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The Discovery of a Bifacial Industry in Vietnam

This study investigates the origin of bifacial lithic industry in the Lower Paleolithic of Southeast Asia. We describe stone tools from the stratified sites of Go Da and Roc Tung near the town of An Khê, Vietnam. The lithics represent a homogeneous industry, characterized by Lower Paleolithic primary and secondary reduction techniques. Cores and tools were made using pebbles, and some tools were manufactured on flakes. The tool-kit includes bifaces, picks, spurred implements, carinated end-scrapers, various types of side-scrapers, choppers and chopping tools, and denticulate and notched pieces. Bifaces and picks are the predominant tool types. Primary reduction was aimed at manufacturing simple pebble cores with cortex striking platforms, while radial and orthogonal cores occur less frequently. Tektites found with the lithics were dated by $^{40}K/^{38}Ar$-method to 806 ± 22 and 782 ± 20 ka BP. We propose to name this industry the An Khê culture. We suggest that the An Khê emerged through convergent evolution of the pebble-flake industry associated with the first wave of Homo erectus migration from Africa 1.8–1.6 Ma years ago, and is unrelated to the Acheulean tradition introduced by the second wave of migration to Eurasia.

Keywords: *Vietnam, Lower Paleolithic, An Khê culture, bifaces, convergent evolution.*

Introduction

In terms of both technology and typology, the Paleolithic of Southeast Asia (including Vietnam) is quite different from contemporaneous industries of the more westerly regions of Eurasia. The initial peopling of the region is believed to have occurred 1.8–1.6 Ma BP, with the first migrants consisting of *H. erectus* groups from Africa associated with the pebble-flake rather than Oldowan industry (Derevianko, 2015). This date estimate, however, is based solely on fossil remains, as no sites with lithics have yet been found dating to this period. Moreover, Lower Paleolithic sites with reliable stratigraphy are few in this region. The age of the earliest stratified sites slightly predate 1 Ma. Several non-contemporaneous Lower Paleolithic industries are known in Southeast Asia, including the Tampanian, Anyathian, Pacitanian, and other industries.

After the initial peopling of the region by *H. erectus*, lithic industries were largely unaffected by subsequent migrations from western Eurasia. This does not imply, however, that Southeast Asian groups lived in isolation across this period. Small groups of immigrants might have reached East and Southeast Asia more than once, resulting in gene flow and interactions. Nevertheless, the lithic industries of these regions remained basically unaffected, and the industries can be regarded as autochthonous. The reason for this stability was not likely cultural stagnation, lack of innovative technologies, or cognitive deficiency (Movius, 1944, 1949; Clark, 1998; and others), but, on the contrary, environmental plasticity. Specifically, the tool industries of this region appear to have been an adaptation to the absence of large sources of high-quality raw materials, which prompted Lower Paleolithic humans to rely on organic materials such as bone, wood, and especially bamboo (Hutterer, 1985; Pope, 1984, 1985, 1988; Pope, Cronin, 1984; Lycett, 2007; and others).

Hallam Movius described two Lower Paleolithic traditions—Acheulean, which was based on the bifacial technology and distributed in the western part of the Old World (Africa and western Eurasia), and a second, pebble-based technology with choppers and chopping tools (East and Southeast Asia). Over the last 70 years, hundreds of Paleolithic sites have been discovered and studied in East and Southeast Asia, and the resulting dataset makes it possible to reassess lithic industries from eastern Eurasia. The idea of two coexisting culture provinces separated by a "Movius line" has been discussed at various conferences and in numerous publications. One of the first discussions was published by *Current Anthropology*, following a study by Seonbok Yi and Geoffrey Clark (1983). Like many later discussions, this initial debate largely focused on disproving Movius's hypothesis of a cultural boundary. Subsequent research has demonstrated clearly that both traditions, that based on bifaces and that focused on choppers and chopping tools, had been practiced in East and Southeast Asia in the past, establishing an early appearance of bifacial traditions in this region.

The Paleolithic industries of Vietnam

The first Paleolithic sites in Vietnam were discovered by Madeleine Colani. In the 1920s and early 1930s, she conducted excavations in the provinces of Hòa Bình, Ninh Bình, Thanh Hóa, and Quảng Bình. As a result, Colani (1927) identified an Upper Paleolithic culture termed Hoabinhian. Later on, Hans D. Kahlke (1965, 1973) found stone tools in association with bones of Pleistocene animals and remains of *H. erectus* in caves in northern Vietnam. In the 1960s, one of the prominent specialists in Paleolithic archaeology, Pavel Boriskovsky, conducted research in Vietnam. Apart from excavations, he also educated future archaeologists in this country. Eventually, in the 1960s, a Vietnamese school of experts in Paleolithic studies emerged.

The earliest Paleolithic sites documenting the initial peopling of Vietnam are attributable to the initial Middle Pleistocene (Boriskovsky, 1966, 1971; Kahlke, 1973; Ciochon, Olsen, 1986; Olsen, Ciochon, 1990; Davidson, Noble, 1992; Nguyễn Khắc Sử, 2007a, b; and others). In the cave sites of Tham Qujen and Tham Hai, located in Lạng Sơn Province bordering China, researchers recovered ten teeth of *H. erectus*, fragments of teeth belonging to extinct anthropoid apes, and remains of primarily extinct fauna species (*Ailuropoda*, *Stegodon*, *Pongo*, and others). These sites are dated to 475 ± 125 ka BP (Marwick, 2009).

In Vietnam, as elsewhere in Southeast Asia, following the appearance of *H. erectus*, technological characteristics of local industry (based largely on the use of wood, bone, and bamboo) was mostly unaffected by external influence. Bamboo may have played particularly important role in early human survival in Vietnam. Bamboo shoots would have been used for food; knives, points, etc. may have been manufactured of ripe bamboo stems. Organic materials were likely processed with crude stone implements such as choppers, chopping tools, side-scrapers, and knives with various modifications. Because of the persistent significance of soft materials in Southeast Asian tools, crude blanks, often described as "Paleolithic", actually occur at Neolithic and even Early Bronze Age sites.

In this regard, surface collections from Mount Do (Vietnam) are noteworthy. In 1960, during the excavations of a Bronze Age burial ground and a settlement located in the Thanh Hóa Province, archaeologists found crude stone artifacts lying on slopes of Mount Do. Boriskovsky participated in this research as an advisor. Artifacts from Mount Do drew his attention by their archaic appearance, and he investigated this site for several seasons (1966, 1971; and others). Mount Do is located on the right bank of the Tu River, the tributary of the Ma River, 23 km from the seacoast. The mount is composed of Mesozoic basalt with quartz veins. Exposures of basalt bedrock are visible at a height of 20–40 m above the foot of the mount. Ancient people used the basalt scree as a source of raw material for tool-making. During the first years of research, ~1500 lithic artifacts were collected. Boriskovsky conducted statistical analysis of 825 of these finds. He identified 782 flakes, including 37 Levallois products. According to his research, the artifact assemblage yielded two typical Acheulean handaxes, one crude bifacial chopping tool, seven crude unifacial choppers, and 15 rectangular handaxes and cleavers including fragments (1966: 60). While having some doubts about the precise age of artifacts from Mount Do (Ibid.: 60–62), Boriskovsky inferred that the site belonged to the Lower Paleolithic—an attribution that was questioned by many researchers (Olsen, Ciochon, 1990; and others). In 1986, Vietnamese archaeologists discovered a Bronze Age workshop on Mount Do. Stone axes resembling Lower Paleolithic bifaces were apparently manufactured in this workshop (Nguyễn Khắc Sử, 2007b). Amazingly, even a highly experienced specialist in Paleolithic studies like Boriskovsky, was capable in misattributing these late bifacial tools (resembling handaxes in shape and technology) to the Lower Paleolithic. The key reason for Boriskovsky's mistake is that typologically similar types of tools were manufactured in South and East Asia for hundreds of millennia (Movius, 1958: 354).

Consequently, criteria used to assess African and Eurasian lithic industries often fail to detect the Middle Paleolithic in eastern Eurasia. East and Southeast Asian lithic industries evolved over the entire Pleistocene (more than one million years) without following cultural sequences seen in Africa or western Eurasia. Key developments absent from this region include the Levallois technique of primary reduction. In Vietnam, as in eastern Eurasia at large, dozens of archaeological cultures have nonetheless been described, using pebble, discoid, orthogonal, and other types of cores and a variety a pebble chopping tools. No valid or generally accepted criteria for distinguishing the Middle Paleolithic are yet available from this region. Again, it would be erroneous to speak of one and half million years of stagnation, as evidenced by the Lower Paleolithic sites with bifacial tools, such as handaxes, in China. Bifacial tools appeared in China about one million years ago, and were used over the entire Middle and the first half of the Upper Pleistocene. Having originated in China, this bifacial industry differed from the African and western Eurasian Acheulean, and its appearance in East Asia may be ascribed to convergent evolution (Derevianko, 2008, 2014; and others). Despite the stability of tool types in Southeast Asia across the Paleolithic, the discovery in Vietnam of bifacial Lower Paleolithic tools resembling Acheulean handaxes attests to the absence of cultural "stagnation" in Vietnam.

Recent discoveries of Lower Paleolithic sites with bifacial industries in Vietnam

Since 2009, the joint Russian Vietnamese archaeological expedition has excavated Paleolithic sites in Vietnam, led by A.P. Derevianko and Nguyen Khac Su. Initially, excavations were carried out in several caves with cultural horizons attributable to the Upper Pleistocene.

