**SUPPLEMENTARY INFORMATION**

**Extended analysis of the lithic assemblages**

A total of 2021 items (Table 3) from Levels 4, 5, 7, 8, 9 and 10 of the Fuente Mudarra site were analysed. The first 3 levels were excluded from the technological analysis because FM1 was a jumbled level due to disturbance by agricultural equipment, and Levels FM2 and FM3 contained few remains and were heavily disturbed. Levels FM6, FM11, FM12 and FM13 were found to be archaeologically sterile. The main shared characteristic of all analysed levels is the preference for Neogene flint as raw material, and essentially centripetal operations aimed at producing small-sized PB.

*Level 4*

1394 lithic remains were found on Level 4. The main problem at this level is the preservation of these archaeological remains, which are heavily degraded due to the formation of patinas, fracturing and gelifraction scars (gelifraction is a type of fracture produced by the action of ice that in our case will result in gelifraction domes and splinters (see fig.4)). This is evidenced by the large proportion of indeterminate and fragmented items (frag, FPB and frag of PB). Gelifracts also appeared (fragments with gelifraction scars and also gelifraction debris) (see Table 4).

Neogene flint is the predominant raw material on this level, comprising 89.31% of all items. It is followed by quartzite (3.51%), quartz (2.36%), indeterminate flint (2.36%), Cretaceous flint (1.64%) and other little-used material such as sandstone and limestone.

On Level 4 (L4), 11 natural bases and fragments of this material have been documented. In this archaeological context, many of the natural bases (nB) made from Neogene flint are unworked, some are fractured and others have been tested and then discarded after a couple of deliberate removals. Sizes vary from a minimum of 47x33x28 mm to a maximum of 185x155x108 mm.

We found 29 nB made of quartzite river pebbles which may have been used as hammerstones, although no percussion scars were documented. They are therefore unlikely to have been part of the operative chain, and were merely a result of the formation of the deposit. The cortical surfaces of these pebbles are degraded, making it impossible to distinguish the zones where the scars may have been located.

Only one Neogene flint core (1GNBe) was found at this level. It was exploited on a large nB (132x120x67 mm), with natural platforms (Fig. 5a). Exploitation of this large volume was begun but then abandoned, probably due to the low quality of the raw material, since the flint contained intrusions and geodes. This initial tentative exploitation produced a well-defined centripetal surface and another slightly exploited surface in an orthogonal bipolar direction. A 100-105º angle was generated between the two surfaces, facilitated by the natural shape of the nB. The first surface generated edge angles of 20/30º, while the angles of the second one (85º) are abrupt (Fig. 5a).

The core volume is asymmetrical, the centripetal surface is most exploited, and no preparation is detected on any of them. This let us to define it as a centripetal peripheral exploitation of secant planes in an initial state of exploitation. Large-sized flakes were produced using the system employed on this core, with maxima of 60x53 mm and observable minima of 45x58 mm.

We resorted to the analysis of the positive bases to define the reduction sequences, given the lack of more cores. Starting with the complete PB, we selected those with sufficient conservation to ascertain all the criteria set out in the methodology. Due to the above-mentioned preservation issues at this level, we were only able to define the origin of 18 out of the 220 complete PB (8.18%), 16 of which show origins in centripetal systems or chordal secant planes exploitations (14 of type A1 and 2 of type A2) and only 2 in parallel planes (1 of type B1 and 1 of type B2). (Fig. 6a,b,I,j,m).

Positive bases (PB) or flakes were prominent in the assemblage, comprising 58.67% of the total material on this level, including complete (15.78%) and fractured bases (FPB: 5.95% and Frag os PB: 36.94%). The majority are less than 30 mm long . This level predominantly contains small and micro-sized flakes, along with a large amount of knapping debris. 25.9% of complete PB are less than 20x20 mm.

In general, the flakes have non-cortical butts, plain and unifaceted, with basically non-cortical dorsal faces and several removals from the dorsal face (see figure 7).

There is a small proportion of retouched tools, not quite 2% of the items. There are various types of BN2Gc from Level 4, despite being a modestly represented category, with 7 sidescrapers (types R11 (1), R21 (2), R22 (1), R23 (3)), 5 denticulates (D1), 3 notches (D21), 2 tayac points (D24), 1 becs and 2 abrupt retouches (A1 and A2). (Fig. 8)

The features common to all these shaped items are unifacial retouch, a preference for simple and abrupt retouches and not especially invasive with respect to either the ridge or the face. Sizes indicate that the largest items were usually chosen to be retouched (Fig. 8). As a result, the sizes tends to be larger than those of the positive bases.

*Level 5*

Fuente Mudarra Level 5 yielded a total of 297 items. The proportion of fractured items is quite similar to Level 4, however their surfaces were better preserved, with a smaller percentage of gelifraction scars (see table 4). Orange patinas are found on items from this level.

