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New evidence of a lithic assemblage containing *in situ* Late Pleistocene bifaces from the Houfang site in the Hanshui River Valley, Central China

Nouvelle preuve d'assemblage lithique du Pléistocène supérieur contenant des bifaces in situ *: le site de Houfang dans la vallée de la rivière de Hanshui en Chine centrale*

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ABSTRACT

As few lithic assemblages containing *in situ* bifaces in China have been dated to over 600 ka and few industries with the association of *in situ* bifaces and reliable Late Pleistocene dates have been formally reported, the nature and evolution of Chinese industries with bifaces remained unclear for a long time. The Houfang site, deposited in the Aeolian soils of the second terrace of the Hanshui River, Central China, yielded 162 stone artifacts including 2 typical bifaces in stratigraphic context. TT-OSL dating indicated that the sediments containing bifaces were deposited between 110 and 90 ka B.P. Preliminary technological analysis suggested that the percentage of bifaces in this assemblage is much lower (< 3%) than in the Acheulean complex and that the operative schemes for producing typical bifaces are totally different from those of Acheulean implements. So, on the one hand, it provides new evidence for questioning the validity of the "Movius Line" *sensu stricto* and, on the other hand, it serves as an important marker for investigating the technological evolution and possible cultural affiliation within East Asia and casts new light on the technological specificity and continuity in East Asia and on the main cultural differences between this area and the Old World Acheulean Complex.

RÉSUMÉ

La nature et l'évolution des industries lithiques à bifaces de Chine est restée confuse pendant longtemps, du fait que le peu d'assemblages contenant des bifaces *in situ* en Chine ont été datés à plus de 600 000 ans et que peu de séries attribuées au Pléistocène supérieur ont été publiées. Le site de Houfang, déposé dans les sédiments éoliens de la deuxième terrasse fluviatile de la rivière de Hanshui en Chine centrale, a livré 162 artefacts lithiques incluant deux bifaces typiques en stratigraphie. Les datations TT-OSL indiquent que les sédiments

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contenant les bifaces se sont déposés entre 110 000 et 90 000 ans B.P. L'analyse technologique préliminaire que nous avons effectuée suggère que le pourcentage des bifaces dans cet assemblage est plus bas (< 3 %) que celui attendu dans un complexe acheuléen et que les schémas opératoires de production des bifaces typiques sont totalement différents de ceux des outils acheuléens. Donc, le site de Houfang fournit, d'une part, de nouveaux éléments pour remettre en question la validité de la « ligne de Movius » *sensu stricto*, et sert, d'autre part, d'élément clé pour explorer l'évolution technologique et la possibilité d'une affiliation culturelle en Asie de l'Est. Il peut mettre en lumière la particularité technologique et la continuité en Asie de l'Est ainsi que la différence culturelle essentielle de cette région par rapport au complexe acheuléen de l'Ancien Monde.

1. Introduction

Since the proposal and definition of the "Movius Line" (Movius, 1949; Swartz, 1980), the presence or absence of bifaces in China, their relationship with the Acheulean industries of Europe and Africa, as well as the nature and characteristics of Chinese Paleolithic cultures have been hotly debated. At present, the existence of bifaces in Chinese Paleolithic is beyond question in light of their discovery in several site complexes including Bose Basin (Hou et al., 2000; W. Wang, 2005; Wang et al., 2008; W. Wang et al., 2014), Luonan Basin (S.J. Wang, 2005, 2007; Wang et al., 2005, 2011), Lantian area (Wang et al., 2014a, b), Hanshui River Valley (Li, 1998; Li et al., 2009) and the Danjiang River Valley (Pei et al., 2015; Wang and Hu, 2000; Wang et al., 2013). However, most of the lithic assemblages containing bifaces were surface finds and very few sites yielded bifaces in a primary stratigraphic dated context. These include Fengshudao (Wang, 2005b; W. Wang et al., 2014), Damei Nanbanshan (Wang et al., 2008), Shuangshu (Li et al., 2011, 2014b), Liangshan Longgangsi (Sun et al., 2012), Dishuiyan (Liu and Feng, 2014), Ganyu and Jijiawan (Wang et al., 2014a, b), Maling 2A (Pei et al., 2015). As reported, most of these sites were dated to over 600 ka (late Early Pleistocene to early Middle Pleistocene). Apart from Dishuiyan (Liu and Feng, 2014), Maling 2A (Pei et al., 2015) and several localities in the Lantian area (Wang et al., 2014a, b), few lithic industries with *in situ* bifaces and reliable Late Pleistocene dates have been formally reported. In view of this, the newly discovered Houfang site from the Hanshui River Valley which has yielded a lithic assemblage containing *in situ* bifaces dated to the early Late Pleistocene, provides new well-documented evidence of late occurrences of bifaces and will contribute greatly to our understanding of the nature and evolution of lithic assemblages containing bifaces in China and East Asia.

2. Geological background and stratigraphy

The Houfang site (32°48′ 32″ N, 110°35′ 4″ E) is located in Wangjiashan Village, Qingqu Town, 20 km west of Yunxian County of Hubei Province, 1.5 km south of *Yunxian Man* site, and 184 m above sea level (Fig. 1). The site was discovered in 1994 during the surveys undertaken by IVPP (Li, 1998). The rescue excavation was carried out by a team comprised of Wuhan University, Nanjing University and Yunxian Museum of Hubei Province from October to November in 2010, exposing an area of 400 m^2. The excavation zone was divided into two parts (zone I and II), comprised of a 10 m × 10 m grid (IT1), a 5 m × 20 m grid (IT2) and two 10 m × 10 m grids (IIT1 and IIT2).