In 2014, Vietnamese archaeologists discovered Lower Paleolithic sites with bifacial tools near the town of An Khê, in central Vietnam. In 2015, the joint expedition began systematic excavations there (Nguyễn Khắc Sử, Nguyễn Gia Doi, 2015; Derevianko, Tsybankov, Nguyễn Giang Hai et al., 2016; Derevianko, Sử, Tsybankov et al., 2016; Derevianko et al., 2017a, b). Over the last four years, 23 Lower Paleolithic sites with bifaces have been discovered in the area of An Khê, clustered in seven loci (Fig. 1). At the locus termed Roc Tung, we found 12 sites on the left bank of the Ba River, on the shore of a water reservoir (Fig. 2, 3). Roc Lon 1 and Roc Giao 2 are located on the same shore. Roc Lon 2 and Roc Nep 1 and 2 are situated east of the Ba River, closer to mountains. Roc Giao 1 and Roc Huong lie far away from the reservoir, downstream the Ba. Go Da site was found downstream of the reservoir, on the right bank of the river, almost opposite Roc Huong (Fig. 4). Nui Dat 1, 2, and 3 are also located on the right bank of the Ba, on the gentle eastern slopes of small Mount Dat, in close proximity to the local hydroelectric power station.

At these sites, we recovered Lower Paleolithic pebble tools both on the modern ground surface and in test pits in an undisturbed context.

In 2015–2018, our team conducted systematic excavations at Roc Tung and Go Da. The most technologically and typologically representative

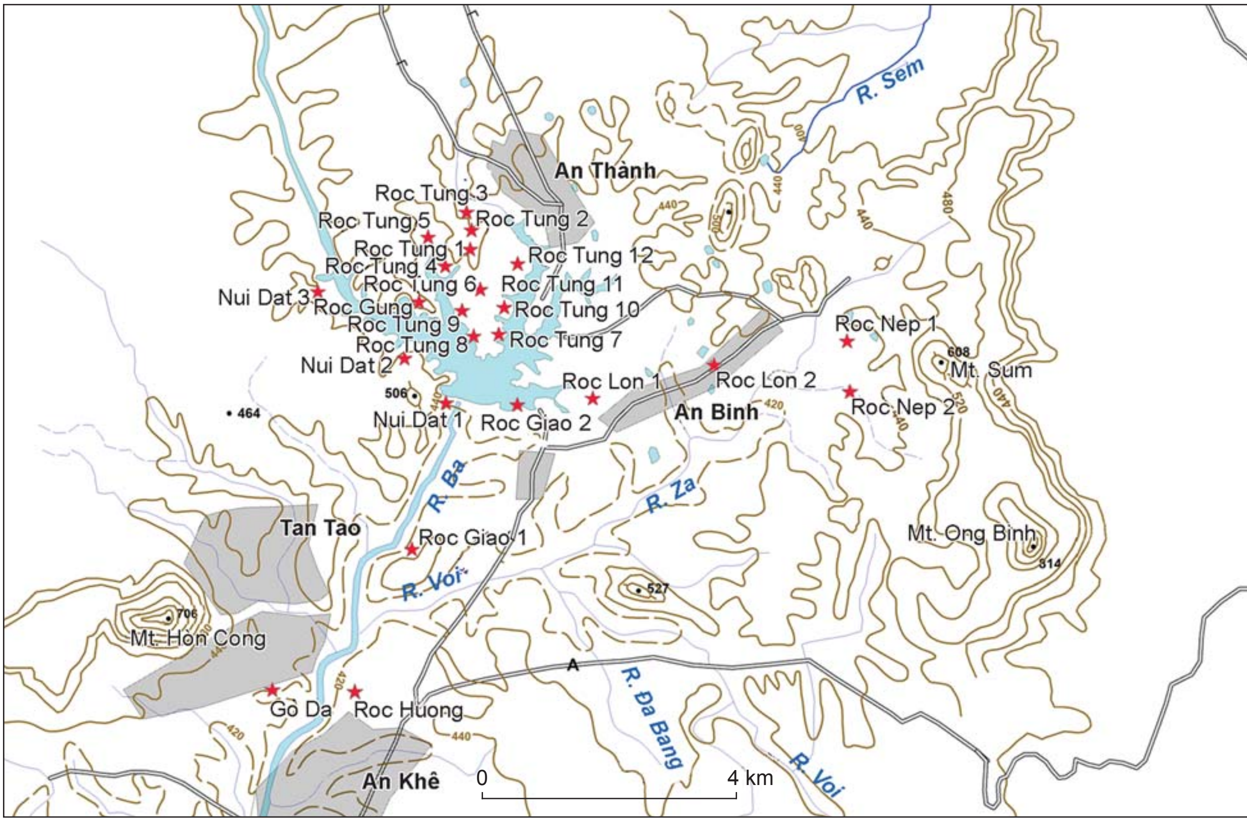


Fig. 1. Map showing the location of the An Khê Lower Paleolithic sites.

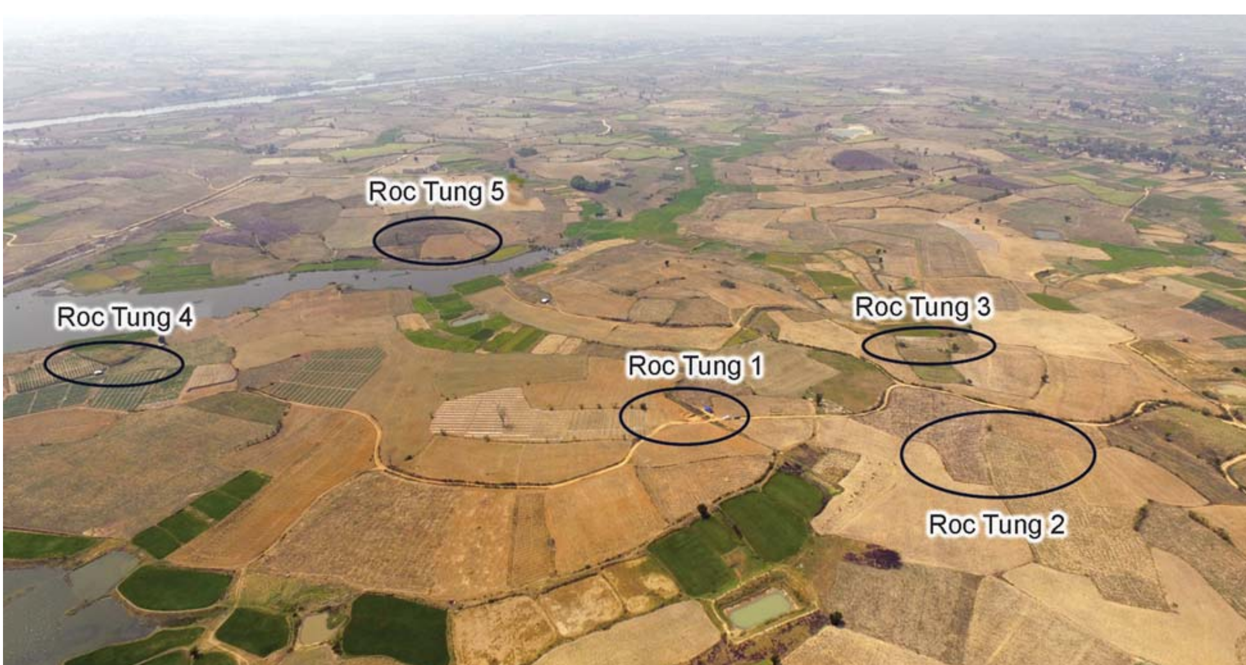


Fig. 2. Roc Tung 1–5 Lower Paleolithic sites.

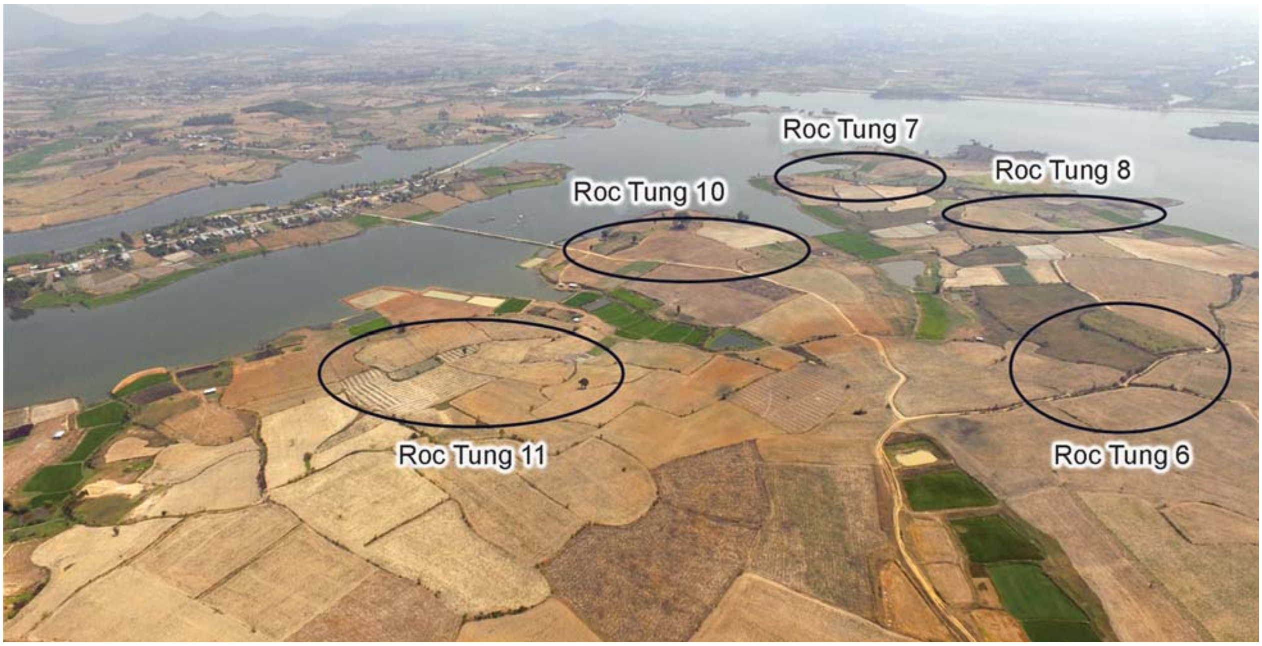


Fig. 3. Roc Tung 6–8, 10, and 11 Lower Paleolithic sites.

