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Analysis of lithic technology of Lower Pleistocene sites and environmental information in the Nihewan Basin, North China

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ABSTRACT

The Nihewan Basin is an important area for studying the evolution of early hominids in China. Among 15 recently discovered and reported Lower Pleistocene sites in the Basin, eight (Majuangou, Xiaochangliang, Dachangliang, Banshan, Donggutuo, Feiliang, Huojiadi, Xujiapo) have been specifically analyzed by the authors. This paper is a synthesis of results of analysis of lithic technology and palaeoenvironmental information of these sites. Three distinct arrangements of techniques are identified from the eight sites, which represent the different lithic techniques, cognitive capability and cultural contents. The "DGT Core" from Donggutuo indicates that the cognitive capability and the culture deepness of early hominids in China surpassed expectations. Re-evaluation is required of early human technology and behavioral mode in China.

1. Introduction

The Nihewan Basin of North China is one of the most important archaeological areas in Asia, and has numerous sites dated between 1.7 Ma and 1.0 Ma. The earliest sites provide at present the best estimate of when hominins first reached Northeast Asia, and show that they were able to live, at least occasionally, as far north as 40°N, which is also the latitude of Dmanisi, Georgia (Gabunia et al., 2000).

Since the initial discoveries in the 1920s, notable variability in the fauna and archaeological records have been documented in the Nihewan Basin. The archaeological record ranges from the Early Palaeolithic to the Neolithic, and the discovery of Early Pleistocene sites in particular attracted wide attention in the scientific community. Beginning with the excavation of Xiaochangliang site (You et al., 1979) in 1978, newly-discovered Lower Pleistocene sites (Xie et al., 2006) make the Nihewan Basin a crucial area for the study of early human evolution and culture in China, or even in East Asia (Schick et al., 1991).

At the high-latitude Nihewan Basin during the Early Pleistocene, the area was characterized by increased environmental and climate fluctuation (Zhu et al., 2007). Early Pleistocene hominins in the Nihewan Basin met long-term climate variability and some episodic environmental shifts. The abundance of discovered Lower Pleistocene Palaeolithic sites indicates early hominids could survive in the local environment of this area. The lithic technology and environment coupling is discussed here.

2. The sites

More than 15 Lower Pleistocene Palaeolithic sites have been found in the Nihewan Basin (Wei et al., 2011). They are all located in the eastern part of the Nihewan Basin, around the Donggutuo Village and Cengjiawan Platform (Fig. 1). At present, the age of the earliest site, Majuangou, is 1.66 Ma (Zhu et al., 2004). Given the incompletely published data for some sites, this paper focuses on eight sites (Fig. 1, Table 1): 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).

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Table 1
Early Pleistocene sites in the Nihewan Basin.

Site name	Age (Ma)	Stone artifacts (*N*)	Bone tools (*N*)	Fossils (*N*)
Xuajiapo	0.91–1.01	4	–	–
Huojiadi	≈1.0	60	–	–
Donggutuo	≈1.1	2175	2	>1571
Feiliang	≈1.2	108	–	1419
Banshan	≈1.32	95	–	–
Xiaochangliang	1.36	1635	4	>3297
Dachangliang	≈1.36	33	–	22
Majuangou	1.66	227	–	>143

