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## Chapter 1

# The Emergence of Stone Tool Technology

## *A Comparative Study between Some Early Stone Age Assemblages in East Africa and China*

Louis De Weyer

### INTRODUCTION

The development of the human lineage is undeniably traced to the African continent. All current data of the evolutionary branch of hominids are in Africa, from Sahelanthropus, Orrorin, Ardipithecus, Australopithecus, Kenyanthropus, Paranthropus to Homo. Ancient fossils found outside Africa are rare during the Lower Pleistocene.<sup>1</sup> The oldest are dated around 1.9–1.8 million years ago, MYA, and attributed to *Homo ergaster* or *erectus*. In Dmanisi (Georgia) in the Caucasus, five fossil skulls dating back to 1.8 million years, have been discovered and represent the largest number of individuals found at the same archaeological level. Originally named *Homo georgicus* (Lumley and Lordkipanidze 2006), the authors initially considered these fossils to be “descendants of early African Homo” (Lumley and Lordkipanidze 2006, 8), that is to say of a *Homo habilis* or *rudolfensis* at an evolutionary stage close to that of *H. ergaster*. Other authors prefer, instead, on the basis of anatomical and dimensional characters, to use the name *Homo erectus* (Rightmire et al. 2006). The analysis of a new complete skull made it possible to go in the direction of the second hypothesis, and the fossils of Dmanisi are today integrated at the initial stage of the *H. erectus* branch, denominated *H. erectus ergaster georgicus* (Lordkipanidze et al. 2013).

On the Asian side, data before 1.5 million years are rare but exist, nonetheless. Hominid remains have been identified in Longgupo, dated to more than 2 million years. However, the bones are limited to mandibula fragments and

their interpretation is much debated. Some authors attribute the fossils to a *Homo taxon* (Huang et al. 1995), while others prefer to consider it as a great ape (Ciochon 2009; Schwartz and Tattersall 1996; Wu 2000). Without any fossil record as old to compare in the region, the question cannot be solved by paleoanthropology. It is interesting to notice that these fossils are associated with a significant lithic material. More recent fossils have been found in Indonesia, at 1.9 million years at Mojokerto (Anton 1997; Huffman et al. 2005) and 1.6 Ma at Sangiran (Sartano 1961, 1982; Swisher et al. 1994) attributed to *H. erectus* sensu lato. Yuanmou site in Yunnan, Southern China, two incisors attributed to *Homo* sp. were discovered and dated around 1.7 million years (Qian and Zhou 1991; Worm 1997; Zhu et al. 2003).

However, older indirect evidence of the presence of hominines exists in China. The ancient deposits of Majuangou III in the Nihewan Basin in Northern China (Wei 1994; Xie et al. 2006; Zhu et al. 2004) dated around 1.7 million years are regularly cited as representing the oldest continental Asian sites. Several sites also compose an Early Stone Age record in the Nihewan Basin, with especially Xiaochangliang, at 14 million years (Zhu et al. 2001; Li et al. 2008; Ao et al. 2011), and Donggutuo at 11 million years (Singer et al. 1999; Hilgen et al. 2012). But two very old sites, well dated and rich in archaeological material, are also known.

A large collection of lithic artifacts associated with well-preserved fauna has been discovered in Renzidong sinkhole (Jin et al. 2000; Gao et al. 2005). The site was recently dated between 2.4 and 2 million years (Jin and Liu 2009; Wang et al. 2012). The stratigraphic unit CIII of Longgupo site, where the fossil remains presented above have been discovered, has yielded a fauna, and a consequent lithic industry (Boëda and Hou 2011). The dating has also been done very recently and confirms a very ancient age, between 2.5 and 2.2 million years (Han et al. 2017). Those assemblages are debated though, as no hominin remain was associated with the lithics so far. Although these sites have been known for a long time, summaries about the peopling of Eurasia hardly ever refer to them.

The oldest current data are therefore not paleoanthropological but lithic. This is also the case for the majority of information in Eurasia for the Lower Pleistocene, since very few hominin remains have been found in comparison with the archaeological sites discovered. The question of the first dispersal out of Africa remains open, and it is likely that a hominin older than *H. ergaster* or *H. erectus* may be discovered in Eastern Asia. The question of the first hominin incursion out of Africa is not an archaeological problem in itself. The dates are destined to go back in time as discoveries come up. The recent publication of the Lomekwi 3 site, dated at 3.39 million years (Harmand et al. 2015), shows that the history of techniques is much longer than we perceive at present.

