LPDR Caves Project

โครงการจัดตั้งป่าสงวนและอนุรักษ์ป่าไม้
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FOMACOP

FOREST MANAGEMENT AND CONSERVATION PROJECT
Lao - World Bank - GET - FINNIDA Cooperation

A project to explore and develop the caves of the Lao Peoples Democratic Republic

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THE LAO CAVE EXPLORATION PROJECT

Details of the LPDR Caves Project are also available at the following site on the World Wide Web

http://www.liv.ac.uk/Geomagnetism/laos/

REPORT FOLLOWING THE 1996 LPDR CAVES PROJECT TO KHAMMOUANE AND VIENTIANE PROVINCES

CONTENTS

Introduction

This report summarises the survey visits made to caves in Khammouane Province and in Vientiane Province Lao PDR during the period 19th March to 11th April 1996. This joint Lao PDR/British cave survey expedition represents the first successful visit of its kind by a foreign cave specialist team. The difficulties in planning and executing such a venture are immense and it is only through the continued support from the Lao PDR Forestry Department and the Forest Management and Conservation Project (FOMACOP) staff in Vientiane that the 1996 visit was such a success.

Acknowledgements

The British team wish to thank all our Lao PDR counterparts, in particular:

Mr. Chantaviphone Inthavong...Director Department of Forestry, Vientiane Mr.
Bouahong Phanthanousy...Director FOMACOP
Mr. Bouaphanh Phanthvong...Deputy Director FOMACOP
Mr. Paphakone Vongxay...FOMACOP
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Mr. K. Salyvong...Protected Area and Watershed Centre
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Mr. Bouasy...Field guide, Department of Agriculture and Forestry, Vang Viang
Mr. Bounhorn Chanthamat, Dept. of Museums and Archaeology, Ministry of Culture
Mr Southam Latthachack...Deputy Governor of Khammouane Province
Members of the F orestry Department in Thakhek
Ms. Geraldine Zwack...FOMACOP/MIDAS Agronomics

and finally many thanks for the help provided by village leaders and local people in both Khammouane and Vientiane Provinces.

British Team Members

The 1996 LPDR Caves Project team members and their specialties are as follows;

Mr. Adrian Gregory...Expedition leader, cave photographer and surveyor
Dr. Steve Openshaw...Cave genesis and geology, cave surveyor
Mr. Kevin Senior...Geologist, cave photographer and surveyor
Mr. Phil Papard...Geologist and cave surveyor

The British team would also like to express thanks to the following people and organisations who assisted with finance, equipment and logistics during the 1996 expedition:

The Ghar Parau Foundation, The Foundation for Sports and Arts, The Royal Geographical Society, The Sports Council, Emirates Airlines, Alexandra Workwear Ltd, Rabone Chesterman Ltd, Mike Meredith, Howard Limbert, Howard Jones, Lyon equipment, Tony Haigh (British Gas), Warmbac Wetsuits and MIDAS (Vientiane).

CAVES OF THE THAKHEK AREA, KHAMMOUANE PROVINCE.

Introduction

During our visit to Khammouane Province, the town of Thakhek was used as our base (Figure 1). We had originally intended to explore the many areas of speleological interest in the karst areas around Thakhek. Following several meetings with the provincial leaders, who were concerned for our safety, our explorations were restricted to the area around Ban Mouang (Sheet E-48-90, Grid ref. 816415, Figure 2), 25 km to the north-east of Thakhek. Brief tourist visits to Tham En and to the Nam Hinboun river cave (Tham Kong Row) were also made. Explorations around the Tham Kong Row and Tham En have, at present, been conducted by a team of French cave specialists (Mouret et al, 1994; Mouret and Vacquie, 1993). Copies of their reports are enclosed. Our report gives detailed information on only those caves visited for the purpose of survey work but gives a brief description of Tham Kong Row.

Karst Development

The village of Ban Mouang is best approached using a combination of Highway 12 and a track which is met just after crossing the river emanating from Tham Xiangliap. The karst to the north-east of Thakhek is formed in Permo-Carboniferous limestone (Mouret and Vacquie, 1993; Workman, 1977). These limestones display erosional properties typical of a tropical environment. Passing through the perimeter of the karst many towers are evident illustrating the result of long-term tropical weathering. Beyond these towers the central karst areas remain much less weathered and significant peaks and ridges predominate. The valley floors are covered by a mix of paddy fields and forest whilst the limestones themselves are bare.

The main control on base level in the Thakhek area is the Mekong River. The slow rate of downcutting by the Mekong has resulted in the Nam Don and associated tributaries eroding the valley floors flat over a large area. This is particularly evident around Ban

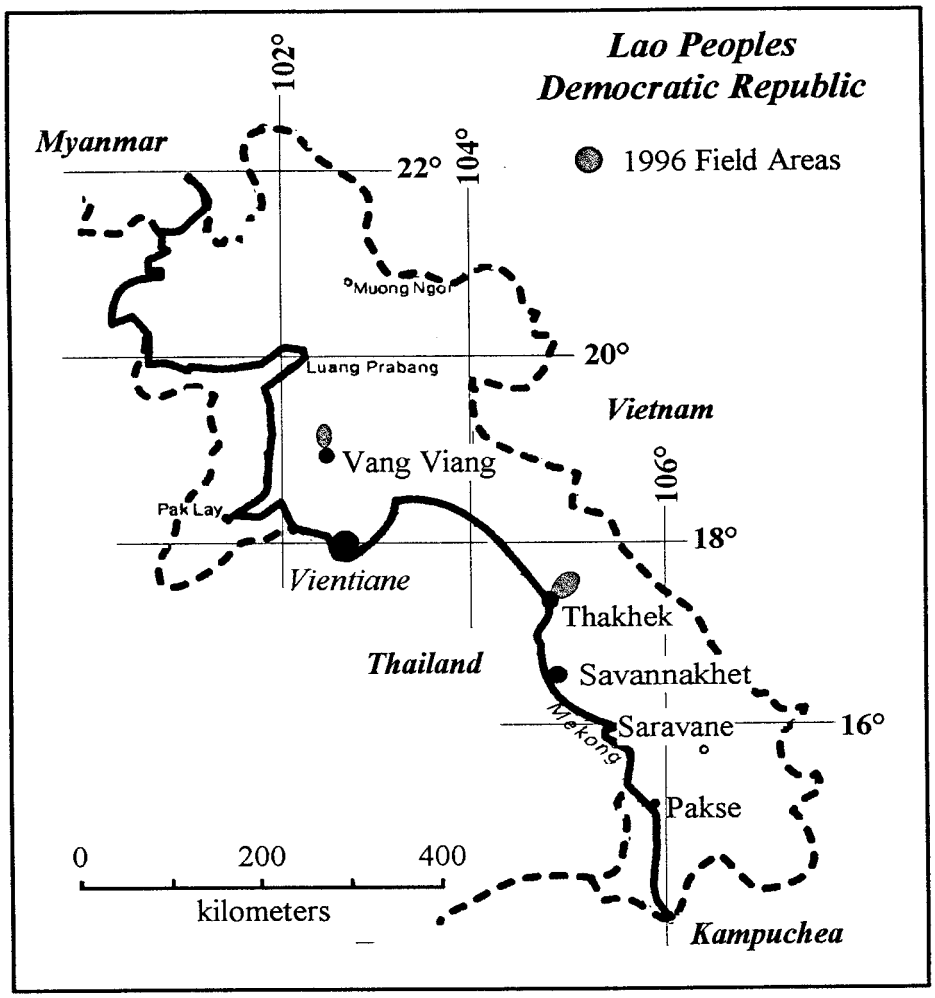


Figure 1. Map showing location of Lao PDR and the principal sites visited during the 1996 expedition.

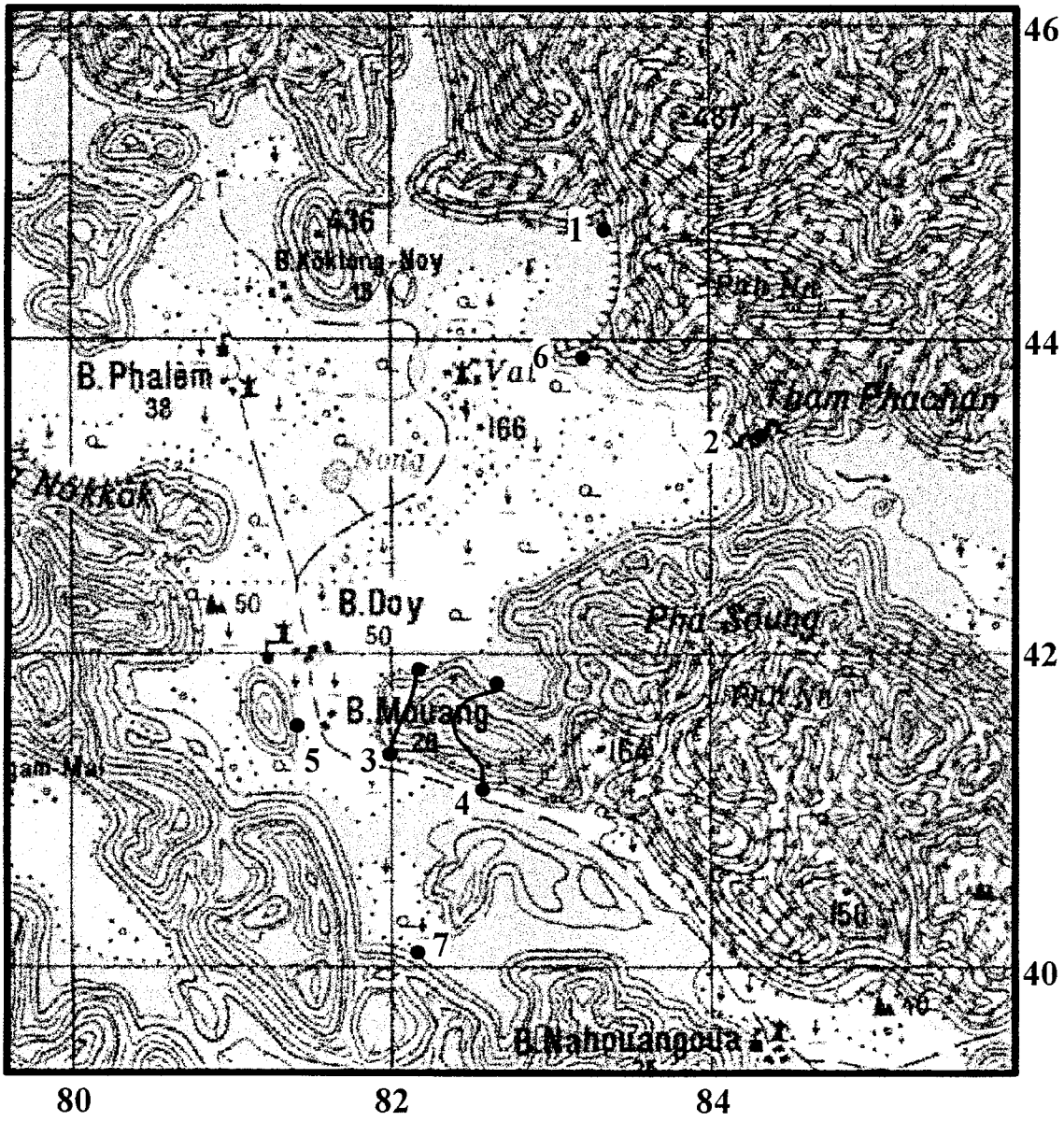


Figure 2. Surveyed caves around the village of Ban Mouang. 1. Tham Physeau 2. Tham Patchan 3. Tham Sompoy 4. Tham Jongchott 5. Tham Quaie 6. Tham Pong 7. Tham Nonsim. 1:100,000 sheet number E-48-90.

Mouang (photo 1). In addition to the current base-level at the valley floor, numerous former base-levels are marked as shelves at and above the height of 200m. These shelves are quite hard to distinguish since they are heavily weathered. However, they do provide some evidence to suggest the presence of high level cave passage. The difficulty in gaining access to the higher peaks to search for high level cave passages and shafts would be immense due to lack of access tracks and the development of pinnacles and deep gullies.

The process by which the valley floor erosion has occurred is clearly displayed. Beneath each cliff face is a deep undercut in which wet season flood waters are carried. These undercuts will develop mainly from solutional weathering but also by abrasion to a point where the overlying cliff collapses and the debris is eroded quickly by further solutional weathering operating on an increased surface area. Numerous cliff collapse features are seen around Ban Mouang, for example that at the northern entrance to Tham Jongchott. There is also some evidence to suggest that the truncation by caves of spurs descending from the higher peaks also significantly contributes to the widening of the valley floor. This truncation may assist in the formation of isolated towers at the edges of the valley floor. For example, the tower containing Tham Quaie may have formed by such a process. The remainder of this section gives a detailed description of the caves visited and surveyed around Ban Mouang.

The Caves

Tham Patchan- Cave of the Wooden Buddha.

Tham Patchan is an impressive through cave of just over 500m length which cuts through a spur descending from the limestone massif above (Sheet E-48-90; grid ref. 842433, Figure 2). The western entrance forms an arch 50m high and 60m wide and these dimensions are maintained throughout the main cave. To the left, just inside the western entrance, is a monastery on a ledge 15m above the floor of the passage (Figure 3).

The cave appears to owe its development to a major fracture which can be seen in the cave roof. During the wet season the water level of the river is estimated to rise by up to 3m from flood debris deposited on the cave walls. During our visit in the dry season there was no flowing water and only static pools remained. In the wet season the waters leaving the cave from the western entrance flow in an undercut beneath the cliff face.

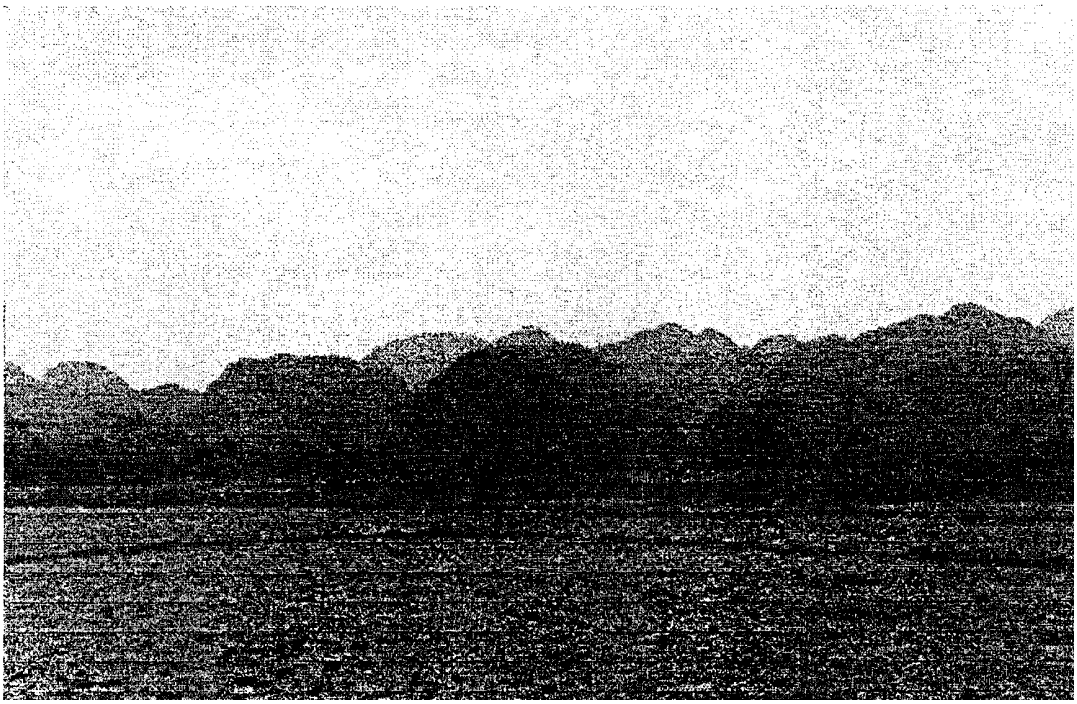


Photo 1. Looking north-east from the village of Ban Mouang across the valley floor to the central limestone massif

