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Loessic palaeolith discovery at the Beiyao site, Luoyang, and its implications for understanding the origin of modern humans in Northern China

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ABSTRACT

The excavation at Beiyao Palaeolithic site during 2007–2008 uncovered a number of lithics including 49 cores, 180 flakes, 3 tools and 486 pieces of knapping debris, making a total of 719 artefacts. Research conducted on these finds produced two main points. The first was that a new cultural layer was discovered in the loess layers dating to MIS3–MIS2, in this cultural layer some of the raw material had been transported over considerable distances. The second aspect of this research focused upon the relationship between the temporal distribution of the lithics and the changing climate. Although human activities took place at the site during both cold or warm weather periods, human activities during warm periods were much more intense than in cold periods before MIS3. From MIS3, human activities were obviously intensified during cold periods. This shift may have some relationship with the emergence of modern humans.

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1. Introduction

Since the topic of “modern human revolution” was proposed over 30 years ago, the debate on the origin of modern human has been a focus in international palaeoanthropology and Palaeolithic circles (Cann et al., 1987; Mellars and Stringer, 1989; Mellars et al., 2007). Research on this topic has received more and more attention from East Asia in recent decades (Mellars, 2006; Baker et al., 2007; Habgood and Franklin, 2008). Research has been conducted on artefacts themselves and also has examined paleoanthropological behaviour and even social organization and the symbolism inherent in artefacts (Bar-Yosef, 1998, 2002; McBrearty and Brooks, 2000; Habgood and Franklin, 2008; Stringer, 2011). In China, a basic core-flake technology represents the main artefacts from the lower Palaeolithic through to the upper Palaeolithic (Wu et al., 1989; Zhang, 1990). This makes it difficult to study the transition from the middle Palaeolithic to the upper Palaeolithic using only lithic material. To better resolve this issue, the collection of artefacts other than lithics should be emphasized, such as ecofacts including both bone and plant remains from archaeological sites. This should

allow researchers to explore differences in human behaviours and social organization. In this research process, searching for the archaeological sites including sites where the cultural remains are continuous from the middle Palaeolithic to the upper Palaeolithic is a basic prerequisite.

In September 1998, the Luoyang City Cultural Relics Team excavated a loessic Palaeolithic site at Beiyao village in the northern suburbs of Luoyang (34°42′24″N, 112°28′46″E: southeast quadrant 07T₂) (see Fig. 1). The first researchers considered the stratigraphic chronology to be within the middle to upper Palaeolithic period, between MIS5–MIS3, or 100–30 ka (An et al., 1999; Xia et al., 1999). In 2007–2008 we re-excavated and re-dated this site, revising its chronological range to extend from MIS7 to MIS2 or, in other words, from 200 to 10ka (Du et al., 2011; Liu and Du, 2011). This site suited the above-mentioned research requirements. In addition, loess, due to its advantages in chronology and environmental research, is well suited for making the leap from research on artefacts to understanding human behaviour.

2. Stratigraphic dating of the Beiyao site and the excavation squares distribution

The Beiyao site lies on the Neogene terraces located on the southern banks of the Chan River (Fig. 1), a tributary of the Luo

