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SERVICE GEOLOGIQUE DE BELGIQUE
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BELGIAN-VIETNAMESE SPELEOLOGICAL EXPEDITION SON LA 1993

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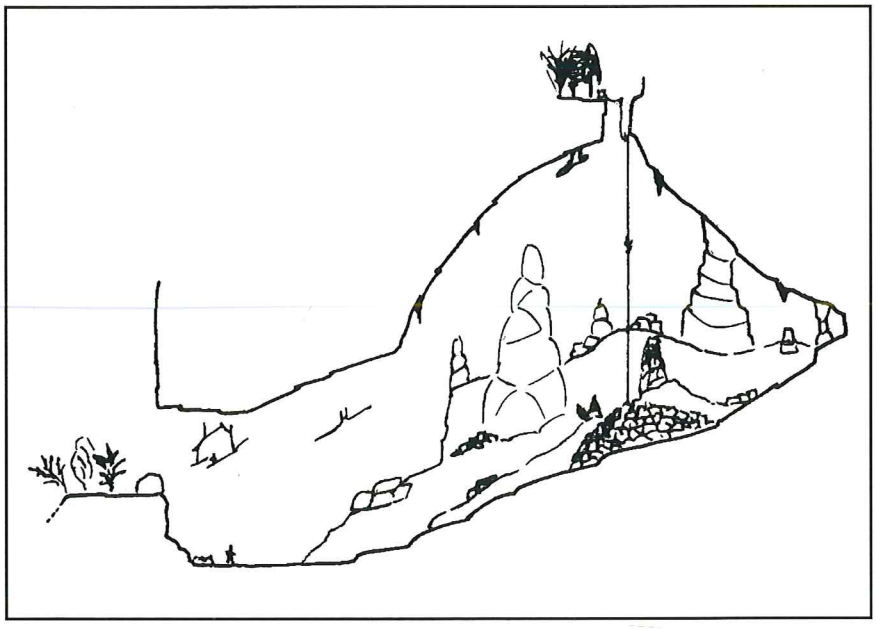

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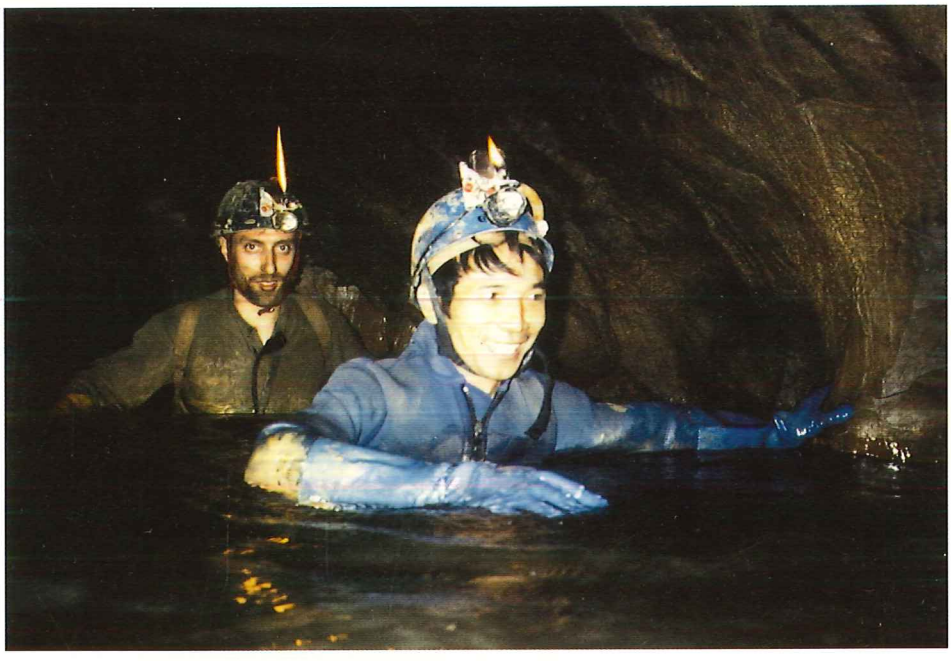


Belgo-Vietnamese cooperation in action! (aquatic progression in Snake Cave).

CONTENTS

Downstream Son La city, the fertile Nam La river valley is surrounded by a vast expanse of unexplored karst scenery.

Introduction

Vietnam has well over 60.000 square kilometers of exposed karst, most of that total being situated in the North. One of the most important areas is the North-West Bacbo region. This region extends from the border with China to the sea coast of Bacbo gulf in the South-East over a length of about 400 km and a width ranging from 10 to sometimes 40 km. On initiative of the Geological Survey of Vietnam, the Belgian Geological Survey and the Belgian Vietnamese Karst and Caves Association a speleological expedition was organised to investigate some of the karst features in this region. During January 1993 Vietnamese and Belgian speleologists explored caves in the Son La area. This publication presents the results of the expedition. We consider it to be the start of a long term cooperation between Vietnamese and Belgian cavers and karst researchers. The potential for exploration is in fact enormous. Only some caves are known, many more await ...

PART I
PRELIMINARIES

KARST IN VIETNAM

Distribution of carbonate rocks

Carbonate rocks are widely distributed in Vietnam north of latitude 16°. They cover almost 60,000 km^2, or almost 20% of the Vietnamese territory and are subject to tropical karst development (Fig. 1). Few karst investigations have been made but an overview of karstic regions and landscapes has recently been published by Pham Khang (1991) and Nguyen Quang My (1992). The drowned karst plain of Halong Bay along the Tonkin Gulf is possibly the best known, but most carbonate rocks crop out in the mountainous parts of northern Vietnam. The largest continuous carbonate zone stretches over 300 km in Northwest Vietnam, from the Chinese border at Phong Tho (Lai Chau province) to the coastline of Ha Trung (Thanh Hoa province) including Son La (= Tay Bac Bo karst).

Carbonate rocks in North Vietnam form an extension of the South China carbonate platform which constitutes the largest karst region in the world; they have similar origins as those of South China, including the Guilin tower karst and the East Yunnan karst (Dusar & Zhang Shouyue, 1991). Carbonates were deposited over the widest possible time span, from Archean to recent reefs. Thin-bedded, impure precambrian and early paleozoic limestones are less suited for karstification contrary to the very pure Permo-Carboniferous and Triassic limestones which reach considerable thicknesses of 1000-2000 m. Neotectonic uplift and subsequent erosion has exposed these limestones over several thousand meters, allowing rapid development of vertical karst features. On the other hand coastal subsidence is responsible for drowned karst plains. Under such circumstances the humid tropical climate with high rainfall and intense biochemical processes leading to the acidification of the infiltrating water favours high rates of karst denudation and cave formation.

Characteristics of karst in Vietnam

Karst development in Vietnam is influenced by the action of a moist tropical climate on diverse carbonate rocks, generally subject to rapid tectonic uplift. Hence the karst of Vietnam is characterised by:

- persistence of tropical monsoon climate since the Neogene
- rapid karstic dissolution and erosion processes

- rugged topography and downcutting (lowering of base level) under influence of tectonic uplift, or mature landscapes with predominant negative relief forms in low lying areas
- development of tower karst and karst plains, of great agricultural importance (cone karst is rather found in areas with less deformed limestones)
- few rocky outcrops under a thick weathering crust
- rapid denudation and removal of soils due to deforestation, and reduction of importance of bio-pedological factors in karst processes
- predominance of huge karstic funnels created by underground rivers

Previous studies

Karst and cave investigations also have important socio-economic benefits. Underground water supply for drinking water and for irrigation, reduction of flood hazards, geotechnical engineering at dam construction sites, carbonate rock quality for cement factories or dimension stone quarries, cave mapping for military defence and tourism are among the most important reasons for conducting karst research. However karst studies are still in a preliminary stage.

The first remarkable works were conducted by Fromaget (1927, 1941) and Couron (1931) who emphasised the role of the karst topography in regional geological investigations. After the victory of 'patriotic resistance' many new studies of the genesis, morphology and development of the tropical karst of Vietnam were conducted by Le Xuan Phuong (1957), Birot (1954), Zubashenko (1961, 1964), Fridland (1961), Le Trong Tuc in Hoang Thieu Son et al (1965, who were the first to discuss potential economic utilisation of the karst domain), Glazek (1966), Nguyen Duc Chinh & Vu Xu Lap (1970). During the period 1972-1976, a team of researchers of Hanoi University (Nguyen Quang My, Nguyen Vi Dan, Nguyen Xuan Truong & Nguyen Duc Kha) studied limestone mounts at Yen Duyen, Bim Son (Thanh Hoa province) for cement factories, at Hoa Binh for the construction of the Da river hydropower station.

Cave archeological investigations were carried out since the beginning of this century by french scientists such as Mansuy (1924), Colani (1926-28), Gouron (1932), Saurin and Fromaget (1936). Many caves with remains of early human occupation were discovered: Tham Khuyen and Thung Long in Lang Son contain bones of Homo erectus (Peking man), aged about 300,000 years; Homo sapiens dwelled in caves as was shown by the Hoa Binh (12.000 to 18.000 years BP) and Bac Son (6.000 to 10.000 years BP) stone cultures. Many additional cave archeological sites have been discovered by Vietnamese researchers since 1960.

Underground studies are more rare. During the period 1985-1990, Czechoslovakian and Bulgarian karst workers studied the touristic potential of showcaves. Before the present expeditions no real cave investiga--tions were carried out in Northwest Vietnam, with the exception of a cave entrance survey in the middle basin of the Da river by speleological expeditions of the Hanoi University led by Nguyen Vi Dan et al in 1972. This team recorded a density of 2 to 6 caves per km2 in the Lang Nga, Muong Ngay, Muong Day and Muong Lao areas.

Foreign participation in underground exploration started in 1990-1993 with two british (Phong Nha, Ke Bang massif, Limbert, 1992) and one belgian expedition.

Speleothem growth in the heated athmosphere (30°) of the fossil gallery in Khau Pha Pass cave, adequately named "Sau Na".

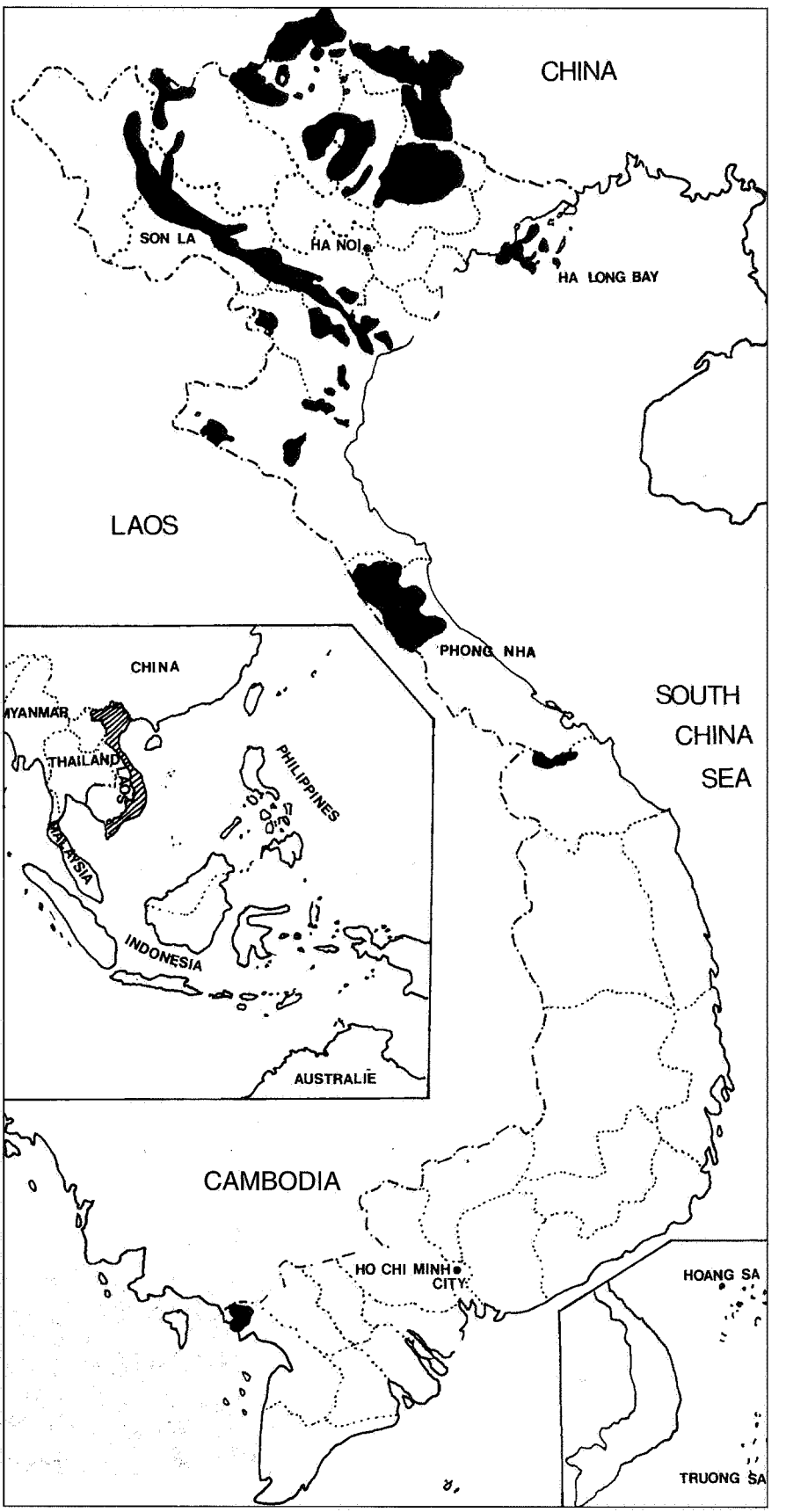


Fig.1: Karst areas of Vietnam

PART II
SON LA AREA

GEOGRAPHICAL CHARACTERISTICS OF THE SON LA AREA

Son La town, capital of Son La province is a major centre in Northwest Vietnam (West Bac Bo). It is situated on National Highway 6, connecting Hanoi with historic Dien Bien Phu (Fig. 7). The centrepiece of the speleological investigations, Khau Pha Pass cave is located 12 km to the northeast of the town centre, with coordinates 21°20'N and 103°53'E (Fig. 3). Son La town lies in the Nam La river valley where most of the province's population and overland communication systems are concentrated.

Young hunter of the H'mong people

The area is populated by different ethnic groups including Kinh, Thai, H'mong who practice dryland farming. Agricultural production is highly dependent on climatic conditions and the living standard is low. Natural hazards, droughts and floods are frequent threats to the life of people, also weakening the economic system.

Mapping history

Topographical maps at scale 1:50,000 were available for the present study, including sheets 5752 II, 5852 III, 5751 I, 5851 IV.

Geological mapping has been carried out on various scales: 1:1,000,000 (Tran Van Tri et al, 1973; Phan Cu Tien et al, 1988), 1:500,000 (Dovjikov et al, 1965), 1:200,000 (Tran Dang Tuyet et al, 1976; Phan Son et al, 1974; Nguyen Xuan Bao et al, 1969). At present a 1:50,000 scale geological prospecting map is compiled. From these studies, the stratigraphic succession and structural framework of the geological formations has been determined.

Geomorphological maps at scale 1:500,000 cover the whole of the country (Le Duc An et al, 1975). At present a 1:50,000 scale geomorphological map is compiled.

A hydrometeorological, geomorphological and geological survey of the Son La region has preceded the present study (Do Tuyet & Pham Kha Tuy, 1992).

CLIMATIC AND HYDROLOGIC CONDITIONS

Climate

Owing to its location within the northern hemisphere subtropical zone and at the southeastern end of the eurasian continent, Vietnam has a humid tropical climate heavily influenced by the monsoon regime prevailing in Southeast Asia. In winter the Siberia-Mongolia high-pressure zone brings cold and dry air to Vietnam. As a consequence Northwest Vietnam possesses a tropical monsoon climate, characterised by two seasons: a hot and rainy summer or a colder and dry winter (Nguyen Trong Dieu, 1992).

In Son La, the annual mean temperature is 21°C. The absolute maximal temperature reaches 40°C, while the minimal recorded temperature is 1.1°C.The average

humidity of the air attains 80%, but may drop in winter to an alltime low of 6%. The mean annual rainfall attains 1413 mm, but precipitations are unevenly distributed over the year. The rainy season lasts from April to September while the dry season lasts from October to March. About 85% of the rain falls during the rainy season in summer. Most of the summer rain fall in showers or storms. Days of over 50 mm rainfall are not rare. Particularly in July and August rains of over 100 mm/day may occur (Fig. 2)

Fig. 2a Mean air temperature and relative air humidity, multiannual data, Son La station

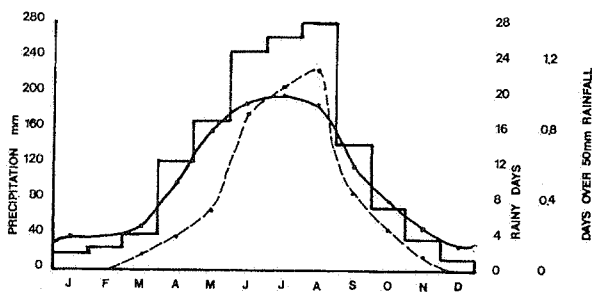


Fig. 2b Mean monthly rainfall (precipitation in mm), average monthly number of rainy days (continuous line), and average monthly number of days with over 50 mm rainfall (interrupted line); after Tran Minh et al, 1992

Soils

Red soils, derived from chemical dissolution of limestones, cover most of the Son La area. This type of soil is endowed with good properties for vegetation growth. However, because of the rugged landscape, cultivation is difficult and the land is vulnerable to drought in the dry season. Rampant soil erosion results from deforestation for wood and subsidence farming. Eroded topsoil is ever more accumulating in depressions, choking karstic sinkholes or increasing the sediment load of rivers (the Red River derives its name from the transported sediment).

Hydrography

As is the case for the greater part of North Vietnam, drainage is converging towards the Red River - Thai Binh river system. In the Son La area precipitation runoff is along the Nam La river, a tributary of the Nam Pan, flowing through Son La town. The catchment area of the Nam La river is over 2000 km^2; the drainage density attains 1.8 km/km^2 on terrigenous formations, with fewer, blind valleys forming in karst terrain. The average slope attains 39%, testifying of the rugged mountainous character of the countryside. The river starts in the western mountains at an altitude of 1500 m. The main river course follows a NNE-SSW direction, passing through Son La town (altitude 600 m) with flat drainage base to Ban Sang (alt. 600 m), where it disappears on an underground course, to reappear again at Pa Pan (alt. 180 m), 5 km to the east. At Pa Pan the Nam La river flows into the Nam Pan river which flows itself northwards to the major Da river near Ta Bu (Fig. 3).

Nam La river discharge into underground caves averages 89.4 million m^3 of water annually, reaching a maximal quantity of 121.9 million m^3 in a year with maximal precipitation. About 72% of the total annual discharge is transported during the summer months (April to September) while the months of July to September are responsible for 57% of the total annual discharge.

In the dry season, river flow is mostly supplied by groundwater, flowing out of karstic caves. One such cave, known as Ban Ca provides 20,000 m^3/day, which forms the main water supply to Son La town. During floods, discharge will mount to 600-800 m^3/sec, with maximal river depth of 5 m. Even at the highest floods all water is swallowed by the ponors at Khau Pha. Many people and animals have been killed and swept into the caves by floods. The flood of 27 June 1991 took away 16 persons and innumerable large household animals.

Fig. 3 drainage pattern of the Nam La river, scale 1 : 225,000

GEOLOGY

STRUCTURAL SETTING

North Vietnam is located at the meeting point of two active tectonic belts of global scale, the mediterranean (tethys) and the circumpacific. This region is characterised by successive phases of rifting and collision. The Bac Bo region is located at the Lower Paleozoic collision zone of the Indochina and South China plates along the Song Ma suture zone which traverses North Vietnam in a NW-SE direction to the south of Son La. The northern zone as part of the Paleotethys basin rifted along the Da river during the Indosinian = early Kimmerian epoch , then collided again during Cretaceous times as a result of the formation of the Truong Son range in Middle Vietnam.

The continental area became uplifted during the Neogene Himalayan event (Phan Cu Tien et al, 1991; Sengör, 1987). The Neogene Red River (Song Hong) or Hanoi rift (containing the densely populated Red River delta), connected with the opening South China sea, lies to the East of these structures. The NW-SE structural grain has been preserved throughout this complex history (Fig. 4).

