

SHOULDERED ADZES, BIFACES, AND CHERT PRISMS: A CHARACTERIZATION OF MIMOTIEN STONE TOOL ASSEMBLAGES FROM LATER CAMBODIAN PREHISTORY

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Mimotien circular earthworks in the red soil area of east Cambodia and southern Vietnam (Anonymous 1930; Malleret 1959; Groslier 1966 a, b) are dated to the end of the Neolithic and the beginning of the Metal Age with the settlements ending in the second half of the first millennium BC (Haidle 2001). Fifty-six of these very homogeneous settlement sites with outer wall, inner ditch and central platform have been recorded so far (Nguyen 1984, 1997, 1999; Luong 1985; Nguyen 1986; Kojo and Pheng 1997; Dega 2002; Thuy 2002; Haidle 2006), of which Krek 52/62, in Ponhea Krek district, Kampong Cham province, Cambodia, is the most intensively examined (Dega et al. 1997; Kojo and Peng 1998; Albrecht et al. 2000; Vin 2003). A total area of 100 m² has been excavated there between 1997 and 2004 by a German-Cambodian team from Tübingen University, Royal University of Fine Arts Phnom Penh and Memot Centre for Archaeology. Artefacts are concentrated on the edge of the inner platform. These include pottery, spindle whorls and other ceramic artefacts (Heng and Som 1999; Haidle et al. submitted) as well as fragments of glass bangles (Haidle 2001; Haidle and Neumann 2004) and an abundance of lithic artefacts. Some hundred stone tools in different stages of their artefact life, from blanks to finally discarded pieces, have been discovered together with debris from production and reworking. The lithic inventories of this (Heng and Mao 1999) and other Mimotien earthworks (Chhor et al. 1999; Thuy 1999; Dega 2002) present a diverse picture of raw materials (Neumann and Haidle 2002), tool types, production modes, and functions.

Raw material

At least eight raw material groups have been identified by mineralogical analysis. At Krek 52/62 the most widespread is hornfels, a fine-grained metamorphic rock, which was used for adzes, chisel-like and pointed tools, as well as bracelets (Table 1). This main raw material is heavily weathered due to the aggressive chemical conditions in the acidic tropical red soil with a pH value below 4. Typically, the artefacts made from this raw material display a very soft, light-grey to beige surface; details of traces from production and use have been destroyed

during imbedding in the red soil and in the cleaning process. Fine grained copper-bearing volcanic rock akin to hornfels, which is not so prone to weathering as hornfels itself, is very rare at Krek 52/62. However, this is the main raw material at other sites like Huon Khim, and is used for the same purposes as hornfels. The fragments of lithophones, which have been discovered in Mimotien context at the Groslier site (Thuy 1999), and at the circular earthwork Phu Mieng, Binh Long district in Vietnam (Albrecht et al. 2000), were probably made from similar raw material, yet these pieces have not been analysed directly.

At Mimotien earthwork sites fine-grained sandstone of different quality is the preferred raw material for multifaceted grinding stones, polishers and whetstones. Small and medium-sized quartzite pebbles were selected as burnishing tools to smoothen the surface of the pottery and give it a faint shine. Half a dozen of these tools have been found at Krek 52/62, and another one is known from the upthrust of a modern trench at the circular earthwork O'Angkam. The sources of all the more or less common raw materials mentioned above are expected to occur in local or regional distance, but lithic raw materials likely to be imported from further afield are also present. A very distinctive coarse limonitic sandstone has been found at Krek 52/62 in two bifacial tools and a flake. Five regular and unmodified bladelets and two ca. 2 cm long prisms from this site are the only evidence of chert variants of very good quality. The set of stone raw materials from Mimotien context is completed by two single beads of garnet of mixed pyrope-almandine type and of carnelian respectively. While the nearest deposit of garnet is located some hundred kilometres to the north in Rattanakiri, the carnelian might even originate from the Indian subcontinent.