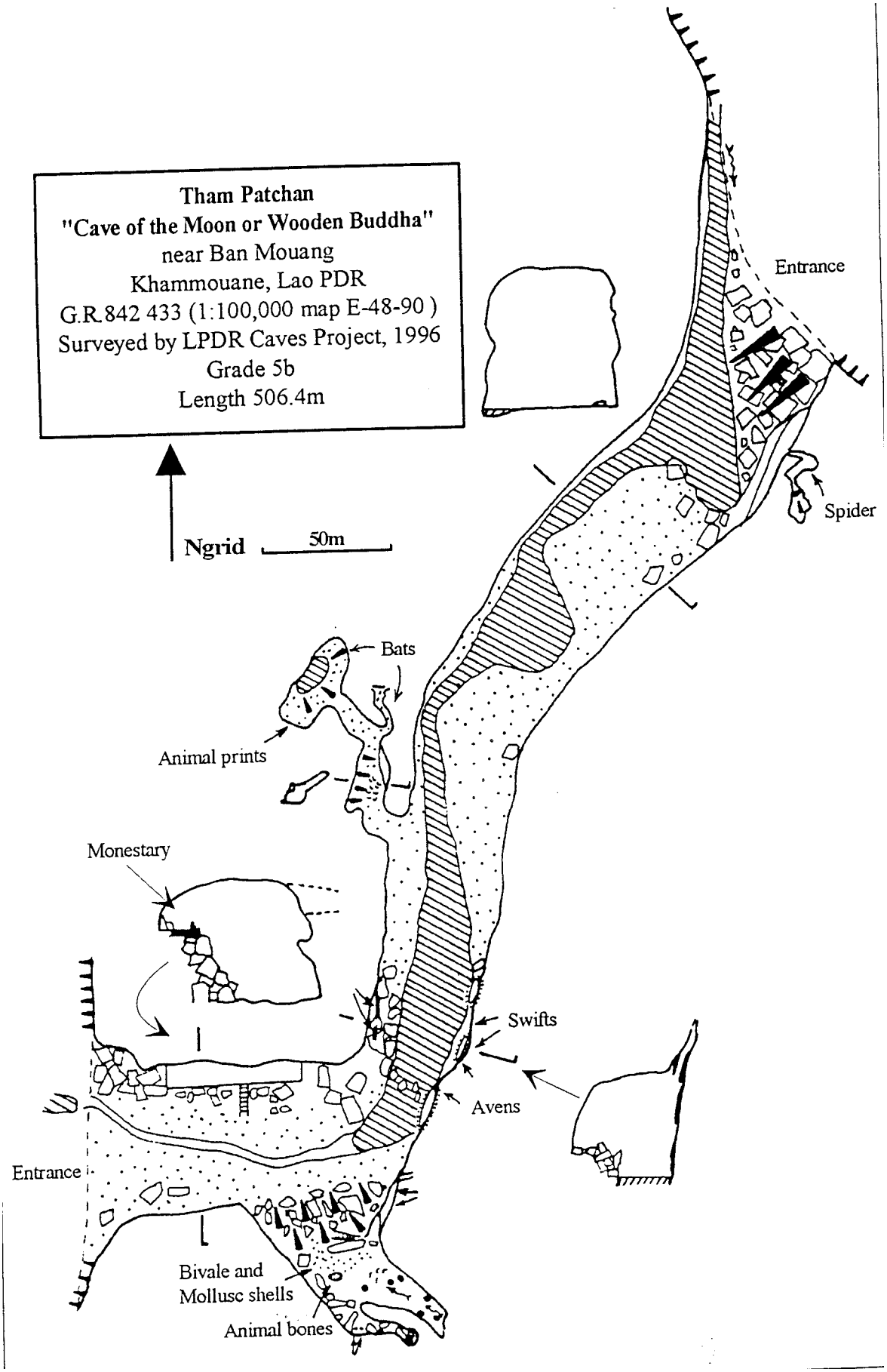


Figure 3. Survey of Tham Patchan

The main route through the cave is obvious but there are several notable side passages worthy of description. Entering the cave from the west, the main passage takes a long sweeping bend to the north (Figure 3). On the right of this bend a slope comprised of ochrous sediment and decayed flow stone leads up to a prominent ledge about 40m from the floor of the main passage. This ledge marks a former cave floor level. Among the rocks and debris on the ledge are large numbers of snail shells which have been carried and subsequently deposited by receding flood waters. From the ledge several features were noted. The first of these are two holes around collapsed flow stone formations which are linked by a crawl. Again on the ledge but further into the cave, is a second hole marked by a subsided flow stone column. This hole can be descended by an easy 2m climb on the right through flow stone blocks but at its base it is blind. On the floor were several broken animal bones. Above the hole on the left of the flow stone column a short climb up leads to a 3-4m wide phreatic tube with tree roots entering via fissures in the overlying limestone. After a short distance this passage becomes blocked by layered sediments and flow stones indicating that at least two periods of calcite precipitation have occurred. The most obvious passage that can be entered from the ledge leads past some ancient columns to a boulder and flow stone choke with no passable way on.

Back in the main passage several ascending shafts can be seen in the roof At one point a bamboo pole marks an attempt to reach the nests of cave swifts of which many were seen in Tham Patchan.

There are two further side passages in Tham Patchan. The first is approximately half way through the cave in the southern wall. This passage divides into two and the left branch ends in a muddy, domed chamber with a pool on its left-hand side. Long-Eared bats were found roosting here in solution pockets. The right-hand branch quickly becomes a low and tight crawl in an elliptical rift. The final side-passage is just inside the eastern entrance arch and is entered via a ledge approximately 5m above a static pool. The passage is a small phreatic tube about 2m in diameter which degenerates into a crawl after about 25m

Tham Pong

Tham Pong (sheet E-48-90; grid ref. 832 438; Figure 2) lies 3km to the west of Tham Patchan and is also part of the course of the Nam Dong. No survey work was undertaken. The

cave is an impressive rock arch some 85m long, 25m wide and 30m high and is located in an isolated spur descending from the cliffs to the north. The cave is used for bathing and fishing by locals and water buffalo. A ledge on the northern side of the cave leads to a difficult climb to a roof tube from where locals catch cave swifts. It contains a large pool of slow flowing water.

Tham Physeau- Cave of the Butterfly

The limited explorations in Tham Physeau suggest the presence of a long system under the limestone massive to the north and east of the cave (sheet E-48-90; grid ref. 835469; Figure 2). Limited time in the field and the lack of permission to revisit the site permit only a hypothetical assessment of its potential.

The cave itself is best approached via a pleasant area of forest before a slope leads up to the entrance 13m above the valley floor. It may be possible to enter the cave lower down the slope via numerous low, wet arches in the cliff face. The impressive 40m wide and 25m high entrance arch (Figure 4) leads to a boulder slope with some gour pools on the right which are descended to a 'T' junction in a river passage approximately 1 Orn across. Downstream, to the right, the passage becomes smaller and a deep water filled canal is negotiated before ending in a sump. A climb out of the canal at the sump may lead to a possible by-pass but this was not fully investigated. The canal was notable for its population of fish and crabs neither of which appeared to be cave-adapted species.

Back at the entrance slope, the upstream passage maintains its 10m wide dimensions. Initially easy walking, after 50m it becomes easier to traverse over boulders and flow stone deposits on the left. At this point the passage is between 20 and 30m in height. Steady going over boulders eventually enters an area of large scale breakdown where the passage size increases to approximately 40m wide and 40-50m high. On the right-hand wall a large passage entered for an estimated l00m continues unexplored and the strong draught emanating from it suggests potential for continuation for some considerable distance.

From the breakdown chamber, the original passage continues north past a large flow stone boss and a strong outward draught becomes more noticeable. At the normal stream level a profusion of calcite flow stone causes the stream to backup and for a sump but an easy 6m climb on the left through a 1.5m high gap followed by a traverse passes over the top of the

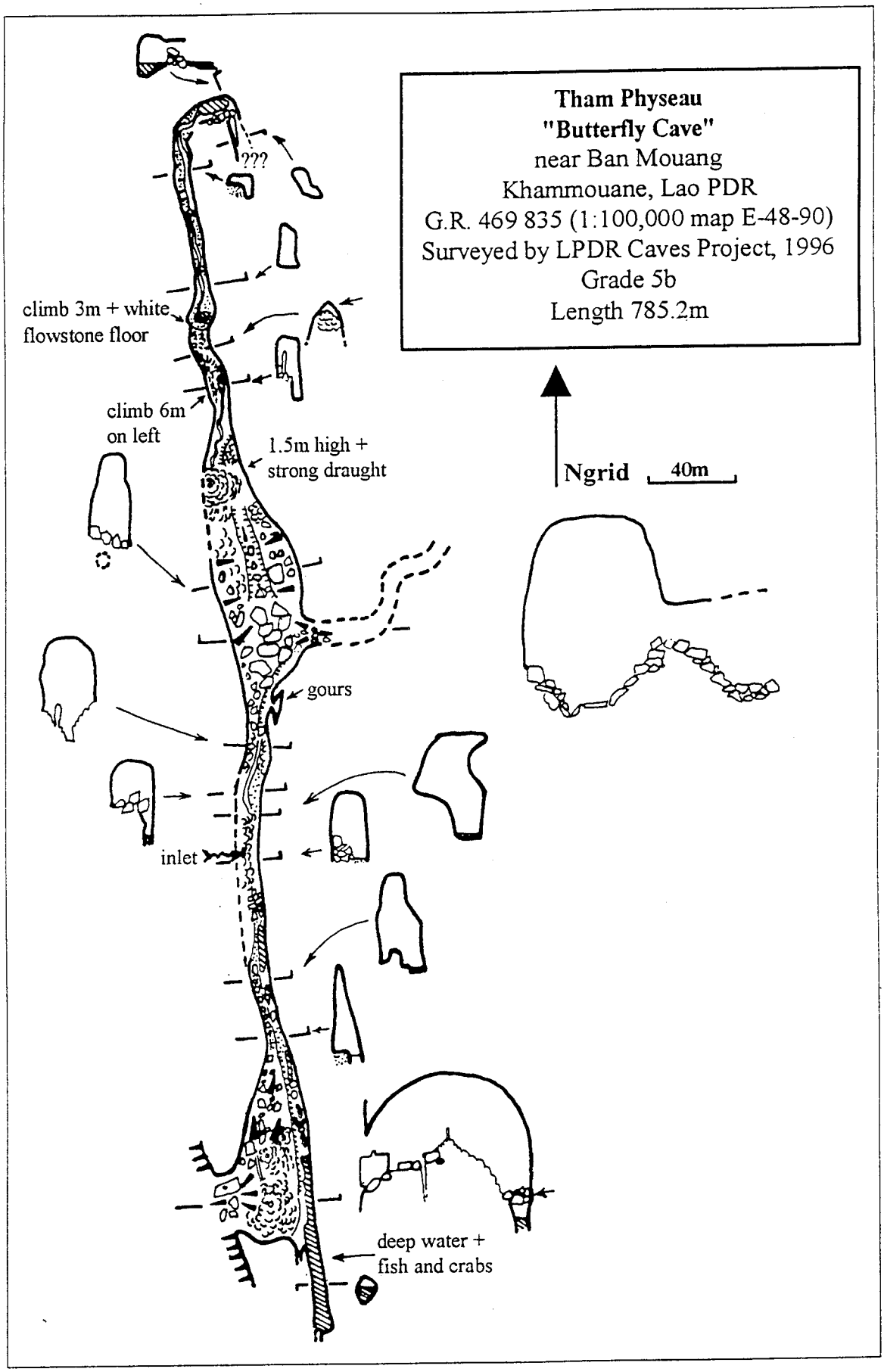


Figure 4. Survey of Tham Physeau

obstruction. The draught is particularly strong here due to the restricting effect of the sump and flow stone at stream level. Beyond, a climb down over brilliant white gour pools enters a small chamber containing several pools of water.

From this point onwards the passage size decreases to a maximum of 5m across and 5m high. Progress is initially made over muddy boulders and then between mud banks. These mud banks are evidence for the complete flooding of this section of the passage during the wet season. It is most likely that the waters backup due to the flow stone constriction further downstream. The limit of exploration is met after a pool is by-passed by a traverse on the right and the beginning of a crawl in passage 2-3m wide and 2m high is reached. The walls at this point in the cave are sharp and very brittle. Beyond the crawl progress is made by traversing at water level before the passage becomes smaller still after 10m. A draught is still evident at this point suggesting further passage beyond.

Tham Physeau contains some very impressive passage, although not as large as for example Tham Patchan, and also contains some superb formations. The abundance of formations is most likely due to the very few visits by locals. The trend of the cave appears to be determined by a pair of joints of which only one has an effect on the passage development in most sections of passage. However, in places the two joints have acted in unison to produce the characteristic flat roof A third parallel joint appears to have helped in the formation of the gour filled gallery before the main junction. The continuation of this joint may also have assisted in the development of the large breakdown chamber at and beyond the main junction.

Tham Jongchott - Crouching Cave.

The entrance is a 2m high arch found in an undercut amongst trees at the base of the cliff (sheet E-48-90; grid ref 827 411 Figure 2 and Figure 5). The entrance arch quickly becomes lower before a 'T' junction is encountered after 15m where it is possible to stand upright again. To the right at this junction is an attractively shaped and clean washed rift passage whose walls have been polished by sediments carried in flood waters. This process of mechanical abrasion also acts in the undercuts below cliff faces. Immediately beyond this rift is a small chamber from which a rift continues but is too tight to enter.

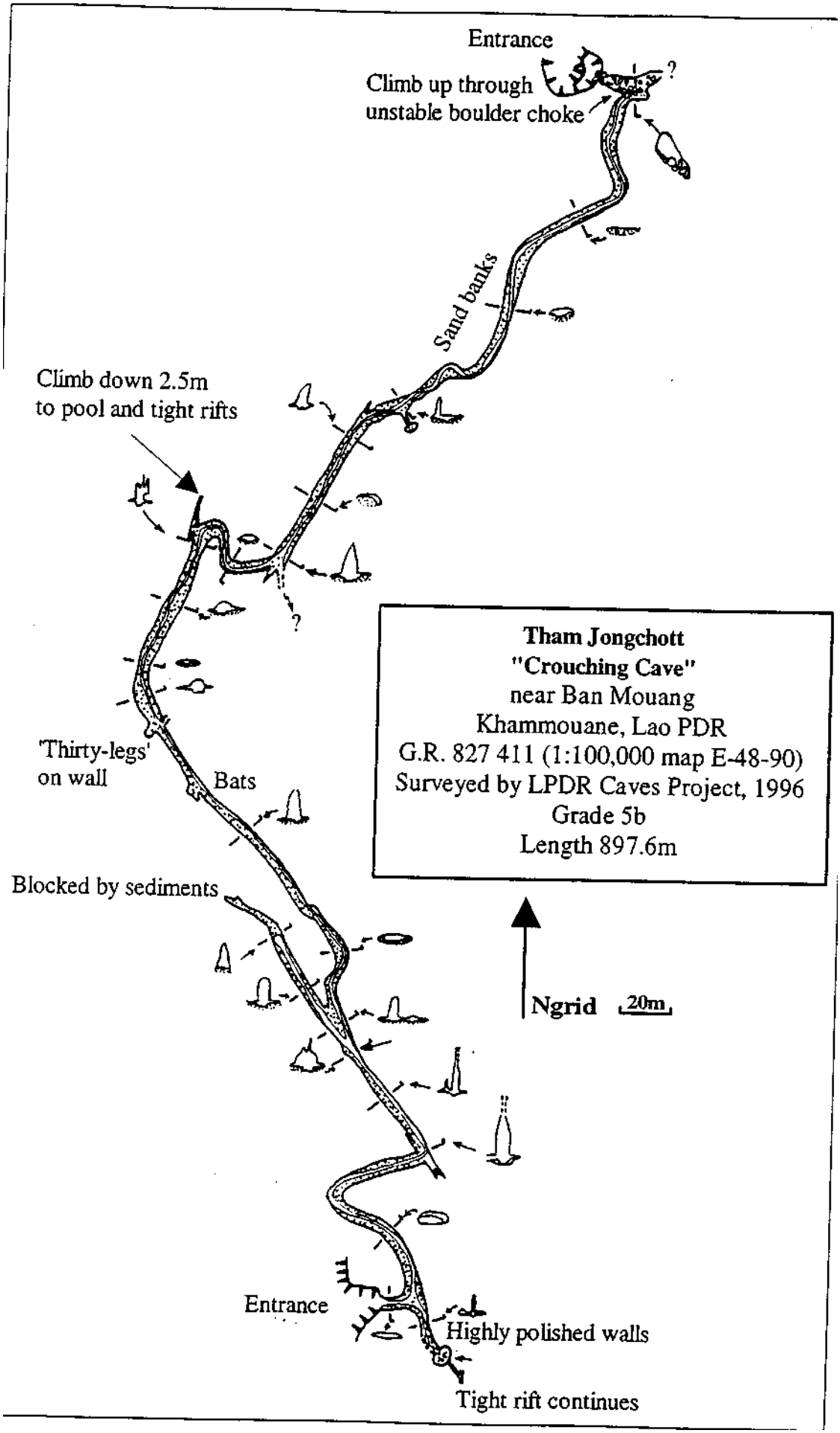


Figure 5.Survey of Tham Jongchott.

The main way on in to the cave is left at the 'T' junction. A mixture of hands and knees crawling, stooping and walking leads to a rift chamber at least 15m high. Rifts on the right are too tight to enter but the main way continues beneath two parallel joints. Initially the passage beneath the left-hand joint is the easiest route but it soon becomes more advantageous to use the passage beneath right hand joint. A second low section leads to a circular chamber about 6m in diameter in which many bats were found to be roosting. A few meters further into the cave an alcove on the left can be best seen by climbing up a sediment bank (station 11). Large earwiglike insects, known to the locals as 'Thirty-Iegs', were found on the walls of this alcove. About 10m further on from station 11 the passage splits. Straight on is a continuation of the rift which appears to end but a small eyehole on the left arrives at the top of a 2.5m drop. This drop is easily climbed and lands in a muddy pool at the bottom of a 10m + high rift. Traversing 15m around the pool leads to a climb up a mud slope to a small and tight rift which was not entered.

In the main passage, the right-hand split leads to a low hands and knees crawl in what is a substantial stream way during the wet-season. The passage is elliptical in shape and is partially filled with sediment in which a channel has been cut by a smaller, post-wet-season stream. After several meanders the roof suddenly rises after approximately 50m and a 'T' junction at a rift is met. The walls at the junction are covered with flow stone and stalagmites. To the right the passage continues for 20m to a descending rift which was tight and not entered on this occasion. The main way on is to the left at the 'T' junction in a 5m wide sand floored rift passage with a notch at stream level. An oxbow on the right just past station 33 gives easier going than following a crawl in the dry stream bed. A passage on the right 30m beyond the oxbow leads after 15m to a circular chamber with several blocked or too-tight passages. The main passages continues along a single joint and slowly reduces in size from a rift to an elliptical tube followed by a low crawl. At the end of the crawl the passage widens to walking size but a large and recent-looking boulder choke appears to bar any further progress. However, a draught can be felt coming from the boulders and by carefully squeezing up into the choke its top is gained in a large 15m wide and 25m long chamber with daylight visible up on the left. No way was found back down to the stream way beyond the boulder choke although some more prolonged digging may yield a possible route. To gain daylight a scramble up the boulder slope leads to a 2m climb and squeeze up between jammed boulders. This entrance is amidst thick jungle and the valley floor is regained via several overgrown climbs down rock shelves and large boulders, that have fallen from the cliff above.