Fig. 4. Go Da and Roc Huong Lower Paleolithic sites.

assemblages of those yielding bifaces were collected at sites in Roc Tung. The sites are located on an elevated hilly plateau cut by numerous rivers, flowing primarily from west to east. The landscape is strongly affected by erosional activity. The bedrock is composed of basalt, acidic tuffs, and granite, while overlying sediments are primarily lacustrine and riverine, including alluvial fans. Soft sediments were accumulated mainly during the final Early and Middle Pleistocene. Before these were formed, the bedrock had been exposed to prolonged weathering, following which a relatively thick weathering crust was developed. The upper stratum has been heavily disturbed by anthropogenic activities (plowing and construction of utility and irrigation structures) to a depth of 20–30 cm. In places where loose sediments had been disturbed (by water flows, erosion, or irrigation canals) to a depth of approximately 1 m, we recovered surface artifacts. Other sites in the Roc Tung cluster are scattered across an area of several square kilometers, and therefore cannot be regarded as one site with a single cultural horizon. In places where clusters of artifacts had been detected, we conducted test excavations 2 m^2 in area. At each of our test localities in the Roc Tung, we found artifacts *in situ* in similar contexts.

Because the sites in this area are unevenly spaced, the cluster's spatial definition must be considered tentative. Future excavations will hopefully make it possible to specify the true number of sites present on the landscape. Clearly, the area is too large to represent a single occupation of Lower Paleolithic humans. Pilot excavations demonstrated that cultural layers belonged to a single stratigraphic horizon, and all localities revealed similar lithics in terms of their technology and typology. Each of the sites has a small total area, and gives the appearance of a short-term camp in a place that was regularly revisited by ancient humans. Here we describe only excavated sites at Roc Tung and Go Da (for the detailed description of all sites see (Derevianko, in press)).

The Roc Tung 1 site (14°02′253″ N; 108°40′822″ E) is located on an elevated and relatively flat area of agricultural land. Fifty-two lithic artifacts were gathered from the ground surface: cores, pebbles and boulders with traces of modification, flakes, choppers, chopping tools, side-scrapers, unifacial point, bifaces, and spurred implements.

In 2015, upon collection of surface finds, we conducted excavations measuring 36 m^2 at an elevation of 456 m above sea level (hereinafter a.s.l.).

The stratigraphic sequence of the southern wall of excavation includes the following deposits:

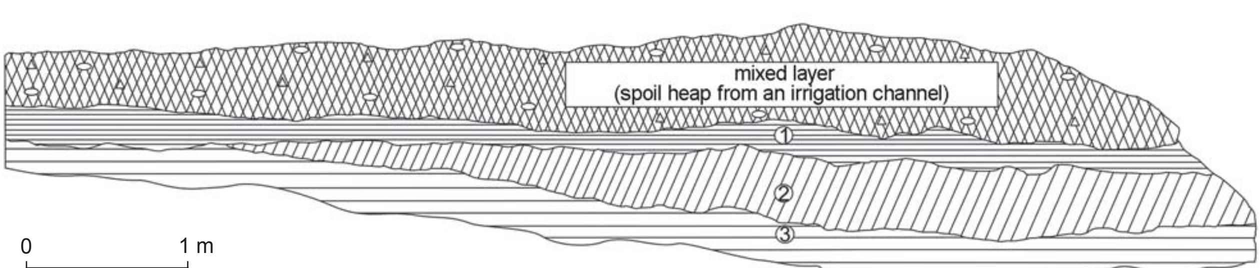
The upper portion of overlying soft sediment is a spoil heap from an irrigation channel cutting through the undisturbed part of the modern ground surface. The thickness is 0.4–0.5 m. Three strata were identified there (Fig. 5).

Stratum 1. Modern soil buried under the spoil heap, and composed of light loam, gray in color. Thickness 0.1–0.2 m.

Stratum 2. Grayish-brown lightly carbonized loam with a minor admixture of grus (up to 5 %). Brownish-red lateritic inclusions occur in some places. The portion of the layer located south of excavation was destroyed by agricultural activities. Thickness 0.6–0.7 m.

Stratum 3. Brownish-red heavy eluvial loam (laterite). The sediments are highly carbonized, and gradually change color to grayish-brown toward the bottom. From the top downwards, lateritic and

A



B

Fig. 5. Stratigraphy of Roc Tung 1.

carbonized sediments gradually mix with weathering crust. Visible thickness up to 0.55 m.

The lithic assemblage derived from the excavation consists of 70 artifacts, including pebbles with traces of test knapping (25 spec.), flakes (14 spec.), cores in various stages of reduction (18 spec.), and tools and tool blanks (13 spec.).

At Roc Tung 1, six test pits measuring 2 m^2 each were made. The pit closest to the central excavation was 25 m away, and the furthest 120 m southwest of the excavation. All the test pits display similar stratigraphy, and contain Lower Paleolithic artifacts. In test pit 2, we found two core artifacts. One of them is a single-platform core with one flake removal surface and a cortex striking platform. The other one is a single-platform nucleus with two adjacent flaking surfaces. A chopper-like side-scraper and a spurred tool were also recovered from the pit.

Roc Tung 2 was discovered 324 m northeast of Roc Tung 1 (14°02′253″ N; 108°40′929″ E). The site is located at an elevation of 452 m a.s.l. Twenty-two artifacts were collected from the ground surface. The assemblage consists of a core, pebbles with traces of test knapping (4 spec.), large pick-shaped chopping tools and their blanks (11 spec.), and flakes (6 spec.).

Not far from this site, 390 m northeast of Roc Tung 1, we discovered the site of Roc Tung 3. Here, three artifacts were collected from the ground surface and three artifacts were found in the test pit, in the stratigraphic context similar to that recorded at other sites.

Roc Tung 4 (14°02′053″ N; 108°40′584″ E) is one of the most informative sites in our study area. It is located at 438 m a.s.l., precisely 569 m southwest of Roc Tung 1. Fifty-six lithic artifacts were recovered from surface collections: cores (5 spec.), pebbles with traces of test knapping (17 spec.), and large laminar spalls and flakes (34 spec.).

In 2016, we conducted an excavation 1, 12 m^2 in area, along with six test pits (No. 1–6) measuring 2 m^2 each at Roc Tung 4. We observed the following stratigraphic sequence in the excavation and test pits:

Stratum 1. Modern soil consisting of two sublayers.

A. Light loam gray in color with a minor admixture of grus. Thickness 0.1–0.2 m.

B. Light loam light-grayish-brown in color with a minor admixture of grus (5–7 %). Thickness 0.20–0.25 m.

Stratum 2. Heavily carbonized lateritic loam with a high fraction of grus (30–40 %) reddish-brown in color. The color of sediments changes to grayish-brown toward the bottom. The upper portion of the stratum is a horizon of boulders and grus, where lithic artifacts were found. Visible thickness 0.5–0.6 m.

The lithic assemblage recovered from the excavation consists of 73 artifacts, including cores (8 spec.), pebbles with traces of test knapping (31 spec.), flakes (30 spec.), and tools and their blanks (4 spec.).

In 2017, we continued field studies at Roc Tung 4. Two excavations and four test pits (No. 7–10) measuring 2 m^2 each, were made. Test pit 8 was expanded into excavation 3 (Derevianko et al., 2017a), while we conducted excavation 2 (30 m^2) in the area adjoining the eastern wall of excavation 1, originally examined in 2016.

We observed the following stratigraphic column in excavation 2:

Stratum 1. Modern soil. Light loam gray in color with a minor admixture of grus. The horizon is heavily disturbed by modern agricultural activities. Thickness 0.10–0.25 m.

Stratum 2. Grayish-brown loam with a red tint. It contains a minor admixture of grus (up to 5 %). The sediments are lightly carbonized, and comprise some brownish-red lateritic inclusions. The stratum occurs sporadically. Its major part was possibly destroyed by agricultural activities. Thickness 0.10–0.15 m.

Stratum 3. Brownish-red, highly carbonized lateritic loam. In its upper part, the horizon of boulders and grus can be observed, and yields lithic artifacts. Visible thickness up to 0.4 m.

The artifact assemblage from the excavation comprises 80 pieces. It includes pebbles with traces of test knapping (26 spec.), core preforms (2 spec.), flakes (41 spec.), cores (3 spec.), and tools (8 spec.). Boulders and pebbles of fine-grained siliceous rock were used as raw materials.

Excavation 3 is located at 440 m a.s.l., on a gentle slope, 35 m northeast of excavation 2. Stratigraphic context is the same as in excavation 2. The cultural horizon yielded 383 lithic artifacts, including pebbles with traces of test knapping (101 spec.), core preforms (11 spec.), flakes (206 spec.), cores (30 spec.), tools (32 spec.), and tool blanks (3 spec.). The most common raw material was siliceous rock characterized by dense fine-grained structure, almost without internal defects. Quartzite was much more rarely used.

