



Tham Pha Mue, a rock art site in Central Laos and potential stylistic connections in Mainland Southeast Asia

Noel Hidalgo Tan¹ · Olivia Rivero Vila² · Xabier Eguilleor-Carmona² · Jean-Philippe Degletagne³ · Nitixay Khamphoumy⁴ · Boumpasakxay Khampoumi⁵

Received: 23 April 2025 / Revised: 16 December 2025 / Accepted: 22 December 2025

© Research Center for Chinese Frontier Archaeology (RCCFA), Jilin University and Springer Nature Singapore Pte Ltd. 2026

Abstract

Tham Pha Mue, a newly documented rock art site in Khammouane Province, central Laos, represents a significant addition to the study of Southeast Asian prehistoric art. This cliffside rock shelter, the first of its type described in Laos, contains over 200 rock art motifs, predominantly hand stencils, alongside a substantial number of anthropomorphic and zoomorphic depictions. The site's motifs exhibit striking similarities with rock art traditions elsewhere in Southeast Asia, including sites in Laos, Thailand, and as far south as Peninsular Malaysia. In this paper, we present a description of the rock art at Tham Pha Mue and explore its potential connections to a broader regional visual vocabulary. The consistency of certain motifs, such as human figures with distinctive attributes or the presence of specific abstract designs suggests shared a symbolic reference across ancient communities. We propose that Tham Pha Mue offers evidence for a prehistoric network of symbolic communication, reflecting common material culture and reinforcing the importance of cross-regional comparisons in understanding Southeast Asia's archaeological record.

Keywords Lao PDR · Rock art · Khammouane

1 Introduction

This paper presents a description of the Tham Pha Mue (Lao: ຖໍ່ ພາມູ້) a rock art site in Khammouane Province, central Lao PDR (hereafter, Laos), which represents a unique example of Laotian rock art with stylistic similarities to several rock art sites in Mainland Southeast Asia. Situated on the southwest-facing slope of a limestone massif in a karst valley, the site commands a panoramic view of the surrounding landscape. At an elevation of 280 m above sea level, the rock shelter occupies a prominent geographic position that likely held strategic and symbolic importance for its creators. The site was documented in March 2024 as part of a larger initiative to establish Laos' first UNESCO Global Geopark. Tham Pha Mue is distinguished by its extensive array of over 200 rock art elements, making it one of the most significant collections of rock art in the country. This paper presents the findings of the 2024 baseline surveys, highlighting the site's archaeological importance, its potential for regional connections, and its implications for future research and conservation.

Khammouane Province, encompassing over 16,000 square kilometres of predominantly forested mountainous

✉ Noel Hidalgo Tan
seearch@gmail.com

Olivia Rivero Vila
oliviariiver@usal.es

Xabier Eguilleor-Carmona
xabiereguilleor@usal.es

Jean-Philippe Degletagne
eleanashadow@gmail.com

Nitixay Khamphoumy
nitixay@hotmail.com

Boumpasakxay Khampoumi
bounpasakxay@yahoo.com

¹ SEAArch Heritage, Singapore, Singapore

² University of Salamanca, Salamanca, Spain

³ Eléana SASu, Bron, France

⁴ Department of Heritage, Vientiane, Lao PDR

⁵ Department of Forestry, Vientiane, Lao PDR

terrain, is renowned for its dramatic karst landscapes. Situated in Central Laos, it is bordered by Bolikhamsai and Savannakhet provinces in the north and south, and neighbouring countries Thailand and Vietnam to the west and east. The defining geological feature of this region is the Khammouane Formation, a Carboniferous-age carbonate rock formation that has shaped the province's topography. Over millions of years, processes of erosion and dissolution have carved out extensive limestone massifs, resulting in a terrain rich with caves, gorges, and underground rivers. These karst features have long served as natural refuges and resources for human populations, fostering an intimate relationship between geology and culture. This geological complexity also supports rich biodiversity, providing habitats for a variety of species and influencing settlement patterns over millennia.

Tham Pha Mue was discovered by local villagers in the 1990s. Oral histories from the village of Baan Khoun Ngeun recount how hunters first encountered the site while hunting for wild goats. Among these accounts, the late Mr. Houng is often credited with its discovery. Baan Khoun Ngeun is also a recent settlement, established during the construction of National Road No. 8 in the 1990s. The site is at the northern edge of the provincial border, and approximately 30 km from the Thailand-Lao border, within a striking karst valley that provides both seclusion and visibility (Fig. 1). The site's location and elevation suggest it may have functioned as a natural lookout or a space for communal activities imbued with symbolic significance. The site's location within the proposed Phou Hin Poun UNESCO Global Geopark also makes it a potential cultural geosite. This initiative, supported by the Khammouane-Ardèche Stratégie Territoriale (KARST) project, financed by the French Development Agency and the French Ministry of Europe and Foreign Affairs, aims to integrate heritage preservation with sustainable tourism, positioning Tham Pha Mue as a focal point for academic and public engagement.

The 2024 survey of Tham Pha Mue aimed to establish a comprehensive baseline inventory of its rock art. The site is recorded as nine distinct panels, designated A-I, containing an array of motifs rendered predominantly in red pigments, with the occasional use of black and white. The most frequent motifs are hand stencils, which account for nearly half of the recorded elements, followed by geometric patterns, anthropomorphic figures, and zoomorphic depictions. The hand stencils are particularly notable for their diversity, including examples with truncated fingers and overlapping arrangements that suggest intentional composition. The recording process utilized UAV imaging, photogrammetry, and DStretch enhancement to ensure precise documentation. These methods not only captured the visible motifs but also revealed faded elements obscured by

weathering and mineral accretions. The resulting dataset provides a robust foundation for future analysis and comparative studies.

The environmental conditions of Tham Pha Mue indicate its potential for direct dating. Mineral accretions covering and surrounding some motifs present an opportunity for uranium-series analysis, which has been undertaken successfully in other parts of the region, notably Indonesia. Direct dating of rock art remains rare in Southeast Asia, this site offers a rare chance to anchor its motifs within a definitive temporal framework. The implications of such dating extend beyond Tham Pha Mue, contributing to a broader understanding of the region's prehistoric timeline. Although this paper does not include dating results, a datation mission has been planned as a critical next step in advancing the study of Southeast Asian rock art. Establishing a chronology for Tham Pha Mue's motifs will enhance interpretations of its cultural significance and its place within regional artistic traditions.

The motifs at Tham Pha Mue also exhibit striking stylistic similarities with other rock art sites across Southeast Asia, suggesting the existence of shared cultural or symbolic traditions. For example, the hand stencils at Tham Pha Mue bear parallels to those found at Pha Taem in Northeast Thailand and Gua Tambun in Peninsular Malaysia. Similarly, the geometric patterns and anthropomorphic figures are cognate with motifs documented at sites along the Mekong River, which forms part of the border of Khammouane province and an important communication channel in Mainland Southeast Asia. These connections raise important questions about the movement of ideas, peoples, and artistic practices across the region. Were these similarities the result of direct interaction between communities, or do they reflect parallel developments inspired by shared environmental and cultural factors? Tham Pha Mue offers a vital piece of this puzzle, providing tangible evidence of how some symbols and stylistic conventions can seemingly travel considerable geographic distances.

This paper seeks to present the results of the 2024 survey at Tham Pha Mue, emphasizing its archaeological and cultural significance. By documenting the site's motifs and analyzing their stylistic and cultural implications, this study contributes to a growing body of research that situates Laos within the broader context of Southeast Asian rock art research. As a rock art site, Tham Pha Mue is unusual because of its uncommon geographical setting, and because the motifs found within have similarities with other rock art sites in the region. Its discovery and documentation represent an essential step toward filling the gaps in the archaeological record of Laos, offering new perspectives on the region's prehistoric traditions and their connections to the wider world.



Fig. 1 Map of rock art sites mentioned in text

1.1 Archaeology and the rock art of Laos

Archaeological research in Laos has long faced significant obstacles, yet the country's rich heritage offers unique opportunities for expanding our understanding of Southeast Asian prehistory. The challenges stem from a combination of historical, logistical, and political factors, which have restricted the scope and depth of archaeological investigations. One of the most pervasive barriers is the limited financial, technical and human resources available for

archaeological exploration (Marwick and Bouasisengpaeuth 2017). Laos remains relatively underfunded in terms of heritage research, and its difficult terrain—a landlocked country marked by karst landscapes—adds additional logistical demands for archaeological investigation, which has been mitigated somewhat with advanced technologies for site identification, documentation, and preservation. Unfortunately, such technologies, including digital surveying tools and modern excavation equipment, remain in short supply. This lack of resources has made it difficult to thoroughly

investigate and manage Laos' archaeological wealth, particularly in remote or ecologically sensitive areas.