Son La town and vicinity lie in the Tay Bac Bac Bo Foldbelt (Northwest Vietnam) with continental crust consolidated since the end of the early Paleozoic (Tay Bac Fold System), although affected by younger tectonic movements. Within this foldbelt developed the Upper Paleozoic - Triassic Song Da rift depression, due to a virgation of the North Laos - Malaysia oceanic basin, and composed of sedimentary-volcanic sequences, and terminated by siliciclastic-carbonate-siliciclastic sequences, which attain a thickness of 3000 to 5000 m. The extensional Song Da basin then was affected by NW-SE oriented folding, due to Indosinian (=Kimmeric) closure of the Paleotethys (beginning since the Late Permian and

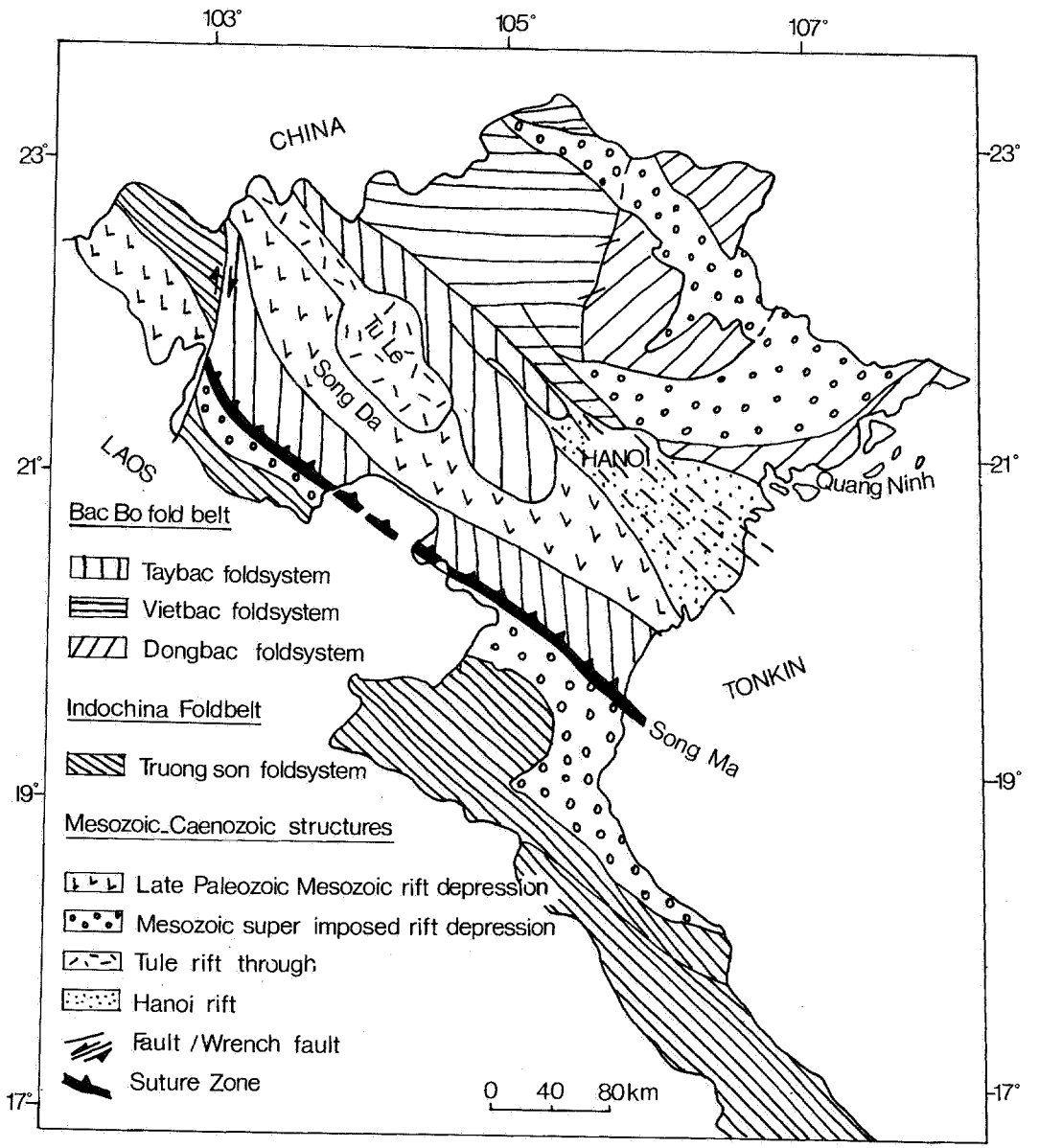


Fig. 4 Tectonic framework of North Vietnam

culminating during the Middle Triassic). Uppermost Triassic to Paleogene molasse with coal, red beds and volcanics, all strongly intruded, were finally deposited in the Tu Le volcano-tectonic rift through to the north-east of the Song Da depression. Cretaceous compression affected this through . All these deposits were finally uplifted during the Neogene Himalayan collision event (Tran Van Tri et al, 1977 and 1979; Tran Dang Tuyet et al, 1976; Phan Cu Tien et al, 1991; Phan Son et al, 1974).

As a consequence folded Late Proterozoic to Middle Triassic formations, including the karstified limestones, are all exposed near Son La. Sedimentation in the Triassic Paleotethys basin thus was interrupted when it accreted to the northern Laurasian continent during the Kimmeric deformation stage. Since Late Mesozoic times till present the North West Bac Bo is characterised by a continental regime leading to denudation and karstification. Similar successions are found in the South-Central China karst districts, located on the same craton (Dusar, Swennen & Zhang Shouyue, 1994; Dusar & Zhang Shouyue, 1991).

Continuous tectonic activity in the Son La region is indicated by strong uplift and associated tilting towards the Da river valley to the east. This has resulted in the destruction of the Miocene-Pliocene peneplanation surface and the ceation of deeply incised valleys. Furthermore Son La town is situated on the active Tuan Giao - Son La seismic zone. Many destructive earth-quakes have been recorded in this zone, causing property damage, rock falls, ground cracking and landslides. As recent as 1992 an earthquake occurred in Ta Khoa at 100 km to the SE of Son La, with an intensity of 4.1 on the Richter scale.

STRATIGRAPHY

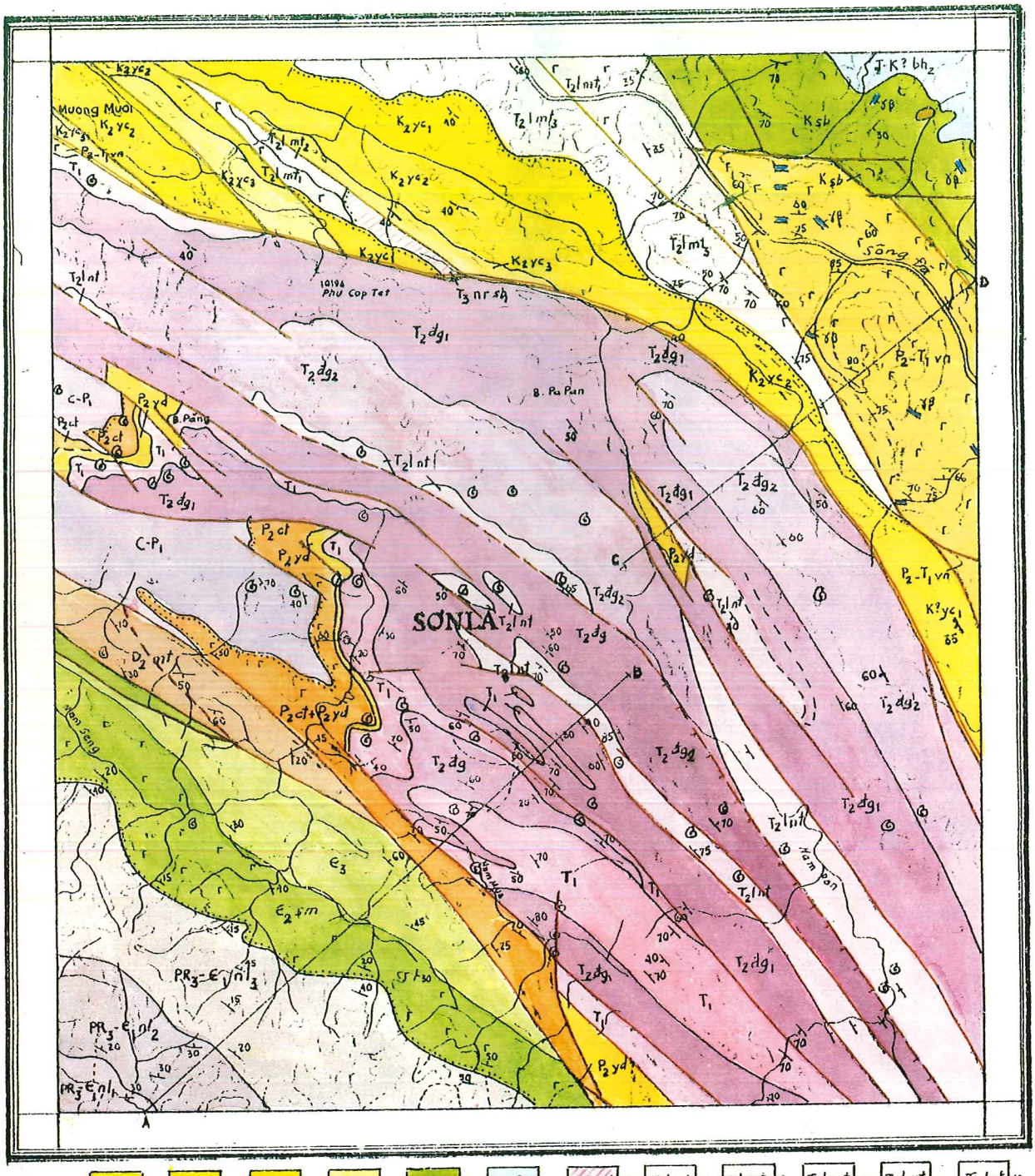
Many different formations ranging from Late Precambrian to Middle Triassic occur in the study area, with thin Quaternary deposits limited to the Nam La valley (Fig. 5). Although extensive karst development is restricted to the Triassic Dong Giao Formation, a summary stratigraphic description of all rock units on the Son La area is presented, using the official vietnamese nomenclature, starting from the oldest rocks:

Nam Le Formation (PR_3- $\in_{1nl}$): the oldest rock unit is outcropping in the Su Sung - Chao Chai mountain range about 10 to 12 km to the southwest of Son La town, delimitating the catchment area of the Nam La river. It forms the core of the Song Ma anticlinorium, extending in NW-SE direction, with many minor folds. Nam Le Formation is composed of foliated micaschist with biotite, psammitic micaschist and quartzite. An upwards decreasing quartz content allows a subdivision of the Nam Le Formation in three members.
The degree of metamorphism has reached the amphibolite facies grade. Nevertheless organic walled microfossils have been found, suggesting a Late Proterozoic-Early Cambrian age.
The total thickness of the Nam Le Formation is estimated at 1600m.

Song Ma Formation ($\in_{2sm}$): these rocks are distributed in the area of Muong Chanh, about 8 km west of Son La town. A threefold subdivision is possible. The lower part is composed of light coloured fine grained quartzitic sandstone in beds 5 to 20 cm thick, greenish grey psammitic schist, black thin-bedded silicite; the middle part of black to light grey schist with light grey limestone beds; the upper part of siltstone, carbonaceous slate and greenschist.
Trilobites point towards a Middle Cambrian age.
The rocks are complicately folded. Its thickness is estimated at 700 m.

Pa Ham Formation (O_3-D_{1ph}): these rocks occur to the west and northwest of Son La town (just outside the area covered by the geological map), where they unconformably overly the Song Ma and Nam Le formations. They mainly consist of black to dark grey limestones with irregular bed thicknesses and intercalations of siltstones, slates and greenschists, characteristic of the actinolite zone of low-grade metamorphism.
The Pa Ham Formation is fossiliferous; corals and stromatoporoids indicate a Late Ordovician to Early Devonian age.
The total thickness may reach 1100 m.

Mo Tom Formation (D_{2mt}): this formation is stretching in a NW-SE direction to the west of Son La town. It is subdivided in two members. The lower member is composed of dark grey marl and fine grained, thin to medium bedded limestone; the upper member of massive black limestone.
A Middle Devonian age is derived from the coral


SONLA
Muong Muoi
B. Pa Pan
B. Pang
Phu Cop Tet
Song Da
Nam Mua
Nam Sang
Ham Yen
Fu La Lop
Phu G
Ban Phan
A
B
C
D

assembly.

Total thickness attains 800-1000 m.

Permo-Carboniferous limestones (C-P_1): these units which have not yet been formally subdivided are widely outcropping immediately to the west and northwest of Son La town. They mainly consist of massive, irregularly bedded dark grey to light grey limestones. Different carbonate facies types are observed. Thin bedded shale and siltstone intercalations locally occur.

Foraminiferal faunas including Fusulinids, served for the age determination.

The thickness of the Permo-Carboniferous limestones is 200 m.

Cam Thuy Formation (P_{2ct}): this formation is encountered on the peak of Son La pass, 5 km north of Son La town. It mainly consists of dark grey to black basaltic rocks with agglomerates. Siltstone, tuffaceous siltstone and tuffite intercalations occur in the lower part. The Cam Thuy Formation grades into the overlying Yen Duyet Formation.

Various fossils indicate a Late Permian age.

Total thickness attains 100 m.

Yen Duyet Formation (P_{2yd}): this formation is encountered in the southern reaches of Son La pass, at Ban Me. It is composed of shale, siltstone, sandstone, with thin intercalations of siliceous limestone. Basic tuff intercalations near the base mark the transitional character to the underlying unit.

Shallow-water fossils and microfossils also indicate a Late Permian age.

Total thickness attains 120 m.

Co Noi Formation (T_{1cn}): this formation is well represented in the Son La area. Two principal zones of occurrence are located along the Road N°6 in eastern direction, and along Nam La valley. It is mainly composed of irregularly bedded shale, siltstone and fine grained sandstone with thin carbonate intercalations. Upper and lower contacts of this formation are conformable despite the complex folding.

An Early Triassic age is derived from rich mollusc faunas.

Total thickness attains 150-200 m.

Dong Giao Formation (T_{2dg}): this sequence constitutes the most important outcrop area in the Son La district as part of the northwest vietnamese carbonate axis extending over almost 400 kilometers with an average width of 10-20 km, from beyond the Vietnam - China border in the Northwest to the coast of Bac Bo Gulf in the Southeast. It consists of two members. The lower member consists of dark grey to black rather thinly bedded limestone with frequent interlayerings of grey shale and marl. The upper member consists of light grey or pinkish massive limestone. Most karstic phenomena are developed in these limestones which closely resemble the lower T_{1d} Daye Formation and the upper T_{1j} Jialinjiang Formation of the Yangtze Paraplatform in South-Central China (Dusar, Swennen & Zhang, 1994). Upper and lower contacts of this group remain conformable. The limestones are folded with fold axes extending in a NW-SE direction and limbs dipping 30°

<<< *Fig. 5 Geological map of Son La*

LEGEND:

1. Yen Chau formation. upper sequence: Calcareous conglomerate, sandstone, aleurolite. 2. Yen Chau formation, middle sequence: Gritstone, sandstone aleurolite interbedded with conglomerate. 3. Yen Chau formation, lower sequence: Conglomerate (with sandstone pebbles and some limestone pebbles), gritstone, sandstone, aleurolite. 4. Yen Chau formation: conglomerate, aleurolite, gravellite, clayish shale. 5. Ngoi Thia Complex, Suoi Be formation: Tuffogene sandstone, tuffogene shale, red tuffogene conglomerate, tuffite, limestone, spilite, rhyolite porphyry and associated tuffs. 6. Van Chan Complex. Ban Hat formation. Upper sequence: Volcanic and sub-volcanic orthophyre, rhyolite porphyry, felsite, spilite and various tuffs. 7. Suoi Bang formation: Sandstone, shale, aleurolite, gravellite, carbonaceous clayish shale, lenses of coal. 8. Muong Trai formation: upper sequence: aleurolite, shale, sandstone, thin lenses of limestone. 9. Muong Trai formation, middle sequence: Limestone, marl, porous and impure limestone. 10. Muong Trai formation: lower sequence: Sandstone, aleurolite, interbedded with shale, few basic effusives. 11. Muong Trai formation: Aleurolite, shale, marl, limestone, clayish limestone, few basic effusives. 12. Nam Tham formation: Aleurolite, shale. 13. Dong Giao formation, upper sequence: Light grey, thin-bedded to massive limestone. 14. Dong Giao formation, lower sequence: Irregularly bedded limestone and marl. 15. Dong Giao formation (T_2dg): Limestone, marl scarcely interbedded with thin beds of clayish shale. 16. Lower Triassic: Calcareous sandstone, oolitic limestone, aleurolite and reddish brown clayish shale. 17. Vien Nam formation: Spilite, basalt pophyry, keratophyre, greenschist with some felsite and associated tuffs. 18. Yen Duyet formation: Clayish shale, calcareous shale, siliceous shale, limestone. 19. Cam Thuy formation: Porphyrite, diabase and associated tuffs. 20. Carboniferous-Lower Permian: Dark-grey bedded limestone. 21 Mo Tom formation: Dark-grey, light-grey and medium to thick-bedded crystalline limestone. 22. Song Ma formation middle sequence: Green-schist, ribbon-bedded sericitic schist, black phyllite. 23. Upper Proterozoic-Lower Cambrian: Nam La formation, upper sequence: Grey, greenish grey finely foliated sericite schist (flyschoid). 24. Nam La formation, middle sequence: Quartz-sericite bearing schist, dark-grey sericitic schist. 25. Nam La formation. lower sequence: Quarzite, light grey foliated quartzite interbedded with quartzsericite bearing schist. 26. Gabbro diabase, lamprophyre. 27. Granite, granite aplite. 28. Phu Sa Phin complex: Alkaline syenite, porphyroid alkaline quartz syenite, alkaline granite. 29. Regional fault: confirmed, inferred. 30. Normal fault, confirmed, inferred. 31. Unclassified fault: observed, inferred. 32. Strike and dip of beds. 33. Strike of vertical beds. 34. Animal fossils. 35. Spilite. 36. Section line.

to almost vertical.
Rich mollusc and foraminifera faunas confirm a Middle Triassic (Anisian) age.
Total thickness ranges from 1200 to 1800 m.

Nam Tham Formation (T_{2lnt}): this formation has a limited distribution, forming a NW-SE stretch alongside the Nam La valley in Ban Tong. It is composed of thin bedded yellowish to whitish grey shale, siltstone to fine-grained sandstone.
Abundant mollusc faunas confirm a Middle Triassic (Ladinian) age.
The thickess of the Nam Tham Formation attains 100 m.

Muong Trai Formation (T_{2lmt}): this sequence is occurring in the Da river valley from the emergence of the underground Nam La river at Pa Pan. It is mainly composed of unevenly bedded siliciclastics, with few marl and limestone beds. In the lower part appear thin beds of basic volcanic rock and associated tuffs. A subdivision in three mappable units is possible.
The fauna confirms a late Ladinian age similar to the underlying Nam Tham Formation.
Total thickness of this complicately folded and faulted sequence is 1500-2000 m.

Uppermost Triassic to Cretaceous Formations do not outcrop in the Son La area; they have been removed by the progressive denudation primarily affecting the youngest, Late Indosinian deposits.

Quaternary (Q): these deposits are not much developed in the study area, with the exception of the Nam La river alluvium. They represent lower to higher floodplain and first terrace, and are composed of boulders, sand, clay with particle size up to 40 cm.
The thickness varies from 1-2 m to 8-10 m at erosional pits and depressions in the river bed.
Scree deposits develop at the foot of limestone scarps. Cave sediments have not been investigated yet.

GEOMORPHOLOGY

CARBONATE HOST ROCKS FOR KARSTIFICATION

Of all carbonate rocks only the 'Anthracolitic' (Permo-Carboniferous) and Dong Giao (Triassic) limestones show notable karst development. These limestone units are thickest, massively bedded and very pure with up to 98% of $CaCO_3$ for the Dong Giao Formation and 96.70% of $CaCO_3$ for the Permo-Carboniferous limestones. They are folded and faulted. They were subject to neotectonic uplift and subsequent erosion attaining max. 3000 m. Because of pulsations in the uplift different planation levels and corresponding stages of cave formation have been formed. Uplift varies along different tectonic blocks but is greatest in the Northwest. Consequently the regional relief and cave systems are inclined towards the SE. All these conditions are responsible for the complexity of cave systems and for physical hardship during exploration but they also could lead to great potential depth of cave development.

SON LA KARST

The Son La area including Khau Pha cave system forms part of the Thuan Chau - Son La karst highland. This highland is situated in the centre of the Northwestern Karst, extending over 300 km in a NW-SE direction, with an average width of 10-30 km. The highland is characterised by three elevation levels at 1,300 m, 900-1,100 m and 500-600 m. To the east this area is limited by the Song Da, also known as the Black River (altitude 100 m), to the west by the high mountains of the Su Sung - Chao Chai range (altitude 1,700-2,000 m). Topographic steps between the karst highland and the mountain range correspond to tectonic faults.

The Son La karst highland is dissected by NW-SE, SW-NE, sublatitudinal and submeridional trending faults. Along these faults limestones are fractured, concentrating precipitation runoff with extensive development of karst features.