## LITHIC ASSEMBLAGES

Apart from Lomekwi 3 at 3.39 million years, considered by the authors by preceding the Oldowan and named lomekwian (Harmand et al. 2015; Hovers 2015), the earliest evidence of the technical phenomenon appears at Gona, northern Ethiopia at 2.6 million years (Semaw 2000).

From 2.6 until 2.2 million years, early evidences of stone tool production appear in several geological formations of northern Ethiopia and the border between southern Ethiopia and Northern Kenya.

In the north, Gona EG-10 and EG-12 delivered an early evidence of stone tool production, at 2.6 Ma (Semaw 2000). The localities A.L. 666 and A.L. 894, Hadar Formation, Afar Depression, also delivered stone artifact at 2.5 million years (Roche et Tiercelin 1980; Hovers et al. 2002). In the Hata Member of the Bouri Formation, in the Middle Awash Valley, dated at 2.5 million years, bones with cut marks were found, but no stone tools (Asfaw et al. 1999; de Heinzelin et al. 1999).

The Turkana Basin, at the border of Ethiopia and Kenya, also provided numerous occurrences. In the lower Omo Valley, the Members E and F of the Shungura Formation provided several localities dated around 2.3 Ma where stone tools were found (Chavaillon 1976; Delagnes et al. 2011). In the Lokalelei Member of the Nachukui Formation, in West Turkana, northern Kenya, three sites provided stone artifacts, at Lokalelei 1 1 $\alpha$  and 2C, dated at 2.34 Ma (Roche et al. 1999; Delagnes et Roche 2005).

Fejej Fj-1, in southern Ethiopia (de Lumley et Beyene 2004), dated around 1.9 Ma (Chapon et al. 2011) delivered a numerous quartz assemblage. The KBS Member of the Koobi Fora Formation, East Turkana, northern Kenya, provided numerous sites (Isaac 1997), as well as KS-1 to 3, Kanjera South Formation, in southwestern Kenya (Plummer et al. 1999; Braun et al. 2008, 2009). Several sites from the Bed I of Olduvai Gorge in Tanzania (Leakey 1971; Mora and de la Torre 2005) are also emblematic from this period. Oldowan evidences are also documented in Gauteng, South Africa, at Swartkrans (Kuman 2007; Kuman and Field 2009) and Sterkfontein around 2.2–2 million years (Clarke 1994; Kuman and Clarke 2000).

In Northern Africa the site complex of Ain Hanech (Setif region, Algeria) delivered three Oldowan sites dated at 1.8 million years: Ain Hanech, Ain Boucherit, and El Kherba (Sahnouni et al. 1997; Sahnouni et al. 2002). The site of Ounjougou in Mali is the only Oldowan site known in stratigraphy. An Oldowan-like industry has been discovered in the lower levels, very similar to Ain Hanech and Olduvai Bed II assemblages (De Weyer 2017). Unfortunately, it is impossible to date the sediments older than 150 ka (Tribolo et al. 2015), so the age of this assemblage is unknown.

Outside of Africa, the evidence is divided between Western Europe and Eastern Asia, with only one site in between. In Caucasus, Dmanisi, Georgia, dated at 1.81 million years, delivered an important lithic assemblage associated with five individuals of *H. erectus ergaster georgicus* (de Lumley et al. 2005; Mgeladze et al. 2011; Lordkipanidze et al. 2013). In Western Europe, the earliest evidence for lithic industries are dated at 1.4 Ma in Pirro Nord, southern Italy (Arzarello et al. 2009, 2016), and between 1.4 and 1.2 Ma in Barranco León and Fuente Nueva 3, Orce, southern Spain (Toro et al. 2003, 2010).

The earliest lithic assemblages in Eastern Asia are all located in China. They were discovered in three areas: the Yangtze River Beds in Chongqing region, the sinkhole of Renzidong in Anhui province, Central China, and the Nihewan Basin in Northern China, West of Beijing. Longgupo and Renzidong are the earliest evidence of hominin activities outside Africa to date, at around 2.2 million years (Huang et al. 2015; Gao et al. 2005). The Nihewan Basin is a very rich area for Lower Pleistocene deposits, and several key sites were discovered for the Mode 1. Majuangou III at 1.7 million years, Xiaochangliang at 1.4 million years and Donggutuo at 1.1 million years are the most representative examples, with large assemblages to study.

