PALEOANTHROPOLOGY IN MAINLAND SOUTHEAST ASIA: EXCAVATION AT TAM HANG, LAOS

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The purpose of this research is to contribute to the paleoanthropological history of mainland Southeast Asia from the earliest Pleistocene (1.8 mya) to the mid-Holocene (ca. 5 kya), principally through field work and survey in northern Laos with a focus on the site of Tam Hang. Tam Hang is an historic site known for its archeological and human remains that span the Paleolithic and Neolithic and for its two Pleistocene-aged faunal assemblages (Fromaget, 1936, 1937, 1940 a,b; Arambourg and Fromaget, 1938). In 2007, with funding obtained in part by the Leakey Foundation, a Lao-French-American team performed a thorough analysis of the site, including study of its geology, paleontology and archaeology, and began a systematic survey of the surrounding areas for additional fossil-bearing localities. The following results are presented here:

1. Middle Pleistocene excavations at Tam Hang South
2. Archaeological excavations at Tam Hang South and Tam Hang Central
3. Survey and discovery of new sites for future research: site of Nam Lot

Brief history of the site

The site of Tam Hang is located in Hua Pan Province, northern Laos (20°24'N and 104°02'E; elevation: 1120 m) (Fig. 1). It is at an altitude of 1120 m and is part of the Annamite mountain chain, which runs northwest to southeast along the Laos-Vietnam border. The site is a cave and rock shelter complex with a geologically-active karstic network located at the base of the P'ou Loi Mountain.

Figure 1. A. Location of Laos on Southeast Asian mainland. B. Location of the site of Tam Hang.

The site of Tam Hang was discovered in 1934 by Jacques Fromaget of the Geological Service of Indochina. Upon its discovery, Fromaget excavated three localities along 100-meters of the rock shelter (Fig. 2): Tam Hang North (THN), Tam Hang Central (THC) and Tam Hang South (THS). Tam Hang is an exceptional site paleontologically because it is the only locality on the Indochinese peninsula that preserves two Pleistocene faunal assemblages of different ages: one Middle Pleistocene (at THS) and one Late Pleistocene (at THS, THC and THN) (Arambourg and Fromaget, 1938). Tam Hang South remains the most significant of the sites, however. The walls and karstic network of the THS rock shelter contain Pleistocene sediments with mammalian fauna. Terminal Pleistocene and Neolithic archaeological artifacts and human remains were recovered from sediments under the shelter.

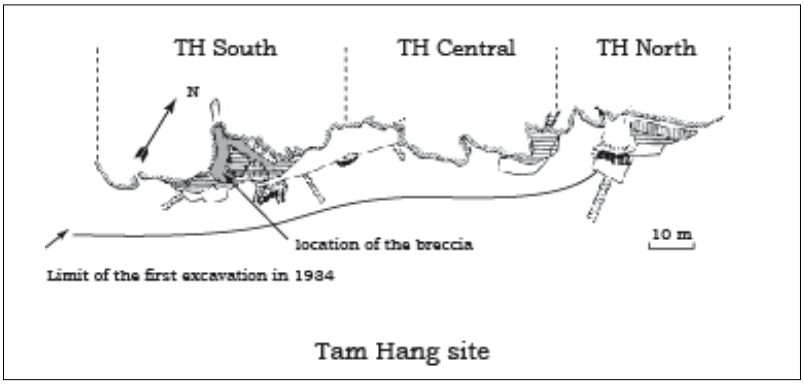

Figure 2. Tam hang excavation (modified from Fromaget, 1940).

Approximately sixty years later, Thongsa Sayavongkhamdy, Director of the Department of Museums and Archeology in Vientiane, re-identified the deposits. In 2003, a small section of THS was re-opened by Sayavongkhamdy and Fabrice Demeter of the Musee de l'Homme. At this time, preliminary excavation of the breccias at THS resulted in the removal of 575 isolated mammalian teeth. In addition, an archaeological excavation was begun under the rock shelter where terminal Pleistocene and Neolithic remains had previously been excavated by Fromaget. A 15 m^2 excavation area was opened and three occupation levels were identified. A first level just under the current soil included skeletal elements of large mammals that had been blackened by fire, which were attributed to recent human activity. The second level contained ceramics, and it sat atop a lower lithic level measuring several meters in thickness. The ceramic level produced 389 fragments belonging to at least 70 vases. The lithic level produced 217 stone tools.

The current research builds on the preliminary work done in 2003. Paleontological excavation was continued in the walls of the rock shelter of THS (Fig. 3: THS1). Archaeological excavations were opened at THS (Fig. 3: THS 4, THS 5) and THC (Fig. 3: THC 1).