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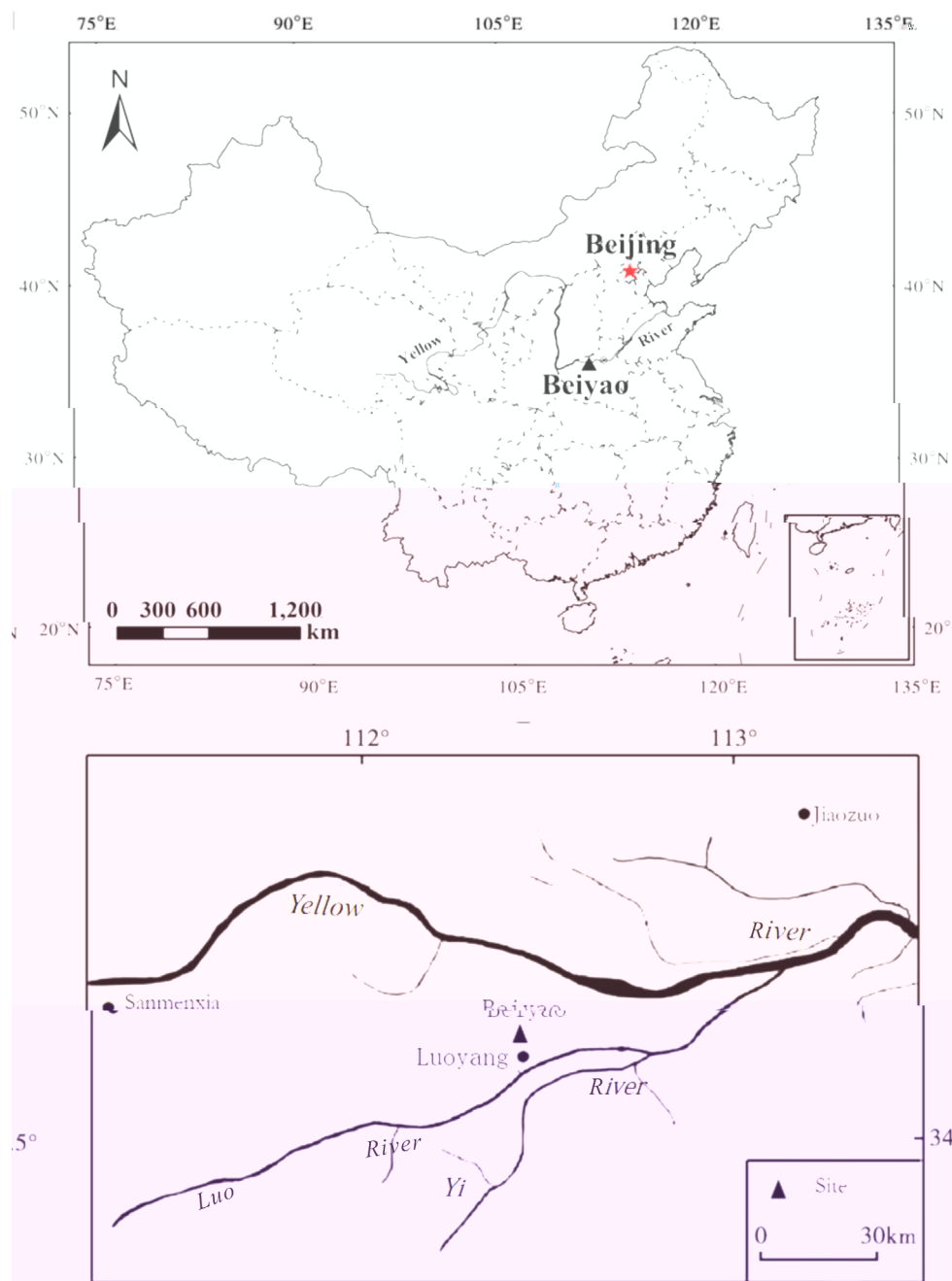


Fig. 1. Geographic location of the Beiyao site, Luoyang.

River which flows into the Yellow River. The ancient site lies more than 20 m above the modern riverbed. The upper strata of the terraces are composed of loess, and the lower strata are fluvial deposits. In 2007, we mapped three excavation squares alongside a large pre-dug pit. Of these, Trench 07T1 was $10\text{ m} \times 10\text{ m} \times 1.3\text{ m}$, and its strata included the complete S_2 soil unit and a part of the L_2 loess unit (see Yang and Ding (2010) for stratigraphic nomenclature of Chinese loess). Post-excavation examinations on loess and pollen samples taken from a 1 m^2 square in the northwestern corner led to our excavating a further 3 m depth. Trench 07T2 was on a steep cliff and was 7 m wide from east to west. Its north–south dimensions were inevitably affected by the steep cliff and were between 8 and 11.5 m; it was 4.2 m deep and its strata included the palaeosol units S_1 – S_2 . Trench 07T3 measured $10\text{ m} \times 10\text{ m} \times 7.6\text{ m}$, with strata from S_0 to S_1 . In 2008 as part of a process to collect more samples

that are equivalent to the L_1 period, we also excavated Trench 08T1. This had dimensions of $7\text{ m} \times 13\text{ m} \times 3.5\text{ m}$, with strata dating above MIS3.