Compounding this issue is the presence of unexploded ordnance (UXO) scattered across the countryside, a legacy of conflicts that occurred throughout the 20th century. These hidden dangers make excavation and exploration both hazardous and costly. Many potential archaeological sites, particularly in rural areas, remain inaccessible until UXO clearance operations are conducted (Sayavongkhamdy et al. 2000). As a result, large portions of Laos' prehistoric record likely remain undiscovered. However, despite these barriers, recent years have witnessed a resurgence in archaeological research in Laos. International collaboration has enabled new surveys, reassessments of sites first recorded during the French Indochina period, and the use of advanced technologies to document Laos' archaeological landscapes. This renewed interest has led to the discovery of additional prehistoric sites, which are helping to map early human occupation across the country.

The earliest evidence of human presence in Laos dates to the Pleistocene, with key discoveries highlighting the region's role in the migration of modern humans into Southeast Asia. Excavations at Tam Hang in the 1930s revealed fossilized hominin remains, including molars and cranial fragments, alongside members of the *Stegodon-Ailuropoda* fauna (Arambourg and Fromaget 1938; Fromaget 1940). However, the integrity and dating of these associations remain debated. A more definitive contribution comes from Tam Pa Ling Cave in Huà Pan Province, where the earliest anatomically modern human specimens in mainland Southeast Asia are found, dating between 86–68 ka (Freidline et al. 2023). This discovery situates Laos as a pivotal region in the study of early human migration and adaptation, potentially linked to southern and inland dispersal routes from Africa.

During the late Pleistocene and early Holocene, Laos was home to small-scale hunter-gatherer communities whose archaeological signatures are sparse and discontinuous. Sites like Tam Nang An and Tham Hua Pu in Luang Prabang Province have yielded stone artifacts and radiocarbon dates suggesting episodic use (Sayavongkhamdy et al. 2000). The shift to the Holocene saw increased rock shelter use, as evidenced by high densities of artifacts at sites like Tham Vang Ta Leow, potentially reflecting greater population density or intensified resource use (White et al. 2009).

The Holocene brought transformative changes with the appearance of agriculture, metal use, and increasingly complex societies. Laos' central location along the Mekong River facilitated cultural and technological exchanges, particularly with Southern China, Northern Thailand, and Vietnam. Surface surveys in Luang Prabang Province have revealed diagnostic artifacts such as ground stone tools,

decorated pottery, and bronze items, indicating a transition from hunter-gatherer lifestyles to settled agricultural communities. By the Iron Age, evidence from sites like Xepon in Savannakhet Province demonstrates the development of metallurgy, with copper production and trade connecting Laos to regional economic networks (Pryce et al. 2014; Tucci et al. 2014). The Late Holocene also saw the emergence of unique burial practices, exemplified by the Plain of Jars, where massive sandstone jars were used for mortuary purposes over multiple phases of activity (O'Reilly et al., 2023; Shewan et al. 2021).

These developments from Laos paint a cultural and technological complexity from the highland and mountainous regions of Mainland Southeast Asia that complement the better understood archaeology of the lowlands, suggesting interactions and movements of people over long periods of time. Little research has been published specifically on the archaeology of Khammouane province; White et al. (2019) report on excavations at the old city of Thakhek, the provincial capital, indicating the discovery of various ceramics, including local earthenwares, regional stonewares, and international tradewares from Vietnam, Thailand, China, and Japan, dating from the 14th to the 18th centuries. We also have a handful of rock art reports which are detailed later in this paper.

Laos, although relatively underexplored compared to neighbouring Thailand has a diverse number of rock art sites, although many have not been formally described or recorded (Tan and Hoerman 2019; Singthong et al. 2016; Tan 2014). The painted sites are often found in karst landscapes, feature a range of motifs, from hand stencils to religious carvings, reflecting long-standing interactions between human communities and their environments. The ones noted in published works are concentrated in Luang Prabang Province: the Pak Ou Caves are a significant Buddhist pilgrimage site, and red paintings can be found inside the cave and cliff face, some of which may predate the Buddhist use of the site (Tan 2018a, 2014b, 2014c; Tan and Taçon 2014; Tan and Walker-Vadillo 2015). Closely related to the Pak Ou Caves is Pha Taem, which is located 80 km upriver. This cliff face site features over 300 red pictograms, including handprints, anthropomorphs, and zoomorphs. The visual culture of Pha Taem suggests connections with Pak Ou and broader Southeast Asian traditions, both downstream to Thailand, and north to China (Tan 2018b; Bo 2020). Also in Luang Prabang Province is the site of Pha Nang Aen near the Pak Ou Caves. This site features inscriptions resembling Sukhothai script, highlighting early regional interactions and the spread of writing systems in the historic period (Lorrillard 2009; Ferlus 1995). Absent of chronological clues such as writing, and diagnostic images, it is presumed that the paintings are prehistoric, although the depictions of domesticated

bovids (indicated by a bovid figure on a leash accompanied by a human figure) would suggest that the rock art may not be older than 4,000 years.

Several rock art sites have been noted within Khammouane province, particularly by French spelunkers. Ostermann and Mouret (2004) note four cave sites with paintings in them: Tham Nong Kha, Tham Phanang, Tham Heud and Tham Seua. Of the four, Tham Nong Kha features a red painting of a human figure with bent knees and upraised arms, similar to that found in Pha Taem and in the Huashan images of Southern China (Wu et al. 2019; Gao 2017). The remaining three sites contain black images, including one of a rider on an elephant in Tham Phanang. An earlier survey by Watanabe et al. (1985) also noted cave sites 7 km northeast of Thakhek, near Ban Sangom. One cave, Tham Kao, contained a numerous black and white line drawings, grouped as human figures, animals, and people riding animals ('horses'). According to the villagers, the white paintings were recent, made in the last 20–50 years (i.e. the decades after World War II).

Rock art research in Southeast Asia has gained significant traction in recent decades, driven by increased regional stability and growing awareness of rock art's cultural value, leading to an increase in research by both local and foreign researchers (Jalandoni 2022; Tan and Scott 2021; Tan and Hoerman 2019; Tan 2019a, 2019b; Jalandoni et al. 2019). This surge in activity has illuminated the distribution, themes, and significance of rock art across the region.

Although no Mainland Southeast Asian rock art has been directly dated, recent findings from Island Southeast Asia, particularly Sulawesi, where rock art has yielded dates as old as 51,000 years (Oktaviana et al. 2024; Brumm et al. 2021, 2024), suggest the possibility of similarly ancient traditions on the mainland. We can only rely on indirect evidence for dates of sites on Mainland Southeast Asia, where associated archaeological remains from red paintings sites like Ban Rai (Thailand) and Padalin Caves (Myanmar) are tentatively dated to 7,000–28,000 BP based on material associations (Treerayapiwat 2005; Schaarschmidt et al. 2019). Absent of direct dates and diagnostic iconography, red paintings are generally considered prehistoric, with black and white paintings appearing later in superimpositions (Taçon et al. 2014). However, while black paintings are often considered to be relatively recent, dates from the Philippines suggest that even black rock art can be as old as 3,500 years (Jalandoni et al. 2021).

1.2 Survey and recording

The survey of the Tham Pha Mue rock art site was conducted in March and December 2024 with a multidisciplinary team of foreign and Lao researchers. The site was recorded using

photography and a variety of photogrammetry techniques to obtain a baseline of the site's rock art. An Unmanned Aerial Vehicle (UAV) DJI Mavic 3 was utilized to capture high-resolution aerial photographs of the surrounding karst landscape and to reach images that were located on higher elevations to provide context for the rock art and site's geographic and environmental setting. Images were processed to create orthomosaic maps, aiding in spatial analysis and rock art identification.

Close range photogrammetry was developed through RPAS images and detailed photographic record of each panel, using full frame digital cameras (Canon EOS R7 with optics Canon RF 50 mm F1.8 STM Canon RF 16 mm F2.8 STM and Nikon D850 with optics NIKKOR LENS 24–120 mm f/4G AF-S and Nikon AF-S VR Micro-Nikkor 105 mm f/2.8G IF-ED). Detailed three-dimensional models of the rock art panels of varying resolutions were produced. Software such as Agisoft Metashape, Adobe Photoshop and DStretch was used to create scaled representations of the site and enhance faded or weathered motifs respectively. The methodology applied at no time involved contact with the wall. The documentation process focused on systematically recording and classifying the motifs present on each panel. Panels A through I were demarcated and surveyed sequentially, with each panel photographed at high resolution. Images were then cross-referenced with DStretch-enhanced photos to verify the accuracy of motif identification.

One panel (Panel D) was difficult to record due to its extraordinary dimensions and a fissure that prevents the visibility of the entire panel. Motifs were classified into four primary categories: hand stencils, anthropomorphic figures, zoomorphic figures, and geometric patterns. Each motif was assigned a unique identifier and recorded with meta-data, including dimensions, orientation, and relative position on the panel. Special attention was given to exceptional features, such as truncated hand stencils and overlapping patterns, which may hold cultural or chronological significance. Some of the more notable motifs are discussed later in this paper.