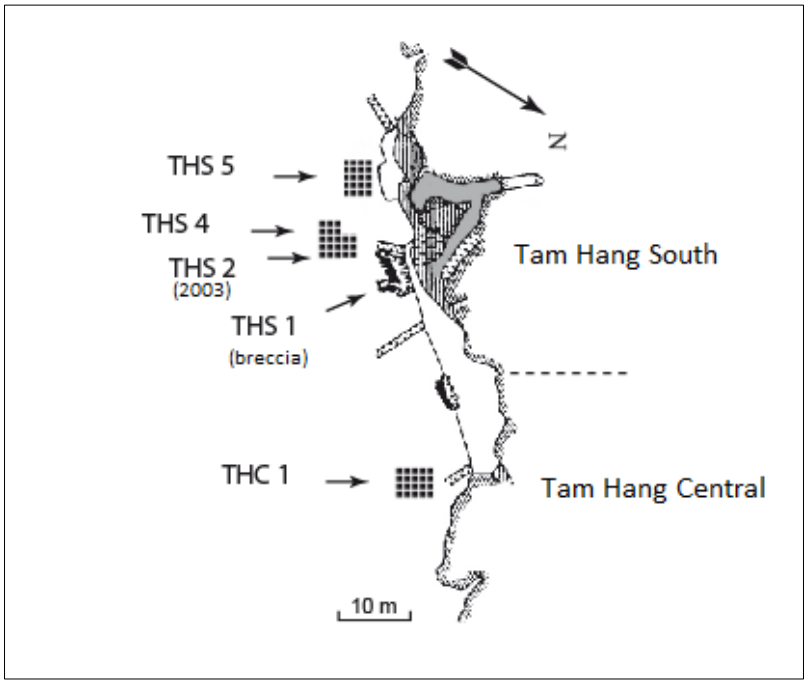

Figure 3. Location of the rock shelter and excavation sites. Paleontological excavation site is THS 1. Archaeological excavation sites are THS 2 (excavated in 2003), THS 4, THS 5 and THC 1.

MIDDLE PLEISTOCENE EXCAVATIONS

Methodology

Most of the fossiliferous layers of Tam Hang were partially exploited in the 1930s by Fromaget who distinguished two different breccias at THS and THC. These two sites are located at the same vertical level but are separated by a distance of ca. 80 m (Fig. 2). On our observations, the remaining breccias from THC were very poor in vertebrate remains so only the breccias from THS were excavated.

Tam Hang South was divided into three levels: a superior pit, middle pit and inferior pit (Fig. 4). The superior and middle pits of THS contain particle concentrations of limestone clasts, iron pisolites, shells and bone fragments (up to ca. 15 cm in some rich areas). Because they are high in calcite and strongly cemented, these breccias were difficult to exploit. The lower breccias are very different, having a dark brown color and sandy clay content. A lack of secondary calcite cementation made the lower breccias significantly easier to excavate than the middle and upper breccias. The most complete and well-preserved teeth and fragmentary jaws come from this level.

Excavation proceeded primarily within the lower breccias of THS. These breccias were extracted using a hammer and burin. In some places where the breccias were hard and highly encrusted, the removed sediments were crushed and sieved to collect small mammal and microvertebrate remains. Fauna extracted from THS and fauna collected during the 2003 excavations were identified and evaluated relative to the faunal lists provided by Arambourg and Fromaget (1938). These remains are used to orient the site of THS in time and consider its paleoenvironment.

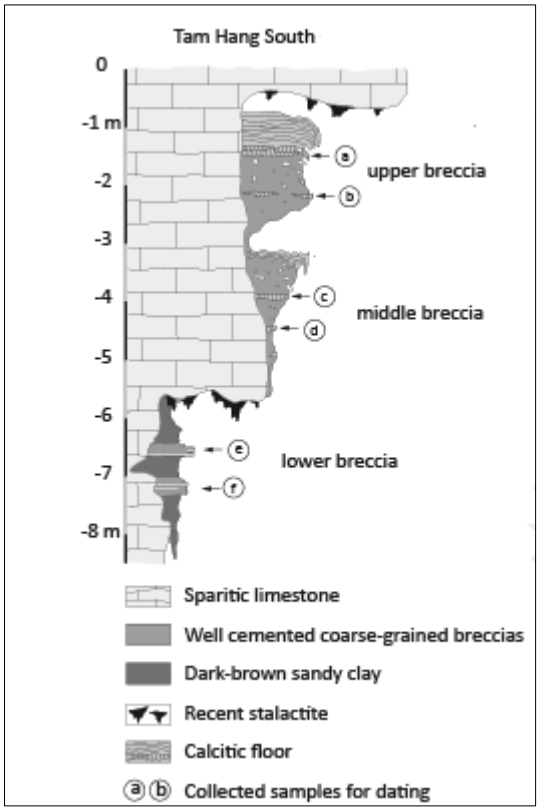

Figure 4. THS stratigraphic section. Drawing by P. Duringer.

Results

Excavation at THS revealed 404 isolated teeth of middle- to large-sized mammals: *Artiodactyla* (cervid, bovid and suid), *Perissodactyla* (rhinocerotid and tapirid), *Proboscidea* (elephantid and stegodontid), *Carnivora* (mustelid, canid viverrid, felid and ursid), *Rodentia* (hystricid and murid) and *Primates* (cercopithecid, colobid, hylobatid and pongid). Overall, the faunal inventory of 2003 and 2007 is composed of 35 taxa, among which 22 are identified at the species level, 6 at the subspecies level and 5 at the genus, subfamily or family level (Table 1).

