



# **Technological analysis of the quartz industry of Maboué 5 – Layer 3 (Lopé National Park, Gabon): Implications for the Late Stone Age emergence in western Central Africa**

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## Technological analysis of the quartz industry of Maboué 5 – Layer 3 (Lopé National Park, Gabon): implications for the Late Stone Age emergence in western Central Africa

### Highlights

- Maboué 5 presents a sedimentary sequence ranging from Late Pleistocene to Middle Holocene in the Lopé National Park in Gabon.
- Layer 3 – which provided a 14C date between 44 600 and 14770 cal. BP – delivered the richest quartz lithic industry of this sequence.
- A combined productional and techno-functional approach is applied to describe the Layer 3 lithic assemblage.
- The technological analysis highlights the co-occurrence of both Late and Middle Stone Age technological patterns within the Maboué 5 – Layer 3.
- The results highlight the technological variability of the early Late Stone Age quartz lithic industry in western Central Africa.

### Abstract

In Central Africa, Late Stone Age (LSA) seems to emerge before the Late Glacial Maximum (LGM) usually associated to a fluctuating savanna expansion and forest cover reduction. However, few sites with a reliable chrono-stratigraphic context allow us to deal with the emergence, the diffusion and the specificities of the regional lithic assemblages associated to the Late Stone Age. The site of Maboué 5, located in the Lopé National Park in Gabon provided useful lithic corpus to consider these questions. This paper provides a detailed technological analysis of the Layer 3 dated between 44 600 and 14 770 cal. BP. We consider both the production patterns of the entire assemblage and the morpho-structural characteristics of the tools. Our results exhibit a lithic assemblage associating both Middle and Late Stone Age technological patterns as well as argue for regional technological variability among early LSA quartz assemblages. Finally, we highlight the specificities of quartz lithic industry of a site in the poorly documented region of western Central Africa and we question the validity of the regional nomenclature, namely the Tshitolian and Lupemban facies to classify this final Late Pleistocene lithic assemblage.

### Keywords

Gabon, N.P. Lopé, lithic technology, Middle Stone Age, Late Stone Age, quartz, Maboué

## 1. Introduction

Most evidence for human occupation in western Central Africa is known from prehistoric sites dating to less than 40 000 years ago. The associated Late Pleistocene lithic assemblages include Late Stone Age (LSA) microlithic artifacts, which are sometimes attributed to the Tshitolian facies, and Middle Stone Age (MSA) lithic artifacts regionally characterized by a diversity of shaped tools, blade and preferential flake production and attributed to the **Lupemban** facies (Cornelissen, 2002; Miller, 2001; Taylor, 2011). Both facies were established by H. Breuil in 1944 from the eponymous sites of the Tshitolo Plateau and the Lupemba Valley in Kasai region in the Democratic Republic of Congo using typical hallmarks such as bifacially shaped arrowheads for the Tshitolian and elongated bifacial points interpreted as thrusting spears for the **Lupemban**. His chrono-cultural framework was based on an evolutionary view of stone tools becoming increasingly refined and reduced in size through time (Breuil, 1944). Due to the poor chronological contextualization and the absence of clear distinctive patterns between the **Lupemban** and the Tshitolian – beyond the presence/absence of certain tool types – these are sometimes hardly distinguishable and thus gathered into the “Lupembo-Tshitolian” (Clark, 1963; Cornelissen, 2002). Although these facies have been discussed for several decades now (Mesfin et al., 2020b), it is now broadly acknowledged that we must move beyond the use of this nomenclature and propose new approaches and new questions on the Late Pleistocene lithic assemblages from Central Africa.

Even though evidence for Earlier and Middle Stone Age so-called “Sangoan” and “**Lupemban**” industries are numerous, Central African open-air sites prior to ~40 ka are mostly prone to vertical disturbances, namely the “stone-lines” into which several archaeological layers are mixed, limiting discussion on chronological patterns (Brown et al., 2004; Cahen, 1976; Fairbridge & Finkl, 1984; Mercader et al., 2002; Schwartz, 1996; Stoops, 1990). A further problem is separating out specific regional patterns from the nomenclature established decades ago, which is still very much based on typology to place the lithic corpus into the broadest stages of the Central African Stone Age (e.g. the Acheulean, Sangoan, **Lupemban** and Tshitolian) (Cahen, 1978; Cahen & Van Noten, 1971; Clark, 1971; Taylor, 2011, 2016). This may be due to the sparse distribution of contextualized sites which restricts micro-regional and/or local analysis of human behavior in a delimited space and time period.

However, western Central Africa is of key relevance for understanding human relationships to the African forest belt and for enriching the current debates on behavioral adaptations of Pleistocene hunter-gatherers to diverse tropical and equatorial environments at a global scale (Eggert, 2014; Mercader, 2002a, 2002b; Perry et al., 2014; Roberts, 2019; Roberts et

al., 2020, 2017; Roberts and Petraglia, 2015; Taylor, 2016, 2011). The question is even more meaningful now that subsistence strategies based only on foraging in African rainforest environments is believed to be possible (Bailey et al., 1989; Bahuchet et al., 1991; Sato et al., 2012; Yasuoka, 2013; Mercader et al., 2000a; Hewlett, 2014). The Lopé National Park in Gabon, listed as a UNESCO World Heritage site in 2007 both for its environmental and cultural heritage, plays a major role in understanding western Central African prehistory as the long history of research in this area has established palaeoenvironmental, chronological and cultural sequences (e.g. Assoko Ndong, 2003, 2002; Chiti et al., 2018; de Bayle des Hermens et al., 1987; Henga-Botsikabobe et al., 2020; Jeffery et al., 2014; Moumaneix and Nkombe, 2017; Nfoumou et al., 2017; Obiang Mba, 2020; Oslisly, 2016, 2011, 2001, 1998, 1993; Oslisly et al., 2013; Peyrot et al., 2003; Saulieu et al., 2018; Sebag et al., 2016; White, 2001). The park extends from the equator to the northern foothills of the Chaillu Mountains and covers the middle part of the Ogooué Basin, a river of 1080 km flowing east to west, from the Ntale Mountains in the Republic of Congo to near Port-Gentil in Gabon.

At the Lopé National Park, most of the documented sites are dated to the Holocene (e.g. Assoko Ndong, 2002; Oslisly, 1993, 1994, 2001; Oslisly et al., 1996; Peyrot et al., 2003) but the site of Maboué 5 provides an unique open-air stratified palaeoenvironmental sequence spanning from Final Pleistocene to the Middle Holocene and presenting three archaeological layers deposits (Oslisly et al., 2006, 2004) (Figure 1). The preliminary analysis of the lithic material pointed toward a technological continuum between the different layers. The radiocarbon dating using Accelerator Mass Spectrometry (AMS) provided an age of  $40010 \pm 850$  (Gif 11413) (Oslisly et al., 2004, 2006), 44 600 – 42 431 cal. BP for a charcoal directly associated to the archaeological deposit. It is the densest layer of lithic artifacts at the site and the preliminary analysis suggests technological continuity with other final Late Pleistocene and Holocene sites discovered in the Lopé National Park such as Maboué 2, Maboué 3 or Lopé 2 (Assoko Ndong, 2002; Oslisly et al., 1996). This suggests an overall stability in lithic technical behaviors from the final Late Pleistocene in a fluctuating environmental context.

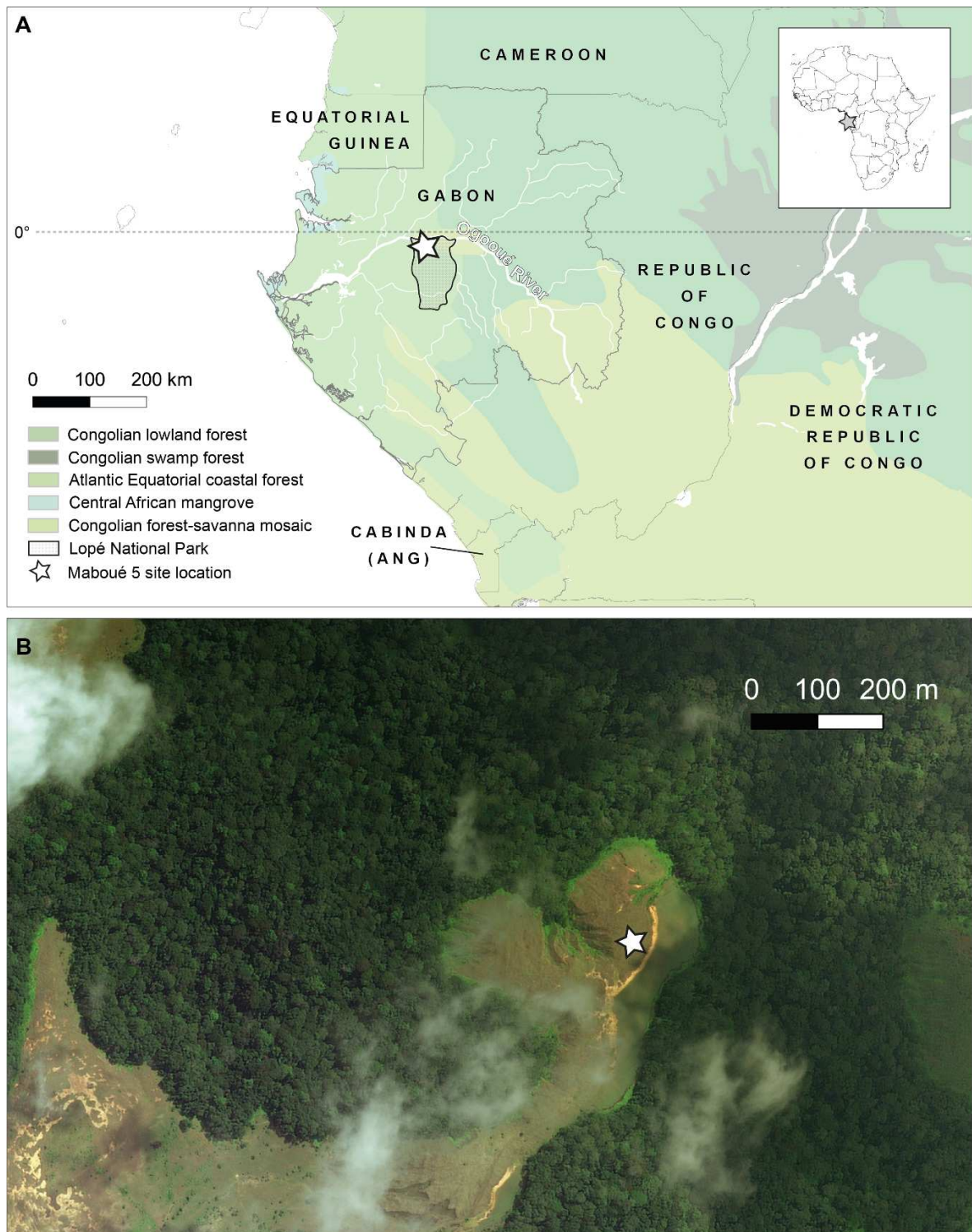


Figure 1 A: Maboué 5 in geographical context with the main rivers of Gabon and the Ogooué Basin. Eco-regions of western Central Africa are based on data from Conservation Science Program - World Wildlife Fund (Olson et al., 2001); B: Aerial view of Maboué 5 on the 315m high hilltop in the relict savannah environment.