1.3 Description of the site and its rock Art

The Tham Pha Mue rock shelter is located on the southwestern face of a long limestone massif, prominently visible from afar and distinct from the surrounding limestone mountains. Access to the site is from National Road No. 8 from the west, approximately 1 km from the base of the mountain. The shelter is situated about 280 m above sea level and 90 m above the ground, as determined by UAV telemetry (Fig. 2).

The shelter is about 30 m wide and 6 m deep, overlooking the valley to the west. It is edged by a steep drop-off. The

Fig. 2 Frontal view of the site taken from a UAV. Human figures for scale

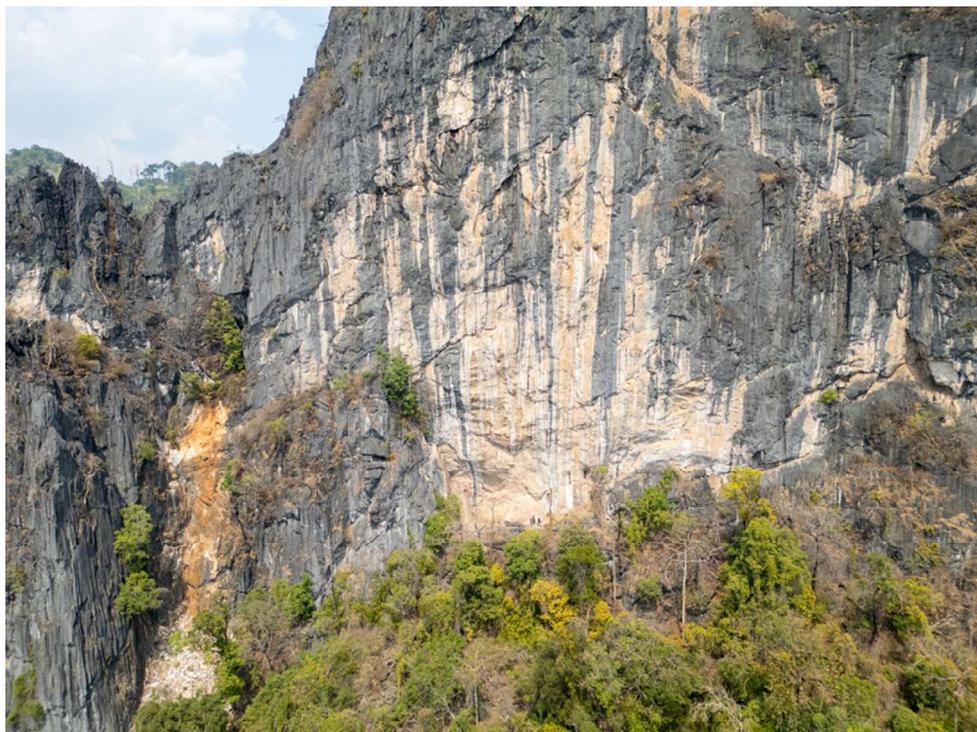


Fig. 3 The main concentration of paintings, designated as Panel D (to the left of the black stripe, partially hidden behind a crevice) and Panel E (right of the black stripe)



site was accessed at the northwestern corner, beside Panel A. The rock art is found all along the walls of the shelter in eight concentrations, designated Panels A to I. Many of the paintings are at floor level within easy reach, while the main concentration of paintings (Panels D and E) is situated between 3 and 14 m off the floor (Fig. 3). A crevasse at the

northern end of the rock shelter shields Panel D. It is possible that the crevasse was used as a climbing aid to access the higher reaches of the wall to paint, possibly with the aid of scaffolding or ladders made from perishable materials.

The preservation of the rock art is varied. Many forms on Panels F and G are faded and barely detectable with

the naked eye. Water wash running down the walls has destroyed some paintings and caused mineral accretions to accumulate on the wall. Despite this, some paintings can be detected underneath the accretions, providing excellent potential for calcite-based dating.

Reconnaissance of the other cliff faces along the massif yielded no rock art; the paintings appear to be exclusively found in the rock shelter at the base of the largest open cliff face. The floor of the shelter, while rocky, contains many smooth and worn surfaces, suggesting frequent use, although the timing and frequency of this occupation remains uncertain. Goat droppings were also found on the floor of the shelter, consistent with accounts of hunting activity from villagers.

The rock paintings at Tham Pha Mue are diverse, although the predominant motif is negative hand stencils (which comprise more than half of rock art elements), along with geometric shapes and zoomorphic figures, such as buffalo and anthropomorphic figures. Most of the rock art are paintings with in red or red-orange pigments, with a small number of black and white elements. These depictions show similarities with other rock art in the region which is discussed later in the paper. However, the motifs lack any diagnostic iconography which may provide a clue about their

age, hence the preliminary interpretation is that the site is consistent with what is generally described as ‘prehistoric’ rock art in Southeast Asia. There does not appear to be a narrative attached to the paintings. Some paintings may be interpreted to be associated with one another because of their proximity and colour similarity, but nothing in the paintings suggest a frame or a frieze.

Tham Pha Mue is recorded as nine distinct panels of rock art, designated as Panels A through I (Fig. 4). These designations correspond to their order of discovery and location within the site, spanning from north to south. The rock art in Panels A, F, G, H and I is located at the floor level of the rock shelter, making them easily accessible for observation and recording. In contrast, Panels B, C, D, and E are situated higher up on the walls, ranging from 4 to 14 m above the floor.

The highest concentration of paintings is found in Panels D and E, each containing over 50 distinct elements. To document these panels comprehensively, recording was undertaken using digital photography, UAV imaging, and photogrammetry. The panels are described in order from A to I.

Panel A Panel A is the northernmost section of the Tham Pha Mue. The dominant motif on this panel is a crude carving of a ‘Buddha’ image, infilled with white pigment. This ‘Buddha’ figure is approximately 1 metre above the floor and stands 55 centimetres tall. The ‘Buddha’ is depicted in a cross-legged sitting position, with a line across the torso indicating a monastic robe covering one shoulder. While the position of the hands cannot be precisely determined, they appear to be resting on the lap in the position of *Dhyana mudra*.

Interviews with local villagers indicate that this ‘Buddha’ image was created in 2012–2013 by the villagers themselves, adding a layer of contemporary significance to the site. They were, however, unable to explain why this image was created or who specifically created it. Such activity is not unusual, and the painting of Buddha images in caves is reported in at least one other site in Laos (Lewis et al. 2015). Buddhist imagery is commonly found in similar rock art sites in both Northeast Thailand and Laos, but they are stylistically and chronologically distinct from the ‘prehistoric’ rock art (Tan et al. 2016).

Further analysis of Panel A using DStretch enhancement uncovered an additional image of a ‘fish’ (A02) beside the ‘Buddha’. This fish depiction is approximately 22 centimetres wide and bears a resemblance to other ‘fish’ rock art found at Pha Taem in Thailand’s Ubon Ratchathani province, located downstream along the Mekong River.

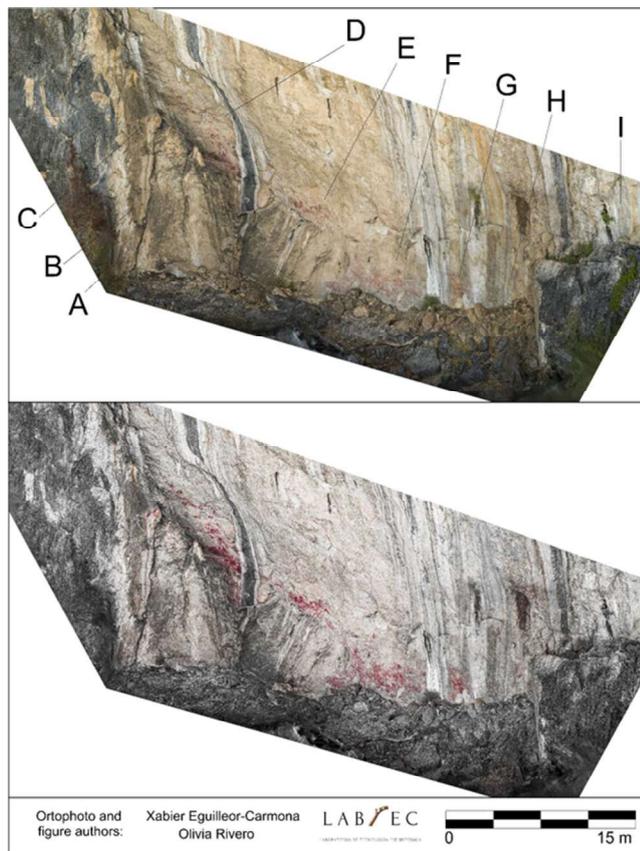


Fig. 4 Orthoimage view of Tham Pha Mue, facing north. The locations of the panels are labelled

Panel B Panel B is located along the same face as Panel A but approximately 3 m above the floor, making recording difficult. It is situated roughly between Panel A and Panel C, with Panel C positioned approximately 7 m from the floor. In Panel B, one faded hand stencil is visible to the naked eye. Using DStretch, two additional hand stencils were detected. There are possibly other hand stencils to the right of B03, but even with image enhancement, it was not possible to make a positive identification.