Roc Tung 5 (14°02′302″ N; 108°40′471″ E) is located at 443 m a.s.l., 632 m northwest of Roc Tung 1, on a gentle slope of the eastern coast of a small cove of the water reservoir. Artifacts collected from the site's surface number 15 in total: cores (3 spec.), pebbles with traces of test knapping (3 spec.), flakes (3 spec.), tools (5 spec.), and one tool blank.

Roc Tung 6 (14°01′782″ N; 108°40′927″ E) is located at 448 m a.s.l., 903 m southeast of Roc Tung 1, on a hill with slopes smoothed by agricultural activities. Judging by remnants of small hillocks, now covered with bushes, at least 1 m of the sediment initially present at the site has been removed through human action. Archaeological remains were found on the slope declining towards northeast.

Roc Tung 7 (14°01′421″ N; 108°41′116″ E) is located at 440 m a.s.l., 1600 m southeast of Roc Tung 1, on one of the small elevations gently sloping eastwards, with a 1.5 m deep rice platform. The rest of the slope is heavily deformed by agricultural activities and occupied by cultivated fields (Derevianko, Tsybankov, Nguyễn Giang Hai et al., 2016). Archaeological remains were recovered both from ground surface and from within sediment deposits.

We conducted excavation 1, 20 m^2 in area, approximately 30 m north of the hollowed rice field, and observed following stratigraphic sequence:

Stratum 1. Modern soil, light loam gray in color. This horizon is heavily disturbed by modern agricultural activities. Thickness 0.10–0.15 m.

Stratum 2. Brownish-red, strongly carbonized lateritic loam with a high fraction of grus (up to 30 %). The top part of the stratum consists of fine and medium-sized, heavily weathered quartzite pebbles, with archaeological remains. Visible thickness 0.20–0.25 m.

The artifact assemblage recovered from the excavation is made up of 150 pieces, including pebbles with traces of test knapping (52 spec.), core preforms (5 spec.), flakes (63 spec.), cores (11 spec.), and tools (19 spec.).

At Roc Tung sites 8–12, we collected surface finds and excavated test pits, which revealed similar stratigraphic composition to other sites.

A somewhat different stratigraphy can be observed at the sites located on the right bank of the Ba River, of which Go Da is the best studied site in this locality. The site is located (13°58′306″ N; 108°39′136″ E) 2 km from the central bridge across the river, at 440 m a.s.l., and approximately 50 m above the water's edge. The excavation was made 900 m west of Ba, on a hill composed of granite bedrock. A part of the site has been destroyed by modern quarrying. A deposit section approximately 41 m long remains undisturbed. This east-west oriented section declines in elevation towards the west. The base of the section consists of granite overlain with weathering crust between 20–30 cm thick. The weathering crust is covered by slope wash sediments forming an apron. These sediments are suggestive of significant environment and climate change—most probably, a strong cooling event. The slope wash sediments include coarse-grained sandy loam, angular grus, and granitic debris. The maximal thickness of the apron is observed in the eastern part of the deposit, the minimal thickness in the western part. In some places, we observed accumulations of coarse debris; the largest such accumulations are concentrated in the central part of the deposit.

The apron appears to have been formed primarily due to weathering of the granite bedrock and minor transport of coarse debris from the most elevated areas of the ground surface. Erosional processes accompanied formation of the apron, rendering its upper portion uneven, while its basal part evenly covers the bedrock and weathering crust. The stratum containing the main cultural horizon was produced by slope wash and erosion processes; herein lies its distinction from the cultural horizons on the left bank of the Ba River.

At Roc Tung and other sites on the left bank of the Ba, cultural horizons are located within a laterite overlying, and partially included in, the weathering crust on the granite bedrock. At Go Da, the cultural horizon was found directly in the weathering crust and slope wash sediments. No distinct red laterite layers (which would attest to very warm and humid conditions) are found at Go Da. When hominins settled in the An Khê region, the climate would have been cool and arid, prompting the intense deflation and erosion visible in the deposits on the right bank of the Ba River. Apparently, humans still lived there when the environment changed: when the climate became warmer and more humid, loose laterite deposits like those at Roc Tung would have begun to form. The dates of the two sites differ by nearly 30 thousand years.

The Go Da cultural horizon is covered by loose sediments with various origins. They were repeatedly redeposited with large time intervals in between deposition events. These sediments include weakly lithified lateritic, slope wash, aeolian, and clay-rich components. Thus, the sedimentation processes occurring on the right bank of the Ba appear to have differed significantly from those on the left bank.

It can be assumed that in the Early Pleistocene, the granite bedrock was exposed for a long time, causing a weathering crust to be formed by deflation. During the cooling event at the final stage of the Early Pleistocene, slope wash apron was formed from weathering crust (5–10 cm), large angular grus, and debris. We recovered lithic artifacts from the weathering crust and in the lower portion of the apron. Laterite was subsequently formed in sediments overlying the apron; however, owing to redeposition and anthropogenic interference, this laterite horizon cannot be traced as clearly as at the Lower Paleolithic sites on the left bank of the Ba River. However, based on stratigraphic positioning, the Lower Paleolithic sites on the right bank are somewhat older than those on the left bank.

Bifacial industry from Lower Paleolithic sites in Vietnam

Over four years of investigations conducted at the Lower Paleolithic sites with bifaces near the town of An Khê, approximately 1200 lithic artifacts were found, including 872 pieces recovered from cultural horizons, and more than 300 pieces collected from the ground surface. All finds belong to the Lower Paleolithic and are very similar in terms of typology and techniques of primary and secondary reduction. Bifaces and picks represent the principal types of tools. The industry of this sort was discovered in Vietnam for the first time. We propose to name this industry the An Khê culture.

Lithic artifacts recovered from the Lower Paleolithic sites in the Ba River basin can be classified into eight main categories: (1) cores and bifaces (implements flaked on both sides) (11 spec.); (2) picks (56 spec.); (3) spurred tools (40 spec.); (4) carinated end-scrapers (4 spec.); (5) side-scrapers of various types (54 spec.); (6) choppers and chopping tools (70 spec.); (7) denticulate tools; (8) notched tools (Derevianko, Sử, Tsybankov et al., 2016). Cores and tools were mostly made on pebbles and boulders varying in size and shape, and on their fragments. Rare tools were fashioned on flakes, and unretouched flakes were occasionally utilized. Course-grained vein quartz was the main raw material in the Ba River basin; quartzite was very seldom used. Inhabitants of the sites appear to have collected the raw material in the river valley, where large stones had rolled down in the course of deflation and erosional processes.

At all the Lower Paleolithic sites studied, primary reduction was aimed at manufacturing simple pebble cores, with one or two cortex striking platforms. Assemblages contain a small number of cores with a striking platform created by the removal of one or two flakes, and radial nuclei. Some cores of the first two types demonstrate several flaking faces. Cores with cortex striking platforms in the studied assemblage include specimens where a flaking surface and striking platform form nearly a right angle (Fig. 6, *1*). Amorphous flakes of varying size were detached from such cores. In some cases, flaking surface and striking platform are arranged at an acute angle (Fig. 6, *2*). Judging by removal scars, large flakes with a salient bulb of percussion were detached from such cores.

Cores of the second type exhibit a striking platform prepared predominantly by a single removal (Fig. 6, *3*). Flakes were detached from two conjoining or opposite sides of the core's lateral surface (Fig. 6, *4*). In very rare cases, cores with two platforms and two flaking faces exhibit initial flaking surfaces that served as the platform for subsequent detachments (Fig. 6, *5*).

Radial cores are occasionally encountered in the lithic assemblage from the study sites (Fig. 6, *6*, *7*). These are normally round in shape and have a lenticular profile and cross-section. Most of them exhibit a striking platform prepared on the edge between the flaking surface and the back of the core. Large flakes were produced via centripetal removals. The preparation of such cores required considerable skill and knowledge of the properties of rocks (Derevianko, Sử, Tsybankov et al., 2016: 12).

Judging by the location of working edges, available choppers and chopping tools can be subdivided into transverse (Fig. 7, *1*) and longitudinal (Fig. 7, *2*) choppers. Some specimens exhibit a sharpened tip (Fig. 7, *3*, *4*). Some chopping implements show retouch on one surface of the working edge, others on both. Secondary reduction was focused largely on the blade; whereas other areas retained cortex.

Implements with a deliberately fashioned spur (or a "nose-shaped" point) (Fig. 7, *5*) constitute a special category of tool. Distinguishing these from bifaces and picks, the point on this tool type was produced by the detachment of large flakes, or by additional retouching and small spalls forming a kind of shoulder. Some tools in this category are quite large and weigh up to 4 kg.

Side-scrapers form a fairly high percentage of the tool assemblage. These implements can be classified according to longitudinal and transverse working edges. The specimens are further characterized by convex (Fig. 8, *1*), concave, undulating, or serrated (Fig. 8, *2*) working edge. Most side-scrapers were fashioned on pebbles (Fig. 8, *3*, *4*); some implements were made on large flakes or fragments of pebbles (Fig. 8, *5*, *6*). In distinction from choppers or chopping tools, side-scrapers were produced on flatter pebbles fashioned by two or three rows of large spalls, and subsequently trimmed with fine marginal retouch.