Species	Permanent teeth	Deciduous teeth
Cervus unicolor	2i1, 3P3, 1P4, 5M, 8p2, 3p3, 3p4, 8m1/m2, 3m3	2D3, 1D4, 1d2, 2d3, 6d4
Muntiacus muntjak ssp.1	2I, 3P2/P3, 5P4, 12M, 4p3/p4, 6m1/m2, 3m3	5D4, 3d4
Naemorhedus sumatraensis	1P4, 1M1/M2, 1M3, 1m1/m2	-
Bubalus cf. *bubalis/B. bubalis*	5M, 1 P3, 1 p2, 3p3, 1p4, 4m1/m2, 1m3	-
Bos cf. *sauveli/B. sauveli*	1P2, 1P3, 1p2, 3p3/p4, 1m1/m2, 1m3	1D3
? *Sus* cf. *scrofa* ssp.1 ? *S. scrofa* ssp.1	2P1, 1P2, 2P3, 3P4, 7M1, 7M2, 1M3, 2p1, 4p2, 9p3, 6p4, 6m1, 1m2, 6m3	1D3, 5D4, 1d4
Sus cf. *barbatus*	2P3, 1M1, 3M2, 2M3, 2p2, 2p4, 1m2, 2m3	2D2, 1D3
Rhinocero s unicornis	-	2 d1
Rhinoceros sondaicus	1 m2	3 d1, 3 d2, 2 D2, 1 D3
Rhinoceros sp.	-	2 d4
Rhinocerotina undet.	1 P/M, 2 M	2 D2, 1 d2/3, 1d
Tapirus indicus intermedius	1P2, 2p2, 1m2	-
Megatapirus augustus	1m2	-
Elephas sp.	1 M	2d
Stegodon orientalis	1M/m	1D/d, 1D4
Arctonyx collaris cf. *rostratus*	1p4, 2m1	-
Melogale personata	2m1	-
Cuon alpinus cf. *antiquus*	1C, 1M1, 1p4, 1m2	-
Paradoxurus hermaphroditus	1m1	-
Panthera tigris ssp.	1C, 2I3, 1P4, 1c, 1p4	-
Ursus thibetanus cf. *kokeni*	2P4, 1M2, 1m2, 1m3	-
Helarctos malayanus	1m2, 1m3	-
Ursid undet. (*Ursus*/*Helarctos*)	1I3, 2C	-
Macaca sp.	2I2, 3C, 5P3, 3P4, 13M, 4c, 3p3, 1p4, 7m1/m2, 2m3	-
? *Trachypithecus/Presbytis*	1I2, 1M1/M2, 1p4	-
Hylobates sp.	1p4	-
Pongo pygmaeus	2M1/M2	-
Hystrix brachyura	38I,i, 5P4, 17M, 17m	-
Leopoldamys sabanus	1 hemi mandible	-

Table 1. List of new permanent and deciduous teeth identified from THS locality. Table from Bacon et al. (2010).

In comparison with the faunal list drawn up by Arambourg and Fromaget (1938), most of the original taxa were reidentified using updated systematics, including archaic types such as *Stegodon orientalis* and *Megatapirus augustus* (Table 2). The originally excavated material is no longer available for study, so it is likely that certain species identified in the new fossil sample correspond to some species previously identified by Arambourg and Fromaget (1938). It is possible that, for example, *Cervus orientalis* is synonymous with *Cervus unicolor*, the only abundant great-sized cervid present in the new record at THS. This may also apply to *Bos geron, Bubalus teilhardi, Nemorhaedus caudatus, Sus lydekkeri, Rhinoceros sinensis, Felis aff. Issidiorensis, Ursus angustidens*, and *Ursus premalayanus*, all of which were identified by Arambourg and Fromaget (1938). For the Indian lion (*Panthera leo* cf. *indicus*) cited in the species list of 1938, our new data suggests that Arambourg and Fromaget originally misidentified the teeth because of their great size. This is probable, as the tiger (*Panthera tigris*) represented at THS possesses very massive premolars. The material recovered in our excavations was not sufficient to recognize *Elephas namadicus* or the three distinct species of *Macaca*.

New fauna recovered in this excavation include elements of *Tapirus indicus, Melogale personata, Meles meles, Paradoxurus hermaphrodites, Pongo pygmaeus, Leopoldamys sabanus* and the archaic species *Stegodon orientalis* and *Megatapirus augustus*. The new collection provides additional material of *Rhinoceros unicornis* and *R. sondaicus*, but not of material attributable to the Sumatran rhino, *Dicerorhinus sumatrensis*, although listed by Beden et al. (1972). Two tapirs are now recognized at THS (*Tapirus indicus* and *Megatapirus augustus*), while only the latter was mentioned by Arambourg and Fromaget (1938). We also confirm the rarity of *Pongo pygmaeus*, which is represented by only two of the 979 teeth from this site.

New data also confirm the presence of three archaic subspecies, *Ursus thibetanus* cf. *kokeni, Arctonyx collaris* cf. *rostratus, Cuon alpines* cf. *antiques*, and the possible presence of *Tapirus indicus* cf. *intermedius*, although this material is limited to a few teeth.