The Oldowan/Mode 1 technical complex is not homogeneous. An important variability is hidden under this name, and several hypotheses were proposed to explain this diversity. In this chapter, we will provide an overview of the different hypotheses and compare the African Oldowan with the Mode 1 in China to highlight the technical universals and local specificities involved in the history of techniques.

## OLDOWAN/MODE 1 STONE TOOL TECHNOLOGY

The Early Stone Age industries are composed of “low-elaborated” flakes and artifacts such as pebbles or blocks made by one-sided or two-sided removals that produce a continuous cutting edge (typically called choppers and chopping-tools), as well as polyhedrons, subspheroids, and spheroids. This set refers to the assemblages prior to the appearance of the bifaces and cleavers, tools that characterize the Acheulean. Nevertheless, this type of industry continues during the following periods, associated with the new tools.

Flake production is said to be “undeveloped” or “low-elaborated” because it has simple characteristics in terms of knowledge and know-how (Pelegrin 1991), is not standardized, and is almost always made from the raw material available locally, whatever its quality for knapping. Nevertheless, this type of debitage involves an understanding of the principles of hard rock fracturing, which involve the mass of the hammerstone and the percussion angle necessary for the production of a conchoidal fracture.

The cores are pebbles or blocks of raw material, which are knapped on one or more faces in short series of flakes. The most common knapping technique is freehand hammer percussion. The use of bipolar percussion on anvil is attested in many deposits, often used to cut pebbles of small dimensions, or presenting specific reactions to size, such as quartz, for example. (de Lumley and Beyene 2004; Mgeladze et al. 2011; de la Torre et al. 2004).

## **HYPOTHESES CONCERNING THE VARIABILITY**

Mary Leakey (1971) proposed a chronological division based on Beds I and II of the Olduvai sequence: the classical Oldowan dated between 1.85 and 1.65 million years, composed of cobbles, flakes, and hammering and grinding tools; the Developed Oldowan A (DOA), which sees an increase in the intensity of flake debitage and the proportion of spheroids, dated between 1.65 and 1.53 million years; the Developed Oldowan B (DOB), between 1.53 and 1.2 million years, with a regression of the number flakes per core, and especially the appearance of shaped tools, as well as the proportion of spheroids that remains important.

Glynn Isaac (1976) considered both Oldowan and Developed Oldowan as a single entity called Oldowan Industrial Complex. Some authors also argue that Developed Oldowan sites should be included as part of the Early Acheulian (de la Torre et al. 2005). Braun and Harris (2003, 2009) highlighted a variability depending on the occupation context of several sites of KBS and Okote Member of Koobi Fora. Other researchers have also proposed to group the sites older than 1.9 million under the term Pre-Oldowan, by pointing out the smaller number of sites and the less-diversified nature of the tools, notably the absence of large percussion tools (Roche 1996, 1999; Lumley and Beyene 2004; Lumley et al. 2009).

The analysis of Lokalalei 2C sites in West Turkana, Kenya, dated at 2.34 million years (Delagnes and Roche 2005) and Kanjera South, near Lake Victoria, Kenya, between 2.3 and 1.9 million years (Braun et al. 2008, 2009; Plummer and Bishop 2016) has shown that a significant level of technical knowledge is present even in the oldest sites, and today, we speak more generally of Oldowan technocomplex, as proposed by Isaac (1976).

## **COGNITIVE ABILITIES AND TECHNICAL SKILLS**

The variability of the industries is the result of many factors, the most frequently cited of which are the site occupation context and the availability and quality of raw material resources near archaeological sites. Studying the Koobi Fora KBS industry (1.8–1.65 million years), authors have proposed

the “Least effort strategy” model (Toth 1982, 1985, 1987; Schick 1994), with reference to raw material savings (use of local raw material, whatever its quality) and debitage (“opportunistic” debitage with the sole search for a cutting edge, without control of the debitage). The theory of the least effort strategy is based on the idea that Mode 1 technologies cannot be regarded as traditions comprising a set of defined rules and tool design, since they consist only of applying simple principles of percussion. (Schick 1994).