From a global perspective, Central African Pleistocene **palaeoenvironments** between 40 ka BP and 15 ka BP are characterized by important fluctuations between wet and dry phases impacting on the extent of forests and savannas (Frenzel, 2008; Gasse, 2000; Giresse et al.,



1994; Maley and Brenac, 1998; Mercader et al., 2000b; Miller, 1988; Moeyersons, 1979, 1997; Roche, 1991; Runge, 2007; Runge et al., 2013; Vincens, 1991) especially during the Late Glacial Maximum (LGM; from ca. 26.5 ka to 19 ka, Clark et al., 2009). Forest cover began to reduce between 48 and 40 ka (Lezine and Cazet, 2005; Oslisly et al., 2006; Roche, 1991; Runge et al., 2013) and oscillations are observed throughout the Late Pleistocene; for example, a wetter phase is suggested between 28 and 26 ka cal. BP (Lezine and Cazet, 2005) and a much drier phase between 20 and 15 ka (Roche, 1991). It is acknowledged that since the LGM, the extent of the Central African forest belt has shifted and was rather a mosaic of diverse ecotones with some rainforest refugia (Leal, 2004). This suggests that hunter-gatherer populations associated with the same techno-complex were occupying different ecological niches, from grass savannas to forest environments, and sometimes simultaneously (e.g. forest galleries, grassland patches etc.) (Cornelissen, 2016, 2002; Mercader and Brooks, 2001; Oslisly et al., 2013). However, in Central Africa, Late Pleistocene evidences of human occupation limited to rainforest environments are very rare compared to the Holocene (Cornelissen, 2016; Livingstone Smith et al., 2017). Pleistocene reliable data originate mostly from Cameroon (Njuinye and Mudip) and Equatorial Guinea (Mosumu) (Mercader and Martí, 2002) based on correlations with the palaeoenvironmental sequence of the lake Barombi Mbo in southwestern Cameroon (Maley and Brenac, 1998). Holocene sites are potentially the result of human resilience to Central African forest cover expansion, up to 3-2.5 ka BP (Mercader et al., 2000a; Tovar et al., 2019). At Maboué 5, the preservation and analysis of charcoals within four interstratified layers suggest that the sedimentary sequence covers an environmental transition from a more forested environment to a mosaic of rainforest and remnant grass savanna patches land-locked in the Gabonese forest (Henga-Botsikabobe et al., 2020; Oslisly et al., 2006, 2004; White, 1986, 2001).

Due to the scarcity of established and reliable regional sequences comparable to Maboué 5, we focus on the Maboué 5 – Layer 3 to provide insights on final Late Pleistocene hunter-gatherer technical behavior in the Middle Ogooué Valley, during the onset of the savanna expansion.

## 2. Site settings and lithic material

Maboué 5 (0°8'33"S / 11°31'24"E) was discovered in the Lopé National Park in 1998 owing to hill slope erosion which exposed lithic artefacts. Excavation at Maboué 5 were conducted in 1999 over 4 square meters and exposed the presence of four interstratified horizontal beds of charcoal. The four layers of Maboué 5 have been defined based on these four charcoal beds. Among these four layers, three presented charcoals directly associated to lithic remains (Figure 2). Sediments were sampled every 10cm along the 350cm deep profile

in order to conduct a multidisciplinary approach and the results argue for a changing environment over time and an absence of vertical disturbance since > 44 600 cal. BP up to Middle Holocene. The results are detailed in several publications (Assoko Ndong, 2003, 2002; Oslisly et al., 2006, 2004) and the following sub-sections are based on these papers.

## 2.1. Site formation process and integrity

Maboué 5 is located on the top of a well delimited hill culminating at 315 m above sea level. Excavation exposed four *in situ* layers presenting macroscopic charcoal remains – among which three presenting also quartz lithic artifacts – within a homogeneous deposit of sandy-clayey sediments (Figure 2). Granulometric analysis suggested that silt-size sediments dominate all along the sequence (>85%) except on the uppermost 10cm (≈53%), followed by fine sands and finally medium to coarse sands. It argues for a homogeneous sandy-clayey sediment throughout the sequence. This sediment is characterized by a dominance of quartz grains from the base to 230 cm deep, and then by reddish goethite grains. The quartz grains are non-used and goethite crystal aggregates have been observed, arguing for slow homogeneous sedimentation by runoff with a decrease of energy through the sequence but with no major climax (Oslisly et al., 2006, 2004). The granulometric data argue for an absence of post-depositional vertical perturbation and an absence of “stone-lines”. The entire sandy-clayey matrix is composed of inframillimetric charcoal remains, especially in the uppermost part of the sequence suggesting rising importance of bushfires during the Holocene. The microscopic charcoals are distributed independently from the macroscopic charcoals present in each layer (Oslisly et al. 2006). The granulometric and petrological characteristics and the interstratification of the four horizontal layers point toward the absence of “stone-lines” and a vertically undisturbed sequence at Maboué 5. These so-called “stone-lines” are a regional distinctive signature of archaeological palimpsests and are characterized by a layered accumulation of the biggest gravels (Brown et al., 2004; Cahen, 1976; Fairbridge & Finkl, 1984; Mercader et al., 2002; Schwartz, 1996; Stoops, 1990). These stone-lines are usually associated to quartzite and sandstone [Lupemban](#) tools in the Middle Ogooué Valley (Assoko Ndong, 2003, 2002). In addition, the topographic location on the hilltop which reduced the possibility of horizontal perturbation, the coherency of the 14C dates along the sequence and the preservation through time of the palaeolandscapes in theses relict savannah patches (Peyrot et al., 2003) reinforce the idea of *in situ* sequence at Maboué 5.

## 2.2. Palaeoenvironmental data

Palaeoenvironmental proxies are provided thanks to sedimentological analysis, charcoal remains preservation and  $\delta^{13}\text{C}$  isotopic analysis. Isotopic analysis of  $\delta^{13}\text{C}$  suggests a

transition from C3 to C4 plants during the sequence (Figure 2). C3 plants dominate from the lateritic crust up to 260 cm deep. This suggests a forested environment or a wooded savanna up to the Layer 3 deposit, followed by savanna recolonization up to the Holocene Layer 1 (Oslisly et al., 2006, 2004). The uppermost samples delivered evidence of anthropic impact on the landscape related to the importance of forest fires.

Macroscopic charcoal remains analysis revealed the presence of different Marantaceae forest wood throughout the sequence (Oslisly et al., 2006, 2004) (Table 1). Marantaceae forests are associated with rainforest environments especially in Gabon and the Republic of Congo and are characterized by scattered high trees with a giant herbaceous stratum (Gillet, 2013; White, 2001). Several species associated with savanna borders have also been identified.

Table 1 Ligneous species identified by layer and their association to a specific environment.

Layer	Species	Environment type
Layer 1	<i>Dalbergia</i> sp.	Savanna border
	<i>Beilschmiedia</i> sp.	Marantaceae forest
	<i>Albizia</i> sp.	River banks and forest galleries
Layer 2	<i>Trichilia prieureana</i>	Variable forest type
Layer 3	<i>Chytranthus</i> cfr. <i>setosus</i>	Marantaceae forest
	<i>Cathormium</i> cfr. <i>altissum</i>	Savanna border
	<i>Allophyllus africanus</i>	Marantaceae forest
	<i>Ocotea</i> sp.	Dry environment marker
Layer 4	<i>Beilschmiedia</i> sp.	Marantaceae forest

These first results suggest the presence of a mosaic of environments characterized by tropical forest and grass savanna, especially during the Layer 3 accumulation. This appears to be a common feature in the location of western Central African LSA sites (Miller, 1988). Indeed, at the site of Batéké - La Sablière, southeast of Kinshasa in the Democratic Republic of Congo, an undated Tshitolian site is associated with a savanna environment although rainforest wood species were also identified among the charcoal remains (Cahen & Mortelmans, 1973). At Shum Laka rockshelter in the West Region of Cameroon, it is suggested that populations occupied an open environment with forest galleries (Cornelissen, 2003; Moeyersons, 1997). Another example is Ntadi Yomba rockshelter in the Republic of Congo: the ~7 ka BP occupation attributed to the Tshitolian provided an important bone assemblage indicating subsistence strategies that targeted diverse faunal species found in both savannas and rainforests (e.g. *Diceros bicornis* usually associated with open environments and *Proxerus stangeri* associated with rainforests) (Van Neer and Lanfranchi, 1985).



### 2.3. Chronological context

Despite the absence of bone remains, the charcoal preservation directly associated to lithic artifacts in the layers 2, 3 and 4 made AMS radiocarbon dates possible. The following dates were re-calibrated using OxCal v.4.4.2 (Ramsey 2020) and the IntCal20 calibration curve for the northern hemisphere (Reimer et al. 2020) and calibrated dates (cal.) are presented are 95.4% probability interval and reported in terms of years 'before present' (BP) (Figure 2):

- Layer 1, 40 to 50 cm deep, has been dated to  $4\,430 \pm 40$  BP (Gif 11411), 5 280 – 4 860 cal. BP ;
- Layer 2, 130 to 140 cm deep, has been dated to  $12\,570 \pm 100$  BP (Gif 11412), 15 240 – 14 770 cal. BP ;
- Layer 3, 260 to 280 cm deep, has been dated to  $40\,010 \pm 850$  BP (Gif 11413), 44 600 – 42 431 cal. BP ;
- Layer 4, 310 to 320m deep, yielded a date of  $\geq 57\,100$  BP, (Gif 11414 - GifA 101 063) beyond the chronological range of the radiocarbon dating method and thus is considered here as undated.

Thus, the chrono-stratigraphic sequence of Maboué 5 is contemporaneous with a large part of the chronology of the regional LSA which spans ~40 to ~3.5 ka BP in Central Africa (Oslisly et al., 2013). However, only the layers dated to Late Pleistocene delivered evidence of material culture. Despite the coherency of the  $^{14}\text{C}$  chronology, the presence of a unique  $^{14}\text{C}$  date per layer is not sufficient. Thus, we consider the  $^{14}\text{C}$  date of Maboué 5 – Layer 3 as a *terminus ante quem* age. Consequently, Maboué 5 – Layer 3 may be considered as ranging between 44 600 and 14 770 cal. BP. This chronological range of the Maboué 5 – Layer 3 deposit indicates final Late Pleistocene thus contemporaneous or predating the LGM.

