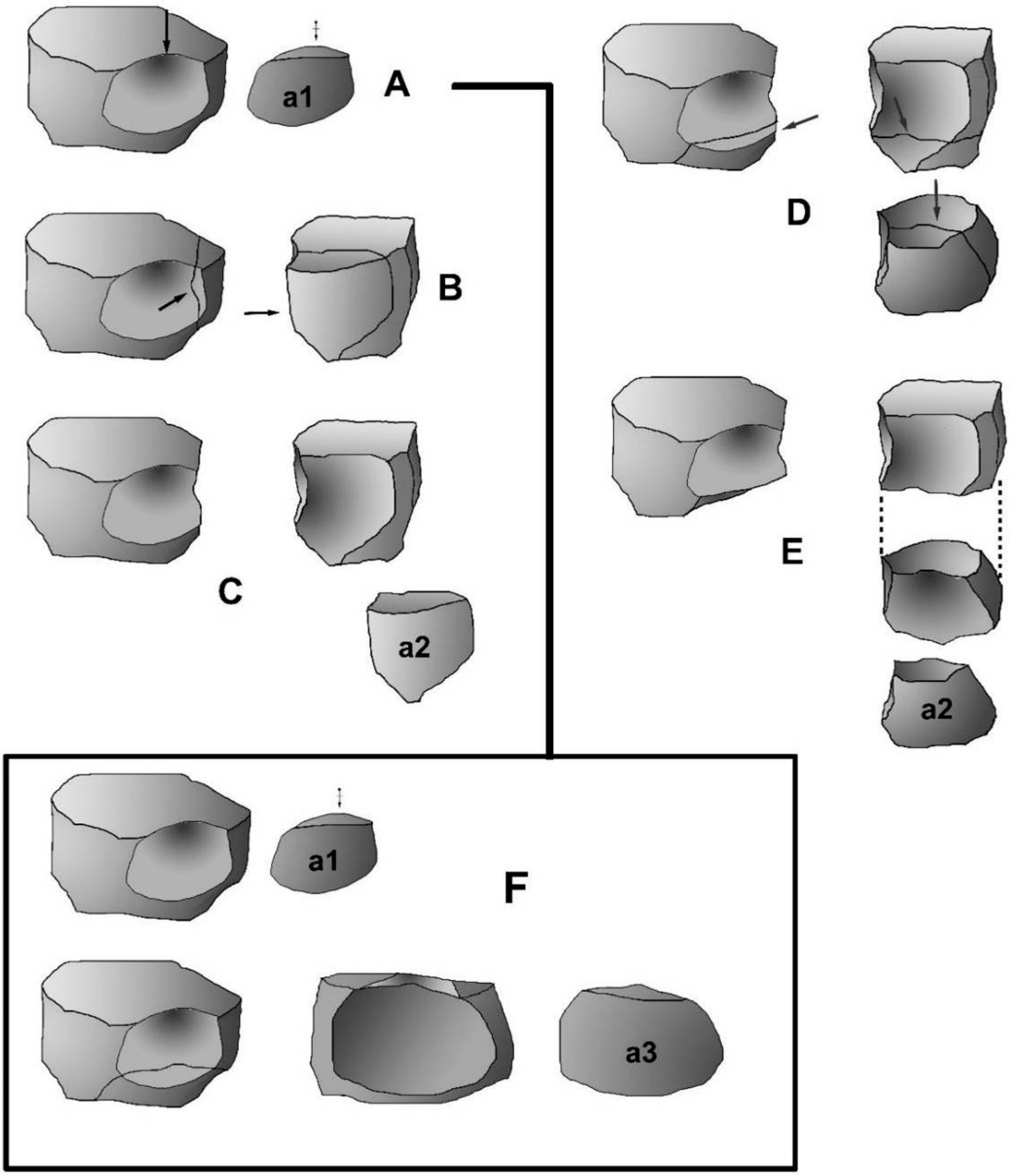

Figure 12. Large flake flaking method and modalities following the "concavity algorithm". A, B, C, D and E using the lateral concavity of the previous negative. F, using the distal concavity of the earlier negative. Based on the archaeological record form the studied sites.

The application of this orthogonal method defined by us as a "concavity algorithm", have several modalities depending on the specific place on the negative used as platform for the following large flake. This method has similarities with the "quina" debitage method (Bourguignon 1996) since the aim of both is the production of thick flakes, although in our examples there is no contiguous flaking series.