The Houfang site is situated in Yunxian Basin, on the left bank of the upper reaches of Hanshui River. The geological formation of this region is mainly Paleozoic metamorphic rock series, covered by Tertiary red rock series near Yunxian County (Shen, 1956). Four Pleistocene terraces are located along the valley near the site, closely related to the uplift of the Qinghai-Tibet Plateau and the development of the Hanshui River. These four terraces, numbered 1, 2, 3, 4 from bottom to top, are respectively situated 10 m, 25 m, 40 m and 50 m above the old river level. Apart from the first terrace, the fluvial gravel bed and coarse fluvial sands underlie Aeolian soils varying in thickness: 2–10 m on the second terrace, 1–5 m on the third and 20 m on the fourth terrace. On the fourth terrace, in particular, the loess–paleosol sequences are very clear, enabling the identification of 5–6 paleosol layers. The Houfang site stone artifacts were buried in the Aeolian soils of the second terrace.

Six layers were identified from top to bottom and stone artifacts were unearthed respectively in Layers 2 and 3. The stratigraphic sequence of the Houfang site is as follows (Fig. 2):

- a gray-brown layer, made up of loose silty-sandy clay, containing sporadic gravels and modern cultural relics, 0.1–0.85 m in thickness;
- compact yellow-brown clay, with vertical joint structure, ferrimanganic mottling, adhesive film and crumb structure, containing some wormholes and plant root holes, 1.5 m thick, containing 89 stone artifacts including bifaces and picks;
- variegated and relatively compact bluish-grey clay, with very fine reticulate texture. This layer is mainly distributed in excavation zone IT2, and partly extends into IT1. The sediments are much thicker in the northwest than in the southeast, the central part is concave, with an average thickness of 0.8 m, bearing 73 stone artifacts;
- relatively compact dark yellow-brown sandy clay, with ferrimanganic mottling, adhesive film and a few wormholes and plant root holes, 1.8 m in thickness, with a transitional contact with the layer above;
- very fine brown sandy silt, solidifying after drying, very widely distributed, > 4 m in thickness;

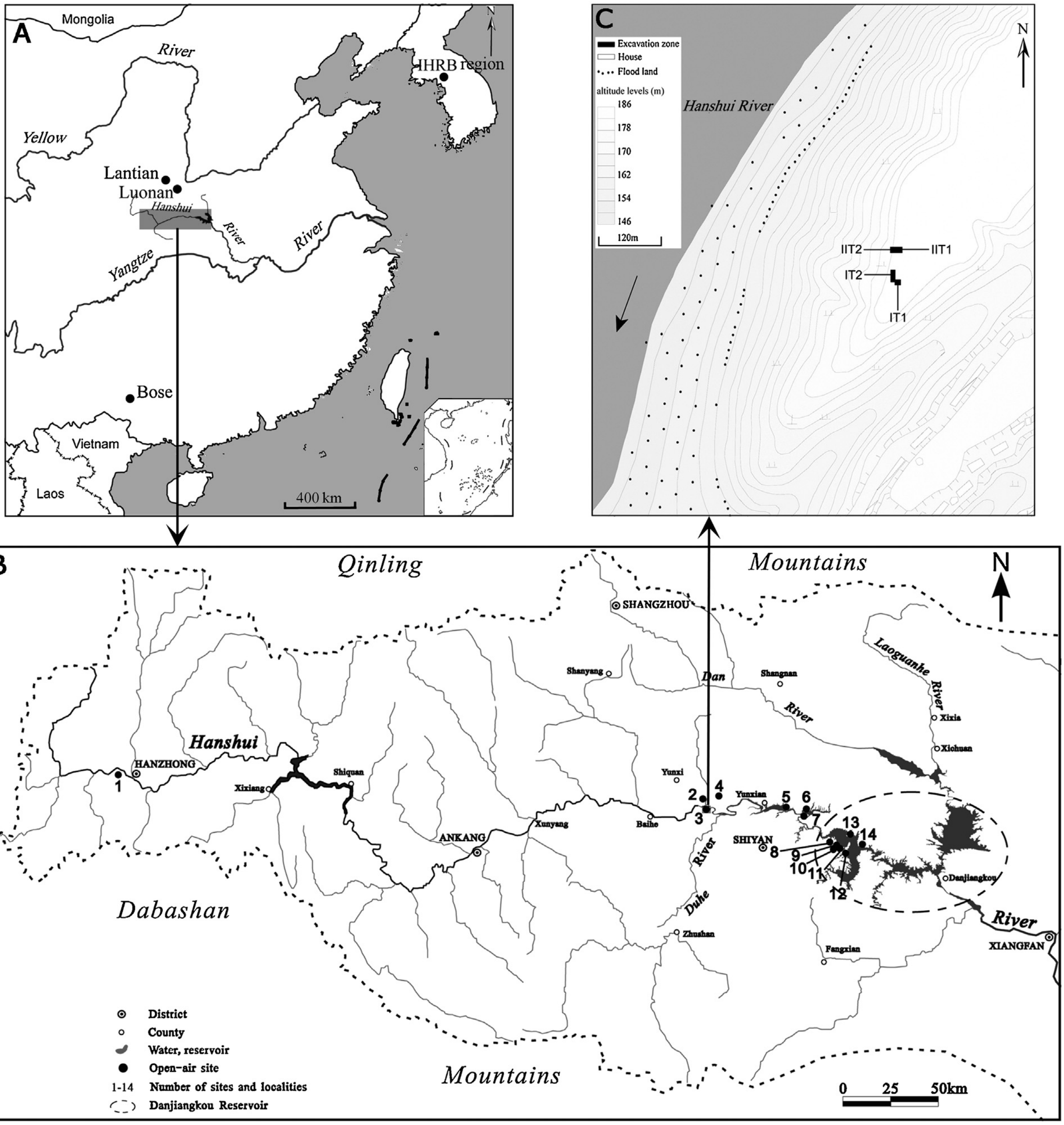

Fig. 1. A. Location of the Hanshui River and site complexes yielding bifaces in China and South Korea. B. Location of major Paleolithic sites yielding bifaces *in situ* in the Hanshui River Valley. 1. Liangshan Longgangsi; 2. Quyuanhekou; 3. Houfang; 4. Dishuiyan; 5. Liuwan; 6. Yuzui-2; 7. Jiantanping; 8. Beitaishanmiao-2; 9. Shuiniuwa; 10. Dudian; 11. Shuangshu; 12. Waibiangou and Datubaozi; 13. Guochachang-II; 14. Longkou. C. Study area showing excavation zone of the Houfang site.