Tam Hang South Arambourg and Fromaget (1938)	**Tam Hang South** (2003, 2007 excavations)
Artiodactyla	**Artiodactyla**
Cervus orientalis	*Cervus unicolor*
Muntiacus aff. *muntjak*	? *Cervus* cf. *eldii*
Muntiacus cf. *muntjak*	? *Axis porcinus*
Bos geron	*Muntiacus muntjak* ssp.1
Bubalus teilhardi	*Bos sauveli* /*B.* cf. *sauveli*
Bovidé de petite taille	*Bubalus bubalis* /*B.* cf. *bubalis*
Nemorhaedus cf. *caudatus*	*N. sumatrensis* /*N.* cf. *sumatrensis*
Sus lyddekeri	? *Sus scrofa* ssp.1/ ? *S.* cf. *scrofa* ssp.1
Sus sp.	*Sus* cf. *barbatus*
Perissodactyla	**Perissodactyla**
Rhinoceros cf. *sinensis*	*Rhinoceros unicornis*
Dicerorhinus sumatrensis *	*Rhinoceros sondaicus*
Megatapirus augustus	*Rhinoceros* sp.
	Rhinocerotina indet.
	Megatapirus augustus
	Tapirus indicus intermedius
Proboscidea	**Proboscidea**
Elephas namadicus	*Elephas* sp.
Stegodon orientalis	*Stegodon orientalis*
Carnivora	**Carnivora**
Arctonyx collaris rostratus	*Arctonyx collaris rostratus*
Panthera leo cf. *indicus*	*Meles meles*
Felis aff. *issidiorensis*	*Melogale personata*
Ursus angustidens	? *Martes* cf. *flavigula*
Ursus premalayanus	*Cuon alpinus* cf. *antiquus*
	Viverra zybetha
	Paradoxurus hermaphroditus
	Prionailurus cf. *bengalensis*
	Panthera tigris ssp.
	Ursus thibetanus cf. *kokeni*
	Helarctos malayanus
	Ursid undet. (*Ursus*/*Helarctos*)
Primate	**Primate**
Macaca robusta	*Macaca* sp.
Macaca mulatta	? *Trachypithecus*/*Presbytis*
Macaca cf. *andersoni*	*Hylobates* sp.
Pongo pygmaeus	*Pongo pygmaeus*
Rodentia	**Rodentia**
Hystrix brachyura	*Hystrix brachyura*
Rhizomys troglodytes	*Leopoldamys sabanus*

Table 2. Comparison of faunal lists from Arambourg and Fromaget (1938) with that of the current excavation. Table from Bacon et al. (2010).

Discussion

The newly recovered THS mammalian assemblage has the characteristics of Middle Pleistocene fauna, being composed of both extinct species (*Megatapirus augustus, Stegodon orientalis*) and modern species showing few advanced evolutionary stages (*Tapirus indicus intermedius, Arctonyx collaris* cf. *rostratus, Cuon alpinus* cf. *antiquus, Ursus thibetanus* cf. *kokeni*) (Matthew and Granger, 1923; Hooijer, 1947, 1948; Colbert and Hooijer, 1953; Beden and Guerin, 1973; Cuong, 1985; Schwartz et al., 1994, 1995; Tougard, 1998). This is in contrast with assemblages from the Late Pleistocene, which show a predominance of modern forms (de Vos and Long, 1993 ; Long *et al.*, 1996 ; Bacon *et al*., 2008b).

In this respect, the THS fauna resembles those of other late Middle Pleistocene sites such as Phnom Loang in Cambodia (Carbonel and Guth, 1968; Beden et al., 1972; Beden and Guérin, 1973; Tin Thein, 1974); Thum Wiman Nakin in Thailand (Ginsburg et al., 1982; Chaimanee and Jaeger, 1993; Tougard, 1998, 2001; Esposito et al., 1998, 2002); and Yenchingkuo in southern China (Matthews and Granger, 1923; Colbert and Hooijer, 1953) (Fig. 5). These are distinguished from the relatively modern faunas found at the Late Pleistocene sites of Lang Trang (de Vos and Long, 1993; Long et al., 1996) and Duoi U'Oi in northern Vietnam (Bacon et al., 2008b). At Lang Trang, some archaic forms (Stegodon orientalis, Tapirus indicus, Cuon alpinus, Rhinoceros sondaicus, and Elephas namadicus) may still be present (Long et al., 1996), suggesting that these taxa could have persisted during the beginning of the Late Pleistocene. The Duoi U'Oi assemblage, however, is devoid of any archaic components, which marks the end of the "Stegodon-Ailuropoda era" by 70,000 years ago in the region.

General paleoecological implications can also be drawn based on the Tam Hang assemblage (Nowak, 1999). The presence of the gibbon *Hylobates* specifically indicates an environment of humid forest. Tam Hang is also marked by an abundance of large mammals (two rhinocerotides, an elephant, a stegodon, two bovids, two tapirs) that suggest humid conditions (Tougard and Montuire, 2006).

