C. R. Palevol 18 (2019) 142–157

Contents lists available at ScienceDirect

Comptes Rendus Palevol

www.sciencedirect.com

Human Paleontology and Prehistory (Prehistoric Archaeology)

# Discovery of a new open-air Hoabinhian site in Luang Prabang province (Lao PDR). Dating and technological study of the lithic assemblage

## *Découverte d'un nouveau site de plein-air hoabinhien dans la province de Luang Prabang (Laos). Datation et étude technologique de l'assemblage lithique*

Valéry Zeitoun[a,*], Emmanuel Bourdon[b,1], Keo Oudone Latsachack[c], Alain Pierret[b], Sommay Singthong[d], Henry Baills[e,f], Hubert Forestier[g]

[a] *UMR 7207 (CR2P), CNRS–UPMC–MNHN, Sorbonne Université, Université Pierre-et-Marie-Curie, tour 46-56, 5e étage, case 104, 4, place Jussieu, 75252 Paris cedex 05, France*
[b] *iEES-Paris (IRD–Sorbonne Universités–UPMC–CNRS–INRA–UDD–UPEC), c/o Department of Agricultural Land Management (DALaM), Vientiane, Lao People's Democratic Republic*
[c] *IRD Ban Naxai, Saysettha District, P.O. Box 5992, Vientiane, Lao People's Democratic Republic*
[d] *Muséum national d'histoire naturelle, UMR 7194 CNRS–MNHN–UPVD, Department of History and Archaeology, Faculty of Social Sciences, National University of Laos, PO. Box 3722 Dongdok Campus, Xaithany District, Vientiane Capital, Lao People's Democratic Republic*
[e] *UMR 7194 du Muséum national d'histoire naturelle, 36, rue Geoffroy-Saint-Hilaire, 75005 Paris, France*
[f] *Université Via Domitia, avenue Paul-Alduy, 66100 Perpignan, France*
[g] *Muséum national d'histoire naturelle, UMR 7194 CNRS–MNHN–UPVD, Institut de paléontologie humaine, 1, rue René-Panhard, 75013 Paris, France*

ARTICLE INFO

*Article history:*
Received 13 April 2018
Accepted after revision 23 May 2018
Available online 22 November 2018

Handled by Marcel Otte

*Keywords:*
Hoabinhian
Laos
Technology
Southeast Asia
Dating

ABSTRACT

The Hoabinhian is a distinctive lithic techno-complex of mainland and Island Southeast Asia. Knowledge of its relationships with key patterns of technological change at a global scale has progressed over the last two decades. However, our understanding of the Hoabinhian as an indicator of evolution during Prehistory can be substantially enhanced by examining its regional and chronological variability. Here, we present the characteristics of original Hoabinhian artefacts found in a new open-air site at Houay Pano, near Lak Sip (Luang Prabang province, Laos). This technological study of such a classic assemblage, including sumatraliths dated to $5.5 \pm 0.6$ ka, is a major contribution to Laotian prehistory and our understanding of the tempo-spatial variability of the Hoabinhian techno-complex.

© 2018 Académie des sciences. Published by Elsevier Masson SAS. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

* Corresponding author.
*E-mail address:* pythecanthro@gmail.com (V. Zeitoun).
[1] Deceased author.

https://doi.org/10.1016/j.crpv.2018.05.003
1631-0683/© 2018 Académie des sciences. Published by Elsevier Masson SAS. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

*Mots clés :*
Hoabinhien
Laos
Technologie
Asie du Sud-Est
Datation

R É S U M É

Le Hoabinhien est un techno-complexe lithique spécifique de l'Asie du Sud-Est, continentale et insulaire. La connaissance de ses relations avec les principaux modèles de changement technologique à l'échelle mondiale a progressé au cours des deux dernières décennies. Cependant, notre compréhension du Hoabinhien comme indicateur d'une évolution au cours de la Préhistoire peut être considérablement améliorée par l'examen de sa variabilité régionale et chronologique. Nous présentons ici les caractéristiques des artefacts hoabinhiens originaux trouvés dans un nouveau site de plein air à Houay Pano, près de Lak Sip (province de Luang Prabang, Laos). L'étude technologique de cet assemblage classique comprenant des sumatralithes datés de 5,5 ± 0,6 ka constitue une contribution majeure à la préhistoire laotienne et à notre compréhension de la variabilité temporelle et spatiale du techno-complexe Hoabinhien.

© 2018 Académie des sciences. Publié par Elsevier Masson SAS. Cet article est publié en Open Access sous licence CC BY-NC-ND (http://creativecommons.org/licenses/by-nc-nd/4.0/).

## 1. Introduction

Characterized by sumatraliths, the Hoabinhian is a lithic techno-complex from the late Pleistocene to Holocene, found in Mainland and Island Southeast Asia. However, it has long been hypothesized that this techno-complex may also have existed in Southwest China in rock-shelters of mountainous regions (Dai, 1988), but its first occurrence in dated deposits has only recently been confirmed in the Yunnan Province (Forestier et al., 2017; Ji et al., 2016). The oldest Hoabinhian industry in Asia is dated around 43.5 ka in the Xiaodong rock-shelter, and one of the more recent assemblages has been found at the border between Thailand and Myanmar, at Huai Hin, dated to around 3700 ± 30 BP (Forestier et al., 2013). Employing 'technological criteria' in his analysis of Hoabinhian artefacts, Gorman (1969, 1971, 1972) proposed that the absence of significant changes in lithic technology could probably be correlated with an apparent continuity in ecological conditions throughout the terminal Pleistocene into the Holocene. Such a view correlates with the geography of the Hoabinhian that spreads over a broad region from southern China to Sumatra, including North Vietnam, Laos, Myanmar, Thailand, Cambodia, Malaya, and also Northeast India.

For many years, the difficulty in defining the Hoabinhian phase as being distinct from the Neolithic or a local 'Mesolithic' (Mansuy and Colani, 1925), or even from a Pleistocene pebble-tool culture, was due to the overlapping nature of its three sub-stages, and also because some assemblages termed 'Hoabinhian with pottery' were similar to 'Hoabinhian without ceramic' (Reynolds, 1990). In North Vietnam, the former cultural phase (Hoabinhian with ceramic) of the middle Holocene was called 'Bacsonian', according to the initial proposal of Mansuy (1924, 1925a, 1925b) or 'Dabutian' in reference to the site of Da But (Nguyen, 2005; Patte, 1932).

The 'Neolithic transition' is an open research topic for East and Southeast Asia; it is limited to a period between the Southeast Asian Hoabinhian and the advent of metals as early as 2500 BP. Since the Neolithic of Southeast Asia probably has its roots in the sites of southern China (Hung et al., 2017), we will not discuss this topic in this article, even though the Hoabinhian site of Houay Pano is contemporary with this period.

The geographical locations of the Hoabinhian lithic assemblages have been widely accepted and used as evidence for paleoenvironmental human adaptations in Southeast Asia, and have been compared with other sites at a global scale and with adjacent regions, such as East Asia and South Asia (Gorman, 1970; Hutterer, 1977; Solheim, 1972). After two decades of defining Hoabinhian as a techno-complex (Forestier, 2000; Forestier et al., 2005b, 2013, 2017; Moser, 2001, 2012) rather than a tradition (Dunn, 1970), culture (Borikovsky, 1966; Matthews, 1966), or period (Mansuy and Colani, 1925; Saurin, 1969), it is now possible to discuss the emergence of cultural diversity in mainland Southeast Asia from a technological perspective (White, 2011).

As has recently been summarized (Singthong et al., 2016), archaeological excavations in Laos have been rare due to half a century of political instability. The re-investigation of Laotian prehistory did not really begin until 2005 with the Middle Mekong Archaeological Project led by J. White (Marwick et al., 2009), whose work focused on the Luang Prabang region. This area has been known since the late 19th century for the polished stones and metal tools collected by the 'Mission Pavie' (1879–1895) (Massie, 1904). Subsequently, an archaeological survey followed by the excavation of the Ban Don Tio cave was undertaken (Mansuy, 1920). Fromaget and Saurin (1936) later documented the excavations carried out in the caves of Tam Pong, west of Mekong, and at Tam Nang Anh 10 km north of Luang Prabang city (Fig. 1). Three different archaeological levels were identified at Tam Pong, with the presence of unifacial lithic pieces. Following this early period of research in Laos, only a few isolated Hoabinhian lithics and other prehistoric artefacts were described (Raymaekers, 2001; Sayavongkhamdy et al., 2000).

The work of the Middle Mekong Archaeological Project led to the discovery and excavation of Phou Phaa Khao rock-shelter and Tham Vang Ta Leow cave (White and Bouasisengpaseuth, 2008). The latter site provided three dates of around 9000 BP at the base of a sequence

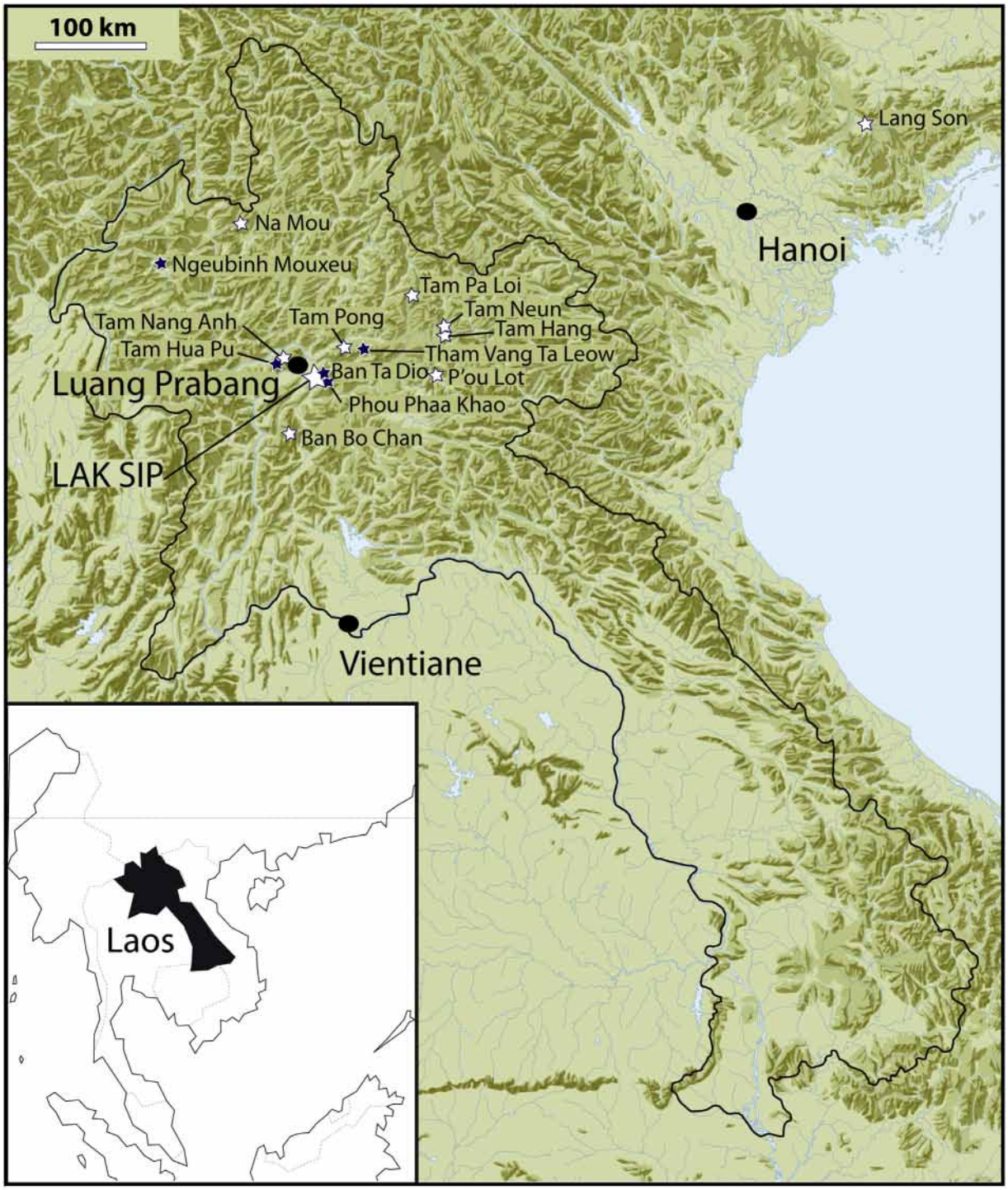


**Fig. 1.** Location of Lak Sip and the Laotian sites producing archaeological material. Dark stars: historically discovered sites; light stars: recently discovered sites.