After combining data from the four squares and the natural profiles, the site's strata details from top to bottom were as follows (see Fig. 2):

- (1) A ploughed and disturbed stratum with a thickness of 0.3–0.4 m.
- (2) A reddish-brown palaeosol unit exhibiting a gradual lightening in color from top to bottom with its upper soil layers clearly disturbed and disrupted. It was 0.55–0.65 m thick.
- (3) A light yellow loess layer with a thickness of about 6.4–7 m. Within this were two narrow bands of poorly-developed palaeosol which were able to be subdivided into five small

strata each and which contained a small quantity of stone artifacts.

- 3-1 A loess stratum, with palaeosols containing some calcium carbonate and calcium nodules, and with a thickness of 1.2–1.6 m;
 - 3-2 A palaeosol stratum, with the upper part containing some calcium nodules and its colour become more reddish brown from top to down. It has a fine and dense composition, with this tendency clearly weakening compared with the second stratum. The thickness was 0.8 m.
 - 3-3 A loess unit, with a loose and porous composition, containing calcium carbonate veins and calcium nodules, being 0.9–1.2 m thick;
 - 3-4 A palaeosol, with a fine and dense soil-like composition becoming lumpy, with a clear 20 cm well-developed, and a thickness of 0.8–1 m;
 - 3-5 A loess unit of a fine and dense soil-like composition, light yellow in color, and containing calcium carbonate veins and calcium nodules increasing in frequency toward the bottom. Its thickness was 2.4 m.
- (4) A 2.2 m thick brownish-red palaeosol with numerous stone artefacts.
 - (5) A 2.4 m thick pale yellow loess layer with the lower part containing calcium nodules, and very few stone artefacts.
 - (6) A 2.2 m thick dark grey loess evincing stone artefacts.
 - (7) A 2 m thick dark brownish red palaeosol stratum with scale-shaped soil, black ferromanganese membranes and very few calcium carbonate pseudomycelia and carbonate nodules, evincing a great quantity of stone artefacts.

During the archaeological excavation process, we collected a complete set of sediment samples and OSL samples at 10 cm intervals at Beiyao. Testing results are shown in Fig. 3. According to its stratigraphic characteristics and magnetic susceptibility record and correlation with other profiles representative in the Loess Plateau (Lu et al., 2007; Yang and Ding, 2008, in press; Yang et al., 2012), the age of the Beiyao site is reliably defined.

3. Lithics research

3.1. The relation between vertical distribution of lithics and environmental change

In order to understand the vertical distribution of lithics, we established a main testing point in the southwestern corner of each excavation square. We gathered artefacts correlating to the main testing points. Testing used three-dimensional coordinates.

In 2007–2008, we recovered a total of 719 lithics. Trench 07T1 provided a total of 100 lithics, 99 of which were unearthed from the S₂ stratum, and one from the L₂. Within the total excavation area of 07T2 (56–63 m²), 572 lithics were found, with 492 unearthed from S₂, 9 from L₂ and 71 from S₁. Trench 07T3 had an open area of 100 m²