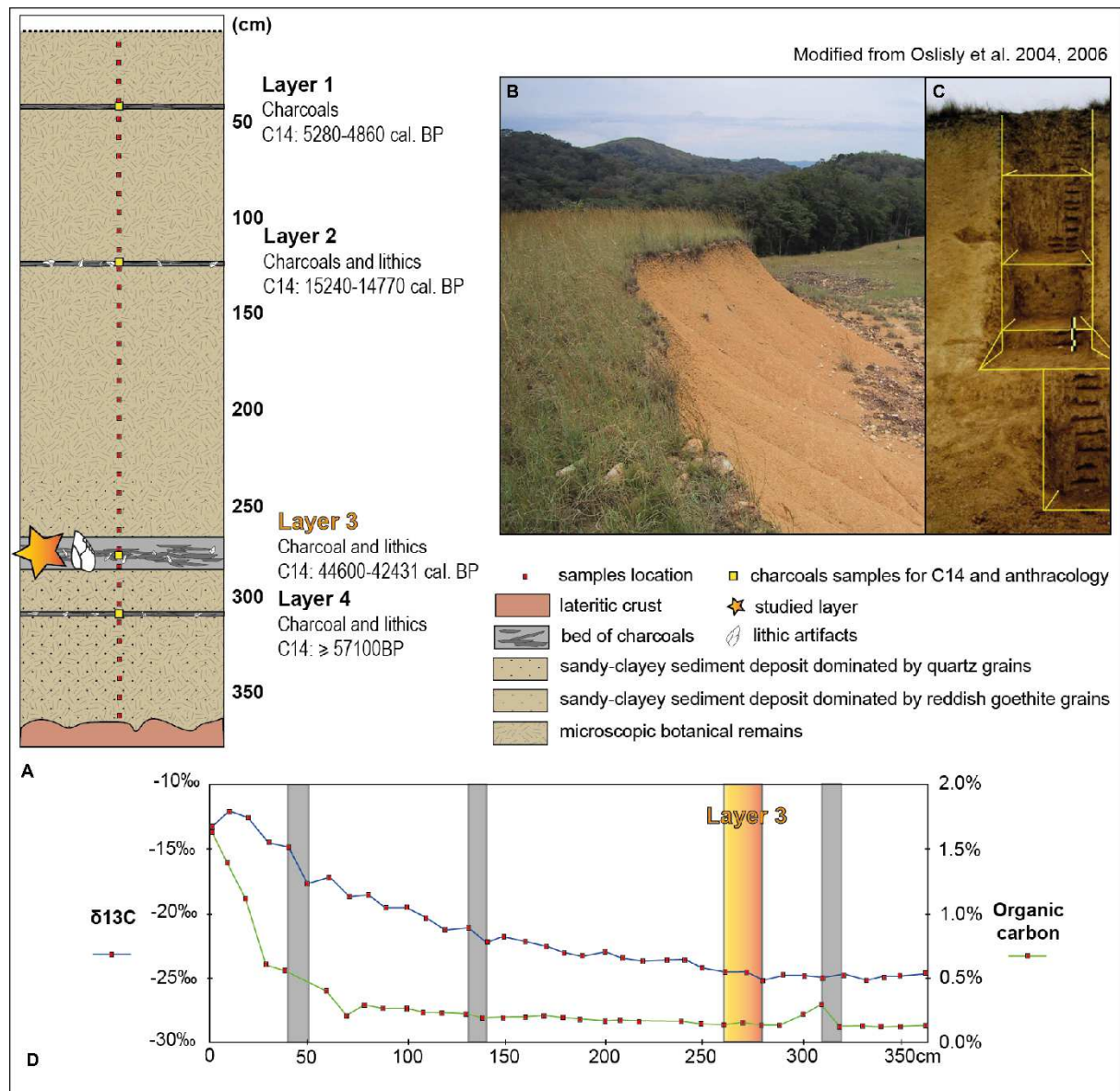


Figure 2 Chrono-stratigraphic context of Maboué 5. A. Chrono-stratigraphic sequence; B. View of the site landscape and erosion slope; C. View of the stratigraphic sequence; D.  $\delta^{13}C$  isotopic analysis curve along the sequence. Modified from Oslisly et al. 2004, 2006 / Photo credit: R. Oslisly.

## 2.4. Lithic assemblage

Lithic remains were recovered from layers 2, 3 and 4. All layers are mainly composed of quartz artifacts and microlithic production and tool types such as notched flakes and awls in all the layers. These preliminary results focused on a diachronic and regional perspective of the Maboué 5 lithic corpus and argued for technological continuity throughout the sequence, suggesting a long-standing LSA technical tradition in the area (Oslisly et al., 2006, 2004). However, Layer 2 and Layer 4 did not provide a fairly representative corpus numerically for a diachronical detailed comparison, and only Layer 3 provided a lithic corpus rich enough to conduct a significant technological analysis. Therefore, it deserves a specific attention.

In this context, several reasons prompted us to reappraise the material of Maboué 5 – Layer 3. First, Central African prehistory is still rooted in the broad regional nomenclature and consequently the vague regional sequence is difficult to situate in current pan-African studies (Cahen, 1978; Clark, 1971; Cornelissen, 2002; Lanfranchi and Clist, 1991; Mesfin et al., 2020b; Taylor, 2016, 2014). This generalization may be due to the technical peculiarities of Central Africa such as the variable shaping reduction strategies through Earlier, Middle and Late Stone Age (Cahen, 1975; Clark, 2001; de Bayle des Hermens, 1981; Demayumba, 2018; Emphoux, 1970; Lanfranchi & Lanfranchi-Salvi, 1986; Mesfin, 2018; Van Moorsel, 1968). Thus, the region is in need of sites with detailed technological analysis of contextualized lithic assemblages. Second, renewed analysis of Maboué 5 – Layer 3 will allow us to replace this layer in the context of the recent debates on the origins of stone tool miniaturization and on the (un)systematic association of microlithic production with the LSA (e.g. Ambrose, 2002; Clarkson et al., 2018; Hiscock et al., 2011; Leplongeon, 2014; Leplongeon et al., 2017, 2020; Pargeter, 2016; Pargeter & Shea, 2019; Tribolo et al., 2017). Third, by focusing on the richest layer, Layer 3, comprising 596 lithic artifacts, this will enable a first step for describing human technical behaviors during the climatic oscillations of the final Late Pleistocene in the tropical environments of the Middle Ogooué Valley.

### 3. Methods

Due to the small number of lithic artifacts at Maboué 5 – Layer 3, we chose to apply a combined technological approach on this assemblage based on the acquisition of qualitative data via a detailed analysis of each artifact. Furthermore, the choice of a qualitative technological approach is based on the absence of comparative analysis and the will to present a specific lithic assemblage in detail without classifying it at a broader chrono-cultural level. First, we assessed the lithic production in the frame of the *chaîne opératoire* concept by using physical and mental refittings – meaning, reconnecting the association of specific stigmata to specific methods/strategies of flake production or shaping by a detailed reading of the negative scars and cortical surfaces (Audouze and Karlin, 2017; Bodu, 2007, 2001; Pelegri, 1991; Schlanger, 2004; Schurmans and Bodu, 2007; Sellet, 1993). The terminology used for describing artifacts is based on Inizan et al. (1995). In this, we distinguished different operational schemes based on the orientation of the removals and the different chronological production phases (blank selection/acquisition, preparation and exploitation) but also considering the techniques used (bipolar, free-hand, pressure etc.) and the production objectives (convergent-edged flakes, elongated blanks etc.). The chronological sequence of the scars on the cores is assessed through the diacritical schemes (Dauvois, 1976). We used the core data to classify the flakes and to attribute the flakes to the identified reduction strategies whenever possible, using the dorsal scar pattern organization, meaning

the number of removals and orientation (uni-/bi-/multi-directional, orthogonal, convergent) and their association with the butt morphology : type (faceted, dihedral, plain, cortical etc.), width, thickness, exterior platform angle and flaking angle.

Second, we applied a morpho-structural approach – also called the “techno-functional approach”. It was developed in the late 1990’s to address the lack of methodology in French lithic studies between the production phases (“*chaîne opératoire*”) and the functional phases (use-wear analysis); meaning the volumetric objectives of the production and functional potentialities of the tool volume before its use (Boëda, 2013, 1997; Forestier, 2020; Lepot, 1993). This approach consists in describing the stone-tool morphological and technological structure using the three synergetic parts of a tool: the active / prehensile / transmitting parts – also called “*Unités Techno-Fonctionnelles*”. First, we identify the tools’ edge’s part suitable for a contact with the material being worked based on the observation of specific criteria present on the cutting-sharp edges. These include the continuity of an edge’s delineation, the location of the cutting edges in relation to the technological and/or morphological axis (axial/lateral/disto- or proximo-lateral tools), its angle values (rounded to the nearest 2.5°) and its morphology in plan (convex, denticulate, concave, rectilinear, convergent etc.) and in section (simple beveled, double beveled, trihedral points etc.) (Boëda and Hou, 2011; Donnart, 2010; Grimaldi et al., 2020; Kot, 2014; Li et al., 2014; Marciani et al., 2018; Mesfin et al., 2021; Nicoud, 2013; Rocca, 2016; Viallet, 2019, 2016; Wei et al., 2017; Zhou et al., 2019). This morphologically homogeneous delimited part of the tools is conventionally called the “potentially active part” or the “UTFa” (“*Unité Techno-Fonctionnelle active*”). However, it does not refer to the used part of the tool – which can only be assessed through micro-use wears analysis – but to the tool volumetric structure potentiality (Boëda, 2013; Bonilauri, 2010; Chevrier, 2012; De Weyer, 2020, 2016; Forestier, 2020; Soriano, 2000). Second, the potentially prehensile parts – interpreted as gripped or hafted – are also characterized by the observation and description of specific features of the surfaces opposite to or contiguous with the potentially active parts, such as a lateral back or a thicker proximal part. Based on this morpho-structural perspective, the “back” is defined here as a lateral or proximal flat surface presenting an angle of about 90° to both main surfaces (superior/inferior) of the tool blank. It must be distinguished from “naturally backed flakes” where the back is created by the lateral part of the flaking surface exploitation, sometimes for maintenance of the core convexities, and that we name here “*débordant* flakes”. It must also be distinguished from “backing” which is abrupt retouch that creates a lateral back (Beyries and Boëda, 1983; Leplongeon et al., 2020).

Third, the tool blank morphology is also an important variable that we took into consideration (section, morphology, size) as it helps in considering whether specific blank characteristics

are more frequently associated with the gripped/hafted part or active part. The objective of this approach is not to propose hypotheses on the tool function, but on the ways that prehistoric knappers managed their blanks to obtain functional tools beyond the production aspects of blank acquisition and transformation. Thus, this approach considers volumetric conceptions, meaning the identification and characterization of the redundant organization of the different **volumetric** parts (active/prehensile or hafted/transmitting part).

The lack of consensus on the regional terminology, especially regarding microlithization, led us to use metric data to establish the terminology used in the paper. Microliths are usually considered as <5cm **and sometimes even <3cm** (e.g. Diez-Martín et al. 2009), **even though these are usually smaller than 3cm in length** (Clark 1985, Leplongeon 2014). **Microlithic industry is related to** intentional bladelet and flakelet production (Pargeter and Shea 2019); however, there is no real consensus among scholars. Some propose a more restrictive definition regarding the production systems (e.g. **terminological distinction between "industries with microliths" and "microlithic industry"** (Leplongeon 2014)), retouch, design aspects of microliths, their shape and size standardization, but also their association with other tool implements within entire assemblages (Porráz 2009; Leplongeon, 2014; Pargeter, 2016, **Wedage et al. 2019; Pargeter and Shea 2019**). In our case, the low number of detailed technological studies of western Central African LSA assemblages still prevents us from establishing a regionally-specific definition of the microlithic industry. Thus, microlithic products (retouched or unretouched bladelets and flakelets) are broadly considered here as <3cm pieces. **This induces a more important requirement to expose the microlithic aspect of the Maboué 5 – Layer 3 industry.** For other size thresholds, small products, retouched or not, are considered as <5cm, medium-sized between 5 and 10cm and large artifacts as >10cm. We also distinguished between blades and bladelets based on metric attributes: a blade has a length greater than or equal to twice its width, and a bladelet is a blade which has a length <3cm.

## 4. Results

### 4.1. General data on the Maboué 5 Layer 3 assemblage

Raw material is composed mostly of quartz (98.3%) with a few flakes in quartzite (0.8%). Regarding the residual natural surfaces, quartz could be obtained through a vein of quartz or procured as slightly rolled blocks but also as pebbles and cobbles. The quartz they used is very diverse with both monocrystalline and polycrystalline rock types, and quartz transparency varies from milky to hyaline. However, despite this diversity, almost all of the artifacts present small natural fracture fronts which may have impacted on conchoidal fracture diffusion during knapping. This is suggested by the irregular surfaces, the difficulty in



312 reading the lithics and the fracture rate. Indeed, we identified 89 flakes with small peripheral  
313 fractures – especially snap breaks (n=57) – and 29 indeterminable flake fragments. In  
314 addition, 20 silet accidents, five plunging flakes and five hinged flakes were identified.