As shown in the theoretical model, flakes are easily produced by knapping on the lateral part of the previous negative (see Figure 12, types a1 and a2), but distal negative areas can be also used depending on the particular morphology of the block (see Figure 12 type a3 and see

Supplementary files 1 and 2 - additional videos). In any case, the morphology of the produced large flake is similar by using lateral or distal concavities, with initial cortical large flakes and later semicortical and no cortical flakes.

Regarding the use of hammerstones during these exploitation methods, the use of massive maces for the massive blocks is the only way to start the division. After the production of usable flakes, highly dense hammerstones with a high weight used on flat or slightly convex surfaces is the best technique. In this case, holding such blocks could be produced with two hands or just by driving the hammerstone to the core taking advantage of the gravity (see Figure 5 and Supplementary files 1 and 2)

3. One technique for each core

The general reduction process indicates that starting from massive blocks the process follows different division stages to obtain manageable sub-blocks to apply controlled techniques with different methods depending on the product morphology.

In the case of massive blocks, we have documented the use of a wide range of techniques on the same unipolar method. Depending on how inside the percussion is performed and always favoured by the existence of internal fissures in most of the massive local flint blocks, throwing percussion techniques, more or less controlled, as well as different direct percussion techniques, are documented. This circumstance seems to be accredited by the presence of different percussion and/or crushing aggregated clusters within the same massive core (Figures 7 and 10), as well as massive maces with wide percussion areas (Cuartero 2014). In these cases, the more internal location of the percussions is produced, the less efficiency in the block fragmentation is obtained. In this way, direct internal percussion tends to be less effective than a peripheral one.

In the case of the giant core *débitage*, the existence of a diversity of methods with the presence of accumulation of peripheral and internal percussion stigmas seems to confirm the use of throwing, percussion techniques (with lower control of the percussion points than other techniques). For the case of big or large cores, the “on the floor” and direct percussion techniques are those that seem to have been more often applied attested by the rotation of the exploitation sequence and the existence of a greater control in the application of percussion as attested by the absence or the disperse concentration of percussion stigmata on the cores.

Massive and giant cores with high volumes inhibit the effective rotation of the morphology, and thus, limit the knapping strategy applied to unipolar methods. Large volumes in the core allow the application of bifacial methods and only with medium volumes alternant and orthogonal methods were applied.

Aside from a greater or lesser dispersion of impact points on the cores, as indicator of techniques employed, flaking on giant cores shows a greater degree of adaptability in the method conception from what we recorded in other flaking and shaping methods. For example, the adaptation to the lithic raw material quality determines the existence of unifacial exploitations (see Figure 9). The raw material quality is fundamental for an effective large flake production and hence the flaking methods adjust the exploitation to the good quality areas. or in the case of more homogeneous quality, orthogonal, discoid or unipolar methods.

From the results of experimental flaking, the use of unipolar and orthogonal percussions are the most productive methods to create large flakes, conceived as number of large flakes obtained per volume units. In the case of tabular morphologies with almost one surface, the unipolar method is the most appropriate and with quadrangular blocks the orthogonal is adequate.

4. Conclusions

The existence during Acheulean of a structured production based on different productive levels involves the handling of flint volumes that require adapting differentiated techniques in each of these phases. This adaptive exploitation concept implies the specialization of the human group responsible for the large flake production and the mutual cooperation in this task. For the exploitation of big dimensions blanks that do not allow an easy manipulation or rotation, the throwing percussion and the "two hands" techniques with "block on the block" and unipolar methods are the only viable options. In such cases, the objective of the production does not necessarily have to seek the direct production of flakes and fragments destined to the shaping, but frequently the rupture of the blocks in others of manageable dimensions. When this occurs, the exploitation schemes and percussion techniques change starting to use "two hands" percussion and "on the floor" percussion with alternating, bifacial and orthogonal methods. In these cases, the objective is aimed at obtaining large flakes, as a previous step to the shaping of the biface or an LCT (Baena Preysler *et al.,* 2018).

The documentation of these technical adaptation processes, depending on the production phase as well as on the dimensions of the blank, have been recorded in quarry catchments and initial exploitation areas. In these contexts, the nature and quality of the flint outcrops produce the attraction of human communities to create extraordinary adaptability of the productive system that sometimes was able to transform blocks of enormous dimensions and incorporate them within a complex productive sequence. At the same time in fluvial contexts, they were able to adapt to dimensions and morphologies of completely different blanks as pebbles and fragments from the same propose.