Fig. 1. A. Localisation de la rivière de Hanshui et complexes de sites ayant livré des bifaces en Chine et Corée du Sud. B. Localisation des principaux sites paléolithiques ayant livré des bifaces *in situ* dans la vallée de la rivière de Hanshui. 1 : Liangshan Longgangsi ; 2 : Quyuanhekou ; 3 : Houfang ; 4 : Dishuiyan ; 5 : Liuwan ; 6 : Yuzui-2 ; 7 : Jiantanping ; 8 : Beitaishanmiao-2 ; 9 : Shuiniuwa ; 10 : Dudian ; 11 : Shuangshu ; 12 : Waibiangou and Datubaozi ; 13 : Guochachang-II ; 14 : Longkou. C. Zone d'étude montrant les zones de fouille du site de Houfang.

- brown gravel bed, > 4 m thick, containing lots of well-rounded poorly sorted pebbles, composed of quartz sandstone, siltstone, quartz, sandstone, arkose, andesite, gabbro, gneiss and granite. Pebble sizes vary from 3 cm to more than 30 cm.

3. Dating analysis

As the sediments of the Houfang site did not yield suitable dating materials for radiocarbon and U-series analysis, we used thermally transferred optically stimulated

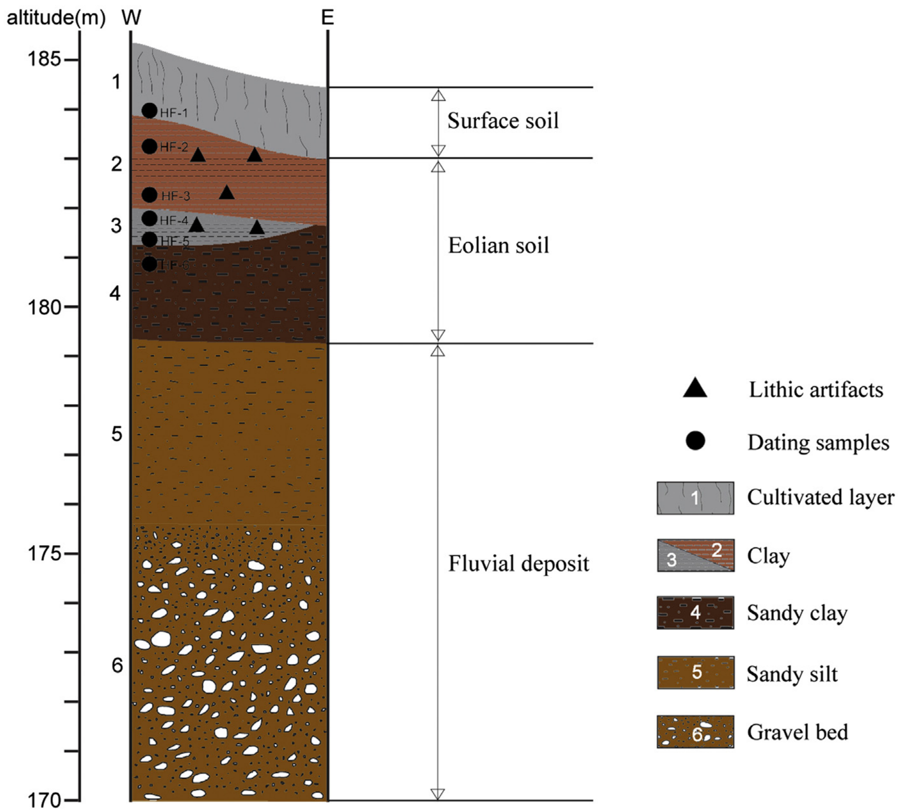

Fig. 2. (Color online). Stratigraphy and TT-OSL dating samples of the Houfang site.

Fig. 2. (Couleur en ligne). Stratigraphie et localisation des prélèvements pour datation par TT-OSL des échantillons du site de Houfang.

luminescence (TT-OSL) technique for dating of quartz. This technique was first used by Wang (Wang et al., 2006a, b, 2007) then several modifications to the SAR TT-OSL protocol were proposed to solve some problems with the use of this technique (Adamiec et al., 2010; Porat et al., 2009; Stevens et al., 2009; Tsukamoto et al., 2008). It has been proven efficient in some sites (Sun et al., 2010, 2012, 2013), indicating that it may be suitable for the samples younger than 300 ka and older than 100 ka, which is out of the range of optically stimulated luminescence (OSL). According to data of this area, we deduced that the age of Hominin activity in Houfang site would be out of the range of OSL method, so we attempted to apply TT-OSL method to date the layers yielding stone artifacts in the Houfang site.

A total of 6 samples were collected. HF-1 was taken on the bottom of Layer 1; HF-2 and HF-3 were sampled on the top and bottom of Layer 2; HF-4 and HF-5 were collected in upper parts and on the bottom of Layer 3; HF-6 was extracted from upper parts of Layer 4. The preparation and measurements of samples were all carried out in Luminescence Dating Laboratory of Nanjing University. According to the results, the ages were consistent as a whole from top to bottom except an inversion between HF-4 and HF-5 (Table 1). This inversion would result from hydatogenesis of Layer 3 which was composed of bluish grey clay. In general, for the archaeological layers yielding stone artifacts, the Layer 2 containing bifaces was dated to 110–90 ka and Layer 3 should be younger than 180 ka.