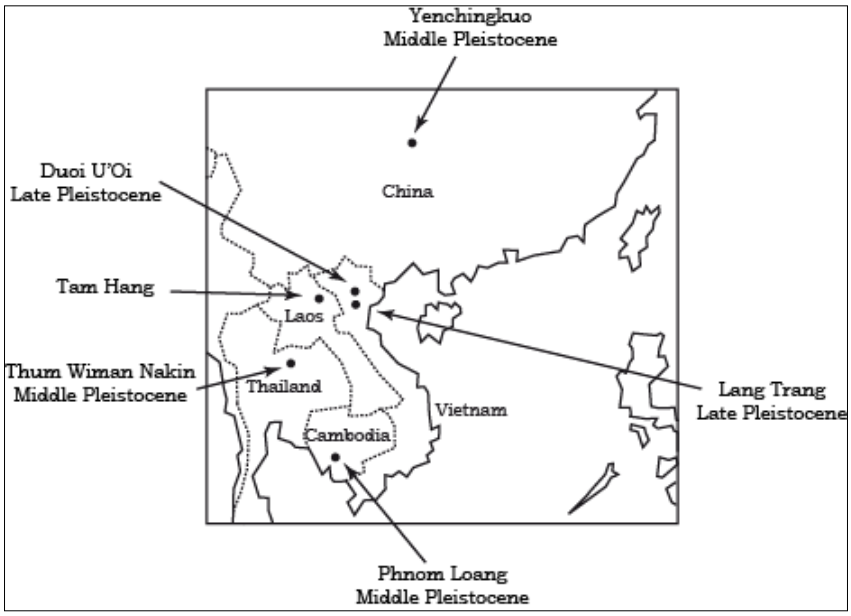

Figure 5. Middle and Late Pleistocene sites mentioned in the text. Map from Bacon et al. (2010).

The other species present at THS suggest various habitats, but all include forests or wooded environments (Lekagul and McNeely, 1988; Nowak, 1999). The Malayan tapir (*Tapirus indicus*) and the Javan rhinoceros (*Rhinoceros sondaicus*) are obligate browsers living in tropical moist forests and swamps (Nowak, 1999; Bacon *et al*., 2008a, 2008b), while the Indian rhinoceros (*Rhinoceros unicornis*) points to a mixture of habitats ranging from riverine grasslands to tropical forests (Laurie *et al*., 1983; Nowak, 1999). The sun bear (*Helarctos malayanus*) inhabits dense forests at all elevations (Lekagul and McNeely, 1988), and the Asiatic black bear (*Ursus thibetanus*) frequents moist deciduous forests and bushy areas, especially in the hills and mountains. The sambar (*Cervus unicolor*) and the muntjac (*Muntiacus muntjak*) prefer wooded areas (Nowak, 1999). Stegodons (*Stegodon orientalis)* and elephants (*Elephas*) were living in forested, diverse habitats (Saegusa, 2001). These conditions would have existed in the Indochinese province since 500,000 years BP, as evidenced by the wildlife of Tham Kuyen (Ciochon et al., 1996) and of Yenchingkuo (Matthew and Granger, 1923; Colbert and Hooijer, 1953). They would have persisted into the Upper Pleistocene given the composition of wildlife of Lang Trang (Long et al., 1996).

Exhaustion of the paleontological layer of Tam Hang

With respect to the paleontology, we consider the exploration of the breccias of THS finished. This part of THS was scoured in its entirety, and the deposits are at present exhausted. The other breccia deposits along the rockshelter between THS and THN do not contain fossils. There are no remains at THC, and we were unable to identify the second fossiliferous horizon (that corresponds to "the inferior horizon" of Arambourg and Fromaget (1938)), that could have allowed us to refine the inventory of this other assemblage.

LATE PLEISTOCENE EXCAVATIONS

Methods

The description of the stratigraphy left by Fromaget is unclear and thus unreliable for understanding the depositional processes for the terminal Pleistocene and Holocene layers at THS, although this is the area from which late Pleistocene human skeletons were recovered (^{14}C dates: 15,740±80 years BP). Archaeological excavation conducted at the site in 2003 opened two new test pits at the region of Fromaget's original excavation (Demeter et al., 2009). The first was a 10m^2 x 2m archaeological excavation underneath the rockshelter (Fig. 6; THS2). In addition, a 3-m test pit was excavated adjacent to this grid for analysis of the geology (Fig. 6).

In 2007, the archeological excavation at THS was extended to include two new squares: THS 4, a 4x3 m site located south of THS2 and THS 5, 3x4 m site located west of THS2 (Fig. 6). Our objective was to assess the stratigraphy of the area (using the test pit dug in 2003) and investigate any archeological levels located underneath the rock shelter. In order to accommodate the rough terrain, a suspended grid was installed. The position of objects recovered during excavation was recorded in three dimensions before removal from the site. Samples of animal bone were removed from the site for ^{14}C analyses (performed at the Radiocarbon Laboratories, Geological Survey of Illinois, University of the Illinois at Urbana-Champaign).