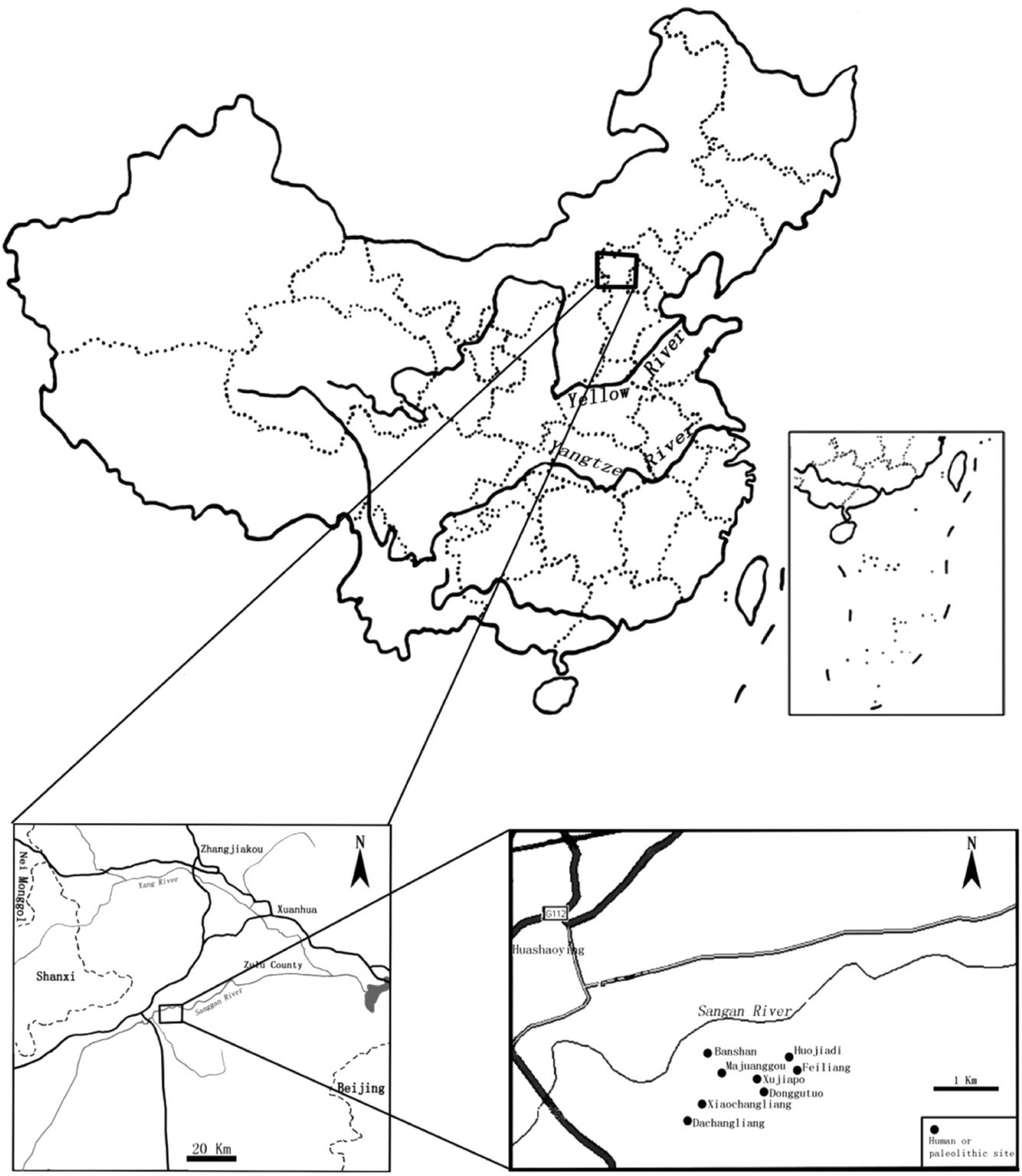

Fig. 1. The geographical position of Lower Pleistocene sites in the Nihewan Basin.

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3. Paleoenvironmental context

At present, the Nihewan Basin is characterized by a moderate semi-arid climate, with a mean annual temperature of ~7.7 °C and a mean annual rainfall of ~364 mm. Winters are relatively cold and dry under the influence of the East Asian winter monsoon, while summers are relatively warm and humid under the influence of the East Asian summer monsoon. The Nihewan Basin is located at the northeastern edge of the Chinese Loess Plateau. As in the Chinese Loess Plateau, it would have been very sensitive to precipitation changes during the Pleistocene as well. During the last glacial maximum, the precipitation in this area is considered to be ~75% below the present-day rainfall, due to strong winter and weak summer monsoons (Liu et al., 1995; Maher and Thompson, 1995; Florindo et al., 1999).

During the Pleistocene, the Nihewan Basin experienced both long- and short-term climate and environmental variability of global and regional significance, which has been well reflected by several studies using multiple climate proxy indicators (Fig. 2). For example, a long-term decrease in chemical weathering intensity in the Nihewan Basin during the Pleistocene is suggested by magnetoclimatological proxies of anhysteretic remanent magnetization (ARM) and AH-ratio, clay mineralogical proxy illite/chlorite and Chemical Index of Alteration (CIA) (Ao et al., 2010) (Fig. 2b–e). This long-term decrease in chemical weathering intensity implies a long-term decrease in East Asian monsoon precipitation and increase in aridification during the Pleistocene. Consistent with this paleoclimatic inference, the pollen record obtained from the Dadaopo section in the northeastern Nihewan Basin reveals vegetation shifts from typical subtropical species, through well-developed forest vegetation, to grasses and herbs, corresponding to a stepwise intensified aridification in the basin during the Quaternary (Yuan et al., 1996). Consistently, mineral magnetic studies of Chinese loess–paleosol sequences also suggest a long-term increasing trend in aridification and cooling of the Asian continental interior over the last 2.6 Ma (Deng et al., 2006) (Fig. 2g). For the short-term variability of climate, the Nihewan fluvio-lacustrine (Ao et al., 2012; GPC) (Fig. 2f) and Chinese loess sequences (Deng et al., 2006) (Fig. 2g) suggest more than ten glacial–interglacial cycles during the period of early human occupation in the Nihewan Basin. Although the Nihewan Basin never saw glacial ice during the Pleistocene, the glacial period brought considerable cooling and drying.