The quantity of sediment and flood debris suggests that during the wet-season Tham Jongchott is completely flooded. As the flood waters recede the associated reduction in stream energy causes a large proportion of the suspended load to be dropped as large sediment banks. In the case of Tham Jongchott the accumulation of sediment has served to protect the bed and lower walls of the passage allowing erosion of the passage roof as the thickness of bed sediment increase; a process known as paragenesis (Ford and Williams, 1989). Subsequent removal of the sediment by downcutting stream waters, brought on by a lowering of the base-Ievel, gives the characteristic high rift passage seen today.

Tham Sompoy

Tham Sompoy is located just above the valley floor level in the same limestone spur as Tham Chongchott but is further west, closer to the end of the spur (sheet E-48-90; grid ref 820 413; Figure 2 and Figure 6). The cave appears to remain dry throughout the year suggesting that its waters were captured by Tham Chongchott. The southern entrance to the cave is approximately 13m wide by 7m high and is gained via a 3m high climb up over boulders. A small shrine is located on the left of the entrance arch. The passage continues with the same dimensions for approximately 280m and is an easy walk over a mixed calcite and mud floor with occasional flow stones and stalagmites. A small pool is passed after 200m and above are a series of vertical shafts (avens) indicating that some higher level development may have taken place.

At 280m the passage is partially blocked with flow stone and boulders but a short 1m high crawl under a block on the left bypasses this. Immediately beyond the crawl is a further blockage comprising of loose boulders. This blockage is easily by-passed on the right.

From the boulder blockage the passage is approximately 7m wide and up to 7m high and the floor is composed of decayed calcite and rock fragments which are quite dusty. Further avens are seen in the roof at 400, 450 and 500m from the southern entrance and again this suggests high level development. On the right near the northern end of the cave is a rift emitting a very strong draught. It was not possible to enter this rift as it was too tight.

The cave passage ends at a short climb down over boulders 2m above the valley floor just to the west of the collapse. area at grid ref. 823 413. Tham Sompoy has been regularly entered by locals who take bats from the cave for food.

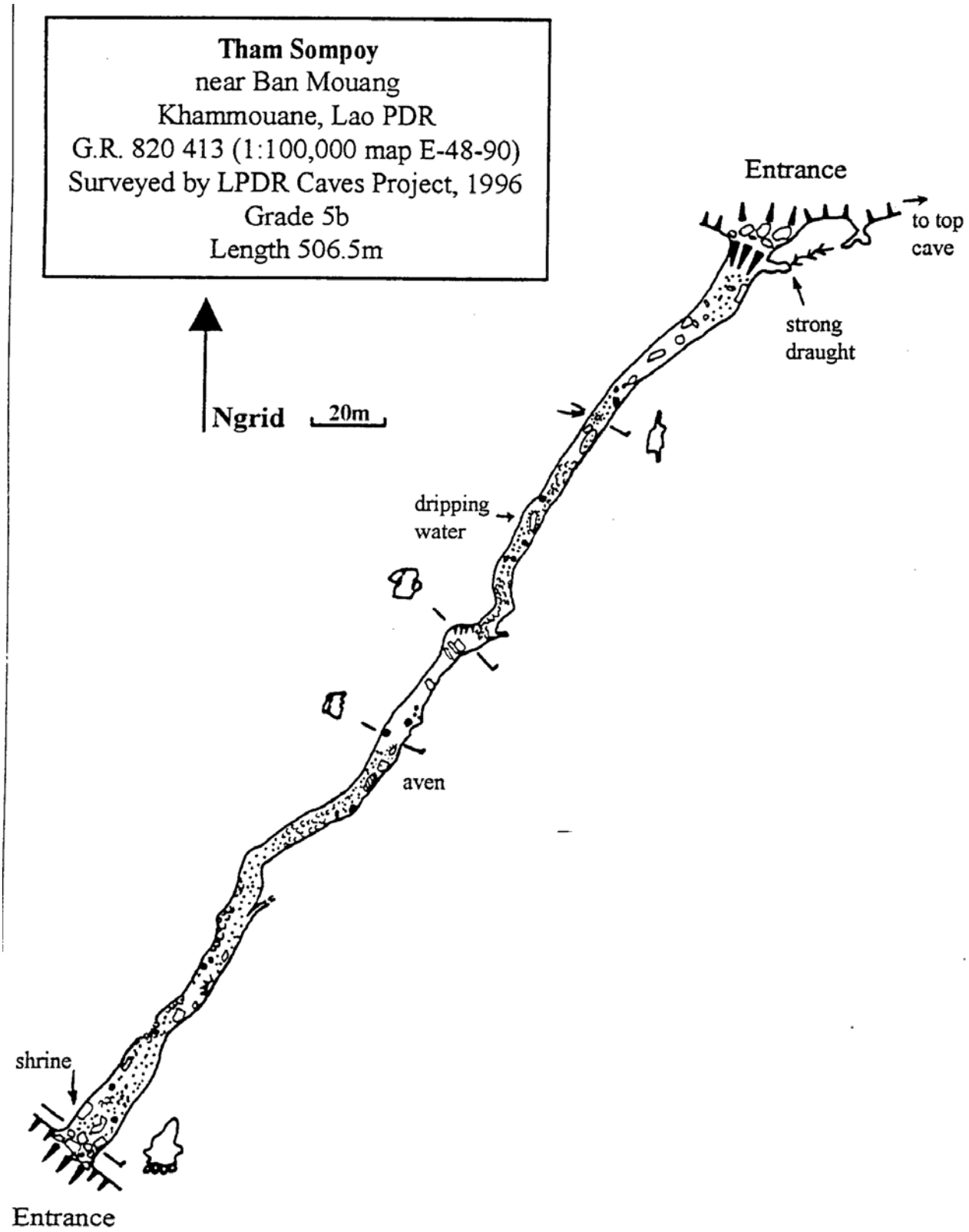


Figure 6. Survey of Tham Sompoy

Tham Quaie

Tham Quaie is located in an isolated tower 250m to the west of Ban Mouang (sheet E48-90; grid ref. 812414; Figure 2). The entrance portal is found at the southern end of a deep undercut. The cave contains large numbers of long-eared bats which are used as a food source. The cave itself is used by children as a play area and consists of l00m of walking with occasional easy hands and knee crawling (Figure 7). The western entrance is approached via the deep undercut and is initially stooping height for 1 0m before entering a well decorated chamber. Numerous crawls from this chamber re-emerge in the undercut to the north of the entrance. After a further 30m the passage appears to be blocked by a large stalagmite deposit but this is bypassed on the right. The passage continues 2-4m in width until daylight is seen through a hole in the roof It is possible to climb out from the cave through this hole to a viewpoint looking over Ban Mouang. Continuing below the hole in the roof the passage degenerates in to a crawl for 20m to the eastern entrance. The valley floor is gained over a pile of heavily vegetated boulders.

Tham Nonsim

Tham Nonsim is located approximately 2km to the south of Ban Mouang (sheet E-4890; grid ref. 822401; Figure 2). No survey work was undertaken in this cave and its estimated length is 60m. The entrance is approximately 1.5m high and wide and these dimensions are maintained throughout the cave. The floor of the cave is composed of semi-dry mud.

20m from the entrance is a rift in the roof which emits a strong draught. This rift was not entered. The cave continues in a similar muddy fashion and ends at a muddy, low arch which would require considerable effort to pass. There is no tourist potential in Tham Nonsim.

Visit to the Nam Hinboun River Cave- Tham Kong Row

Tham Kong Row (Sheet E-47-78; grid ref. 745 862; Figure 8) was visited by our team in order to make a representative photographic record that would be available to the

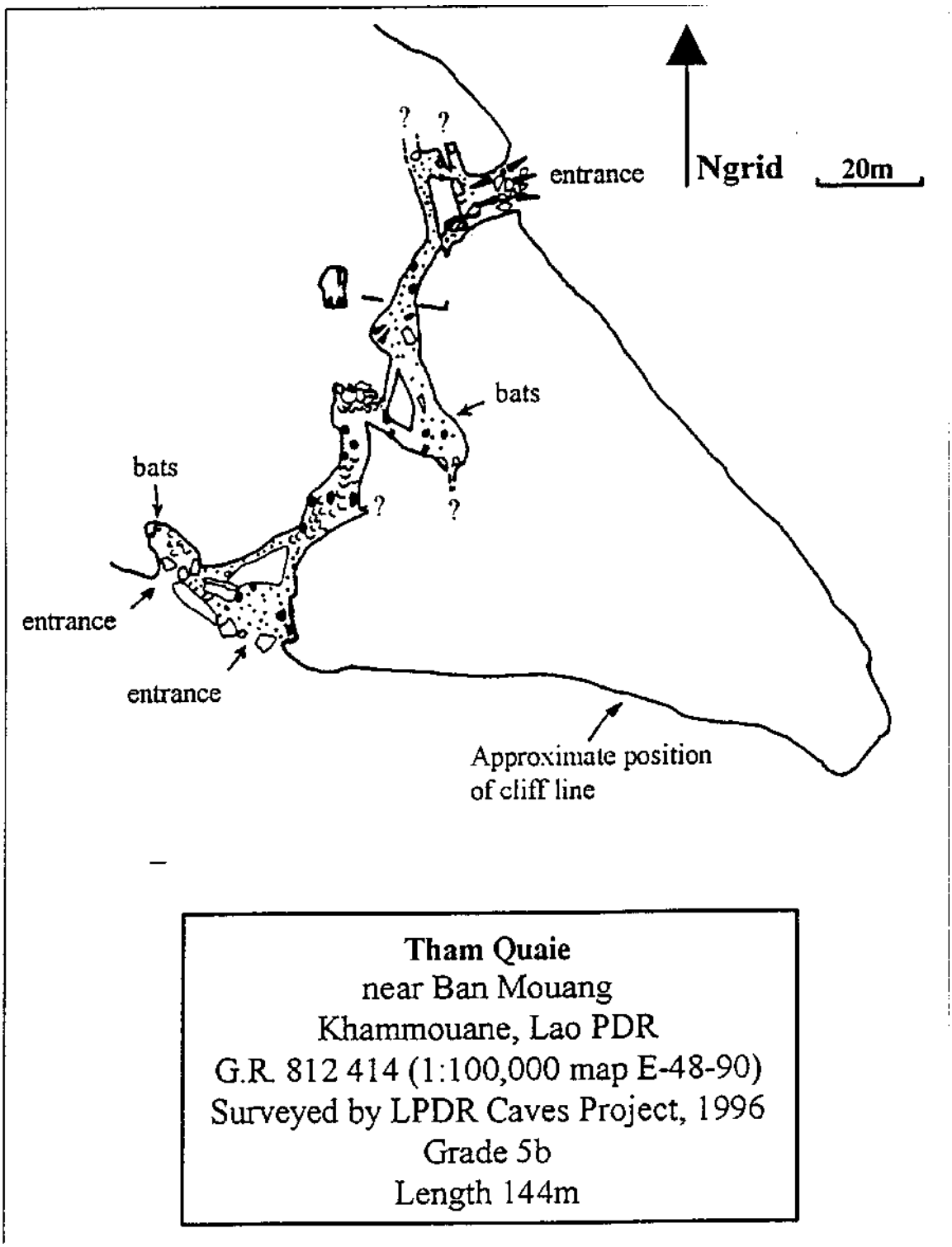


Figure 7. Survey of Tham Quaie.

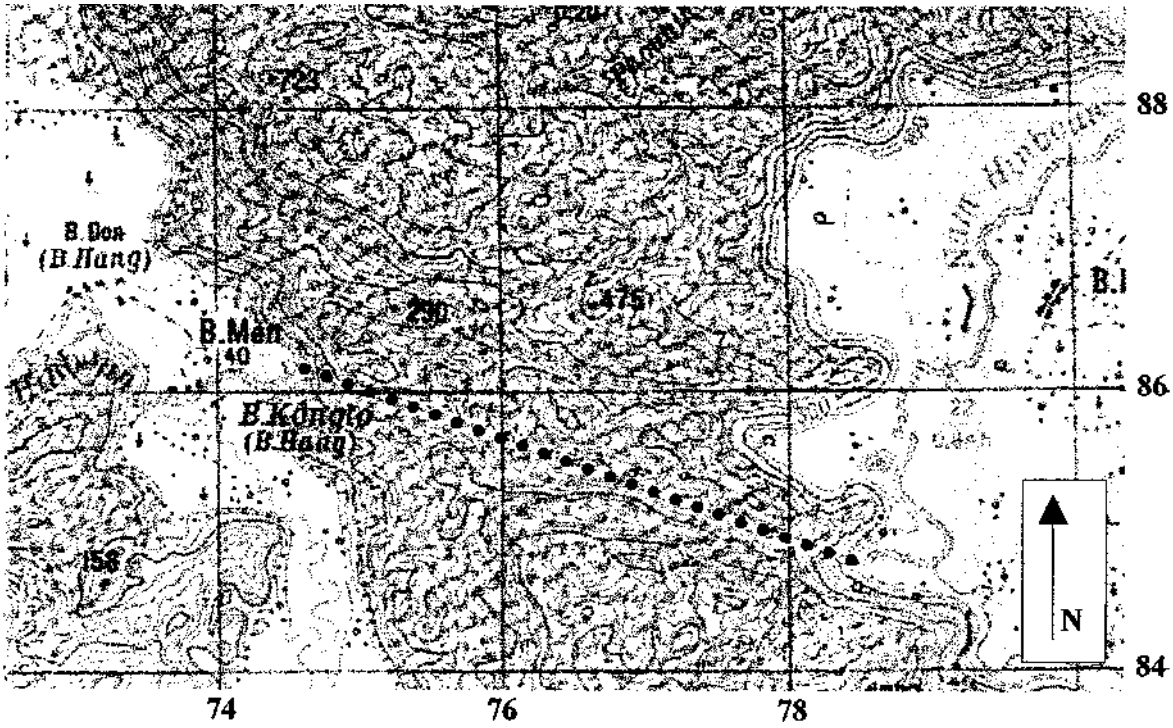


Figure 8. The Nam Hinboun River Cave (Tham Kong Row). The dotted line shows the approximate line of the under ground water course. During our stay the village of Ban Hang was used as abase. 1:100,000 sheet number E-47-78

FOMACOP project. The cave itself has been surveyed by a French cave specialist team (Mouret *et al,* 1994) although unexplored higher level passages remain.

The approach to the cave requires the use of a 4 WD vehicle and even this method of transport is not immune to the conditions. A small rainfall is sufficient to make access extremely laborious and in places impossible (Photo 2a). A travel time of 5 hours should be allowed after leaving the surfaced road and arrival at the village of Ban Hang.

A short boat journey upstream from Ban Hang leads to the 25m wide, 15m high entrance arch. The river flows from the cave and immediately falls down a 2m step. Entering the cave on the right a bank descends to the waters edge where the boats are regained. The locals haul the boats through the shallow entrance section without passengers. For the 6km trip to the upstream entrance the boat is rarely left. Throughout this distance the river passage is on average 30m wide and 25m+ high. Excepting for a few banks of cobbles and finer sediments in the widest section of the cave (photo 2b), the river fills the entire width of the passage. There are numerous sections of the cave where high level development is seen in the form of galleries and avens. It is believed that these passages were extended significantly during 1996 by a further visit by a French caving team.

Tham Kong Row is most certainly the most impressive cave in Khammouane Province. It would make a memorable trip for any tourist but the access difficulties pose major problems outside of the dry season.

Photo 2. A river crossing on the 5 hour off-road approach to Tham Kong Row.

Photo 6b. Looking downstream from the 3km point in Tham Kong Row. The passage at this point is 80m wide and 60-80m high.

CAVES OF THE VANG VIANG AREA, VIENTIANE PROVINCE.

Introduction to the Karst of Vang Viang.

The small town of Vang Viang is located approximately 150km north of Vientiane (Figure 1) and can be reached by vehicle along Highway 13 in around 3 hours. The scenery around the town is dominated by the alternating succession of Mesozoic sandstones and limestones which dip in a north-easterly direction. The results of erosion have left the limestones as sharp ridges separated by the considerably lower and more rounded sandstone strata. Around Vang Viang the maximum relief is around 1500m to the west but reaches 1600m some 30km further north near M. Kasi (sheet E-48-25 Grid ref 430 292). The wide valley containing Vang Viang is on sandstone which appears to mark the position of a major north-west - south-east trending fault. Subsequent erosion of these sandstones by the Tham Xong has resulted in a wide and flat-bottomed valley floor.

It is important to note that caves in the Vang Viang area have their base level controlled locally by the Nam Xong and as a result there are many caves in the area mostly at or just above valley floor. Most of the caves explored by the expedition were active stream caves which during wet season are major flood conduits. Other caves visited can be described as fairly recently abandoned upper levels due to a steady down-cutting of the valley floor. The expedition did not have sufficient time to search for high level passages in the limestones to the west of Vang Viang. There is some possibility of significant development high above the valley floor although access to these areas would be difficult. Caves surveyed during the expeditions 1996 visit are marked on Figures 9 and 10. All the caves were within the western limestone ridge (Photo 3) except for Tham Nang Phonhom which has formed within a second limestones ridge North of Ban Phatang (Sheet E-48-25, Grid ref. 294 120). This second ridge is the continuation of the ridge to the west of Vang Viang but is offset due to faulting. The following section describes more fully the location and the features found within each cave from south to north. Some exploratory work was carried out to the north and prospects for future work are outlined in the relevant section of this report.