Some authors contest this interpretation (Reti 2016; De Weyer 2016). Joseph Reti (2016) proposed an experimental study of this hypothesis by studying the DK site at Olduvai Gorge. Taking the least effort strategy as a null hypothesis, he found that the results obtained by experimentation did not correspond to the reduction strategies observed on the DK site. His study shows a planning of the debitage from the stage of selection of the blocks of raw materials, and a management of the nucleus during the phase of reduction.

Hominin techno-economic behaviors have also been studied in West Turkana, particularly at the Lokalelei 2C site (Harmand 2005, 2009). Lokalelei 2C is dated at about 2.34 million years. The raw material used is a phonolite of good quality for knapping, found in the form of pebbles at about 50 m from the site with other raw materials of lower quality, as rhyolite, for example. On some phonolite pebbles, more than fifty flakes per core have sometimes been knapped. The authors conclude that hominines of Lokalelei 2C were probable awareness of the different knapping qualities of the rocks and predominantly utilized phonolite to produce their tools (Delagnes and Roche 2005; Harmand 2009).

The question of raw material availability is presented as the main factor in the variability of the Oldowan assemblages. On most sites, the selected raw materials are local, and sometimes of poor quality. However, several authors have demonstrated a selection of the best raw materials available in the surrounding space, such as in Hadar (Hovers 2012). In Kanjera South, the groups brought back a substantial portion of the raw materials of more than 10 km (Braun et al. 2008, 2009). Some of the quartz materials used on Olduvai Gorge DK site also come from at least 8 km (Blumenshine et al. 2003). In order to understand and describe how raw material quality influences tool production, De Weyer (2016) compared production systems and tools produced at three sites with different raw material choices. Fejej, with an assemblage composed almost exclusively of quartz, Koobi Fora with a use of the local basalt, and DK, composed of quartzite and basalt, and also some pieces in quartz.

At Koobi Fora, knapping methods are said to be single-flake oriented, with the research of a suitable angle to produce flakes, without predetermination of large series of flakes. The cores are quickly exhausted as the angles disappear.

At Fejej, the selection of pebbles with a large flat surface makes it possible to produce series of flakes on the same core, and long continuous series are observed from the natural striking platform created by the plane surface. At Olduvai, the methods change according to the raw material worked. Quartzite pebbles are produced using the same recurrence methods as in Fejej, while flake-by-flake strategy is used on basalt pebbles.

From this work, the variability observed within the Oldowan Industrial Complex appears more complex, and not only the fact of geographical constraints. We may conclude that hominin groups were able to adapt to their environment for raw material procurement, and that they performed a strong selection based on their knowledge and specific choices that may be different from one site to another. Then, lithic assemblages may be considered as significant cultural traits, or at least witness different technical traditions (De Weyer 2016). This diversity should also be investigated in Chinese Early Stone Age assemblages. Indeed, many Lower Pleistocene sites are located in China, and the different context gives a good opportunity to question the technical variability in other contexts than Eastern Africa.

## EARLY STONE AGE IN CHINA

### Longgupo

The site of Longgupo was discovered in 1984 (Huang 1986). It is located at Wushan, Chongqing Municipality, south of the crossing of the Three Gorges of the Yangtze, in the Miaoyu Basin. Three excavation campaigns have been led, directed by Pr. Huang W.B. for the first and second (Huang and Fang 1991; Huang et al. 1995; Huang and Zheng 1999), and Pr. Boëda E. and Pr. Hou Y.M. for the third one (Hou et al. 2006; Boëda and Hou 2011).

This site delivered mandibula fragments first attributed to a hominid (Huang et al. 1995), but the attribution has been debated (Schwartz and Tattersall 1996; Ciochon 2009). Some remains of *Gigantopithecus blacki* contributed to spread doubt, and it is still impossible today to know which species made the stone tools (Wei et al. 2014).

The stone-tools modification, though debated at the beginning, has been clearly established and constitutes the earliest record of the hominid presence in Eastern Asia. The sequence has been recently dated to 2.5–2.2 million years for the Lowest Member and 1.8–1.5 million years for the Upper Member (Han et al. 2015; Huang et al. 2015). Although no hominin species has been clearly identified in Longgupo, the site represents the earliest evidence of human presence in China and in Eastern Asia in general. The richness of its very detailed sequence makes of this site a key one to study earliest Chinese hominin behaviors.