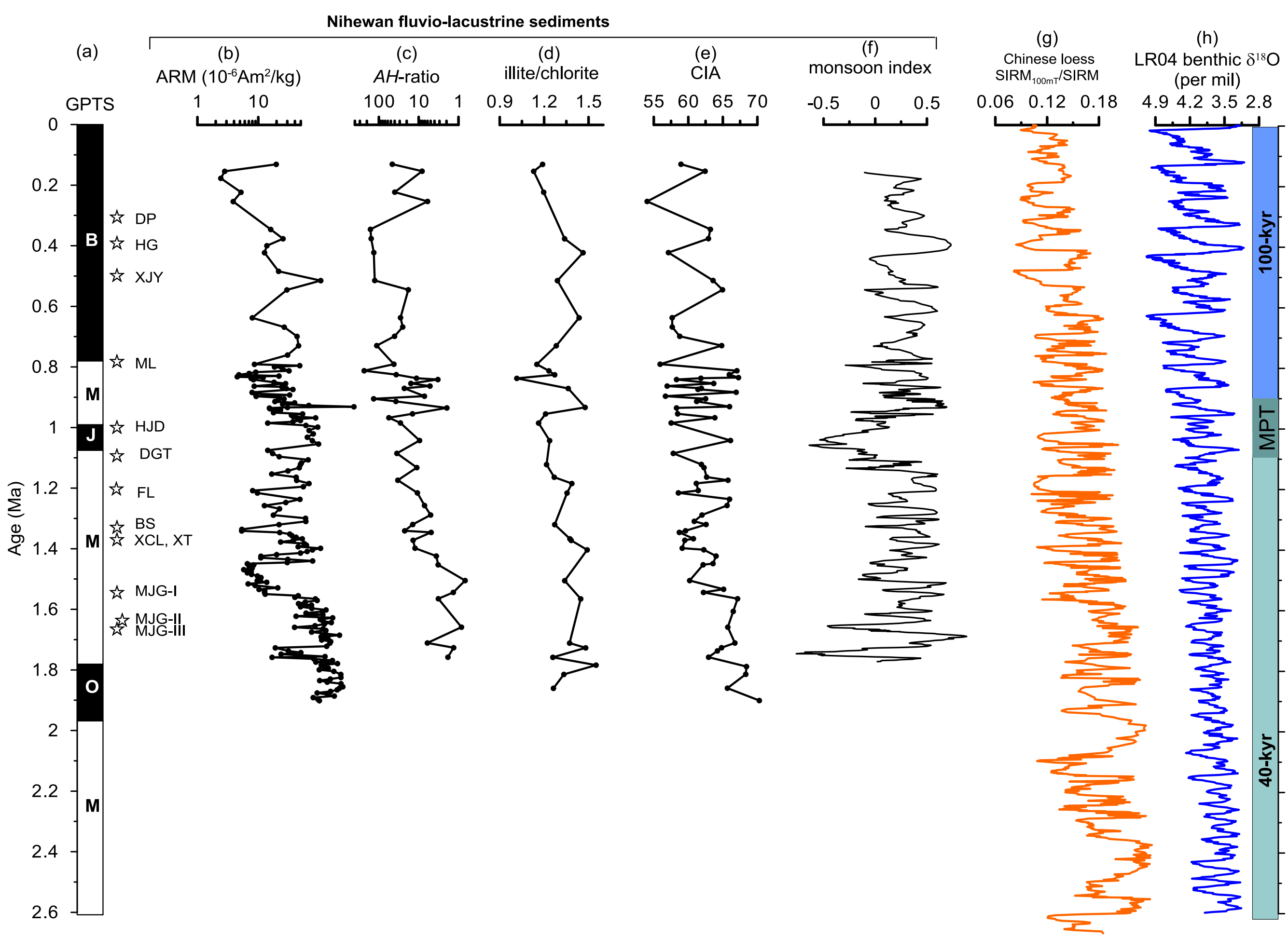

Fig. 2. Synthetic diagram relating all the well-dated Pleistocene Paleolithic sites in the Nihewan Basin to the GPTS, and temporal variations of North China and global climate during the Pleistocene. (a) Pleistocene Paleolithic sites in the Nihewan Basin within the framework of GPTS (Lisiecki and Raymo, 2007); magnetoclimatological proxies of (b) Anhysteretic remanent magnetization (ARM) (Ao, 2010); (c) AH-ratio (AH-ratio characterizes the relative amount of newly formed fine-grained ferrimagnetic minerals during heating, which is linked to the relative concentration of chlorite in the samples). For more detailed description see Ao et al. (2009); (d) Illite/chlorite (Ao et al., 2009); (e) Chemical Index of Alteration (CIA) (Ao et al., 2010); (f) Summer monsoon index (Ao et al., 2012) of the fluvio-lacustrine sequences in the eastern Nihewan Basin; (g) Changes in the SIRM100 mT/SIRM ratio from the Jingbian loess sequence on the northern Chinese Loess Plateau (SIRM is the saturation isothermal remanent magnetization, and SIRM100 mT represents the residual SIRM after 100-mT alternating field demagnetization) (Deng et al., 2006); (h) LR04 benthic $\delta^{18}O$ stack (Lisiecki and Raymo, 2007).

In face of these long- and short-term variations of climate, however, early humans never totally abandoned the Nihewan Basin. Early human occupation in the Nihewan Basin possibly occurred during the interglacial periods. The extremely warm and long interglacial conditions may have been necessary for early humans to survive in northern China during the early expansion from Africa. However, along with their prolonged occupation in northern China, they may have continually evolved and enhanced their ability to resist the increasingly harsher climate in northern China, e.g., making tools from animal bones, preying on large grazing animals and processing food from animal tissues (Zhu et al., 2004). Especially, the overwintering problem of the 40°N temperate zone may have been solved by hunting and eating animals. Thus, early humans were gradually able to resist mild interglacial, hostile glacial and increasingly hostile glacial periods during the early Pleistocene, as suggested by the climatic context and chronology of the occupation at the Xiantai, Xiaochangliang, Donggutuo and Maliang sites (Ao et al., 2010). Especially, the increasing climatic contrast between glacial and interglacial occurred during and after the Mid-Pleistocene climate transition (MPT) (Fig. 2h), but there were still early humans in the Nihewan Basin (Deng et al., 2008; Ao et al., 2010) (Fig. 2a), showing a high adaptability of early humans to various climate and environments. The MPT marks the movement to 100-kyr glacial cyclicity and represents an important evolutionary process in global palaeoclimatic history. During the MPT global climate shifted from a mode characterized by ~41-ky cyclicity (obliquity) to a new state dominated by ~100-ky periods corresponding to eccentricity variation (Pisias and Moore, 1981; Clark et al., 2006).

4. Technological research

Several aspects of lithic technological research are discussed in this paper, including raw material exploitation, flaking techniques, blank selection, retouching techniques and typology.

4.1. Raw material exploitation

Lithic raw material is one of the most important means of production for Pleistocene hominids. The availability and quality of raw material, the ability to exploit it, and the rate at which raw material was consumed all represent substantial limiting factors for hominid adaptations and the nature of lithic technology.

Table 2 presents the ranges and percentages of lithic raw materials exploited at the eight sites. Similarity exists between the eight sites in that the main raw material used is chert procured locally. Chert as a common silicate is the ideal raw material for making stone tools (Inizan et al., 1999), but the widely distributed chert available in the Nihewan Basin is characterized by joint surfaces and cracks, meaning that it is not the ideal raw material for knapping. Chert is easily obtained locally and is of relatively good quality for knapping, that early humans primarily selected such chert for knapping indicates that they had knowledge of stone properties and made a deliberate choice. Pei and Hou (2001) researched the characteristics of raw materials at Donggutuo, summarizing the pattern of chert exploitation: collecting fragmented pieces directly from fracture belts and quarrying from these fracture belts were the principal strategies of raw material procurement. In general, the extent of raw material utilization at Donggutuo was small. The strategies of raw material exploitation at Donggutuo represent the pattern seen at the other sites. Utilizing the nearest and relatively suitable raw materials for knapping is the relatively economic strategy for Early Pleistocene humans in the Nihewan Basin.

Table 2
Types and source of raw materials in different sites.