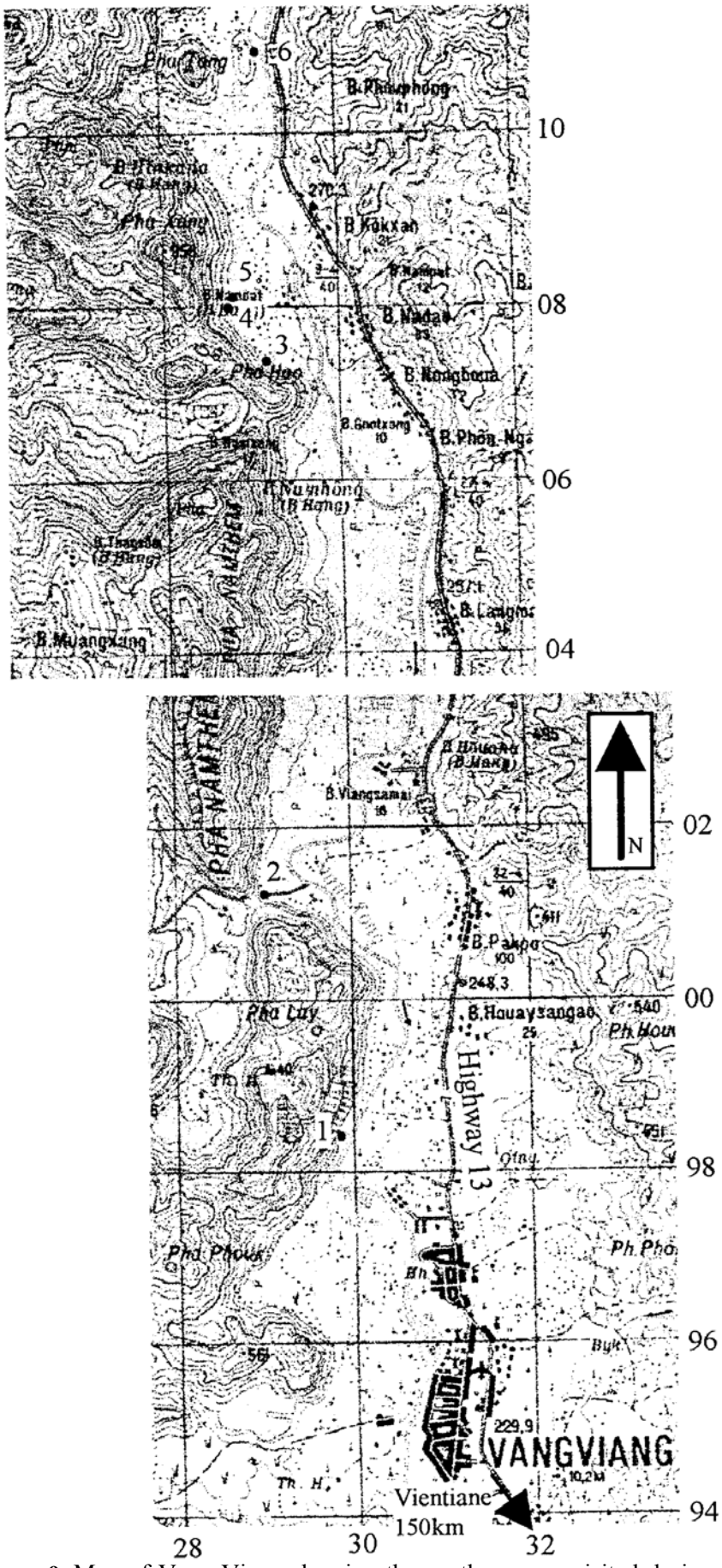


Figure 9. Map of Vang Viang showing the southern area visited during 1996. 1. Tham None 2. Tham Namthem 3. Tham Xang 4. Tham Lom 5. Tham Hoi 6. Tham Phatang. 1: 100,000 maps sheets E-48-37 and E-48-25.

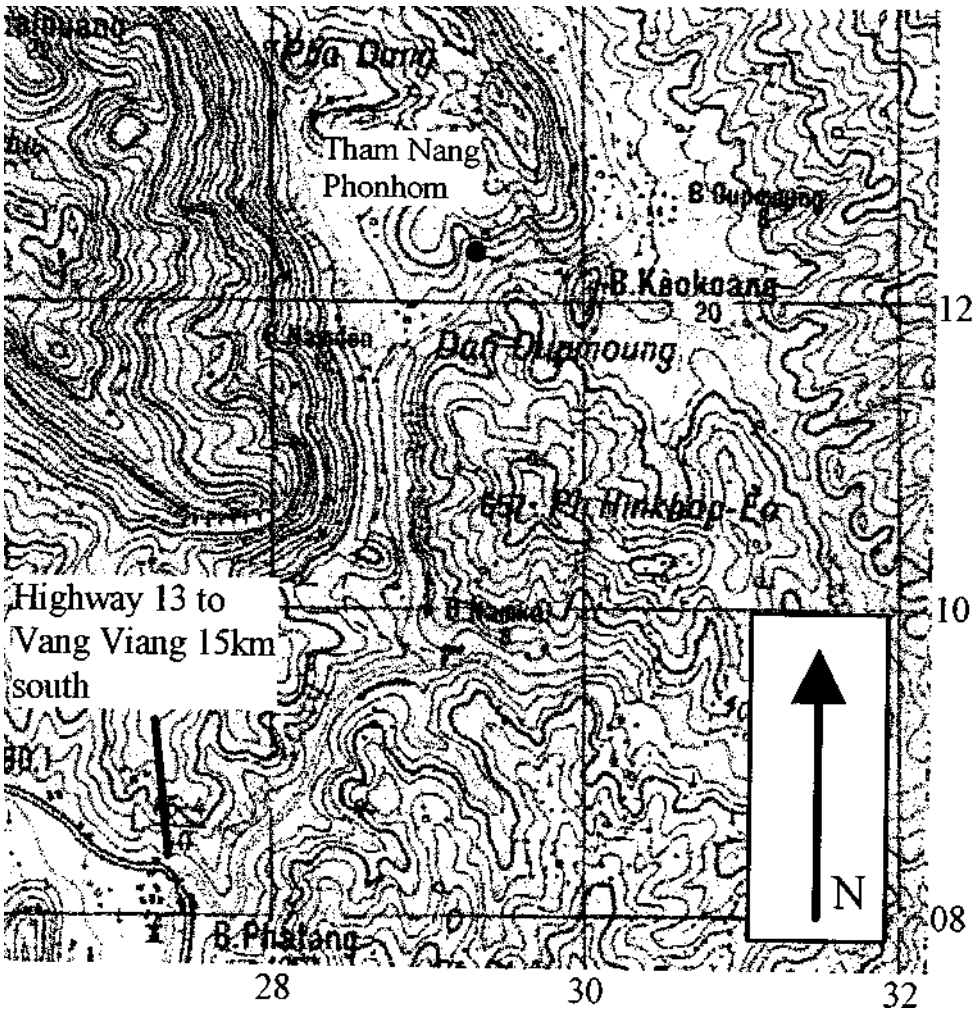


Figure 10. Vang Viang northern area showing position of Tham Nang Phonhom. 1: 100,000 map sheet E-48-25.

Photo 3. Looking North from Highway 13 along the limestone ridge to the west of Vang Viang.

Tham None

Tham None is located on the southern side of the river approximately 3 km north-west of Vang Viang (Sheet E-48-37, Grid ref. 297983, Figure 9). The cave is approached using a track built to allow access to the resort for construction traffic. The Nam Xong is easily crossed by wading at this point and subsequently a 250m walk to the north-west leads to the entrance arch.

Tham None is easily recognised from the concrete wall leading from the entrance. This wall is part of an old irrigation system built by the American Army to provide water for rice cropping. The height of the wall suggests that Tham None emits waters at least 2m deep during wet-season flooding although the majority of the cave was dry during our visit. Entry to the cave is through a 3m wide and 8m high arch into a passage of similar dimensions with a hole 3 m up on the left (Figure 11) . A small pool of water is passed and 20m beyond the passage appears to end at a substantial boulder choke. The way on is up a 3m climb on the left about 5m before the choke. At the top of the climb a 5m length of smooth walled, almost tube-like passage leads to a chamber. To the left (south) the passage continues around flow stone and collapse debris to appear at the top of the climb just inside the entrance arch. Straight on (north-west) the passage enters the uppermost of a pair of parallel rifts. The upper rift narrows and becomes too tight whilst the lower rift is entered through an arch down a sandy 45° slope and a junction. T o the right after 50m the northern side of the boulder choke in the entrance passage is met. The quantity of debris indicates that during flood the waters are forced to back up and by-pass through the upper rift passage. To the left (north-west) the passage continues as a 4 to 5m wide trench with a slope on the right. After 20m the slope can be climbed over a mixture of sand and calcite giving way to mud and finally slippery flow stone. There is much evidence for visitation to this part of the cave from litter and burnt bamboo. The reason becomes obvious when continuing up the slope into a well decorated passage. This passage heads east for approximately 40m to a entrance which is gained via a squeeze through boulders.

Back at the bottom of the slope the main passage continues to the north-west with a few gentle meanders. A bat colony is thought to roost in this section of the cave. The cave

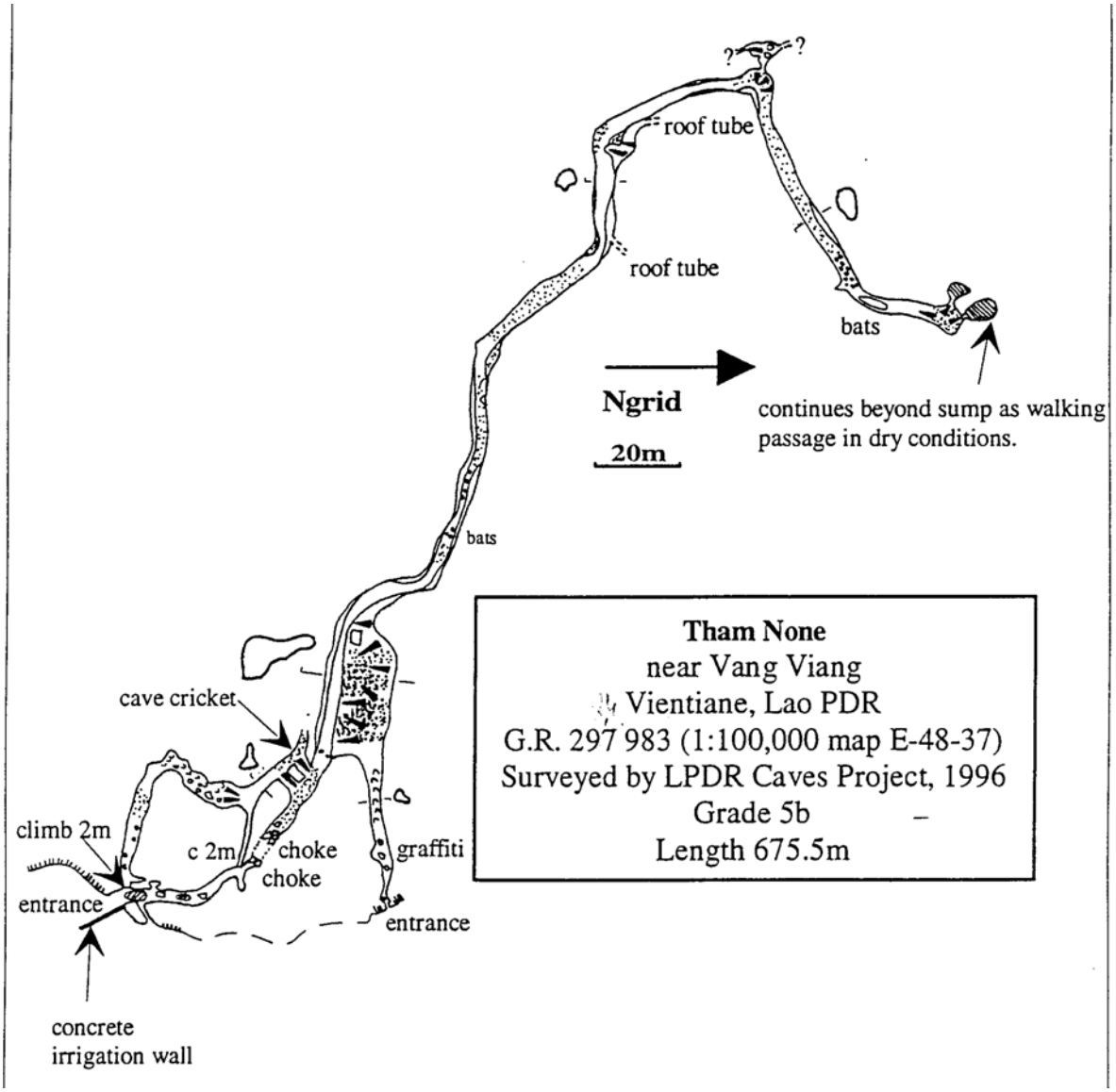


Figure 11.Survey of Tham None.

Photo 4. Swimming into the sumps at the far end of Tham None

floor is on the whole clean-washed in this section indicating that flow is rapid and unimpeded. Approximately 150m from the junction a 3 m diameter roof tube can be seen on the right. It may be possible to enter this tube but would require some climbing equipment. A second roof tube is seen at the top of a sand and flow stone slope after a further 50m. Again this would require climbing equipment to reach. Approximately 50m further on the passage takes a 90° bend to the north-east. On this bend a climb up a slope on the east leads to a small chamber with numerous ways on, none of which were fully explored. In the main passage a further l00m walking in passage 4-5m wide and 3-10m high leads to the sumps. There are two sump pools in close proximity which are almost certainly connected underwater (Photo 4). Large deposits of sand in this area indicate the loss of transportation energy as the waters leave the sumps. During our visit there was no water flowing in the cave indicating that these sumps are static for much of the time. However, according to the local people these sumps can be passed during drier conditions and the cave can be followed for some distance beyond.

2 Tham Namthem

Tham Namthem is located approximately 4.5 km north of Vang Viang and is a short but impressive through trip. The cave is used as a means of access for local farmers who have rice paddies in the depression behind Pha Namthem (Sheet E-48-37, Grid ref 290 012, Figure 9 and Figure 12).

The entrance is reached by driving across paddy fields and by subsequently wading through the Nam Xong. On the west side of the river a dry stream bed leads to the cave entrance. The second entrance is perhaps best to gain access to the cave and this is reached by following a track to the right some 30m before the obvious entrance. A steady climb up reaches an entrance at the cliff face where bamboo ladders allow easy access into the passage below.

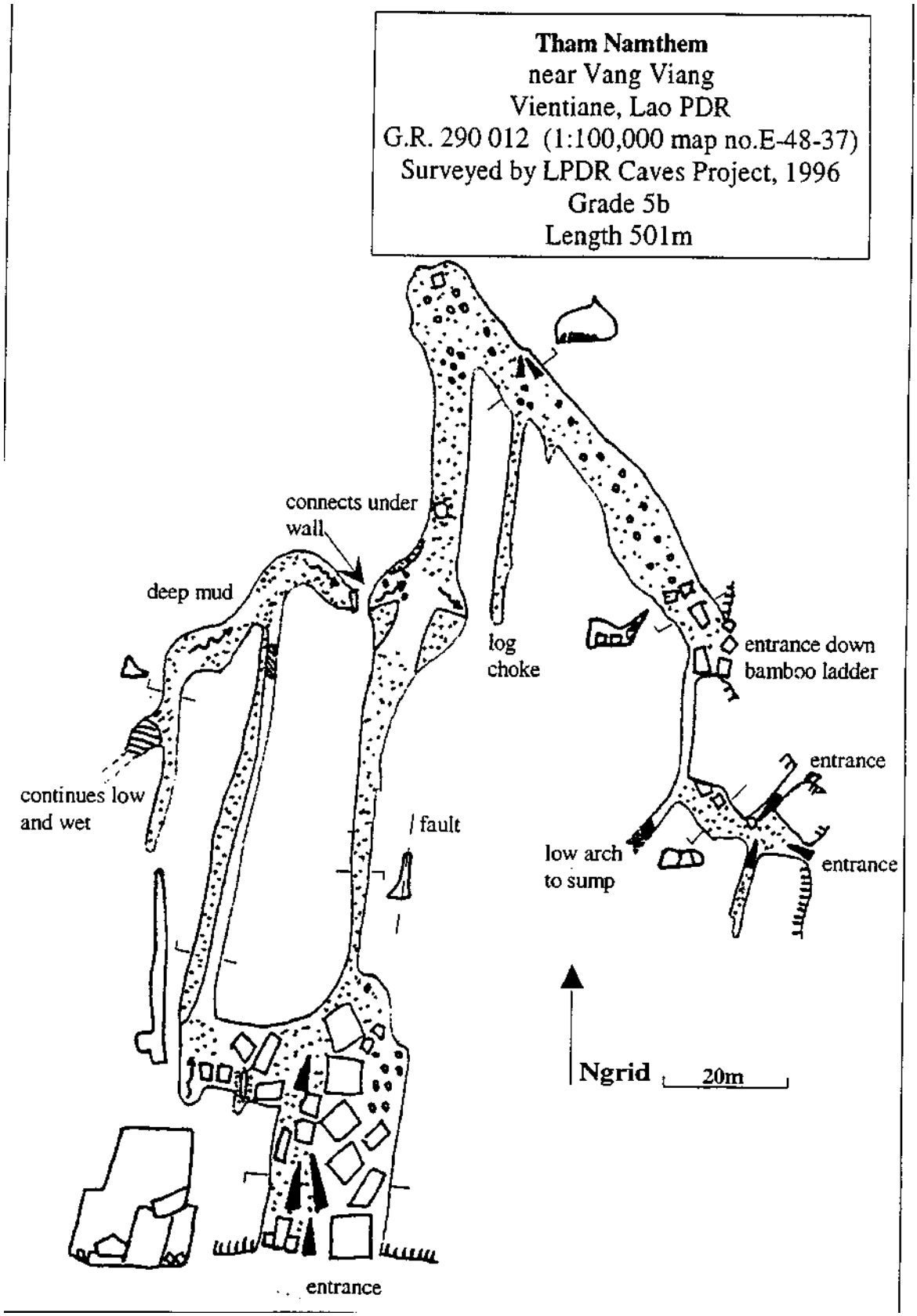


Figure 12.Survey of Tham Namthem.

After descending the ladders a tube to the left eventually leads to the lower entrance after 30m (Figure 12). To the right, however, is the main way on in passage 4-5m wide to a dogleg left. Beyond the dogleg the passage is mud floored and follows the line of a fault. In a wider section of the passage a small volume of water issues from under the right hand wall. After some 60m the huge far entrance chamber is reached. Its floor is covered with vast boulders up which more bamboo ladders have been constructed to reach the floor of the depression outside.