In addition to chronometric analysis, geomorphologic investigation was also conducted around the site. In the upper reaches of the Hanshui River (from Shiquan to Danjiangkou city), about four fluvial terraces were identified and are comparable between the different regions (Shen, 1956). The four terraces at Quyuanhekou (near *Yuanxian Man* site), very close to the Houfang site, can serve as a reference.

Geomorphologic and sedimentologic analysis revealed that the craniums and lithic artifacts of *Yunxian Man* were buried in the fourth terrace, the surface of which is 200 m above sea level and 50 m above the old river level. According to paleomagnetic and ESR dating, the sediments of *Yunxian Man* site were deposited during 830–870 ka (Yan, 1993), 984–780 ka (de Lumley and Li, 2008) or 581 ± 93 ka (Chen et al., 1997). The fourth terrace can thus be attributed to the late Early Pleistocene and early Middle Pleistocene. The Houfang site was buried in the second terrace, the surface of which is 185 m above sea level with a gravel bed 170–175 m above sea level. The altitude of all the stone artifacts ranges between 180 and 185 m. Thus, it can be inferred that the Houfang site would have been formed from the late Middle Pleistocene to early Late Pleistocene, which corresponds well to the dating results.

Table 1
TT-OSL dating and ages for sediments yielding stone artifacts in the Houfang site.
Tableau 1
Données et résultats des datations TT-OSL des sédiments ayant livré des artefacts lithiques dans le site de Houfang.

Sample N°	Depth (m)	Layer	^{238}U(ppm)	^{232}Th (ppm)	^{40}K (%)	Water content (%)	Dose rate (Gy/ka)	D_e (Gy)	Age (ka)
HF-1	0.3	Bottom of 1	3.11 ± 0.11	14.9 ± 0.40	2.09 ± 0.06	15	3.70 ± 0.18	316.0 ± 25.7	85.3 ± 8.3
HF-2	0.9	Top of 2	2.67 ± 0.10	14.6 ± 0.39	1.99 ± 0.06	15	3.43 ± 0.17	317.9 ± 40.2	92.6 ± 12.7
HF-3	2.0	Bottom of 2	2.76 ± 0.10	14.3 ± 0.37	1.87 ± 0.06	15	3.29 ± 0.25	374.8 ± 25.9	114.0 ± 11.7
HF-4	2.6	Upper parts of 3	2.61 ± 0.10	14.6 ± 0.39	2.04 ± 0.06	15	3.43 ± 0.17	512.3 ± 17.0	149.2 ± 9.4
HF-5	3.1	Bottom of 3	2.61 ± 0.10	14.1 ± 0.39	1.75 ± 0.06	15	3.13 ± 0.16	417.2 ± 22.6	133.4 ± 10.2
HF-6	4.0	Upper parts of 4	2.79 ± 0.10	13.9 ± 0.36	1.86 ± 0.06	15	3.27 ± 0.23	607.2 ± 37.7	185.5 ± 17.3

4. Lithic technology

A total of 162 stone artifacts were unearthed, including 89 pieces from Layer 2 and 73 pieces from Layer 3. Most of the artifacts display relatively sharp and fresh edges, showing little weathering or transformation by natural elements. Two pieces were refitted, indicating the *in situ* deposition of this lithic assemblage. The raw materials were exclusively water-rounded cobbles, locally available from ancient riverbeds located on the bottom of the second Hanshui River terrace. Most of the raw materials are quartz, representing more than 70% of the whole assemblage. Among the other raw materials, quartz sandstone and siltstone were the most abundant, accounting for 10% and 7% of the assemblage respectively. Quartz siltstone, arkose and sandstone were also used, but in very low proportions, cumulatively representing 10% of the whole assemblage. Only six pieces (3%) were in other materials, such as andesite, granite, acidic gneiss and gabbro.

The Houfang site lithic assemblage is mainly comprised of cores, flakes, retouched tools (e.g., scrapers, awls, denticulates), bifaces, picks, choppers, hammers, hammer-anvils, chunks, fragments and unworked cobbles (Tables 2, 3). The knapping technique was exclusively direct percussion with a hard hammer.

In general, two knapping concepts are present; débitage and façonnage. Both of them coexisted in Layers 2 and 3 (Li et al., 2014a, b, c). In Layer 3, two types of débitage were identified; one was Type F-bipolar débitage on an anvil, and the other was Type C-orthogonal débitage (Boëda, 2013). For Type F-bipolar débitage on an anvil, the operative scheme consisted in selecting ovoid quartz cobbles as cores and then resting them on an anvil and striking them with a hammer stone. In ideal conditions this would produce regular "orange segments", but in most cases it would produce several irregular pieces such as orange segments, chips, flakes or other fragments. Some products obtained in this way could be retouched or used immediately. A few orange segments were selected as Type C cores, relatively small in size (Table 4). Once the striking platform was formed on one end of orange segments (i.e. a flat surface created occasionally or intentionally), Type C débitage would be undertaken along the morphological axis of the core, unidirectionally and by taking advantage of the lateral convexity formed by prominent crests, which were created by the intersection of flat surfaces on the débitage surface. After removing the first débitage series (including three/four unipolar flakes), another part of this core was exploited, corresponding to the second débitage series. As for façonnage (shaping), only one atypical unifacially-knapped implement was identified but the operation failed due to the presence of fissures.