315 Fifteen short refit units have been recovered from the four square meters excavated: silet  
316 accident flakes have been refitted (N=3) (Figure 3-G) suggesting breakage during the  
317 knapping process but also transversal snap breaks which may have occurred through post-  
318 depositional processes (N=2) (Figure 3-B). We refitted discarded flakes (N=9) (Figure 3-  
319 C,E,F,H) and one unit is composed of a core associated with three discarded flakes (Figure  
320 3-D). Silet accident and discarded flake refitting units suggest minimal horizontal movement  
321 of artifacts. However, the units are small and may not only reflect the restricted size of the  
322 excavation, but also practices of lithic artifact export by the Maboué 5 populations.

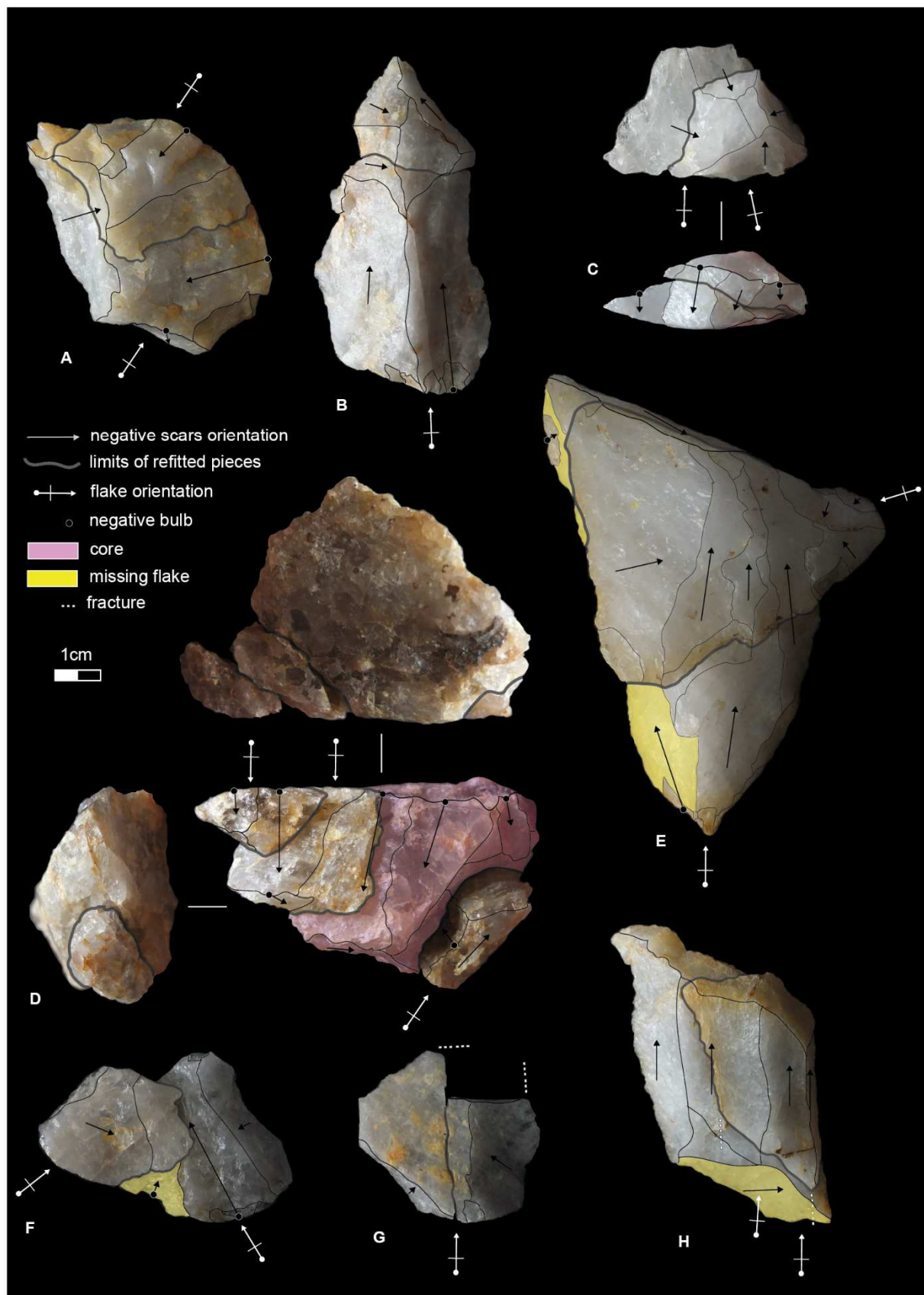


Figure 3 Examples of refits units from Maboué 5 Layer 3.

Regarding the techno-typological categories of the assemblage (Table 2), all categories are represented by up to 5 mm-long flakes. Debris is characterized here as an entire product which is not a flake fragment but which cannot be positioned in the *chaîne opératoire* due to the absence of intentional production signs (Inizan et al., 1995). The presence of these debris, together with a hammerstone showing macro-usewears on each extremity (Figure 4), and the different refit units, suggest that knapping activities occurred on site. However, the finest size fraction is missing due to sieving not being carried out and this may impact the amount of microliths present in the assemblage. The flakelets category represents 29% of the entire assemblages and the flakes category represents 38.8%. However, we can observe that the mean metric values for flakes suggest a small flakes dominated assemblage.

Table 2 Techno-typological inventory of the Maboué 5 Layer 3 (N and %) and minimal, mean, standard deviation and maximal metric values for length, width and thickness, in mm (orientation according the flaking axis).

Effectives			Length				Width				Thickness			
Techno-types	N	%	Min.	Mean	s.d.	Max.	Min.	Mean	s.d.	Max.	Min.	Mean	s.d.	Max.
Flakes	231	38.8	15	36.15	11.03	71	13	32.75	9.52	63	2	9.46	4.12	26
Flakelets	173	29.0	8	22.09	5.08	30	10	19.59	5.01	30	2	6.01	3.19	23
Retouched flakes	61	10.2	17	39.41	12.16	72	11	28.70	8.14	49	3	9.69	5.10	25
Flake fragments	29	4.8	18	26.62	8.54	49	5	17.00	5.55	28	1	6.62	4.48	18
Debris	15	2.5	10	15.47	4.16	22	3	12.00	3.64	19	1	2.33	1.95	9
Blades	22	3.7	31	47.14	13.57	79	11	20.32	7.23	39	3	8.72	3.93	18
Bladelets	13	2.2	18	26.15	3.29	30	8	11.23	2.24	15	2	4.23	1.54	8
Retouched blades	14	2.3	31	51.93	20.27	91	11	22.64	9.00	41	7	13.29	5.01	23
Retouched bladelets	1	0.2	27	-	-	-	12	-	-	-	10	-	-	-
Shaped tools	5	0.8	55	78.40	19.23	110	15	37.40	13.27	55	8	23.80	10.22	40
Core on flakes	8	1.3	27	37.25	6.86	46	18	29.00	7.80	42	13	16.25	2.92	22
Bipolar cores	7	1.2	25	40.14	8.97	50	18	24.71	4.72	32	13	15.71	2.43	19
Peripheral core	4	0.7	40	53.50	10.75	66	21	29.00	10.42	44	15	16.50	2.38	20
Prepared cores	4	0.7	37	46.00	7.39	55	33	36.50	4.04	42	16	19.25	1.48	27
Discoidal cores	1	0.2	63	-	-	-	55	-	-	-	37	-	-	-
Multifacial cores	1	0.2	50	-	-	-	42	-	-	-	19	-	-	-
Hammerstone	1	0.2	130	-	-	-	75	-	-	-	55	-	-	-
Undetermined fragments	6	1.0	18	32.00	9.65	46	12	18.17	4.07	23	8	9.83	1.47	11
Total	596	100.0												



Figure 4 Hammerstone with polar and mesial percussive wears recovered at Maboué 5 Layer 3.

## 4.2. The core assemblage

Among the 25 cores, we identified six different reduction strategies:

### 4.2.1. Non-standardized cores-on-flakes (N=8)

These cores are all on flake blanks but are neither standardized in shape, reduction intensity nor flaking orientation. No convexities or platform preparation or maintenance was observed. Two cores have removals on both surfaces (ventral and dorsal) of the original flake blank whereas others only exploited the ventral surface of the flake blank. In the latter group, three cores show a centripetal modality but the use of **arrises created by the precedent removals** as guides is almost absent. It is suggested by the low overlapping of the removals. These cores produced only flakelets, both cortical and non-cortical.

### 4.2.2. Prepared bipolar cores (N=7) (Figure 5-C, F)

All cores of this type are homogeneous in size and morphology. These are characterized by an elongated flaking surface opposite to a convex, completely or partially cortical surface. First, lateral preparation of the elongated flaking surface convexity is done through small removals. However, we could not identify whether the preparation was carried out using the

bipolar or freehand technique. Second, blades and/or bladelets are obtained using the bipolar-on-anvil technique. Reduction sequences are short and no reinitialization was observed, but the reduction strategy remains very homogeneous among bipolar cores.

#### 4.2.3. Non-standardized prepared cores-on-flakes (N=4) (Figure 5-B, E)

These cores are mainly on first flakes (N=3) and knappers used the ventral surface as a flaking surface and arranged the convexities through a few small removals. Only one striking platform is prepared and from this prepared platform, one to two preferential flakelets or bladelets are obtained. Cores are homogeneous in size but in each case, the knappers took advantage of the original blank convexities. This adaptation to core blank led to considerable technological variability and unstandardized preferential flaking.

#### 4.2.4. Peripheral bidirectional cores (N=4) (Figure 5-D)

These cores are characterized by an angular blank which can be a slab or a thick flake. Knappers exploited the thickness of the blank with a peripheral bidirectional modality and thus used the two opposite large and flat platforms to define the size of the flakes and their distal morphology.

#### 4.2.5. Discoidal core (N=1) (Figure 5-A)

Only one discoidal core is present in assemblage. It is characterized by the production of convergent discoidal flakes and an alternation between the two conic opposed surfaces between almost every removal suggests an important control of the surfaces' convexities and flake shape. This core testifies to the longest reduction sequence we observed among the core assemblage but also has the largest removals.

#### 4.2.6. Multifacial core (N=1)

One core presents a reduction chronology in two distinct sequences; the first suggests unidirectional flaking from a flat striking platform, followed by production of small flakes through a short orthogonal sequence.