In addition, we opened a square at Tam Hang Central (THC1) on 5x4 meters (Fig. 7). The same suspended grid technique and provenience recording for found objects was utilized. Samples of bone and charcoal were removed for ^{14}C analyses.

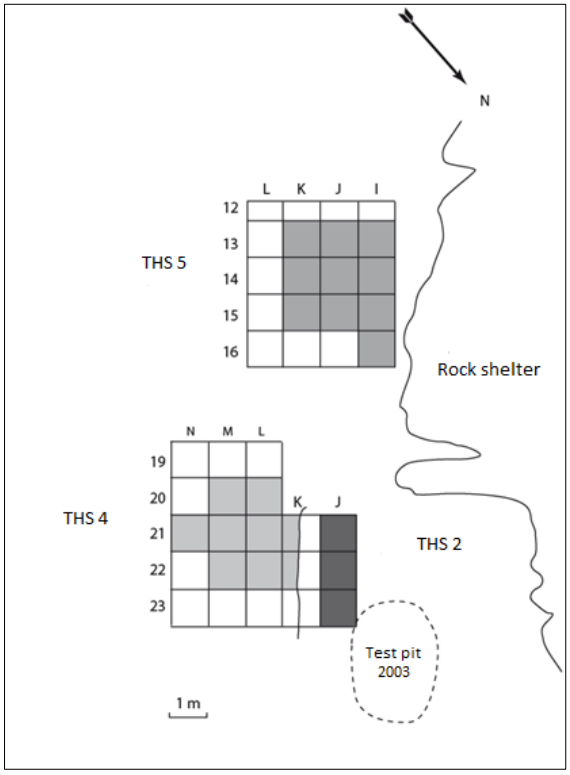

Figure 6. Location of THS 4 and 5.

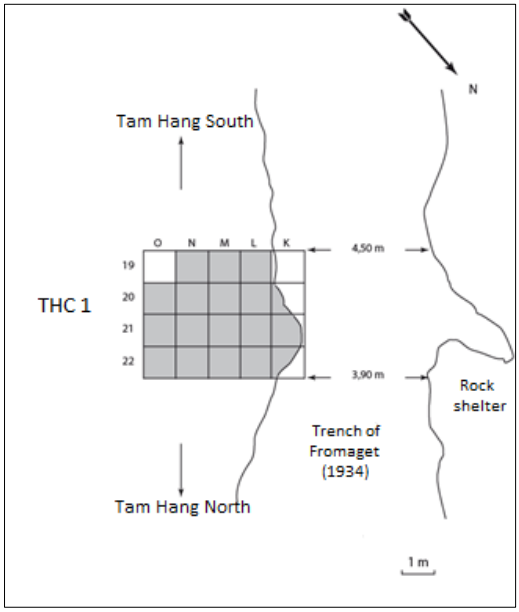

Figure 7. Location of THC 1.

Results

Stratigraphy and archaeology of the area underneath the rock shelter at THS was analyzed and is presented briefly below. A complete analysis of THC has not yet been completed. Based on archaeology and radiocarbon dates from the site, there appears to be some disturbance in the occupation levels that will require further study in the next field seasons. The numbers of lithics and ceramics and radiocarbon dates are provided for both sites. Discussion is limited to THS.

Stratigraphy

Analysis of the stratigraphy of THS demonstrates six successive layers of clays as well as two well-developed conglomerate beds dominating the deposits (Fig. 8). Cultural layers are identified as relevant. These layers are described from superior to inferior.

The most superior layer (Fig. 8, layer A) is 10-15 cm thick and contains organic matter. It is composed of a rich, sandy-argillaceous soil characterized by numerous in situ roots of extant plants. It is filled with a great deal of surface debris. Layer B consists of brown to red-brown silty pelites that contain variable proportions of quartzite and arenite. Granule- to gravel-sized iron- and manganese-rich pisolith concretions are scattered throughout the profile from top to

bottom (although they never exceed 1%). This layer produced artifacts such as circular engraved spindle whorls. Though rare, an occasional boulder or cobble is found in Layer B.

Layer C is an argillaceous-cemented conglomerate that is channel-shaped laterally. The pebbles consist of poorly-cemented argillaceous sandstone. Layer D is similar in color and consistency to layer B. Ceramic fragments were recovered from this layer. These fragments are from pottery with impressed or incised decoration, and they have been formed using diverse clays (Demeter et al., 2009).

Layer E is characterized by large limestone boulders from a succession of rock collapses from the cliff. Their deposition in several layers clearly demonstrates that the conglomerate layer was formed by several deposits (rock collapses) over time. All of these blocks have the same slope descending along the shelter, and the archaeological surface of Layer E follows this same slope. Based on Fromaget's description (1940b), the human remains were recovered from this layer. The radiocarbon date derived from these remains of 15,740±80 years BP gives a minimum age for this layer.

Layer F is the same color and consistency of layers B and D with brown to red-brown silty pelites that contains variable amounts of quartzite and arenite. The upper part of this layer has occasional boulders and cobbles. In the lower part of layer F, pebbles appear inside the pelites. These pebbles are formed by centimetre-sized argillaceous sandstone (as in Layer C). The density of the pebbles increases towards the base of the profile. A lithic industry that may be associated with the Hoabinhian tradition was identified in this layer (Demeter et al., 2009).