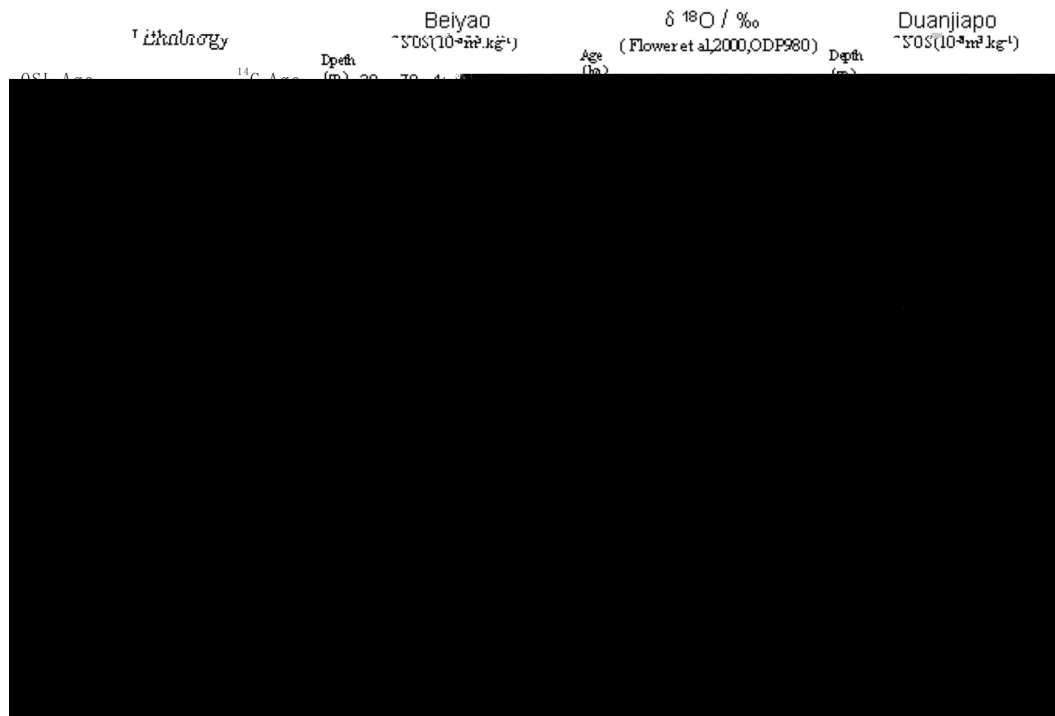


Fig. 3. Comparison of marine oxygen isotope and magnetic susceptibility curves for loess as recorded at the Beiyao site and at the Duanjiapo profile.

The relationship between quantity of lithics and climate change is shown in Fig. 4 and Table 1. Most importantly, lithics were present in both warm and cold periods. Furthermore, the lithics were found in the three peaks and two dips in the curve of Fig. 4. These three peaks correspond with MIS7, MIS5 and MIS3–2 down to MIS2, while the first two peaks correspond with the two warm periods, providing evidence of the relation between climate change and intensity of human activity. Following this line of thought, the final peak on the graph ought to correlate with MIS3, but as can be seen in Fig. 4, the peak clearly extends to a further stage; the MIS3–1 stage with more optimal climatic conditions evinces no lithics, whereas during MIS3–2 and MIS2, a clear increase is shown in lithic quantities. It appears that humans strengthened their adaption to the cold climate after 35 ka. Human adaptations to cold climates likely included the use of lithics to hunt game for food and clothing.

3.2. Lithics features in technology

We analysed the change over time in the lithics at the Beiyao site stratum by stratum. The principal lithic types include cores, flakes, knapping debris, fragments and a few tools (Table 2). We concentrated upon studying the knapping technologies and raw material resources.

3.2.1. Features of lithic raw materials

It can be seen from Table 2 that there were five different raw materials at the Beiyao site, namely quartzite, sandstone, quartz sandstone, quartz, and flint. The first four types of raw material were the ones most used by the Beiyao occupants throughout the MIS7–2 stages, and the single piece of flint discovered was unearthed from MIS2. Our analysis of the lithics showed that a large amount of cortex present on most artefacts including cores, flakes or fragments. Some gravel even existed in the site, indicating these raw materials all came from riverbeds. After investigating the Chan River and the nearby Luo River, we discovered a great abundance of the first four types of raw material on their riverbeds. However, although a large quantity of investigation was conducted on the modern riverbeds of the Chan River and River Luo, no flint was evident. This is perhaps because this type of raw material is in extremely sparse or perhaps because, as a high quality raw material, it was imported to the site. Research on the exact location of the flint raw material source is ongoing.