Panel C Panel C is located approximately 7 m above the ground, on the same face of the rock shelter as Panels A and B. The walls containing Panels C and D are separated by a crevasse, a rift at the southern corner of the rock shelter. While it cannot be definitively determined how the painters reached that height, we were able to physically access Panel C by climbing the edge of the rift.

The panel comprises three hand stencils, some of which are visible from the floor. One of these stencils was detected during image enhancement. The most prominent hand stencil is extraordinary, as it appears to be a hand-and-wrist stencil, but also the edge of the stencil is very distinct. It

would have been difficult for a single person to execute a hand-and-wrist stencil while hanging from the edge of the rift, while also maintaining a clear edge around the paint spray. Thus, the nature of the rock art suggests that at least two people were involved in their creation. This may also imply that the creation of the rock art relied on a presence of a stable structure, such as a scaffold, made from perishable materials (Fig. 5).

Panel D Panel D represents the largest concentration of rock art at the Tham Pha Mue, covering an area of 20 square metres, approximately 4 m wide and 5 m tall. Recording this panel was particularly challenging due to its physical location; most of the panel is situated behind the rift that separates the northern wall from the eastern wall (Figs. 6 and 7). Entry to the rift is about 2 m above the floor, and the rift itself is 1.5 m wide, making wide-angle photography difficult. A 3D model was obtained through RPAS images. This allows a complete restitution to be obtained in spite of the orographic difficulties.

The rock art on Panel D was analysed in three sections: the upper level, the middle section, and the lower section.

Fig. 5 Orthoimage view of Tham Pha Mue panels A, B, C and image enhanced showing the main figures of the panels



Figs. 6 a and b Orthoimage of panel D and image processing carried out for a better visualisation of the motifs

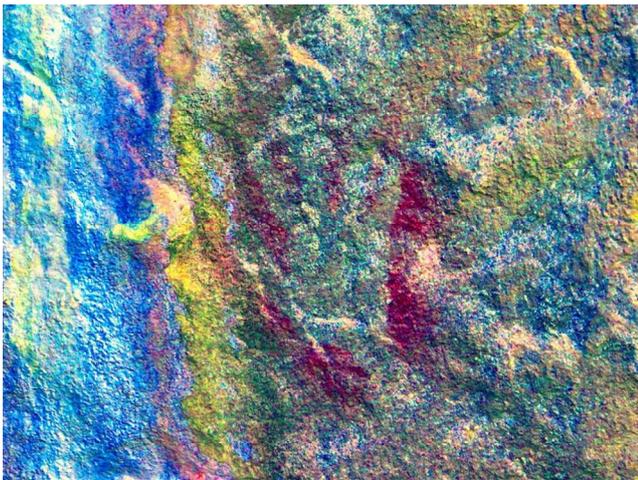
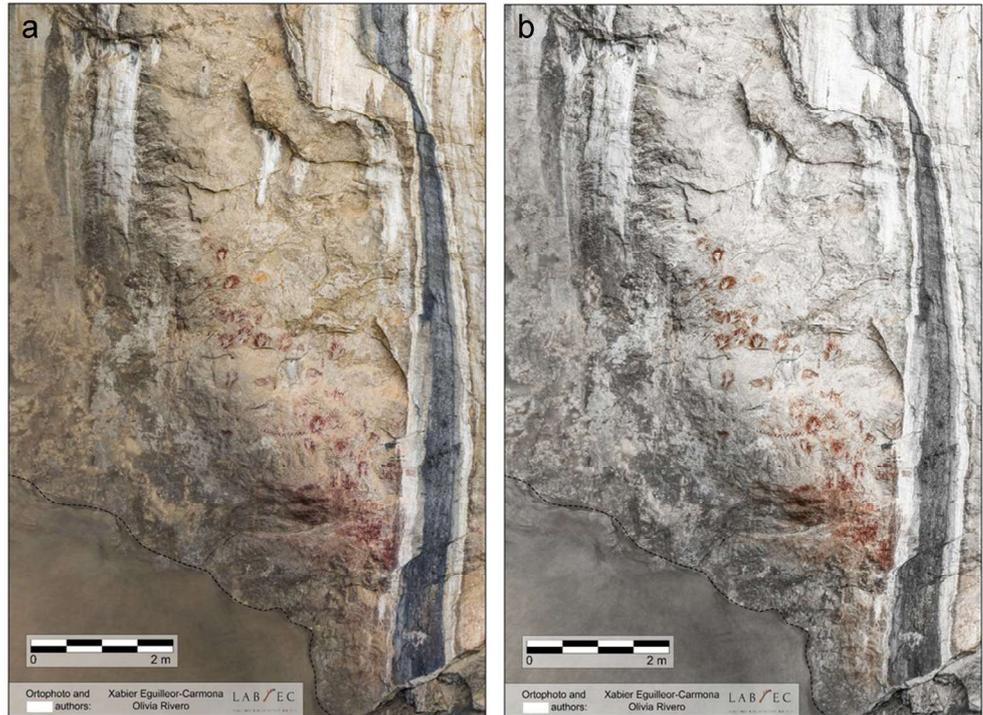


Fig. 7 Right-hand negative stencil from the upper part of panel D, the highest figure in the rock shelter

Despite being located in a crevasse, most of the rock art on Panel D can be seen from the main rock shelter, suggesting that they were created with visibility in mind. Exploration deeper into the crevasse yielded no signs of occupation or additional rock art.

The upper level of Panel D is mainly composed of hand stencils. The highest altitude depiction is a right-hand negative hand at 14.3m above the current shelter floor (Fig. 7). The stencils continue on a diagonal line from the upper left to the lower right, following the edge of the rift in front of the panel. Besides hand stencils, the rock art includes anthropomorphic and zoomorphic elements, such as red stick figures

and quadrupeds in both red and black pigments, and a white hand stencil. The middle section features abstract and geometric designs, including horizontal and vertical wavy lines and angular ‘bamboo’ figures (Fig. 8).

A notable feature of Panel D is the water wash on the right side, forming a 1.5-meter wide band of white-black-white accretion, marking the border of this panel and separating it from Panel E. Some animal figures and handprints (notably prints and not stencils) can be detected underneath the white accretion, suggesting good potential for dating. Panel D is also the only panel to have black paintings, which are located also under the white accretion (Fig. 9).

Panel E Panel E is delineated from Panel D by the arbitrary border of the white-black-white water wash line (Fig. 10). At the left end of the panel, a calcite wash covers part of the figures, including a hand stencil in red (Figs. 11a and b). This fully exposed section of the rock shelter wall is situated about 4.5 m above the current floor. The panel consists of red and exceptionally white paintings (Figs. 11c and d), a mix of hand stencils and diverse forms of rock art, including anthropomorphs, zoomorphs, and abstract figures. Over 50 elements have been identified on Panel E. Notably, there are numerous orange dots in the area above the paintings. It cannot be determined if these dots are anthropogenic or the result of natural processes.

This panel also shows different ways in which red pigment was applied (in the form of aerographic pigment for



Fig. 8 Some figures of the central part of panel D: a left-handed white hand stencil, anthropomorphic figures, zoomorphs and geometric signs. DStretch enhancement using the ybr setting

the hands, applied with an ochre pencil for some animal and anthropomorphic figures, or diluted in water for signs and anthropomorphic figures). This variability, as well as the colourimetric differences, suggests that, as in panel D, these are panels of graphic accumulation of long chronology.

Fig. 9 Black paintings on central part of panel D. The white accretion is partially superimposed to the pigment of the zoomorphic figure



Fig. 10 Panel E

Panel F Moving to the right (southeast) of Panel E, the ground slopes upwards, and the wall presents with splashes of red. The rock art on Panel F is difficult to see under normal circumstances, with some handprints and hand stencils being barely discernible. Image enhancement has revealed that the rock art on this panel consists mostly of hand stencils and handprints, the latter being predominantly found in this panel. Notable motifs include fine lines (F15 and F16), which were initially mistaken for handprints (Fig. 12). A white water wash line marks the end of this panel. In front of Panel F, there is a patch of floor uncovered by rocks and

Fig. 11 Some depictions of Panel E: **a** Hand stencil under the calcite layer, accompanied by signs in red and anthropomorphic figures. **b** DStretch enhancement using the lds setting. **c** White hand stencil and red hand stencils and signs in the right part of the panel. In this part of the panel, a large number of representations of hands can be distinguished, some of which could correspond to children. **d** DStretch enhancement using the yrd setting



Fig. 12 Panel F

strewn with small light pebbles and seeds, suggesting potential for burial or excavation.