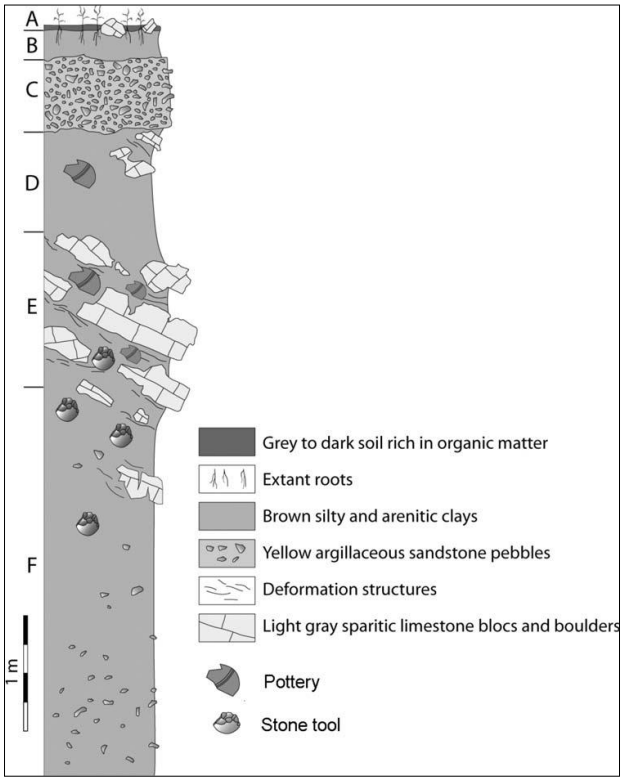

Figure 8. Stratigraphic section underneath the THS rock shelter. Drawing by P. Duringer.

Archaeology

At THS, two main cultural layers were discovered. A lithic layer (Fig. 8: layer F) was identified below a layer of pottery fragments (Fig. 8: layer D), with an admixing or transition layer in between (Fig. 8: layer E). Charred animal bones were recovered across both layers. The layer of large, collapsed, limestone blocks were found above the ceramic layer. A third level, rich in organic material and containing almost the entirety of the charred animal remains, constitutes a layer above the rock fall that marks the end of the human occupation of this part of the shelter since only isolated pieces of lithics or ceramics were recovered.

Samples for radiocarbon dating were taken from the lithic level at THS 4 and 5 and from the ceramic level at THS 4. The lithic layers from these sites are consistent, with a date of 11625 ± 35 years BP at THS 4 (Table 3) and dates of 10070±40 years BP and 13215±45 years BP at THS 5 (Table 4). At THS 4 the ceramic layer corresponds to a date of 7080 ± 25 years BP.

At THC, both ceramic and lithic material was recovered, but there are inconsistencies in the types of materials recovered and disturbances of the occupation levels indicated by heterogenous datings (Table 5). Study of the stratigraphic and sedimentological context will require additional analysis and will guide future excavation to reach the *in situ* levels.

Ref.	Identification	Sample	Age	Error	Depth
A1134	THS4-111	apatite	7080	25	3,66m
A1121	THS4-119	carbon	11625	35	3,82m

Table 3. 14C dates for samples taken from THS 4.

Ref.	Identification	Sample	Age	Error	Depth
A1135	THS5-131	apatite	13215	45	3,25m
A1293	THS5-290	collagen	10070	40	3,23m

Table 4. 14C dates for samples taken from THS 5.

Ref.	Identification	Sample	Age	Error	Depth
A1122	THC1-139	carbon	160	20	0,42m
6156	THC1-94	carbon	300	70	0,86m
6254	THC1-143	carbon	470	70	1,19m
A1123	THC1-169	carbon	1375	20	1,20m
6255	THC1-190	carbon	1100	70	1,40m
A1224	THC1-153	collagen	9775	35	1,53m
A1292	THC1-272	collagen	9380	40	1,62m

Table 5. 14C dates for samples taken from THC 1.

The recovered pottery was very fragmentary, but a total of 308 fragments were recovered: 44 from THC and 252 from THS (86 in THS4 and 166 in THS5). Twelve other pottery fragments could not be precisely localized. The fragments come primarily from vessels with globular bodies and wide necks, small bowls and cylindrical vessels with straight rims. The majority of fragments show an impressed or incised decoration with various motifs. The most predominant

of these is a pattern of oblique discontinuous lines. Many vessels have motifs composed of vertical and parallel cord impressions that are more or less regular. This design could be the result of using a rope wound around a paddle. Some cord impressions may have been smoothed over the entire surface with the use of a piece of textile. The clays are predominantly gray, but the internal and external surfaces are often beige, sometimes dark gray and rarely orange, which may result from differences in the firing process.

A total of 771 lithics were collected from THS4 (330), THS5 (269) and THC1 (172). These artifacts were made primarily from a locally available quartzite from the nearby river. A small fraction were made from andesite and sedimentary rocks. The assemblage includes large stone tools, flakes and cores. All the tools were made by direct percussion with a hard hammer.