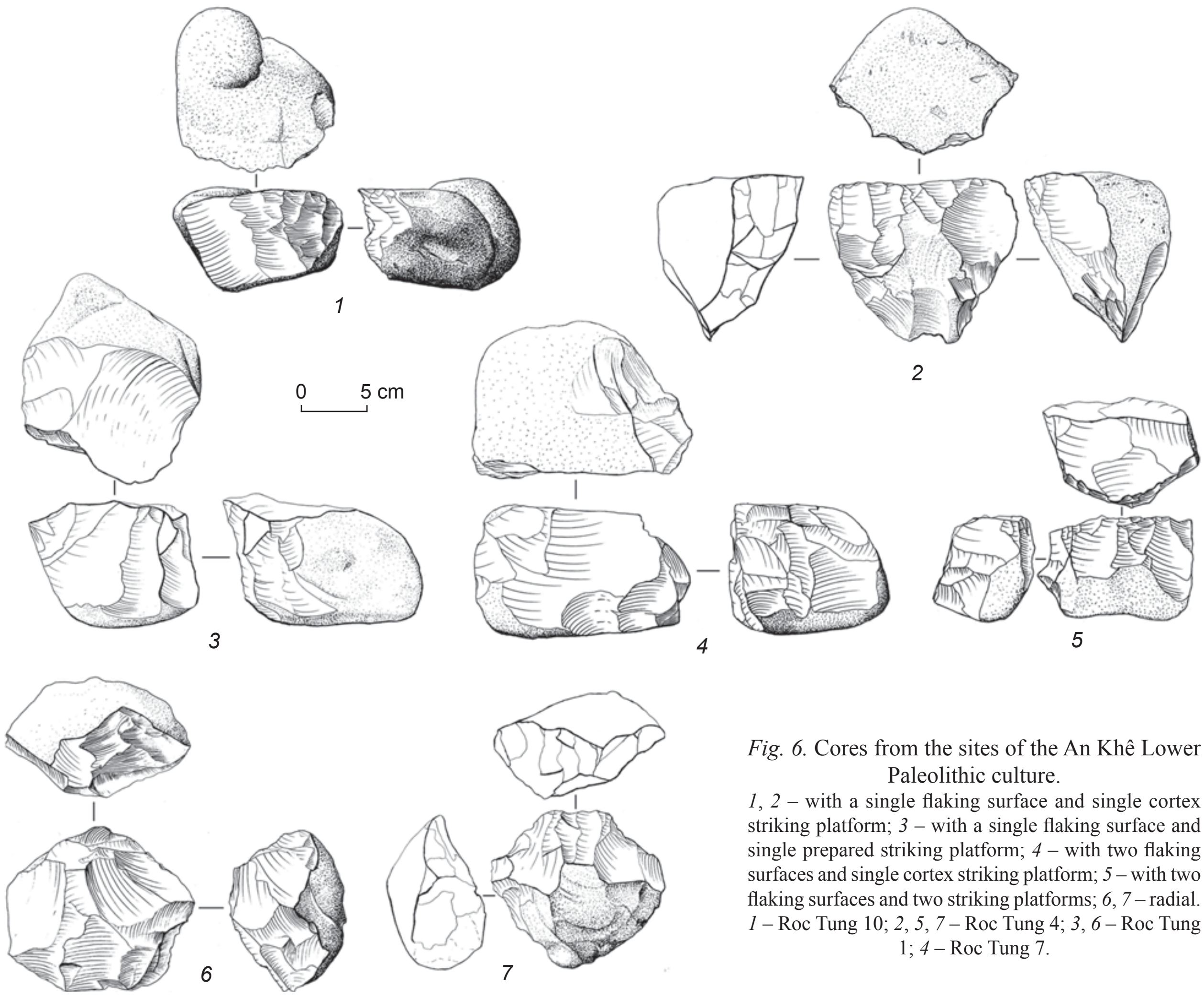


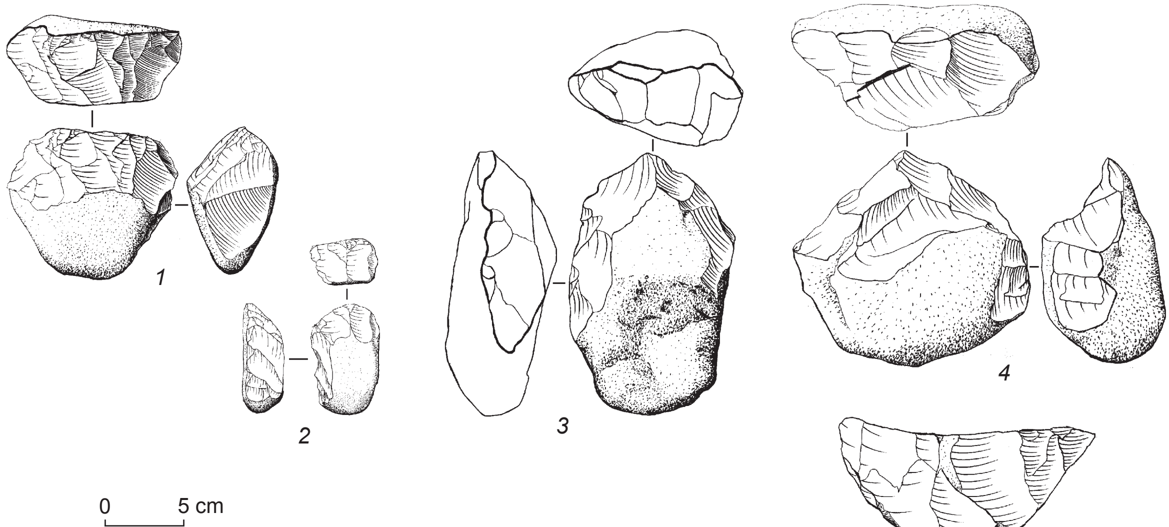
Fig. 6. Cores from the sites of the An Khê Lower Paleolithic culture.
1, *2* – with a single flaking surface and single cortex striking platform; *3* – with a single flaking surface and single prepared striking platform; *4* – with two flaking surfaces and single cortex striking platform; *5* – with two flaking surfaces and two striking platforms; *6*, *7* – radial.
1 – Roc Tung 10; *2*, *5*, *7* – Roc Tung 4; *3*, *6* – Roc Tung 1; *4* – Roc Tung 7.

Working edges were flaked on one or both sides. In all cases, the back of the tools retains cortex.

The tool kit also contains denticulate (Fig. 9, *1*, *2*) and notched implements. Most of them are smaller than choppers, chopping tools, or side-scrapers. The working edge is fashioned by large spalls removed from the longitudinal or transversal lateral margin. Some specimens exhibit alternate retouch that forms notches. Similarly to other tools, only the working edge was trimmed, whereas on other parts of the implements cortex was preserved.

Core-shaped scrapers and carinated end-scrapers (Fig. 9, *3–5*) form a small though notable tool grouping. These were produced mostly on elongated pebbles. One end of this tool type usually displays scars from small and narrow removals. Core-shaped scrapers are numerous at Lower Paleolithic sites scattered across a large territory, and comprise a special category of Lower Paleolithic tool. The earliest core-shaped scrapers were recovered from the pre-Acheulean horizons of Olduvai (Leakey, 1971). Carinated end-scrapers were recorded at some Lower Paleolithic sites with pebble-flake and Acheulean industries in Africa, Near East, Caucasus, Siberia (Karama site), and elsewhere (Clark, Kleindienst, 1974; Lyubin, Belyaeva, 2004; Amirkhanov, 2006; Derevianko et al., 2005). Their presence at Lower Paleolithic sites widely separated in time and space likely resulted from technological convergence, not from migrations (Derevianko, 2015).

Bifaces required the most energy expenditure and skill to produce. All implements in the analyzed assemblage were made on large, elongate, triangular pebbles with a lenticular profile and cross-section. The convergent tip of such tools exhibits large flake removals on both sides (Fig. 10). In some cases, the working edge was trimmed through the removal of smaller spalls, while the remainder of the tool



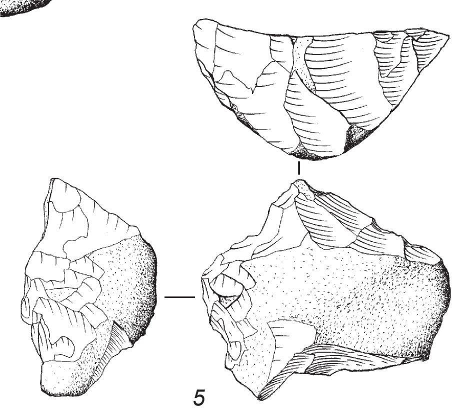


Fig. 7. Tools from the sites of the An Khê Lower Paleolithic culture.
1 – chopper with a transverse working edge; *2* – chopper with a longitudinal working edge; *3*, *4* – choppers with a sharpened tip; *5* – spurred tool.
1, *2*, *4* – Roc Tung 4; *3* – Roc Tung 1; *5* – Roc Tung 7.