The pattern detected in the previous level is repeated in terms of choice of raw material, Neogene flint still the predominant raw material (91.24%). However, there is a significant increase in the number of Cretaceous flint items (6.06%). The others materials found on this level: quartzite, quartz, sandstone and limestone, are marginal (less than 1%).

The nB of this level primarily consisted of 10 blocks of Neogene flint, in some cases showing signs of test removals without exploiting the natural base.

Three 1GNB have been found with peripheral centripetal exploitation or chordal exploitation of secant planes, regardless of their original base.

Only one of the cores is exploited on nB (1GNBe). It has cortex on the least exploited surface (Fig. 5b). The core is in an intermediate exploitation phase (95x87x85 mm). Both surfaces show signs of removals, which form an 80º angle, converging on an undulating edge around the entire perimeter.

In cores with a discoid tendency like this one, the alternating exchange of platforms can give rise to these edge undulations (Terradas, 2003), an indication of non-hierarchical exploitation. In this particular case, both surfaces seem to have been exploited at the same time, with a lack of preparation.

The two BN2Ge (cores on flake), show the same system employed in a similar way (Fig. 5c and 5d). It should be noted that one of them shows a somewhat more hierarchical exploitation, within the secant plane dynamic. It was subsequently reused as a tool after retouching the distal part of the PB . (Fig. 5c)

The PB reflect exploitations essentially involving centripetal systems with secant planes. 100% of the 16 PB whose exploitation could be defined, were identified with type A1: the result of centripetal peripheral exploitation of secant planes (Fig. 6c and 6d).

Positive bases are widely represented at this level. They account for 60.6% of the total between PB, FPB and Frag of PB. The dorsal surfaces are non-cortical, with three or more previous removals.

The percentage of retouched tools is smaller on Level 5 than Level 4. Only 6 retouched tools have been found, one of them fractured. There is no typometric relationship amongst them, with the lengths of these six tools ranging from 16 mm to 72 mm (Fig. 9).

Four of these tools (sidescraper, denticulate and retouched flake) are made on Neogene flint (R22, R21 and D1) (Fig. 8g and 8h), and two on Cretaceous flint (D21 and D23) (Fig. 7i and 7j). The common features included unifacial retouches, and abrupt or semi-abrupt angles. Retouches on the Neogene tools are deep in comparison to the surface, while on the Cretaceous tools, they tend to be more marginal. In the Cretaceous flint items (sizes less than 50 mm), remainders of cortex are detected in rounded zones, indicating that they are made from small-sized nodules. The ridges are used to shape small continuous retouches. Most of the observed retouches do not span the entire ridge.

*Level 7*

This level yielded a relatively small number of lithic items (only 98), but they are preserved in a very good state. There is no evidence of gelifraction here, and there is considerably less fracture. All items from this level have completely black/grey patinas, which are uniform on all surfaces.

As in the higher levels, Neogene flint is the predominant material (75.51%) on Level 7. The 16.32% of undetermined flint is due to the difficulty of identifying the material de visu, given the dense patinas on material at this level.

The nB found at this level are principally 6 quartzite pebbles and one block of fractured Neogene flint. Its base is not exploited, but it show~~ed~~ a couple of orthogonal bipolar bifacial test removals. It is probably discarded because of its poor quality, with intrusions, coarse grains and geodes appreciated inside the block.

It is difficult to define the exploitation systems used on Level 7, because there are no cores. In 12 of the 32 complete PB (37.5% of PB), the origin could be attributed to centripetal exploitation systems. Peripheral exploitation of secant planes is defined in 10 of the products (7 type A1 and 3 type A2) (Fig. 6e and 6f) and 2 cases of peripheral exploitation of parallel planes (1 type B1 and 1 type B2) (Fig. 6k).

The flake categories (PB, FPB and Frag of PB) comprise 64.2% of the total. Amongst the PB there is knapping debris, and small, medium and large flakes with sizes ranging from 7x7x1 mm to 62x38x15 mm (See figure 9).

The butt types are unifacetted and non cortical (Fig. 7). In all cases, the dorsal surfaces are non-cortical, with more than 3 removals, generally centripetal.

Only three retouched items were found on this level, all of them in larger sizes (Fig. 9). One of the items (Fig. 8m) is made on a fragment with two opposing notches (D21), a large denticulate (D3) (Fig. 8l) and an abrupt deep retouch on a fragment (Fig. 8k).

*Level 8*

Level 8 contain~~ed~~ 209 stone technology items, with similar features to those on Level 7. There are no remains with gelifraction and there are a smaller proportion of fractured items than on Levels 4 and 5. Like in Level 7 (see table 4), intense greyish patinas were generated in all the pieces.