The archaeological record recovers in the central area of Madrid indicates the recurrent visit of the flint outcrops and secondary deposits for the catchment and exploitation activities. Those activities generate accumulation of extensive flint residues wasting areas in a clear anthropogenic process that preludes the nowadays what are known as Anthropocene.

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Data accessibility statement

The authors confirm that the data supporting the findings of this study are available within the paper and 3D scan collection of representative samples of the materials can be found in https://doi.org/10.21950/O7TAFL. For further information, please write an email to the corresponding authors.

List of supplementary files

Supplementary file 1
"Giant core 1.mp4"
"Percussion lancée". Experimental technique throwing percussion on massive flint block using a flint hammerstone

Supplementary file 2
"Giant core 2.mp4"
"On the floor" percussion. Experimental percussion technique on the ground applied on giant flint core using a quartzite hammer

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Perspectiva experimental sobre el *débitage* de núcleos gigantes: el caso del Achelense tardío del centro de la Península Ibérica

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Resumen:

Tradicionalmente, los conjuntos achelenses se caracterizan por la presencia de LCTs (grandes útiles de corte) y particularmente por piezas bifaciales. En este contexto, la existencia de grandes lascas como soportes para esas herramientas es uno de los principales criterios para un enfoque crono-geográfico de la variabilidad dentro de este tecnocomplejo. Durante el Achelense, se aplicó una amplia variedad de métodos sistematizados para la producción de soportes, probablemente como respuesta a limitaciones particulares de la materia prima e incluso a tradiciones o restricciones culturales.

En el caso de la Península Ibérica, las canteras y talleres recientemente excavados en la región de Madrid demuestran la complejidad de las estrategias de talla y conformado durante la segunda parte del Pleistoceno Medio. En particular, ejemplos como Charco Hondo 2 (ubicado en la zona de Los Ahijones) o Canteravieja (ubicada en Los Berrocales), ambos en Madrid, demuestran la existencia de una explotación específica de núcleos gigantes para la obtención de lascas y una adaptación de la explotación a los soportes.

En esta contribución, se presentan y estudian experimentos basados en materiales arqueológicos de Charco Hondo 2 para entender la existencia de estrategias particulares en la producción de grandes lascas. Conceptos como la predeterminación o simplemente la adaptación a una restricción particular de la materia prima (incluso la combinación de ambos conceptos) surgen al realizar los experimentos. En cualquier caso, estas pruebas nos proporcionan una excelente herramienta para la comprensión tanto cuantitativa como cualitativa de las secuencias de reducción y las intenciones humanas.

Para ello, se llevaron a cabo numerosos modelos experimentales de producción de grandes lascas que posteriormente fueron remontadas para la generación de esquemas diacríticos. En paralelo, los núcleos procedentes de los yacimientos, analizados mediante el estudio de las secuencias de explotación, han permitido analizar patrones de explotación en estas grandes piezas.

La existencia durante el Achelense de una producción estructurada basada en diferentes niveles productivos en función de los volúmenes manejados, requieren la adaptación de técnicas diferenciadas en cada una de estas fases. Este concepto de explotación adaptativa supone la especialización del grupo humano responsable de la producción de lascas grandes y la cooperación mutua en estas tareas, aparentemente por parte de personas expertas. Para la explotación de grandes soportes, que no permiten una manipulación o rotación fácil, la percusión lanzada y las técnicas de “dos manos” con métodos de “bloque sobre bloque” y unipolares son las únicas opciones viables. En tales casos, el objetivo de la producción no necesariamente debe buscar la producción directa de lascas y fragmentos destinados la posterior configuración de grandes útiles, sino con frecuencia la ruptura de los bloques en otros de dimensiones manejables. Cuando esto ocurre, los esquemas de explotación y las técnicas de percusión cambian, comenzando a usar percusión “con dos manos” y percusión “sobre el suelo” con métodos alternantes, bifaciales y ortogonales. En estos casos, el objetivo está dirigido a obtener lascas grandes, como paso previo al modelado del bifaz o de una LCT.

En estos contextos de captación, la naturaleza y calidad de los afloramientos de sílex atraen a las comunidades humanas para crear una extraordinaria adaptabilidad del sistema productivo que a veces fue capaz de transformar bloques de enormes dimensiones e incorporarlos dentro de una secuencia productiva compleja. Al mismo tiempo, en contextos fluviales, fueron capaces de adaptarse a dimensiones y morfologías de soportes completamente diferentes, como cantos y fragmentos, con el mismo propósito.

Palabras clave: Núcleos gigantes, Achelense, Arqueología experimental, afloramientos, *débitage*