As raw materials with a high consumption rate only fine-grained sandstone and hornfels-type rock can be identified at Krek 52/62, but the latter is replaced by fine grained Cu-bearing volcanic rock akin to hornfels at some other circular earthwork sites. All other raw materials are rare (Table 2). For all raw material groups long use periods dominate as far as they can be identified; a long use with reworking – yet not at the site – is also likely for

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Artefact type group	Raw material							
	Hornfels-type rock	Cu-bearing volcanic rock	Fine-grained sandstone	Quartzite pebbles	Coarse limonitic sandstone	Chert	Garnet	Carnelian
Adze	+	+						
Chisel-like	+	?						
Pointed tool	+							
Bladelets						+		
Grinding / polishing / whet stone			+					
Bifacial tool					+			
Burnisher				+				
Bangle	+	?						
Bead							+	+
Pendant						+		
Lithophone		+						

Table 1. Mimotien artefact type groups according to raw material .

Raw material	Consumption		Use	
	High	Low	Short	Long
Hornfels-type rock	+		+	+
Fine grained Cu-bearing volcanic rock akin to hornfels	(*)	+	+	(*)
Fine-grained sandstone	+			+
Quartzite pebbles		+		+
Coarse limonitic sandstone		+	?	?
Chert		+	?	+
Garnet of mixed pyrope-almandine type		+		+
Carnelian		+		+

Table 2. Intensity of consumption and duration of use of stone raw materials at Krek 52/62.

*At other circular earthwork sites fine grained Cu-bearing volcanic rock akin to hornfels is used instead of hornfels-type rock with a corresponding high consumption rate and long use period.

the bifacial tools made of coarse limonitic sandstone. Wear traces for the chert prisms indicate a long use period as pendants; by contrast, the use of the chert bladelets might have only been intended for a short period, yet their function and evaluation as rare items is unknown and thus the time span from manufacture to discard cannot be estimated. The categories of short and long use periods do not perfectly align with the assumed distances from primary raw material occurrence, but are also influenced by functional considerations.

Artefact type groups

It is not intended here to set up a detailed morpho-typological classification of the Mimotien lithic artefact inventory; the problems of snapshots from different phases of the life cycles of artefacts grouped together in typological classes are well-known and discussed elsewhere, as are the problems of different to contrasting categorizations if the samples are analysed with a technological or functional perspective (see Boer-Mah 2008; Marwick 2008; Pawlik 2008). Rather, it is meant to give an impression of the variety of different morphotype groups of lithic artefacts present in Mimotien assemblages. The type groups can be distinguished based on three different frequency classes: frequent – present in considerable number at several sites, common – present in

low number at a minimum of two sites, rare – present in low number at only one site. Thin-butted and shouldered adzes have been abundantly produced in lengths that range from 2.5 to 13 cm. Different artefact life stages from roughouts, flaked blanks, ground tools to finally discarded fragments can be found at the sites together with a considerable amount of debitage. Morphologically adjacent and probably functionally in part overlapping are chisel-like tools with small blade edges between 1.5 and 3 cm, nearly parallel lateral edges and length-width-ratio of 3 up to more than 5. A number of fragments of hornfels bangles with square cross-section has been found at Krek 52/62, while at other earthworks, for example the Groslier site, triangular cross-sections dominate. Grinding, polishing and whetstones are made of fine-grained sandstone and in rare cases of some other raw material not yet analysed. They are generally small, between 5 and 10 cm maximum length, and show several smooth faces indicating intensive use to nearly being exhausted. Few of these artefacts display long and narrow grooves on one or several of their facets, some with round and some with pointed cross-section. Adzes, chisel-like tools and grinding stones are all frequent at several sites.

The group of pointed tools, including possible borers and points, ranks among the common artefacts. They are modifications on flakes, small cores or fragments of

Raw material	Mode of production / modification						Use
	Knapping		Grinding		Drilling		
	Flake tool	Core tool	Grinding	Polishing	Hollow drilling	Conical/biconical	
Hornfels-type rock	+	+	+	?	+		
Fine grained Cu-bearing volcanic rock akin to hornfels	?	+	+	?			
Fine-grained sandstone		?					+
Quartzite pebbles		+					+
Coarse limonitic sandstone		+					
Chert	+	?	+	+			
Garnet of mixed pyrope-almandine type				+		+	
Carnelian			+	+		+	

Table 3. Modes of production used on different raw materials. Techniques applied at Krek 52/62 are in grey. ? possible techniques which have not been proven yet at the site due to weathering or reworking of the surface.