**Fig. 1.** Situation de la localité de Lak Sip et des sites laotiens présentant du matériel archéologique. Étoiles sombres : sites historiques ; étoiles claires : sites récemment découverts.

containing Hoabinhian artefacts, which is surmounted by tombs, one of which has been dated to around 1800 BP (White et al., 2009). As part of this project, the riverbanks of the river system were systematically explored around Luang Prabang, including the perimeter of Lak Sip (Fig. 2). A multidisciplinary field research program operates in the Houay Pano catchment area (Lacombe et al., 2016; Ribolzi et al., 2017; Rochelle-Newall et al., 2016; Valentin et al.,

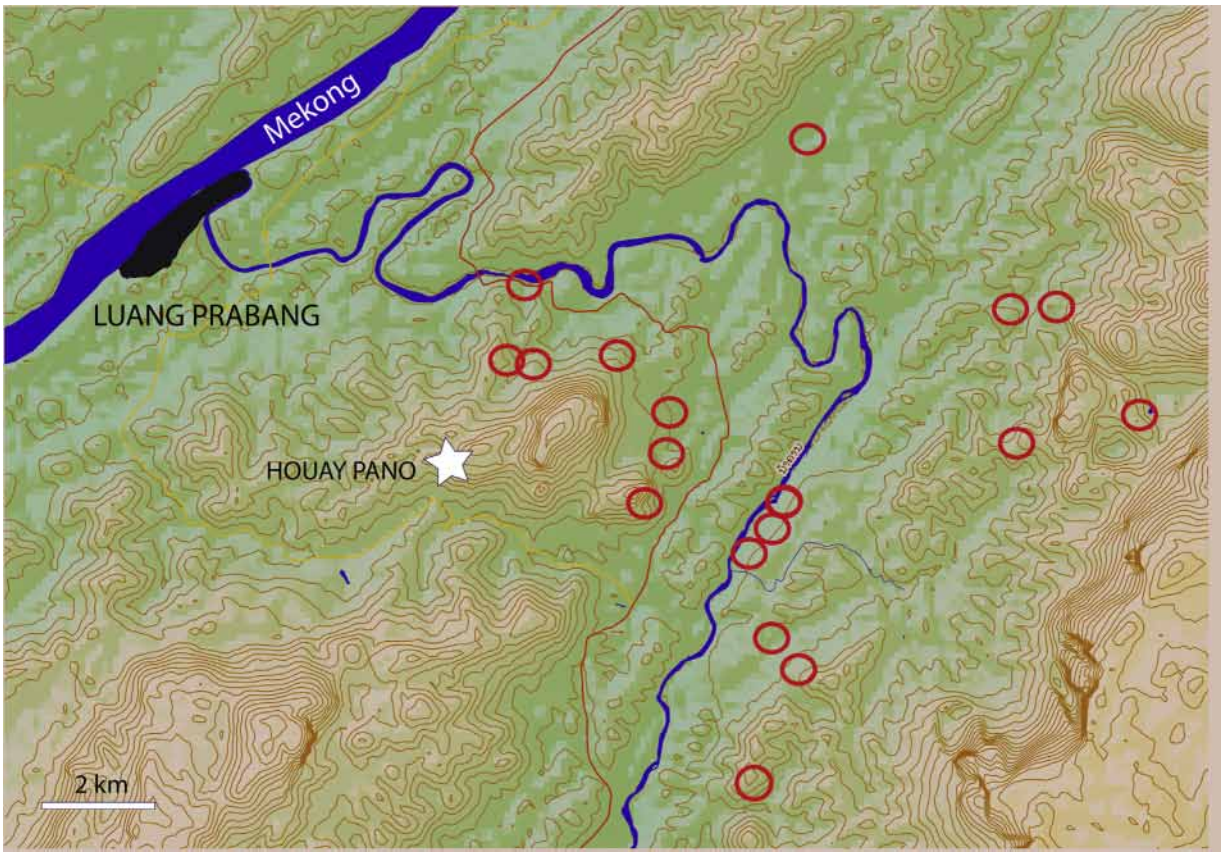


**Fig. 2.** Location of Houay Pano site (star) and survey locations of the Middle Mekong Archaeological Project (circles).
**Fig. 2.** Situation du site de Houay Pano (étoile) et position des localités prospectées par le Middle Mekong Archaeological Project (cercles).

2008; https://www.mtropics-fr.obs-mip.fr/), and E. Bourdon identified a lithic assemblage in the outcrop at an altitude of 635 m above sea level (N 19° 51′ 32″, E 102° 10′ 30″).

## 2. Material and methods

A survey carried out in the forest on a hillside ridge delivered 23 stone tools, including unusual lateral long choppers shaped on specific elongated pebbles (close to a sub-cylindrical shape). These choppers were presumably selected by prehistoric knappers to preferentially retouch the longest side of the pebble.

More than the overall raw material supply strategy, the most important step in the operational sequence (*chaîne opératoire*) of the Hoabinhian techno-complex is probably the choice of pebble morphology before knapping. The chosen natural pebble must meet all the morpho-technological criteria and have a correct equilibrium plane to obtain a peripheral edge by regular contour shaping. Thus, to form a uniface sumatralith, what is needed is a thin, flat pebble with a natural plano-convex section. The complexity of the Hoabinhian operational sequence can be summarized as involving three aspects: the project, the conceptual schema and the operational schema. This explains the variability of the operational sequences and the diversity of the different pebble tools produced (Forestier et al., 2015, 2017). Such a pre-selection process relates to unifacial flat pebbles or 'sumatraliths', chopper-chopping tools (Fig. 3), and the polished adzes discovered on the surface (Fig. 4).

The excavation carried out at Houay Pano identified an archaeological layer 10 cm below the ground surface. All of the lithic material was found in a 35-cm-thick layer of massive clayey sediment (6.5 Y/3.5/4). This archaeological layer is surmounted by a argilo-limonous transition level (7YR3/3) and is based on a massive clayey level with ferromagnesian nodules (7.5YR/3.5/4.5) (Fig. 5). The collected material includes hammers, pebble tools, scrapers, notches, and flakes.

### 2.1. Lithic artefacts

The lithic material is divided into two main groups of artefacts: surface and excavation artefacts.

The surface artefacts ($n = 24$) are not abundant, but they allowed a precise categorization of the stone industry as a Hoabinhian assemblage knapped on pebble raw material. The typological analysis of surface artefacts also revealed two polished stone adzes among the pebble tools. The shape morphologies commonly encountered are oval, quadrangular, elongated, and parallelepiped. The active parts of these pebble tools are shaped with retouch

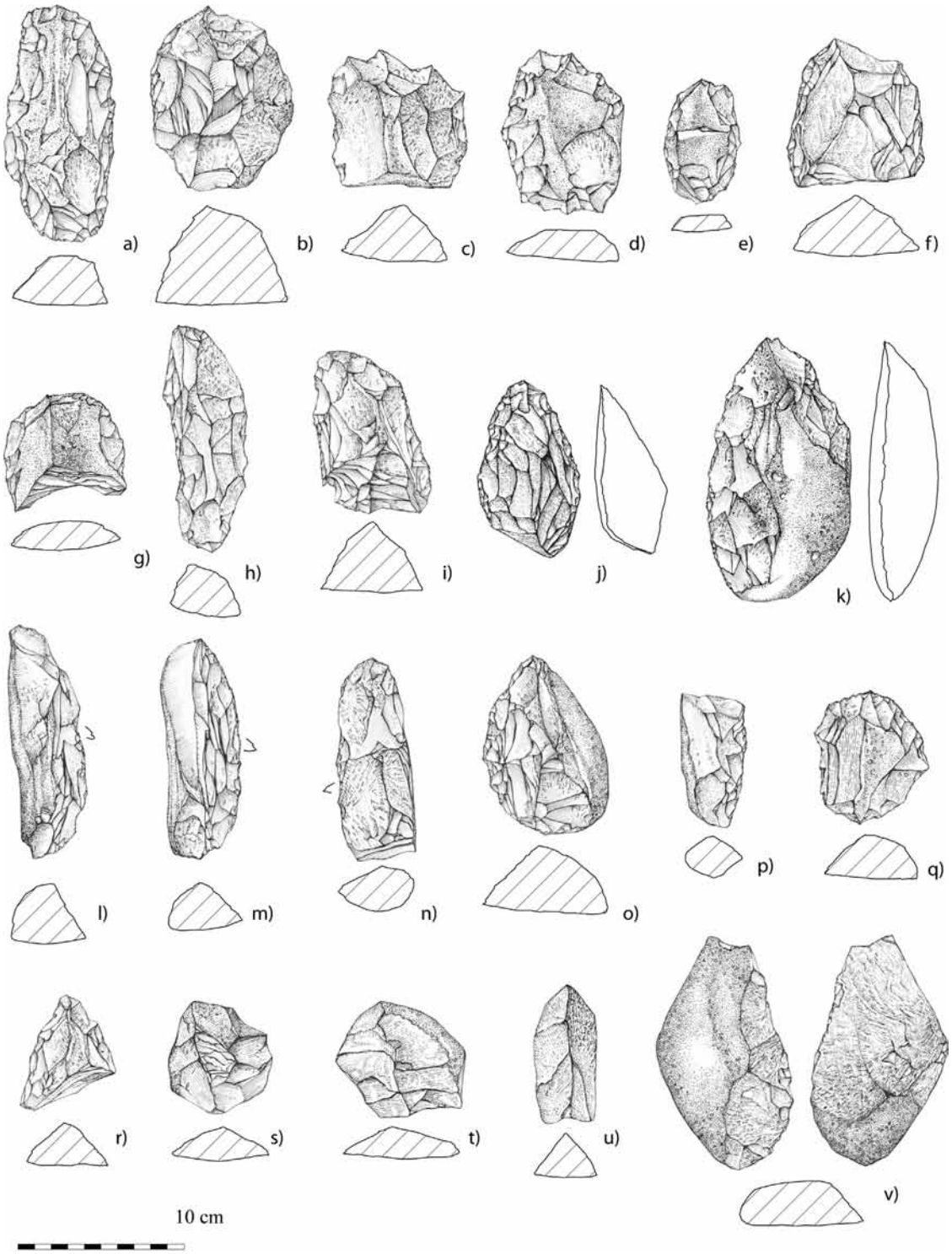


**Fig. 3.** Lithic material collected on the surface at Houay Pano: a–f: sumatralith; g: broken sumatralith; h and i: atypical sumatralith; j: convergent sumatralith; k: convergent uniface; l–p: lateral chopper; q: uniface; r: triangular uniface; s-u: flake; v: lateral scraper on pebble.