3.2.2. Lithic production technology

The author have detailed analyses lithic technology unearthed in 1998 (Liu and Du, 2011), and which is very similar to that discussed in this paper. During the excavation from 2007 to 2008, a total of 49

Table 2
The number and frequency of lithic raw materials.

Stage of $\delta^{18}\text{O}$	Loess strata	Quartzite		Sandstone		Quartz sandstone		Quartz		Flint	
		Amount	Percentage	Amount	Percentage	Amount	Percentage	Amount	Percentage	Amount	Percentage
MIS2	L ₁₋₁	3	23.1%	4	30.8%			5	38.5%	1	7.6%
MIS3	L ₁₋₂ –L ₁₋₄					1	25%	3	75%		
MIS4	L ₁₋₅	1									
MIS5	S ₁	33	33%	7	7%	8	8%	52	52%		
MIS6	L ₂	1		1	11.1%	3	33%	5	55.6%		
MIS7	S ₂	283	47.9%	82	13.9%	132	22.3%	94	19.9%		
Total		321	44.5%	94	13.1%	144	20.1%	159	22.2%	1	0.1%

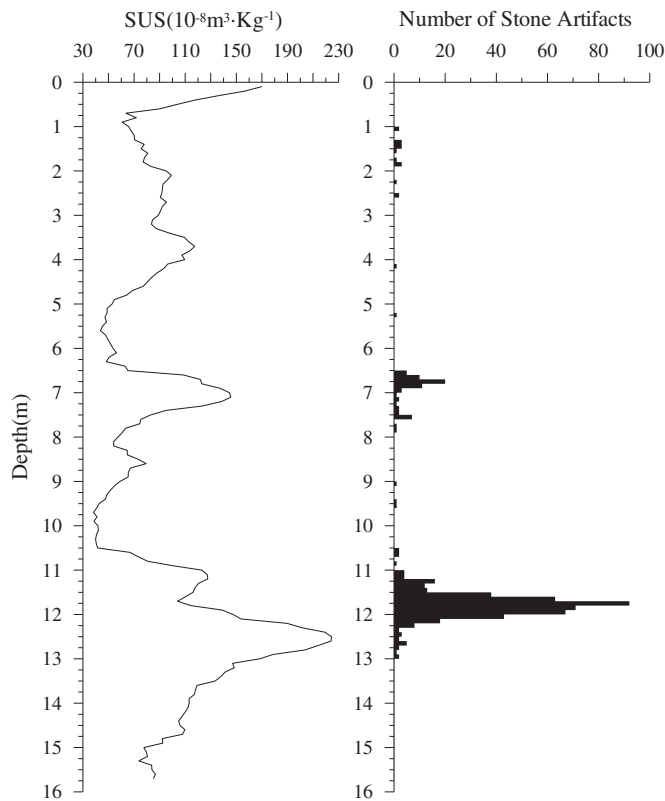


Fig. 4. Vertical distribution of the lithics at the Beiyao site.

cores was unearthed from the Beiyao site (Table 3), including 11 disk-shaped cores, 11 uni-platform cores, 9 bi-platform cores and 18 multi-platform cores. As Fig. 5 shows, samples LB07T₁512:2 and LB07T₁59:5 include a disk-platformed core and a bi-platform core respectively. LB07T₁58:19 and LB08T₁42:2 were multi-platform cores. However, these four types of cores were not prefabricated. Although the disk-shaped cores had a higher flaking rate, they are still considered ordinary cores and occur from the Lower Palaeolithic through to the upper Palaeolithic at many sites in China, including Locality 1 and Locality 15 of the Zhoukoudian site and at the Xujiayao site. These types of cores are more common in the sites dating to the upper Palaeolithic period. The multi-platform cores were found in the three main cultural layers, whereas only one multi-platform core was found in MIS2. Therefore, in terms of cores, the flaking technology at the Beiyao site belongs to the simple core-flake technology, and lithic technology changes between the early and later periods of the sites are not evident. The results of the flakes analysis indicates that, as with the cores, all 179 flakes were recovered from the site were all ordinary flakes, and no blade, microblade or Levallois technology was present.