On the west side of the entrance chamber a further passage in a parallel joint leads to a 'T' junction. Right quickly leads to a wall under which the stream sinks. This is the source of the water in the parallel passage. To the left at the 'T' junction the passage becomes extremely muddy and wet and was not pushed due to a strong smell of sewerage.

3 Tham Xang

Highway 13 is followed north from Vang Viang for 9km to a track on the left immediately following a bridge (Sheet E-48-25 Grid ref 311 061; Figure 9). This track crosses the Nam Xong via a wooden bridge, runs along the river bed and then follows the left hand bank of the river to reach the village of Ban Namhong. There are several tracks at this point but most head to the north towards the new irrigation channel currently under construction. The tracks combine near a vehicle depot and climb onto the banks of the channel which is then followed to the cave entrance (Sheet E-48-25 Grid ref 292 074, Figure 9) which will supply water for the irrigation scheme, Tham Xang is the resurgence of the Nam Xang which sinks at a sandstone/limestone interface approximately 1.5km to the west. At the base of the cliff the 3 m high and 10m wide entrance tube contains flowing water about 1m deep (Figure 13). Progressing into the cave, the water levels drop considerably and the cobble covered floor is exposed. Approximately 50m into the cave a unobtrusive passage on the right can be entered. According to local people this is the way that leads to the entrance on the western side on the limestone ridge. We did not explore this passage in any detail during our visit.

Beyond this passage the main passage forks. To the right the cobble streambed descends into deep water in a 5m diameter smooth walled tube (Photo 5). The deepest

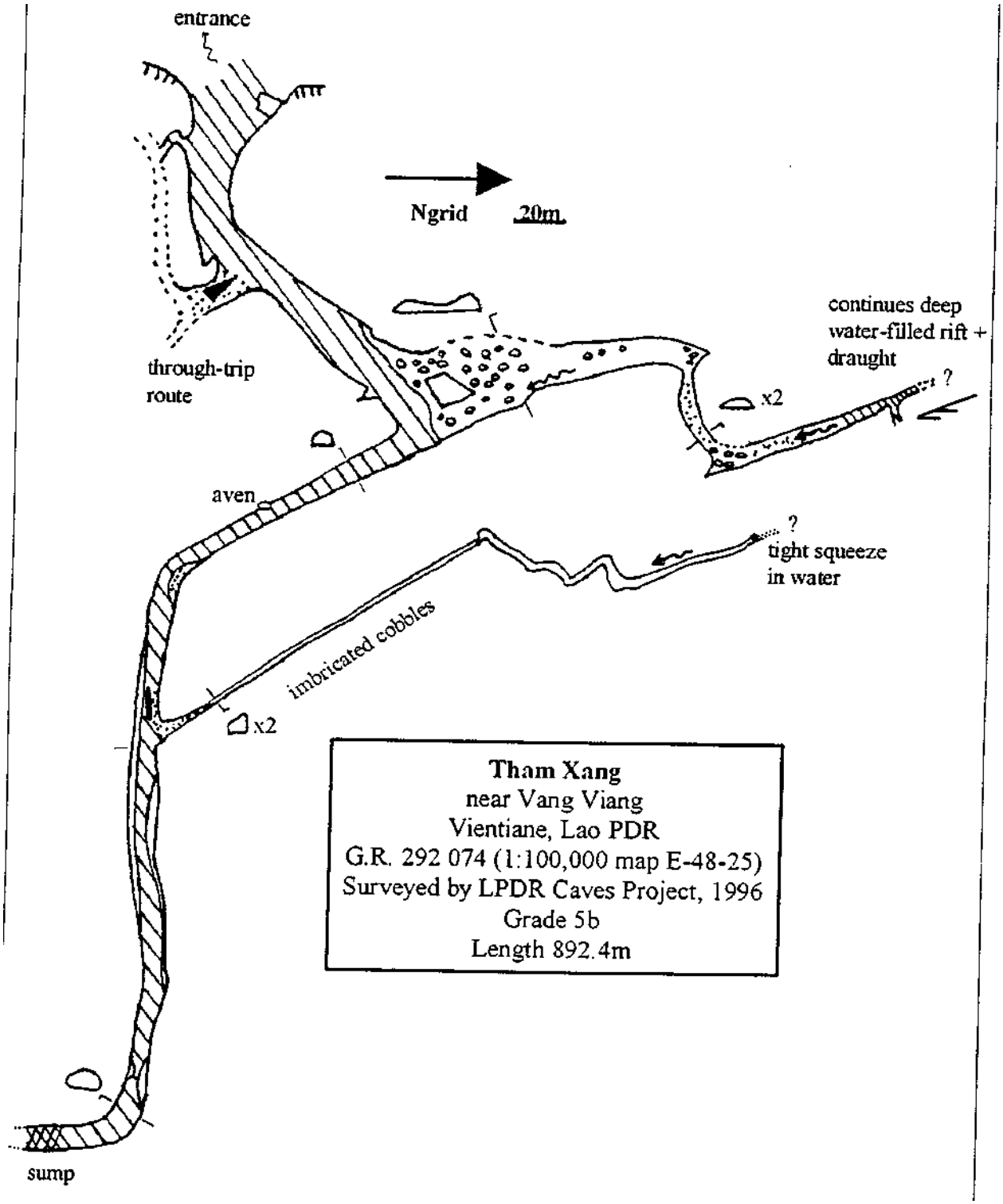


Figure 13. Survey of Tham Xang.

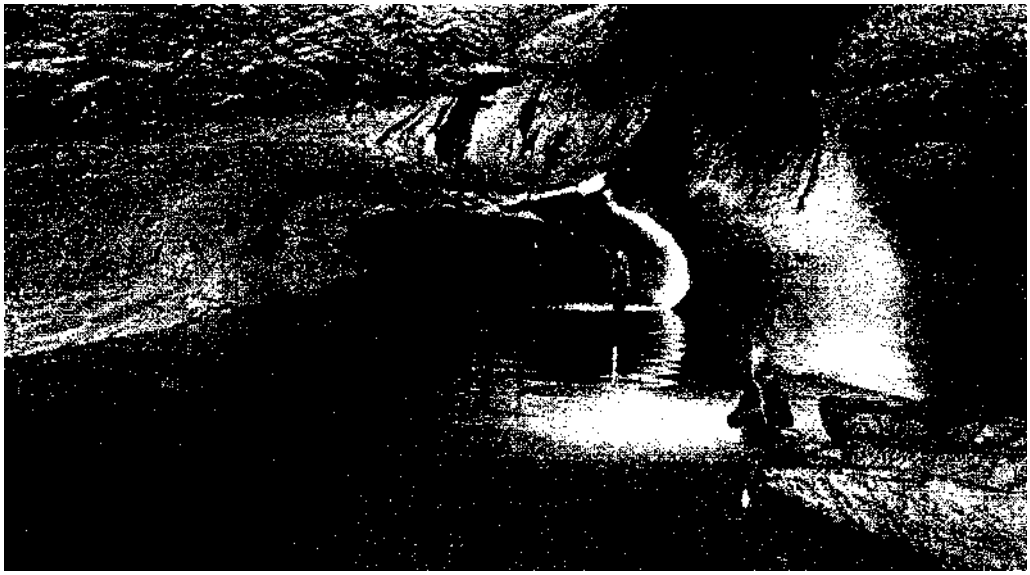


Photo 5 . View along the south-trending river passage in Tham Xang.

water can be avoided by walking on a submerged ledge on the left before leaving the water at a mud bank on a bend. The passage subsequently retains the same dimensions but the floor alternates between pools and clean washed floor. Again the pools can be mostly avoided by traversing on ledges. Approximately 30m from the bend the passage is divided into two smaller tubes by a flake and immediately beyond this a 2m diameter tube is seen on the left. The floor of this tributary passage is notable for its imbricated and cemented cobble floor which indicates flow to the north during floods. This passage follows a joint for approximately 70m before a series of cross-joints have allowed the passage to erode through to the next parallel joint. At this point the passage dimensions drop to 1-2m wide and 1-5m high and the way on eventually becomes too tight.
Beyond the flake the water filled tube continues for about l00m before a sharp bend to the right. Here the water deepens and a large sump pool bar further progress.
Left at the fork in the entrance passage meets the active stream in a 2m high and up to 10m wide bedding heading south. The floor is covered with a wide variety of cobble sizes ranging from 5 cm to 20 cm in diameter. These large cobbles suggest a stream with considerable energy during flood. Approximately 50m from the fork the bedding becomes too low ahead and the way on is through a 10m bedding of less than 1 m high on the right before entering a 15m high rift. Following this rift passage to the south the water level rises and the roof drops. Eventually swimming is required in a rift passage of awkward dimensions. This area was not fully explored due to high water levels and rain the previous night. However, it is thought that these waters are the same as those found in the Tham Hoi stream way approximately 750m to the north.

4 Tham Lom - Wind Cave

Tham Lom (Sheet E-48-25, Grid ref 287 080 Figure 9) is reached via the same track as Tham Xang. However, l00 m before the hut at the entrance to Tham Xang the track takes a right hand turn and passes into an abandoned paddy field. Crossing diagonally across the field towards the cliff face leads to a well maintained track just wide enough for a vehicle. After parking, a track to the left is followed which climbs up to the cliff face before a short climb down into the entrance.

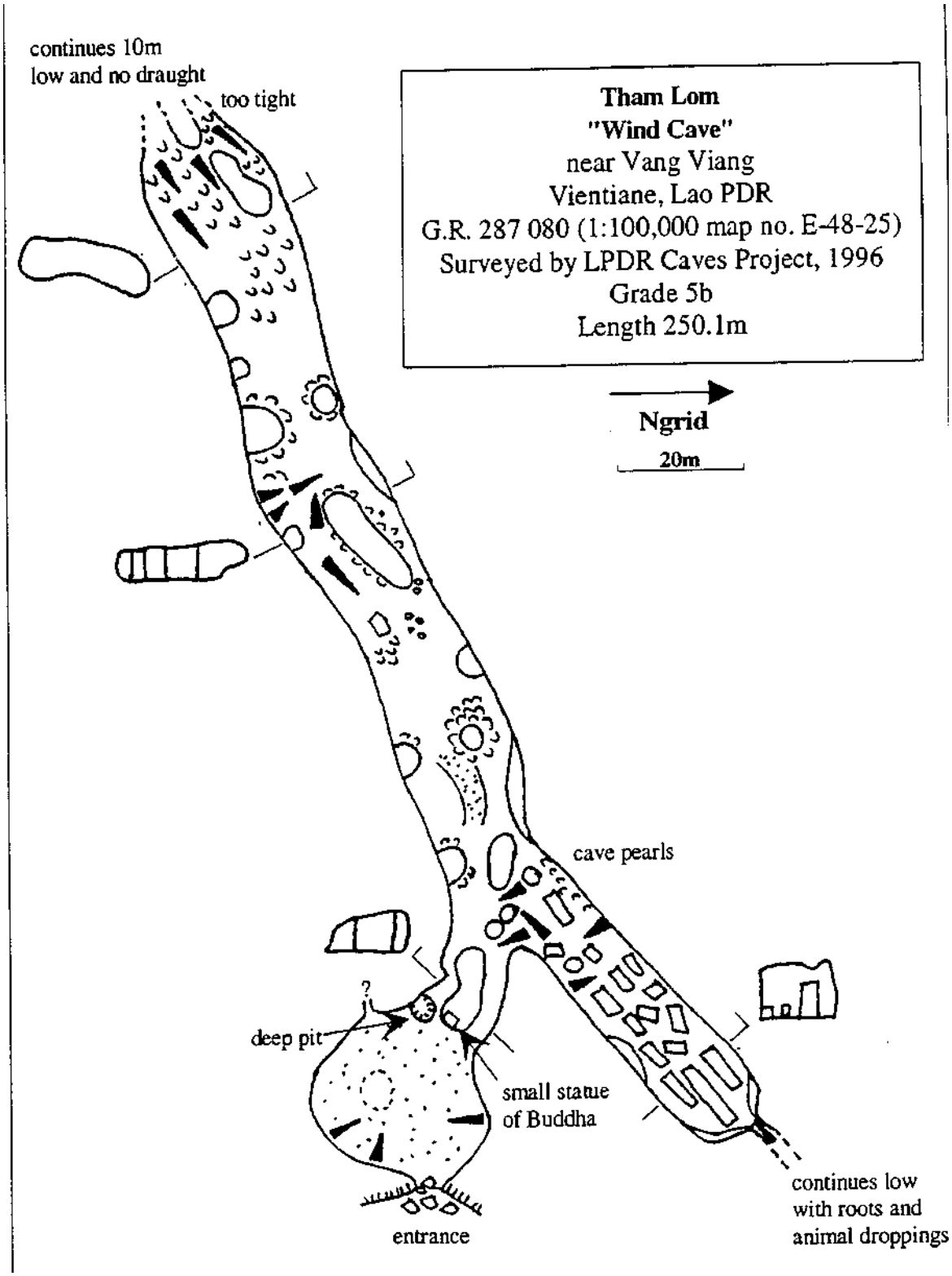


Figure 14.Survey of Tham Lom.

The entrance is a climb down through boulders to a bamboo gate (Figure 14). Inside is a spacious chamber 25m in diameter and l0m high containing a small Buddha statue. The chamber is mud floored and is notable for its well trodden appearance and for the deep hole on its western side which has been surrounded by a wooden fence. The way into the cave is past this hole and through a short squeeze on the left of a calcite boss which divides the passage into two.

Beyond the passage increases in size to 20m in width and is amply decorated with huge stalagmite bosses and flow stone. Immediately following the squeeze a passage can be entered to the right by meandering up and through some smaller bosses. This section of passage would be 20m high if it were not for the large boulders partially filling the floor area. At floor level between the boulders are vast numbers of decaying cave pearls. The end of the passage is reached by climbing over the top of the boulders to a mud slope. Up the mud slope is a 0.5-1m high and 2m wide bedding with tree roots and animal droppings. After 20m the way on becomes too tight although the edge of the cliff face must be in close proximity .

Back in the main passage, the way forward continues past many bosses to a climb up a calcite gour after 60m. The top of the gour looks forward over the remainder of the passage which is reached by a scramble down a slippery gour. The end of the passage is reached at the top of a gently inclined gour which almost meets the roof of the passage. The way on over the top of the gours rapidly becomes too tight. There is no draught emanating from the back of the cave indicating that .the way on is completely blocked although it may yield to some digging.

Tham Lom may be an older section of the Tham Hoi/Tham Xang system and may have carried water out from the ridge before Tham Hoi captured its waters.

5 Tham Hoi- Snail Cave

The entrance to Tham Hoi (Sheet E-48-25, Grid ref. 287 082, Figure 9) is reached via the same tracks as for Tham Lom and Tham Xang. After parking beneath a tree Tham Hoi is reached by a short walk to the north beneath the cliff face up an obvious track. The entrance is easily recognised from the large gold painted Buddha and owl statues. The

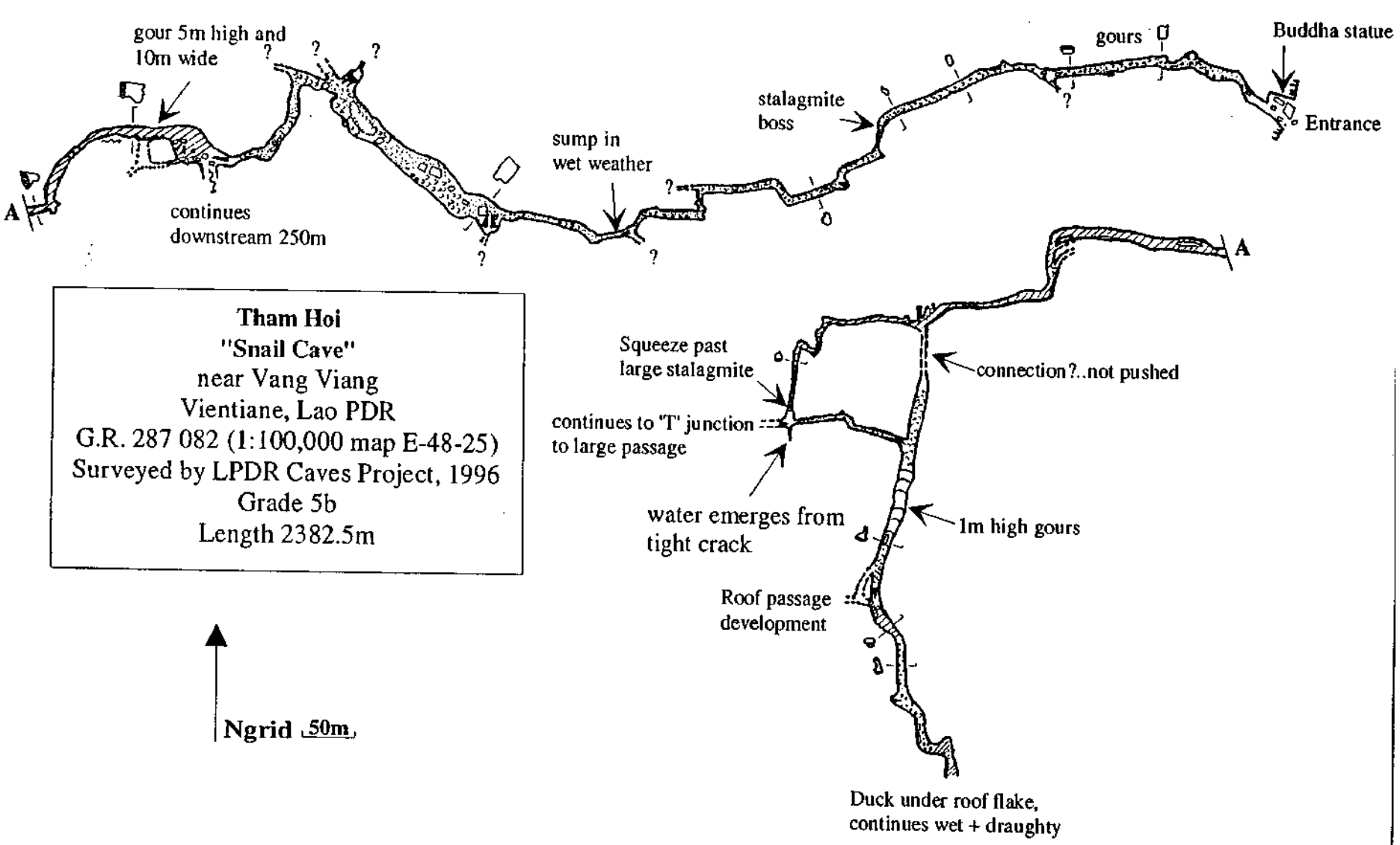


Figure 15. Survey of Tham Hoi.

entrance has dimensions of 3m wide and 10m high and the passage is easy going with a dry sand/mud floor with cobbles in places (Figure *l5).* There are numerous ancient gour pools which have begun to deteriorate partly due to chemical erosion but also from large numbers of passing local villagers. Tham Hoi is entered frequently by local people to catch fish from the stream met further into the cave. The passage remains much the same with dimensions of 3m by 10m and a mixture of mud and cobble floors until approximately 650m from the entrance when the floor and roof dip and the walls close to a width of 1m. During the wetseason this part of the cave is likely to flood and bar access for a period of time. However, there is no evidence for the presence of a stream flowing out of Tham Hoi. Instead, it is percolation waters that will submerge this section of passage. Beyond the constriction, the passage resumes its usual 5m width and 5-10m height for a further 300m where the passage width increases dramatically up to 35m. This wide section of the cave has a soft sand floor and in places is extremely well decorated with flow stone and stalagmites and at least one passage enters from high above on the southern side of the main passage.