In Layer 2, two types of débitage were identified; Type F-bipolar débitage on anvil, and Type C-orthogonal débitage (Boëda, 2013). For Type F-bipolar débitage on anvil, the operative scheme consisted in selecting a long and relatively oblate cobble as a core, then resting it on an anvil and knapping it with a hammer stone. Nearly all the products obtained in this way were hemi-cobbles. These products are apparently different from those obtained in Layer 3, mainly due to the fact that the shape of the selected cobbles was different. For Type C-orthogonal débitage, the cores from this layer are apparently larger in size than those obtained in Layer 3 (Table 4). The operative scheme consisted in selecting cobbles with a roughly quadrangular transversal section providing natural lateral convexity for subsequent débitage series. First, one or two flakes were removed from a natural platform, creating relatively flat scars which served as a platform for the second series. In the second series, several flakes were removed in a unipolar direction. The third or fourth series were then produced in a unipolar direction, either from the negative of the second series or from a natural flat surface. Each series comprised fewer than four expedient flakes and each core contained no more than four débitage series. As for façonnage, a total of eight tools were identified. The raw materials are exclusively non-quartz, namely siltstone and quartz sandstone. All of them are large in size with visible differences between techno-types (Table 5). Four operative schemes were identified, including operative Scheme 1 ($n = 4$, on a simple bevel matrix), operative Scheme 3 ($n = 1$, bifacially knapped, with a convergent cutting-edge on the distal part and an approximately inverted triangular transversal section on the mesial part), operative Scheme 4 ($n = 2$, bifacially knapped, with a convergent cutting edge on the distal part and a biplan/biplan transversal section on the mesial and distal parts) (Figs. 3, 4), operative Scheme 7 ($n = 1$, bifacially knapped, with an irregularly trapezoidal transversal section on the mesial part, an oblique triangular transversal section on the distal part and an irregularly long triangular profile on the sagittal view) (see Li et al., 2014c for definition and numbering of different operative schemes

Table 2
Composition of the assemblages in Layers 2 and 3 of Houfang: débitage products (cores, flakes) and shaped tools.
Tableau 2
Composition des assemblages des couches 2 et 3 du site de Houfang : éléments du débitage (nucléus, éclats) et outils façonnés.

Layer	Débitage							Façonnage					Total
	Type F-Bipolar débitage on anvil					Type C-Unipolar débitage		Bifacial pieces			Unifacial pieces	Other products	
	Orange segments	Chips	Flakes	Half cobbles	Probable bipolar products	Cores	Flakes	Typical bifaces (OS 4)	Bifaces with back (OS 7)	Picks (OS 3)	Choppers (OS 1)	Flakes of façonnage	
2	1			12		6 (2)	3 (1)	2	1	1	4	6 (4)	36
3	8 (3)	3 (1)	8 (3)		7 (1)	2	8 (4)				1		37

The number in parenthesis means the quantity of retouched tools, which were accomplished on such type of blanks. "OS" is the abbreviation of "operative scheme".

Table 3
Frequencies for hammers, chunks, fragments and unworked cobbles.
Tableau 3
Fréquence des percuteurs, blocs fracturés et galets non taillés.

Layer	Hammer stone	Hammer/anvil	Chunks	Fragments	Flakes cracked from the hammer	Unworked cobbles	Total
2	4	1	5 (2)	16 (1)	1	26	53
3	1		4	22 (3)		9	36

The number in parenthesis represents the quantity of retouched tools which were accomplished on such type of blanks.

Table 4
Average size for products of Type-F bipolar débitage on anvil, cores and flakes of Type C and unworked cobbles from Layers 2 and 3.
Tableau 4
Taille moyenne des produits de type débitage bipolaire F sur enclume, nucléus et éclats de type C et galets non taillés provenant des couches 2 and 3.

		Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
Layer 2	Products of Type-F bipolar débitage on anvil ($n=13$)	88	62	49	371
	Cores of Type C ($n=6$)	91	78	64	662
	Flakes of Type C ($n=3$)	40	38	12	19
	Unworked cobbles ($n=26$)	107	84	58	877
Layer 3	Products of Type-F bipolar débitage on anvil ($n=26$)	44	32	19	32
	Cores of Type C ($n=2$)	43	46	30	84
	Flakes of Type C ($n=8$)	47	60	22	78
	Unworked cobbles ($n=9$)	83	61	42	360

Table 5
Descriptive data for shaped tools unearthed from Layer 2.
Tableau 5
Données descriptives des outils façonnés provenant de la couche 2.

Operative Scheme	Number	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
1 (Chopper)	2010YHIT2②: 34	105	87	64	757
	2010YHIT1②: 12	151	119	57	1221
	2010YHIT1②: 25	146	95	67	1121
	2010YHIT1②: 16	110	119	51	980
3 (Pick)	2010YHIT1②: 14	177	87	54	910
4 (Bifaces)	2010YHIT1②: 15	144	91	63	622
	2010YHIIT1②: 50	132	82	59	580
7 (Biface with back)	2010YHIT1②: 8	168	97	75	1350

of façonnage). These operative schemes and corresponding techno-types were revealed by our techno-functional analysis as follows:

Operative Scheme 1 was used to obtain choppers ($n=4$), which were manufactured on cobbles with irregular quadrangular transversal sections on the mesial part. Most of the surface is cortical and one surface is always naturally flat to serve as a striking platform during production. Knapping was concentrated on the other surface, creating a single-wedged profile in sagittal view.

Operative Scheme 3 was used to produce a pick ($n=1$) through bifacial knapping but the two surfaces are not symmetric. On one surface, a series of removals were intentionally produced to form a flat surface, which served as a basic platform to finish the technical characteristics of a cutting-edge. The pick presents an approximately triangular (convex/plan) transversal section on the mesial part and a regularly triangular section on the point and bears a single-wedged profile in sagittal view.