**Fig. 3.** Matériel lithique recueilli en surface à Houay Pano : a–f : sumatralithe ; g : fragment de sumatralithe ; h et i : sumatralithe atypique ; j : sumatralithe convergent ; k : uniface convergent ; l–p : chopper latéral ; q : uniface ; r : uniface triangulaire ; s–u : éclat ; v : racloir latéral sur galet.

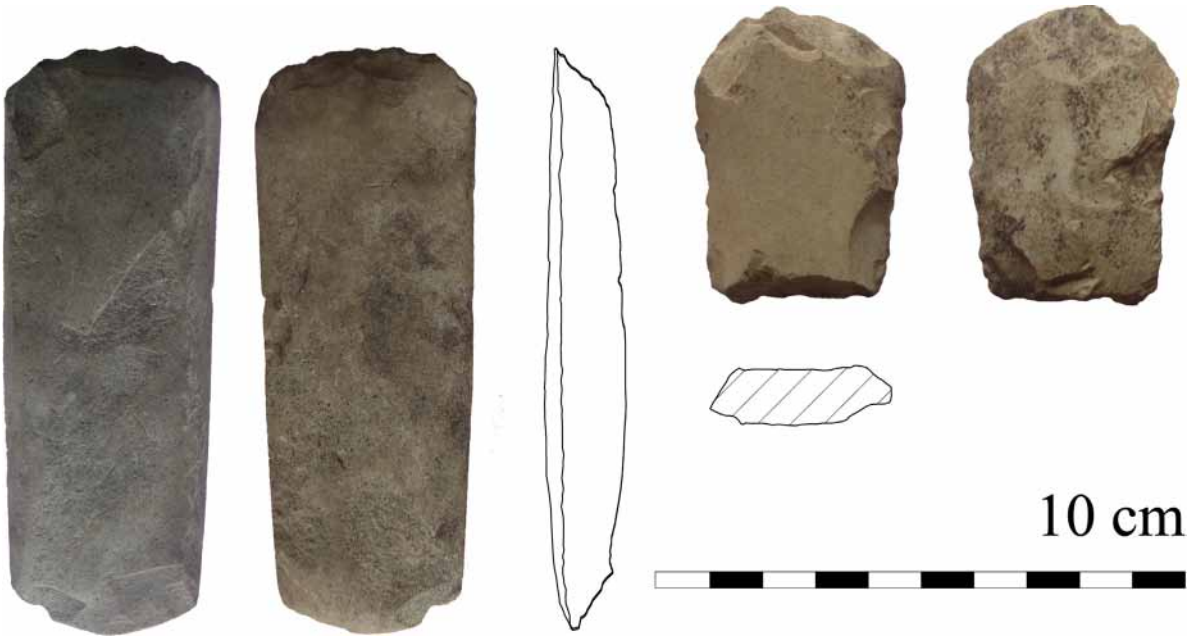


**Fig. 4.** Polished adze and piece of polished adze.
**Fig. 4.** Hache polie, fragment de hache polie.

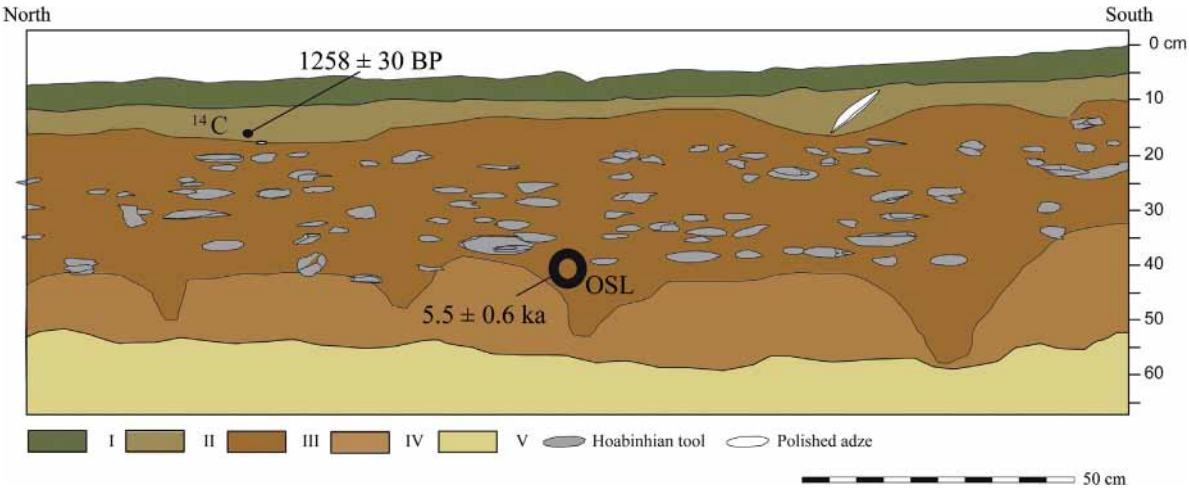


**Fig. 5.** Synthetic profile of Houay Pano with indication of the dating. I: Organic clay-silt horizon (8.5YR/1.5/2); II: clay-silt transition horizon (7YR3/3); III: locally bioperturbed massive clayey horizon (6.5 Y/3.5/4); IV: massive clayey horizon with ferromagnesian nodules (7.5YR/3.5/4.5); V: yellowish clayey horizon, altered rock (8YR/4/4.5).
**Fig. 5.** Coupe synthétique de Houay Pano, avec indication des datations réalisées. I : Horizon organique argilo-limoneux (8,5YR/1,5/2) ; II : horizon de transition argilo-limoneux (7YR3/3) ; III : horizon argileux massif localement bioperturbé (6,5 Y/3,5/4); IV: horizon argileux massif à nodules ferromagnésiens (7,5YR/3,5/4,5) ; V : horizon argileux jaunâtre, roche altérée (8YR/4/4,5).

preferentially on three techno-functional units/parts: distal part (pointed/convergent edge), lateral edge (lateral chopper), and peripherical-outline (typical Hoabinhian shaping, sumatralith–unifacially flaked pebble).

Analysis of the 116 excavated pieces from the single stratigraphic level also assigned the material to the Hoabinhian on morpho-typo-technological criteria. Two-thirds of these artefacts were in silicified limestone and sandstone, and the remainder in quartz. These artefacts consist of 73 unretouched flakes (Fig. 6), 14 flake tools (Fig. 7) and only 27 pebble tools (in the strict sense) which are classified into three distinct groups: lateral chopper (Fig. 8), typical sumatralith (unifacial), and '*limace*' (Fig. 9), a French term used by F. Bordes in his Paleolithic typology (Bordes, 1961). More or less symmetrical, the *limaces* are frequently heavy, thick, large and stunted, and have a double scraper edge converging in a fully retouched contour. It should also be noted that a grinding stone (Fig. 10) was found within the lithic assemblage, and that a polished adze (Fig. 11) not conforming with the rest of


**Fig. 6.** Unretouched flakes.
**Fig. 6.** Éclats non retouchés.

the assemblage was collected in the wall of the excavation.

Apart from the 14 flake tools made from shaping flakes, the Houay Pano stone tools are very cortical and have been made from long, heavy pebbles. These tools are mainly composed of unifacial pebbles comprising 'typical sumatraliths' (4%) shaped on oval-quandrangular morphology ($\leq$ 100 mm length), and also 'lateral choppers' with a thick

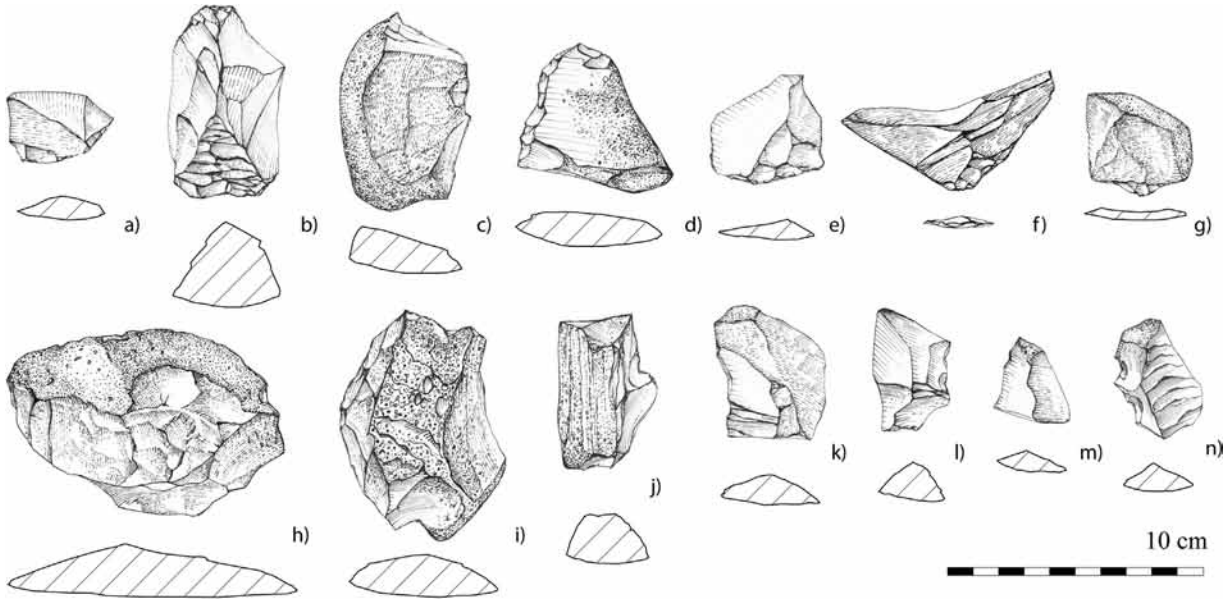


**Fig. 7.** Tools on flake: a: scraper; b: end scraper; c: natural back scraper; d: inverse scrapper; e–g: retouched flake; h–m: notch; n: double notch.
**Fig. 7.** Outils sur éclat : a : racloir ; b : racloir final ; c : racloir à dos naturel ; d : racloir inverse ; e–g : éclat retouché ; h–m : coche ; n : double coche.

cortical back opposite to the cutting edge (6%: ≥ 100 mm length). The *limaces* represent 4%, with sometimes an invert flat retouch on the proximal part (Fig. 9k). In addition to sumatraliths, numerous long and heavy lateral pebble tools and lateral choppers characterized the assemblage. Compared with the other stone tools, the dimensions of the lateral choppers (length, width, thickness) are greater, suggesting that morphology selection was made in terms of length and thickness. Another characteristic of this assemblage is the heterogeneity of the atypical and broken sumatraliths, including a pointed chopper ($n = 1$), an end scraper ($n = 1$), and also three hammers, one anvil and an unusual unifacial bi-point (Fig. 9e).