The passage width decreases after a further 180m and three large un-entered passages leave the main passage on, and just after, a sharp left hand bend. The passage now contains a large quantity of breakdown material and the way ahead is by scrambling over sharp angular boulders. The main streamway (presumably the upstream waters of Tham Xang) can be heard from this point. It is interesting to note that this section of passage was once filled with stream deposits (cobbles) which have subsequently been partially reexcavated. Scallop markings on the passage walls suggest flow was towards the entrance. The re-excavation of these ancient stream deposits may indicate a period of renewed high water levels perhaps due to a blockage in the main stream.

The passage narrows to 3m wide and then enlarges to impressive dimension on a ledge overlooking the main active stream. Below the waters flow from right to left over a series of impressive gours and cemented cobbles (Photo 6). An easy climb down a mixture of sand and boulders reaches the stream level.

Downstream was not explored during our visit but we estimate that 300m separates the upstream limit of Tham Xang and this point in Tham Hoi. This connection is likely to involve a great deal of Swimming and will be extremely sensitive to flooding.

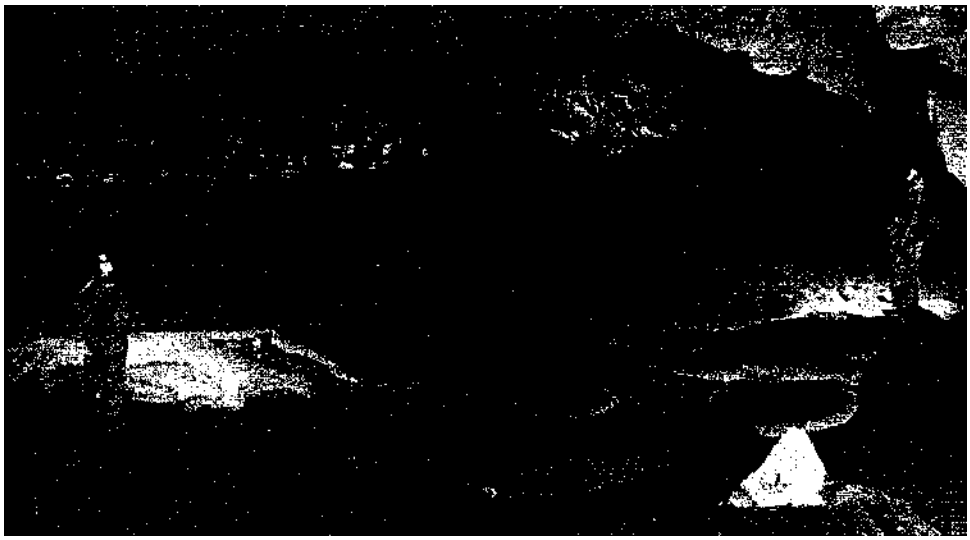


Photo 6a. Looking upstream from the junction with the main river passage in Tham Hoi.

Upstream the stream passage is approximately 30m wide and is easy going in knee-deep water to a sandbank on the inner apex of a left hand bend. Beyond this point is a 6m high and 15m long orange coloured gour emanating from a low arched passage above. This passage was not entered. The gour is passed on the right by a swim through a deep pool and beyond the 7m wide and 4m high passage ascends steadily over a series of gours and pools for approximately 270m. Beyond, the incline lessens and progress becomes a mixture of swimming and crawling over submerged ledges and gours. A large partially cave-adapted catfish was caught in this area suggesting a plentiful supply of fish for local people. The passage begins to ascend once more after 300m and a squeeze past a large stalagmite in the stream suddenly emerges in a 30m diameter and 20m high chamber with three ways. Straight ahead the stream emerges from a tight. calcited rift and although probably not difficult no attempt was made to explore in this direction. To the right a 30m square section passage with boulders and a sand floor heads for 50m to a second 'T' junction with a similarly sized passage. No further exploration was conducted in this section of Tham Hoi.

Our explorations took us left at the chamber into a short 5m wide mud floored passage which after l00m arrives at a 'T' junction. A short slope leads down into the bed of the dry streamway. This section of passage contains large boulders and huge 1.5m high gours which suggests that a large stream is present during flood conditions. To the left for 50m leads to a stream which was left unexplored but appears to head back to an inlet seen in the previous streamway.

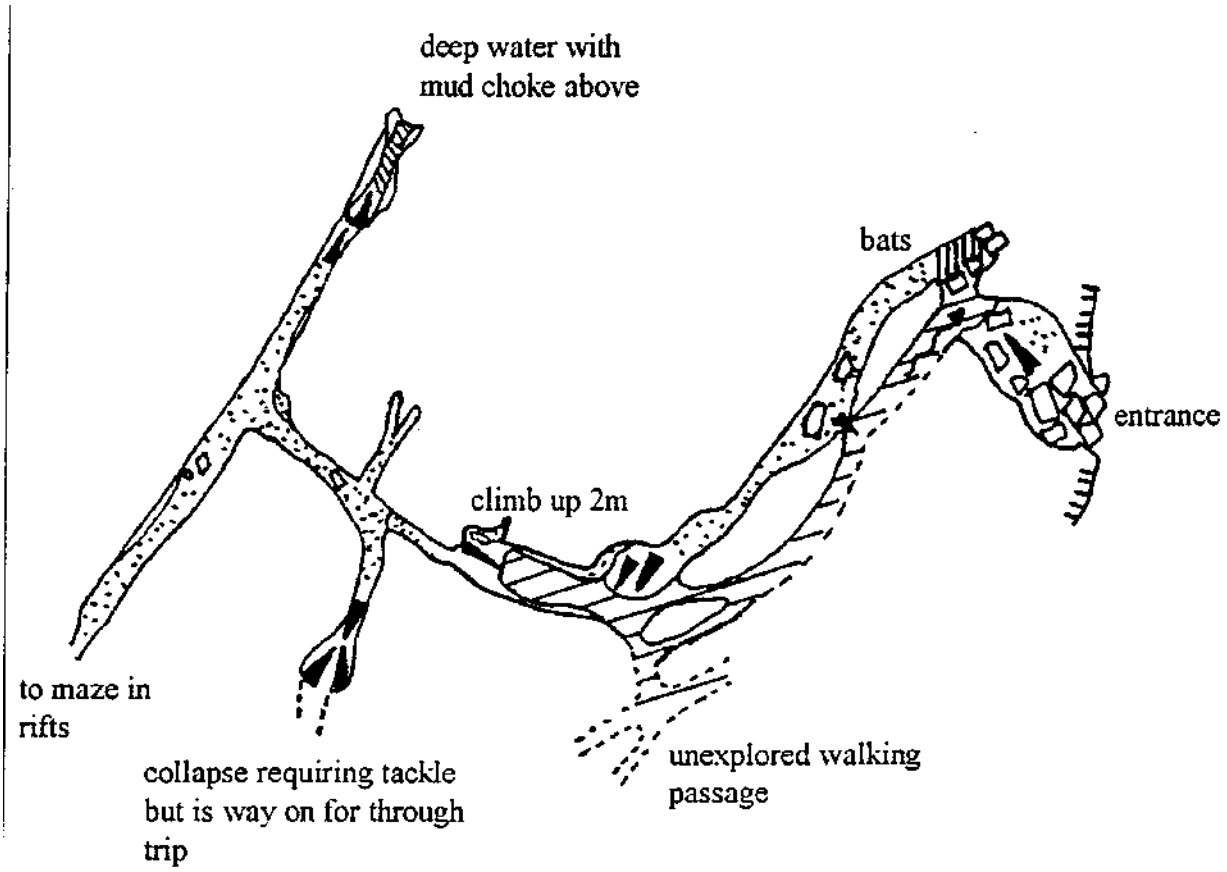
To the right progress is made in a l0m wide passage by climbing over gours and stepping carefully over polished, rounded boulders for just under 120m. Here, on a left hand bend, is a tree trunk wedged across the passage. There are also signs of some passage development above the stream level. Continuing at stream level through a chest deep pool the passage was followed for a further 140m to a pool under a large rock flake. The passage continues beyond this point which marks the maximum penetration by our group.

Tham Phatang.

Tham Phatang is located in an unusual situation (sheet E-48-25, Grid ref. 291 110, Figure 9) and is apparently a through trip to a second cave at Grid ref. 286 115 (sheet E48-25). The Pha Tang tower has an obvious resurgence at it base at river level. The clarity of the resurgence water is emphasized in the river as a iridescent blue smear. The entrance is reached by wading through Nam Xong followed by a climb up through boulders into an entrance some 5m above river level. The cave is entered by descending through wedged boulders into a muddy pool (Figure 16). Wading through this pool a squeeze through boulders on the right leads to a short hands and knees crawl which appears at the top of a mud slope looking down into the slow flowing stream passage. A second method of reaching this point is to continue in the muddy pool and to duck under a flake of rock. This route arrives at the same point but at the bottom of the mud slope in the downstream continuation. Many bats were seen in this section of the cave. To the right (upstream) is an easy wade in knee-deep water until a mud wall requires a 2m climb to pass it. At this point the stream course is lost and hands and knees crawling leads to a junction. To the left a mud wall marks a recent collapse and is the way on to the second cave according to the local people. Some climbing equipment would be needed to pass the collapse.

To the right at the junction a further short crawling section arrives at a second 'T' junction. To the left is a high (10m+) rift leading to a network of loose and bouldery climbs through which no continuation was found. To the right after l0m the passage becomes a 3m wide rift with deep water at its base and no way on above. The water at the base of the rift is at the same level as the resurgence indicating that a large proportion of the cave passage is submerged.

The fact that local people have made the through trip suggests that further exploration could yield some interesting caving. However, during our visit the lack of suitable equipment prevented access to the 'true' way on.



Tham Phatang
named from Tower above
near Vang Viang
Vientiane, Lao PDR
G.R. 291 110 (1:100,000 map no.E-48-25)
Surveyed by LPDR Caves Project, 1996
Grade 5b
Length 197.0m

Ngrid 20m

Figure 16. Survey of Tham Phatang.

Tham Nang Phonhom - Scent of Girls Hair Cave

Tham Nang Phonhom is reached by following Highway 13 north to the village of Ban Phatang (Sheet E-48-25, Grid ref 294 122; Figure 10). After crossing the river a track on the right climbs and then contours above the river for approximately 5km where a flat floored area between limestone blocks is encountered. From base of the block named Pha Dang a large river issues (Sheet E-48-25; Grid ref. 305 171). The cave is confusing to describe since it consists of a multitude of old river conduits at valley floor level of which one, the largest passage, is currently active.

The active river passages occupy the northern section of the cave (Figure 17) and are of impressive dimensions (20-25m wide). The river occupies the entire floor area in these passages and was estimated to be carrying at least 0.5 cubic meter s-1 of discharge (Photo 7). The older abandoned passage consists of one large passage with numerous smaller passages heading off it. The large passage resembled the currently active river sections although now inactive. The abandoned passages are best reached by crossing the river emerging from the middle entrance on the west. Two directions are then possible. To the left a large 20m wide and 15m high passage continues for 80m to a boulder slope and daylight ahead. At this point a cross-rift on the left leads to the active stream passage and to the right a l0rn wide passage can be followed for 80m to a calcited choke and tree routes.

Back at the river crossing to the right, a 10m wide rock floored passage widens to 30m. A large sandbank on the left can be stepped on to or the right hand wall can be followed. Either way leads to a large almost circular chamber with four possible routes. Assuming the sandbank is the point of entry the first passage on the left leads over dry gours and some breakdown to a stalagmite blockage after 60m.

The second passage on the left enters a linear passage leading to a small entrance portal overlooking the village of Ban Hang on the east of the block.

The third passage issues a large draught which is present to a sharp right hand bend after 50m. The draught comes from a roof tube 4m above the passage floor on this bend which was not entered. Beyond the roof tube the passage is well decorated with flow stones

and a particularly impressive gour. After a further 80m a tight calcite obstruction is encountered but the passage appears to continue and was not entered on this occasion.

The fourth passage on the left leads to a large entrance arch overlooking the river outside the cave. However, on the left a passage 10m above the river runs parallel to it and contains numerous entrances in the cliff face and a pit down to the river level.

Tham Nang Phonhom is an interesting example of horizontal cave development where little downwards erosion occurs. Instead, erosive energy is expended horizontally resulting is a honeycomb of related passage that once carried the full extent of the river waters. The cave would make a novel tourist visit but is rather too short for any serious tourist development.

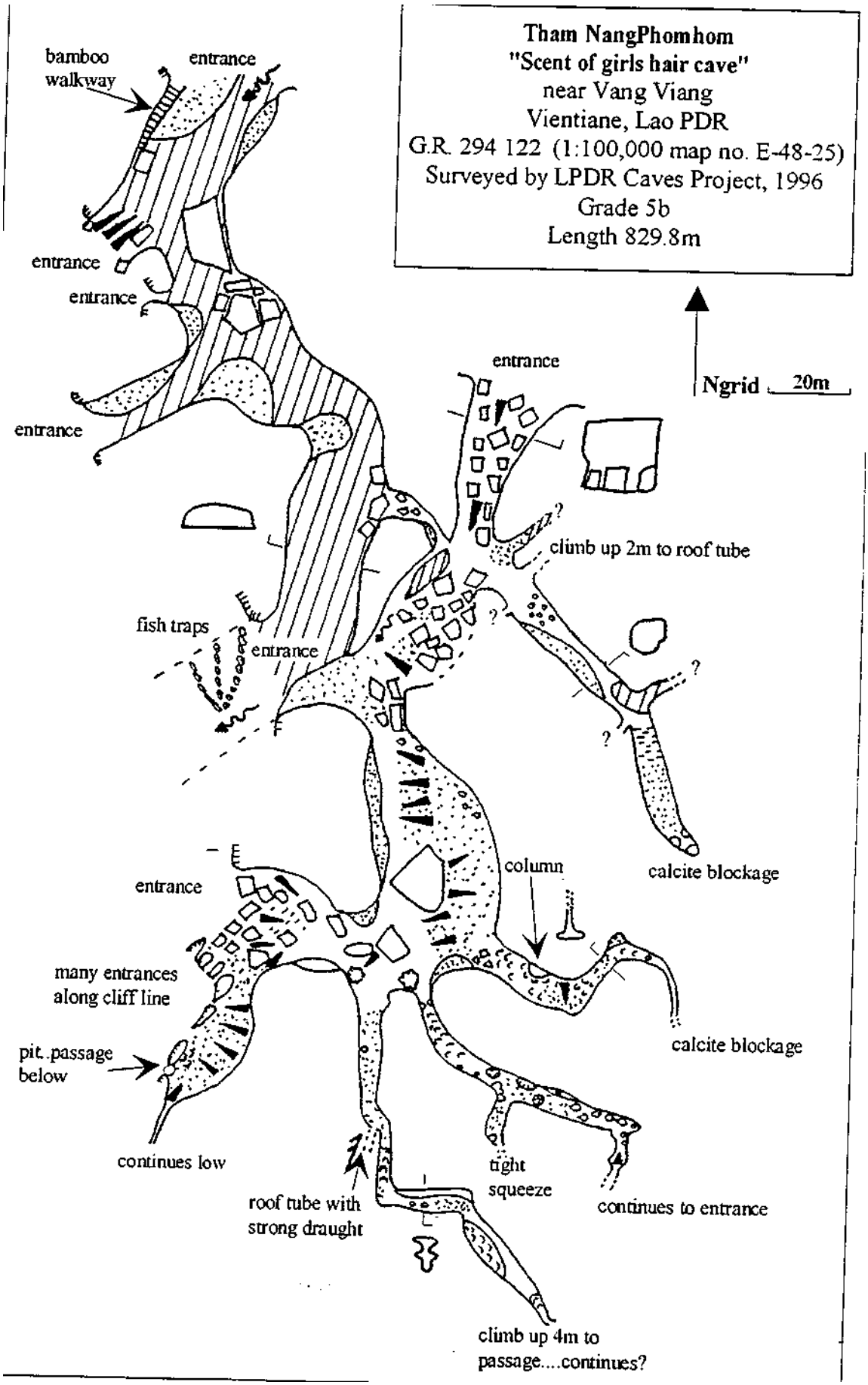


Figure 17. Survey of Tham Nang Phonhom.

Photo 7. View from the river bed looking into the main downstream entrance of Tham Nang Phonhom, Vang Viang, Vientiane Province.

Tourist Development in the Karst of Lao PDR.