Artefact type group	Mode of production / modification						Use
	Knapping		Grinding		Drilling		
	Flake tool	Core tool	Grinding	Polishing	Core drilling	Conical/biconical	
Adze		+	+	?			
Chisel-like		+	+	?			
Pointed tool	+	+	+				
Bladelets	+						
Grinding / polishing / whet stone		?					+
Bifacial tool		+					
Burnisher		+					+
Bangle		+	+	?	+		
Bead			+	+		+	
Pendant	?	?	+	+			
Lithophone		+					

Table 4. Modes of production of stone tool morphotypes from Mimotien circular earthworks. The grey boxes mark modes of production executed at Krek 52/62.

former core tools. Due to heavy weathering of the raw material (see Table 2), it is impossible to analyse earlier technological phases or use in detail. Burnishers that were probably used in pottery production are characterised by slight to moderate wear facets and comprise unmodified quartz pebbles and pebble tools with one or two flakes removed for better handling. Only fragments of lithophones are known from two circular earthworks sites so far. They have been identified as parts of this category of musical instruments (cf. Schaeffner 1951) by their width of 10-15 cm, the lens-shaped cross-section and the careful bifacial modification. The association to the Mimotien inventory is likely, but not proven by well-documented *in situ* observations.

Evidence of rare artefact groups, which coincide with rare raw material groups, comes only from Krek 52/62 where a considerable area has been excavated. Two bifacial tools made from coarse limonitic sandstone are grouped together on the basis of their raw material and the production technique. Morphologically, the small, around 5 cm long and slightly pointed real biface is quite different from the larger, around 13 cm long piece with parallel edges, which is mainly unilaterally worked and still

shows a considerable amount of cortex. Yet both do not fall under any of the other known morphological categories. The morphological group of bladelets consists of five pieces of very homogeneous size (length between 3.5-5 cm) and raw material (chert). Ornaments, which had been worn either attached to clothes, set into a socket or beaded on a thin string are particularly rare, but occur in a variety of raw materials and forms. While chert was ground and polished to small prisms, the irregular natural form of the garnet bead was kept and only polished. The carnelian, by contrast, was thoroughly shaped into a regular globular bead.

MODES OF TOOL PRODUCTION

The most prominent techniques applied to produce and modify Mimotien stone tools are the knapping of core tools and grinding. Different raw materials (Table 3) have often been worked into core tools representing a variety of morphotypes (Table 4), while flake tools are relatively rare. Initial preparation of grinding stones by knapping is possible but cannot be confirmed due to the intensive reworking of the surfaces. Some of the core tools, especially adzes, chisel-like tools, and bangles, were further

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Artefact type group	Mode of use									
	Hoeing Chopping	Woodwork	Sculpture	Grind Polish	Whet	Drill	Cut	Burnish	Adorn	Sound
Adze	+	?	?							
Chisel-like		?	?							
Pointed tool						?				
Bladelets							+			
Grinding / polishing stone				+						
Whet stone					+					
Bifacial tool	?	?					?			
Burnisher								+		
Bangle									+	
Bead									+	
Pendant									+	
Lithophone										+

Table 5. Modes of use of stone artefact morphotype groups from Mimotien circular earthworks. The grey boxes mark frequent modes of use. Stone tools with a cutting purpose are extremely rare in Mimotien contexts.

processed by grinding. Polishing can only be proven in those raw materials which are not affected by acidic weathering, thus it is only seen in the rare ornaments made of chert, garnet, and carnelian. Drilling is evident in three variants. First, the large openings of the stone bangles were produced by hollow drilling, which leaves a waste core in the centre. Second, to perforate the garnet and carnelian beads, specialized fine and imperishable tools can be assumed to have been used. The garnet bead was biconically drilled with the irregular cones meeting only in a small aperture. The drilling of the carnelian bead shows as third variant a high technical standard with a very regular, narrow and nearly cylindrical hole which was probably achieved by drilling only from one side and reworking of the hole after the perforation. Grinding, polishing and whet stones as well as burnishers are mainly shaped by intensive use.