The flat-bottomed Nam La river section between the Can Trang at the centre of Son La town and Ban Sang, where the river disappears in the underground course, is considered as a karstic erosion valley, bounded by limestone escarpments with heights of several hundred meters (Fig. 6)

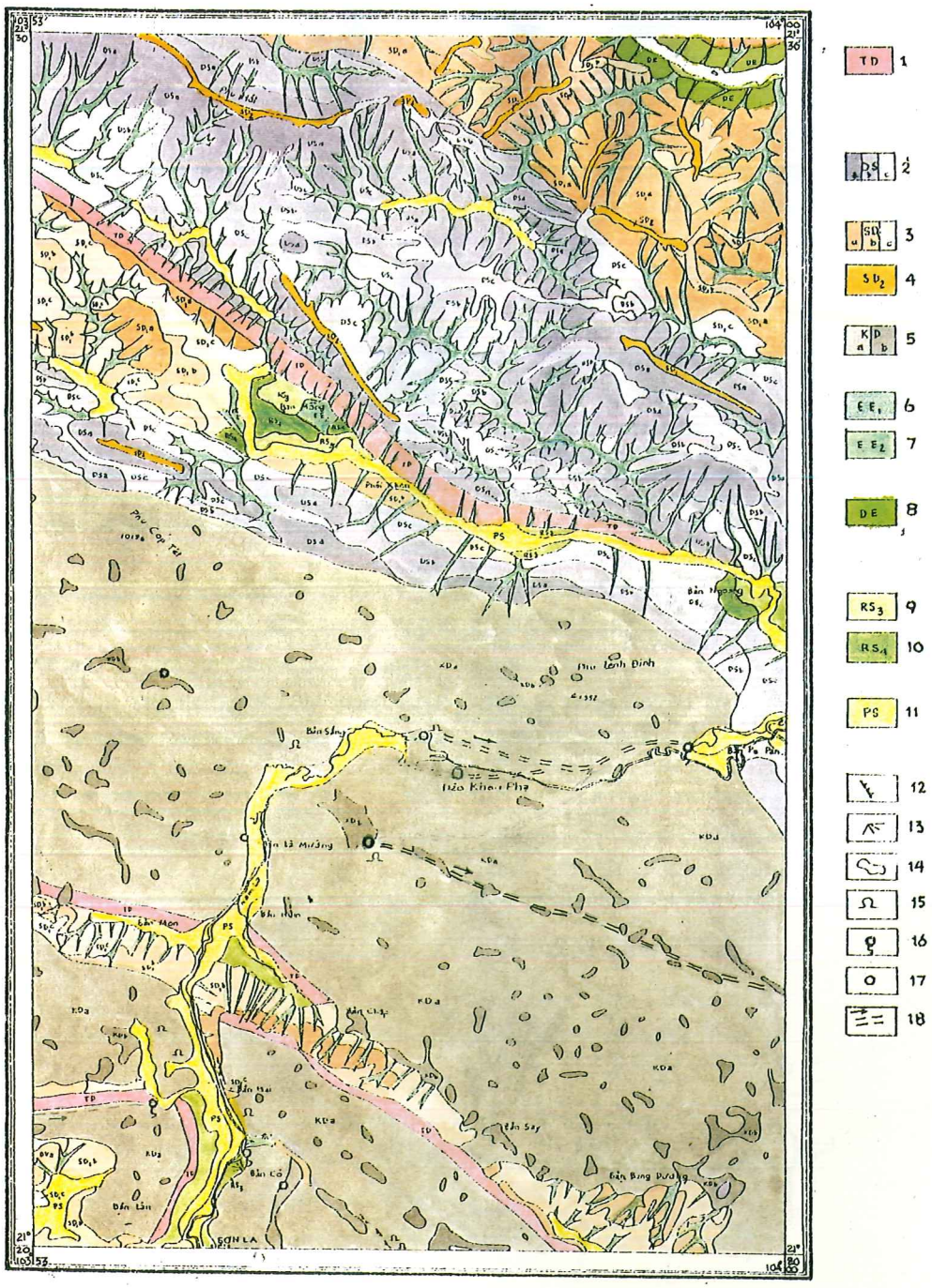


Fig. 6 Geomorphological map north of Son La town.

LEGEND

LANDFORM UNITS:

TECTONIC DENUDATION RELIEF: 1. Slopes of highland mainly formed by faulting activity in Quaternary (Q).

DENUDATION RELIEF: 2. Slopes of mountains formed by denudation of Yen Chau formation in Neogene-Quaternary (N-Q) with gradient: a. >35°, b. 15-35°, c. <15°. 3. Slopes of mountains formed by synthetic slope processes in Neogene-Quaternary (N-Q) with gradient: a. >35°, b. 15-35°, c. <15°. 4. Relicts of ancient planation surfaces of Pre-Quarnary (PQ)

KARST: 5. Karstic relief (MZ-KZ): a. mounds, b. sinks, funnels, valleys (negative). EROSION: 6. Present slopes and beds of valleys, 7. Erosion terrace of Late Pleistocene (QIII), 8. Erosion slopes of the valleys changed by denudation in Quartenary (Q). SEDIMENTARY RELIEF: 9. First terrace of Late Pleistocene (QIII), 10. Secondary terrace of Middle-Late Pleistocene (QII-III), 11. Present aluvial surface. ELEMENTS AND FORMS OF RELIEF: 12. Denudation scarps, 13. Alluvial cone, 14. Karstic sinks, 15. Karstic caves, 16. Karstic water exposure, 17. Karstic well, 18. Inferred underground karstic river.

The valley bottom has a width of only 200-500 m, containing alluvial deposits of low flood plain, high flood plain and locally lower terrace. Thickness of alluvial deposits varies between 1-2 m and 10-15 m; composition is variable, from clay to boulders up to 40 cm in diameter. Scree deposits are often found at the foot of the limestone escarpments. At many places karst springs feed the river.

IMPORTANCE OF KARST AND CAVES INVESTIGATION IN THE SON LA DISTRICT

The economic benefits of the belgian - vietnamese speleological expedition in Son La are mainly related to the local water resources. Surficial water supply is insufficient for irrigation during the dry season; therefore only one crop per year is possible, contrary to the situation in the more favoured parts of the country. In order to increase agricultural production for a growing population and strengthen the local economy, underground water resources have to be tapped. These are mostly contained in karst reservoirs in the limestones, but their location is largely unknown due to the erratic nature of underground karst development. Hence access to underground water reserves is dependent on detailed subsurface cave exploration. Mapping of the underground water flow is also necessary for understanding the mechanisms of catastophic flooding due to overflow from underground rivers (such as the flood of July 1991), and for remedial measures to prevent such hazards.

Increasing demand for electricity and protection against flooding and mud built-up of the existing Hoa Binh dam by means of regularisation of the river discharge, has prompted the vietnamese government to construct an additional hydroelectric power station at Tabu on the Song Da. The Tabu station should be the biggest of Vietnam with electric output of about 4,500 MW. The main dam will be situated at TaBu where the NamPan with its NamLa tributary flows into the Song Da. The water level of the reservoir will be raised by 180 m to 280 m height; consequently part of the karstic Northwest region will be flooded. Whether the karst will yield additional water to the reservoir or rather will divert the water and prevent complete filling of the reservoir, are important questions which should be resolved by cave investigations in the Son La region. Structural characteristics of the limestone bedrock, neotectonics based on rockfall and other deformation of cave deposits or on change of drainage patterns, rates of karstic dissolution, soil erosion and redeposition or transport in the karst zone should be additionally tackled by further, more detailed investigations.

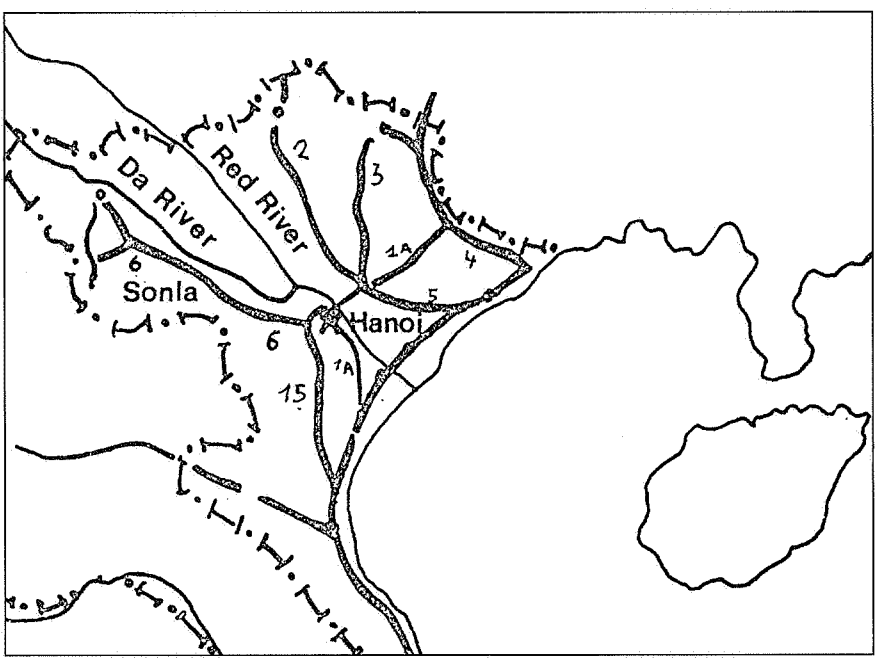


Fig. 7 Position of the studied region, showing main roads with national road numbering

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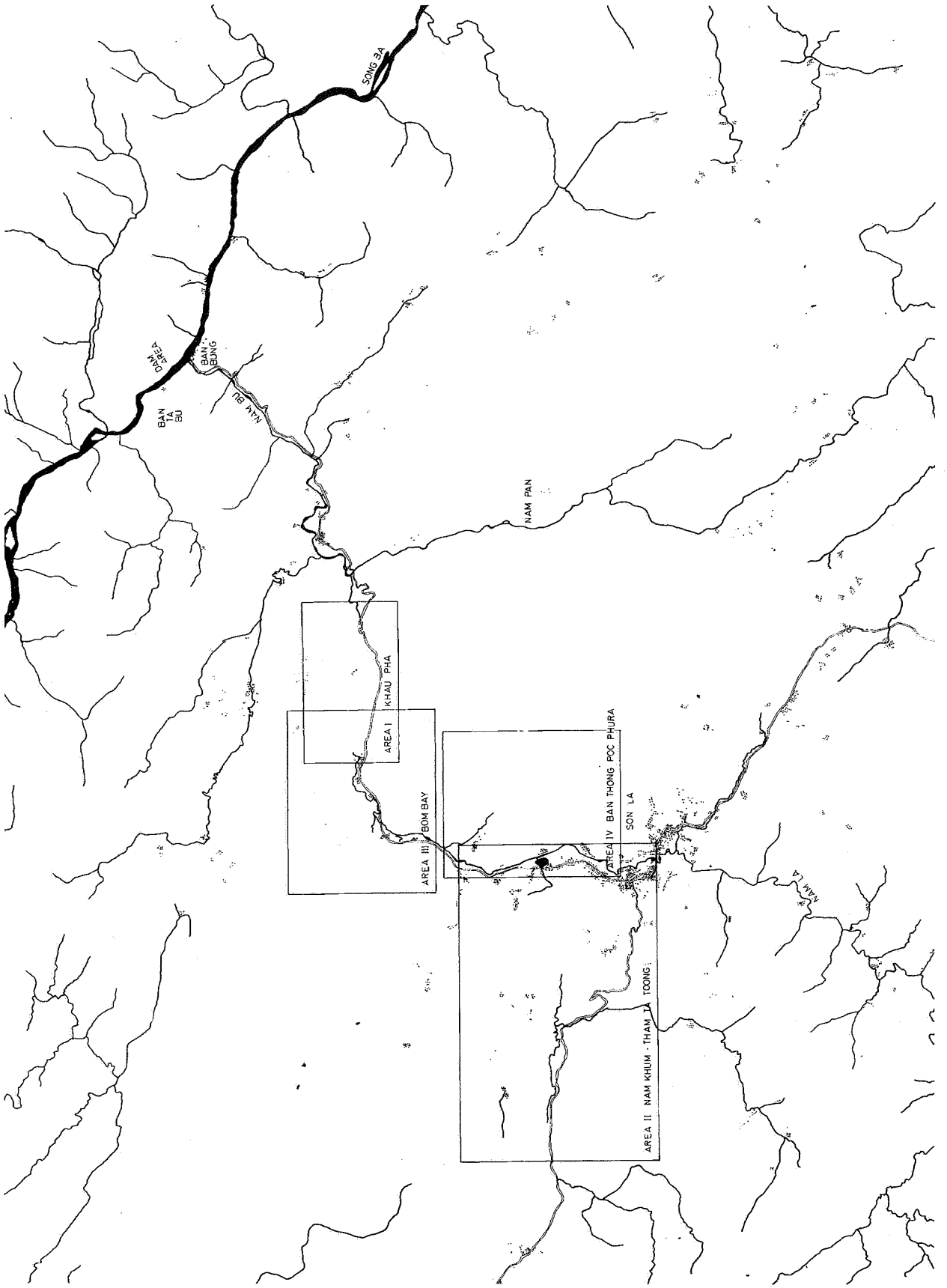
PART III
RESULTS OF THE '93 EXPEDITION

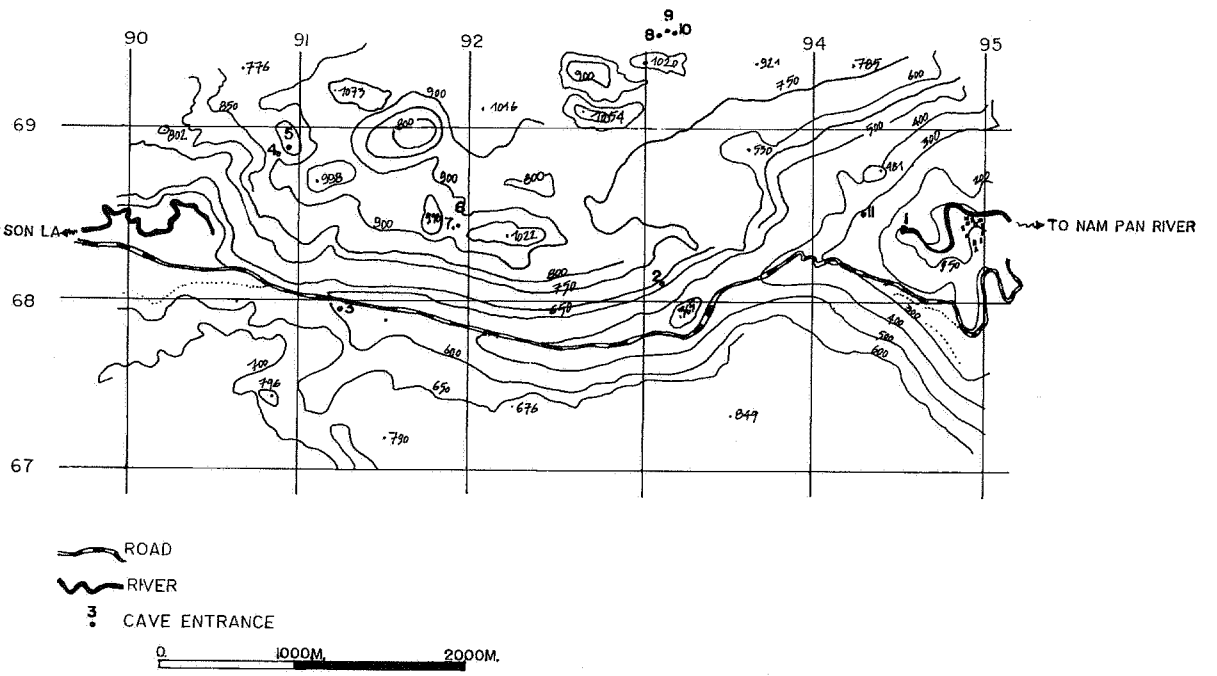
During the expedition in Son La more than 200 karst features were observed, some of them gave way to important cave systems. The efforts have been concentrated to 4 major areas, all having a large potential (in depth, in extension, or both):

- *Khau Pha*
- *Nâm Khum - Tham Ta Tong*
- *Bom Bay*
- *Ban Tông*

It is worth to notice that there are some complications for the exact location of the caves on the maps. Indeed part of the area that we have explored is covered by a topographic map on a scale 1/25.000 (Sheet F-48-88-D-d), for the other part only a map on a scale 1/50.000 (Sheet 5751 I) is available for the moment. This complicates the location since the two maps use a different projection (UTM and GAUSS), which means that for the part of the area that is covered by the two maps different coordinates are possible for the same cave. So we always mention which map we used for the location.

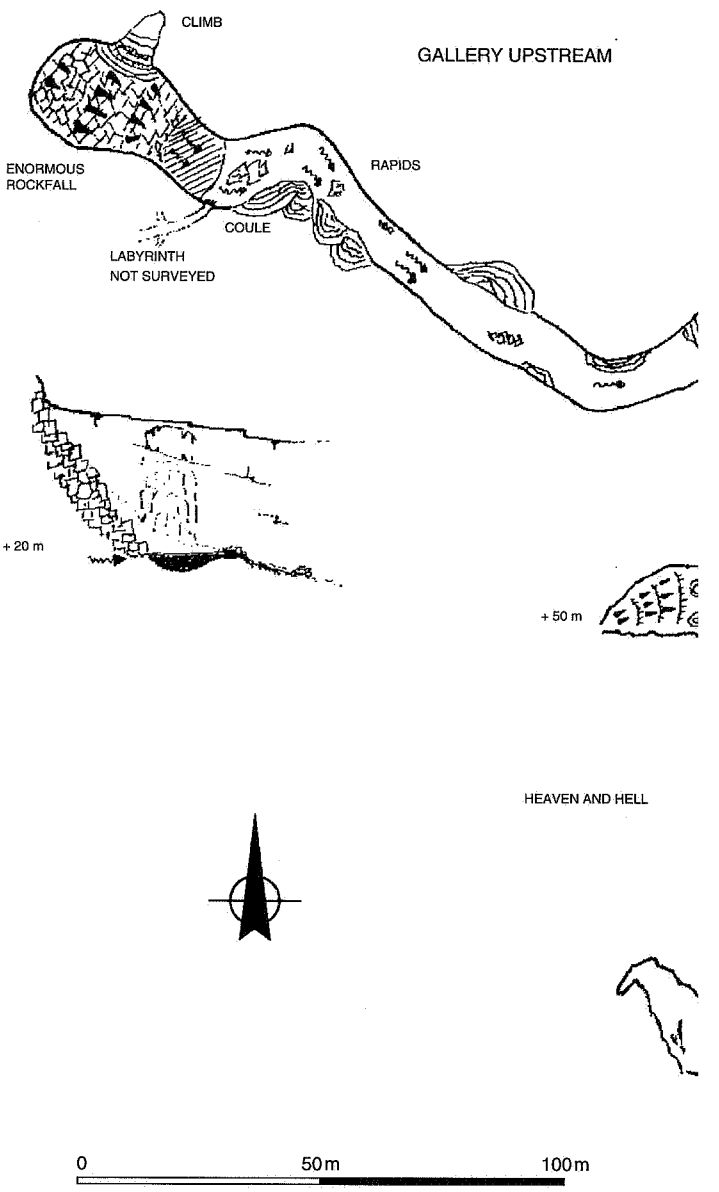

SONG 3A
DAM AREA
BAN TA BU
BAN BUNG
NAM BU
NAM PAN
AREA I KHAU PHA
AREA III BOM BAY
AREA IV BAN THONG POC PHURA
SON LA
NAM LA
AREA II NAM KHUM - THAM LA TOONG

AREA I: KHAU PHA



	CAVE NAME	VILLAGE/LOCATION	COORDINATES ALTITUDE MAPSHEET	TYPE OF CAVE/ENTRANCE	DEVELOPMENT	DEPTH	INTEREST
K_1	**Hang Doi 1** (Bat Cave)	Ban Nâm Liêp	94,49 x 68,41 180 m (F-48-88-D-d)	*Very important emergence*	1434,5 m	+ 47 m	*Probably resurgence of the complete Nam La cave system*
K_2	**Hang Doi 2**	Khau Pha Dry Valley	93,11 x 68,1 645 m (F-48-88-D-d)	*Large horizontal cave entrance: Big 'abri-sous-roche'*	318,4 m	- 14,48 m	*Guano / Completely fossil*
K_3	**Hiéu Luông** (Where the buffalo's died)	Khau Pha Pass	91,26 x 67,92 515 m (F-48-88-D-d)	*Shaft not far from the road in the dry valley*	241 m	- 49 m	*Beautiful shaft choked at the bottom*
K_4	(No Name)	Khau Pha High Land	90,90 x 68,84 820 m (F-48-88-D-d)	*Shaft at the side of a big doline*	41,15 m	- 37,67 m	*Becomes too tight if hammering possible to continue*
K_5	(No Name)	Khau Pha High Land	90,91 x 68,87 800 m (F-48-88-D-d)	*At the bottom of a big doline between blocks*		- 10 m	*Choked*
K_6	(No Name)	Khau Pha High Land	91,87 x 68,43 880 m (F-48-88-D-d)	*Shaft*	72 m	- 60 m	*Very beautiful shaft / Mud floor / Choked*
K_7	(No Name)	Khau Pha High Land	91,87 x 68,43 880 m (F-48-88-D-d)	*Shaft at 15 m from K6 Between boulders*	60 m	- 45 m	*Choked*
K_8	**Yêu Tinh** (Phantom or Ghost Cave)	Khau Pha High Land	93,35 x 67,90 870 m (5751 I)	*Shaft*	124,71 m	- 102,54 m	*Deepest shaft found Near Khau Pha / Choked*
K_9	(No Name)	Khau Pha High Land	93,40 x 67,90 865 m (5751 I)	*Small shaft between boulders*		- 8 m	*Same depression as Yêu Tinh / Choked*
K_{10}	(No Name)	Khau Pha High Land	93,45 x 67,86 850 m (5751 I)	*Shaft between boulders*		- 30 m	*Same depression as Yêu Tinh / Choked*
K_{11}	**Wim's Cave**	Ban Nâm Liêp	94,31 x 68,50 300 m (F-48-88-D-d)	*Beautiful shaft / Enormous draught*	120 m	- 84 m	*Connects to the other side of the mountain / Huge chamber*