Site name	Raw materials (%)									Source
	Chert	Siliceous limestone	Quartzite	Quartz	Breccia	Dolomite	Limestone	Sandstone	Others	
Xuajiapo	100									Local
Huojiadi	78.3	12	1.7						+	Local
Donggutuo	86	+	1.8	+	5	3			+	Local
Feiliang	≈100								+	Local
Banshan	61		+	13			7		+	Local
Xiaochangliang	≈100								+	Local
Dachangliang	>90					+			+	Local
Majuangou	>90			+				+	+	Local

+ Raw material found in the site but cannot be given a precise percentage.
Other materials including opal, crystal, achate, and andesite, have very low percentages in the sites.

4.2. Technical analysis

This article discusses analysis on some parts of flaking technique, choice of blank, retouching work, tool typology, morphology and size. Significance of the discovery and research on the "Donggutuo core" is the key point.

4.2.1. Flaking techniques

"Flaking technique", demonstrated by characteristics on flakes and cores, is defined as the process of knapping flakes from cores. The methods of the percussion technique have been well researched by many scholars (e.g., Debenath and Dibble, 1993). There are good materials for researching flaking techniques from the eight sites.

The main method for producing flakes is direct hard hammering at all eight sites, along with the bipolar method at only a few sites: for example, 23 bipolar cores and 28 bipolar flakes from Xiaochangliang, 1 bipolar core from Huojiadi site, 2 bipolar cores and 8 bipolar flakes from Donggutuo site. In addition, 19 long blades were identified at Xiaochangliang (You, 1983). The small "long blades" made using the bipolar method at the Xiaochangliang site have been considered as having more advantageous features, although some researchers (e.g., Chen et al., 2002) interpret them as the result of using special raw materials than applying advanced techniques. However, this opinion fails to explain the phenomenon of similarity in raw materials among the eight sites, while the bipolar method is present in only a few of the sites. Pei and Hou (2001) have also argued that there are blades knapped by the pressure method, but this view was questioned by others (e.g., Chen et al., 2002). Further research is needed to resolve this debate. The "Donggutuo core

(DGT)" (Hou, 2003, 2008), a prepared core discovered in the Donggutuo Lower Pleistocene site, which was wedge-prepared for producing small elongated flakes, may provide new insights. A detailed discussion of the "DGT core" is presented below.

Through analysis of cores and types of flakes, the degree of flaking can be determined. This paper primarily presents results of the analysis of core exploitation based on the variability in flake types (Toth and Schick, 2006) as classified in different reports. Cores from Xujiapo, Banshan, Majuangou and Feiliang are dominated by single platform cores, while cores from Dachangliang, Donggutuo and Huojiadi have mainly multiple platforms (Fig. 3). Despite the lack of detailed core exploitation ratio data in the Xiaochangliang report, observations of the artifacts at Xiaochangliang and Donggutuo confirm their similarity. Dachangliang shows a high ratio of core exploitation. Analysis of core types consists of analysis of flaking methods which show the advanced feature of flaking techniques at several sites, such as Donggutuo and Xiaochangliang.

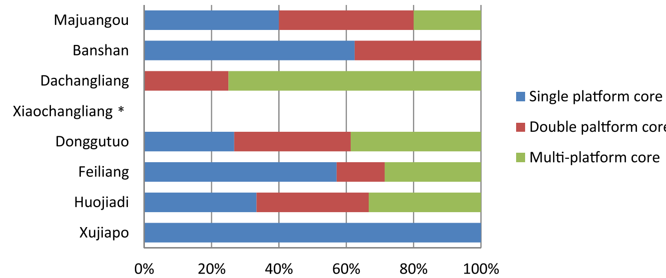

Fig. 3. Percentage of different types of cores in different sites. *There is a lack of detailed core exploitation ratio data in the Xiaochangliang reports.

4.2.2. Blank selection

To some extent, blank selection reflects technological variability between different human groups. Generally in the Nihewan Basin, flakes are the primary blanks for producing tools, followed by chunks (or core fragments). Pebble blanks were rare (Table 3). All blanks at Xiaochangliang, Dachangliang and Banshan were identified as flakes. However, for the chopping tools at Xiaochangliang, discovered during the 1990–1997 excavations, pebbles and chunks were used, showing that flakes were not the only blank type, although they were the dominant type (Wei, 1994). In addition, given the scarcity of stone artifacts at Dachangliang and Banshan, the rate of 100% flake blanks cannot represent the entire artifact assemblage. The flake blank rate at Donggutuo is 86%, and Feiliang, Majuangou and Huojiadi are respectively 50%, 33% and 33%. The reported artifacts from Feiliang, Majuanggou and Huojiadi are fewer than those excavated, meaning the ratios do not represent the real situation. However, the fact that flakes are the principal blanks at Donggutuo and Xiaochangliang is undeniable. Patterns of blank selection, with a high rate for flakes, reflect the technological similarity between the eight sites.

which commonly appear in the Lower Pleistocene sites in China. However, evidence of a prepared core striking surface was observed on some flake platforms. The platforms of a notch from Feiliang and a flake from Huojiadi for example, have retouching (or platform preparation trimming retouch). Three flakes show platform preparation, and a predetermined core, classified as a "DGT core", was found at Donggutuo. In addition, previously flaked surfaces used as striking surfaces, creating a smooth surface, can be seen at Majuangou. Generally, direct percussion with a hammerstone was the dominant method to produce flakes.