Seventy-five percent of the lithic material at Huay Pano is composed of flakes and flake tools, and 25% are pebble tools from which the flakes were produced during the shaping sequence (Fig. 12a). Among the most represented flakes, 84% are unretouched. The remaining 8% are retouched flakes, with macro-use marks on the edge, and 8% are micro-tools (end scraper, scraper, and notch) (Fig. 12b). Among the tools, 67% are manufactured from pebbles, 35% of which are unifacial tools (lateral chopper, sumatralith, *limace* and bipoint) and 22% are chopper tools. The flake tools represent only 33% of the total number of tools, with a majority of utilized tools and a small minority of notches relative to end scrapers and scrapers. The pebble tools are dominated by the lateral chopper (17%) which appears as a strong and original cultural marker of the Lak Sip lithic Hoabinhian assemblage; 12% are 'typical' sumatraliths, 12% are *limaces*, and 5% are atypical sumatraliths associated with 7% of hammer stones (Fig. 12c). Latero-transversal choppers, pointed choppers, end scrapers, and unifacial bipoints are also present. If we compare the group of the flake tools or utilized flakes with the pebble tools, we can observe that the most represented tools belong to two categories in equal proportion: the lateral choppers and utilized flakes (6%), and to a lesser extent the *limace* (4%), the typic uniface and the notch (Fig. 13a).

Usually the quantification of the cortex rate of the lithic pieces of an assemblage can quantify the length of the operational sequence (*chaîne opératoire*), but the production of unifacial pieces of pebble must be taken into account. Sumatraliths and unifaces, whose upper surfaces present more or less extensive evidence of residual cortical zones, are tools made of pebble with the cortex proportionally more important than those made of flake, with relative proportions of about 1/6 and 1/2, respectively (Fig. 13b). The quantity of cortex of the cortical flakes ($n = 33$) corresponds to the initial phase of the shaping reduction process on the pebbles to produce sumatraliths, choppers and *limaces*. The dorsal position of the cortex is more or less extended according to the different stages of the progression during the operational sequence. The flakes without cortex ($n = 40$) come from the last stage of the shaping or resharpening phase of the stone. The cortical or non-cortical flakes used as tools ($n = 7$) are the product of the shaping sequence.

The study of artefact size can determine whether or not fragment size was a selection factor when making the tools (Fig. 14a). It appears that long and thick flakes were preferred for making tools, while width does not seem to have been a selection criterion. The dimensional analysis of the three major types of pebble tools (chopper, *limace*, and sumatralith) also gives interesting observations. The choppers were chosen from amongst the largest pebbles (Fig. 14b), but this selection was not very strict judging by their standard deviation. On the other hand, the *limaces* show rather standardized widths and thicknesses, and their lengths are quite variable. The sumatraliths are the most interesting morphometric case in the assemblage because these pieces have a very tight standard

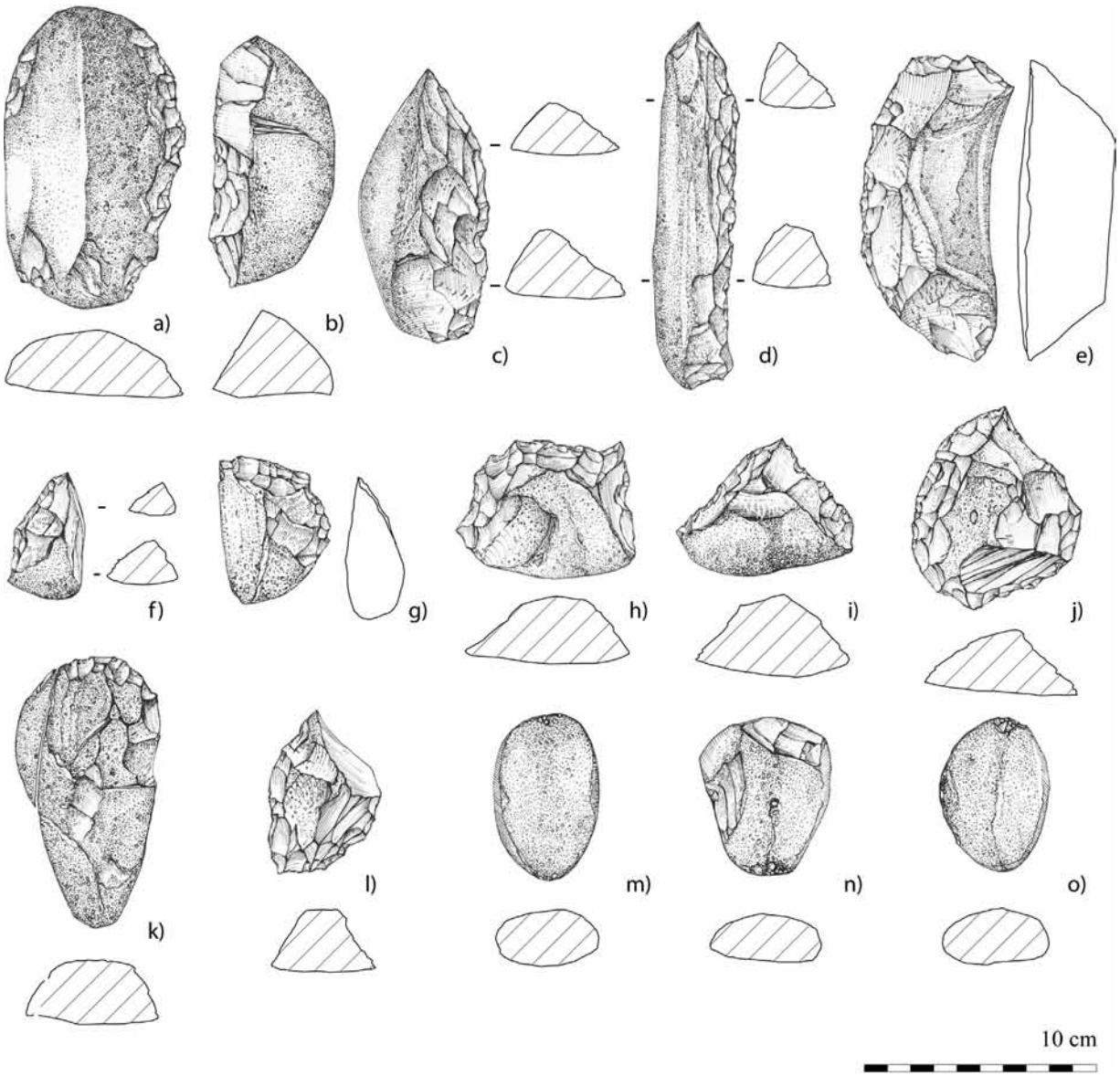


**Fig. 8.** Pebble tools: a–f: lateral chopper; g and h: chopper; i: convergent chopper; j: pebble tool; k: broken-end scrapper; l: fragment of pebble; m–o: hammer.
**Fig. 8.** Outils sur galet : a–f : chopper latéral ; g et h ; chopper ; i : chopper convergent ; j : outil sur galet ; k : racloir à extrémité cassée ; l : fragment de galet ; m–o : percuteur.

deviation with 9 cm < length < 10 cm; 4 cm < width < 5 cm; 3 cm < thickness < 4 cm, strongly suggesting that the knapper followed a precise tri-dimensional standard in their conceptual scheme.

### 2.2. Dating

Charcoal contained in the layer above the archaeological level was dated to 1258 ± 30 BP (Wk 23951). A sample of sediment taken at the base of the archaeological level was sent for OSL dating to the Division of Earth and Environmental Sciences at the Korea Basic Institute (Table 1). For this latter dating, the Single-Aliquot-Regenerative protocol was followed according to Choi et al. (2003). The radionuclide concentrations of the sample were measured using low-level high-resolution gamma spectrometry and conversion to dose rates used the data presented by Olley et al. (1996). All dose rates were modified using present and saturated water contents, and also the attenuation factors given by Zimmerman (1971). A Beta attenuation factor of 0.93 ± 0.03 was used for dose rate calculation of the sample. Cosmic ray contributions were assumed to be 0.13 ± 0.03 Gy/ka. After extraction of pure quartz grains from the sample, the separated grains were checked for the absence of feldspar contamination by IR stimulation on the natural and beta-irradiated

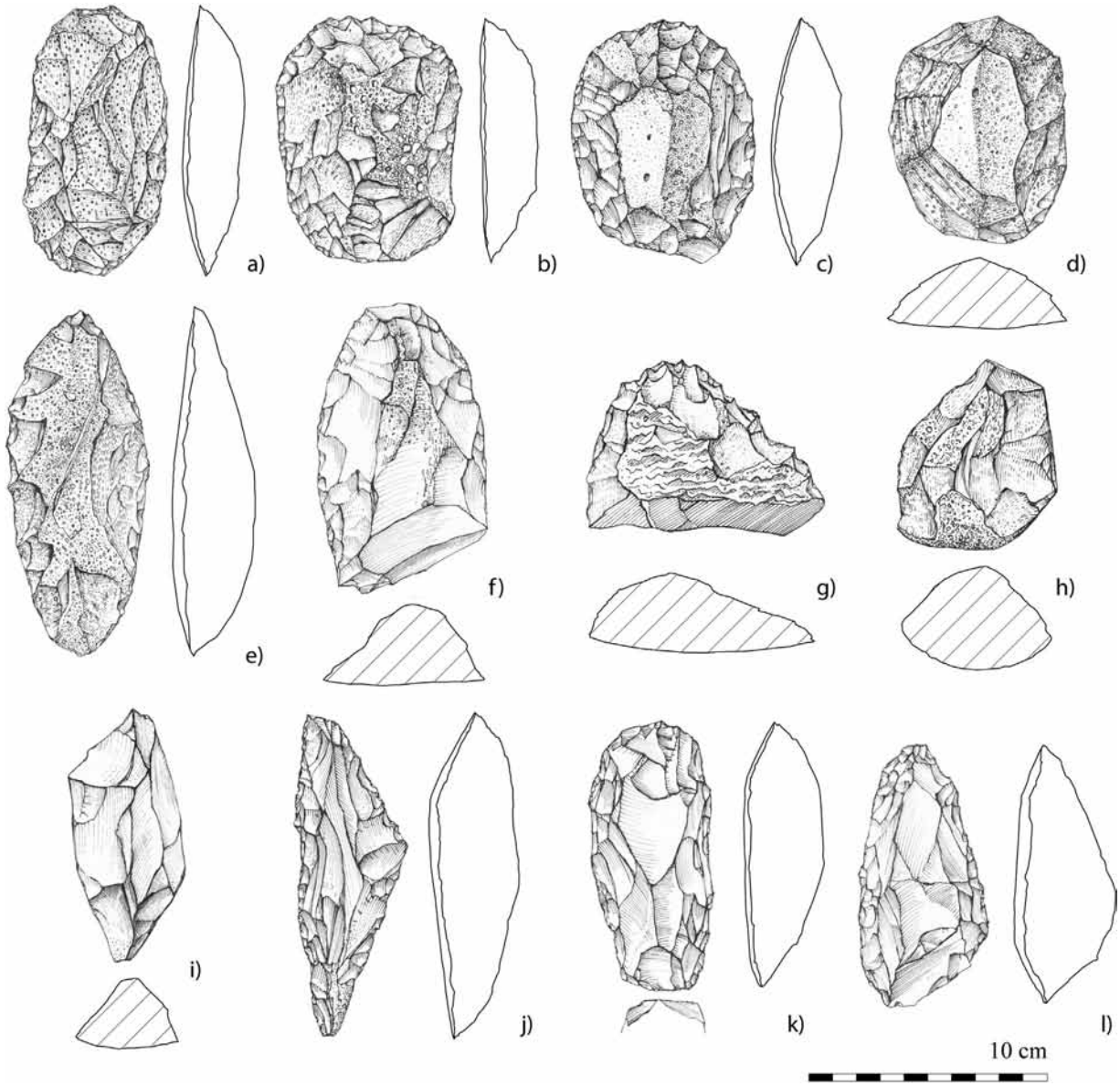


**Fig. 9.** Unifacial tools: a–d: typical sumatralith; e: convergent sumatralith; f: broken sumatralith; g: fragment of sumatralith; h: atypical sumatralith; i–l: atypical sumatralith (limace).
**Fig. 9.** Outils unifaciaux : a–d : sumatralithe ; e : sumatralithe convergent ; f : sumatralithe cassé ; g : fragment de sumatralithe ; h : sumatralithe atypique ; i–l : sumatralithe atypique (limace).

aliquots. The OSL measurement was carried out using two automated Risø TL/OSL measurement systems. The stimulation light source was a blue-LED ($470 \pm 30$ nm) array which delivers ~30 mW.cm$^{-2}$ to the sample position. The readers were also equipped with $^{90}Sr/^{90}Y$ beta sources delivering $0.068519 \pm 0.001530$ Gy·s$^{-1}$ and $0.215695 \pm 0.004633$ Gy·s$^{-1}$ to the sample. Photon detection was through 7 mm of Hoya U-340 filter. Equivalent doses were estimated using the SAR protocol (Murray and Wintle, 2000). For *De* estimation, 8 mm aliquots were used. Finally, these OSL dating techniques yielded an age of $5.5 \pm 0.6$ ka for the base of the level containing the archaeological artefacts.