On the course through the valley of Son La the water of the Nam La river disappears in many different sinkholes, as well on the left as on the right bank. Most of them are situated beyond Ban Tong. The most important one seems to be the one near Ban Sang at the far end of the valley, where the water meets the karstic mountains near Khau Pha pass at an altitude of 600 m. The water of all these sinkholes is supposed to reappear at the emergence of Hang Doi, near the village of Ban Nam Liep, at an altitude of 180m. There is a denivellation of 420 meters and a distance of 4500 meters between sinkhole and emergence. However, the sinkhole near Khau Pha pass is choked by trunks, stones and mud transported by the annual floods. In fact the water disappears between boulders a few meters before the doline which is supposed to be the true sinkhole. The authorities of Son La confirmed that this sinkhole had been open until the late sixties and described it as deep shaft. During our stay local people tried to free this passage, but without success. The other sinkholes of the Nam La river (ban Ai, ban Muong, ...) were also choked. So the only possible way into the Khau Pha system seemed to be the emergence at Ban Nam Liep. There are two possible ways in: one at the water level, where we found a way between blocks, and one 50 meters higher via a fossil passage. We used this passage which led after a few hundred meters to the impressive underground river course (7 to 8 m3/sec in dry season). We could explore this river course for about one kilometer, as well as some higher fossil and hot (up to 30) passages. Unfortunately the exploration was stopped by a huge collapse. For this reason we tried to look for another access on the plateau above. On this fantastic plateau, covered by a very dense jungle we found indeed different shafts. But all these shafts (some entrances where some 900 meters above the level of the emergence) where choked, although some of them had very large dimensions (20 to 30m width, and even a chamber of 150 x 50m). The deepest reached more than 100 meters of depth. No access to the underground river could be found. However the underground river system of Khau Pha is probably composed by different stages, formed at different ages of karst development, connections between the different stages being choked. There are several higher fossil stages, where as the low stages are still active but very complex. In the fossil stages the carbonate rock is very erroded and corroded, in some places deposits of flowstone could be observed, and some floors are covered



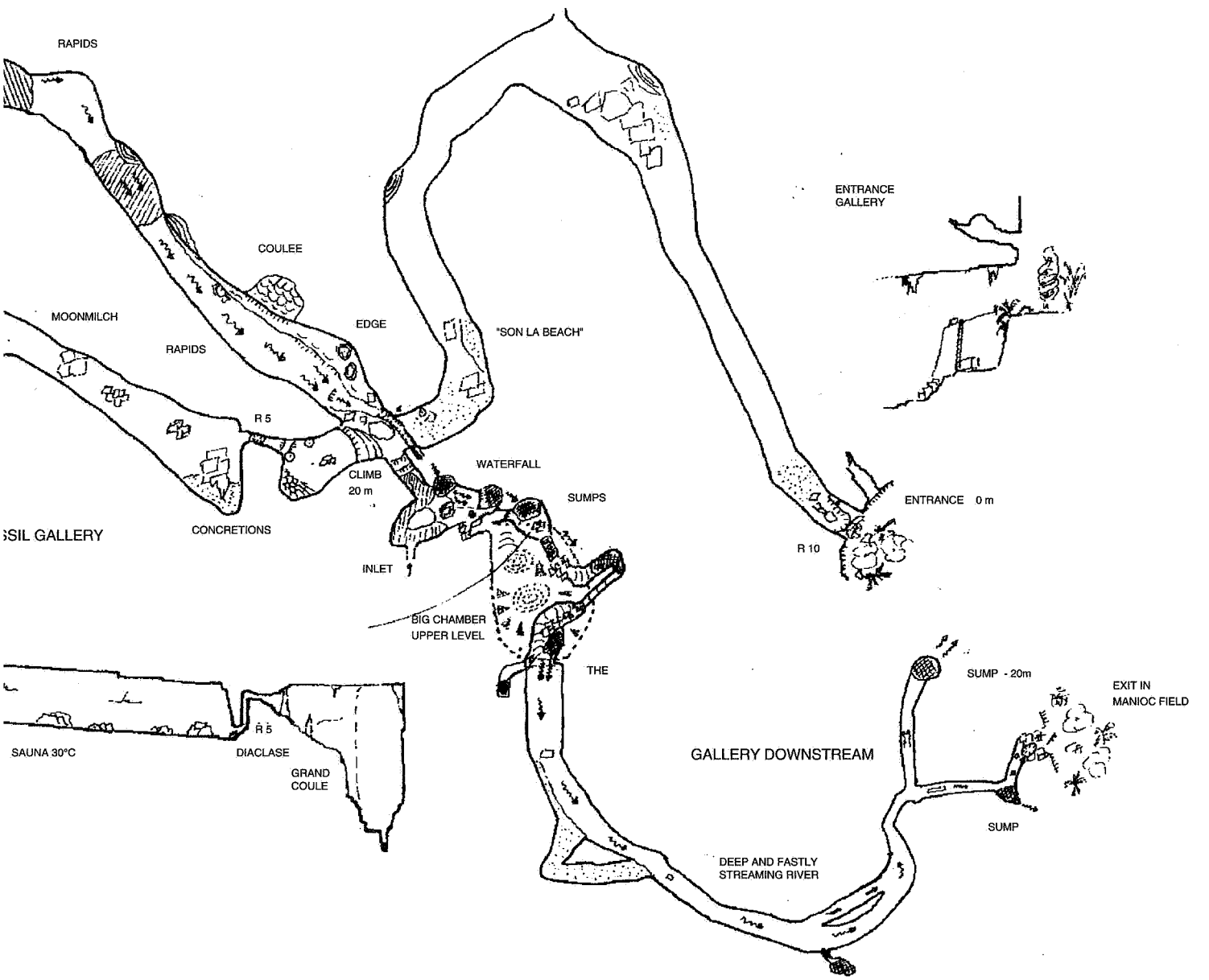
with sand and mud as sediments. Near the entrance at Nâm Liep there is some bat guano. This area deserves a new visit. There may exist other shafts, and one could try again to look for a passage to bypass the big collapse in Hang Doi. Perhaps it could be considered to do more work at the sinkhole side since it seems that a viable entrance existed there before, and since the easiest way for exploration is probably as near as possible to the water passage.

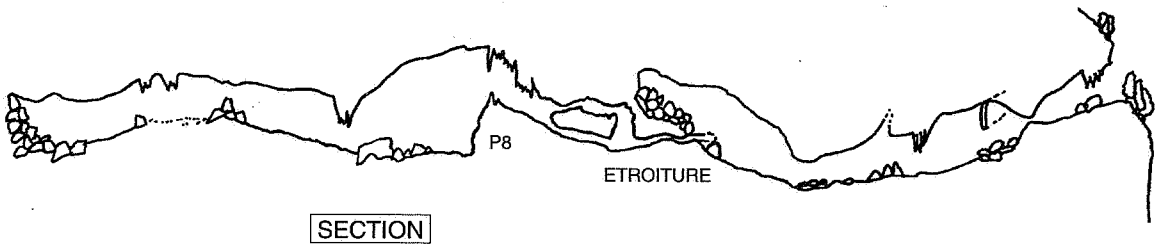
EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993

K1
BAN NAM LIEP
– HANG DOI 1 –

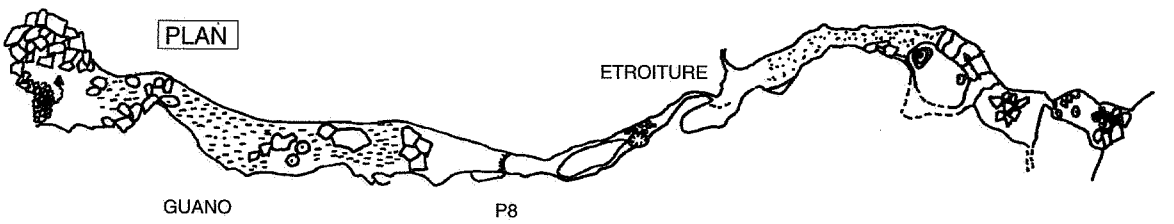
ALT: 180 m
X: 94.49
Y: 68.41
(1/25.000: Sheet F-48-88-D-d)

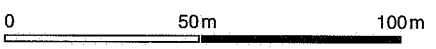
DEN: + 47 m
DEV: 1435 m





SECTION





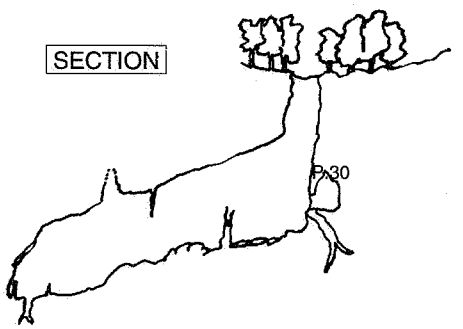
EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993

K2
KHAU PHA DRY VALLEY
– HANG DOI 2 –

ALT: 645 m
X: 93.11
Y: 68.10
(1/25.000: Sheet F-48-88-D-d)

DEN: - 14.48 m
DEV: 318 m

SECTION



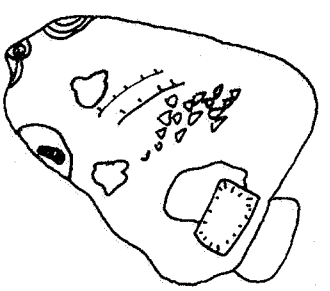
-49 m

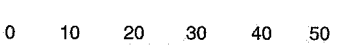
EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993

K3
KHAU PHA HIGHLAND
– HIÉU LUONG –

ALT: 515 m
X: 91.26
Y: 67.92
(1/25.000: Sheet F-48-88-D-d)

DEN: - 49 m
DEV: 241 m





HANG DOI I (fig. K_1)

Alt: 180 m
X: 94.49
Y: 68.41 *(1/25.000 : Sheet F-48-88-D-d)*
DEN: + 47 m
DEV: 1435 m

After a rather difficult climb 50 m above the resurgence of the Nam La river one can find a huge entrance to the fossil gallery. To facilitate the entrance to the cave we installed a 10 m ladder. One can find his way through big boulders in the large gallery (30 m wide, 40 m high). After 200 m the gallery turns to the left. In the curb we discovered a pool with a muddy beach, we named it 'Son La Beach'. After another curb to the right we reached the spectacular underground river (7 to 8 m^3/s).

We crossed the river and found, after a 20 m climb over a rockfall, the continuation of the fossil gallery. In this gallery we climbed toward a diaclase that brought us into a big chamber. Because of the elevated temperature (30°C.) and the high humidity, we called this part 'Sauna'. After about 100 m we were stopped by a muddy and slippery wall. It took quite some time to climb this wall, but it only offered us a short continuation: after a sharp turn downwards we could not find any more passage. Here the temperature was so high that we could hardly breath. In the chamber we saw lots of concretions, a few of them had a diameter of several meters.

So we decided to return to the underground river again and tried the exploration upstream. After about 100 m of progression at the right side of the river at a small edge, just above the waterlevel, we passed a beautiful coulee with some marvellous rimstonepools on top of it. Further on the river becomes wider and looks here like a large basin, to continue our exploration, we had to get into the water, we installed here a 25 m tyrolienne[1] to protect ourselves from the wild water. After the basin the river turns toward the left. We followed the river, mostly by wading through the fastly streaming water. We reached an enormous rockfall that blocked the way on. This rockfall is very unstable. We tried to climb over the rockfall on the right side by using our climbing pole, but we did not succeed. On the left side of the rockfall lies a labyrinthic cavesystem A lot of the galleries in this part of the cave are filled with water and were not explored.

Back at the crossing of the active and fossil part of the cave, we started the exploration of the downstream part of the river. Here we had to conquer a sequence of waterfalls and rapids. A few short sumps were bypassed. After all these obstacles we could explore a broader part of the river with strong rapids. During the exploration of the upper level we ended up in a terrific large chamber, covered with concretions, coulees and white twinkling crystalline. Once more we had to deal with a very high temperature. In this chamber we caught a rare centipede. Further downstream the river divides in a delta-like system. In most of the streamways we were blocked by sumps, but finally we found one exit, all of a sudden we did find ourselves in the middle of a maniocfield. About 20 m to the left and 10 m lower we see the river emerging. (Here a sump blocks the entrance to the cave-system) At the surface the river flows smootly (about 10 m wide) to the Nam Pan river.

1. Tyrolienne: Rope fixed on both sides of the river to make sure that the cave-explorers are not swept away by the flood while traversing the streamway.

HANG DOI II (fig. K_2)

Alt: 645 m
X: 93.11
Y: 68.10 *(1/25.000 : Sheet F-48-88-D-d)*
DEN: - 14.48 m
DEV: 318m

In an attempt to find new entrances to the main underground waterpassage we explored a cave overlooking the dry valley on the east side of the Khau Pha pass, and right above the enormous doline near the main road. The local people who guided us, called this cave Hang Doi (Bat Cave).

The cave presents itself as an "abri-sous-roche" at an altitude of 645m We entered a chamber (35 to 20 by 30m), a gallery leading off at the bottom of it. This gallery ends some 30m further on, on top of a ascending. At the start of the slope one could feel a rather strong draft coming out of a small passage between blocks. After a small crawl, the ceiling goes up to about 8m A small pitch (8m) leads to a rather large chamber, leading to a further series of chambers The floor is covered by guano, sometimes hip deep. The last chamber is blocked by numereous beautiful concretions. No side passages could be found, the draft was gone, it was probably due to the difference in temperature between the air contained in the chambers (more then 20 °C) and the air outside (some 5 °C).

HIÉU LUONG (fig. K_3)

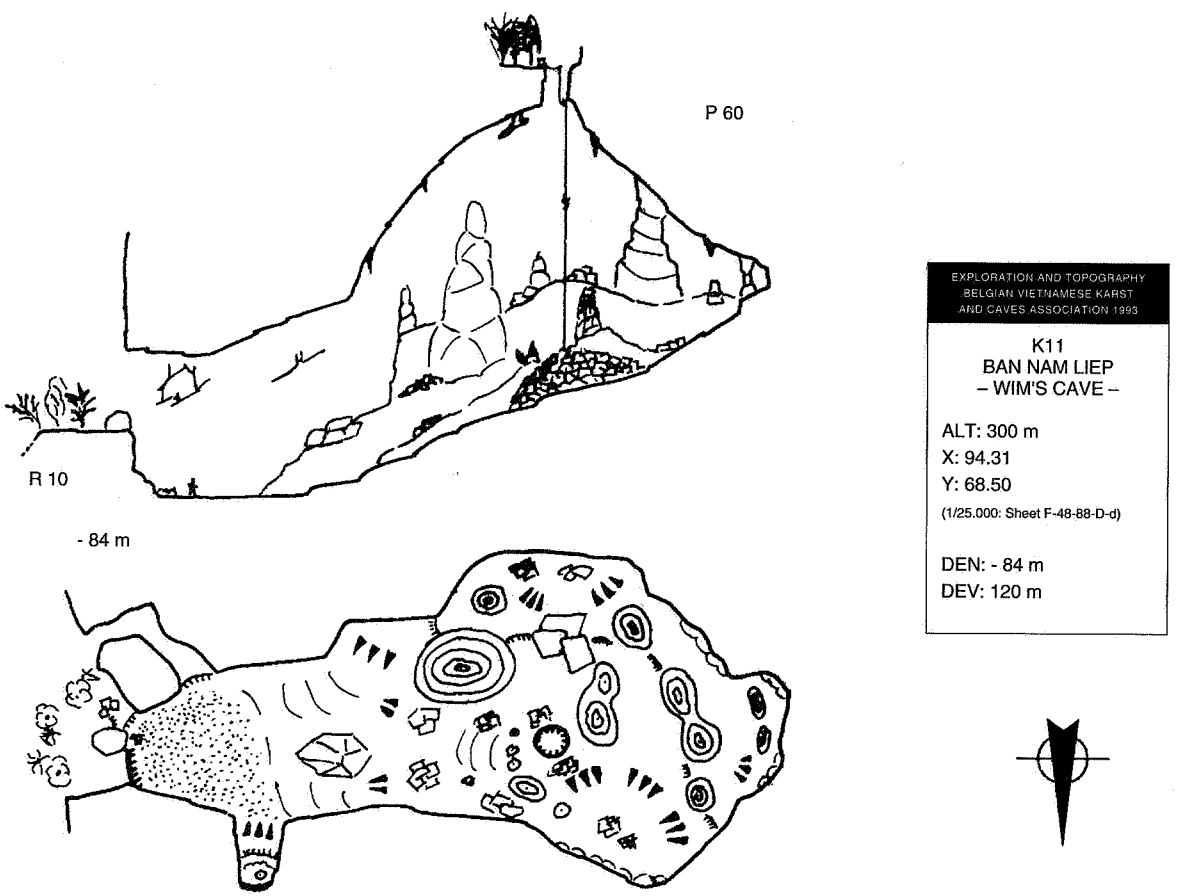
Alt: 645 m
X: 93.11
Y: 68.10 *(1/25.000 : Sheet F-48-88-D-d)*
DEN: - 49 m
DEV: 318m

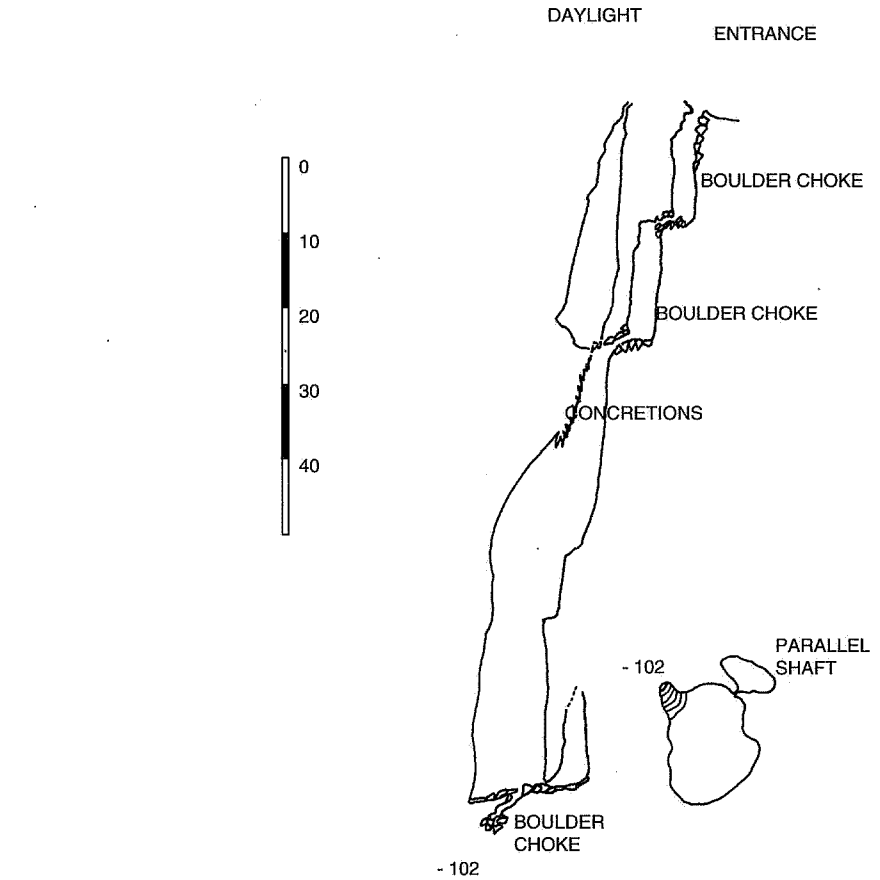
Near the ponor of the Nam La River at the Khau Pha Pass in the dry river, at the right side of the road, coming from Son La, we found a beautiful shaft. After a pitch of 30 m (freehang) we arrived in a big chamber, at least 50 m large. The slope ends 70 m further in a little pitch that is choked at the bottom by boulders.

WIM'S CAVE (fig. K_{11})

Alt: 300m
X: 94.31
Y: 68.50 *(1/25.000 : Sheet F-48-88-D-d)*
DEN: - 84 m
DEV: 120 m

Hundred meters on the left, descending from the road in Khau Pha dry valley, on a crest covered by jungle, Wim's cave is a large, deep and windy shaft, found just before Wim's precipitate departure to Belgium. The cave being near the Hang Doi axis, we hoped to bypass the boulder choke at the end of Hang Doi 1. Descending a 60 m pitch, we entered into a big chamber (125 m x 60 m). In the front, a large window ligthens this huge hall. It is an other entrance of easy access (when you know where it is !), not far from Hang Doi 1 (about 100 m on the left). We got foothold on fallen rocks surrounded by many giant stalagmites. At the bottom, the sandy floor is covered by numerous snail shells. We searched for a continuation without succes. This cave is most probably part of the fossil level of Hang Doi.