At the eight sites, tools were retouched through direct percussion with a hard hammer. However, stone tools at Xiaochangliang also shows "small and elaborated" retouch (Huang, 1985), but the Donggutuo even more so (Wei, 1985) which is not common for the hard hammer technique. Different types of retouch were used on flakes, either on the dorsal surface (which is the major retouching method in the eight sites) or the ventral surface. Xiaochangliang, Huojiadi, Majuangou, and Donggutuo in particular, are characterized by higher diversity in retouching techniques. In addition, two bone artifacts found at Donggutuo were retouched by hard hammer, with alternating retouch on the dorsal surface identified by preliminary observations (Wei, 1985).

Table 3
Characteristics of lithic techniques.

Site name	Flaking technique	Blanks selection	Retouching method	Types	Sizes
Xuajiapo	Direct hammer percussion	–	–	Cores; chunks	Small
Huojiadi	Direct hammer percussion; bipolar	Primarily flakes; chunks; pebble	Percussion with hard hammer	Cores; chunks; scrapers; burins; points; borers	Primarily small; middle size
Donggutuo	Direct hammer percussion; bipolar; pressure (possible)	Primarily flakes; chunks; pebble	Percussion with hard hammer	Cores; chunks; end-scrapers; burins; points; borers; notch; denticulate; side scraper; choppers	Primarily small
Feiliang	Direct hammer percussion	Flakes	Percussion with hard hammer	Cores; chunks; scrapers; notch	Primarily small; minute and middle size; large
Banshan	Direct hammer percussion	Flakes	Percussion with hard hammer	Cores; chunks; scrapers	Primarily small
Xiaochangliang	Direct hammer percussion; bipolar	Primarily flakes; chunks; pebble	Percussion with hard hammer	Cores; chunks; burins; points; borers; notch; choppers	Small; middle
Dachangliang	Direct hammer percussion	Flakes	Percussion with hard hammer	Cores; chunks; scrapers	Primarily small; minute and middle size; large
Majuangou	Direct hammer percussion	Primarily flakes; chunks	Percussion with 4hard hammer	Cores; chunks; scrapers	Primarily small

4.2.3. Retouching technique

Retouching techniques applied to cores is a predetermining technique primarily observed in Upper Palaeolithic industries (Odell, 2004). In Lower Palaeolithic sites of this region, prepared cores were mainly retouched on the striking platform. Generally, the eight sites contain the features that lack of core preparation

4.2.4. Type, morphology and size of stone artifacts

Typology is principally based on the shapes and functions of stone artifacts, and is considered as reflecting different human groups in cultural analysis (Bordes and de Sonneville-Bordes, 1970). Generally (Table 3; Fig. 4), cores, flakes and chunks have been found at each site, indicating that flaking behavior took place where early

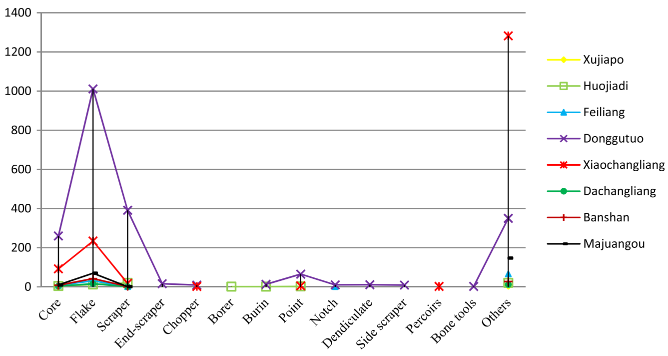

Fig. 4. Types of stone artifacts in different sites.

humans lived, but Xujiapo, with only four stone artifacts recovered, is an exception. The scraper is the principal type at the eight sites, and especially common at Donggutuo and Xiaochangliang. In addition, more elaborate stone tools including burins, borers, sidescrapers and endscrapers have been found at Donggutuo and Xiaochangliang. At Feiliang, the phenomena that cores at the same time are hammers suggest the possibility that people used multi-functional tools (Xie et al., 1998).