## 3. Discussion

The Hoabinhian is a common lithic assemblage found throughout Southeast Asia. It is generally attributed to hunter-gatherer societies that occupied this region (Higham, 2013), but little is known about these societies in terms of their technological variability over time. Initially three cultural periods were distinguished in Southeast Asia: an archaic period with pebbles worked unifacially, an intermediary period with smaller-sized pieces and a better manufacturing process associated with adze-like tools grinded at one extremity, and finally, a third period with retouched tools, such as side-scrapers, end-scrapers, knives

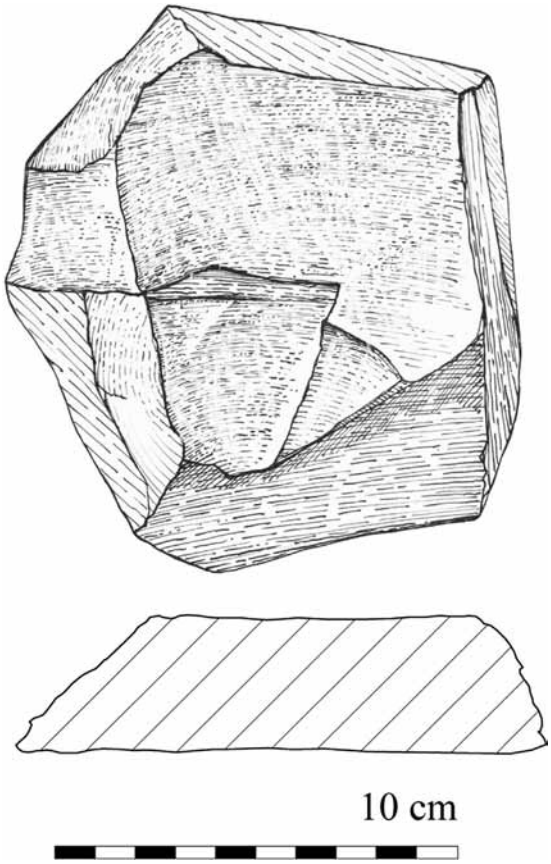


**Fig. 10.** Grinding stone.
**Fig. 10.** Meule.

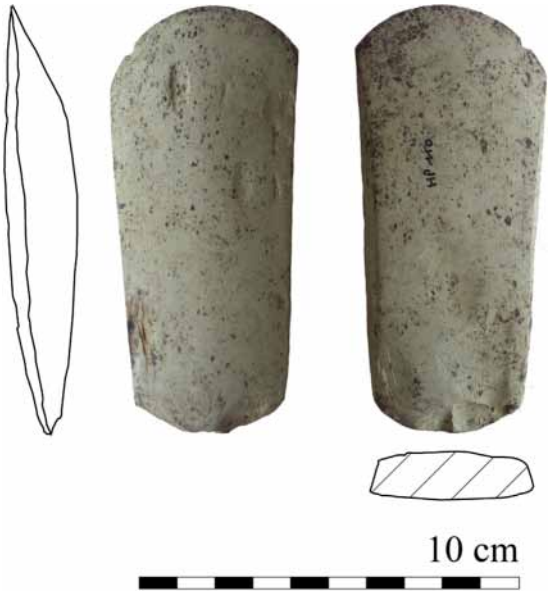


**Fig. 11.** Polished adze.
**Fig. 11.** Herminette polie.

and pestles (Colani, 1927). At that time, the name Hoabinhian was taken from the name of the Hoa Binh area where M. Colani worked at several sites (Colani, 1927, 1929a, 1929b). During the first *Congrès préhistorique d'Extrême-Orient* held in Hanoi in 1932, the commission defined Hoabinhian as 'a civilization with general flake implements and somewhat varied types and archaic shapes and characterized by tools worked on only one face, hammer stones, pieces with a big sub-triangular section, discs, short-axes, almond-shaped lithic tools and with a relatively large quantity of bone tools'. Subsequently, Hoabinhian also acquired a chronological definition, comprising three sub-stages: stage I with only fairly coarse and large flaked tools, stage II with smaller, more precisely worked tools, associated with simple artefacts made from pebbles grinded only on the cutting edge, and stage III with even smaller tools, retouched flakes and very rare grinded artefacts. Sumatraliths were present at each sub-stage and can be considered as 'master fossils' of the Hoabinhian. Historically, the first 'sumatraliths' were recovered in 1920 by J. Neumann in shell-middens at Batu Kenong, near Labuhan Deli in North Sumatra (Witkamp, 1920). These tools were similar to those found by Callenfels near Medan at the same time (Callenfels, 1924). It is of note that the first work dedicated to sumatraliths in North Sumatra was undertaken by Houbolt (1940). In the 1970s other researchers focused modern archaeological excavations on shell-middens (Brandt, 1976; Glover, 1979; Heekeren, 1972), and only more recently in caves in Southern Sumatra (Forestier, 2007a, 2007b) that have led to new discoveries at Gua Pandan and in Nias at Tögi Ndrawa (Forestier et al., 2005a, 2006, 2010).

A temporal definition of Hoabinhian was identified with the Mesolithic culture for some time (Gorman, 1969;

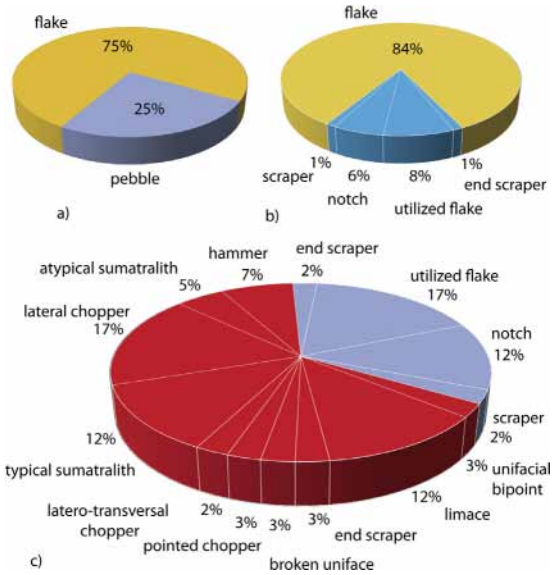


**Fig. 12.** a: Percentage of flakes in the lithic assemblage; b: percentage of retouched flakes in the flakes; c: percentage of pebble tools categories.
**Fig. 12.** a : Pourcentage d'éclats dans l'assemblage lithique ; b : pourcentage d'éclats retouchés parmi les éclats; c : pourcentage d'outils sur galet.

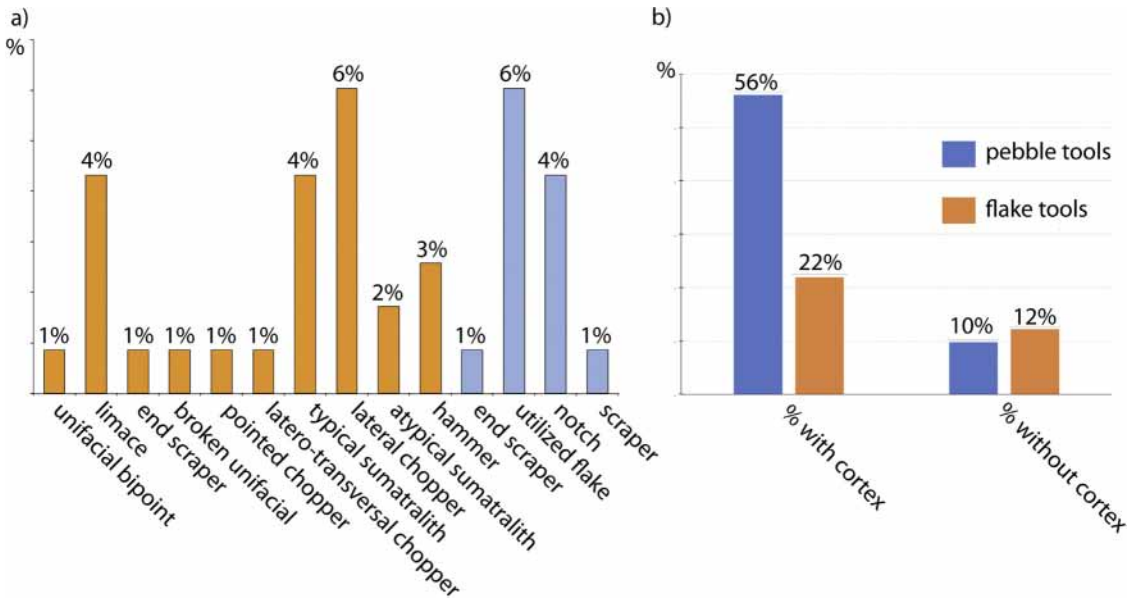


**Fig. 13.** a: Percentage of tools on flakes and pebbles; b: proportion of corticals in the different lithic supports.
**Fig. 13.** a : Pourcentage d'outils sur éclats et galets ; b : proportion de cortex sur les différents supports lithiques.

Heekeren, 1972; Matthews, 1966), but this conflation of the Hoabinhian with the Mesolithic was rejected by Callenfels in 1932 (in Collectif, 1932) and by Mourer and Mourer (1971) who highlighted the inapproptiateness of using the European terms. Saurin and Carbonnel (1974) reported on differing definitions of the Hoabinhian, in terms of chronology, technology and facies, discussing the similarities of Tam Hang in Laos with northern Vietnam, following the observations of Colani (Colani, 1931), and also reviewing the former debate on discontinuities between the Holocene and the Pleistocene. Whether or not the Hoabinhian belongs to an Indochinese Mesolithic is another question, also considering that the Neolithic may overlap with the Bacsonian to which Patte (1936) associated sub-stages II and III of the Hoabinhian. An evolutionist approach was provided for the Vietnamese sites, associating the Sonviian with the Hoabinhian (Nguyen, 1991; Van Tan, 1980, 1995, 1997) as was formerly done with the Bacsonian (Mansuy, 1924, 1925a, 1925b). There are, however, few well-dated sites whose assemblages are well-described from a typo-technological point of view, to be able to describe any chronological or regional evolution. Although Solheim (1970) initially pursued a vision of the Hoabinhian in three chronological sub-stages, finally he adhered to the notion of a techno-complex developed by Gorman (1969, 1971, 1972) who was perhaps one of the first to employ 'technological criteria' in his analysis of Hoabinhian artefacts. In the following years, Reynolds (1989, 1990, 1992) developed a typo-technological approach and Pookajorn (1996) assessed the reality of the Hoabinhian 'techno-complex' based on material from the Krabi province in southern Thailand. Finally, it was decided that the various lithic industries associated with Southeast Asian prehistoric 'cultures' (e.g., *Anyathian*, *Lannathian*, *Nguomian*, *Sonviian*) have no real analytical value or any strong typo-technological justification, and the confusion resulting from these ambiguous terminologies has led to the gradual abandonment of all but one cultural designation: the Hoabinhian (Zeitoun et al., 2008).