Assuming that the number of the stone artefacts represents the intensity of human activity, it appears that human activity was more intense in warmer periods than in the cold period before MIS3. However, after MIS3, human activities increased in intensity during the colder period. Assuming that the distance travelled to obtain lithic raw material represents the range of human activity, it appears that human activity was limited to these raw material sources close to the site before MIS3, but after MIS3, the human activity expanded to include a large range. However, both before and after MIS3, there is no apparent change in human flaking technology, and a basic core-flake technology appears to have sufficed.

4. Discussion and conclusion

There are two different theories about the origins of modern Chinese people. Scholars who believe that modern humans arose in Africa suggest that the modern humans could have reached East Asia following two possible routes, one from Africa across the Red Sea into Arabia, then following the coast to South Asia and Southeast Asia before entering Southern Chinese; the second followed a northerly route from West Asia across Europe, entering Russia over the Ural Mountains and travelling through Siberia to reach Northern China (Foley and Lahr, 1997; Stringer, 2000; Bar-Yosef, 2002; Klein, 2008). However, recent researches suggest that people might have migrated from Africa on the southerly route earlier than on the northerly route (Field and Lahr, 2005; Macaulay et al., 2005; Mellars, 2006). Those scholars who hold to the concept of the ‘multiregional origins model’ take the view that modern Chinese people might have continuously evolved from local prehistoric humans and that in this process they might have interbred with peoples from outside their immediate areas (Wu, 1998, 2006a, 2006b). Although these two schools have produced much prehistoric, migratory and archaeological evidence to support their claims, some unavoidable questions still remain.

First of all, the greatest problem with the ‘multiregional origin model’ school of thought is the lack of archaeological artefacts relating to modern humans during the MIS4 stage. It is thus very difficult to establish detailed evidence of either physical evolution or behavioural transformation (Liu, 2006). On the other hand, the archaeological data absence in this era is a confusing issue, because researches undertaken in West Asia, Africa and Europe indicated that there was a marked increase in population as evident by an increase in site quantity, following the emergence of modern humans and the development of new-found powers of technical innovation (Mellars, 2011). If modern humans had already appeared in Northern China by MIS4, then why are there some few archaeological sites? If it is to be proposed that modern humans could not have emerged by this stage, antedating early *Homo sapiens*, why were anatomically modern human Tianyuan cave men

Table 3
The number and frequency of stone artifacts.

Stage of δ ¹⁸ O	Loess strata	Cores				Flakes					
		Discoid cores	Single table cores	Double table cores	Multi-table table cores	I	II	III	IV	V	VI
MIS2	Upper of L ₁				1	1		1			2
MIS3	Middle of L ₁										1
MIS4	Lower of L ₁										
MIS5	S ₁	2			1	1	1	4		1	4
MIS6	L ₂				2	1					1
MIS7	S ₂	9	11	9	14	6	17	49	4	49	36
Total		11	11	9	18	9	18	54	4	50	44