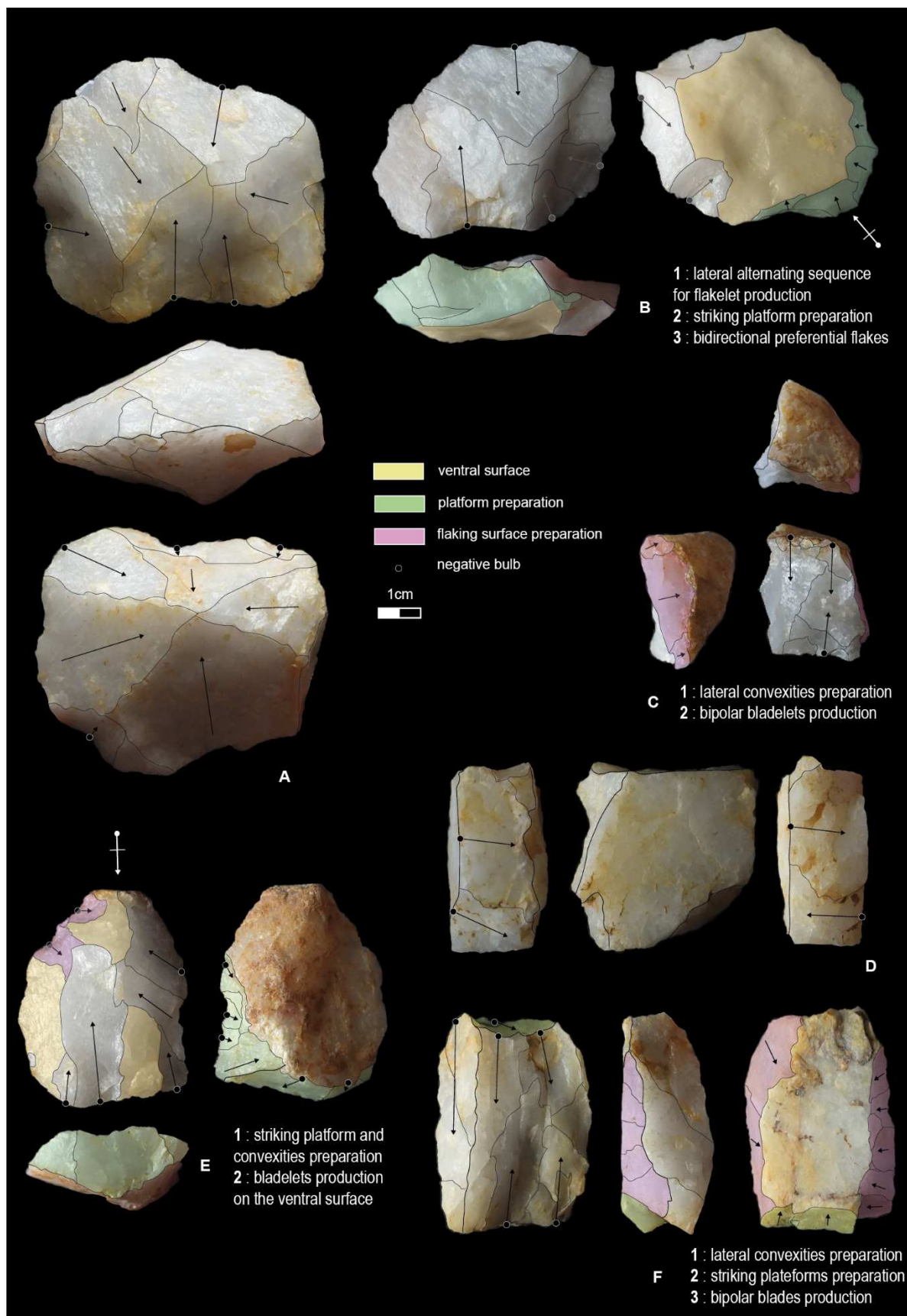


Figure 5 Examples of cores from Maboué 5 Layer 3.

#### 4.3. The flake assemblage

#### 4.3.1. Bipolar production (n=59)

Signs indicating use of the bipolar technique have been identified on 59 products. Thirty flakes present a punctiform or linear butt associated with a rectilinear profile characteristic of the bipolar technique (Figure 7-C,E,F) (e.g. Barham, 1987; de la Peña, 2015; Soriano et al., 2010) and 20 flakes present a plain butt. On the latter, the bipolar technique is identified through the presence of two opposed bulbs on the ventral surface, frequently associated with a distal platform (n=14). The scar orientation is mainly bidirectional (n=37), unidirectional (n=12) and orthogonal (n=6) which is coherent with the bipolar cores in the assemblage. Eleven pieces possess a blade morphology and five have a bladelet morphology.

#### 4.3.2. Prepared core production (n=43)

Among the 43 flakes obtained through prepared core technology, we identified 24 *débordant* flakes on which the natural back indicates that the preparation of the striking surface's convexities was made by multiple small removals. These *débordant* flakes suggest both the maintenance of convexities and/or the production of predetermined flakes with a lateral back. The core blank preparation is also suggested on the butt: 19 flakes present a faceted butt and we can observe the negative bulbs of the preparation scars on 12 of them. The dorsal scar patterns point towards a diversity of flaking modalities, showing centripetal (n=12), convergent (n=8), orthogonal (n=8), unidirectional (n=6) and multidirectional (n=5) scar orientations. Even though some flakes present convergent (Figure 7-J) or parallel lateral edges (Figure 7-I, K), no blades or bladelets carry signs of prepared core production.

#### 4.3.3. Discoidal production (n=30)

The discoidal production method is identified on one core and 30 flakes. The organization of the negative scars is centripetal (n=22) or convergent (n=8). This depicts a sensu stricto discoidal configuration of the core with predetermined or predetermining flakes occurring through a frequent (every one or two removals) alternation between the two opposite surfaces (Boëda, 1993; Mourre, 2003). This has been observed both on the cores and on the flake assemblage due to the presence of residual negative bulbs on the dihedral butts (n=15). Three *débordant* flakes suggest convexity maintenance. Knappers employed the discoidal strategy for the production of convergent-edged flakes morphologically very close to Levallois points (e.g. 'pseudo-Levallois' points) (n=11) (Figure 7-G, H), but also for parallel-sided flakes. The discoidal production ranges from medium-sized (5-10 cm) and small (<5 cm) flakes to flakelets (<3 cm) and present a similar morphometric distribution as prepared core flakes (Figure 6).

#### 4.3.4. Core-on-flake production (n=9)

We could identify nine flakelets which show a part of a ventral surface on their dorsal surface. All of them are <3 cm in length and have a plain (n=5) or dihedral (n=4) butt suggesting no striking platform preparation. More broadly, these products can be considered as Kombewa flakes and associated with non-standardized cores-on-flakes.

#### 4.3.5. Undetermined production (n=346)

Most of the flakes in the assemblage could not be attributed to any formal production scheme. The morphometric data and the techno-typological attributes indicate a very heterogeneous assemblage. Dorsal scar patterns show a dominance of multidirectional (n=96), unidirectional (n=83) centripetal (n=65) and bidirectional (n=53) modalities. The butt types show mainly non-prepared striking platforms with plain (n=224), dihedral (n=52) and cortical (n=10) butts. Twenty-two punctiform and five linear butts may also refer to a specific flaking technique but could not be classified with certainty.

Table 3 Butt metric data of the different flake techno-types of Maboué 5 Layer 3: flaking angle, exterior platform angle, butt width and thickness.

Techno-types	Flaking angle				Exterior platform angle				Butt width				Butt thickness			
	Min.	$\bar{X}$	s.d.	Max.	Min.	$\bar{X}$	s.d.	Max.	Min.	$\bar{X}$	s.d.	Max.	Min.	$\bar{X}$	s.d.	Max.
Mixed	60	102.3	11.1	140	55	83.5	9.44	115	2	16.3	8.13	45	1	6.0	3.52	21
Prepared	80	102.2	10.86	120	65	82.7	7.18	95	3	20.9	9.93	55	1	6.9	2.98	15
Discoidal	85	108.0	10.64	125	65	79.1	7.30	95	10	27.4	10.56	47	2	7.8	3.51	17
Bipolar	75	100.1	10.41	120	70	83.7	6.63	90	4	16.4	13.50	45	2	6.5	4.46	16
Kombewa	80	94.4	8.46	105	75	86.7	8.66	100	13	16.1	2.53	20	2	4.2	1.48	6
Cortical	90	106.5	11.46	140	70	84.0	8.24	100	6	19.5	9.03	40	1	7.9	4.16	18
Blade	80	100.9	10.56	120	70	82.4	7.85	100	3	13.4	7.73	29	2	6.7	3.95	15
Bladelet	75	96.0	9.94	110	75	85.5	5.99	95	7	8.8	1.62	11	1	3.9	1.93	7

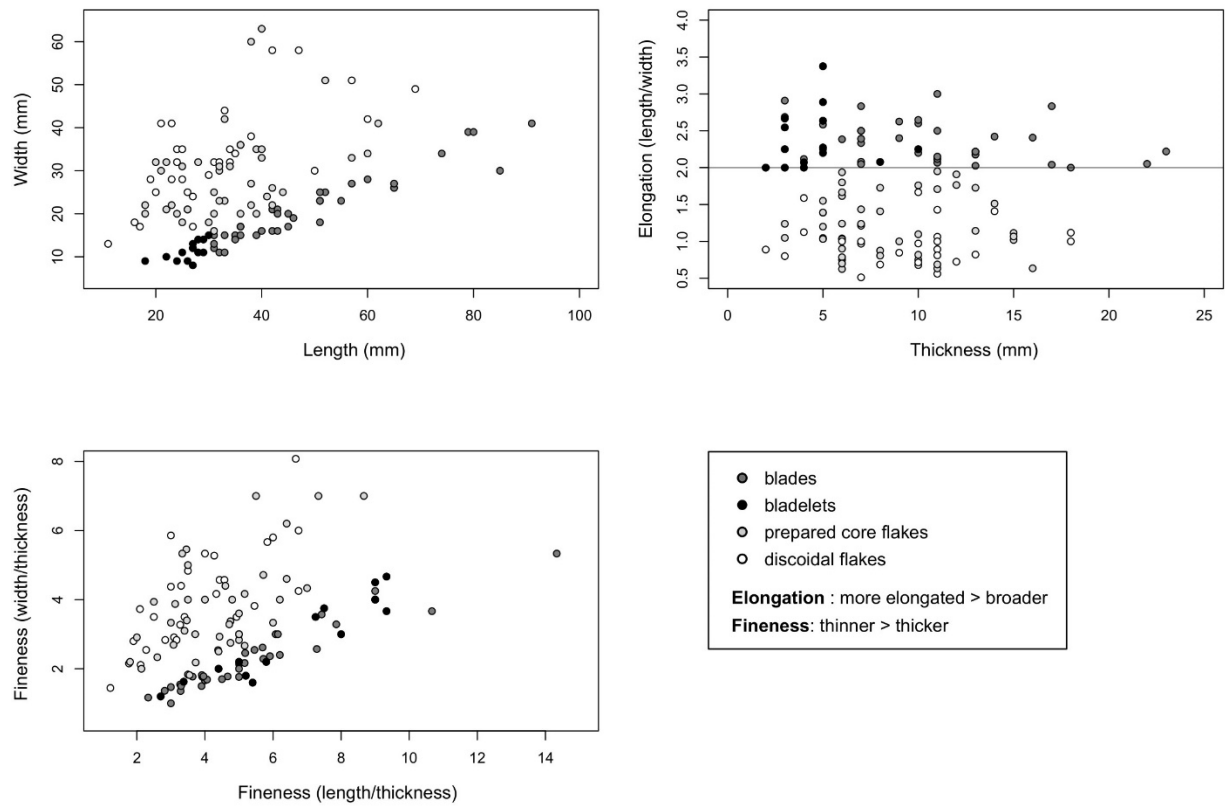
#### 4.3.6. Observations on the first stages of the reduction sequence

Among the flake assemblage, 41 pieces have cortical surfaces, providing information on the first stages of the reduction sequence. These cortical flakes suggest variability in the beginning of the reduction sequences, with a range of locations retaining cortical surfaces and varied scar orientations on the dorsal surfaces: unidirectional (n=10), multidirectional (n=8), bidirectional (n=7) centripetal (n=6) and orthogonal (n=2). Twenty-nine of these products have been classified as “undetermined reduction strategy”. Thus, these constitute a very heterogeneous group which contrasts with other flake groups we described. **However, the scarcity of cortical butts (n=13) suggests that knappers tend to give the first blows to open a striking surface in order to obtain flat and plain striking platforms. A few first flakes possess bipolar knapping patterns on their ventral surface suggesting the opening of the quartz natural volume using the bipolar/anvil technique (n=11). We also used these products**

to identify the initial blank type, including both river pebbles/cobbles (n=20) and blocks (n=20).