Longgupo site was originally a cave formed in a classic karst system in the Miaoyu Basin. The sedimentation is mostly attributed to alluvial deposits coming from the Miaoyu He, as demonstrated by the rounded gravels and cobbles deposited in the cave. Some karst infiltration deposits may also have occurred occasionally, as some speleothems indicate (Rasse et al. 2011).

More than 1,500 artifacts were uncovered from the different field seasons led by several teams (Huang et al 1995; Hou et al. 2006; Boëda and Hou 2011). The authors highlighted a short stone tool modification strategy. The hominins selected their raw materials on purpose and only modified the cutting edge. On the other hand, a huge techno-functional variability is suggested, meaning that unless a short and effective reduction sequence, the tool diversity was large (Boëda and Hou 2011).

The main raw material used is local limestone, collected in the form of pebbles or fragmented blocks. However, 10 percent of the tools are produced on exogenous materials (lava, chert) absent from the vicinity of the site. Their provenience has not been identified. These tools arrived on the site already knapped. It is made of pebbles tools and large retouched flakes.

The production methods in Longgupo are based on the shaping of cutting edges on pebbles. The material consists mainly of pebbles with transverse or lateral cutting edge. Some products from bipolar percussion on anvil have also been identified and can be retouched. The particularity of the site of Longgupo is to include a lithic industry almost entirely oriented on the shaping of pebbles. While these objects are known in Africa, their proportions are always anecdotal, and these tools come in addition to a tool-kit mainly consisting of flakes from the debitage. In addition, this technical system is observed continuously on forty-one archaeological levels. These data make this site a unique case, hardly comparable with other Chinese sites but also with African assemblages. The raw material can be invoked as a factor of this technical otherness. The selected limestone pebbles are indeed very hard at knapping, and the choice of shaping can be considered as a cultural response to this natural constraint (Boëda and Hou 2011).

## **Renzidong**

The site of Renzidong (Anhui, Central China) seems most conducive to comparison, because of its chronological proximity to Longgupo (Gao et al. 2005). This is a sinkhole that seems to have trapped animals that hominins would come to recover, or at least consume. The site has yielded numerous faunal remains and an important lithic industry (Jin et al. 2000, 2009).

Although the data still needs to be published in detail, Boëda and Hou (2011) were able to make some observation on the assemblage. The lithic industry seems to be composed of shards debited on local raw materials, with

a preferential use of blocks of pyrite, but one also finds chalcedony, chert, and limestone. Some pebble tools are also mentioned. The Renzidong industry may have characteristics common to Oldowan sites in Africa, particularly in the proportions of flake tools compared to cobbles, but more detailed publications will be required to carry out systematic comparison work.

### **The Nihewan Basin**

The Nihewan Basin is located in northern China, 300 km west of Beijing. These are the highest latitudes in which lower Pleistocene hominin occupations were found, the same as Dmanisi in Georgia (Gabunia et al. 2000). Many sites were discovered between 1.7 and 1 million years, indicating a recurrent presence of hominin groups in the region, though the area was under high climatic variations. Denell and colleagues (2013) studied the climatic data from the Lower Pleistocene record and concluded that those occupations may have been short and seasonal due to very cold temperature during glacial episodes. Nonetheless, many sites have yielded numerous assemblages, both with fauna and lithics. Liu and colleagues (2013) summarized the technological data of eight major sites, Majuangou (Li and Xie 1998; Xie and Li 2002a,b), Xiaochangliang (You et al. 1979; Huang 1985; Chen et al. 1998, 2002; Li 1999; Zhu et al. 2001), Dachangliang (Pei 2002; Deng et al. 2006), Banshan (Wei, 1994; Zhu et al. 2004), Donggutuo (Li and Wang 1985; Wei 1985; Hou et al. 1999), Feiliang (Xie et al. 1998; Zhu et al. 2007), Huojiadi (Feng and Hou 1998) and Xujiapo (Wei et al. 1999).