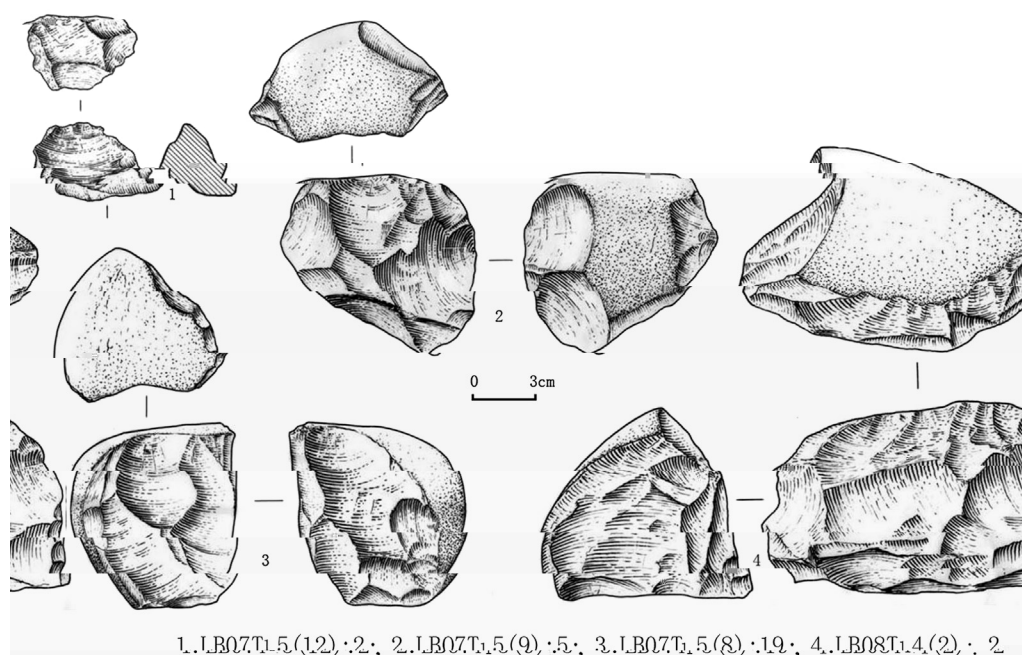


Fig. 5. Cores excavated at the Beiyao site.

already present 35–41 ka (Shang et al., 2007)? This being the case, what could have caused early *H. sapiens* to evolve into the modern humans over such a short period?

In addition, there remains the matter of the environment. The summer monsoon rainfall belt advanced northward in interglacials and retreated southward during glacial periods (Yang and Ding, 2008). As the MIS4 period happened to be cold, it is easy to assume that human activity might have been restricted. However, if this was the case, over a long period in Northern China, human activity fluctuated with, and matched, cold periods and their interregna. The realities of considering the origins of modern human lead inexorably to the question of how the early *H. sapiens* evolved into the late *H. sapiens*. The earliest approximate records of early *H. sapiens* in Northern China are those of Jinniushan Man from Yingkou in Liaoning and Dali Man from Shaanxi: their ages are around 200ka (Lu, 1985; Yin et al., 1999, 2001). Accordingly, we have aimed to establish a pattern in the development of Palaeolithic cultures in Northern China after 200 ka in order to investigate the relationship between the environment and Palaeolithic cultures in North China.

Furthermore, it is incumbent upon the scholars who support the 'African origins' theory to explain the issue of lengthy developmental process of the Palaeolithic cultures in China. Currently, it has been widely accepted by academic circles that there was a continuous dominance of simple core-flake technology around 30 ka (Wu et al., 1989; Zhang, 1990). Only in the northern regions of Northern China such as Xinjiang, Inner Mongolia, Ningxia, Jilin and Heilongjiang, have sites been discovered post-dating 30 ka which used blade technology (Du, 2007). In other words, even if modern humans originated in Africa, they entered China from both the north and the south. However, if one looks at Palaeolithic technology models, why does the new lithic culture only occur in a minority of areas in Northern China? How is it that the majority of areas in Northern China and all of Southern China evince no technological developments?

To summarise, we can come to some preliminary understanding of the puzzle in the origins of modern Chinese people using the archaeological materials excavated at the Beiyao site. Firstly, as

shown from the relationship between the loess magnetic susceptibility curve and the change in numbers of lithics in Fig. 4, lithics were present in both warm and cold periods over a 200,000 year period. This indicates that human activity in Northern China was of a continuous nature but with marked differences in the intensity of human activities in warm and cold periods. There is a superabundance of lithics from the MIS7 and MIS5 stages, but very few from MIS6 and MIS4. If the number of lithics may be used to accurately reflect the intensity of the human activities, this indicates human activity was extremely restricted in cold periods. During the Ice Age glaciations, the centre of human activity moved south with very little human activity in the north. In warm periods, human activity moved north and the number of sites found in the north increased. So, for a long time northern China has evinced a paucity of records from the crucial MIS4 stage, most likely as a result of its monsoonal climate at the time.