Discussion

Preliminary study of the lithic technology from the THS sites indicate an affinity with the Hoabinhian tradition, of which sumatraliths are the most frequently represented tool type. This lithic industry was discovered by Madeleine Colani in 1920 in Vietnam and is found principally in continental Southeast Asia (Gorman, 1970; Reynolds, 1990; Santoni et al., 1989; Sorensen, 1979; Pookajorn, 1979; Zeitoun et al., 2005; Aung, 1969; Mourer et al., 1970; Mourer and Baartstra, 1977; Mourer, 1988), as well as Sumatra (Forestier, 2005). Its appearance dates back to at least 30,000 years BP in Vietnam and Thailand and continues until the mid-Holocene, ca. 5000/4000 years BP (Matthews, 1966; Moser, 2001; White and Gorman, 2004).

Tam Hang thus constitutes the first cultural stage of this tradition for Laos. According to preliminary dates, this site belongs in the mid- to late-Hoabinhian period. However, it is yet to be determined if this is a typical Hoabinhian site or one of its derivatives (Forestier, 2000). The relationship between this system at various levels and sectors of the site is as yet undetermined. The stratigraphic depth of the site makes it possible to consider an evaluation of the development of these technologies, making it a reference for the late Pleistocene/Holocene transitional period.

Analysis of the ceramics from Tam Hang is difficult because Neolithic comparative data is nonexistent in Laos. Two Iron age burial sites in the province of Luang Prabang, Tam Hua Pu and Tam Nang An, have pottery with similar impressions of cord (Sayavongkhamdy and Bellwood, 2000). In addition, the site of Lao Pako in the province of Vientiane also contained ceramics with decorations made from cord similar to those at Tam Hang (Källén and Karlström, 1999).

The ceramic forms at Tam Hang are, at the very least, similar to everyday pottery found in most prehistoric sites of Southeast Asia, with the roped impressions and fine incisions found on a number of fragments from Tam Hang also common in ceramics of the Neolithic of Southeast Asia. The greatest number of comparative prehistoric sites have been studied in Thailand, and similar decorations are present on ceramic fragments at Spirit Cave (ca. 5500 years BP) (Lampert et al., 2003), the Neolithic and protohistoric sites at Obluang (Santoni et al., 1989), the Iron age site of Ban Wang Hai (Pautreau et al, 2001), the Neolithic tombs at Non Pa Wai (Higham, 2002), among others. In Cambodia, these decorative ceramics are found at Samrong Sen, which was occupied during the Neolithic era and the beginning of the Bronze age (Carbonnel and Delebrias, 1968 in Matringhem, 1995).

SURVEY IN NORTHEASTERN LAOS: THE CAVE OF NAM LOT

During survey in the region around Tam Hang, we identified a cave with promising sediments for future research. Stratigraphically, it is situated approximately twenty meters above the filling of Tam Hang. We named this site "Nam Lot" or "the cave of the underground river" (Fig. 9).

The cave of Nam Lot is located 150 meters east of Tam Hang, and it belongs to the same massive limestone formation. The cave presents a half-dozen openings (entries and exits) that are connected as a dense network of galleries and clefts. The principal opening is a gallery measuring 20 meters in length and 15 meters in height. It presents a significant volume of residual sedimentary fillings punctuated by many calcite formations. From base to summit, clayey gaps are covered with a thick aggregate level, and the two levels containing a rich assortment of vertebrate species. Cursory surface excavation revealed several isolated teeth (*A. collaris*, cervid, gibbon).

Figure 9. Left: Entrance to the cave of Nam Lot. Right: Lower breccias at Nam Lot.

The exploration of this cave presents several avenues of interest:

1. Caves offering an abundance of fossils in this region are infrequent. Our experience surveying shows that this cave has a likely chance of producing interesting results. Initial survey of the cave of Nam Lot is promising based on the volume of karstic filling and the wealth of calcite formations.
2. Gaps in the cave measuring at least ten meters vertically can be followed, which implies a geological deposit of substantial length. The presence of a layer of thick conglomerate reaching to the summit indicates a climatic change that is recorded in the major karstic network.
3. This cave was able to present a potential shelter for prehistoric populations. Consequently, we will attempt to spot levels of human occupation.

Additional information regarding the 2003 excavation at Tam Hang can be found in Demeter et al. (2009). More information on the fauna from the 2007 excavation is presented in Bacon et al. (2010). The primary field team responsible for work at Tam Hang includes the following:

Anne-Marie Bacon – Vertebrate Paleontologist, CNRS, Paris, France.
Fabrice Demeter – Anthropologist, Muséum national d'Histoire naturelle, Paris, France.
Thongsa Sayavongkhamdy, Director of the Ministry of Museums and Archaeology, Vientiane, Laos.
Philippe Duringer, Geologist and Sedimentologist, University Louis Pasteur, Strasbourg, France.
Elise Patole-Edoumba, Archaeologist, Muséum d'Histoire naturelle de La Rochelle, France.

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