Totally dominated by small flake tools, these 8 sites present a distinct character of stone artifacts from Lower Pleistocene. Among them, Xiaochangliang and Donggutuo possess evident progress than the others. At the later Donggutuo site the "DGT core" presents a paralleling "chaîne opératoire" of lithic technology together with a small flaking tool system.

4.2.5. "Donggutuo core (DGT)"

A wedge-shaped-like core was discovered at the Donggutuo site, classified as a multiple-platform core (Wei, 1985). In a new excavation at the site in 1997 the second author noted the appearance of this kind of core, and gave them a new name of "Donggutuo-shaped core" (Hou et al., 1999). More of the same type of core was found in previously excavated materials, and designated as "Donggutuo cores (DGT)" after re-study (Hou, 2000, 2003, 2008).

The "DGT Core" (Hou, 2000) is a wedge-prepared core for producing small elongated flakes. Considering "chaîne opératoire", the selection and design of the whole body of the "DGT Core", its

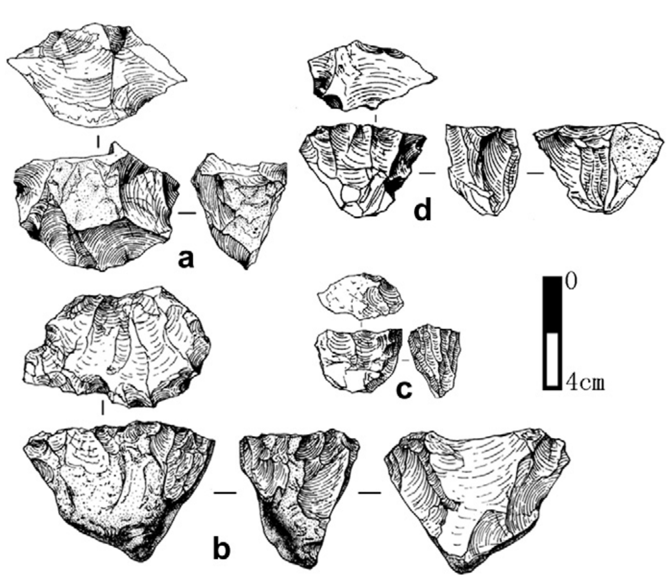

Fig. 5. "DGT core" at four stages of knapping: a, stage I: prepared; b, stage II: tentative knapping; c, stage III: extreme knapping; d, stage IV: discard.

trimming work on the platform, sides and initiated knapping on the ends indicate a very close relationship with Upper Palaeolithic wedge-shaped microlithic cores in China, Northeast Asia, and North America. For producing small elongated flakes, there are four procedures of working schema (Fig. 5) including blank choice, primary trying, flaking and discarding. Further, choosing a proper blank, preparation on platform, transversal face, making keel for controlling knapping work, and concentrating flaking on both ends, all show that the "DGT core" reflects clear ideas of preinstallation and teleonomy of tool makers and possesses the character of a "conceptual mode".

By adopting a new observation and new locating system for the core (Hou, 2000), the similarities between "Donggutuo Core" which was 1 million years old and late microlithic wedge-shaped cores are only one of the key points. The more important thing is the difference between them, which indicates a long time-span for these technological stages. The similarities indicate that these products reflect long-termed requirements and adaptation invented basically in response to needs. On the other hand, their differences indicate experiences and improvements through time. Simultaneously, similarities or differences between them reflect cognition, technology and target management. The "Donggutuo Core" should be the foundation for the later cores.

Several "DGT cores" have been found in the Xujiayao site (Li, 2004), the Shuidonggou site, including Denisova site (Hou, 2005) in Russia, and at least 5 pieces from the recently excavated San-keshu site (Hou et al., 2010). These sites represent different periods of Early, Middle and Later Pleistocene. This indicates continuity of the "DGT core" tradition. The "DGT core" is absolutely not an isolated phenomenon, but had a wide existence. The phenomenon of wedge-shaped cores at Locality 1 and Locality 15 of Zhoukoudian (Gai, 1991) were noted earlier than the "DGT core".

The "DGT core" is emphasized here, as its identification and research is a new growing point for understanding early human tool making technology, cognition and behavior in China. First, it provides a new and the most important evidence of North-China origin of microlithic cores, and allows the tradition of microlithic in China to be traced back to 1.1 Ma (Wang et al., 2005; Wang, 2007). Second, it is helpful to re-evaluate the capability of tool making technology of early humans in China. The early population here invented some unique things and constructed a base of future technological development. Third, it implies some possible pattern of cultural transmission between East and West. Thus, a hypothesis of a prehistoric "Lithic Road" with bidirectional flow was proposed (Hou, 2005).