Panel G Another cluster of paintings can be found further right of Panel F, situated between two white water wash lines. Similar to Panel F, most of the paintings in Panel G are located at torso level, with the exception of one unique hand stencil found about 5 m from the floor. A total of 24 elements were counted on this panel, with most of the rock art comprising positive and negative hand stencils, some of them belonging to children. White mineral accretion from water wash has built up on the right side, likely covering some additional rock art. Unlike Panel D, the mineral build-up in this area is too thick to determine the form of the paintings underneath it. The lower part of the rock wall has also suffered from exfoliation. This exfoliation appears to have occurred before the white mineral wash formed but after the paintings were created. This sequence suggests an opportunity for dating the rock art, as it presents an exposed section where all three periods—creation of the paintings, exfoliation, and mineral wash—can be sampled and analysed together (Fig. 13).

Panel H About 3 m from the previous panel, on the slope leading to the end of the shelter. It is very lost, with practically no distinguishable motif. Only a sign in the form of a

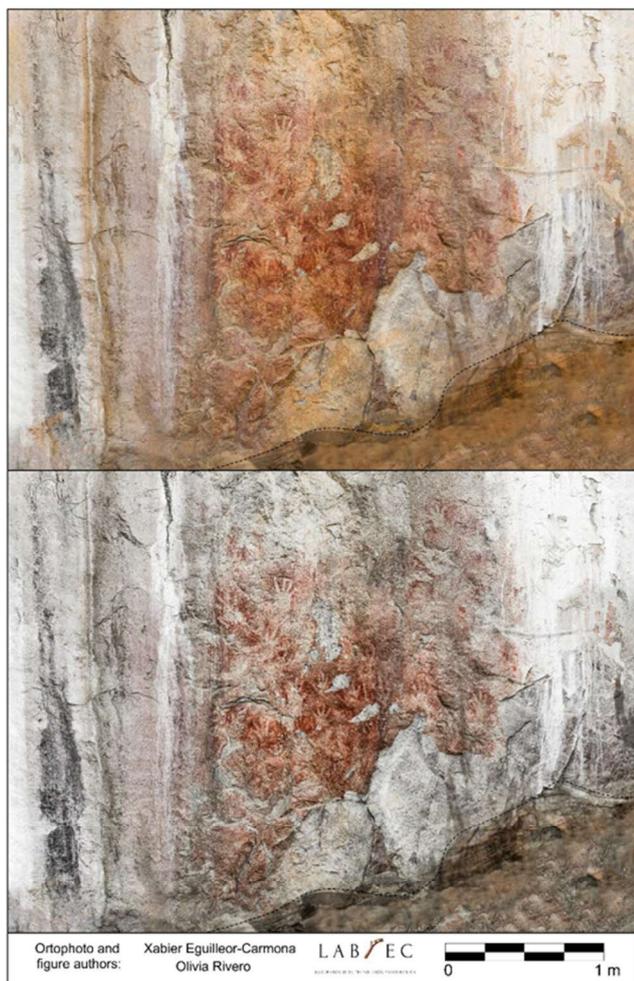


Fig. 13 Panel G

cross can be distinguished in the central part of the panel, on very faded remains of pigment.

Panel I Panel I was discovered after a short scramble up some fallen rocks past Panels G and H. The Panel is made up of a sole orange hand stencil, located 1.95 m from the floor.

Over 200 elements have been recorded in the rock art at Tham Pha Mue. Hand stencils and handprints account for half of the corpus. Among these, some unusual stencils include a hand-and-wrist stencil, a fist stencil, two white hand stencils, a hand stencil showing all the fingers truncated to the same length, and a hand stencil with the depiction of a wrist and bangle. There does not seem to be a dominant handedness based on the distribution of hand stencils, with left-hand and right-hand stencils appearing in almost equal numbers. The presence of unique and varied hand stencils indicates a range of symbolic expressions or possibly different cultural practices



Fig. 14 Superimposition of an anthropomorphic figure (D28) over a hand stencil (D29) in panel D

or time periods. The unusual stencils, such as the fist stencil and the hand-and-wrist stencil, suggest that the creators employed different techniques and held different symbolic meanings. The commonality of hand stencils across different panels indicates a cultural importance. It is notable that the anthropomorphic and zoomorphic figures are concentrated on Panels D and E. This may suggest that they were painted during a discrete period of time.

The relative dating of the rock art at Tham Pha Mue, derived from the superimpositioning of motifs and physical observations, suggests that hand stencils and prints are the earliest motifs, followed by anthropomorphs and zoomorphs, which are superimposed over some of the hand stencils (Fig. 14). Also, the black figures in panel D are superimposed on red figures. This sequence suggests at least three distinct painting episodes. These observations are consistent with general descriptions of Southeast Asian rock art, where hand stencils are often the oldest, and black rock art is more recent than red (Taçon et al. 2014).

One significant potential presented by Tham Pha Mue is the relative ease for which to access the rock art, and the mineral accretion seen on the walls of the shelter, some covering the rock art. This opens the possibility of using uranium-series dating to date the layers above and underneath pigments, thus giving a reliable sandwich date for the age of the paintings. Rock art has thus far not been directly dated in Mainland Southeast Asia. As indicated earlier, where rock art sites that have been excavated, the excavated materials suggest that the rock art could be considerably older, as in the case of the Padalin Caves in Shan State, Myanmar (c. 7,000–13,000 years, Moore 2007) and Doi Pha Khan in Lampang, Thailand (c. 10,500 BCE from human burials, Surinlert et al., 2018). In Island Southeast Asia, direct dates of rock art in South Sulawesi and East Kalimantan are dramatically older - between 39,000 and 51,000 years ago (e.g. Oktaviana et al. 2024; Brumm et al. 2021; Aubert et al. 2019; Aubert et al. 2018; Aubert et al. 2014).

1.4 Affinities to regional rock art

Tham Pha Mue is the first rock shelter type of rock art site to be described in Laos. With over 200 rock art elements, the site has the potential to make comparisons between this site and other sites in the region. Comparable sites within Laos include the Pak Ou Caves and Pha Taem in Luang Prabang province (Tan 2018a, b), which have a similarly large number of rock art elements at each site. These sites are also located on prominent cliff faces and contain red paintings and hand stencils. However, unlike Tham Pha Mue, the Luang Prabang sites are on cliff faces directly over rivers and not within rock shelters.

In a broader regional perspective, the Ou River sites in Northern Laos form an important node within a riverine

rock art network that extends both northwards into China and southwards along the Mekong. The Pak Ou Caves and the Pha Taem cliff paintings on the Ou, located roughly 80 km apart, are red-painted cliff faces with numerous motifs; although each has distinctive imagery, both include handprints and depictions of domesticated bovids, and are hydrologically linked via the Ou–Mekong system to Pha Taem on the Mekong in Ubon Ratchathani Province, which similarly features hand impressions and bovids. A comparable preference for prominent riverside cliffs is seen further upstream in China: in the Zuojiang valley of Guangxi, most known rock art panels are painted high on limestone walls overlooking the river (Shao et al. 2017; Gao 2013), while the Jinsha River valley in Northern Yunnan hosts rock art closely associated with the river course, some of which have U-series ages between c. 13,000 and 8,000 BP (Wu et al. 2022), spanning the Pleistocene–Holocene transition. Bo (2020) has also highlighted resemblances between the Ou River sites and the Cangyuan paintings in Yunnan, situated on limestone cliffs within the Mekong basin and including scenes of human interaction with bovids as well as a smaller number of handprints and stencils. These shared riverine settings and broad categories of imagery suggest long-term connections along the major drainage systems linking Yunnan, Guangxi and Laos, possibly facilitated by southward movements of people, yet at present no close motif-by-motif correspondences can be demonstrated between Tham Pha Mue and the Chinese sites, and any direct cultural linkage must remain provisional.