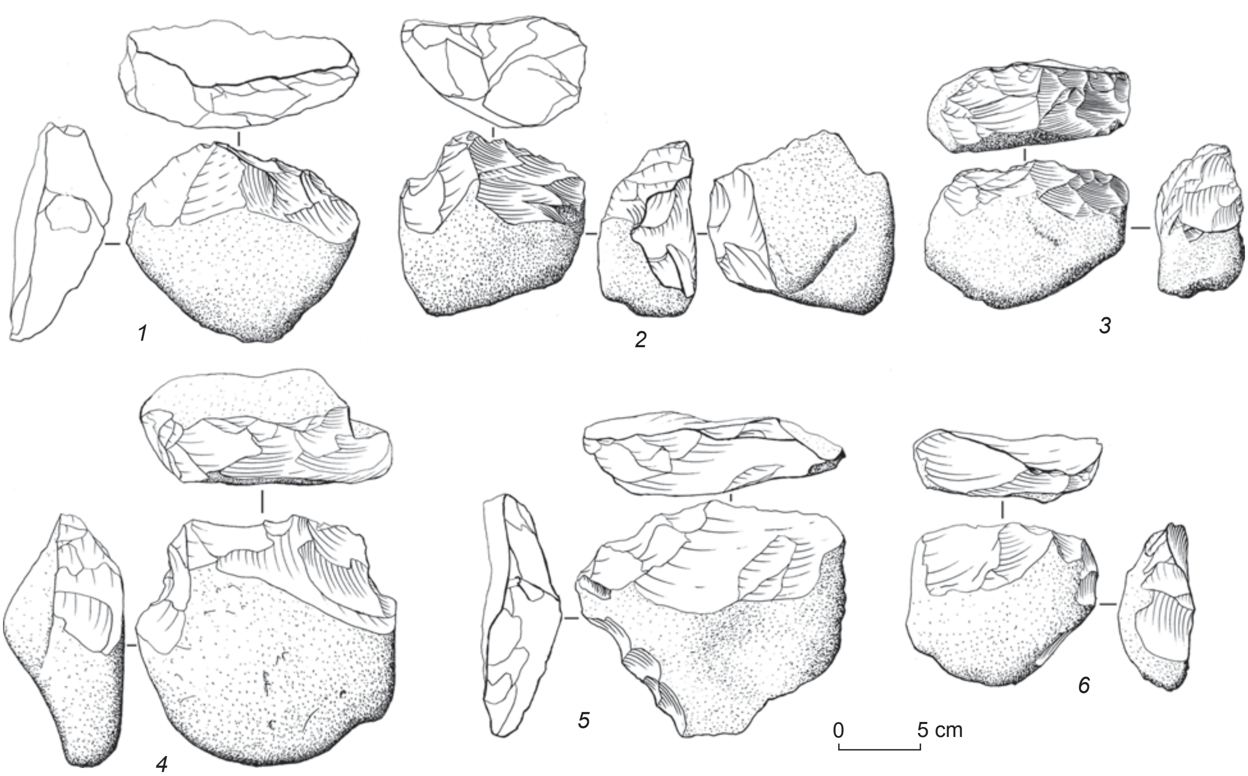


Fig. 8. Side-scrapers from the sites of the An Khê Lower Paleolithic culture.
1 – side-scraper with a convex working edge; *2* – side-scraper with an undulated working edge; *3*, *4* – side-scrapers on pebbles; *5*, *6* – side-scrapers on flakes.
1, *2*, *5*, *6* – Roc Tung 4; *3* – Roc Tung 1; *4* – Roc Tung 7.

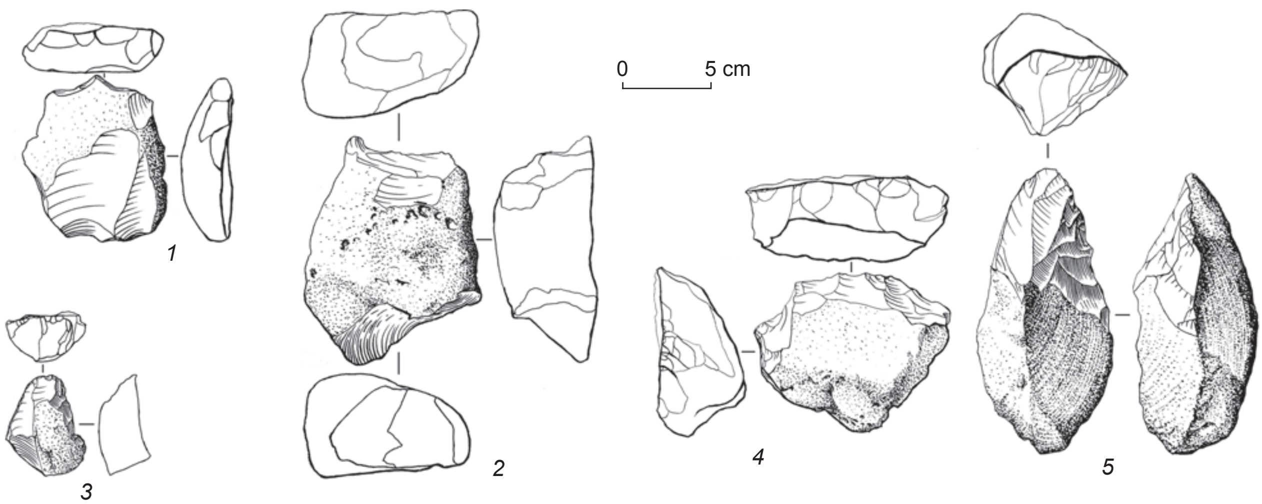


Fig. 9. Tools from the sites of the An Khê Lower Paleolithic culture.
1, *2* – denticulate tools; *3–5* – core-shaped scrapers.
1 – Roc Tung 4; *2–5* – Roc Tung 1.

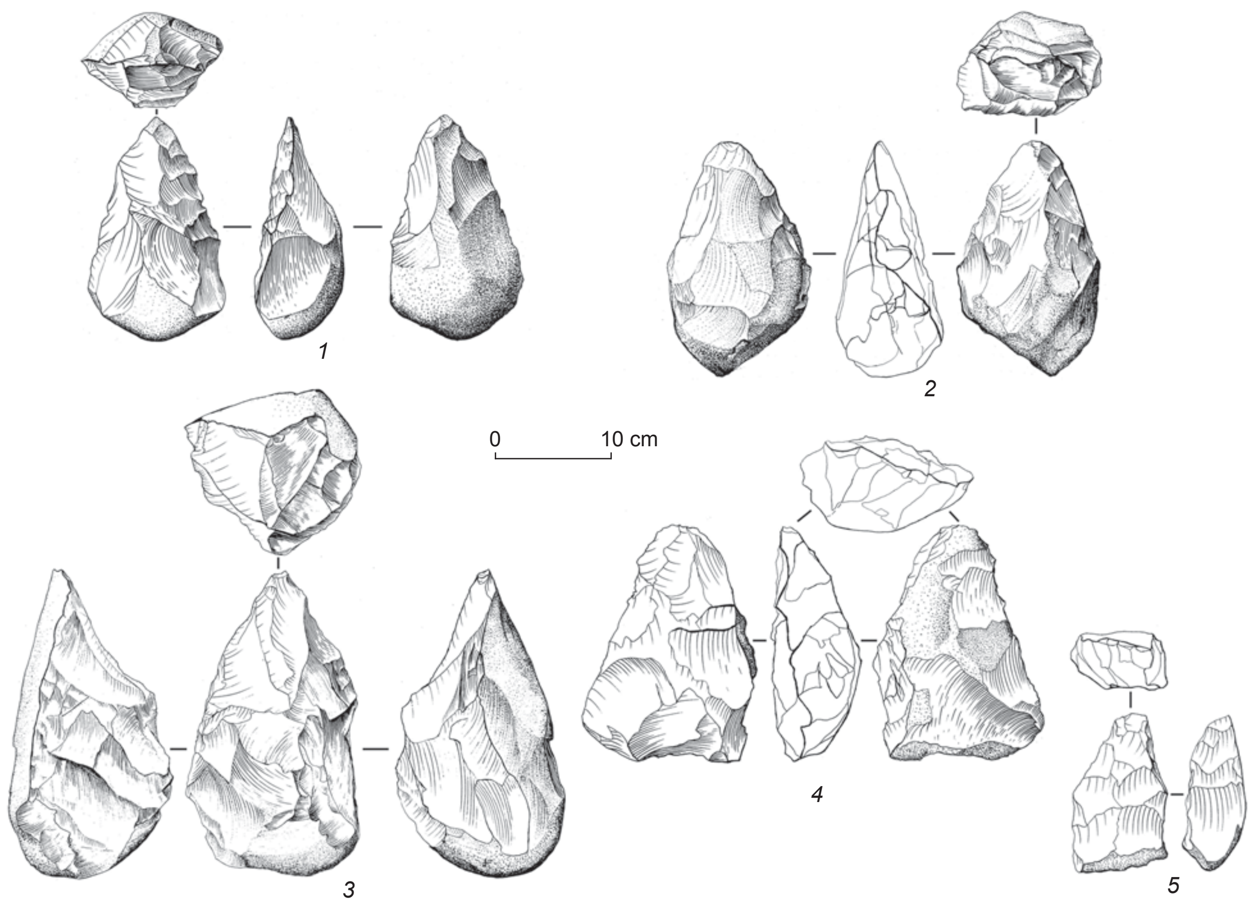


Fig. 10. Bifacially worked tools from the sites of the An Khê Lower Paleolithic culture.
1 – Roc Giao 1; *2* – Roc Lon 2; *3* – Roc Tung 10; *4* – Roc Tung 4 (excavation 3); *5* – Roc Tung 7 (excavation 1).

is covered with cortex. Some artifacts also show evidence of additional working near the "butt" of the biface. A series of symmetric, triangularly elongated bifaces with an unmodified back end contains two specimens that are worth particular mention. One of these was found in excavation 3 of Roc Tung 4 (Fig. 10, *4*). This biface was fashioned on a large elongated pebble. It has a straight base and slightly curved working edge. In terms of shape, it resembles a shark tooth. One surface of the tool is flat and completely covered with scars from centripetal removals; another surface is convex and almost completely treated with flake removals. Only a small area in the center retains cortex. Another biface, found in the excavation at Roc Tung 7, displays scars of partial trimming of flat surface by marginal retouch along the entire perimeter (Fig. 10, *5*).