Following archaeological discoveries in South East Asia and Southern China in recent years, the emergence of modern humans in these areas must have occurred somewhat earlier than commonly believed. The dating of some human fossils places them even earlier in the MIS4 period. After further work in 2000 on the 'Deep Skull' modern human fossil discovered in the Niah Caves in Malaysia, dating of the human fossil gave a date earlier than 46 ka (Baker et al., 2007). Lithics excavated at the Kota Tampan site on the Malaysian Peninsula have from the beginning been considered to be the products of early modern humans and have been dated to 74 ka (Majid, 2003). Some consider the date of the famous Liujiang human fossils as shown through U-system testing to be 67 ka or even as old as 70 ka (Yuan et al., 1986; Wang and Shen, 2004). In 2003, human fossils and ivory engravings from 15 to 12 ka were excavated from the Xinglong Caves in the Sanxia district (Wu et al., 2006). In 2006, five tooth fossils belonging to late *H. sapiens* (103–44 ka) were discovered in the Huanglong Caves in Yunxi, Hubei Province, and it is highly unlikely that these are any younger than 50 ka (Gao et al., 2003). In 2009, human lower jaw fossils were discovered at Chongzuo in Guangxi Province which already exhibited some anatomical features of modern human: these have been dated to 100 ka (Liu et al., 2010).

Consequently, if we assume that, before the late stage of MIS3, modern humans lived in Southern China or the more southerly parts of South East Asia and that, from the later stage of MIS3, they expanded northwards, we can much more easily understand why there is an absence of any record of human activity in Northern China during MIS4. This may also explain why the number of sites in Northern China increased from around 35 ka onward.

In addition, considering the Beiyao site, although there appears to be no evolution in core-flake technology from MIS7 to MIS2, human behaviour does evince some changes in the following two ways. In terms of the human adaption to colder climates, although the MIS3 and MIS2 periods experienced fluctuations in the climate, the relationship between the numbers of lithics and the environment is dissimilar from pre-MIS3 times. Nonetheless, there are subtle changes over this period. During MIS3-MIS2, the climate before 35 ka was more optimal, although the distributions of lithics were fewer early in this time period. If the numbers of lithics discovered at Beiyao are insufficient for delineating the relative strength and/or weakness of human activity, then the research on the chronology of the Palaeolithic sites in Northern China after 50 ka pointed out that the number of Palaeolithic sites dated post-35 ka far outnumber those from the 50–35 ka period (Du, 2007).

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- Yang, S., Ding, Z., 2010. Drastic climatic shift at 2.8 Ma as recorded in eolian deposits of China and its implications for redefining the Pliocene–Pleistocene boundary. *Quaternary International* 219, 37–44.
- Yang, S., Ding, Z., 2014. A 249 kyr stack of eight loess grain size records from northern China documenting millennial-scale climate variability. *Geochemistry, Geophysics, Geosystems* 15, 798–814.
- Yang, S., Ding, Z., Wang, X., Tang, Z., Gu, Z.Y., 2012. Negative $\delta^{18}\text{O}$ – $\delta^{13}\text{C}$ relationship of pedogenic carbonate from northern China indicates a strong response of C3/C4 biomass to the seasonality of Asian monsoon precipitation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 317–318, 32–40.
- Yin, G.M., Sun, Y.J., Ye, Y.G., Liu, W., 2001. The ESR age of shells from the bed of Dali with human fossil. *Acta Anthropologica Sinica* 20, 34–38 (in Chinese).
- Yin, G.M., Zhao, H., Lu, Y.C., Liu, W., Chen, J., Sun, Y.J., 1999. Geological data of the upper age limits of Dali Man fossil horizons. *Quaternary Sciences* 18, 93 (in Chinese).
- Yuan, S.X., Chen, T.M., Gao, S.J., 1986. Uranium series chronological sequence of some Palaeolithic sites in south China. *Acta Anthropologica Sinica* 5, 179–190 (in Chinese).
- Zhang, S.S., 1990. Regional technological gradual advance and cultural exchange of Palaeolithic in north China. *Acta Anthropologica Sinica* 9, 322–333 (in Chinese).