At Krek 52/62 several spatial patterns of stone tool production can be observed. While different stages of adze production and knapping debris of hornfels raw material can be found all over the excavated area, the manufacture of bangles was localised at unit XII where a concentration of 45 fragments was found together with a core of the hollow drilling process. Evidence for the preparation of grinding stones or burnishing stones in form of flake debris is lacking; if at all, these artefacts were likely modified at other places. Like the chert bladelets, the chert prisms, the carnelian and the garnet beads, the limonitic sandstone tools were also probably neither produced nor modified at the site, but were instead brought in as finished pieces.

FUNCTION

Up to now, microscopic use-wear analysis has only been conducted on the chert prisms, revealing their probable mounting in a socket and use as pendants (Pawlik pers. comm. 2003). Although the major part of the raw material at Krek 52/62 shows extensive weathering of the surface and does not allow a detailed use-wear analysis, broad

categories of the modes of use present at the Mimotien circular earthwork sites can be established. Table 5 gives an overview of the main activities done with stone artefacts. The most interesting column is that of a mode of use that is generally a very common field of artefact application in humans, but which is here limited here to a very rare tool class of chert bladelets: cutting. The apparent lack could be explained by the presence of cutting items made of other materials, namely metal. Metal objects have not been found from Mimotien contexts; fragments of glass bangles, however, indicate if not metal processing at Mimotien earthworks, at least contact with other metal processing groups with the possibility of access to metal objects (Haidle 2001; Haidle and Neumann 2004). These phantom artefacts, assumed to accompany the glass ornaments and likely to have existed due to the lack of cutting activity with other tools, were probably not preserved due to the strong acidity of the tropical red soil with a pH value below 4. Alternatively, the lack of metal artefacts may be explained by their primary lack in settlement remains due to curation of the tools and recycling of the valuable material.

As with the production of stone tools, spatial patterns based on their use can also be observed at Krek 52/62. The frequent adzes and grinding stones are evenly distributed all over the excavated area. By contrast, quartz pebbles used to burnish pottery are especially frequent in unit II, where a ceramic anvil gives further evidence for pottery production. In this area, which yielded also the five glass bangle fragments well as the carnelian and garnet bead, both bifacial tools of coarse limonitic sandstone were found. In close vicinity lay a single flake of the same raw material, which could not be fitted to either of the tools. The chert blades show no specific spatial pattern, and the chert prisms were found next to each other in unit XII, close to the production area of stone bangles and to the majority of ceramic balls, which have been interpreted as projectiles for slingshots (Haidle et al. submitted).

CONCLUSION

Although the state of preservation of the bulk of Mimotien stone tools does not allow the whole range of stone artefact analyses, the assemblages from late Neolithic to early Metal Age Cambodia can be distinguished by several features. Two groups – hornfels/ volcanic rock akin to hornfels and fine-grained sandstone – form the major stone raw materials relied on at circular earthwork sites. At least five groups of rare and sometimes exotic stone complete the set of raw materials. Their frequency depends on both the distance to primary sources and the function, respectively the rate of use, of the tools made from each specific raw material. Typical are long use periods for high- and low-consumption raw materials.

A variety of different morphotype groups can be observed with a predominance of core tools. The modes of stone tool production are diverse; shaping a core roughout by knapping with subsequent grinding and polishing formed most of the morphotypes, while flake tools are of minor importance. Morphotype groups as well as raw material groups were applied in diverse and specific functions. A nearly complete lack of cutting tools indicates probable metal use, thus supporting the assumption – based on glass bangles – of a former presence of metal tools.

As far as the small portion of excavated area at Krek 52/62 can tell, local production of adzes and chisel-like tools was common all over the settlement area. The manufacture of stone bangles with rectangular cross-section of the same hornfels-type raw material was limited to one of the units (XII). The distribution of adzes, chisel-like tools, grinding / polishing stones and chert bladelets does not show special areas of use. Burnishing stones, however, were concentrated in unit II, where they, together with a ceramic anvil, point towards an area of pottery production. Both units differ also in the presence of stone artefacts of rare morphotype and exotic raw material as well as other rare items, thus indicating some sort of social differentiation and probably specialisation in craft within the Mimotien settlements. The combined study of lithic features such as raw material together with consumption- and use-rates, morphotypes, modes of production, functions, and spatial differentiations might be a useful approach to characterize not only Mimotien stone artefact inventories, but also late prehistoric lithic assemblages elsewhere in Southeast Asia.

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