Pick tools in the assemblage resemble bifaces in both shape and reduction technique. These were made mostly on large pebbles and boulders, and are normally large and heavy. Only the pointed working edge was subjected to secondary reduction, while the rest of the surface of such implements retains original cortex. The working edge of these tools was bifacially (Fig. 11, *1*, *3*) or unifacially (Fig. 11, *2*) processed. Regardless of the form of the blank, the section of the working blade was triangular, typical of picks. Unlike bifaces, picks have a distinct sharp-pointed and elongated tip; some tips are asymmetric (Fig. 11, *4*).

The lithic industry discovered on the left bank of the Ba was based on the exploitation of local raw material. Cores and tools were made on quartzite pebbles and boulders, and raw material of low quality was often used. Blanks were heavily cracked and coarse-grained, which hampered effective knapping. The recovery of numerous pebbles with traces of test knapping and unidentifiable fragments supports this inference. Blanks were detached from simple cores with a single flaking surface and one or two striking platforms, bearing scars of minimal preparation. Transversally-oriented detachments predominated in the assemblage. Heavily exhausted cores are absent; most cores exhibit scars of only one series of primary removals. Radial nuclei are similarly scarce, and flakes as potential blanks appear to have been of minor importance. Most flakes in the assemblage appear entirely without traces

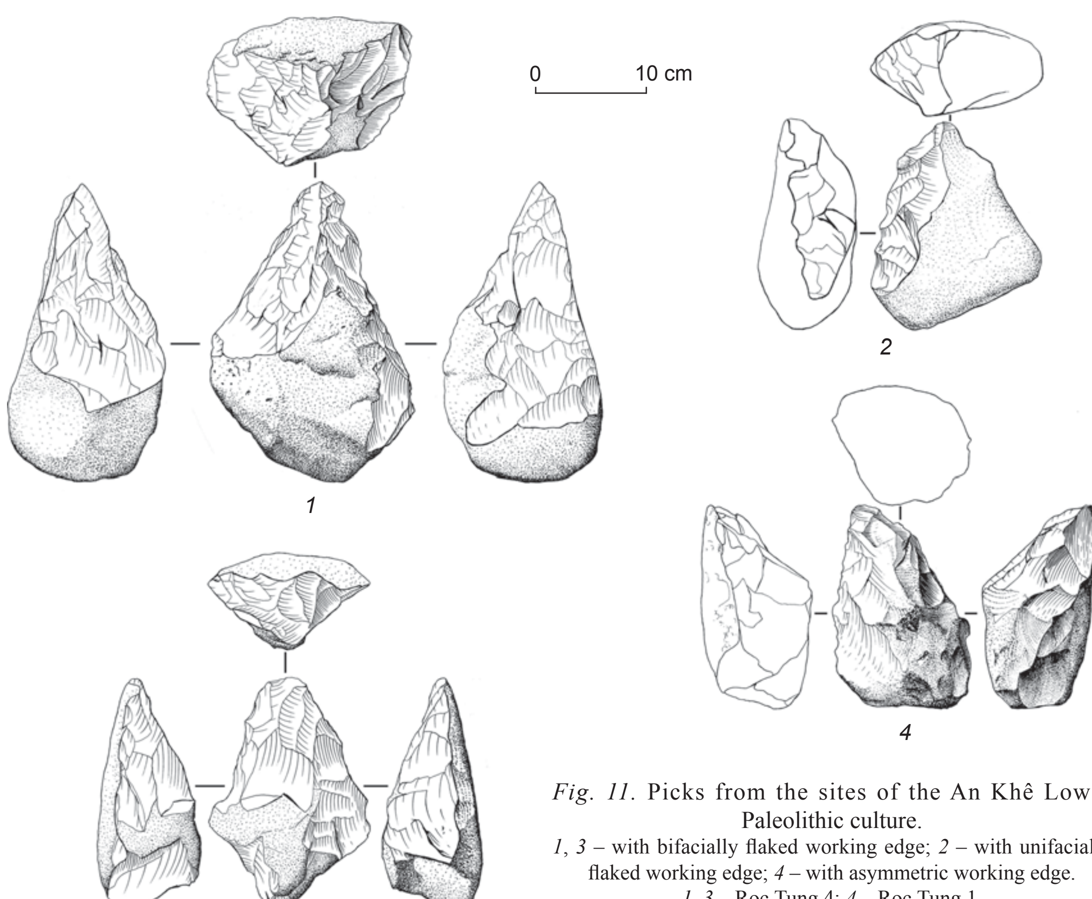


Fig. 11. Picks from the sites of the An Khê Lower Paleolithic culture.
1, *3* – with bifacially flaked working edge; *2* – with unifacially flaked working edge; *4* – with asymmetric working edge.
1–3 – Roc Tung 4; *4* – Roc Tung 1.

of secondary reduction. This industry, in general, can be classified as a pebble industry, since most tools were fashioned on pebbles; only some small-sized side-scrapers, denticulate and notched tools were manufactured on flakes. Picks, spurred implements, choppers, and chopping tool types predominate in the toolkit, while side-scrapers and notched tools are less frequent. One of the most critical features of this assemblage is the presence of bifacially worked tools that resemble Acheulean bifaces in terms of morphology and technique.

Given the technological traits of this industry and their stratigraphic location, this industry is undoubtedly Lower Paleolithic—an observation that we confirmed through geochronology. Along with lithic artifacts, we recovered around 200 tektites, melted and firmed glassy bodies formed by meteorite impacts. Two tektite samples from Go Da and Roc Tung 1 were analyzed in the Laboratory of Isotope Geochemistry and Geochronology in the Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry, Russian Academy of Sciences (Moscow). The date of 806 ± 22 ka BP (lab code 15962) was obtained for the cultural layer at Go Da, while the Roc Tung 1 cultural layer was dated to 782 ± 20 ka BP (lab code 15963).

The discovery of a Lower Paleolithic (final Early Pleistocene) bifacial tradition in Vietnam strongly suggests that Southeast Asia was one of the regions where this industry originated.

Lower Paleolithic bifacial industries in East, Southeast, and South Asia

Hallam Movius separated the Lower Paleolithic industries into two zones: the western zone, where bifaces predominated (including Africa and Eurasia west of central India), and the eastern zone, where choppers and chopping tools were most common (territories east of central India). At the time his "Movius line" hypothesis was formed, he was nonetheless aware of bifaces found in Southeast Asia. Gustav von Koenigswald was the first to report on bifaces found in 1935 at Patjitan, in the southern part of Central Java. Later on, bifaces were discovered in Sumatra, Kalimantan, Bali, and other regions. Movius himself (1944, 1949) identified 153 handaxes in the Patjitan industry, where they made up 6.32 % of the tools. They were less numerous than choppers (17.8 %). The industry also contained chopping tools (3.68 %), hand adzes (3.59 %), and proto-handaxes (8.06 %), which are typologically closer to handaxes than to choppers or chopping tools (Ibid.).

Knowing about such bifaces in the Patjitan industry and those found at Tingtsun, China, Movius (1956, 1958) nonetheless argued that the Paleolithic of East and Southeast Asia was radically different from that of the remaining part of Eurasia. Two possible explanations can be posited for how he may have reconciled this discrepancy. The first is that Movius attributed the Patjitan industry to the Late Pleistocene. Indeed, the Tingtsun bifaces date to that stage. In Europe, this period corresponded to the post-Acheulean age, when the Mousterian was underway. The second reason may be that at the time when the study of the Paleolithic in eastern Eurasia had only begun, Movius felt that the lithic industries of that part of the world and those in the west had. developed along different trajectories.

Although the specific evidence for this division has changed, the totality of archaeological data accumulated over the last six decades supports the east-west division of the Paleolithic industries proposed by Movius—an idea that is further supported by the discovery of the bifacial industry in Vietnam.

The migration of *Homo erectus* associated with the Acheulean from Africa to Eurasia began ca 1.4 Ma BP. The earliest evidence for this movement comes from Ubeidia, Israel—the earliest Acheulean site in Eurasia (Bar-Yosef, Goren-Inbar, 1993). A number of Acheulean sites in Levant, dating to ca 1 Ma, may indicate continuity in the evolution of hominins in that region (Derevianko, in press), although this is only a hypothesis requiring further proof. The second migration wave of *Homo erectus* with the Acheulean industry from Africa to the Near East occurred during the MIS 20, as evidenced by the thoroughly studied site of Gesher Benot Ya'akov (Goren-Inbar, 1992, 2011; Goren-Inbar, Feibel, Verosub et al., 2000; Goren-Inbar, Sharon, 2006; Goren-Inbar, Grosman, Sharon, 2011; and others). What were the repercussions of this wave further east?

The important transit areas for the Acheuleans were the Arabian Peninsula and the Iranian Plateau. In Arabia, the Acheulean localities are primarily represented by surface sites (Petraglia, 2003; Amirkhanov, 2006; and others). The Arabian Acheulean is characterized by bifaces in tandem with implements made on flakes, choppers, and chopping tools. The vast majority of cores are unidirectional with subparallel flaking; cleavers are mostly absent. The northern Arabian Acheulean, unlike that of southern Arabia, includes a few cleavers. The Levallois reduction technique was seldom if ever practiced either in the north or in the south of Arabia. The Acheulean appeared in Arabia ca 500–450 ka BP.

The comparison of technological and typological features of the Acheulean in southern Arabia and in the Near East suggests that bifaces are among the few common features of those industries. In the Near East, however, bifaces were made mostly on flakes, whereas in southern Arabia they were made on nodules and large cores. In Arabia, bifaces were prepared by the removal of variously sized flakes, whereas retouch was almost never practiced. The typical Levallois technique of primary reduction was not used in southern Arabia. In the Near East, its earliest example comes from Gesher Benot Ya'akov. Eventually, the Levallois technique became predominant at Acheulean sites.