#### 4.3.7. Observations on the blades and bladelets

A significant number of blade (n=36) and bladelet (n=14) products have been identified but these seem to reflect unstandardized production. Both categories, blades and bladelets, suggest there is variability in the production mode and share the same strategies of production, with a dominance of plain butts (blades : n=19 / bladelets : n=8) and punctiform butts (blades : n=6 / bladelets : n=4) and diversity in the frequency and orientation of dorsal scars : unidirectional (blades : n=8 / bladelets : n=6), bidirectional (blades : n=16 / bladelets : n=5), multidirectional (blades : n=4 / bladelets : n=2) and orthogonal (blades : n=3 / bladelet : n=1). Using the classification of flakes based on the production schemes when feasible, we suggest that several core reduction strategies succeeded in producing blades and bladelets, most of which have been classified under “undetermined reduction strategies” (blades : n=23 / bladelets : n=8) and the “bipolar reduction strategy” (blades : n=11 / bladelets : n=5). Several pieces retain cortical surfaces which suggest that knappers initiated the blade production on an unprepared core using the natural convexities of the quartz blocks, pebbles or cobbles. From a morphometric perspective (Figure 6), a continuous range of the blades and bladelets can be observed in size and both categories show variability in fineness and elongation. However, both categories overlap when using the morphometric indices which also points towards similar production strategies.



464

465 Figure 6 Bivariate plots of metric data (length, width, thickness, elongation, fineness in mm) of the blades,

466 bladelets, prepared core flakes and discoidal flakes from Maboué 5 Layer 3.



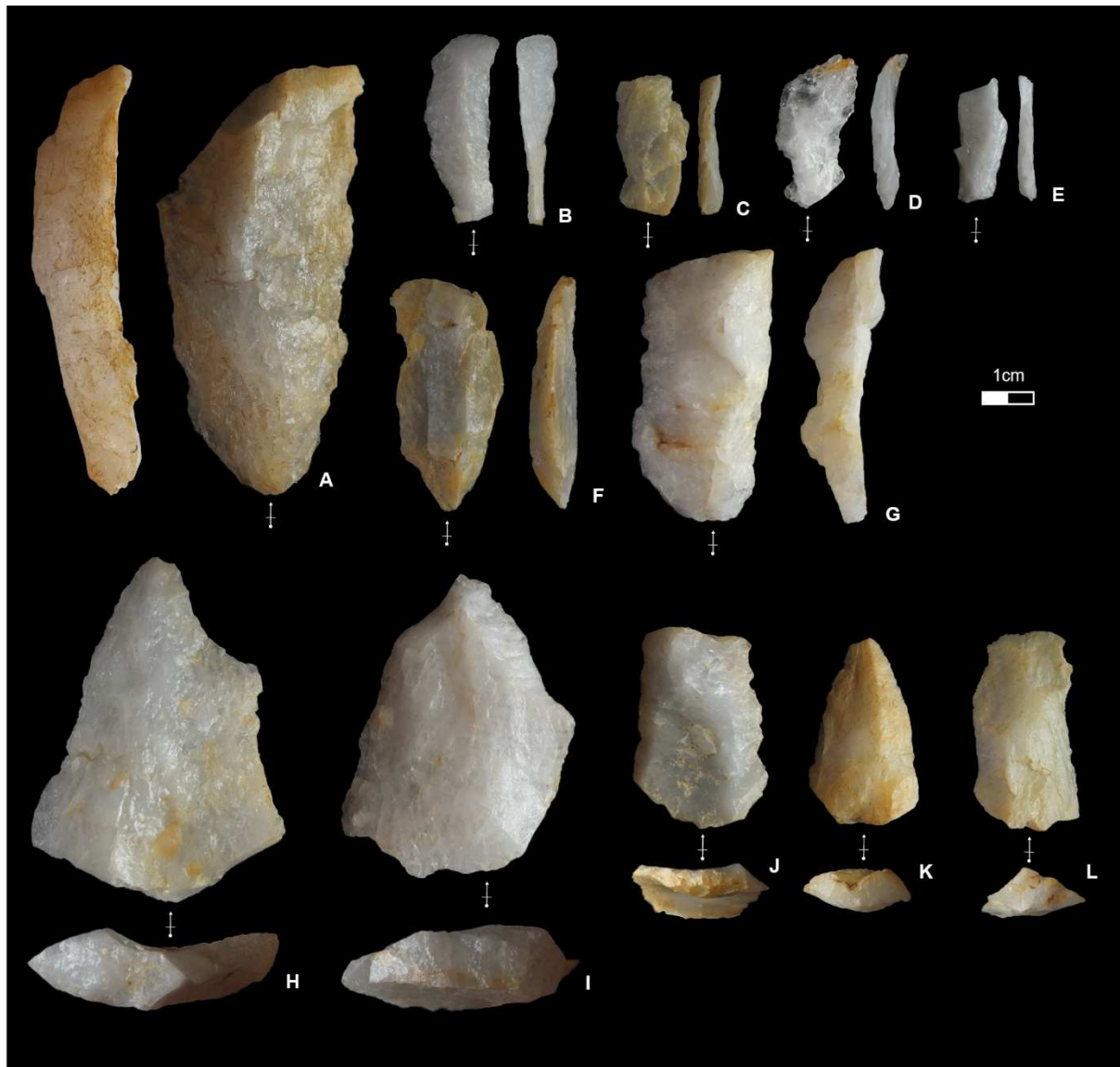


Figure 7 Examples of blades (A, F,G), bladelets (B, C, D, E), discoidal convergent-edged flakes (H, I) and prepared core flakes (J, K, L) from Maboué 5 – Layer 3.

#### 4.4. The flake tools

Among the 76 flake tools, we identified 11 different flake tool types according to the technomorpho-structural patterns, meaning the both layout of the potentially active/prehensile and energy-transmitting parts on a volume, and the characteristics of each of these parts (Figure 8). **Seven** flake tools were considered as atypical and did not fit into any of these categories. Among them, we identified two laterally-notched small flakes, three large blades retouched differently on the proximal part, and one unidentified siltstone blank partially stained by ochre with an abruptly retouched distal and lateral area. From a production perspective, it seems that the abrupt angle of retouch is dominant (n=46), followed by low-angled retouch (n=11). Other products display both abrupt and low-angled retouched areas (n=19). We observed an

absence of standardization in the location of the retouch and no relationships were observed between flake techno-types and flake tool techno-types.

#### 4.4.1. Group 1 (N=12) (Figure 9-C)

All the stone tools in this group possess a lateral back which could be obtained using backing retouch, a fracture plane, or a thick and elongated butt. Retouched removals are large and irregular on the back. The back is always opposite a much thinner cutting edge (angle values are between 70 and 55°) which has an irregular shape with a pointed part located at the distal/proximal or disto-/proximo-lateral. Both the cutting edge and thin points have been considered as potential active parts and suggest that the medium-sized flakes with lateral thickening may have been used as multiple tool blanks. Additionally, knappers took advantage of fracture planes for obtaining lateral backs and robust tool cross-sections.

#### 4.4.2. Group 2 (N=11) (Figure 9-B, D)

Group 2 refers to the *tranchet* tool-type as described in several Central African Stone Age typologies (Bequaert and Mortelmans, 1955; Breuil, 1944; Cahen and Mortelmans, 1973; de Bayle des Hermens, 1981; Leakey, 1949; Mortelmans, 1957). The *tranchet* is a tool type characterized by two opposed lateral backs. From a technological point of view, the lateral backs may be a fracture plane, a butt or obtained through backing. These products have a transversal cutting edge. In the case of Maboué 5, the tool blanks seem to be obtained through different flake techno-types. Nine tools only preserve the mesial part of the initial flake and thus prevent us from inferring the tool blank. Knappers took advantage of fracture planes to obtain the lateral back and if necessary, they retouched the opposite one, sometimes very carefully with numerous small removals. These pieces have a thin and double beveled cutting edge (<55°) and their size ranges from 2 to 5 cm in length, indicating the presence of a small tool component but also that some *tranchets* fall into the microlithic tool category. We observe a continuous metric distribution between microlithic *tranchets* and small-sized *tranchets*. The distal cutting edge can be slightly oblique and while it is always rectilinear, it varies from double to simple beveled. Among the *tranchets* we can distinguish three different groups according to lateral back orientation; however, these products are neither standardized in shape nor in production:

- triangular *tranchets* : the lateral backs converge on the proximal part forming a dihedral proximal extremity.
- rectangular *tranchets* : they possess parallel backs and a proximal thin rectilinear cutting edge,
- mixed *tranchets* : the backs are sub-parallel and these pieces present a proximal thin cutting edge which is shorter than the distal one.

#### 4.4.3. Group 3 (N=11) (Figure 9-F)

This group is characterized by the presence of a robust distal point with a cross-section from rhomboidal to trihedral. The distal point is aligned along the tool axis or slightly off-set suggesting a specific orientation of the tool when using it. The thickness of the tool is quite homogeneous along the morphological axis, creating a robust blank. These products have a larger proximal prehensile part which is not standardized as it may be a dihedral, flat or simple edge. These tools are also characterized by an absence of a thin cutting edge, due to their robust quadrangular to trihedral cross-section. This type of active part is obtained through notches or very abrupt irregular retouch. These tool types are not associated with any size pattern or blank type as informal flakes, blades or even undetermined fragments have been used to obtain these points. These tools range from 3 to 7 cm in length.

#### 4.4.4. Group 4 (N=7)

These are medium-sized tools with a length between 5 and 10 cm, possessing a lateral back opposite to a thin convex cutting edge with an angle of between 50 and 60°. The back is obtained through an unstandardized strategy as we observed a fracture plane, two debordant flakes and one back created by a sequence of abrupt and invasive retouch removals.

#### 4.4.5. Group 5 (N=7) (Figure 9-H, J)

These tools have a plano-convex cross-section, lateral cutting edges and a distal part as thick as the proximal part, suggesting symmetry is important. The lateral cutting edges are irregular and they all have a convex cutting edge with angle values between 70 and 80° opposite a thinner rectilinear cutting edge with angle values between 60 and 70°. This suggests the presence of two different types of lateral cutting edge on the same blank. These tools are very homogeneous both in size and shape with a length between 4 and 5 cm and a width between 2.5 and 3.5 cm.

#### 4.4.6. Group 6 (N=5) (Figure 9-A)

These are small tools presenting a >75° rectilinear and slightly convex cutting edge opposed to a thick convex back obtained through retouch. These backed tools all possess a trihedral distal extremity and are metrically homogeneous with a length ranging from 3 to 5 cm.

#### 4.4.7. Group 7 (N=4)

These artifacts are made on a range of blank types. These are elongated medium-sized tools with a length between 5 and 7cm and have a thick quadrangular cross-section associated with both distal and proximal off-set simple beveled and short cutting edges. The proximal

cutting edge is much thinner with angle values  $<65^{\circ}$  but the distal designated active part is  $>80^{\circ}$ . The convergence between the lateral surfaces and the distal/proximal cutting edge forms a trihedral disto-proximo-lateral thick point which is retouched on three pieces, suggesting a desired pointed off-set tip. One of these tools seem to use a bipolar core as a tool blank.

#### 4.4.8. Group 8 (N=3) (Figure 9-E)

These are thin and small (from 3 to 4cm in length) tools with both distal and proximal convergent cutting edges. These pointed extremities are thin ( $>70^{\circ}$ ) and obtained through retouch on the lateral part of a small flake.