Introduction

The caves within the karst regions of Khammouane and Vientiane Provinces will be of great value both economically and scientifically over the long term. The world-wide development of many cave sites for tourism has shown that both local people and central authorities can benefit economically from what may be only a minimal investment in infrastructure. To many people caves are considered a forbidden and inaccessible environment. The chance to visit a cave in safety and the same time gain some understanding about their development is a good stimulus for the visitor to spread the word about a particular cave. In addition to mass tourism, the growing popularity of 'adventure tourism' both in the western countries and the newly emerging strong economies of Asia provides an ideal market in which to expand provided that sensitive exploitation methods are utilised. This philosophy can be applied to many of the caves of Lao PDR. By definition 'adventure tourism' generally requires virtually no large scale investment relative to more traditional forms of tourism.

Central to this growing market, is the idea of an "unspoiled" environment. As the attraction of such regions lies principally in their individual culture and unique, largely undeveloped environment, the protection and sensitive development of these areas is essential if a sustainable income through tourism is to be maintained. In addition, a low level of development can be a route to ensuring that benefits are experienced at a grass. roots level as local people and existing 'traditional' infrastructure becomes an essential part of the operation.

Any development consideration that does not take a long term view of the protection and management of the key resources can only result in the destruction o that resource and the consequent decline in benefits from it.

Although this report will make some general recommendations regarding the protection of the cave environments it is essential that each site be considered individually and have its own conservation plan developed in conjunction with cave specialists and local people. Various caves are already utilised by nearby villagers for religious purposes, travel and hunting (fish, bats and swifts nests). The traditional needs of these people must be accounted for in any development or conservation decision. We make recommendations based upon the sites that we visited which can equally be applied to any cave site destined for tourist development.

Tourist Development in the Khammouane Limestone around Thakhek

A short period was spent working in this area but our visit provided an excellent introduction to the features of this vast area. The extent of this region and the nature of the landscape contain a wealth of resources that lend themselves to the form of development outlined above. As cave specialists we shall confine ourselves to commenting on the caves themselves and associated features. The rivers, forests and villages of the region provide great scope for a variety of tourist activities but, with the exception of those sites adjacent to caves, fall outside the scope of this report.

Introduction

Our brief visit to Ban Mouang indicated that there are a large number of caves in this area which will certainly conta.in a variety of characteristics. The opportunity to conduct a more complete survey of the area and its caves would be likely to reveal a great wealth of sites for potential utilisation.

Tham Patchan

This cave is limited in length but the dimensions of its main passage make it a site worthy of visiting. The presence of a small monastery provides an additional cultural

attraction. In itself the cave may not be considered worth the journey to visit but in conjunction with an overnight stay in a 'traditional' village and the drive through spectacular scenery a short tourist itinerary could be developed with virtually no infrastructure requirements. Its proximity to Thakhek and consequent access to Thailand means that it could be part of a brief visit to Lao PDR based around Thakhek as a center.

Tham Physeau

An impressive cave that does not lend itself to large scale tourist development at present. However, the cave is not fully mapped and its position suggests there is great potential for the discovery of more passages. The continued mapping of this site is therefore highly recommended as the value of the resource will be increased. The discovery of large chambers or passages with formations could make this site appropriate for development.

Currently the site has value for 'adventure' cave visits such as those operated in Mulu National Park, Malaysia. Training of cave guides would, however, be essential. In addition an individual conservation plan would be necessary to protect the resource. Tham Physeau may have some value for any future biological studies as bats, fish and crabs were observed during the brief survey work carried out.

Other caves Near Thakhek

With one exception the sites we visited were not significant enough to attract tourist on their own. All would provide interest to a chance visitor but little else. The exception was Tham En (sheet E-48-90, grid ref. 745 862; Figure 18) which is an extremely impressive cave and has already been developed for tourism. Unfortunately the development has not been particularly sensitive to the long term preservation of the cave and this has already led to irreversible damage to cave formations and a build up of unsightly litter. Such characteristics will not be considered attractive by the growing number of environmentally aware tourists and tour operators. In addition the adjacent zoo keeps some animals in very cramped and dirty conditions in direct conflict with current

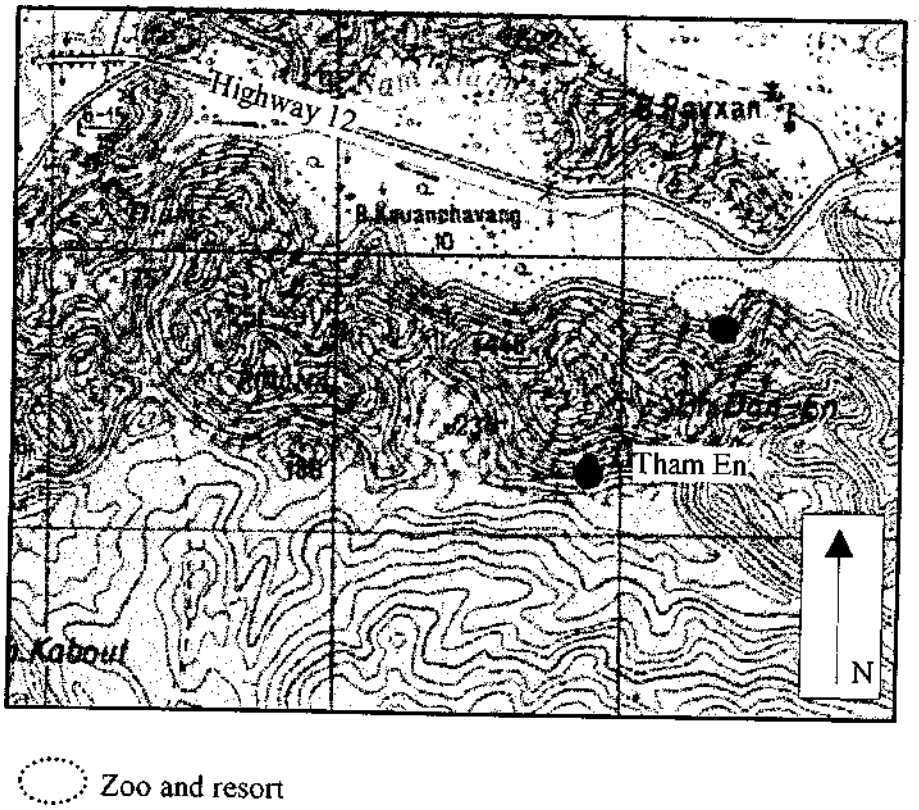


Figure 18. Location of Tham En and its associated resort. 1: 100,000 Sheet E-48-90.

thinking on animal welfare. This site is ideal for development but we recommend that any future plans are made in conjunction with experts or those experienced in the requirements of the growth tourist markets. Steps should be taken immediately to limit further degradation of the site. This could be achieved relatively easily by removing litter from the cave, making the cave a no smoking zone and restricting visitor access to avoid physical contact with areas of delicate speleothems.

Only a fraction of the cave is currently open for tourists and any further infrastructure within the cave should be more sensitively planned. The horizontal nature of this cave and its extremely impressive dimensions may provide an easy opportunity to try adventure caving based around the centre of Thakhek. The cave provides a through trip of around 2km, a traverse from one entrance to another could provide an exciting introduction to the caves of Lao in their natural state. Such a venture would require no further infrastructure but the training of guides and use of appropriate equipment is essential.

Gnomalot District (1:100,000 Map Sheet E-48- 78, Grid ref. 745862)

Only one cave site was visited in this area Tham Kong Row (Hinboun River Cave) (Figure 8). It is clear that there are many more significant ones to be documented. Tham Kong Row is probably the most impressive cave that members of the team have ever seen. The incredible through trip, made by boat, from Ban Hang (downstream) to the upstream entrance took about two hours and is an experience that can be repeated in only very few locations in the world. The extremely easy nature of the traverse of the cave makes this the most appropriate site visited to be utilised as a major tourist attraction. The principle difficulty lies in the fact that access is frequently interrupted by poor weather conditions and even in dry conditions access by track can take up to 5 hours. Rain very quickly makes the area inaccessible to medium sized four wheel-drive vehicles. Initially some work on the existing river crossings would be necessary to lengthen the season during which tourists could visit the cave. In addition, if visitors were to be encouraged in larger numbers the provision of purpose built accommodation in the village would be required. However, it is essential that any such building was strictly in a 'traditional' style and the potential impacts of increased visitors be fully considered.

Full utilisation of this cave would require year round access as peak tourist months coincide with difficulty of access (April to October). Such development would bring greater potential environmental impacts and these would need careful management.

Tourist Development in the Karst of Vientiane Province around Vang Viang

The cave sites that were visited in Vang Viang during 1996 were far more accessible than those of Khammouane and consequently have a greater potential for immediate tourist development. The ease of access unfortunately also means that they have already suffered considerable damage in the form of graffiti, rubbish and broken formations. Several cave sites are quoted in this report and there are clearly numerous other caves that have yet to be documented or fully explored. The continued systematic logging of these caves is highly recommended.

ThamNone

This cave has easy access and may provide good opportunities for adventure tourism if the full extent of the system is known and for this reason we recommend the continuation of mapping and exploration at this site. Currently the passage length known to us is not sufficient to provide an attractive visit for serious adventure tourists. In addition, the lack of speleothem and abundant graffiti defacing the cave walls makes this site currently unsuitable for mass tourism development.

Tham Hoi

An extremely accessible cave in which sufficient passage length and variety has already been mapped to allow significant adventure trips to be planned and safely carried out. The cave is far from fully explored and the continued mapping of it can only add to this important resource.

General Guidelines For The Protection Of Cave Sites

This section highlights some important considerations that need to be made before, during and after the development of caves used as tourist attractions.

1. Smoking in caves should be banned. Smoke can tarnish the upper surfaces of speleothems (as in some Yugoslavian caves) and create a source of litter.

2. Eating in tourist caves should not be allowed as this leads to litter and waste food encourages the invasion of none cave species into the semi-light zone.

3. Steps should be taken to ensure that no graffiti appears. Existing graffiti without cultural significance should be removed where possible.

4. Local people should be made aware of the importance that the caves in their locality remain largely unspoiled.

5. Visitors to tourist caves should be made aware of the conservation ethics and be shown examples of what can happen if conservation measures are not adopted. This can form the basis for displays on cave vandalism and other issues not necessarily related to caves.

6. 'Adventure' cavers and guides should also follow a cave conservation code.

7. A body of inspectors to check that the environment in and around tourist caves is being maintained at a satisfactory level should be created in each karst region. This could be an additional responsibility of the Lao PDR Forestry Department using staff that the LPDR Caves Project would help train.

FUTURE PROJECTS AND CO-OPERATION IN LAO PDR.

Introduction

The success of the 1996 expedition was entirely due to the co-operation of the authorities in Lao PDR, in particular members of the Department of Forestry and the FOMACOP project. Equally important was the building of a joint Lao-British team. The success for future work will depend on having a similar joint team and support. However, for maximum efficiency and safety the numbers should be kept a total of about eight in any one team, including the Lao PDR guides and the British team members. This system worked well in Vang Viang, and was very efficient due to the close and co-operative spirit that developed.

Definition of field areas

The system of defining an area and village as the basis of requesting permission for a visit, worked well in Vang Viang. Where cave names are known they can be used, but in most cases significant caves are known only to the local villages. Some of these are likely to prove more interesting to speleologists and hence will have important eco-tourist potential. We suggest that, where possible, exploration areas and village bases should be agreed and defined with the authorities prior to the start of future expeditions. Excellent 1: 100,000 maps are available of the karst areas and these can be used to define "permitted" and excluded areas with confidence.

To facilitate the organisational process we suggest that a 'speleological coordinator' is nominated by the Department of Forestry . This co-ordinator would liaise with the British team and additionally with the Lao PDR and Provincial authorities to define visit areas prior to a future expedition and obtain the required permissions.

Transport

The use of a four-wheeled drive vehicle and an experienced Lao driver will be essential to a future survey expeditions. This was demonstrated by the excellent transport made available to the 1996 expedition. All the British members were very impressed by the expertise and safety of our driver Mr. Chansorn and of the performance of the FOMACOP and Forestry Department vehicles, and it was clear that without this help many of the sites would not have been visited.

WORK AREAS - Khammouane Province

Khammouane Province contains the largest contiguous area of karst in Lao PDR which extends beyond the Lao PDR border into the Phong Nha region of Vietnam. The Vietnamese area of this karst terrain, is well developed speleologically and has been partly documented by the 1994 British/Vietnamese expedition (Limbert and Limbert. 1996). The speleological potential of the karst in Khammouane is huge and has only been studied at a few accessible locations such as Tham En and Tham Kong Row.

Access to the areas of karst identified as having the greatest speleological potential will be the main barrier to future exploration. Access difficulties are due to a combination of the remoteness of the areas, the lack of all weather roads, the large scale coverage from primary monsoon forest and pinnacle karst, and, but by no means least, the remains of USA ordnance. However, there are areas with relatively easy access that are under cultivation for rice up to the karst towers and cliffs, giving good access to adjacent caves. During the 1996 expedition, these areas were found to the east of Thakhek along cleared valley floors with unsurfaced or basic roads, for example, the road to Ban Mouang. Exploration of jungle areas will continue to be problematic for a long time to come, especially along the Lao PDR/Vietnam border where the ordnance problem is greatest.

Area priorities for further cave survey expeditions to Thakhek, Khammouane Prov'ince.

The Vang Viang karst area (see below) should have the first priority for the next cave survey expedition due to it's ease of access and its potential for development for tourist infrastructure. However, the Khammouane area begs for attention, due to its higher speleological potential in the long term. We suggest the next cave survey expedition to the Khammouane karst should have three primary objectives:

1. To continue the survey of caves in the karst around the village of Ban Mouang. Particular attention should be given to a number of cave sites on the southern edge of the Pha Kouankaohong ridge (Figure 2) including Tham Physeau. The ridge is some six kilometres wide and over 25 kilo meters long, giving considerable potential, as the short visit during this expedition suggested. In addition to Tham Physeau there are promising sites to the south-east of Tham Patchan with good access by four wheel truck from Ban Phendeu or on foot from the Ban Doy area via Tham Patchan.

2. A number of possible resurgence caves have been identified near Pha Nu and to the east of Ban Na (Sheet E-48-90, grid ref 883 395). The latter site is of special interest as it lies in line, and is possibly connected with, the large gorge cutting through the ridge to the NE (Sheet E-48-90; grid ref. 940 420). This gorge is at the end of a large semi-enclosed area with a number of stream sinks shown on the 1: 100,000 maps. The geomorphological speleological significance of this feature should be examined as part of the survey, provided an access route can be found and agreed.

3. Examination of enclosed depressions north of Thakhek.

Three large enclosed depression have been identified to the north of Thakhek (sheet number E-48-90; Figures 19 and 20). The likelihood of a return visit to Khammouane would to a large extent depend on the ability to visit theses areas. We believe that this large area contains extensive cave systems that remain undocumented. At least 22 potential cave site have been identified from the 1:100,000 maps. Access would most likely be by foot and by four wheel-drive vehicle. The northern most depression contains two small villages which could be used as a base during exploration and survey of caves in the surrounding .

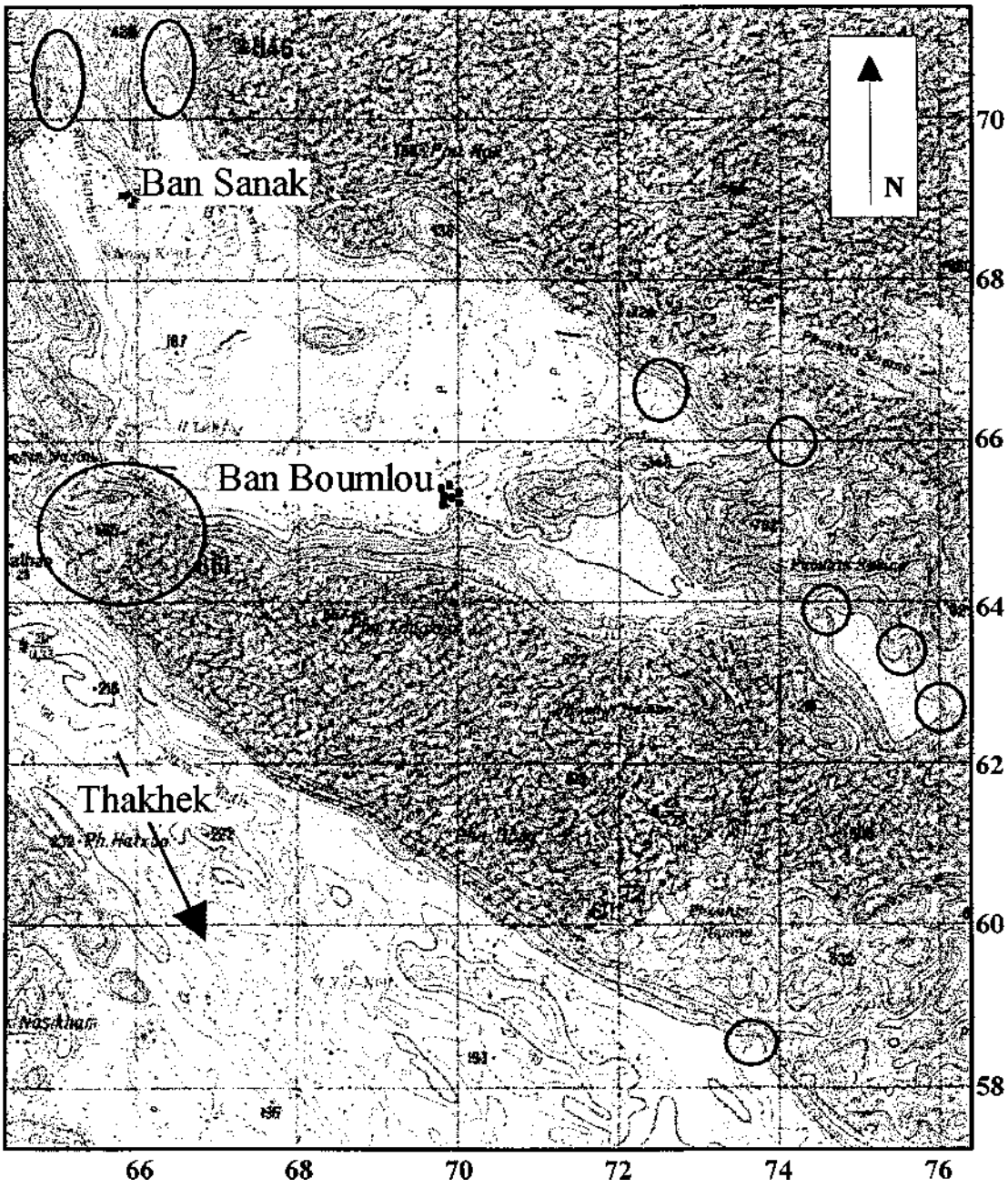


Figure 19. Enclosed depressions to the north of Thakhek. 1: 100,000 map E-48- 78.