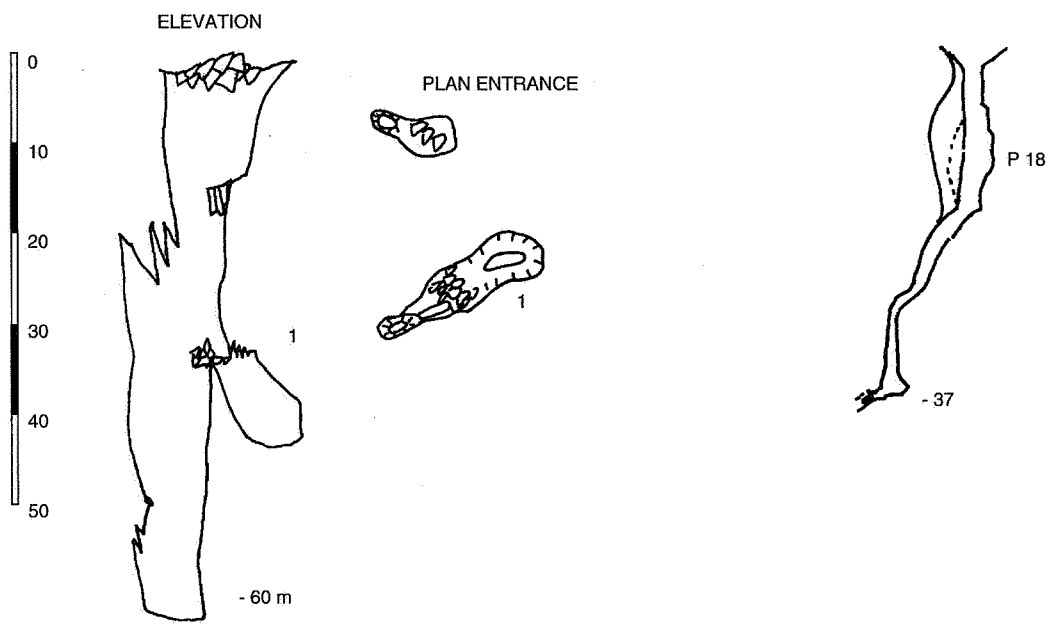


EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993

K8
KHAU PHA HIGHLAND
PHANTOM CAVE

ALT: 870 m
X: 63.50
Y: 52.00
(1/25.000: Sheet F-48-88-D-d)

DEN: - 102,54 m
DEV: 124,71 m



EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993

K6
KHAU PHA HIGHLAND

ALT: 880 m
X: 91.87
Y: 68.43
(1/25.000: Sheet F-48-88-D-d)

DEN: - 60 m
DEV: 72 m

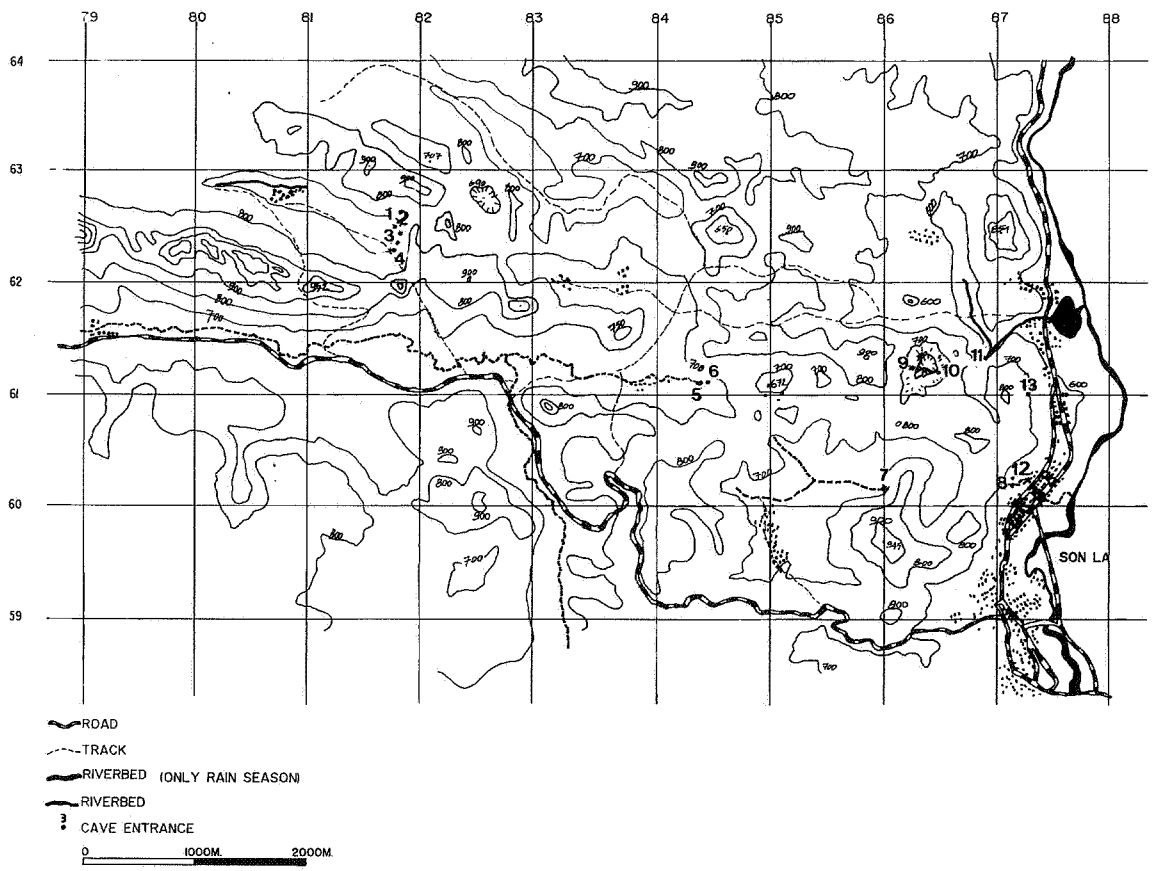
EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993

K4
KHAU PHA HIGHLAND

ALT: 835 m
X: 90.90
Y: 68.84
(1/25.000: Sheet F-48-88-D-d)

DEN: - 37,67 m
DEV: 41,15 m

AREA II: NAM KHUM-THAM TA TONG



	CAVE NAME	VILLAGE/LOCATION	COORDINATES ALTITUDE MAPSHEET	TYPE OF CAVE/ENTRANCE	DEVELOPMENT	DEPTH	INTEREST
N_1	(No Name)	Ban Tham	81,75 x 62,45 690 m (5751 I)	*Sinkhole (in rain season)* *Small entrance between boulders / Choked*	-	-	*Probably connected to Hang Ran*
N_2	(No Name)	Ban Tham	81,80 x 62,40 730 m (5751 I)	*Entrance 5x5m / 30m above valley bottom on a steep slope*	-	-	*Chamber 20x10x10. At the N-side of the chamber a not descended pitch probably connects to Hang Ran*
N_3	**Hang Ran** (Snake Cave)	Ban Tham	81,80 x 62,35 730 m (5751 I)	*Small shaft gives acces to temporary underground river*	1717,7 m	- 86,75 m	*Important and large gallery: temporary underground river, many galleries remain unexplored and could give acces to the underground river of Nâm Khum*
N_4	(No Name)	Ban Tham	81,75 x 62,30 700 m (5751 I)	*Sink*	-	-	*Choked / very near to the upstream end of Hang Ran*
N_5	**Nam Khum** (Whirling water passage)	Ban Hin	84,37 x 61,09 650 m (5751 I)	*Important underground river / Pothole between boulders*	1323 m	- 27,8 m	*Part of the underground river which emerges at Tham Ta Toong*
N_6	(No Name)	Ban Hin	84,43 x 61,09 660 m (5751 I)	*Very tight diaclase*	-	-	*Upper entrance to Nâm Khum*
N_7	**Nam Kha Khu**	Ban Hin	86,05 x 60,14 660 m (5751 I)	*Sink (rain season only)* *Penetrable over a short distance*	50 m (estimated)	-	*Probably connected to Thi Dôi*
N_8	**Thi Dôi** (First Cave)	Son La (Ban Lâu)	87,17 x 60,21 620 m (5751 I)	*Temporary emergence*	1551,3 m	+ 21,2 m	*Connection possible with Nâm Kha Khu*
N_9	**Nam Long**	Son La (Ban Ca)	^{N9} 86,33 x 61,11 602 m	*Huge doline*	^{N9} 544 m	-	*Acces to important underground river/*
N_{10}			^{N10} 86,33 x 61,11 602 m (5751 I)		^{N10} 356 m	-	*Downstream to Thâm Ta Toong / Upstream to Nâm Khum (?)*
N_{11}	**Tham Ta Tong** (Bronze Disc Cave)	Son La (Ban Ca)	86,93 x 61,32 600 m (5751 I)	*Karstic spring (emergence) + Fossil Gallery*	381 m	- 18,33 m	*Drinkwater supply for Son La*
N_{12}	**Bomber Cave**	Son La (Ban Lau)	87,17 x 60,25 630 m (5751 I)	*Horizontal cave / Large porche*	276 m	- 0,13 m	*Used as a shelter during the wars*
N_{13}	Gia	Son La (H. Muong)	87,28 x 61,00 660 m (5751 I)	*Abri-sous-roche*	20 m (estimated)	-	*Used as sanctuary / Was visited by the emperor Lê Thanh Tông in the 15th century*

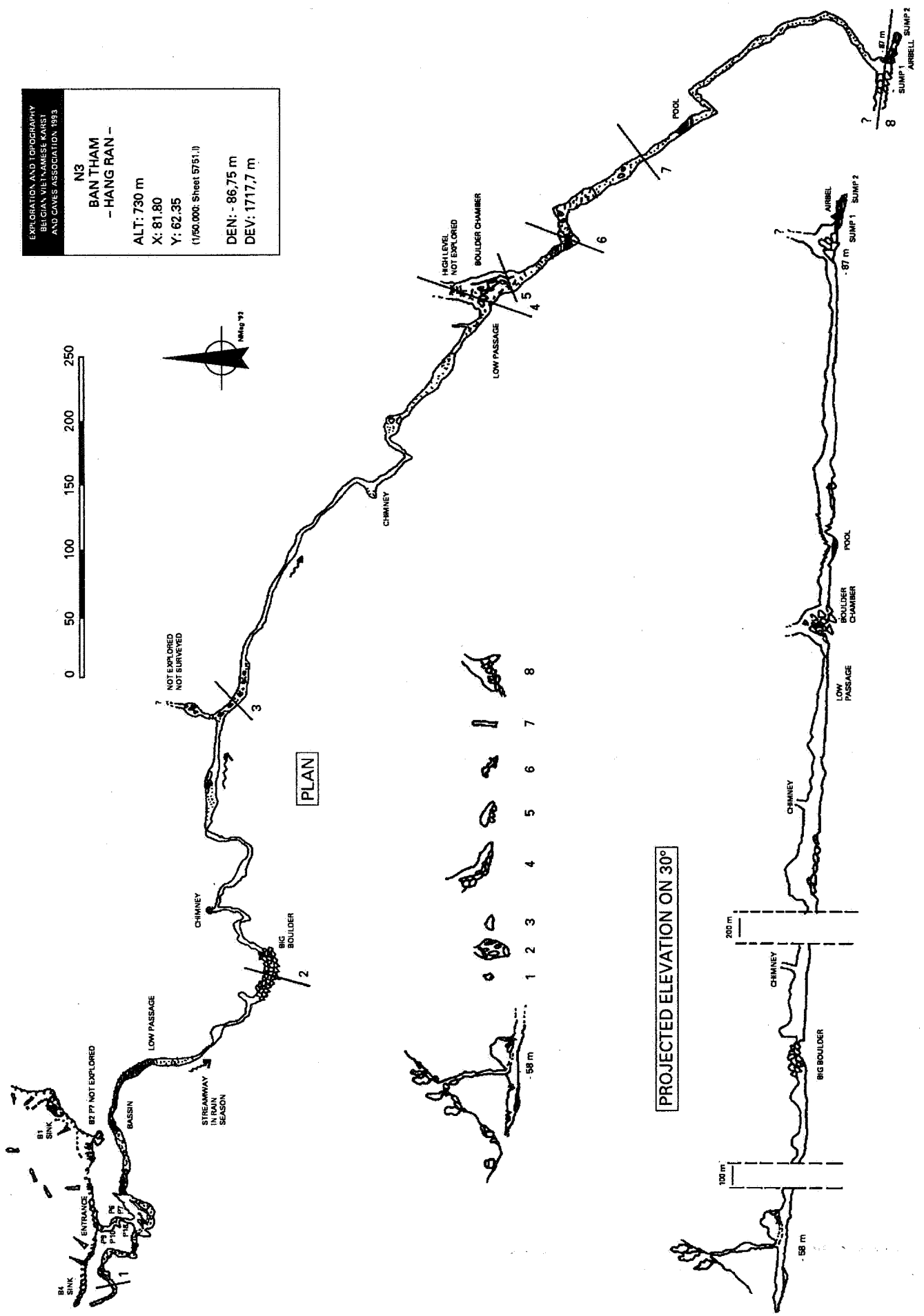
Leaving Son La town on the road to Khau Pha, one meets an important side branch on the left bank of the Nam La river. This inlet is coming from an important underground river system emerging at Tham Ta Tong, the "Bronze Disc Cave". A little dam has been built at the emergence in order to make a reservoir of drinking water for Son La. Children use it also as a swimming pool and grown-ups even as a bath. The temperature of the water (C°) remains almost constant throughout the year, as well as the flow. This is probably an indication for the length of the underground river course and the far or deep origin of the water. Local people suppose that the water is coming from tens of kilometers to the east. And indeed we found windows to the "Jan River" (underground river first found by Jan Masschelein): Nam Long, Nam Khum, and most probably also Hang Ran. Moreover, only a very important basin could explain the constant flow which persists even in the dry season. This area has offered very exciting, sporting and beautiful caving along important underground rivers. The initial exploration, is indicative for a voluminous, extensive and very complex aquatic cave system. We certainly intend to continue the exploration of this area, eventually by diving (diving the sumps we have encountered could be very paying indeed).

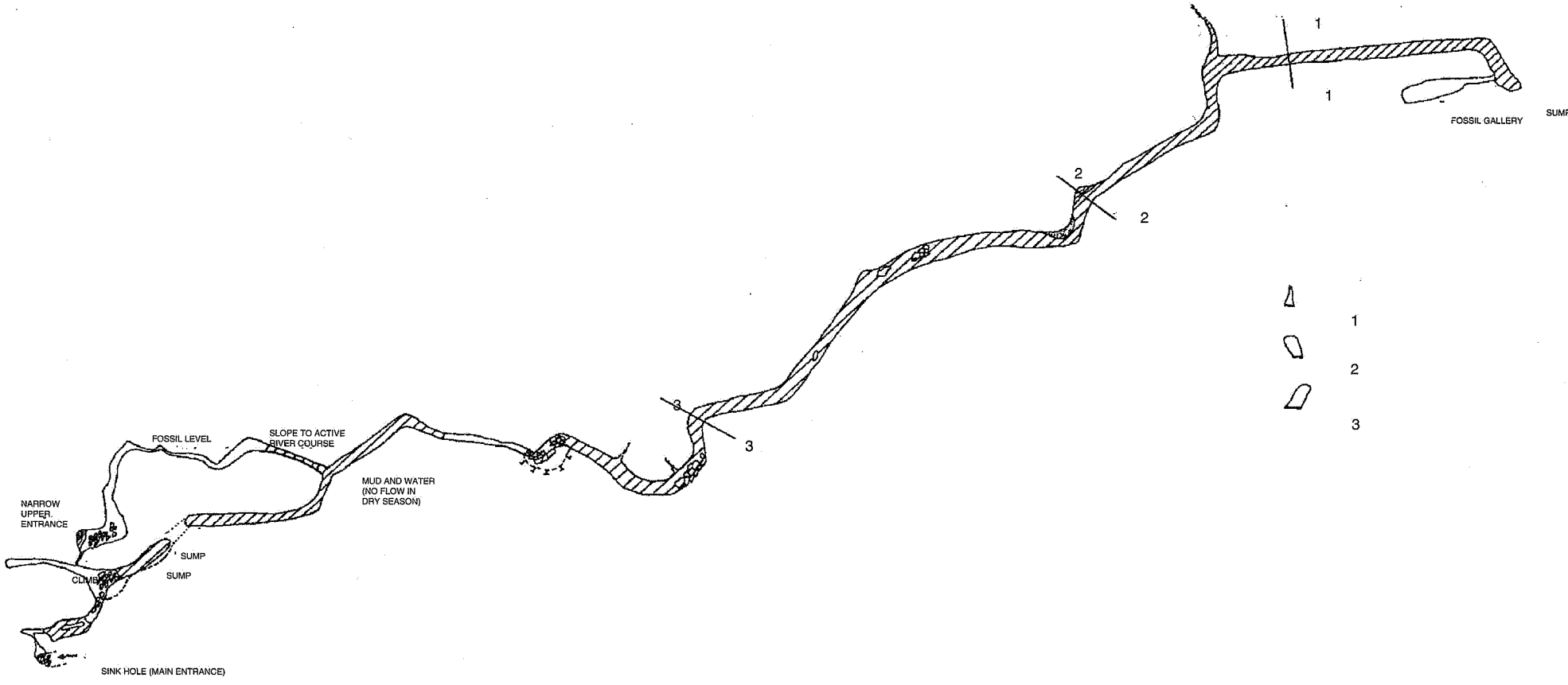
HANG RAN (Snake Cave) (fig. N_3)

Alt: 730 m
X: 81.80
Y: 62.35 (1/50.000 : sheet 5751.I)
DEN: - 86,75 m
DEV: 1717,7 m

This cave is situated in the small depression of Ban Tham, a few km. to the West of Son La, and not so far from the road to Dien Bien Phu (45 min. walk). People from the Ban Tham village showed us this cave at the east side of the depression, some 40m above the bottom. A very strong draught came out of a small entrance, overgrown with thornbush. We spent a few minutes to clear and enlarge it. After a free descent of 9m in a diaclase, the cave widens a bit. A series of small pitches (6m, 11m, 14m, 19m) leads first to a chamber (6x8m), and after a small passage to another chamber (10x12m) with access to a gallery. This gallery proved to be the bed of a temporary underground river (only in rainy season). The riverbed could be followed upstream for some 130m. There are some smaller basins and some beautiful concretions. The gallery ends at water passage, too narrow to pass although a strong draught could be felt. This point must be very near to the surface; the underground river is most probably a drain of the water collected in the depression during the rainy season. Downstream a superb gallery can be followed for more then 1.5 km to a sump. The dimensions of this gallery are rather important (sometimes 8m wide to 25 m high), although there are several smaller passages, and an important rockfall where one has to search the way through enormous blocks. The bottom of the gallery consists of cobble stones, alternated with some muddy passages. The gallery is interrupted by several basins and some are rather deep. All this gives evidence of the underground river that must run here in the rainy season.

At 500m from the bottom of the pitches another gallery enters from the north. We followed it for some 150m, without reaching the end. The gallery continued, but we prefered to follow the main gallery. At about 1 km from the bottom of the pitches one enters in what first only seems to be an enlargement of the main gallery, but proves to be a very high chamber. Also here, we stopped the climbing of the very steep slope on the north side of the chamber without reaching the end. In fact we could see a very big black hole right above and in front of us, but it needed a difficult climb which was left for the next time. The gallery abruptly terminates in


EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993
N3
BAN THAM
– HANG RAN –
ALT: 730 m
X: 81.80
Y: 62.35
(1/50.000: Sheet 5751.I)
DEN: - 86,75 m
DEV: 1717,7 m
0 50 100 150 200 250
NMag 93
PLAN
PROJECTED ELEVATION ON 30°
ENTRANCE
B1 SINK
B2 P7 NOT EXPLORED
B4 SINK
P1
P2
P3
P4
P5
P6
P7
BASSIN
LOW PASSAGE
STREAMWAY IN RAIN SEASON
CHIMNEY
BIG BOULDER
NOT EXPLORED NOT SURVEYED
CHIMNEY
HIGH LEVEL NOT EXPLORED
BOULDER CHAMBER
LOW PASSAGE
POOL
AIRBELL
SUMP 1
SUMP 2
- 87 m
- 58 m
200 m
100 m



0 50 100 150 200 250

EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993

N5
BAN HIN
– NAM KHUM –

ALT: 650 m
X: 84.37
Y: 61.09
(1/50.000: Sheet 5751.I)

DEN: - 27,8 m
DEV: 1323 m

a sump. One of us tried a free dive, but almost drowned when he entered an airbell with bad air. Fortunately his companion could fish him out of the water right in time. At the sump there is also a high gallery coming in from the west, but it was impossible to enter it without undertaking a difficult climb.