According to the authors (Liu et al. 2013), for those localities, the raw material exploitation is quite similar. The main raw material used is chert, distributed along the basin through failures and cracks along a Brescia fault. The chert is only available under small fragments though, so the cores are small. Although the authors argue that Majuangou III site is composed of at least 90 percent of this chert, other researchers have noticed a larger raw material diversity in this site especially, with the use of other materials collected in alluvial accumulations close to the site, leading to select bigger pebbles than on the other sites (Boëda and Hou 2011). Apart from this site, most of raw material procurement is focused on the selection of small chert fragments from the fracture belts close to the sites (Pei and Hou 2001). Raw material procurement in the Nihewan Basin is then almost exclusively local.

Concerning the technology, Liu and colleagues (2013) sorted out three “degrees of sophistication” in the Lower Pleistocene assemblages. First corresponds to a free-hand hammer percussion debitage system leading to produce few tool types, with very retouched pieces and almost no pebble tools. The site of Majuangou III is representing this category. Second degree still involves hard hammer flaking, and also bipolar debitage. Small tools were

produced on flakes, with a diversity of tool types and retouch pieces. Xiaochangliang is the most relevant site for this category. Third stage is composed of the same characteristics than the previous category, and also more prepared cores such as the Donggutuo core described by Hou (2000), a prismatic core prepared to produce series of small elongated flakes. This site is naturally representing this category.

### **Majuangou III**

The Majuangou III site is the oldest known to date in the Nihewan Basin. Dated at 1.66 Ma (Zhu et al. 2004), it is an open-air site, one level of which has yielded several hundred artifacts. A full analysis of the Majuangou lithic industry is difficult as the detailed data are not published. According to a quick study, Boëda and Hou (2011) describe an industry consisting mostly of flakes made from a variety of raw materials from alluvial pebbles and small blocks of chert.

The core reduction process consists in producing small series of flakes from a natural convex surface selected on the blocks. The flakes are used as produced and sometimes slightly retouched. The authors emphasize the very different production systems between Longgupo and Majuangou, and conclude that they are different evolutionary lineages, proposing the hypothesis of two distinct technical traditions during the Early Stone Age in China.

### **Xiaochangliang**

The site of Xiaochangliang, dated at 1.4 million years (Zhu et al. 2001; Li et al. 2008; Ao et al. 2011), has yielded nearly 2,000 artifacts after several excavation campaigns between the 1990s (Chen et al. 1999). The vast majority of the material is produced on nodules or small blocks of chert (96, 7%). Chert artifacts have two possible sources, one from a nodular or stratified outcrop and the other from pyroclastic rocks, mainly with asymmetric and sub-angular breccias of chert, dolomite, limestone, and quartzite (Yang et al. 2016).

The technological study carried out on the materials revealed two debitage methods to produce small flakes. First, a classic debitage by small series of removals, to obtain flakes with regular characters. When the cores are too small to be knapped by free-hand hammer percussion, bipolar debitage is observed, in significant proportions (30% of the cores, Yang et al. 2016). The authors attribute this use of the bipolar debitage as an adaptation to the morphologies of chert block fragments, of small dimensions and sometimes difficult to knap freehand. The retouched pieces are not numerous ( $n = 45$ ), but they give useful information. A total of 38 percent are made on whole

or broken flakes 13.3 percent are on bipolar cores or splinters, and others are on angular fragments. Scrapers compose the majority of the toolkit, but notches and other pieces without regular patterns were observed (Yang et al. 2016).

The retouch tools indicate that the blanks were not produced to be standardized, and that the confection phase is the more important stage of tool making. This pattern is very similar to small tool industries in Eastern Europe during the Mid Pleistocene transition, described in Bilzingsleben in Germany or Vertesszolos in Hungary, for example (Rocca 2016). The diversity of flaking methods and the use of uncontrolled methods like bipolar percussion make sense here, as the main objective is to get small pieces without special technical criteria. Those criteria will be created by the retouch phase.

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## Donggutuo

The site of Donggutuo was discovered in 1981 and has been excavated through several campaigns during the 1990s. It has yielded thousands of artifacts and is one of the richest assemblages in the Nihewan Basin. Dated to 1.1 million years (Singer et al. 1999; Hilgen et al. 2012). The material has been described by several authors (Wei et al. 1985; Hou 2008; Yuan et al. 2011; Wei 2014), and a debate emerged on the degree of conceptualization and technical skills on the site. Free-hand hammer percussion was identified, as well as bipolar percussion. Authors also described finely retouched flakes (Wei et al. 1985; Schick et al. 1991).