We found 22 quartzite nB in sizes ranging from 50x36x30 mm to 136x108x49 mm, and 4 Neogene flint nB in different sizes ranging from 40x30x22 mm to 110x80x45 mm. In some cases, the flint nB seem to have been tested. One item exhibit signs of unipolar longitudinal flake removal on two faces, in sizes between 62x60 and 43x55 mm, after which it was discarded. The flint of this base is very coarse grain, making it difficult to knap. This may have been the reason for its abandonment at such an early state of exploitation.

The exploitation systems are somewhat more varied on this level, with a predominance of centripetal exploitation systems on secant planes. All cores are in the 1GNBe category, i.e., exploitation directly on blocks of Neogene flint.

The first of these BN1Ge is on a large nB (131x100x86 mm). Two moments in the exploitation of this core are distinguished, both in the same sequence. The core is fractured after the removals, but then this fracture serves once again as a percussion platform. Nevertheless, this fracture event do not prevent the block from being discarded (Fig. 5e).

An initial surface is generated in this large volume, with removals from the periphery of the core, arranged centripetally and without exploitation of every point of the perimeter. The negatives show that knapped flakes were in sizes ranging from 13x11 mm to 61x50 mm, with removals on a single angle (35/40º) with respect to the main ridge.

The second surface of the core is fractured. We only appreciate a removal, and we could not determine the organization of the platforms. The base contained many geodes, probably the reason of the fracture. This may also have been the reason for its rejection, despite offering a large volume that could have been exploited. The exploitation system is probably centripetal peripheral or chordal on secant planes, in the initial moments of exploitation.

These patterns also appeared in another 1GNBe, which is largely fractured. In this case, the exploited core on low-quality material contained numerous intrusions and geodes (Fig. 5f). The surface of the main fracture have a large geode which may have been the axis of the fracture. This make it difficult to identify the exploitation system.

Based on the analysis, it seems that at least the two faces were exploited centripetally on secant plane angles.

A third 1GNBe was exploited in the same way, with two centripetal surfaces intersecting with secant planes at the start of the sequence (Fig. 5g). A third surface is generated as a result of the exhaustion of angles and striking platforms, resulting in a trifacial core. The surface of the third face is quite small, with small-sized removals permitted by the ideal angle of this surface. The change of type from bifacial to trifacial centripetal is due to the knapper's search for volume on the third face at an advanced point in its exploitation, when the size is quite small (69x50x46 mm). The face evidenced overlapping removals, many of which were reflected, probably due to the exhaustion of the surface or its convexity. There is no sign of preparation of the surfaces.

Another exploited core is on a medium-sized nB with cortical surfaces (84x65x56 mm). It has two exploited faces, main and preparatory (Fig. 5h). Most of the surface is unexploited. There are several signs of accidents such as hinged flakes.

The first surface has medium-sized removals from opposed platforms, organised in an opposite bipolar manner. The size of the products, between 31x25 and 52x25 mm, is deduced from the removal scars. They are longer than the products from the previously-discussed cores. The second surface show~~s~~ preparatory removals or cortex removal in the preparation of one of the platforms on the first surface. The exploitation system employed on the base is bipolar orthogonal.

Analysis of the complete PB showed, centripetal systems employed in this level (Fig. 6), primarily represented by the results of exploitations of secant planes (17 type A1 and 2 type A2), and only 3 from the exploitation of parallel planes, type B1

The PB on Level 8 repeat the same patterns found on the previous levels, with flakes ranging from 10x11x3 mm to 63x49x11 mm (Fig. 9), with non-cortical, unifaceted butts, and dorsal faces with no cortex, and several previous removals.

Retouched products (1GNBc and 2GNBc) included denticulates (D2), denticulate sidescraper and sidescraper (D23 and frag of R2), endscraper (G11) and tayac point (D24). A noteworthy aspect is that several of these tools were shaped directly on fragments (Fig. 8n-r).

*Level 9*

Work on this level only involved a roughly 1 m2 test area in the south-eastern corner of the main Fuente Mudarra test pit (Fig. 3b). Nineteen lithic technology items were found, 13 of them in Neogene flint, with patinas in different shades of white, grey and black.

The distinctive feature of the Bn from this level is their large size. The 3 Neogene flint Bn included large cobble nodules up to 220x165x150 mm. One of them was tested and then discarded. There are also large quartzite Bn, two of which measured roughly 150x100x50 mm.

PB is the numerically largest the category of material from Level 9, in sizes ranging from 21x27x5 to 51x59x25 mm. Predominant forms, non-cortical butts (except for the quartzite PB, which is cortical) and dorsal faces with several removals (between 2 and 5), two of which were from centripetal exploitation systems.

The remaining undescribed items are fragments of uncertain origin. Abrasion is detected on some times, along with post-depositional fracturing.

*Level 10*

Four lithic industry items were found in the test pit on Level 10 (1 Bn, 1 fragment, 1 FBP and 1 PB), all in Neogene flint, which simply served to confirm occupation at this level.