This very beautiful and important cave is far from finished. Many leads have to be checked . We estimate that the cave is connected to the Nam Khum system. A dive of the terminal sump could be very paying and maybe could lead to the underground river upstream of the Nam Khum sumps. Anyway take care ! Not only for the bad air, but also for the snakes. In fact, returning from the far end, we had to cross a very poisonous snake at a 30 cm distance in the entrance diaclase. The snake had choosen this place to have a little sleep. Fortunately they are not so active in winter ....

NAM KHUM (whirling water passage)

(fig. N_5)

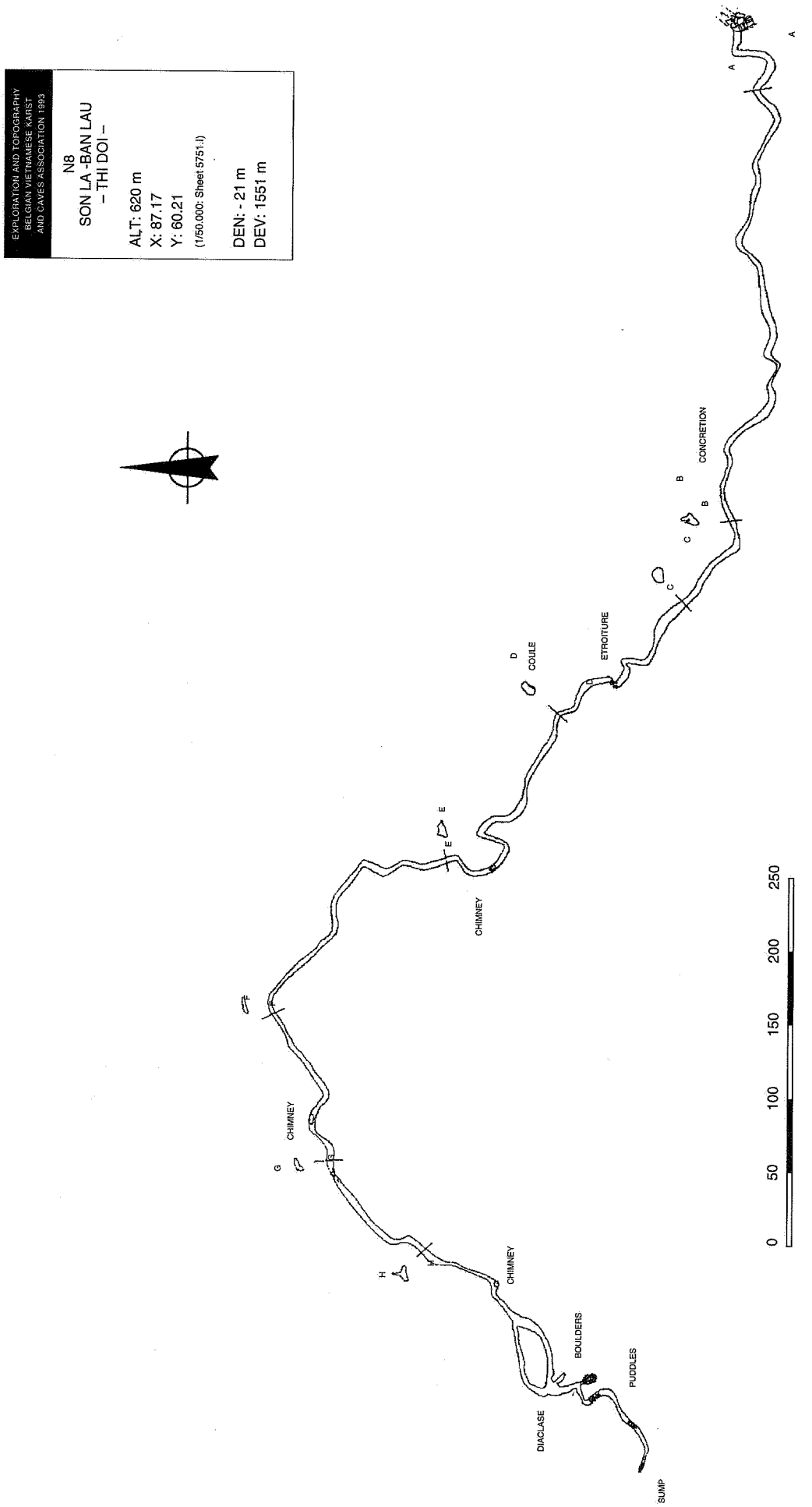
Alt: 650 m
X: 84.37
Y: 61.09 (1/50.000 : sheet 5751.I)
DEN: - 27.8 m
DEV: 1323 m

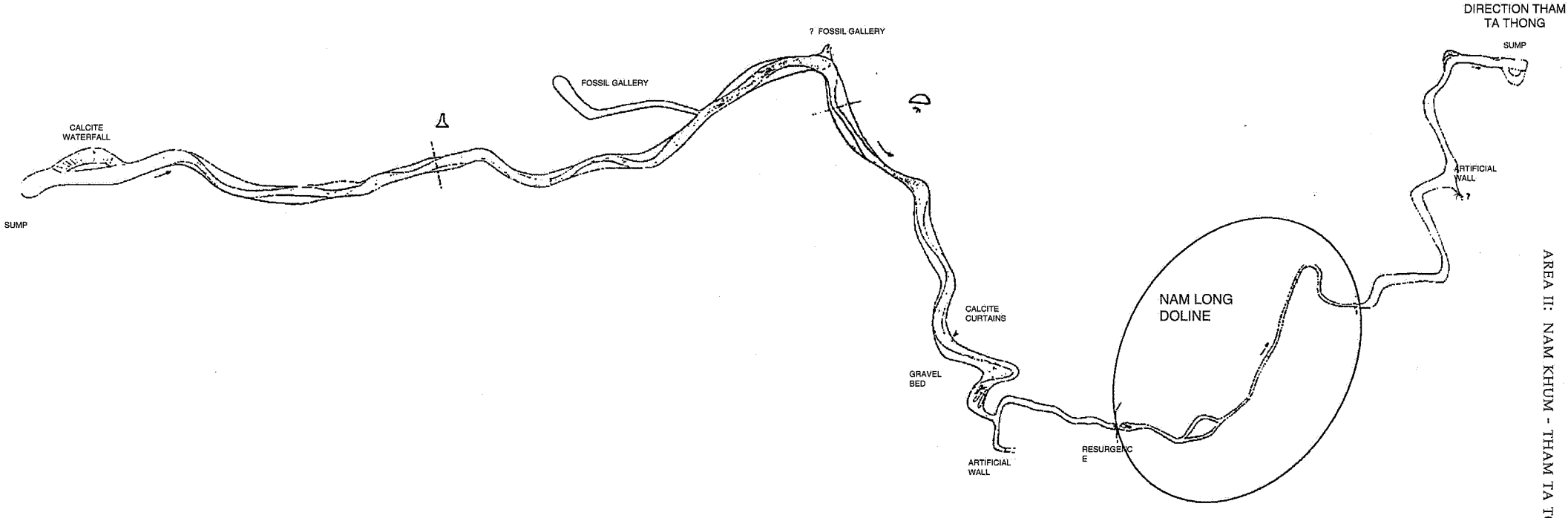
On the topographic map a river flowing from the village of Ban Muôi, Ban Hôt disappears arriving at Ban Hin in a cave called Nâm Khum. At the time of exploration, the river entering at the Nam Khum sinkhole was completely dry, and the entrance was partly blocked by tree trunks. A narrow passage gives way to a short but deep water basin with a low ceiling. After this basin, the active gallery widens, and a second deep and muddy basin is encountered, which ends in a sump at about 80 m from the entrance. This sump was circumvented by taking a fossil upper level, reached after a short climb of about five meters. A verry narrow second cave entrance situated on the hill slope 70 m north of the Nam Khum sinkhole is connected to this upper level. After a short muddy slope (rope of 10 m required !), the river course is met again. 70 m upstream the river ends in a sump, presumably connecting with the sump near the entrance. In the downstream direction, the river bed at first is rather dry and gravelly and the gallery narrows. Shortly after a narrow passage, partly obstructed by enormous blocks and tree trunks, the gallery suddenly descends a few meters (waterfall in wet season), and deep water is met again. Unlike the muddy water basin at the sump, this water is clear, and originates from two affluents at the left. The water, cristal clear, comes out of two nice sumps (very important flow). Further on, the gallery has typical cross-sections of about 8 m wide and 6-10 m high. Deep river sections (to swim), alternate with shallow wild water passages. This gallery is very beautiful (curtains, stalactites, ...), the water is clear and there are only few sediments. 900 m from the entrance, an active affluent is encountered at the left, which remained unexplored. After another 140 m, the high gallery suddenly stops at a large sump. An attempt to find an upper passage by climbing above the sump (an artificial climb in traverse of about 25 m) was not succesfull. The short fossil gallery which joins the rivercourse just before the sump, did not give any continuation either. Since there is no river at the surface for at least 10 km upstream, this cave and of course the upstream sumps certainly merit further exploration.

THI DOI (First cave) (fig. N_8)

Alt: 620m
X: 87.17
Y: 60.21 (1/50.000 : sheet 5751.I)
DEN: - 21 m
DEV: 1551 m

According to the local administration of Son La this cave acts as an emergence during the rain season. At the moment of the exploration the cave was dry. The entrance of the cave was used as a bomb shelter during the war. A few steps lead to a long cylindric gallery, totally submerged in the rain season. The passage is very horizontal, the floor is covered by mud and gravel. The height of the passage varies from 1 to 4 m, but most of the time it demands crab-walking. The gallery continues over several hundreds of meters only interrupted by inaccessible inlets or chimneys. There is a short split, but the two branches join again after a few meters. After a short passage through a diaclase, two very steep, very muddy and wide galleries (almost chambers) enter into the main passage. They were too muddy to try a climb without special equipment and were not explored. A few meters further the terminal sump is reached. At this point we are very near to the sinkhole in the Han Hin valley (Nâm Kha Khu).


EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993
N8
SON LA -BAN LAU
– THI DOI –
ALT: 620 m
X: 87.17
Y: 60.21
(1/50.000: Sheet 5751-I)
DEN: - 21 m
DEV: 1551 m
A
B
C
CONCRETION
ETROITURE
D
COULE
E
CHIMNEY
F
G
CHIMNEY
H
CHIMNEY
BOULDERS
PUDDLES
DIACLASE
SUMP
0
50
100
150
200
250



AREA II: NAM KHUM - THAM TA TONG

EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993

N9-N10
SON LA -BAN CA
– NAM LONG –

ALT: 602 m
X: 86.33
Y: 61.11
(1/50.000: Sheet 5751.I)

DEV: N9 - 544 m
DEV: N10 - 356 m

0 100 200 300

NAM LONG (fig. N_9-N_{10})

Alt: 602 m
X: 86.33
Y: 61.11 (1/50.000 : sheet 5751.I)
DEN: -
DEV: 356 m (downstream from doline)
544 m (upstream)

In the Nam Long doline we found a major part of the missing trajectory of the underground river which is supposed to flow from the Nam Khum system to the Tham Ta Tong emergence. This deep doline is situated south of Ban Bo village and forms a window on the underground river course. Downstream from the doline the river is deep and slow. The ceiling is relatively low (average 5 m), and some of the calcite curtains touch the water. The river level is probably raised artificially by the construction of a small dam at the Tham Ta Tong emergence. A sump is encountered some 350 m from the doline. There were no side-passages, except for a narrow little gallery at the right side, in which also a dam had been constructed, probably to prevent that a part of the water streams to other resurgences.

In the upstream direction the appearance of the river is quite different. The river is shallow, has more denivellation and meanders through gravel deposits. But only the first 100 m of the gallery are rather narrow. At that point a side gallery at the left is blocked with an artificial dam similar to the one in the downstream part. The main gallery widens up and the flat gravel beds allow an easy progression until a sump is reached at some 550 m from the entrance doline. Just before the sump there is a huge fossil, white coloured, calcite cascade. A few fossil side passages were explored, however without much persistency.

THAM TA TONG (Bronze disc cave)

(fig. N_{11})

Alt: 600 m
X: 86.93
Y: 61.32 (1/50.000 : sheet 5751.I)
DEN: - 18,33 m
DEV: 381 m

This is a very important emergence. A little dam has been built here in order to make a reservoir of drinking water for Son La town. As the French in the colonial period, we went upstream in the cave on a bamboo raft, guided by a local official. When we reached the sump at some 100 m from the entrance our guide asserted that, before building the dam, one could go further into the cave. A little free dive (with mask and flippers) through a narrow passage indeed lead to a continuation. Behind the sump it was possible to swim about 150 m in a larger gallery to a second sump, which was deeper and required complete diving equipment. Beautiful disc concretions decorate this river passage. Unfortunately the survey of this part has been lost when returning to base, and therefore this part is missing on the map.

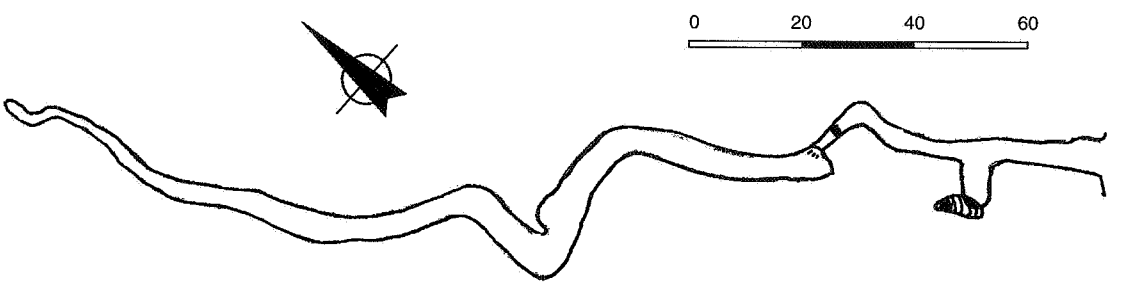
Twenty meters above the emergence, slightly to the right, there is a porch which was used by the local authorities as a shelter during the war. A small passage at the bottom of this porch gives access to a horizontal cave, regulary visited by local people and called: Uy ban cave. This is a fossil level which can be followed over 250 m without any difficulty.

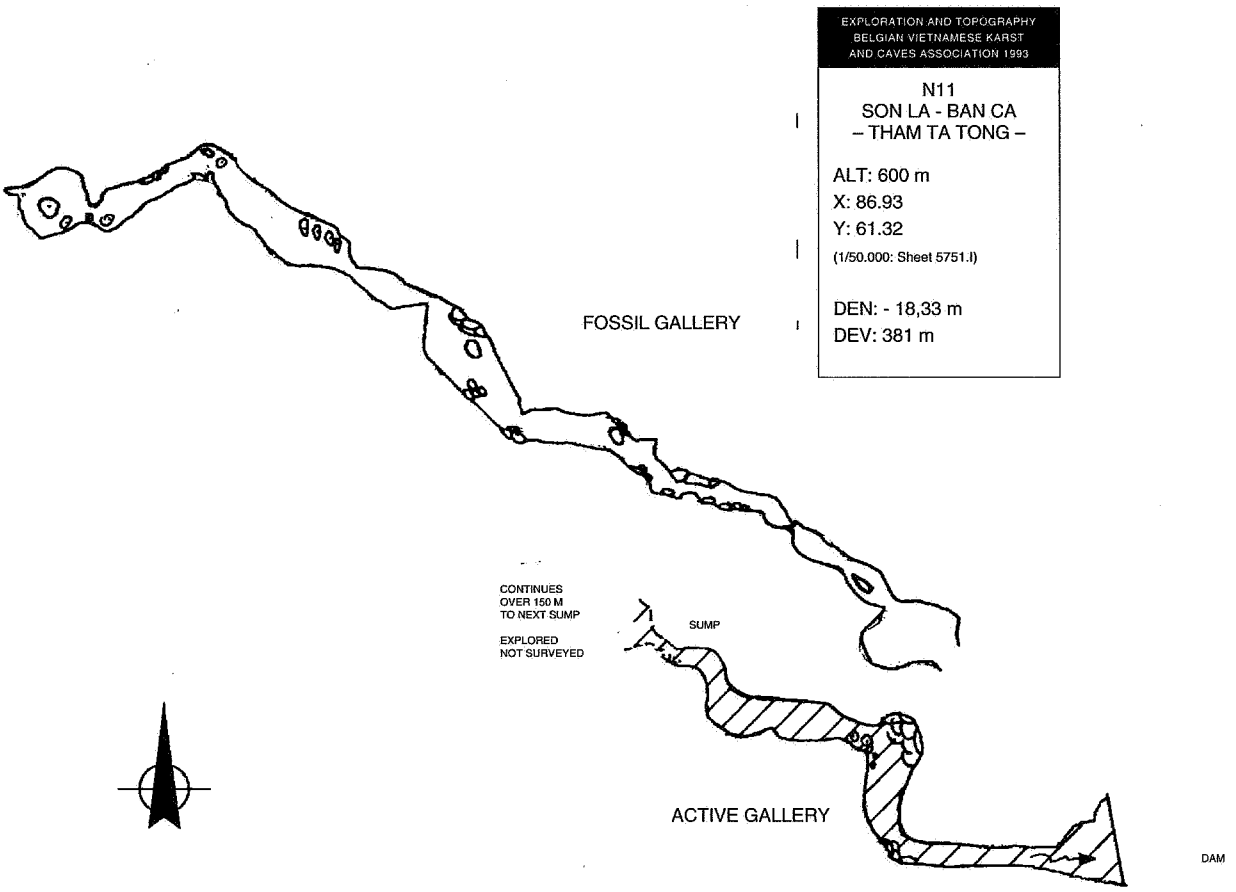
EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993

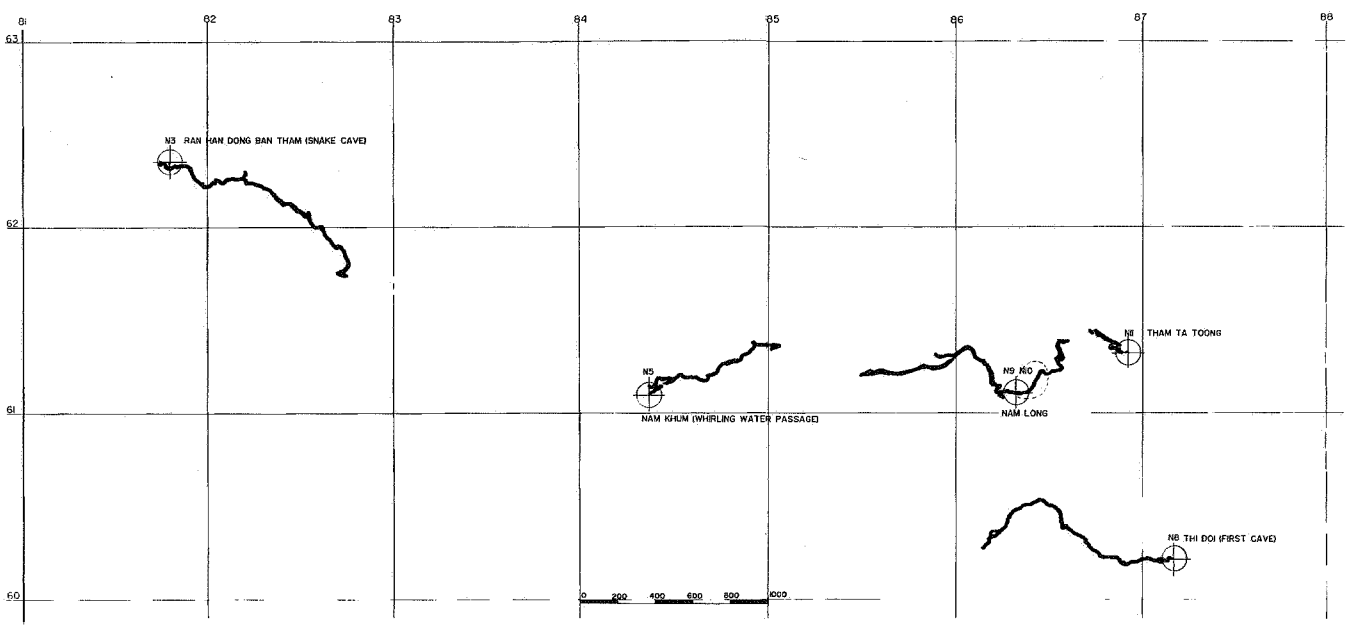
N12
SON LA -BAN LAU
– BOMBER CAVE –

ALT: 630 m
X: 87.17
Y: 60.25
(1/50.000: Sheet 5751.I)