Operative Scheme 4 was applied to produce typical bifaces ($n=2$), through symmetrical bifacial shaping (Figs. 3, 4). Both of the specimens are thick, with a width/thickness ratio of approximately 1.4. Nearly 1/3 of the surface is cortical and the butt for holding is always natural. After a series of bifacial shaping, the final tools present a double-wedged transversal section in the mesial part and a biplan/biplan (irregular double-wedged) transversal section on the cutting-edge part with a double-wedged profile in sagittal view. Both of the specimens present a convergent outline on the point (later broken) and two independent cutting-edges in the mesial part.

According to our technological observation on a regional scale, operative Schemes 2, 5 and 6 were not identified in the Houfang site but in other sites of the Hanshui River Valley (see Li et al., 2014a, b, c).

Operative Scheme 7 was used to obtain a backed biface ($n=1$), which represents a bifacial shaping product but forms an irregularly trapezoidal transversal section in the mesial part and a triangular transversal section on the point and bears an irregularly long triangular profile in sagittal view.

Formal tools were also identified, retouched on bipolar products ($n=8$), unipolar flakes and cores ($n=7$), chunks ($n=2$), fragments ($n=4$) and flakes derived from the production of shaped tools ($n=4$). These tools include scrapers, awls and denticulates. The retouch of these tools was usually simple. A number of unworked cobbles (26 from Layer 2 and 9 from Layer 3) were also found in stratigraphy associated with other stone artifacts. The average size of cobbles from Layer 2 is clearly larger than that of cobbles from Layer 3 (Table 4). The raw materials of these cobbles are comparable to those used for cores and tools. In view of the nature

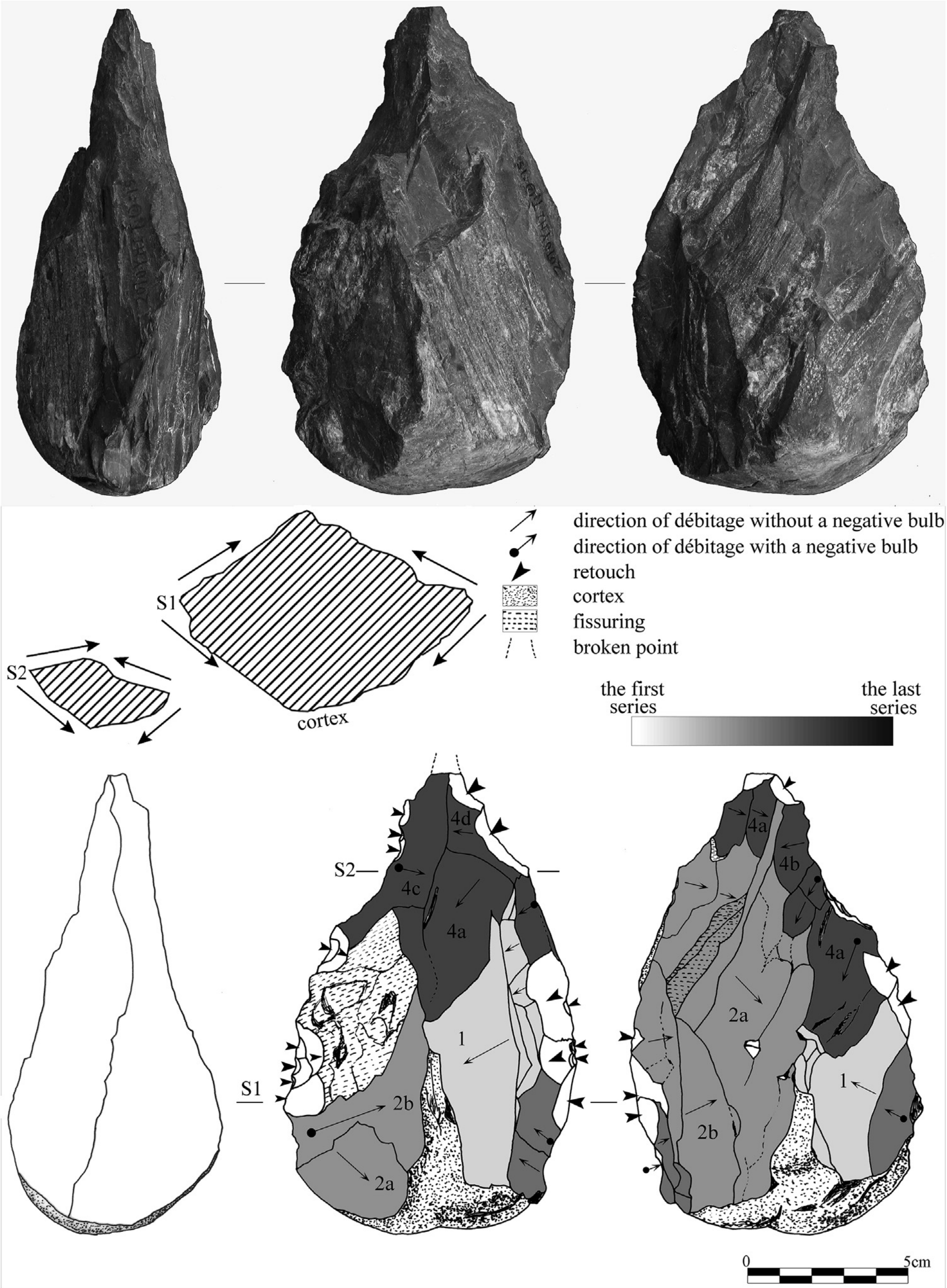

Fig. 3. Photograph and diacritic diagram of a typical biface from Layer 2 of the Houfang site (2010YHIT1② : 15). S1: transversal section of mesial part; S2: transversal section of distal part.

Fig. 3. Photographie et schéma diacritique du biface typique de la Couche 2 du site de Houfang (2010YHIT1② : 15). S1 : section transversale de la partie mésiale ; S2 : section transversale de l'extrémité distale.

of the deposits (Aeolian soils), these cobbles would have been transported by hominids from ancient gravel beds to the site.