Besides to this classical technical set for the region, Hou (1999) noticed and described prepared cores at Donggutuo, which consist in a preparation of a wedge-shaped debitage surface to obtain series of small elongated flakes (Hou 2000, 2003). This interpretation has been contested by other researchers, claiming they could be a variant of the classic cores found in the site (Chen 2003; Xie et al. 2006). Other proposed that they could be the result of bipolar reduction (Wei 2014). Though still debated, the wedge-shaped cores show a preparation that was not observed earlier in the Nihewan Basin. The elongated flakes can be retouched to get pointed pieces. Notched pieces and borers are also documented. The retouch pieces are all made on flake blanks (Yang et al. 2017).

The Donggutuo lithic assemblage is displaying another kind of knapping strategy to take advantage of the raw material constraints. Though in Xiaochangliang the knappers produced any possible blanks and then used retouch to make their tools, in Donggutuo the cores show steps for the preparation of technical criteria that are determining the morphology and the shape of the flakes produced. The core preparation to obtain elongated flakes is unique to Donggutuo in the Nihewan Basin at this period.

## DISCUSSION AND CONCLUSION

The Early Stone Age in China gives a new perspective on the notion of variability of the lithic industries. In Africa, the raw material selected plays an important role in the debitage methods employed. From a good knowledge of the raw material knapping reactions, the hominins selected the type of raw material and adopt a method adapted to produce the flakes they wanted. Although the retouch rate is not very high, the technical criteria defined by the debitage make it possible to obtain a diverse range of flakes, which offers the possibility to use these flakes directly as tools, and sometimes to retouch them to obtain specific cutting edges. If the raw material determines how to produce these tools, the common toolkit remains relatively the same in all sites. The presence of heavy-duty tools to use the mass comes in addition to a toolkit based on small flakes with fine cutting edges. Thus, in East Africa, the raw material constraints are balanced by an understanding of the reactions to knapping of each material, and the choices of raw material constitute a cultural act, or at least a technical tradition.

This idea can also work on several Chinese sites, including Longgupo and Majuangou. The lithic industry of Longgupo, based on the creation of a cutting edge by shaping pebbles is unique and persists on forty-one archaeological levels, between 2.5–2.2 and 1.8–1.6 million years. The choice of shaping can be considered as a technical solution to the hardness of the limestone used. This choice of shaping is not found in other assemblages and echoes bifacial shaping systems that will develop in East Africa from 1.7 million years (Lepre et al. 2011; Beyene et al. 2013). The Longgupo industry is not bifacial at all, but the choice of the “all-shaped-strategy” is the same type of technical option that will prevail during the Acheulean, especially in the Bose Basin in southern China (Xie and Bodin 2007).

The characteristics of the lithic assemblage of Majuangou III seem similar to the technical systems of the African Oldowan. The choice of alluvial pebbles to obtain large flakes, and chunks of chert to make the small ones correspond to the same management of the constraints related to the raw materials as on the Oldowan sites, as for example DK at Olduvai (de la Torre and Mora 2005; De Weyer 2016).

However, a different phenomenon is observed when comparing the technical choices of Xiaochangliang and Donggutuo. Indeed, on these two sites, the almost exclusive use of the same blocks of chert highlights the differences in raw material management. In Xiaochangliang, the recurrent use of bipolar percussion allows to obtain numerous small flakes and fragments, without controlling the products obtained. The retouching phase is thus preponderant in the tool confection and can greatly vary. In Donggutuo, the technical option is different, since we observe a control of the flake

morphology by a preparation of the core, leading to produce standardized blanks for future tools.

Then, how to define the variability of Early Stone Age lithic industries? What is the inherent part of natural constraints, and what is that of culture, of tradition? Though it is impossible to choose a point of view in a categorical way, it is important to consider the diversity of possible technical options in a given context and to observe the response of human groups to the constraints of their environment. By multiplying detailed analyses and looking for the technical criteria, taking into account the phase of selection, production and retouch, we highlight both recurrences and otherness, that is to say technical universals and cultural specificities.

By considering the technical fact by an anthropological approach based on the analysis of hominin stone tool assemblages, it is possible to highlight a diversity that is too often hidden by reductive and general descriptions of the lithic industries. The comparison between two rich areas such as East Africa and China gives new key for understanding cultural diversity at the very beginning of the history of techniques.

## NOTE

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