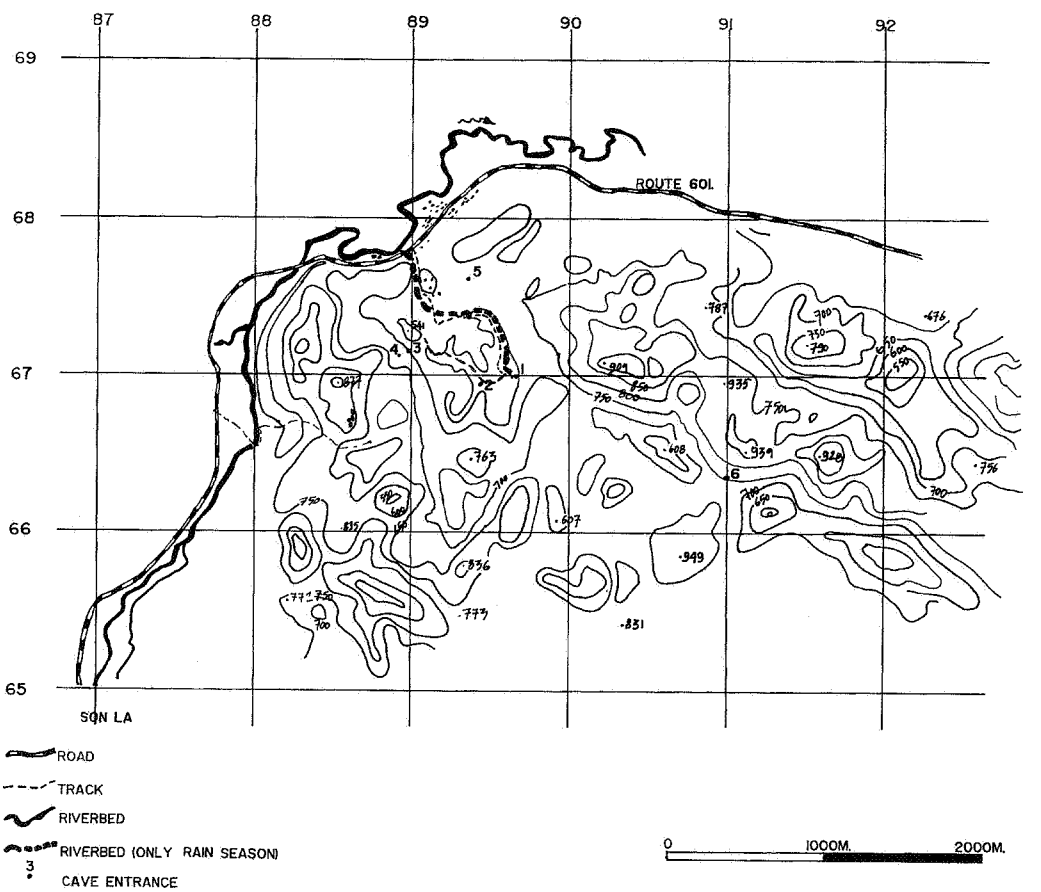
DEN: - 0,13 m
DEV: 276 m




EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993
N11
SON LA - BAN CA
– THAM TA TONG –
ALT: 600 m
X: 86.93
Y: 61.32
(1/50.000: Sheet 5751.I)
DEN: - 18,33 m
DEV: 381 m
FOSSIL GALLERY
CONTINUES
OVER 150 M
TO NEXT SUMP
EXPLORED
NOT SURVEYED
SUMP
ACTIVE GALLERY
DAM
0
50
100
150


81
82
83
84
85
86
87
88
63
62
61
60
N3 RAN HAN DONG BAN THAM (SNAKE CAVE)
N5
NAM KHUM (WHIRLING WATER PASSAGE)
N9 N10
NAM LONG
N8 THAM TA TOONG
N6 THI DOI (FIRST CAVE)
0
200
400
600
800
1000

AREA III: BOM BAY



	CAVE NAME	VILLAGE/LOCATION	COORDINATES ALTITUDE MAPSHEET	TYPE OF CAVE/ENTRANCE	DEVELOPMENT	DEPTH	INTEREST
B_1	**Lôm Co Co**	Bom Bay (Phiêng Hay)	89,7 x 67,0 530 m (F-48-88-D-d)	*Sinkhole Underground river*	675,4 m	- 63,96 m	*Stops at boulder choke Important sinkhole*
B_2	Hieu Phan	Bom Bay (Phiêng Hay)	89,44 x 66,96 530 m (F-48-88-D-d)	*Sinkhole (temporary)*	-	-	*Impenetrable*
B_3	**Hang Ong** (Bee Cave)	Bom Bay (Phiêng Hay)	88,99 x 67,18 600 m (F-48-88-D-d)	*Huge doline / Very big shaft*	150 m	- 98 m	*Possible continuation*
B_4	**No name's cave**	Bom Bay (Phiêng Hay)	88,89 x 67,18 650 m (F-48-88-D-d)	*Huge doline / Big shaft*	89 m	- 84 m	*Choked*
B_5	**Bu Co Phan**	Bom Bay (Phiêng Hay)	89,36 x 67,6 650 m (F-48-88-D-d)	*Shaft*	65,6 m	- 46 m	*Choked*
B_6	**Swallow Cave**	Bom Bay (Phiêng Hay)	91,00 x 66,34 750 m (F-48-88-D-d)	*Enormous doline / Big shaft*	180 m	- 150 m	*Choked*

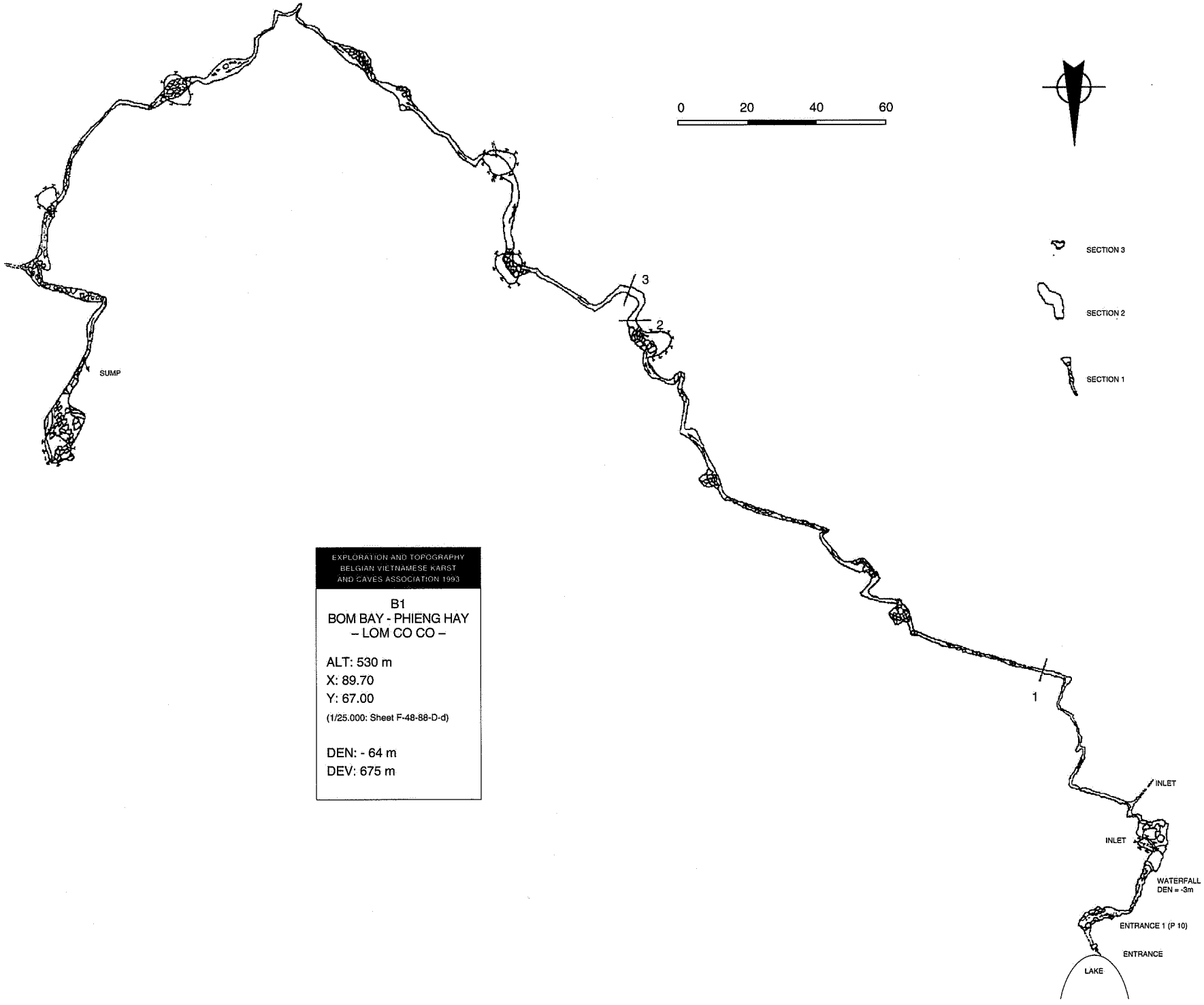
The enormous and very destructive flood on 27 July 1991 destroyed a chain of little hills at the north border of the Bom Bay valley. This valley is a closed depression formed through karstic erosion and has an oval form, 1800 m for the great axe, 800 m for the small axe. After the destruction caused by the flood the major part of the water of the Nam La river enters into the Bom Bay depression. It disappears mainly into two sinkholes: Lôm Co Co and Hieu Phan. The last one is impenetrable. In Lôm Co Co the water could be followed over more then 600 m through a narrow rift, before it was choked by bolders. We have looked for another access to the underground river course, but without success. Nevertheless, several huge pitches have been descended. These big shafts and huge dolines are all at the same altitude, about 650 m (except for Swallow Hole: 750 m), and indicate a much older karstification process; they are now fossil and all are choked. For the moment it seems that blasting in Lôm Co Co leaves the best hope for a continuation. Also a more thorough reconnaissance of the karst eastwards of Lôm Co Co seems necessary, although very difficult because of the very dense jungle. The caves in this area develop along a NW-SE axis or even in the E direction. Normally one could expect that the water would resurge in the Nâm Pan river bed some 400 m below to the east (this river flows near to the border of the karst banks). But after we could see ourselves (during a day walk along the Nam Pan river) and after the local people there are no known resurgences (or emergences). So, where does this water go to?

LOM CO CO (fig. B_1)

Alt: 530 m
X: 89.70
Y: 67.00 (1/25.000: sheet F-48-88-D- d)
DEN: -64 m.
DEV: 675 m.

Since the flood on July 27th 1991 in Nam La (La River) and after the collapse of a large natural dam, Lom Co Co collects part of the water of the Nam La river. In front of the two small entrance-pitches is a lake. The water of the lake flows over in Lom Co Co. In the first pitch, in which the water disappears, the road is blocked by a sump after 10 m The second pitch (P10) gives access to the cave system.

Lom Co Co is an active, (never narrow) meandering cavesystem. The cave reminded us a lot of European caves like the 'Gouffre du Bury' in the French Vercors. At the moment of our exploration we estimated the discharge of the underground river to be 0.5 m^3/s. The water-temperature is about 20°C. Shortly after entering the cave we had to descend a 8 m. waterfall. We observed a lot of inlets and shafts. When we were in the cave the water was 0.5 m to 2 m deep, but we could clearly see that the water is filling up the cave to the ceiling in periods of high water. In the cave is a rather strong draft. At different places we could observe surfical erosion of the rocks by the power of the water and its driftwood. The rocks are clean-washed but often very sharp. After 675 m of quite sportive exploration, practically continuously in the water, our way was blocked by a collapse of boulders. Different attempts to reach the waterlevel again failed. It would be probably a good idea to look for other entrances at the surface. As we assume that Lom Co Co is developing in the direction of the main system of the underground Nam La river, it might be possible to find here an access to the main underground river.



EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993

B1
BOM BAY - PHIENG HAY
– LOM CO CO –

ALT: 530 m
X: 89.70
Y: 67.00
(1/25.000: Sheet F-48-88-D-d)

DEN: - 64 m
DEV: 675 m

HANG ONG (Bee cave) (fig. B_3)

Alt: 600 m
X: 88.99
Y: 67.18 (1/25.000 : Sheet F4888Dd)
DEN: -98 m
DEV: 150 m

This huge fossil doline (40 x 20 m) is situated on a steep hillslope. Due to the instability of the walls, a save descent was only possible by using a parallel shaft. At the bottom of this shaft, a beautiful gallery (20 m wide and 10 m high) slopes down to the west. After passing a dry siphon, the gallery suddenly stops. A narrow shaft at the right hand side was climbed until it ended at about 20 m above the siphon level. A possible continuation at the left hand side at about 4 m above the siphon was not checked (the extremely muddy climb was left for the next expedition ...).

NO NAME'S CAVE (fig. B_4)

Alt: 650 m
X: 88.99
Y: 67.18 (1/25.000 : Sheet F4888Dd)
DEN: -84 m
DEV: 89 m

Deep fossil shaft on a hillslope. The upper part is rather dangerous due to rockfall. It is folllowed by a beautiful vertical part. At the bottom one arrives on a steep rock slope. No way on.

BU CO PHAN (Thai language) (fig. B_5)

HANG CON HOANG (Vietnamese language = deer cave)

Alt: 650 m
X: 89.36
Y: 67.6 (1/25.000 : Sheet F4888Dd)
DEN: -46 m
DEV: 65.6 m

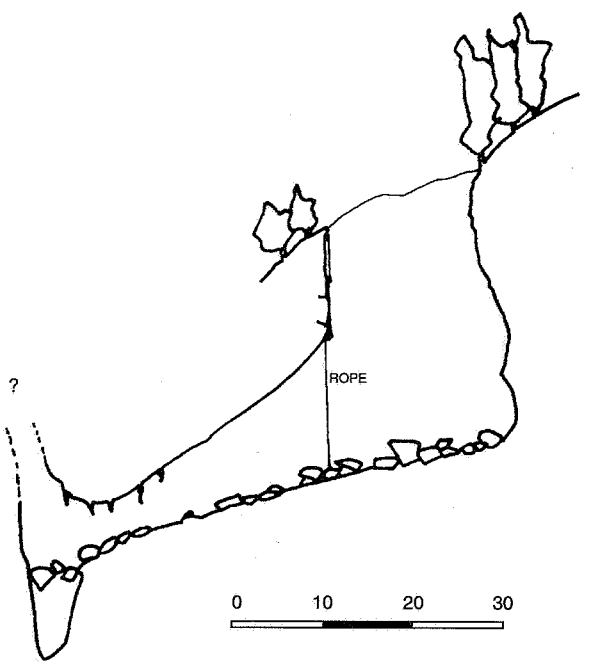
Medium sized fossil doline near to the top of a hill. The walls and the bottom of the doline are covered by plants and speleothems, and a gallery sloping down to the north stops after 30 m. At this end, narrow pasages between blocks can be entered for a few meters before they become too narrow.

SWALLOW CAVE (fig. B_6)

(HANG CHIM EN)

Alt: 750 m
X: 91.00
Y: 66.34 (1/25.000 : Sheet F4888Dd)
DEN: -150 m
DEV: 180 m

A local shepherd told us about a very deep pitch (400 m) at one hour walk from Lom Co Co . When we arrived there we found in fact what we believed to be an enormous chamber with collapsed ceiling. It was located on top of a pass between two valleys, which rather had the aspect of two huge dolines (uvalas). It was an enormous and fantastic pitch. The diameter was about 70 m, the depth about 150 m. The bottom was covered by tons of bat guano and swallow excrements as thousands of them housed in the cave. Two small galleries were completely blocked by concretions. No further continuation could be found.



EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993

B5
BOM BAY - PHIENG HAY
– BU CO PHAN –

ALT: 650 m
X: 89.36
Y: 67.60
(1/25.000: Sheet F-48-88-D-d)

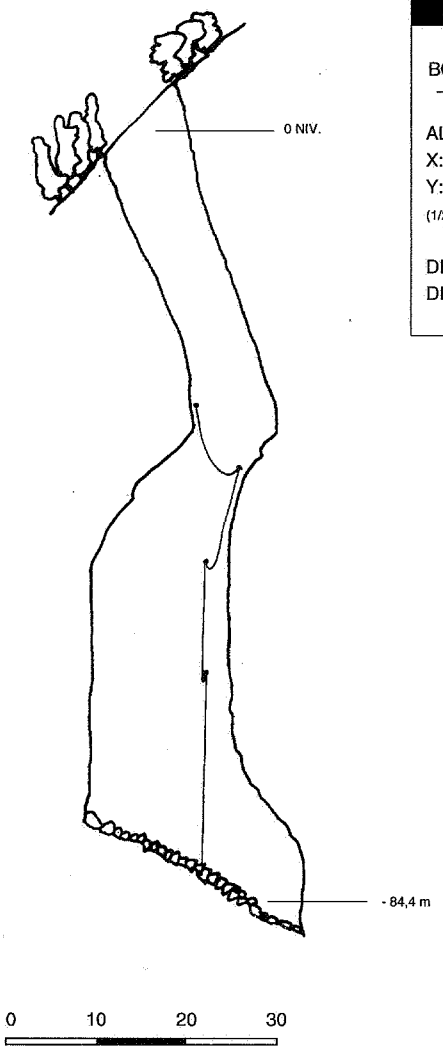
DEN: - 46 m
DEV: 65,6 m

EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993

B4
BOM BAY - PHIENG HAY
– NO NAME'S CAVE –

ALT: 650 m
X: 88.89
Y: 67.18
(1/25.000: Sheet F-48-88-D-d)

DEN: - 84 m
DEV: 89 m

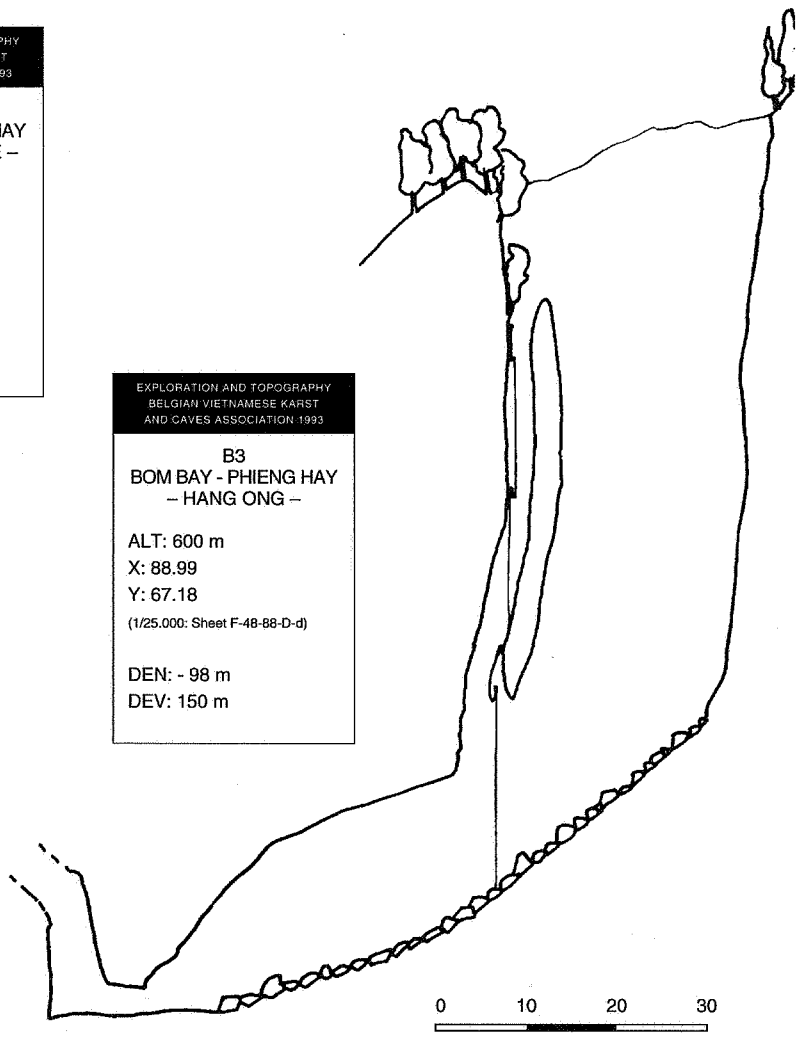


EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993

B3
BOM BAY - PHIENG HAY
– HANG ONG –

ALT: 600 m
X: 88.99
Y: 67.18
(1/25.000: Sheet F-48-88-D-d)