The physical characteristics of Tham Pha Mue are reminiscent of many other rock art sites in Southeast Asia, such as Pha Taem in Thailand (Srisuchat and Mukmikka 1989), Tham Ra Pu Le in Southern Thailand (Bellina et al. 2021), and Lewun in Myanmar (Tan 2019c) (Fig. 15). These sites share common features, being located at the base of large

Fig. 15 Southeast Asian rock art sites located on prominent cliff faces. **a** Tham Pha Mue (Laos); **b** Gua Tambun (Malaysia); **c** Ko Ra Pu Le 1 (Thailand); **d** Lewun (Myanmar)

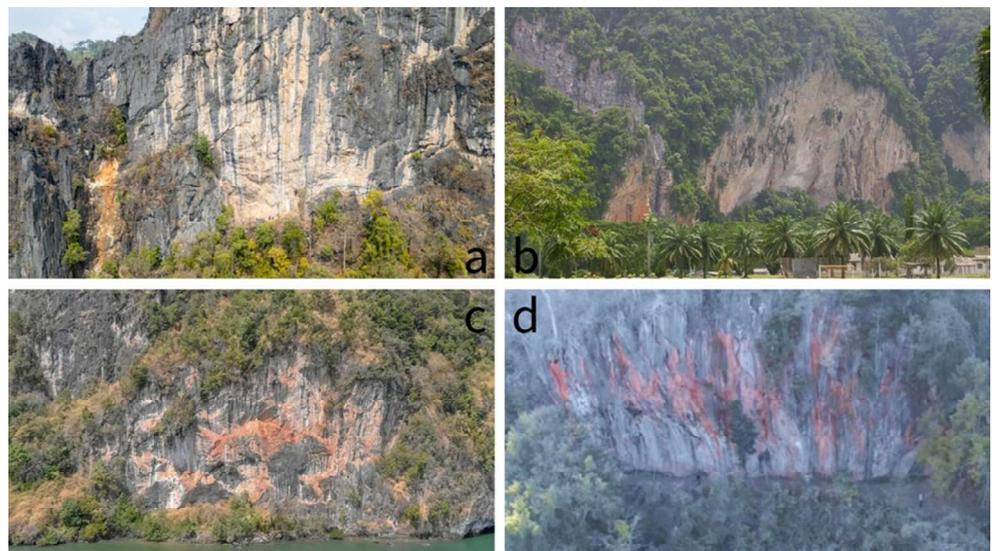


Fig. 16 ‘Mountain goats’ of Tham Pha Mue (left) and Gua Tambun (right)

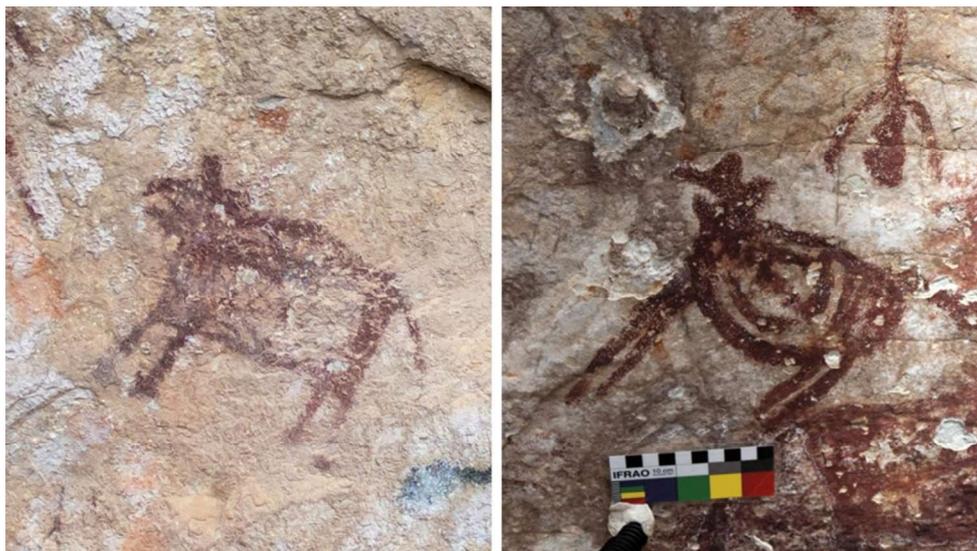
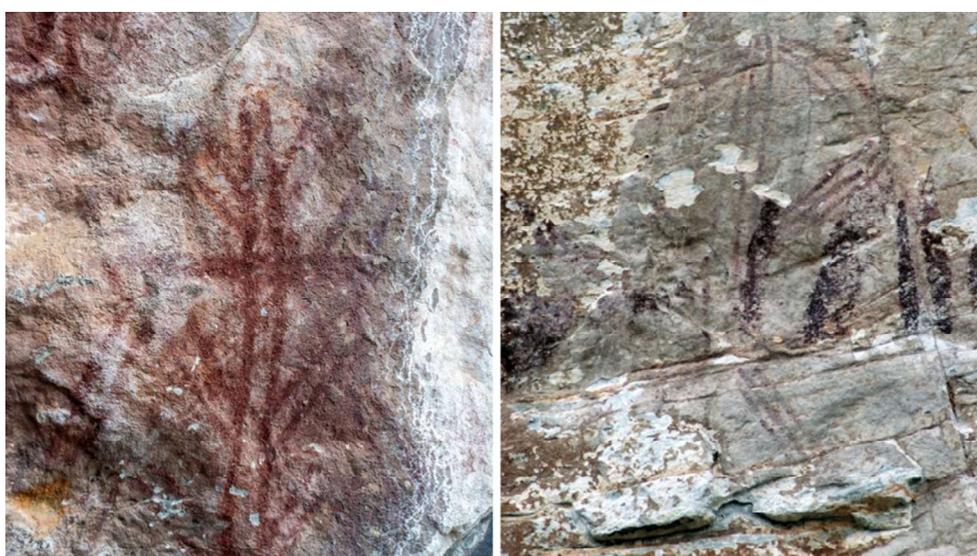


Fig. 17 ‘Bamboo’ designs, in Tham Pha Mue (left) and Gua Tambun (right)



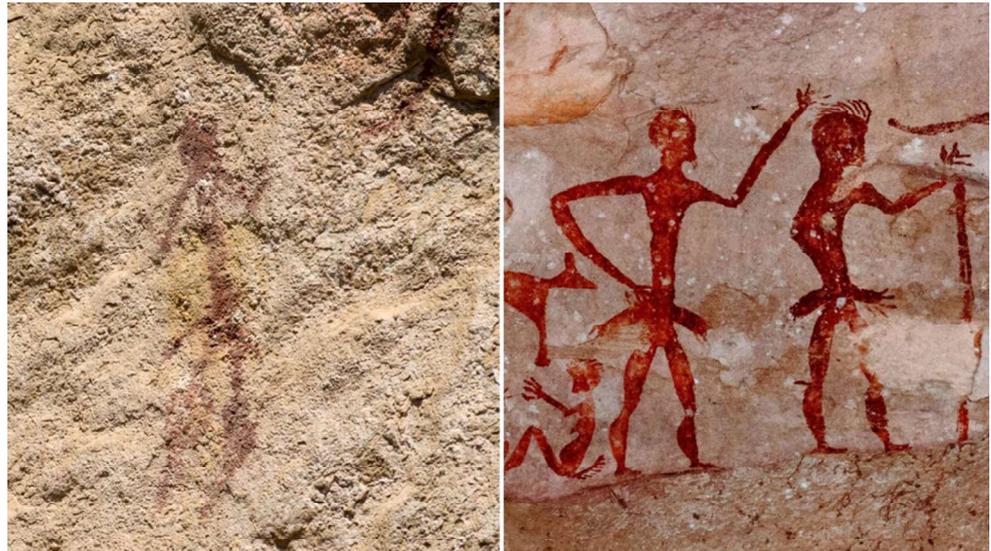
- and often elevated - cliff faces that make them distinct in the landscape. The prominent cliff faces may have served as significant landmarks, visible from afar, which might have functioned as navigational aids or landscape markers for prehistoric populations (Bellina et al. 2021).

The most intriguing similarities are between Tham Pha Mue and much further afield - Gua Tambun in Peninsular Malaysia. Like Tham Pha Mue, Gua Tambun has a large corpus of paintings (640 elements, Tan and Chia 2011; Tan and Chia 2010; Tan 2010a, 2010b). The red physical landscapes and the similarities in individual rock art elements are striking. For example, one of the zoomorphs on Panel D (D44) is remarkably similar to depictions at Gua Tambun, interpreted as a Mountain Goat (southern serow) (Fig. 16). Mountain goat droppings have been identified at the site, and informants from the village stated that the site was discovered by hunters pursuing mountain goats.

Finally, the abstract bamboo-like figures in Tham Pha Mue (D76, D89, D90) are similar to figures found in North-east Thailand (e.g. the Phu Sa Muey Group and Tham Pak Nam in Ubon Ratchathani province) and Gua Tambun (Fig. 17). These observations are not to suggest a direct connection between these sites but rather the existence of a visual vocabulary extant over Mainland Southeast Asia, connecting modern-day Malaysia, Thailand and Laos. While there are significant similarities between the rock art of Gua Tambun and Tham Pha Mue, Gua Tambun is devoid of hand stencils and has very few handprints.

Tham Pha Mue features approximately 35 anthropomorphic figures, mostly depicted as stick figures in static poses with common arm positions being outstretched or upraised. Two anthropomorphs appear to be wearing ‘skirts,’ often interpreted as loincloths, which is a motif seen in other rock art in Thailand, e.g. Khao Chan Ngam in Nakhon

Fig. 18 Anthropomorphs from Khao Chan Ngam (right) in Nakhon Ratchasima Province, Northeast Thailand wearing similar ‘skirts’ to some of the human figures in Tham Pha Mue. Notice also the pronouncement of the calves in the depictions



Ratchasima province (Tan et al., 2014a) and Khao Plara in Uthai Thani province (Srisuchat 1990). One of these skirted figures (D28) also has thick calves, a combination found in Northeast Thailand as well (Fig. 18).