In general, the type C-orthogonal débitage and type F-bipolar débitage on anvil were both applied in Layers 2 and 3, albeit in different proportions, whereas façonnage was largely present in Layer 2 and nearly absent in Layer 3. In terms of concept and method, a salient feature concerning the knapping process was perceived not only for débitage but also for façonnage. It is clear that the knapper did not spend much time initiating raw materials but invested more time and effort into cobble selection before the operation. The selected cobbles presented some appropriate natural characteristics, which were exploited after knapping began. In this sense, the knapping operation was integrated as a complete project

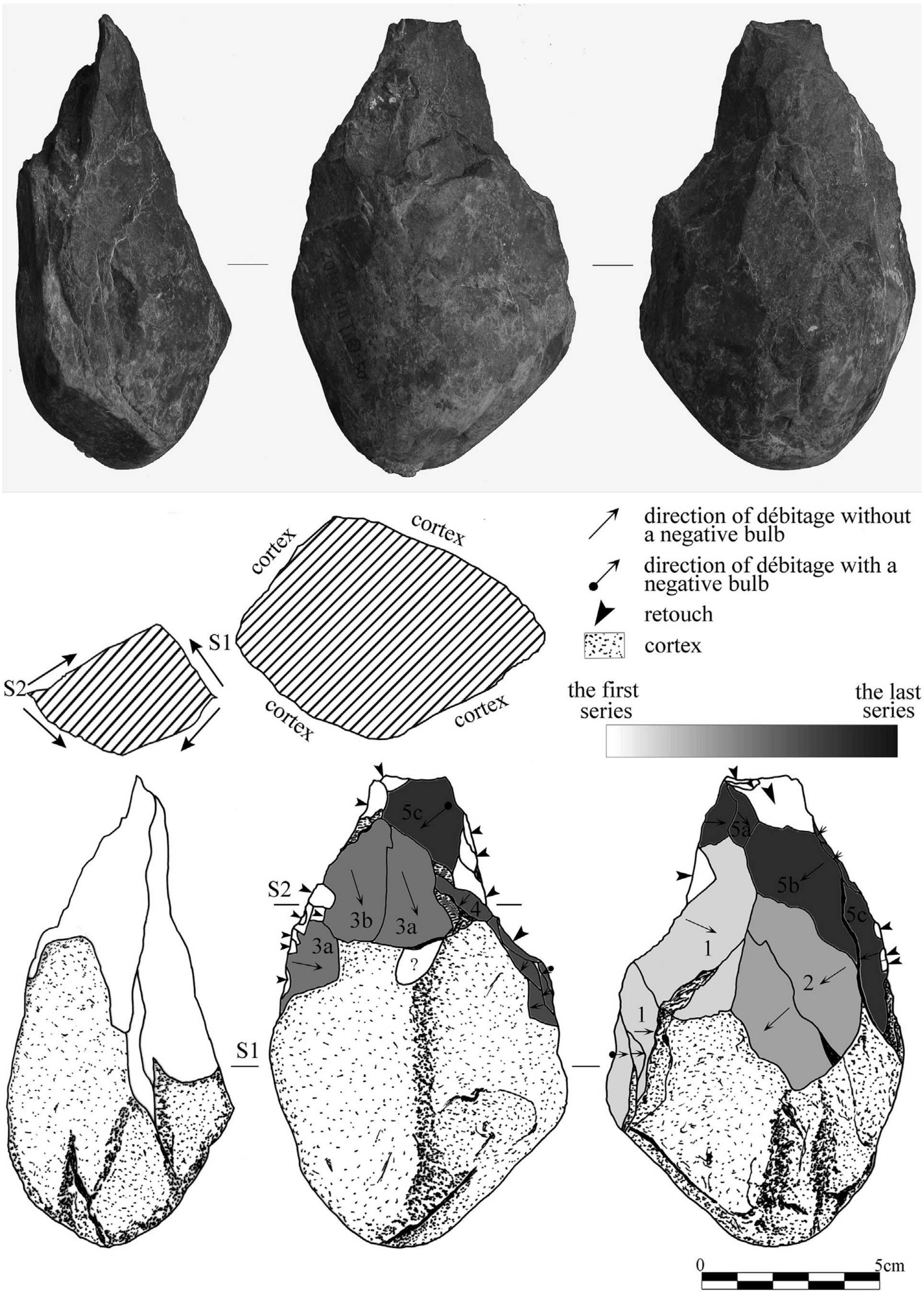

Fig. 4. Photograph and diacritic diagram of a typical biface from Layer 2 of the Houfang site (2010YHIT1② : 50). S1: transversal section on the mesial part; S2: transversal section on the distal part.

Fig. 4. Photographie et schéma diacritique du biface typique de la Couche 2 du site de Houfang (2010YHIT1② : 50). S1 : section transversale de la partie mésiale ; S2 : section transversale de l'extrémité distale.

and accomplished in a seemingly concise but efficient way.