To observe variability in the Hoabinhian it is useful to take into account sites with no taphonomical problems, a reliable chronology, and a precise technological description of the lithic assemblages. Unfortunately, even today, few sites have all these required qualities, making reliable comparisons difficult.

In Laos, the oldest lithic artefacts were found at Ngeubinh-Mouxeu, in the Vieng Phu Khra province; dated between 56 ka and 45 ka (Zeitoun et al., 2012), these objects were made with a broadly unipolar alternating platform system and a short *chaîne opératoire*. Early studies had discovered Hoabinhian tools at Tam Pong (Fromaget and Saurin, 1936; Saurin, 1966) in the Luang Prabang province and at Tam Hang in the Huà Phan province (Arambourg and Fromaget, 1938; Fromaget, 1940a, 1940b; Fromaget and Saurin, 1936). The three archaeological levels recognized at Tam Pong range from the surface to 0.5 m, 0.5 m to 1.40 m, and 1.40 m to 1.80 m, respectively. Hoabinhian lithic artefacts were found in the two lower levels but it is necessary to transcribe what this means in relation to current data and terminology. Reserving the term Hoabinhian to only the archaic stage of Hoabinhian, Saurin (1969) assigns the human remains of Tam Pong to Hoabinhien *stricto sensu*. However, there are human remains in the so-called middle and lower levels, earlier described as Lower Neolithic and Mesolithic. Fromaget and Saurin (1936) had specified that Mesolithic human remains (cf. lower level) were present between 1.45 and 1.8 m, and that a skeleton squatting and lying on the back at the same depth as a polished-edged axe (0.9 m) was present in the Lower Neolithic (cf. middle level). Fromaget (1940) indicates that one skull

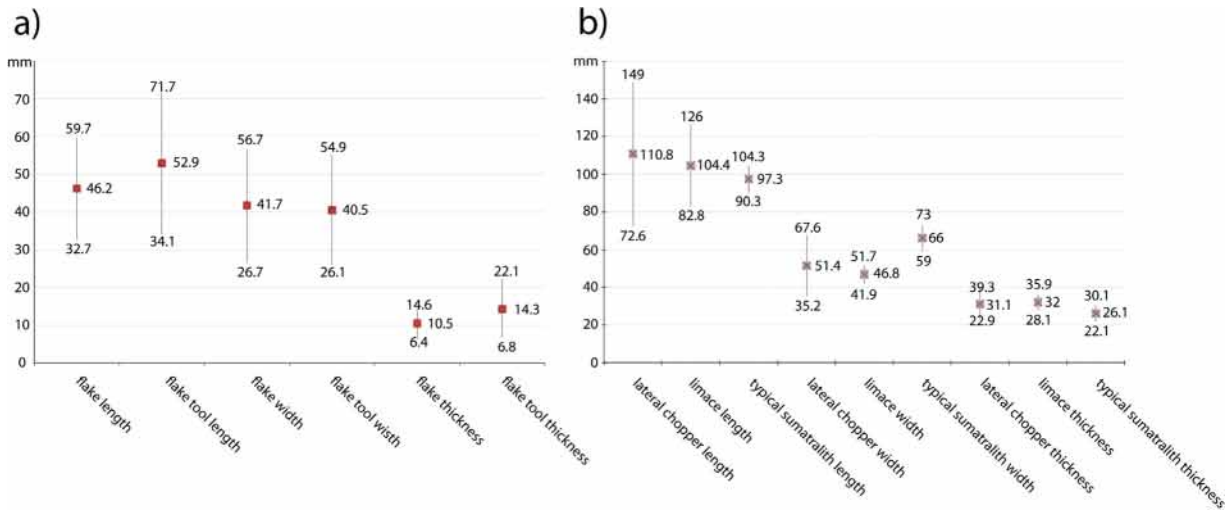


**Fig. 14.** a: Length and width comparisons of flakes and retouched flakes; b: length and width comparisons of the categories of pebble tools.

**Fig. 14.** a : Comparaisons des longueurs et largeurs des éclats et éclats retouchés ; b : comparaison des longueurs et largeurs des différentes catégories d'outils sur galet.

**Table 1**
Dating of the archaeological layer. Wk $^{14}$C AMS dating of charcoal; LK-1 OSL dating of the sediment.
**Tableau 1**
Datation du niveau archéologique. Wk $^{14}$C datation AMS du charbon; LK-1 datation OSL du sédiment.

| Sample | Material | $\delta^{13}$C | Analysis | Conventional radiocarbon age (yr. BP) |
|---|---|---|---|---|
| Wk23951 | Charcoal | −24.9 ± 0.2% | AMS | 1258 ± 30 |

| Sample | Dose rate Gy/Ka | Water content % | Equivalent dose % | Aliquot used | OSL age (ka 1σ SE) |
|---|---|---|---|---|---|
| Lk-1 | 0.48 ± 0.003 | 18.8 | 2.7 ± 0.2% | $n$ = 16 | 5.5 ± 0.6 |

and some post-cranial remains, and the remains of three individuals, including one maxillary and one mandible in connection, came from the Mesolithic (cf. lower level), and one adult skeleton and two children from the middle level. The skull Tam Pong No. 1 (20541) associated with post-cranial remains which was studied by Olivier (1966) was located at 1.45 m, at the top of the lower level and has a radiocarbon age of 5380 ± 60 BP, according to Demeter (2000). However, insofar as it is likely that these human remains belong to burials, some of which have been disturbed, it is not possible to state with certainty the age of the other bones. Assuming that each series of bones (Mesolithic and Lower Neolithic) is assigned to, at least, the overlying level of their burial position, the human remains from the lowest level can be assigned to the age of the middle level and the remains in the middle level to the age of the higher level. With this hypothesis the age of 5380 ± 60 BP would be a minimum age for the interface between the middle and lower Hoabinhian levels, and finally the middle level of Tam Pong would be contemporary to Huay Pano.

The typology of the lithic material collected in Huay Pano is very similar to that described at Tam-Pong (Fromaget and Saurin, 1936, pp. 28–29). Indeed, the middle level of Tam-Pong shows very clear typo-morphological similarities with Huay Pano as pebble tools: oval sumatraliths (Figs. 8a and 9b and c) or sub-triangular amigdaloid, relatively pointed (Figs. 8i and 9e) choppers (Fig. 8h), or different forms of end-scraper pebbles (Fig. 8k). Among these artefacts, those that stand-out due to their originality are undoubtedly the 'pebble tools with natural back and partially backed', which are present in Tam-Pong and which are very well represented in Lak Sip surface material (Fig. 3h, k–p) and excavation material (Fig. 8b–e). Associated with an unifacial pebble called '*hache de type Sumatra*' by Fromaget and Saurin (op. cit.) the 'pebble tool with natural back' or partially backed by retouch, could well be a very representative tool of the Laotian Hoabinhian tool kit. Some similar stone tools have also been reported in the cave material of Tam-Nang-Anh cave near Luang Prabang district (Fromaget and Saurin, 1936, p. 32).

The site of Tam Hua Pu was discovered by Anzai (1976) on the right bank of the Mekong River in the Luang Prabang province, and recently Hoabinhian artefacts have been excavated here (Sayavongkhamdy et al., 2000). Charcoal and shell material at this locality has been dated to 1340 ± 70 BP to 32,500 ± 900 BP, but the chronological series is not clearly linked to the archaeological artefacts due to the disturbance of the layers by human burials. Thus, the hypothesis that the Hoabinhian assemblage dates to around 4000 - 3500 BP is not supported by any clear evidence.

Concerning the Middle Mekong Archaeological Project, while the site of Phou Phra Khao rock-shelter has produced artefacts with similarities to the Hoabinhian, the archaeological layer has not been dated. On the other hand, at Tham

Vang Ta Leow, 67 cores and 6107 flakes were recovered, along with some sherds less than 1 m deep. This Hoabinhian industry was found to be more recent than 9770 ± 50 BP, as indicated by the dating of the layer at the bottom of the excavation (White et al., 2009).

In Hua Pan Province, the Tam Hang rock-shelter consists of three localities: Tam Hang North, Tam Hang Central, and Tam Hang South, covering a total length of 100 m. At Tam Hang South one of the individuals unearthed by Fromaget and Saurin (1936), THS 10, was directly dated to 15,740 ± 80 BP (Demeter, 2000) although Fromaget and Saurin (1936) clearly indicated that the Tam Hang South excavation stopped at 1.60 m (p.24). This represents an unresolved stratigraphic incongruity as Patole-Edoumba et al. (2015) reported a maximum age of 13,215 BP at 3.25 m. The 45-degree dipping of the layers could explain this incongruity, but this is probably due to the lack of records detailing the exact position of the artefacts during the excavation. In addition, because objects from the different test-pits were mixed, as stated in the publication, it is not possible to decipher the real lithic assemblages at each locality nor deduce the exact number of pieces per time interval for each test-pit. Consequently, it is not possible to deduce any evolution of the lithic assemblage over time. According to Patole-Edoumba et al. (2015) at Tam Hang South, test-pits 2, 3, 4, 5 and 6 have 926 objects located mainly at loci 4 and 5 in levels dated between 10,070 ± 40 BP and 13,215 ± 45 BP, However, the relevance of dividing the entire lithic assemblage into chronological batches of respectively 176, 313, 168 and 269 pieces is not associated with any clear mapping. Furthermore, in the Tham Hang Central sector, the lithic assemblage of more than 8000 pieces belonging to a layer dating from 9300 to 9700 BP is not described in detail. Therefore, unfortunately, due to the lack of a valid chronology at Tham Hang South and the lack of a detailed analysis at Tham Hang Central, the technical evolution of the diachronic sequence of Tam Hang is not demonstrated. Thus, these two Laotian localities cannot be used as comparisons for Houay Pano.