There are 29 zoomorphic figures, predominantly quadruped animals. These depictions are not naturalistic, often appearing as generically rectangular or ovoid shapes with few identifying features. The fish is similar to other fish depictions at Tham Phi Hua To in Krabi (Srisuchat 1987; Sarikabutara 1987; Sangwan 1987) and Pha Taem in Ubon Ratchathani, Thailand (Srisuchat and Mukmikha 1989). One quadruped (D29) has a line emerging from its neck that could be interpreted as a leash, but it is not connected to anything else, making it difficult to interpret as a domesticated animal. Despite the presence of animal and human figures in interaction, there is no definitive indication of animal taming; quadrupeds are not depicted with leashes nor ridden. The only weak suggestion of this is the black paintings of animals waking in a line.

Unsurprisingly, many motifs found at Tham Pha Mue can also be found in Northeast Thailand. Tham Pha Mue is not an uncommon name, meaning “The Cave of Palms”. There are at least five other sites similarly named in Thailand where handprints and hand stencils are common: Tham Fa Mue Dang in Mukdahan Province, Tham Fa Mue in Khon Kaen Province, Tham Fa Mue Dang in Phitsanulok Province, Tham Fa Mue in Loei Province and Pha Fa Mue in Ubon Ratchathani Province (see Charoenwongsa 1989). Indeed, hand stencils are found extensively across Northeast Thailand. Besides the hand stencils and handprints, the ‘butterfly’ figure (E36) can also be found in Tham Lai Mue (“Cave of Many Hands”) in Khon Kaen Province; the angular waveforms and parallel zigzag lines can also be seen in Pha Taem of Ubon Ratchathani Province; and the series of

fragmentary curved lines is similar to Nang Khen Fay in Ubon Ratchathani Province. As noted earlier, some of the clothing depicted by the human figures in Tham Pha Mue can also be found in Northeastern and central Thailand. Thus, it can be said that the rock art at Tham Pha Mue is largely consistent with the corpus of rock art found in the Isaan region of Northeast Thailand.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s41826-025-00121-2>.

Acknowledgements This research was organised by the Syndicat Mixte de l’Espace de Restitution de la Grotte Chauvet (SMERGC), in close collaboration with the NGO Tetraktys and financed by the French Development Agency (AFD). Special thanks to the mission team including the authors Latsamy Choumphokham, Gilbert Mantovani, Keomany Phevalaty, Jean-Yves Paille, Sychampa Soune-thongdeng, Labouavone Thongsavat, Raphaël Torquebiau, Kongmany Kommalien and Raphael Trouiller; as well as Sommay Singthong for assistance with Lao translations.

Author contributions All authors contributed to the field research campaigns. Noel Hidalgo Tan: Writing, editing of text. Olivia Rivero Vila: Writing, editing of text. Xabier Eguilleor-Carmona: Image analysis, 3D scanning. Jean-Philippe Degletagne: Image analysis, 3D scanning. Nitixay Khamphoumy: Field Research team. Boumpasakxay Khampoumi: Field Research team.

Funding This research was organised by the Syndicat Mixte de l’Espace de Restitution de la Grotte Chauvet (SMERGC), in close collaboration with the NGO Tetraktys and financed by the French Development Agency (AFD).

Data availability The data supporting the findings of this study are held by the Division of Archaeology, Department of Heritage, Ministry of Culture and Tourism. Access to the data can be requested by contacting the Division directly. Requests may be subject to approval by the Division in accordance with national heritage regulations and policies.

Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

References

- Arambourg, C., and J. Fromaget. 1938. Le gisement quaternaire de Tam Hang (Chaîne Annamitique septentrionale). Sa stratigraphique et ses faunes. *Comptes Rendus De L'Académie Des Sciences* 203: 793–795.
- Aubert, M., et al. 2014. Pleistocene cave art from Sulawesi, Indonesia. *Nature* 514: 223–227.
- Aubert, M., et al. 2018. Palaeolithic cave art in Borneo. *Nature* 564: 254–257.
- Aubert, M. et al. 2019. Earliest hunting scene in prehistoric Art. *Nature* 576:1–4.
- Bellina, B., S. Rotchanarat, N. H. Tan, and O. E. Évrard. 2021. Coastal heritage: Exploring caves and indigenous knowledge in the Lanta Bay (Southern Thailand). *Journal of Indo-Pacific Archaeology* 45:25–41.
- Bo, X. 2020. On the relationship between the Cangyuan rock art in Yunnan, China, and the pha Taem rock art in Laos. *Rock Art Research* 37 (2): 155–166.
- Brumm, A., et al. 2021. Oldest cave art found in Sulawesi. *Science Advances* 7: eabd4648.
- Brumm, A., A. A. Oktaviana, and M. Aubert. 2024. Some Implications of Pleistocene Figurative Rock Art in Indonesia and Australia. In O. M. Abadía, M. W. Conkey, & J. McDonald (eds) *Deep-Time Images in the Age of Globalization*, 31–44. Cham: Springer International Publishing Available at: https://link.springer.com/https://doi.org/10.1007/978-3-031-54638-9_3 [Accessed August 17, 2024].
- Charoenwongsa, P. 1989. *Sinlapa Tham Nai Isan [Rock Art of North-east Thailand]*. Bangkok: Fine Arts Department.
- Ferlus, M. 1995. L'inscription rupestre de Nang An (Louang Phra Bang). In *La Thai'lande des debuts de son his to ire jusqu 'au XVe siecle: proceedings of the first Franco-Thai symposium (July 1988)*, 110–114. Bangkok: Silpakorn University.
- Freidline, S.E., et al. 2023. Early presence of Homo sapiens in Southeast Asia by 86–68 kyr at Tam Pà Ling, Northern Laos. *Nature Communications*. <https://doi.org/10.1038/s41467-023-38715-y>.
- Fromaget, J. 1940. La stratigraphie des dépôts préhistoriques de Tam Hang (Chaîne Annamitique septentrionale) et ses difficultés. Proceedings of the Third Congress of Prehistorians of the Far East. Singapore, 1938.
- Gao, Q. 2013. The Huashan rock art site (China): The sacred meeting place for Sky, water and Earth. *Rock Art Research* 30: 22–32.
- Gao, Q. 2017. Social values and rock art tourism: An ethnographic study of the Huashan rock art area (China). *Conservation and Management of Archaeological Sites* 19 (1): 82–95.
- Jalandoni, A. 2022. Australia-affiliated rock art research in Southeast Asia and Micronesia. In *Histories of Australian Rock Art Research*, ed. P.S.C. Taçon, S.K. May, U.K. Frederick, and J. McDonald, 257–276. Canberra: ANU Press.
- Jalandoni, A., P. Taçon, and R. Haupt. 2019. A systematic quantitative literature review of Southeast Asian and Micronesian rock art. *Advances in Archaeological Practice*. <https://doi.org/10.1017/aa.p.2019.10>.
- Jalandoni, A., et al. 2021. First directly dated rock art in Southeast Asia and the archaeological implications. *Radiocarbon*. <https://doi.org/10.1017/RDC.2021.29>.
- Lewis, H., J. White, and B. Bouasisengpaseuth. 2015. A buried jar site and its destruction: Tham An Mah cave, Luang Prabang province, Lao PDR. In N. H. Tan (ed) *Advancing Southeast Asian Archaeology 2013: Selected Papers from the First SEAMEO SPAFA International Conference on Southeast Asian Archaeology, Chonburi, Thailand 2013*, 72–82, 94–97. Bangkok: SEAMEO SPAFA.
- Lorrillard, M. 2009. Scripts and history: The case of Laos. *Senri Ethnological Studies* 74:33–49.
- Marwick, B., and B. Bouasisengpaseuth. 2017. The History and Practice of Archaeology in Laos. In *Handbook of East and Southeast Asian Archaeology*, ed. J. Habu, P.V. Lape, and J.W. Olsen, 89–96. New York: Springer.
- Moore, E.H. 2007. *Early Landscapes of Myanmar*. Bangkok: River Books.
- Oktaviana, A.A., et al. 2024. Narrative cave art in Indonesia by 51,200 years ago. *Nature* 631 (8022): 814–818.
- Ostermann, J.-M., and C. Mouret. 2004. Découverte de figurations pariétales dans des grottes et abris du Khammouane. *Spelunca* 96 (4): 35–43.
- Pryce, T. O., S. Baron, B. H. M. Bellina, P. S. Bellwood, N. Chang, and P. Chattopadhyay et al. 2014. More questions than answers: The Southeast Asian lead isotope project 2009–2012. *Journal of Archaeological Science* 42:273–294.
- Sangwan, N. 1987. Some rock painting sites in the Phangnga and Krabi Bay area. In *Final report: Seminar in prehistory of Southeast Asia*, 119–141. Bangkok: SEAMEO Project in Archaeology and Fine Arts.
- Sarikabutara, P. 1987. Bird, fish and boat: Mysterious beliefs in the rock painting; particularly of tham phi Hua To, Krabi Province, Southern Thailand. In *Final report: Seminar in prehistory of Southeast Asia*. Bangkok: SEAMEO Project in Archaeology and Fine Arts.
- Sayavongkhamdy, T., P.S. Bellwood, and F. David Bulbeck. 2000. Recent archaeological research in Laos. *Bulletin of the Indo-Pacific Prehistory Association (Melaka Papers)* 19 (3): 101–110.
- Schaarschmidt, M. et al. 2019. pIRIR and IR-RF dating of archaeological deposits at Badahlin and Gu. *Quaternary Geochronology* 49:262–270.
- Shao, Q.-F., E. Pons-Branchu, Q.-P. Zhu, W. Wang, H. Valladas, and M. Fontugne. 2017. High precision U/Th dating of the rock paintings at Mt. Huashan, Guangxi, southern China. *Quaternary Research* 88: 1–17. <https://doi.org/10.1017/qua.2017.24>.
- Shewan, L., et al. 2021. Dating the megalithic culture of Laos: Radiocarbon, optically stimulated luminescence and U/Pb zircon results. *PLoS One* 16 (3): e0247167.
- Singthong, S., V. Zeitoun, A. Pierret, and H. Forestier. 2016. An outlook on prehistoric research in Laos: An inventory and some perspectives. *Quaternary International* 19:177–182.
- Srisuchat, A. 1987. Prehistoric cave and some important prehistoric sites in Southern Thailand. In *Final report: Seminar in prehistory of Southeast Asia*, 103–117. Bangkok: SEAMEO Project in Archaeology and Fine Arts.
- Srisuchat, A. 1990. *Sinlapa Tham Khao Plara [Rock Art at Khao Plara, Uthai Thani Province]*. Bangkok: Fine Arts Department.
- Srisuchat, A., and K. Mukmikka. 1989. *Sinlapa Tham Pha Taem Khong Chiam [Rock art of Pha Taem, Khong Chiam District, Ubon Ratchathani Province]*. Bangkok: Fine Arts Department.
- Surinlert, J., P. Auetrakulvit, V. Zeitoun, C. Tiamtinkrit, and P. Khemnak. 2018. Comparison of rock painting sites in the Pratu Pha Valley, Lampang Province, Thailand. In N. H. Tan (ed) *Advancing Southeast Asian Archaeology 2016*, 248–254, 380–382. Bangkok: SEAMEO SPAFA.
- Taçon, P.S.C., et al. 2014. The global implications of the early surviving rock art of greater Southeast Asia. *Antiquity* 88 (342): 1050–1064.