In Iran, approximately 15 Acheulean sites have been discovered. Most of these are concentrated in the country's northwestern reaches, near the Levant and the Caucasus, and in the northeastern area, adjoining Turkmenistan (Biglari, Nokandeh, Heydari, 2000; Biglari, Heydari, Shidrang, 2004; Biglari, Shidrang, 2006; and others). Acheulean assemblages have been recovered mostly from surface sites, and consist of a few bifaces and cleaver-like implements. These suggest that the Levallois technique was rarely used. The earliest sites can be attributed to the period not earlier than 500–450 ka BP.

In Central Asia, the Late Acheulean industry has been identified in Kazakhstan, Turkmenistan, and Mongolia. The most distinct bifacial industry is associated with the final Lower and early Middle Paleolithic localities (Derevianko, 2014). In this vast region, assemblages with bifaces have been discovered from northwestern Kazakhstan (Mangyshlak Peninsula), in the Cis-Baikal, and in the Irtysh River basin. In Kazakhstan, the greatest number of bifacially worked tools have been recovered from the Mugodzhar Hills (Derevianko, 2014).

Across Central Asia, all Paleolithic assemblages containing bifacially worked tools are characterized by the Levallois primary reduction technique, and cleavers are absent. Bifacially worked tools, mostly fashioned on subtriangular pebbles, are few or isolated. Technologically and typologically, these bifacial tools cannot be regarded as a coherent group. All the Paleolithic localities in Central Asia are not older than 300–250 ka years.

The Indian subcontinent should be specified as a region where bifacially worked tools appeared very early. In South Asia, approximately 10 archaeological sites with bifaces dating from 1.2 to 0.6 Ma years old have been identified. This category of sites includes Isampur (Paddayya, 2001; Paddayya, Jhaldiyal, Petraglia, 2006; and others); Attirampakkam (Pappu, Akhilesh, 2006; Pappu et al., 2011; and others); Morgaon (> 780 ka BP); Singhi Talav (> 800 ka BP); and Bori (670 ± 30 ka BP) (Mishra et al., 1995; Paddayya, Jhaldiyal, Petraglia, 2006; Pappu, Akhilesh, 2006; Gaillard et al., 2009; and others). Assemblages from these sites include bifacially worked tools made on pebbles. The presence of Acheulean cleavers in this region is dubious, and one of the present authors believes that in India, as in East and Southeast Asia, the emergence of bifaces was due to convergent technological evolution (Derevianko, 2014).

The probable migration event associated with the Late Acheulean likely reached India ca 600–500 ka years ago, or possibly somewhat earlier. R. Dennell (2009: 375) claimed that the Acheuleans appeared in India and Pakistan no earlier than 700–600 ka BP. In India, several hundred Late Acheulean sites are known, spanning the time interval between 500–100 ka BP. A convergent, independent emergence of the bifacial technique in South Asia (ca 1 Ma) is suggested by the observation that in adjacent territories west of India (Arabia and Iran), the Acheulean industry appeared no earlier than 700 ka BP.

In summary, the first migration wave of *H. erectus* associated with the Acheulean appears to have moved from Africa eastwards ca 1.4 Ma BP, but had not spread beyond the Near East. The second such wave, originating from Africa at the boundary between the Early and the Middle Pleistocene (Gesher Benot Ya'aqov), marked a rapid advance of the Acheulean into Europe and Asia. This could be either a direct migration or a chain-like transmission of skills involved in the bifacial technology from one hominin group to another.

In Asia, first bifacially worked tools were discovered in China. Assemblages recovered from Pingliang and Yunxian contain solitary bifaces and cleavers (Le site…, 2008; Huang Weiwen, Hou Yamei, Seong Hyun-kyung, 2005). About 30 Paleolithic sites with so-called handaxes and cleavers attributable to the Lower, Middle, and Upper Pleistocene have been identified at this locality. Bifaces were most numerous in the Guangxi Zhuang Autonomous Region, in the Baise Basin, bordering Vietnam. Using 40Ar/39Ar dates on tektites from Baise localities, these sites with bifaces have been dated to ca 732 ± 39 and 803 ± 3 ka BP (Hou Yamei et al., 2000). The biface-bearing horizon contained tools with working edge flaked on both faces, including chopping tools with reduction extending to a greater or lesser surface, resembling the earliest bifaces of Africa (Xie, 2002; Xie, Li, Huang, 2003).

The appearance in China of bifaces resembling Acheulean ones resulted from convergent evolution on a local basis. No other implements found in association with bifaces share common characteristics with the Acheulean industry, and no handaxes of such antiquity have been found west of China. The Baise handaxes are a striking example of convergence in the Lower Paleolithic. Moreover, although bifaces appeared in China at various stages of the Stone Age, these show no technological or typological continuity with the Baise handaxes. This pattern suggests that convergent cultural evolution led to the appearance of bifaces at later stages, when the adaptation strategies had changed. For instance, bifacially worked tools from Dingcun differ from Baise handaxes both typologically and technologically, and they are 500–600 ka years "younger" than Baise specimens.

The Baise industry is very similar to the industry of the An Khê culture in central Vietnam, and differs in key ways from the Acheulean in Africa and Europe. Localities with bifaces in southern China and Vietnam are also much older than Acheulean sites in transit territories between Africa (Turkmenistan, Mongolia, and Kazakhstan) and East and Southeast Asia. These industries are also quite dissimilar in terms of both technology and typology.

Dates based on tektites from sites with bifaces at Baise were questioned by certain experts (Koeberl et al., 2000). Critics suggested that most tektites had been redeposited, and that judging by ethnological evidence, natives of Southeast Asia had also regularly used them for making stone tools or as amulets. Our discovery of tektites *in situ* at Lower Paleolithic sites near An Khê would seem to render these objections moot. All tektites at our study localities were found in association with stone artifacts in the lower stratigraphic layer, within lateritic sediments containing products of bedrock erosion, or within the weathering crust. No anthropogenic or natural disturbances of the lower layer were observed at the places where tektites occurred. Tektites are very small, so it is hardly possible to manufacture artifacts on them. In our view, there are no justifiable reasons to challenge the synchronicity of tektites and bifaces at the Lower Paleolithic sites in north-central Vietnam.

On the basis of the argon analysis, as mentioned above, sites with bifaces near An Khê date to 806 ± 22 ka BP and 782 ± 20 ka BP (Derevianko et al., 2017b). Technologically and typologically they are similar to those at Baise. In our opinion, both result from convergent evolution.

It is not always easy to distinguish bifaces, picks, or chopping tools among other Lower Paleolithic implements recovered from the An Khê region, since these have much in common in terms of morphology, technique, and extent of secondary reduction. All these tools possibly had similar functions. Presumably, it was important for the toolmaker to obtain implements suitable for cutting and processing bamboo, crushing, scraping, etc. The shape of the implement was determined by the type of blank, and also by primary and secondary reduction. No bifaces flaked over the entire surface have been found in the An Khê region. The most common are artifacts of subtriangular shape

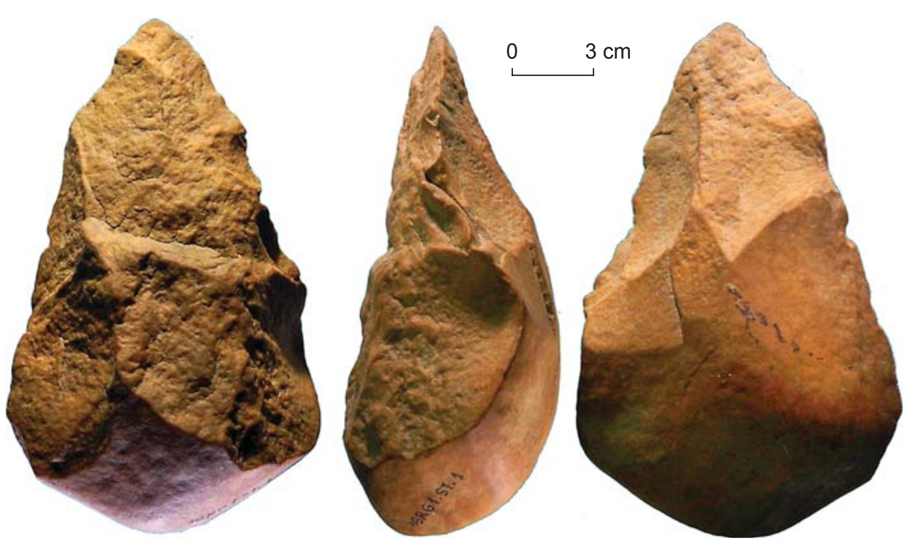


Fig. 12. Bifacial tool of the An Khê culture.

with one third or a half of surface flaked on both sides, and a deliberately prepared pointed tip. Describing these tools from Vietnam as bifaces (handaxes), we must keep in mind that they are not identical to the Acheulean bifaces from Africa or Europe (Fig. 12).

Conclusions

The absence of Acheulean sites dating to 700–800 ka BP anywhere from the Near East to Vietnam and China precludes the idea that the bifacial technique was introduced to eastern Eurasia by migrants of the second wave. The only feature linking the bifacial industries of Vietnam with the Acheulean is the presence of bifacially flaked tools. However, our research shows that the bifaces of the An Khê industry are very different from those of the European Acheulean, as well as from other artifacts of that industry. The absence of cleavers or the Levallois technique at An Khê sites provides every reason to believe that the bifacial technique emerged in Vietnam and China owing to convergent evolution. In East and Southeast Asia, we argue that this technique evolved from the local pebble-flake tradition, as evidenced by primary knapping, secondary reduction, and the entire technological and typological complex of the Lower Paleolithic.

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