#### 4.4.9. Group 9 (N=3)

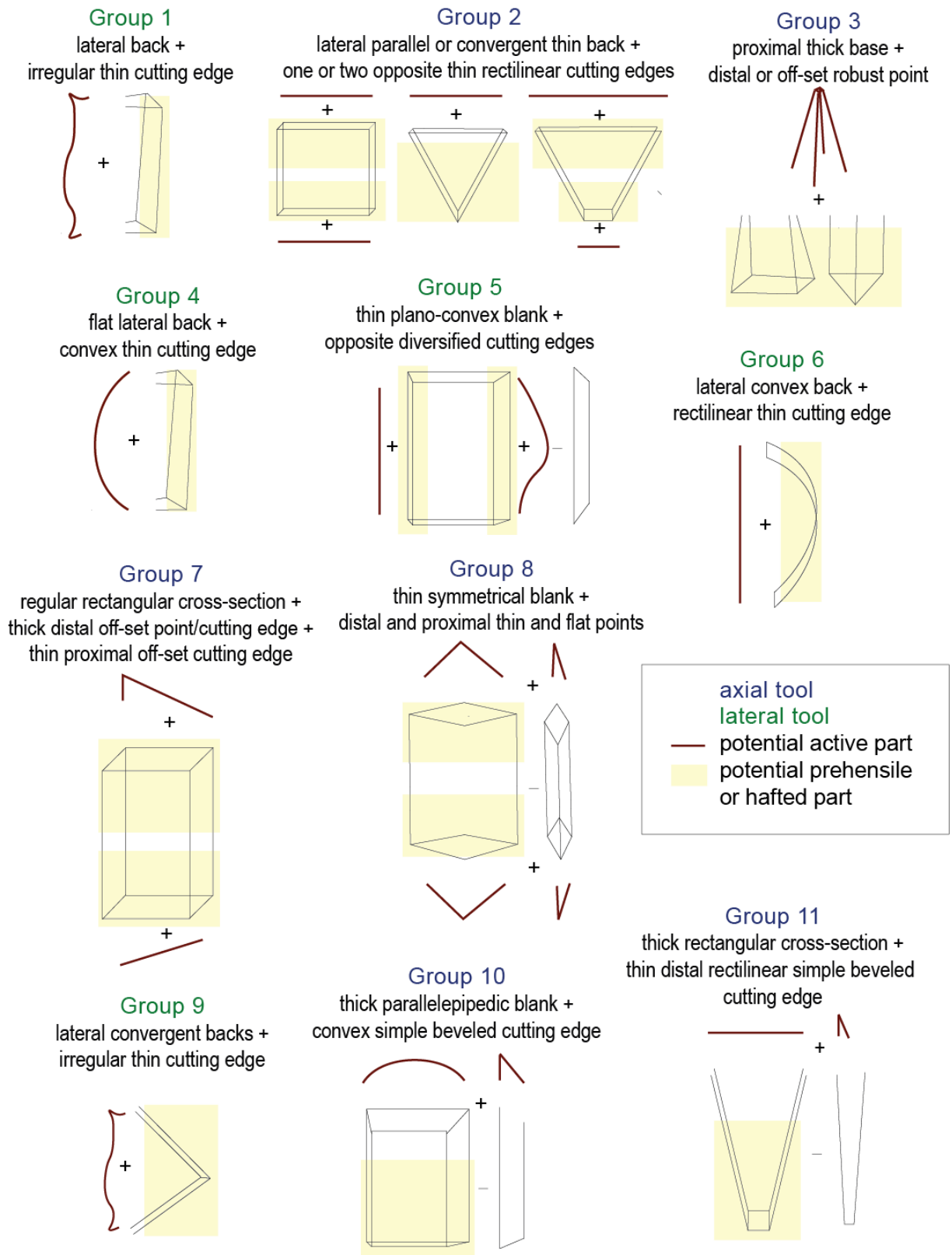
These tools have a long lateral denticulated cutting edge with angle values between  $70$  and  $80^{\circ}$  opposite to a thicker dihedral part formed by the convergence of two fracture planes.

#### 4.4.10. Group 10 (N=3)

These tools are characterized by a convex dorsal surface and slightly concave ventral surface, a length between 4 and 5 cm and a width between 3 and 4 cm. These thick tools possess a robust distal plano-convex retouched cutting edge. From a production perspective, the flake blank seems to derive from the early sequence of unidirectional blade-like removals, as suggested by the scars and remnant cortical surfaces.

#### 4.4.11. Group 11 (N=3) (Figure 9-G)

These are axial tools with a distal simple beveled short and thin cutting edge with angle value between  $50$  and  $60^{\circ}$ . The tool section is rectangular and is much thicker but smaller in width on the proximal part. The proximal part, considered here as a potential prehensile part, is dihedral and regularized through retouch.



571

572 Figure 8 Techno-functional sketches of the 11 tool types identified at Maboué 5 Layer 3.





573

574 Figure 9 Examples of flake tools from Maboué 5 Layer 3.

575 4.5. The shaped tools

576 Only five tools have been produced by shaping. These are metrically characterized by  
577 middle-size class with a length ranging from 5.5cm to 11cm and are all in quartz (Table 2).  
578 As the shaping is a major component of Central African lithic production for the Earlier and  
579 Middle Stone Age, it deserves a specific attention (Clark, 2001; Cornelissen, 2002;  
580 Lanfranchi and Clist, 1991; Lanfranchi and Schwartz, 1990; Mesfin et al., 2020a, 2020b;  
581 Taylor, 2016, 2014).

582 Three of them are on flakes whereas the fourth piece is completely shaped. From a  
583 typological perspective, two pieces can be described using the term “*lanceolate*” and thus  
584 contrast with the flake tool assemblage (Figure 10-A, B). Both pieces have a homogeneous  
585 lenticular section all along the longitudinal axis and a pointed tip at both extremities which  
586 seem to be the main *potentially* active parts. In both cases, the proximal tip is thicker, with  
587 very small angle values and sharp edges. The mesial lateral edges have a homogeneous  
588 morphology that is slightly sinuous. The absence of a defined prehensile part and the  
589 symmetrical aspect of these products may *be related to* hafting. One of these tools is shaped  
590 using soft hammer (Figure 10-A).

591 Two pieces can be identified as small bifaces. These are characterized by large irregular  
592 removals and an absence of retouch or edge regularization along with a thick profile. From a  
593 technological perspective, both pieces show the same *organized structure*, namely a mass  
594 concentrated at the proximal and a thick off-set pointed tip creating respectively a lozenge-  
595 shaped and trihedral section which brings them closer to the flake tool form of Group 3. On  
596 the proximo-lateral part, steep removals create a potential second active part. One of these  
597 two artifacts has a blade-like removal on the dorsal which may have been formed before the  
598 blank acquisition or during a first generation of removals (Figure 10-C).

599 The last shaped tool is a re-shaped tool following a fracture: a distal fragment of a biface has  
600 been reshaped on the proximal part. The distal point is thick with a lozenge-shaped cross-  
601 section and remains unretouched. This artifact appears to be atypical, potentially due to its  
602 recycled nature, and cannot be compared to the other stone tool groups.

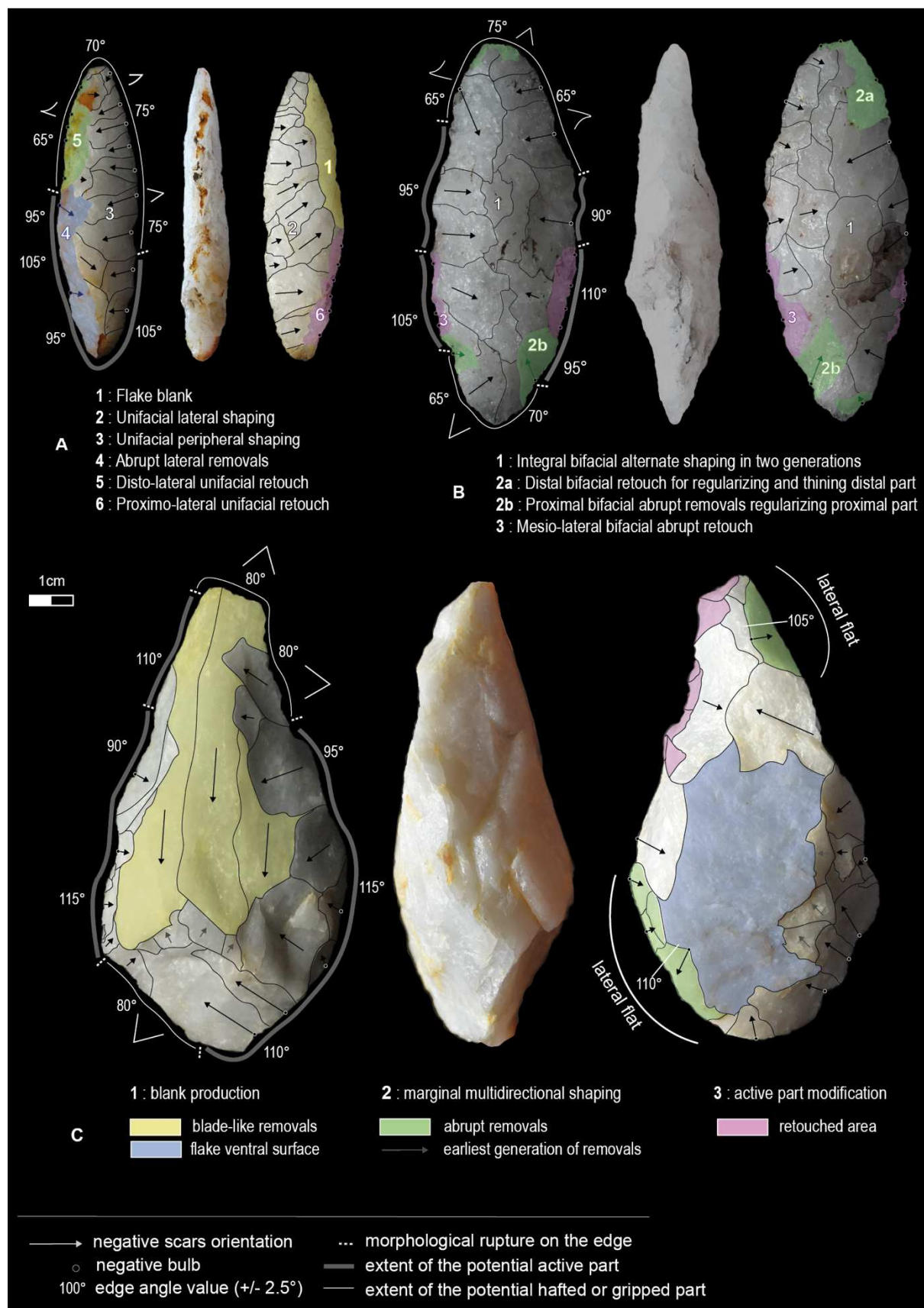


Figure 10 Example of shaped tools from Maboué 5 Layer 3.

## 5. Discussion

This paper aims to describe the technical patterns in the lithic assemblage from Layer 3 of Maboué 5, documenting lithic technical behaviors between 44 600 and 14 770 cal. BP. To do so, we applied a technological approach which generated both production and techno-functional information on this quartz assemblage.

Regarding the stratigraphic integrity of the site, lithic analysis exhibited the presence of fifteen refits which reinforces the idea that Layer 3 is likely to be an undisturbed archaeological deposit (Oslisly et al., 2006, 2004). It is an especially important feature considering the presence of at least 3.75 refit units per meter square for an archaeological layer of a maximal thickness of 20cm.

From a production perspective, we argue for low standardization of flake production, seeing a wide diversity of cores and flaking methods used to produce similar flake types but different ranges of size, from microlithic to medium-sized flakes. This is observed particularly for the blades and bladelets, but also for prepared core flakes and discoidal flakes which both present similar morphometric patterns. In addition, despite the production of flakelets and bladelets identified both in the flake assemblage and on the cores' negative scars, we have not identified a method specifically dedicated to microlithic production, suggesting that microliths are a side/marginalized production.