## 4. Conclusion

The proposal that the absence of significant changes in Hoabinhian lithic technology is correlated with a continuity in ecological conditions throughout the terminal Pleistocene into the Holocene (Gorman, 1969, 1971, 1972) remains very probable as this techno-complex was present throughout Northeast India, southern China, mainland Southeast Asia, and Sumatra, regions that were subtropical forests during this period. Such forested habitats are characterized by the absence of lithic technological modes 3, 4, and 5, and by the presence of highly distinctive pebble tools. The parallelism between lithic technology and subtropical forest appears to be a valid hypothesis when the Indian subcontinent, which is of the same size and latitude to Hoabinhian area, is taken into consideration. According to Blinkhorn and Petraglia (2017), Indian lithic technologies are heterogeneous and the tempo of technological change since the Middle Paleolithic is related to the establishment and intensity of a monsoon regime that has generated a particular mosaic of habitats, including deserts and tropical rainforests, alpine tundra and savannahs, subtropical woodlands and mangroves, and riparian corridors. Lithic modes 2, 3, 4, and 5 are present on the Indian subcontinent. Moreover, the Sri Lankan microlithic tradition represents an early and stable technological specialization exploiting South Asia's tropical forests in the Late Pleistocene and Holocene (Roberts et al., 2017), while the Hoabinhian is defined by the exploitation of pebble. In North and central China, which is of the same size and longitude to Hoabinhian area, but with various habitat types, the onset of the Upper Paleolithic is marked by core-and-flake tools (Otte, 2011; Peng et al., 2018). The proliferation of blade assemblages is demonstrated in Northwest China with an ensuing appearance of microblade assemblages in North China around 23,000 years ago (Qu et al., 2013). Such a fact underlines again the specificity of the Hoabinhian techno-complex on a global scale. However, it is legitimate to question whether this specificity and uniformity are not merely reflections of a lack of precise data.

Reynolds (1990) classified the Hoabinhian as only representing a particular facet of a more complexly organized society, where certain extractive tasks were performed by small groups in 'Hoabinhian localities', and the occupation of the lowlands and larger valley floors involved forest clearance and swidden, which may have involved separate ethnic groups or subdivisions within a single ethnic group. This would appear to be a potentially classic study of 'center and periphery' interactions in an archaeological context. Unfortunately, even today, only a few Hoabinhian sites display clear sequences of layers expressing Hoabinhian variability in such terms. A further detailed study *id est*, including technology and chronology assessments, as provided at Huay Pano, should be undertaken.

Based on the technological study of several lithic assemblages whose stratigraphy and chronology are well-defined, it is possible to identify variations within the Hoabinhian. Lithic technological studies focusing on how stone artefacts have been specifically knapped in Hoabinhian sites, such as Huai Hin in Thailand or Laang Spean in Cambodia, have demonstrated a clear and consistent theme throughout Southeast Asia (Forestier, 2000; Forestier et al., 2005b, 2013, 2015, 2017). Describing the manufacturing methods and techniques used in sites has provided more detailed information on tool use than what is provided by typology alone. Using this approach, the Hoabinhian can be characterised by a production using hard-hammer percussion with three distinct major operational sequences (*chaînes opératoires*), the variability of which remains unknown (Forestier et al., 2015, 2017): (1) a *chaîne opératoire* composed of classic unifacial shaping (*façonnage*) applied on long pebbles to produce final pieces called sumatraliths; (2) a relatively short *chaîne opératoire* also involving the shaping (*façonnage*) of thick ovoid pebbles for the production of choppers or chopping-tools; and (3) a third *chaîne opératoire* that integrates debitage to produce half-pebbles or split pebbles (split + or 'positive' with bulb and split–or 'negative' with negative bulb) that are then shaped (*façonnage*) into tools made by retouch, such as scrapers, denticulated or notches.

The lithic production at Houay Pano in Laos is a new illustration of the diversity of pebble tools in Southeast

Asia during the Holocene. It also illustrates the long history of knapping techniques which characterize the stone tool industry from the end of the upper Pleistocene to the mid-Holocene. Houay Pano may also provide information to confirm the dating of its neighboring site of Tam Pong. Finally, variability in the methods and techniques used for 30,000 years to knap pebbles in subtropical forest of Southeast Asia will need to be clarified in future technological studies of well-dated lithic series.

## Acknowledgments

Funds for excavating and dating were provided by the French ANR–AIRD program "Sédentarités autour du Mékong". We thank Becky Coles for the English language corrections and anonymous reviewers for their constructive comments.

## References

Anzai, M., 1976. Stone artefacts collected at prehistoric cave sites in Laos. Kokogaku Zasshi 61, 81–82.
Arambourg, C., Fromaget, J., 1938. Le gisement quaternaire de Tam Nang (Chaîne Annamitique septentrionale). Sa stratigraphique et ses faunes. C. R. Hebd. Seances Acad Sci. Paris 203, 793–795.
Blinkhorn, J., Petraglia, M., 2017. Environments and culturl change in the Indian subcontinent. Implications for the dispersal of Homo sapiens in the Late Pleistocene. Curr. Anthropol. 58, S463–S479.
Bordes, F., 1961. Typologie du Paléolithique ancien et moyen. Demas, Bordeaux, France.
Borikovsky, P., 1966. Basic problems of the prehistoric archaeology of Vietnam. Asian Perspect. 9, 83–85.
Brandt, R., 1976. The Hoabinhian of Sumatra: some remarks. Modern Quat. Res. Southeast Asia 2, 49–52.
van Stein Callenfels, P., 1924. Het eerste palaeolithische werktuig in den Archipel. Oudheidkundige Verlag, pp. 127–133.
Choi, J.H., Murray, A.S., Jain, M., Cheong, C.S., Chang, H.W., 2003. Luminescence dating of well-sorted marine terrace sediments on the southeastern coast of Korea. Quat. Sci. Rev. 22, 407–421.
Colani, M., 1927. L'âge de pierre dans la province de Hoa Binh (Tonkin) (The stone age in the province of Hoa Binh (Tonkin)). Mem. Serv. Geol. Indochine 14, 1–60.
Colani, M., 1929a. Quelques paléolithes hoabiniens typiques de l'abri sous-roche de Lang Kay. Bull. École Fr. Extrême-Orient 26, 353–384.
Colani, M., 1929b. Quelques stations hoabinhiennes (note préliminaire). Bull. École Fr. Extrême-Orient 29, 261–272.
Colani, M., 1931. Recherche sur le préhistorique indochinois. Bull. École Fr. Extrême-Orient 30, 299–422.
Collectif, 1932. Praehistorica Asiae Orientalis: 1, Premier Congrès des préhistoriens d'Extrême-Orient, Hanoi. Imprimerie d'Extrême-Orient, Hanoi.
Dai, G., 1988. On the relationship between Southeast Asian 'Hoabinhian Culture' and the culture of Southern China. Southeast Asian 1, 52–61.
Demeter, P., (Thesis) 2000. Histoire du peuplement humain de l'Asie extrême orientale depuis le Pléistocène supérieur récent. University Paris-1.
Dunn, F., 1970. Cultural evolution in the late Pleistocene and Holocene of Southeast Asia. Am. Anthropol. 72, 1041–1054.
Forestier, H., 2000. Chaînes opératoires lithiques en Asie du Sud-Est au Pléistocène supérieur final et au début de l'Holocène. L'Anthropologie 104, 531–548.
Forestier, H., 2007a. Les éclats du passé préhistorique de Sumatra : une longue histoire des techniques. Archipel 74, 15–44.
Forestier, H., 2007b. Archéologie à Sumatra. Archipel 74, 15–44.
Forestier, H., Simanjuntak Truman, Guillaud, D., Driwantoro, D., Wiradnyana, K., Siregar, D., Due Awe, R., Budiman, 2005a. Le site de Tögi Ndrawa, île de Nias, Sumatra nord : les premières traces d'une occupation hoabinhienne en grotte en Indonésie. C. R. Palevol 4, 727–733.
Forestier, H., Sophady, H., Celiberti, V., 2017. The Hoabinhian technocomplex in Mainland Southeast Asia: The history of a pebble which hides the forest. J. Lithic Stud. 4, http://dx.doi.org/10.2218/jls.v4i2.2545.
Forestier, H., Sophady, H., Puaud, S., Celiberti, V., Frère, S., Zeitoun, V., Mourer-Chauviré, C., Mourer, R., Than, H., Billault, L., 2015. The Hoabinhian from Laang Spean Cave in its stratigraphic, chronological, typo-technological and environmental context (Cambodia, Battambang province). J. Archaeol. Sci. Rep. 3, 194–206.
Forestier, H., Zeitoun, V., Seveau, A., Driwantoro, D., Winayalai, C., 2005b. Prospections paléolithiques et perspectives technologiques pour redéfinir le Hoabinhien du nord de la Thaïlande (campagnes 2002–2005). Aséanie 15, 33–60.
Forestier, H., Driwantoro Dubel, Guillaud, D., Budiman, 2006. New data about prehistoric chronology of South Sumatra. In: Simanjuntak, T. (Ed.), Archaeology: Indonesian perspective. R.-P. Soejono Festschriift. Lipi, Jakarta, pp. 727–733.
Forestier, H., Simanjuntak, T., Detroit, F., Zeitoun, V., 2010. Unité et diversité préhistorique entre Java et Sumatra. Archipel 80, 19–44.
Forestier, H., Zeitoun, V., Winayalai, C., Métais, C., 2013. The open-air site of Huai Hin (Northwestern Thailand): chronological perspectives for the Hoabinhian. Palevol 12, 45–55.
Fromaget, J., 1940a. Les récentes découvertes anthropologiques dans les formations préhistoriques de la chaîne annamitique. In: Proceedings of the Third Congress of Prehistorians of the Far East, Singapore, 1938, pp. 51–59.
Fromaget, J., 1940b. La stratigraphie des dépôts préhistoriques de Tam Hang (Chaîne Annamitique septentrionale) et ses difficultés. In: Proceedings of the Third Congress of Prehistorians of the Far East, Singapore, 1938, pp. 60–70.
Fromaget, J., Saurin, E., 1936. Note préliminaire sur les formations cénozoiques et plus récentes de la chaîne anamitique septentrionale et du Huat-Laos. (Stratigraphie, Préhistoire, Anthropologie). Bull. Serv. Geol. Indochine XXII (3).
Glover, I., 1979. Report on a visit to archaeological sites near Medan, Sumatra. Bull. Indo-Pacific Prehist. Assoc. 1, 56–60.
Gorman, C., 1969. Hoabinhian: a pebble tool complex with early plant associations in Southeast Asia. Science 163, 671–673.
Gorman, C., 1970. Excavations at Spirit cave, North Thailand: some interim interpretations. Asian Perspect. 13, 79–107.
Gorman, C., 1971. The Hoabinhian and after: subsistence patterns in Southeast Asia during the Late Pleistocene and early recent periods. World Archaeol. 2, 300–320.
Gorman, C., 1972. Excavations at Spirit Cave, North Thailand: some interim interpretations. Asian Perspect. 13, 79–107.
van Heekeren, H., 1972. The stone Age of Indonesia, 2nd ed. Martinus Nijhoff, The Hague, The Netherlands.
Higham, C., 2013. Hunter-gatherers in Southeast Asia: from prehistory to present. Hum. Biol. 85, 21–44.
Houbolt, J., 1940. Bijdrage tot de kenis van de versprending van paleolitische artefacten in Nederlandsch Indie. Tijdschrift Batavia Gravenhage 80, 614–617.
Hung, H.C., Chi, Z., Matsmura, H., Zhen, L., 2017. Neolithic Transition in Guangxi: A Long Development of Hunting-Gathering Society in Southern China. In: Matsmura, H., Hung, H.C., Zhen, L., Shinoda, K. (Eds.), Bio-anthropological studies of early Holocene hunter-gatherer site at Huiyaotian and Liyupo in Guangxi, China. National Museum of Nature and Science Monograph 47, Tokyo, pp. 205–228.
Hutterer, K., 1977. Reinterpreting the Southeast Asian Palaeolithic. In: Allen, J., Golson, J., Jones, R. (Eds.), Sunda and Sahul. Academic Press, London, pp. 31–71.
Ji, X., Kuman, K., Clarke, R., Forestier, H., Ma, J., Qiu, K., Li, H., Wu, Y., 2016. The oldest Hoabinhian technocomplex in Asia (43.5 ka) rockshelter, Yunnan province, southwest China. Quat. Int. 400, 166–174.
Lacombe, G., Ribolzi, O., de Rouw, A., Pierret, A., Latsachak, K., Silvera, N., Pham Dinh, R., Orange, D., Janeau, J.L., Soulileuth, B., Robain, H., Taccoen, A., Sengphaathith, P., Mouche, E., Sengtaheuanghoung, O., Tran Duc, T., Valentin, C., 2016. Contradictory hydrological impacts of afforestation in the humid tropics evidenced by long-term field monitoring and simulation modelling. Hydrol. Earth Syst. Sci. 20, 2691–2704.
Mansuy, H., 1920. Contributions à l'étude de l'Indochine. I. L'industrie de la pierre et du bronze dans la région de Luang Prabang (Haut-Laos). Hanoi, Imprimerie d'Extrême-Orient. Bull. Serv. Geol. Indochine 7 (14 p.).
Mansuy, H., 1924. Stations préhistoriques dans les cavernes du massif calcaire de Bac-Son (Tonkin). Mem. Serv. Geol. Indochine 10, 1–37.
Mansuy, H., 1925a. Nouvelles découvertes dans les cavernes du massif calcaire de Bac-Son (Tonkin). Mem. Serv. Geol. Indochine 12, 1–39.
Mansuy, H., 1925b. Stations préhistoriques de Kéo-Phay (suite), de Khac-Kiêm (suite), de Lai-ta et de Bang-Mac, dans le massif calcaire de Bac-Son (Tonkin). Mem. Serv. Geol. Indochine 12, 1–21.