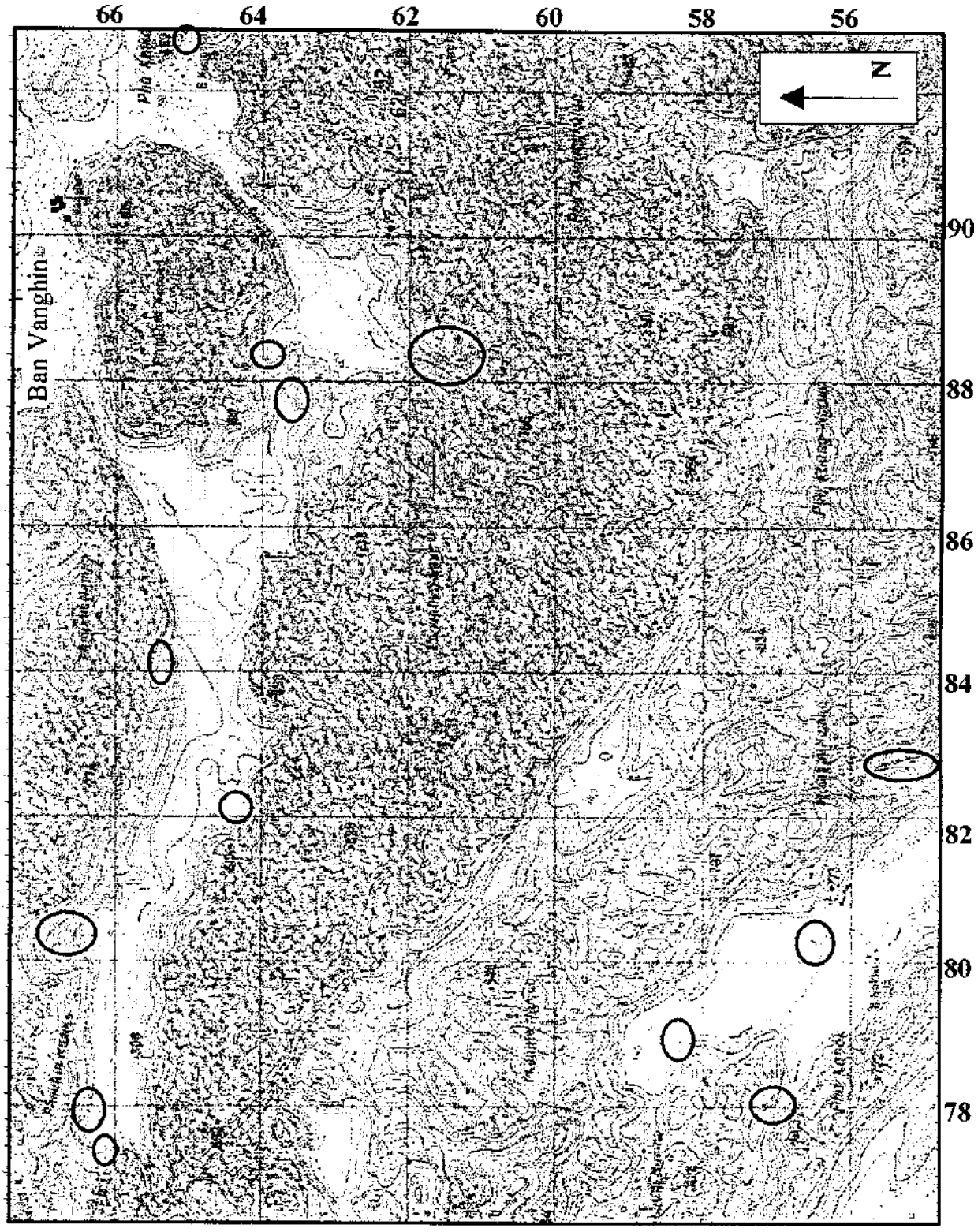


Figure 20. Enclosed depressions to the north of Thakhek. 1 :100,000 map E-48-78. Map in Figure 19 is adjacent to the west.

area. It is likely that some sites would require a walk to reach a base but the plan would be to stay at the site for several days at a time to complete a full and effective exploration. It should be noted that all British participants are experienced in survival in remote areas and long stays in these areas would generally not be a problem.

In addition, a reconnaissance of the east Khammouane karst is a longer-term aim for a future expedition. Access will be the key to future cave survey work and the development of eco-tourism in these areas. However, the increasing amount of ordnance to the east of Lao PDR will be a problem. A brief reconnoitre by four-wheel drive truck using Highway 12 from Thakhek would be a good start to exploration on the east of Lao PDR. This would allow further expeditions to be planned around access from a base camp set up in a village with road accessibility.

For future cave survey expeditions around Thakhek to succeed careful co-ordination with the Provincial and village authorities will be required so potential sites can be identified and access routes agreed prior to the British team's arrival in Lao PDR. The primary base is likely to remain in Thakhek but village bases should be used for prolonged activity in the field. For example, the village of Ban Mouang (Figure 2) was vital to the exploration and survey of caves such as Tham Patchan, Tham Physeau and Tham Jongchott. During the 1996 expedition good relations were established with the people of Ban Mouang that can be further developed during future expeditions.

WORK AREAS - Vang Viang

Although this karst area is much more dissected than in Khammouane, there continues to be excellent potential for long and interesting caves. Caves in this area represent some of the easiest to develop for profitable eco-tourist cave sites due to accessibility from Vientiane along Highway 13, existing and emerging tourist infrastructure and, finally, the lack of ordnance. Despite these developments the area retains its charm, its unspoiled environment and its culture that will continue to attract the more adventurous traveller.

Area priorities for further cave survey expeditions to Vang Viang, Vientiane Province.

A future cave survey expedition will have five primary objectives:

1. Continue the survey of the Tham Hoi - Tham Xang system.
   At present 3,275m have been surveyed, but the two caves are yet to be joined. We also believe that there is the potential for a system length in excess of 10 kilometres with excellent potential for a major eco-tourist site. The main areas needing attention are the downstream river passage in Tharn Hoi, the river by-pass passage near the entrance of Tharn Xang, the fossil passages towards the upstream limits of Tham Hoi and the continuation of the 1996 limit of exploration. In Tham Hoi only the passage up to the river passage and a small part of the river passage has been photographed. The continued production of a photographic record of the cave is an important objective with special attention being given to the gours in the river galleries.

2. Continue the survey of the caves below the Pha Namthem ridge to the west and north of Vang Viang.
   During the 1996 expedition only about half of the major caves known to the Forestry Department in Vang Viang were examined due to lack of time. The remainder of the sites will be surveyed as well as completing the survey of Tham Phatang, where climbing equipment is required to by-pass a recent floor collapse.

3.Continue exploration and survey of the karst around Ban Keokoang.
   This area was visited to survey Tham Nang Phonhom. The area has the potential for extensive cave systems, particularly in the area to the north of Ban Keokoang. Access to this northern area was not possible during 1996 and it is proposed to concentrate on the southern area to the west and south of Ban Keokoang where access is good.

4.River cave north of M.Kasi.
   This cave is known to the M.Kasi Forestry Department staff and is situated adjacent to the Highway 13 to the north of M. Kasi just in Luang Phabang Province (Sheet E-48-25,

Grid ref 230396). As this cave is next to Highway 13 it has excellent eco-tourist potential if it could be suitably developed. However, a future expedition would require access to determine its worth as a tourist cave. This is a major priority for a future expedition.

Area to the west of M.Kasi.

A cave is known to the Department of Forestry at M.Kasi located along the Nam Kay (Sheet E-48-25, Grid Ref. 085 320 (approximate)) and is said to be extensive. Access and accommodation would be required in M.Kasi. This area appears to be in less mature karst from the evidence presented on the 1: 100,000 maps. An examination of the geomorphology of the area including the identification of further caves is required. Local knowledge would be used to find caves in this area.

Training and development for FOMA COP and Forestry Department staff

A future survey expedition will continue the development of speleological skills amongst Lao PDR counterparts. Very good progress was made during 1996 with Mr. Koonmee Salyvong and Mr. Chansom surveying over 1 km of passage in Tham Hoi. During the next expedition it is intended to further develop surveying skills including the computation of raw survey data and drawing up procedures. To aid this process a copy of the British Cave Research Association publication "An Introduction to Cave Surveying" has been provided so future counterparts can have a reference book for study prior to the field work.

An additional aim of a future expedition will be to impart the basic skills of cave photography that can be further developed after the expedition. Caves present a challenge to photographers, and special techniques are needed in addition to those used for surface photography. To fully develop the Lao PDR karst for tourism good photographs are essential to achieve world wide publicity.

During the 1996 expedition little use was made of rope and climbing techniques. During future expeditions the basics of rope access and safety measures will be taught to counterparts. Particularly important are the use of traverse ropes and belaying techniques. These skills are essential for safety during the development of caves for tourism.

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APPENDIX A

Medical report

Advice was given by Drs. John Frankland and Frank Walker, with specific advice on the problems in the Lao/Vietnam region from Mr. Dave Gallavan. A limited medical kit was taken to Lao PDR, consisting of basic first aid equipment including sutures, copious wound washing fluids and medications. These included treatments for bacterial, fungal and eye infections, allergic reactions, abrasion/sweat rashes and various strength of pain killers. In addition, emergency hypodermic needles and a blood/plasma giving set with 1 lt. of Heamacell were taken to minimise the risk of Hepatitis B - this is endemic in Lao and local blood supplies could have been infected.

In the event few medical supplies were used, partly due to the very dry climate and lack of insects at the end of the dry season. All cuts healed with minimum intervention and no fungal or allergic problems occurred. However, it was clear that any visit outside the latter half of the dry season (Jan - April) will encounter very different conditions and a full medical kit will be essential. The areas near the Vietnam border are likely to be more humid and require more medication, as is indicated by the experiences of previous British expeditions to Vietnam (Limbert and Limbert, 1996).

The only medications taken in quantity were for diarrhoea. Lomotil solved most of the problems, but for more persistent cases a single 500mg tablet of Ciprofloxacin was taken. In all cases this solved the problem quickly and no further tablets were taken. While not essential Ciprofloxacin enabled team members to maintain their work programme with minimum disruption.

Falciparum Malaria is a major problem in Lao with resistance to Chloroquine, Proguanil and Fansidar reported. We saw few mosquitos and experienced no bites. This was partly due to taking good precautions with clothing cover at night, mosquitos nets, and liberal Deet 50%. However, future expeditions must take the Malaria risk very seriously when away from Vientiane, and not be lulled into false security. French cavers have succumbed to malaria, despite taking prophylactic medication (type not known). Three members of the 1996 expedition took Larium (Mefloquine) with no serious side effects other than mild euphoria and a tremendous desire to eat. The fourth British member took

Proguanil daily and Chloroquine weekly, having experienced notable side effects with Larium in the past.

APPENDIX B

Notes on Cave Surveys

For detailed description on the techniques used to survey caves see the accompanying booklet *"An Introduction to Cave Surveying"* by Bryan Ellis published by the BCRA.

Survey Equipment

Survey instruments were as follows:
Suunto Clinometer
Suunto Compass
Rabone Chesterman 50 and 30m Fibron tape measures.

Survey Techniques

In brief, a centre line survey is taken through the cave passage using the instruments above. From the first survey station a measurement is made to the second survey station. After noting the readings (inclination, bearing and distance) the instruments are moved to the second survey station and readings are then taken to a third survey station some distance further along the passage and so on. Between each survey station the passage width, height and detail are noted down (photo 8).

On the surface measurements are converted to Cartesian coordinates (X, Y,Z) taking into account the local compass deviation and a correction to grid North. Each survey station is then drawn onto graph paper at an appropriate scale. Finally the passage detail is drawn on either side of the centre line. Standard symbols are drawn in to represent the composition of the cave floor (Figure 21).

Finally, a title and survey grade are added. The survey grades used during the 1996 LPDR Caves project are all BCRA Grade 5b. To achieve this grade surveys must have horizontal and vertical measurements accurate to within 1° and distances accurate to +/- 100mm. In addition, the passage details must be estimated and recorded IN the cave.

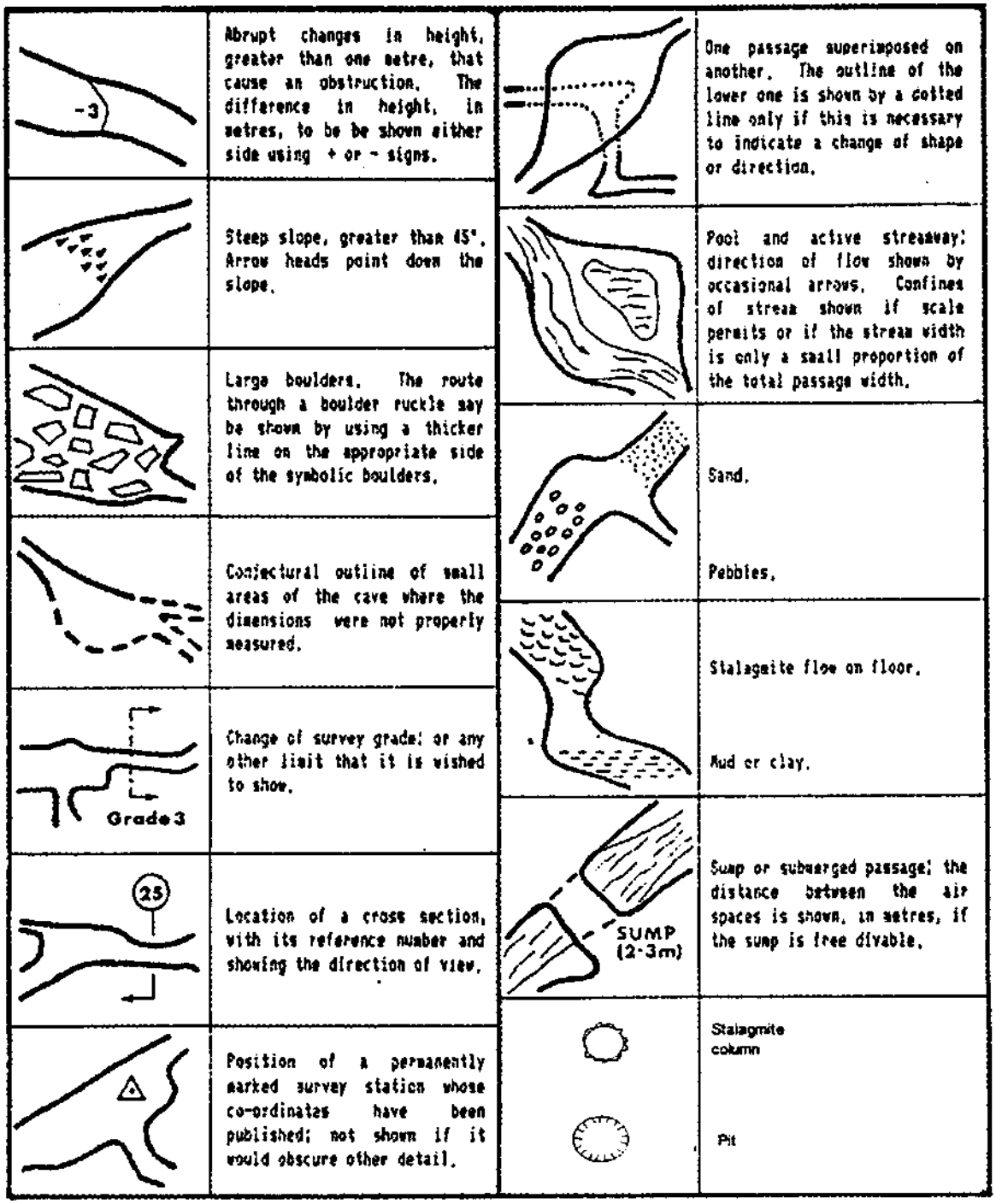

Figure 21. Symbols used on cave surveys.

Photo 8. Surveying into Tharn None. Each person is standing at a survey station and measurements are being taken into the passage.

APPENDIX C

Lao Cave Names

Lao Cave names have been omitted from the surveys and main text body for simplicity but are included below.

Tham En _____ ຖ້ຳ ແອ່ນ

Tham Kong Row (Hinboun River Cave) _____ ຖ້ຳ ກົງ ກໍ

Tham Nonsim _____ ຖ້ຳ ໜອງ ຊ້ຽມ

Tham Sompoy _____ ຖ້ຳ ສົມ ປ່ອຍ

Tham Chongcott _____ ຖ້ຳ ຈ່ຳ ຈອ

Tham Patchan _____ ຖ້ຳ ພ: ຈ ລ.

Tham Physeau _____ ຖ້ຳ ພິ ເສ

Tham None _____ ຖ້ຳ ໜ ລ

Tham Xang _____ ຖ້ຳ ຊ ງ

Tham Hoi _____ ຖ້ຳ ຫ ຍ ລ

Tham Phatang _____ ຖ້ຳ ພ ຕ ງ

Tham Nang Phonhom _____ ຖ້ຳ ນ ງ ພົ ນ ຫ ຍ ລ