However, some technical features have been observed on different types of cores, such as the lateral convexities and striking platform preparation which appears on both bipolar cores and prepared cores. The maintenance of convexities is also supported by the presence of maintenance flakes among both prepared cores and discoidal operational schemes. The intended core configuration is often obtained through the use of a flake as a core blank, making use of existing flake convexities to decrease the need of core preparation before flaking.

The lack of standardization is also observed among the tool assemblage, with no association of flake blank types with specific tool types, various retouch sequences and a range of shaping strategies with both hard and soft hammer despite the small number of shaped tools. From a techno-functional perspective, the flake tool assemblage reveals a wide diversity of tool types and of active parts. However, the thick off-set pointed tips are redundant both among flake tools and shaped tools. The thin cutting edges ( $<70^\circ$ ) are the most frequent, found on axial and lateral tools. The presence of a lateral back is also a common feature of several tool types along with the robust cross-sections this creates.



When considering our results in relation to a potential chrono-cultural affinity, the presence of microlithic to medium-sized *tranchets* and of *lanceolates* may be considered as Tshitolian hallmarks (Bequaert and Mortelmans, 1955; de Bayle des Hermens, 1981; Lanfranchi and Clist, 1991; Miller, 1988; Van Moorsel, 1968). In addition, the presence of bipolar, discoidal and prepared core reduction schemes are also reported among Tshitolian assemblages (Cahen & Mortelmans, 1973). Nevertheless, other Tshitolian or broader LSA hallmarks such as geometrics and projectile points (Miller, 1988) are not represented among the **Maboué 5 – Layer 3** assemblage and the backed tools, prepared core technology, blade production and diversity of shaped tools may also echo the **Lupemban** facies (Barham, 2002; Clark, 2001; Cornelissen, 2002; Taylor, 2016). **Shaped tools have been reported at several Holocene LSA sites such as Nyafessa in Gabon (Matoumba, 2020), Bitorri Cave (Emphoux, 1970) and Pointe-Noire (Droux and Kelley, 1939; Giresse and Kouyoumontzakis, 1971) in Republic of Congo and more recently at Nangara-Komba Shelter in Central African Republic (Lupo et al., 2021). This highlights the difficulty of using shaping as a chrono-cultural marker for prehistoric groups in Central Africa (Cornelissen, 2016). Indeed, the lithic industry of Maboué 5 – Layer 3 presents both criteria of the ‘typical’ regional LSA and MSA facies or the regional “named stone tool industries” (NASTIES, Shea, 2014) (for discussions on the use of the NASTIES in African Late Pleistocene contexts see Conard and Porraz, 2015; Wilkins, 2020).**

**In the Lopé National Park, the mentioned Tshitolian hallmarks are associated to a quartz based industry in Holocene lithic assemblages whereas the so-called “Lupemban” artifacts are mainly in quartzite (Assoko Ndong, 2003, 2002). Thus, the quartz dominance appears representative of LSA sites in the Middle Ogooué Valley, but the MSA-like artifacts have so far only been recovered from stone-lines or surface contexts. At Maboué 5 – Layer 3, the size patterns of the quartz shaped tools (Table 2) suggest a smaller mean size than usually presented for the regional MSA shaped tools (Angue Zogo, 2020; Clark, 2001; Demayumba, 2018; McBrearty, 1985; Mesfin, 2018; Mesfin et al., 2020a; Taylor, 2009). However, the lack of precisely chrono-stratified MSA data set and the small number of shaped tools of Maboué 5 – Layer 3 prevent further comparisons. Indeed, this tendency to produce middle-size tools by shaping strategies may be related to site-function and quartz raw material availability. When considering the idea of raw material management shift between LSA and MSA, the relationship between quartz properties, its availability and the stone-tool size reduction remains unclear. Again, it is due to the lack of well contextualized data for the local MSA period and the heterogeneity of site distribution and raw material use during the LSA in Central Africa (Cornelissen, 2016).**

**Elsewhere in Central Africa, the variation in flake production, presence of shaped tools, absence of standardized production among tool types and scarcity of bladelets are also**

reported in final Late Pleistocene and Holocene assemblages in Central Africa (Cornelissen, 2003; Emphoux, 1970; Lupo et al., 2021; Matoumba, 2013; Mercader and Brooks, 2001; Mercader and Martí, 2002, 1999; Van Neer and Lanfranchi, 1985). Furthermore, in Central Africa, MSA and LSA technological patterns are frequently associated among lithic assemblages dated by radiocarbon analysis to the final Late Pleistocene. This is suggested by several sites affiliated to the Lupemban tradition up to end of the LGM and by the presence of LSA technical patterns at several pre-LGM sites (Cornelissen, 2003, 2002; Mesfin et al., 2020a; Taylor, 2016; Van Noten, 1977). In Western Africa, MSA technical patterns have also been reported up to the Holocene deposits (Scerri et al., 2021, 2017). LSA technical patterns associated to quartz raw material have been suggested at several sites among them:

- the Shum Laka rockshelter S-deposits, dated between ~31 and ~13 ka BP, in Cameroon which is quite stable up to the Holocene layers (Cornelissen, 2003),
- the middle and lower levels of the Matupi Cave sequence in northeastern Democratic Republic of Congo dated between ~33 and ~12 ka BP (Van Noten, 1977)
- and the Layer 3 of Njuinye 34 700 ± 560 BP to 17 800 ± 180 BP (Mercader and Martí, 2002).

Table 4 provides recalibrated BP dates for these assemblages. Based on Cornelissen (2003), Van Noten (1977) and Mercader and Martí (2002) publications, Matupi, Shum Laka and potentially Njuinye revealed archaeological layers chronologically covering pre-LGM to LGM dominated by a quartz industry containing low standardization of tool types and reduction strategies as seen at Maboué 5 – Layer 3. However, Matupi and Shum Laka assemblages are very rich in microliths and <2cm cores. Such cores are not present at Njuinye and Maboué 5 – Layer 3. Although bipolar percussion is observed at Maboué 5 – Layer 3, Matupi and Njuinye, it is absent from Shum Laka. In addition, unstandardized shaping reduction strategies are only reported at the post-LGM layers of Matupi and Shum Laka, whereas they are present at Maboué 5 – Layer 3 and correspond to two specific tool types: lanceolates and bifaces. Even though there is limited evidence for the final Late Pleistocene LSA in Central Africa, what there is shows high diversity of microlithic production strategies among the quartz dominated lithic assemblage during this time period. The persistence of MSA lithic technological patterns is suggested at Matupi and at Maboué 5 – Layer 3 even though, knappers had already shifted toward quartz based industry and microlithization. In West Africa, MSA patterns are observed much later until the Early Holocene (Casey, 2002; McIntosh, 2001; Niang et al., 2018; Scerri et al., 2021, 2017). Overall these patterns point to a complex scenario for the emergence and/or the diffusion of quartz microlithic production in Central and



Western Africa and question the real cultural significance of the MSA technological patterns which needs to be explored at more sites in both regions. This is consistent with ideas developed recently in contiguous regions that the transition from the MSA to the LSA is much less abrupt than initially assumed (e.g. Ambrose, 2002; Biittner et al., 2017; Clarkson et al., 2018; Hiscock et al., 2011; Pargeter and Shea, 2019; Phillipson, 2005; Shipton et al., 2018; Tryon, 2019) but also that some technical features traditionally associated to MSA may be pan-chronological.

Table 4 – 14C dates of the sites used in the general comparison of our discussion. We used OxCal V.4.4.2 (Ramsey 2020) and the IntCal20 curve (Reimer et al. 2020) to provide calibrated Before Present dates.

Site	Layer	Date number	Uncalibrated BP date	Calibrated BP date	Reference
Shum Laka	S-deposit (basal part)	OxA-4945	31 700 ± 750	38 406 – 34 591	Cornelissen 2003
Shum Laka	S-deposit (upper part)	OxA-5200	12800 ± 110	15 625 – 14 974	Cornelissen 2003
Matupi	Lowest Levels (upper limit)	GRN-7348	22 100 ± 240	26 989 – 25 918	Van Noten 1977
Matupi	Lowest Levels (lower limit)	GRN-7349	33 000 ± 1900	42 179 – 34 475	Van Noten 1977
Matupi	Lowest Levels (lower limit)	GRN-7349	33 000 ± 1500	41 351 – 34 915	Van Noten 1977
Matupi	Middle Levels (upper limit)	GRN-7343	12 050 ± 250	14 959 – 13 458	Van Noten 1977
Matupi	Middle Levels (lower limit)	GRN-6918	21 210 ± 400	26 375 – 24 550	Van Noten 1977
Njuinye	Layer 3	-	34 700 ± 560	41 130 – 38 570	Mercader and Martí 2002
Njuinye	Layer 3	-	17 800 ± 180	22 085 – 21 017	Mercader and Martí 2002

In this context, the assemblage of Maboué 5 – Layer 3, which is among the best contextualized regional assemblages for documenting the final Late Pleistocene period in western Central Africa, is a good example of the difficulties in classifying the Central African industries according to one or other regional techno-cultural facies, during the final Late Pleistocene, and even in terms of the broader continental framework of the MSA and LSA. However, we can now argue that at Maboué 5 – Layer 3, in an environment marked by the beginning of the expansion of the savanna, hunter-gatherer lithic technology is composed of both MSA-like technological characteristics, such as the large variability in production methods and the use of prepared core technology, but also includes LSA-like characteristics, such as a microlithic component and quartz raw material dominance. When considering the chronology of the Maboué 5 – Layer 3, we cannot say whether the co-occurrence of MSA and LSA technical patterns depict a continuity of MSA-like technical behaviors during the LGM or the emergence of the LSA-like technical behaviors prior to the LGM.

This unstandardized lithic production ranging from microlithic to medium-sized tools appears to have been suitable for exploiting a changing mosaic of forests and savannas. Maboué 5 – Layer 3, as with Shum Laka rockshelter, Njuinye or Matupi cave, contributes to a scenario which sees a possible gradual shift towards a microlithic quartz industry at the onset of the LGM environmental aridification and the subsequent climatic oscillations, and the utility of this industry in the diverse equatorial forested or non-forested environments exploited by humans in Central Africa.

## 6. Conclusion

The site of Maboué 5 is a unique open-air sedimentary sequence ranging from Late Pleistocene to Middle Holocene in the Middle Ogooué Valley. If the entire sequence has previously been interpreted as a technological continuum, only Layer 3 dated between 44 600 and 14 770 cal. BP delivered a sufficient lithic corpus for detailed lithic analysis. Using both a production and techno-functional approach, we identified the main technological patterns of the quartz based industry: bipolar core reduction is associated with discoidal and prepared core technology, but also occurs with a wide diversity of reduction strategies and shaping. In addition, the unstandardized flake tool production – both regarding the blank and the retouch type – the use of fracture planes, backing retouch and diverse stone tool types suggests relative flexibility in stone tool production. The palaeoenvironmental evidence from Maboué 5 – Layer 3 suggests this industry is associated with a savanna-forest mosaic and provides a further example of the suitability of the microlithic quartz component to a wide range of environments.

When reconsidering the results in light of the existing literature, it appears that the use of both the local and continental techno-cultural frameworks – respectively the Tshitolian/Lupemban and the Middle/Late Stone Age – are of limited utility in interpreting this lithic assemblage which corresponds with a period of technological variability in Central Africa where excavated, dated Pleistocene sites with reliable geoarchaeological contexts are still too few.

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