Mansuy, H., Colani, M., 1925. Néolithique inférieur (Bacsonien) et Néolithique supérieur dans le Haut-Tonkin (dernières recherches). Avec la description des cranes du gisement de Lang Cuom. Mem. Serv. Geol. Indochine 12, 1–44.
Marwick, B., White, J.C., Bouasisengpaseuth, B., 2009. The Middle Mekong Archaeology Project and International Collaboration in Luang Prabang, Laos. SAA Archaeol. Rec. 9, 25–27.
Massie, M., 1904. Catalogues des objets des âges de la pierre et du bronze recueillis dans la région de Luang Prabang. In: Pavie, A. (Ed.), Mission Pavie Indo-Chine 1879–1895. Recherches sur l'histoire naturelle de l'Indochine orientale. Ernest Leroux Éditeur, Paris, pp. 10–16.
Matthews, J.M., 1966. A review of the Hoabinhian in Indo China. Asian Perspect. 9, 86–95.
Moser, J., 2001. Hoabinhian, Geographie und Chronologie eines steinzeitlichen Technocomplexes in Südostasien. Linden Soft, Köln, Germany (194 p.).
Moser, J., 2012. The Hoabinhian Definition—In the Past and Today: A Short Historical Review of Defining the Hoabinhian, Crossing Borders: Selected Papers from the 13th International Conference of the European Association of Southeast Asian Archaeologists. NUS Press, pp. 3–25.
Mourer, C., Mourer, R., 1971. Prehistoric research in Cambodia during the last ten years. Asian Perspect. 14, 35–42.
Murray, A.S., Wintle, A.G., 2000. Luminescence dating of quartz using an improved single-aliquot regenerative-dose protocol. Radiat. Meas. 32, 57–73.
Nguyen, V., 1991. Back to the periodization of Hoabinhian in Vietnam. Recent Research in Prehistory Archaeology in Thailand. Silpakorn University, Thailand, pp. 166–171.
Nguyen, V., 2005. The Da But culture: evidence for cultural development in Vietnam during the Middle Holocene. Bull. Indo-Pacific Prehist. Assoc. 25, 89–93.
Olivier, G., 1966. Révision d'un crâne mésolithique de Tam-Pong (Laos). Bull. Mem. Soc. Anthropol. Paris 9, 229–253.
Olley, J., Murray, A., Roberts, R., 1996. The effects of disequilibria in the uranium and thorium decay chains on burial dose rates in fluvial sediments. Quat. Sci. Rev. 15, 751–760.
Otte, M., 2011. La Préhistoire de la Chine et de l'Extrême-Orient. Éditions Errance,–WorldCat/UniCat, Paris.
Patole-Edoumba, E., Duringer, P., Richardin, P., Shackelford, L., Bacon, A.-M., Sayavongkhamdy, T., Ponche, J.-L., Demeter, P., 2015. Evolution of the Hoabinhian techno-complex of Tam Hang rock shelter in Northeastern Laos. Archaeol. Disc. 3, 140–157.
Patte, E., 1936. L'Indochine préhistorique. Rev. Anthropol. 46, 277–314.
Patte, E., 1932. Le Kökkenmöddong néolithique de Da But et ses sépultures. Bull. Serv. Geol. Indochine 19, 1–66.
Peng, F., Guo, J., Lin, S., Wang, H., Gao, X., 2018. The onset of Late Paleolithic in North China: an integrative review of the Shuidonggou site complex, China. L'Anthropologie 122, 74–86.
Pookajorn, S., 1996. Human activities and environmental changes during the Late Pleistocene to Middle Holocene in Southern Thailand and Southeast Asia. In: Straus, L.G., Eriksen, B.V., Erlandson, J.M., Yesner, D.R. (Eds.), Humans at the end of the ice age: the archaeology of the Pleistocene-Holocene transition. Plenum Press, New York, pp. 201–213.
Qu, T., Bar-Yosef, O., Wang, Y., Wu, X., 2013. The Chinese Upper Paleolithic: Geography, Chronology, and Techno-typology. J. Archaeol. Res. 21, 1–73.
Raymaekers, P., 2001. Prospection archéologique de la vallée laotienne du fleuve Mékong. BAR International serie 972. Archeopress, Oxford.
Reynolds, T., 1989. Techno-typology in Thailand: a case study of Tham Khao Khi Chan. Bull. Indo-Pacific Prehist. Assoc. 9, 33–43.
Reynolds, T., 1990. Problems in the Stone Age of Thailand. J. Siam Soc. 78, 109–114.
Reynolds, T., 1992. Excavations at Banyan Valley Cave, northern Thailand: a report on the 1972 season. Asian Perspect. 31, 77–97.
Ribolzi, O., Evrard, O., Huon, S., de Rouw, A., Silvera, N., Latsachack, K.O., Soulileuth, B., Lefèvre, I., Pierret, A., Lacombe, G., Sengtaheuanghoung, O., Valentin, C., 2017. From shifting cultivation to teak plantation: effect on overland flow and sediment yield in a montane tropical catchment. Sci. Rep. 7, 3987, http://dx.doi.org/10.1038/s41598-017-04385-2.
Roberts, P., Perera, N., Wedage, O., Deraniyagala, S., Perera, J., Eregama, S., Petraglia, M., Lee-Thorp, J., 2017. Fruits of the forest: Human stable isotope ecology and rainforest adaptations in Late Pleistocene and Holocene (~36 to 3 ka) Sri Lanka. J. Hum. Evol. 106, 102–118.
Rochelle-Newall, E., Ribolzi, O., Viguier, M., Thammahacksa, C., Silvera, N., Latsachack, K., Pham Dinh, R., Naporn, P., Tran Sy, H., Soulileuth, B., Hmaimum, N., Sisouvanh, P., Robain, H., Janeau, J.-L., Valentin, C., Boithias, L., Pierret, A., 2016. Effect of land use and hydrological processes on *Escherichia coli* concentrations in streams of tropical, humid headwater catchments. Sci. Rep. 6, 32974, http://dx.doi.org/10.1038/srep32974.
Saurin, E., 1969. Les recherches préhistoriques au Cambodge, Laos et Vietnam (1877–1966). Asian Perspect. 12, 27–41.
Saurin, E., Carbonnel, J.P., 1974. Évolution préhistorique de la péninsule indochinoise d'après les données récentes. Paleorient 2, 133–165.
Saurin, E., 1966. Le mobilier préhistorique de l'abri-sous-roche de Tam Pong (Haut Laos). Bull. Soc. Etudes Indochine 41, 106–118.
Sayavongkhamdy, T., Bellwood, P., Bulbeck, D., 2000. Recent archaeological research in Laos. Bull. Indo-Pacific Prehist. Assoc. 19, 101–110.
Singthong, S., Zeitoun, V., Pierret, A., Forestier, H., 2016. An outlook on prehistoric research in Laos: inventory and perspectives. Quat. Int. 416, 177–182.
Solheim, W., 1970. Prehistoric Archaeology in Eastern Mainland Southeast Asia and the Philippines. Asian Perspect. 13, 47–58.
Solheim, W., 1972. The "new look" of Southeast Asian prehistory. J. Siam Soc. 60, 1–20.
Valentin, C., Agus, F., Alamban, R., Boosaner, A., Bricquet, J.P., Chaplot, V., de Guzman, T., de Rouw, A., Janeau, J.L., Orange, D., Phachomphonh, K., Duy Phai, D., Podwojewski, P., Ribolzi, O., Silvera, N., Subagyono, K., Thiébaux, J., Tran Duc, T., Vadari, T., 2008. Runoff and sediment losses from 27 upland catchments in Southeast Asia: impact of rapid land use changes and conservation practices. Agricult. Ecosyst. Environ. 128, 225–238.
Van Tan, H., 1980. Nouvelles recherches préhistoriques et protohistoriques au Vietnam. Bull. École Fr. Extrême-Orient 68, 113–154.
Van Tan, H., 1995. Différentes lignes de développement du post-Hoabinhien à l'âge de la pierre au Vietnam. L'Anthropologie 4, 652–666.
Van Tan, H., 1997. The Hoabinhian and before. Bull. Indo-Pacific Prehist. Assoc. 16, 33–41.
White, J.C., 2011. Emergence of cultural diversity in mainland Southeast Asia: a view from prehistory. In: Enfield, N.J. (Ed.), Dynamics of human diversity. Pacific Linguistics, Canberra, pp. 9–46.
White, J.C., Bouasisengpaseuth, B., 2008. Archaeology of the Middle Mekong: Introduction to the Luang Prabang Exploratory survey. In: Goudineau, Y., Lorrillard, M. (Eds.), Recherches nouvelles sur le Laos. École française d'Extrême-Orient, Paris, pp. 37–52.
White, J.C., Lewis, H., Bouasisengpaseuth, B., Marwick, B., Arrell, K., 2009. Archaeological investigations in northern Laos: new contributions to Southeast Asian prehistory. Antiquity 83, 319 (project galery, 1 p.).
Witkamp, W., 1920. Kjökkenmöddinger ter Oostkust van Sumatra. Tijdschrift van het Nederlandsch Aardrijskundig Genootschap 37, 572–574.
Zeitoun, V., Forestier, H., Nakbunlung, S., 2008. Préhistoires au sud du Triangle d'Or. Editions IRD, Paris (252 p.).
Zeitoun, V., Forestier, H., Pierret, A., Chiemsiouraj, C., Lorvankham, M., 2012. Multimillenary occupation in Northwestern Laos: preliminary results of excavations at the Ngeubhinh Mouxeu rock-shelter. C. R. Palevol. 11, 305–313.
Zimmerman, D., 1971. Thermoluminescence dating using fine grains from pottery. Archaeometry 13, 29–52.