5. Discussion and conclusion

The lithic assemblages containing bifaces were discovered *in situ* in several site complexes including the Bose Basin (Hou et al., 2000; W. Wang, 2005; Wang et al., 2008; W. Wang et al., 2014), Luonan Basin (Wang, 2005a, 2007; Wang et al., 2005, 2011), the Lantian area (S.J. Wang et al., 2014), Hanshui River Valley (Li, 1998; Li et al., 2009) and Danjiang River Valley (Pei et al., 2015; Wang and Hu, 2000; Wang et al., 2013). The Hanshui River Valley may represent one of the most densely distributed lithic assemblages with bifaces. These tools were unearthed in stratigraphy at more than ten localities, including Quyuanhekou (Lu, 2007), Dishuiyan (Liu and Feng, 2014), Liuwan (Feng et al., 2012), Jiantanping (Hou and Li, 2007), Yuzui-2 (Chen, 2011; Chen et al., 2014b), Beitaishanmiao locality 2 (Fang et al., 2012), Shuangshu (Li et al., 2007; Li et al., 2011, 2014b), Dudian (He, 2009), Shuiniuwa (Chen et al., 2014a), Longkou (Wang, 2011), Guochachang II (Li et al., 2013), Waibiangou and Datubaozi (Li et al., 2011) (Fig. 1B). Apart from a few dated and briefly reported sites, e.g., Shuangshu, dated to an early to middle stage of the Middle Pleistocene (Li et al., 2014b), Dishuiyan, ca. 100–50 ka B.P. (Liu and Feng, 2014), Maling 2A, ca. 200–385 ka (Pei et al., 2015), most of these localities were only roughly attributed to the Middle and Late Pleistocene according to geomorphological comparisons of the terraces. Therefore, the discovery of bifaces in primary context at the Houfang site, dated by TT-OSL to 90–110 ka B.P., not only provides new data for constructing a chronological sequence of Paleolithic cultures in the Hanshui River Valley but also serves as new stratigraphic evidence of the existence of late bifaces and sheds new light on the nature and evolution of lithic assemblages containing bifaces in China.

The nature or characteristics of lithic industries bearing bifaces in China and their relationship with classical Acheulean implements have been focal issues since the identification of bifaces in Bose Basin (Hou et al., 2000; W. Wang, 2005; Wang et al., 2008), Luonan Basin (S.J. Wang, 2005, 2007; Wang et al., 2005, 2011) and the Hanshui River Valley (Li, 1998; Li et al., 2009). In general, two opposite opinions were held. On the one hand, Chinese bifaces were assumed to be equal or similar to Acheulean handaxes (Huang, 1989; Huang et al., 2009) and represented a true Acheulean techno-complex or its variability in East Asia (Li et al., 2014a, b; Pei et al., 2015) or showed similarities with Acheulean large cutting tools (Kuman et al., 2014), which may indicate that hominins with knowledge of Acheulean tool-making strategies dispersed into East Asia from a western source (Petraglia and Shipton, 2008; S.J. Wang, 2005, 2007; Wang et al., 2005, 2011; Wang et al., 2014a, b). On the other hand, it was maintained that Chinese bifacial pieces were not classical bifaces (Chauhan, 2010) and did not present typical characteristics of Acheulean bifaces (Clark, 1998). Similarly, quite a lot of researchers preferred to use other terms to define Chinese bifaces, such as "handaxe-like implement" (Norton and Bae, 2008; Norton et al., 2006), "handaxe-like tools", "so-called handaxe", "bifacial pointed tools", "pick" (Corvinus, 2004; Gao, 2012; Lin, 1994), or "Acheulean-like stone technology" and "Large Cutting Tools" (Hou et al., 2000), rather than to relate them to the classical Acheulean complex. As a result, some researchers considered the bifacial phenomenon in the East as technological convergence (W. Wang, 2014) and proposed a local origin for bifacial implements in China (Boëda and Hou, 2004; Lycett and Bae, 2010; Lycett and Norton, 2010; Otte, 2010). Objectively speaking, to resolve the issues currently surrounding bifaces in China and East Asia, we need more detailed dating results and more in-depth analyses of lithic industries using more sophisticated methodologies and applying uniform comparative criteria. Therefore, our detailed technological analysis of the lithic assemblage from the Houfang site will provide new perspectives and references for defining and comparing lithic industries in China on a much larger scale.

The evolutionary trajectory of lithic assemblage with bifaces in East Asia was also a difficult issue to discuss due to the paucity of industries containing late biface occurrences. For a long time, our knowledge of this issue was confined to the area yielding early bifaces (e.g., Bose Basin [ca. 800 ka]) (Hou et al., 2000; W. Wang, 2005; Wang et al., 2008; W. Wang et al., 2014). It was recently reported that lithic assemblages containing bifaces from later periods were unearthed *in situ* in the Hanshui River Valley (Hou and Li, 2007; Liu and Feng, 2014, among many others), Luonan Basin (Wang et al., 2011) and Lantian Area (Wang et al., 2014a, b). These discoveries should contribute to discussing the nature and possible evolution of biface-bearing industries in China in a broader spatial and/or temporal facies. Outside China, biface-bearing industries are abundant in the Imjin-Hantan River Basins of South Korea (e.g., Chongokni, Kumpari, Chuwoli, Kawoli, Jangnamgyo etc.) (Bae, 1988, 1994, 2002; Bae et al., 2011; Kim and Bae, 1983; Yi and Lee, 1993; Yi et al., 2011, among many others). Among these sites, the best known is Chongokni. The reanalysis of the age suggested that hominin occupations took place in this site between 350 and 300 ka B.P. (Bae et al., 2012). Typological analysis indicated that the handaxes of South Korea (e.g., Chongokni) were similar to those of Bose and Dingcun in China and differed morphologically from typical western Old World Acheulean implements (Norton et al., 2006; Norton and Bae, 2008). Our preliminary analysis also suggested that the bifaces from the Houfang site were comparable to those of South Korea but different from those of classical Acheulean implements. So in this sense, the discovery of the Houfang site not only provides new clues to investigate technological evolution and possible cultural affiliation within East Asia but also casts new light on technological innovation and continuity in East Asia and on essential cultural differences between this area and the Old World Acheulean Complex.

In conclusion, the excavation of the Houfang site indicated that the bifacial concept and bifacially-worked implements did exist in China but in very low proportions (< 3%) and were technologically different from classical Acheulean implements. The only common characteristics between them would be convergent morphology and bifacial knapping. This discovery provides new evidence for the existence of bifaces in the Late Pleistocene of East Asia and brings new markers for exploring the nature and evolution of biface-bearing industries in East Asia and discussing cultural links between the East and West.

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