- Tan, N.H. 2010a. *Scientific Reinvestigation of the rock art at Gua Tambun, Perak. Vol 1: New Research*. MA. Penang: Universiti Sains Malaysia.
- Tan, N.H. 2010b. *Scientific Reinvestigation of the rock art at Gua Tambun, Perak. Vol 2: Inventory of Rock Art*. MA. Penang: Universiti Sains Malaysia.
- Tan, N.H. 2014a. Rock art research in Southeast Asia: A synthesis. *Arts* 3 (1): 73–104.
- Tan, N. H. 2014b. *Painted Sites, Sacred Sites: An examination of religious syncretism in Southeast Asia through rock art site usage Volume 1*. PhD thesis. Canberra: Australian National University. Available at: <https://openresearch-repository.anu.edu.au/handle/1885/204429>.
- Tan, N. H. 2014c. *Painted Sites, Sacred Sites: An examination of religious syncretism in Southeast Asia through rock art site usage Volume 2: Rock Art Images and Tracings*. PhD thesis. Canberra: Australian National University. Available at: <https://openresearch-repository.anu.edu.au/handle/1885/204429>.
- Tan, N.H. 2018a. Rock art at the cave of a thousand Buddhas, Luang Prabang, Lao PDR. *Archaeological Research in Asia* 15: 129–136.
- Tan, N.H. 2018b. The cliff paintings of Pha Taem, Luang Prabang, Lao PDR. *Rock Art Research* 35 (1): 62–78.
- Tan, N. H. 2019a. Rock Art of Southeast Asia. Available at: <https://www.southeastasianarchaeology.com/rock-art-of-southeast-asia/>.
- Tan, N.H. 2019b. Rock Art in Mainland Southeast Asia. In *Rock Art in East Asia: A Thematic Study*, ed. J. Clottes and B. Smith, 126–147. Paris: International Council on Monuments and Sites.
- Tan, N. H. 2019c. *Final Report: Rock Art Record of Lewun Rockshelter, Shan State Myanmar*. Bangkok: SEAMEO SPAFA. Available at: <https://doi.org/10.13140/RG.2.2.35635.07205>.
- Tan, N.H., and S. Chia. 2010. New rock art from Gua Tambun, Perak, Malaysia. *Rock Art Research* 27 (1): 9–18.
- Tan, N.H., and S. Chia. 2011. Current research on the rock art at Gua Tambun, Perak, Malaysia. *Bulletin of the Indo-Pacific Prehistory Association* 31: 93–108.
- Tan, N.H., and R. Hoerman. 2019. Mainland Southeast Asia: Rock Art. In *Encyclopedia of Global Archaeology*, ed. C. Smith. https://doi.org/10.1007/978-3-319-51726-1_3127-1.
- Tan, N.H., and V.N. Scott. 2021. Recent Developments in Rock Art Research in Southeast Asia (2015–2019). In *Rock Art Studies: News of the World VI*, ed. P. Bahn, N. Franklin, and M. Strecker, 146–157. Oxford: Archaeopress Archaeology.
- Tan, N.H., and P.S.C. Taçon. 2014. Rock Art and the Sacred Landscapes of Mainland Southeast Asia. In *Rock Art and Sacred Landscapes*, ed. D. Gillette, W.B. Murray, M. Greer, and M.H. Hayward, 67–84. New York: Springer Science.
- Tan, N.H., and V. Walker-Vadillo. 2015. The curious case of the steamship on the Mekong. *Asian Perspectives* 54 (2): 253–273.
- Tan, N. H. et al. 2016. What rock art? Stories from Northeast Thailand. In *Relating to rock Art in the contemporary world*, ed. L. M. Brady, and P. S. C. Taçon. 37–58. Boulder, Colorado: University of Colorado.
- Treerayapiwat, C. 2005. Patterns of habitation and burial activity in the ban Rai rock shelter, Northwestern Thailand. *Asian Perspectives* 44 (1): 231–245.
- Tucci, A., T. Sayavongkhamdy, N. Chang, and V. Souksavatdy. 2014. Ancient copper mining in Laos: Heterarchies, incipient States or post-state anarchists? *Journal of Anthropology and Archaeology* 2:1–15.
- Watanabe, H., K. Shigematsu, and M. Anzai. 1985. Archaeological survey of prehistoric cave sites in Laos. *Bulletin of the Department of Archaeology the University of Tokyo* 4:31–54.
- White, J. C., H. Lewis, B. Bouasisengpaseuth, B. Marwick, and K. Arrell. 2009. Archaeological investigations in northern Laos: New contributions to Southeast Asian prehistory. *Antiquity*, 83, project gallery.
- White, J., N. Shimizu, Naho, and B. Bouasisengpaseuth. 2019. Preliminary report on the first archaeological investigations in 2018 at the old City, near Thakhek Khammouane Province, the Lao PDR. *Journal of Southeast Asian Archaeology* 39:107–111.
- Wu, Y., X. Mou, X. Bo, and X. Ji. 2019. Rock Art in Yunnan. In *Rock Art in East Asia: A Thematic Study*, ed. J. Clottes and B. Smith, 106–111. Paris: International Council on Monuments and Sites.
- Wu, Y., Y. Jiao, X. Ji, P.S.C. Taçon, Z. Yang, S. He, M. Jin, Y. Li, and Q. Shao. 2022. High-precision U-series dating of the late Pleistocene-early Holocene rock paintings at Tiger Leaping Gorge, Jinsha River valley, southwestern China. *Journal of Archaeological Science* 138: 105535. <https://doi.org/10.1016/j.jas.2021.105535>.
- O'Reilly, D., Shewan, L., Luangkoth, T., Domett, K., Halcrow, S., Khamphouvong, M., Butphachit, A., Sayavongkhamdy, T., Heap, N. 2023. Secondary burial practice at megalithic jar site 1, Plain of Jars Laos. *Asian Archaeology* 7, 105–117. <https://doi.org/10.1007/s41826-023-00067-3>.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.