Inventiveness of stone artifacts at Donggutuo site was beyond previous expectations. Research work on "DGT core" indicates high cognition and rather deep cultural meanings of the early people. The connotations and extents of this new concept still need to be explored.

5. Explanation of living patterns of early humans

The lithic technology suggests that three degrees of sophistication at the eight sites can be defined. 1) First degree: The flaking method is merely hard hammer percussion; the range of tool types is small; the percentage of flake blanks is low; retouching method is principally on the dorsal surface; and shaped artifacts are rare. Representative sites are Dachangliang, Feiliang, Majuangou and Xujiapo. 2) Second degree: Characterized mainly by hard hammer flaking, with the additional use of the bipolar method; artifact types are more variable, including the appearance of notched tools; retouching methods are more varied and applied to dorsal or ventral surfaces, or both; the number of stone artifacts, especially delicate ones, increases. Representative sites are Xiaochangliang and Huojiadi. 3) Third degree: Characterized, excepting the simple direct percussion and bipolar technique in flaking techniques, the pressure method may be present in some special stone artifacts; tool types are more varied, denticulates, burins and some other delicate tools appear; different types of retouching methods are used; artifacts become smaller and more delicate; the most important record is the presence of "DGT cores", a type of prepared core; furthermore, some bone tools are present. The representative site is Donggutuo.

The three degrees of sophistication of the eight sites reflect differences in hominid lithic technology, cognitive ability and the cultural deposits, especially differences in adaptive strategies. Overall, the eight sites have the following characteristics in common: human groups chose to occupy the length of the Nihewan lakeshore; raw materials were exploited near the site, with chert dominant; hard hammer flaking is the major method for core reduction; tool blanks are mostly flakes; most tools were retouched by hard hammer; the retouching method is primarily on the dorsal surface; most tools are retouched simply and the range of tool types is small. These common characteristics of early humans reflect not only similarity in cognitive ability and cultural tradition, but also the strategies adopted by groups living along the Nihewan Lake. Such strategies are dependent on circumstances, but are both practical and flexible. The third degree (Donggutuo site) shows some progress in lithic techniques, including increase in the range of tool types and the presence of more delicate tools, and especially the appearance of the typical "DGT core". As researchers (e.g. Chen, 2002) have noted, Xiaochangliang is known for the quantity of lithic artifacts, but Donggutuo is known for their quality. To some extent, the human groups who occupied Donggutuo had higher cognitive abilities and thus an increased ability to adapt.

6. Conclusions

Given the quantity and quality of lithic artifacts, the Early Pleistocene sites in the Nihewan Basin play a key role, and research on early human evolution in this region is a major focus in Palaeolithic archaeology in China. Based on reconstruction of the paleoenvironmental context and analysis of the lithic technology of the eight Lower Pleistocene sites in the Nihewan Basin, this paper has attempted to describe their characteristics. Based on such generalizations and analyses, some conclusions can be proposed here:

1) Lithic techniques and strategies, including procurement of local chert for tool production, a small range of types of lithic artifacts and most tools having simple retouch, demonstrate the similarity in characteristics of lithic artifacts in the Early Pleistocene in China, as well as the simple but practical adaptive strategies of the Early Pleistocene humans in this region. The long duration of occupation and continuity of strategies for survival indicate that humans who lived in this region were well able to adapt to local environment.
2) Based on the analysis of the lithic techniques at the eight sites, three degrees of sophistication of lithic techniques can be summarized. The three degrees of sophistication indicate differences in lithic techniques, cognitive ability and culture tradition at different sites. The artifacts from Donggutuo show progress in Early Palaeolithic techniques; identification and further analysis of the "DGT core" indicates that an "Asian perspective" (Hou et al., 2010; Liu et al., 2012) may play an important role in fully understanding the development of early human lithic techniques.
3) Research on the Early Pleistocene environment in the Nihewan Basin, an important area for discovering evidence for human origins and evolution, suggests the existence of a climate alternating between cold-dry and cold-moist during the Early Pleistocene (Pei et al., 2009). Although further research on the relationship between human evolution and climate change in the area is needed, current related research indicates that prehistoric humans were able to adapt to the local environment. The comparatively advanced lithic culture in the Nihewan Basin indicates that earlier sites than the site dated to the Early Pleistocene, presently considered as the earliest, should exist (Hou, 1999). However, the discovery of earlier sites requires more investment in systematic survey and test excavations.

Acknowledgments

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