DEN: - 98 m
DEV: 150 m

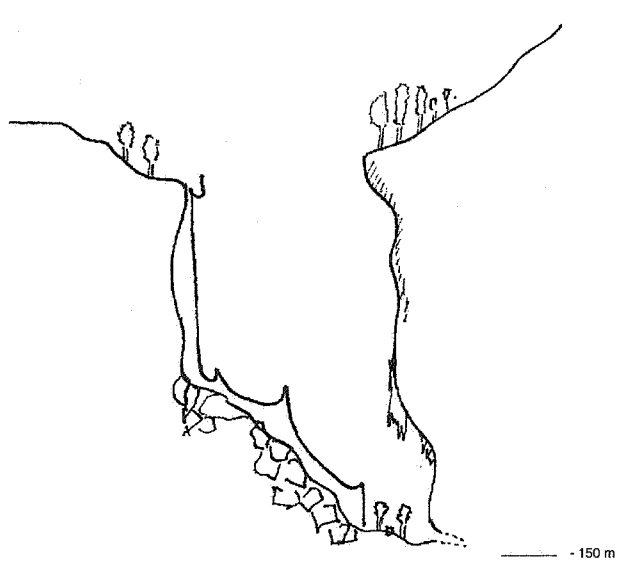


EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993

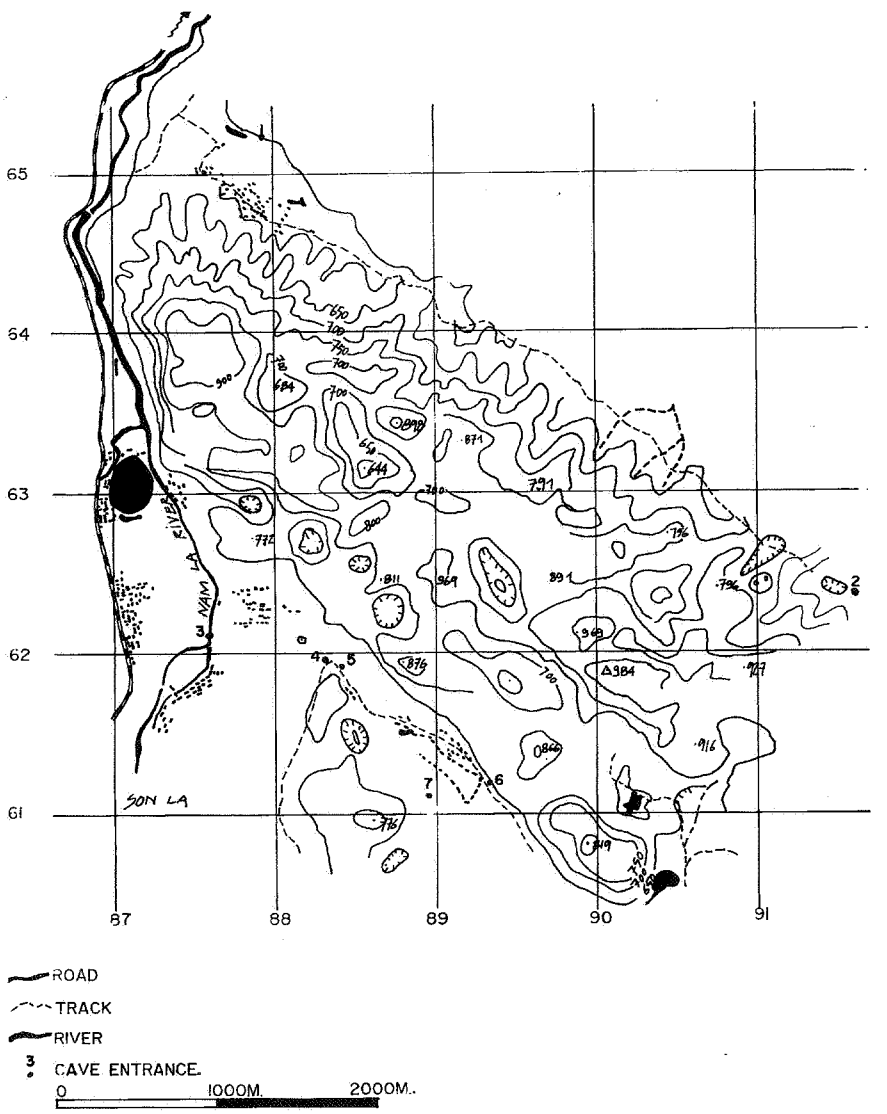
B6
BOM BAY - PHIENG HAY
– SWALLOW CAVE –

ALT: 750 m
X: 91.00
Y: 66.34
(1/25.000: Sheet F-48-88-D-d)

DEN: - 150 m
DEV: 180 m



AREA IV: BAN TONG - POC PHURA



	CAVE NAME	VILLAGE/LOCATION	COORDINATES ALTITUDE MAPSHEET	TYPE OF CAVE/ENTRANCE	DEVELOPMENT	DEPTH	INTEREST
P_1	**Thâm Cohat**	Ban Tong	87,82 x 65,20 620 m (F-48-88-D-d)	*Large porche*	101 m	- 20 m	-
P_2	**Queen's cave** (or Boa Constrictor)	Eastwards from Ban Tông	91,60 x 62,34 650 m (F-48-88-D-d)	*Shaft / Vertical Cave system*	367,5 m	- 151 m	*Interesting cave: possible access to underground river / Nearby there is an active sinkhole*
P_3	(no name)	Poc Phura	87,60 x 62,12 590 m (F-48-88-D-d)	*Emergence*	-	-	*Impenetrable*
P_4	(no name)	Poc Phura	88,32 x 61,98 600 m (F-48-88-D-d)	*Pit*	-	-	*Sumps*
P_5	(no name)	Poc Phura	88,40 x 61,94 600 m (F-48-88-D-d)	*Pit*	-	-	*Sumps*
P_6	**Spider Cave**	Poc Phura	89,31 x 61,18 595 m (F-48-88-D-d)	*Temporary emergence*	208,1 m	- 24 m	*Choked*
P_7	**Bo Phua**	Bo Phua	88,92 x 61,12 590 m (F-48-88-D-d)	*Diaclase*	-	- 5 m	*Sumps*

The caves in this area are situated in the valleys to the SE of Ban Tong and Poc Phura village. Especially the first valley contains many karst features and some very beautiful and small caves. We visited this area only during the last days of the expedition, but it seems to be a very promising area. One very exciting vertical cave system could be explored to - 151 m (without real end) via fantastic pitches. Other active but penetrable sinkholes were noticed but had to be left due to lack of time.

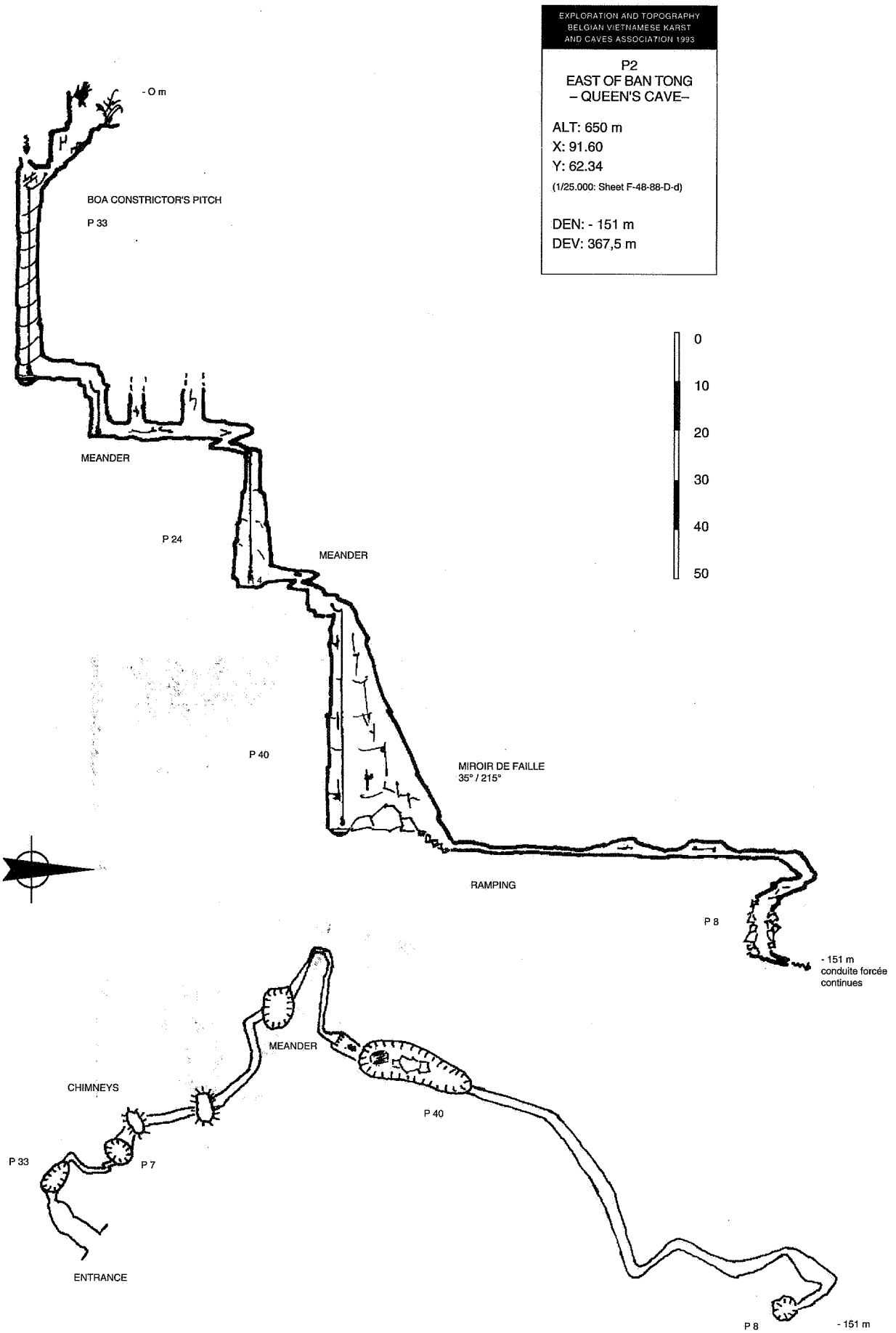
QUEEN'S CAVE (fig. P_2)

(or Boa Constrictor Cave)

Alt: 650m
X: 91.60
Y: 62.34 (1/25.000 : Sheet F4888Dd)
DEN: -151m
DEV: 367,5 m

At the intersection of what seemed to be two faults, two very promising caves were found. One of them was active and collected water which came in from the west side of the valley. The other, 30 m eastwards, acted as a sinkhole only in rain season and was now dry. It was this latter which we explored. A short slope leads immediately to a 33 m pitch. A meander at the bottom is followed a few meters to an 8 m step, a 24 m pitch and then to a very beautiful shaft of 40 m. This shaft is located on a 'fault plane' (35 /215). At the bottom a small gallery starts off for some 80 m. We have several inlets here, but the only way on is trough boulders to a small 8 m pitch. At the bottom a small circular passage "conduite forcée" (1 m diameter) is filled with mud almost to the ceiling. Progression becomes difficult and very slow because of the narrowness of the passage and especially because of the mud. We continued only for about 15 m (it was the last day of the expedition), but the cave goes on.

Typical rural housing, displaying extensive use of bamboo


EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993
P2
EAST OF BAN TONG
– QUEEN'S CAVE–
ALT: 650 m
X: 91.60
Y: 62.34
(1/25.000: Sheet F-48-88-D-d)
DEN: - 151 m
DEV: 367,5 m
0
10
20
30
40
50
- O m
BOA CONSTRICTOR'S PITCH
P 33
MEANDER
P 24
MEANDER
P 40
MIROIR DE FAILLE
35° / 215°
RAMPING
P 8
- 151 m
conduite forcée
continues
MEANDER
CHIMNEYS
P 33
P 7
ENTRANCE
P 40
P 8
- 151 m
0 10 20 30 40 50

THAM COHAT (fig. P_1)

(Co = three, Hat = name of tree species)

Alt: 620 m
X: 87.82
Y: 65.20 (1/25.000 : Sheet F4888Dd)
DEN: -20 m
DEV: 101 m

This large fossil cave is situated underneath a rock face near to Ban Tông village. The large porche is connected to a big chamber. Passages to active cave systems were not found.

Lom Co Co, sportive exploration, practically continuously in the water.

SPIDER CAVE (fig. P_6)

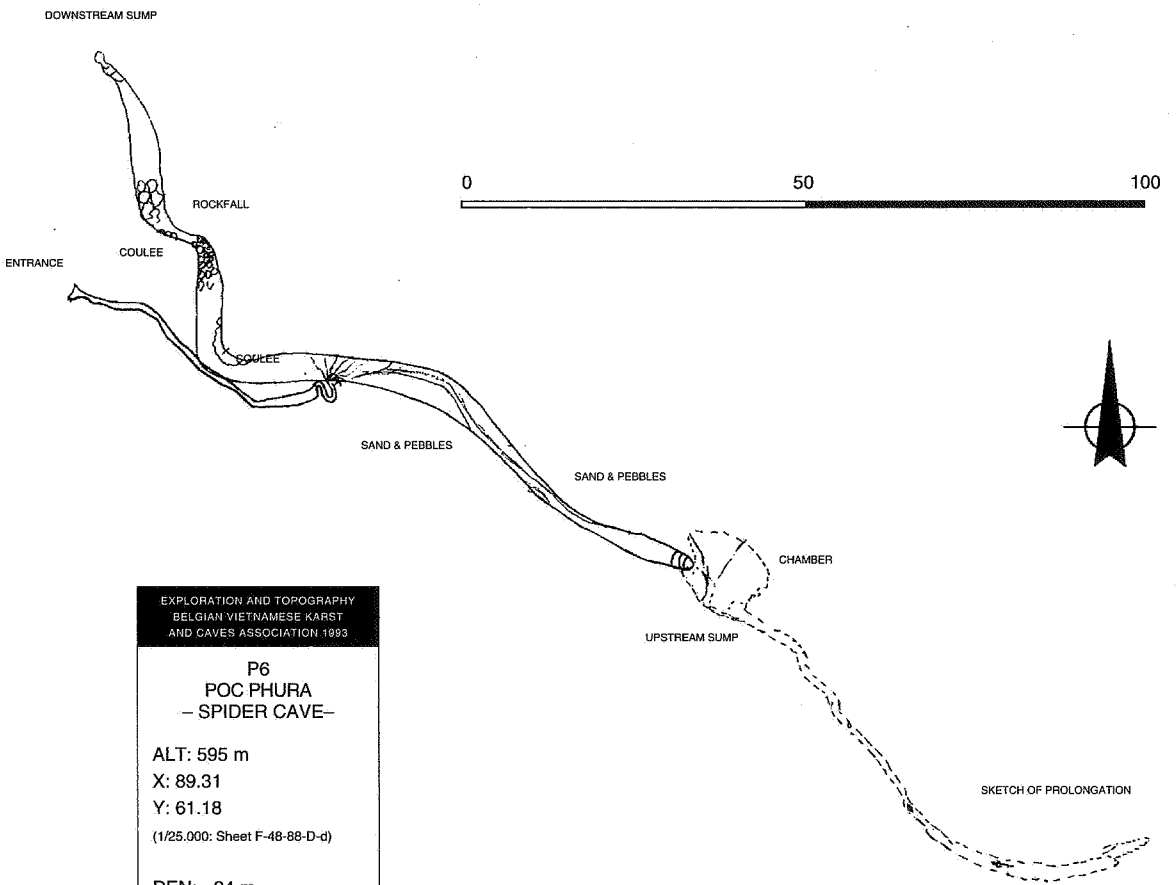
Alt: 595 m
X: 89.31
Y: 61.18 (1/25.000 : Sheet F4888Dd)
DEN: -24 m
DEV: 208 m

There are different caves located in the large valley of Poc Phura, eastwards from Son La. At the end of the valley there is big emergence (P3). The water from this emergence is used for alimentation (drinking, washing, ...) by local people. It flows into a rather big lake, created by an artificial dam. The water emerges here out of a sump. At the other side of the hill that separates this small valley from the large Son La valley, there are two other accesses to the water level. In fact it are two small pits of about two meter deep, filled with water and no possible way on (P4 and P5).

Spider cave (P6) is located at the East side of the valley. It acts as a temporary emergence. A small draughty passage gives way to a little gallery. This ends in a sump at both sides. But at one side, the chamber above the sump gives access to a very small passage about 10m higher. This passage continues over 60m. Here it goes down again but a very big calcite curtain prevents us to regain the lower gallery, although we can hear the stones resound some 10m below.

Bo Phua is the name of the very small village. Near this village a 5 m pitch in a diaclase leads to the water (P7). It is very small but the water makes a very pleasant sound between the walls. After 5 m sump. At the other side of the village there was a well at a depth of about 8m.

Probably all these fenomena indicate that the surface of the phreatic water in this valley lies only a few meters below the surface. So probably one cannot hope to find well developed caves in this area.

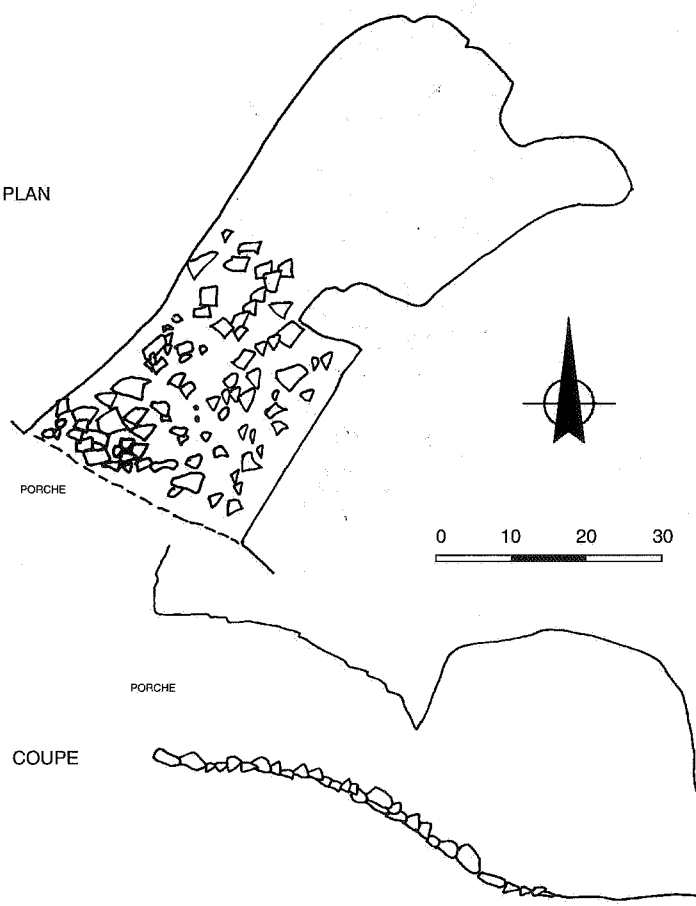


EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993

P6
POC PHURA
– SPIDER CAVE–

ALT: 595 m
X: 89.31
Y: 61.18
(1/25.000: Sheet F-48-88-D-d)

DEN: - 24 m
DEV: 208 m



EXPLORATION AND TOPOGRAPHY
BELGIAN VIETNAMESE KARST
AND CAVES ASSOCIATION 1993

P1
BAN TONG
– THAM COHAT–

ALT: 620 m
X: 87.82
Y: 65.20
(1/25.000: Sheet F-48-88-D-d)

DEN: - 20 m
DEV: 101 m

PART IV
ORGANISATION OF THE '93 EXPEDITION

Every day, a long march to the cave entrances had to be repeated.

We couldn't complain that our preparatory time was too long. The 30th August 1992 we met Yvain Salmon in Louvain. He was going to be our contact in Hanoi and was engaged by Michiel Dusar on his visit to Hanoi earlier that year. Yvain Salmon confirmed us that it would be possible to arrange an expedition for the next winter. On 10 October we met Mr. Tran Dy, director and Ha Anh Tuan, responsable for the international cooperations of the Geological Survey in Vietnam, in Brussels and Louvain. They almost immediatedly agreed to a cooperation and proposed us an area for investigation in the North of Vietnam for January or February 1993. Topographic maps showing the area of Son La were opened and both parties discussed the possible objectives enthousiastically. The cooperation had started, the authorization was only to be a formality.

Three months seemed a very short time to set up a speleological expedition to Vietnam. We had to arrange tickets, equipment, administration, visa, holidays, ... and of course we had to find the financial means to allow seven Belgian cavers, four Vietnamese geologists and two drivers to spend four weeks in the Son La Karst. All this went rather well also thanks to our basic ideas about expeditions: single and precise objective, no big sponsors, no big commitment to the media, financing by personal loan, absolute minimum equipment (backpack, hand luggage and two small tacklebags for each member of the expedition): the advantages are low weight, low cost and very great mobility.

We arrived in Hanoi on the 9th of January. It was no healthy course (jet lag of 7 hours) with sleepless nigths before departure and receptions as soon as we arrived. In Hanoi our Belgian-Vietnamese friendship was officialized by the signature of a very clear and very correct convention in the presence of Piet Steel, then Belgian Ambassador in Vietnam.

From Hanoi we drove to Son La in two 4WD and a minibus by the the main Hanoi-Dien Bien Phu road (N6). It meant 320 km within ... 12 hours. At this speed, we had time to appreciate the incredible and fantastic karstic landscape (karst all the way long !) as well as the friendly local population.
In Son La we were installed in a government building, categorized as hotel. Every day we enjoyed the comfort of a rudimentary bed, a warm shower, 220V electricity, etc... We had access to a canteen, where the receptions took place also. Outside a little private restaurant served us copious and varied meals in the morning and in the evening. At noon we got a substantial but invariable snack. At the post office, fax and telephone assured us of communication with Hanoi, and, when necessary also with the rest of the world at reasonable rates.

A TYPICAL DAY:

Early awakening, too early because of the public radio broadcasting through loudspeakers in the street, starting at 6 p.m..... Getting up 1 or 2 (or 3) hours later according to the individual. Breakfast at 7.30 or 8.00: omelette and "Com Pho" (soup with rice, vegetables and chicken) or "Bami" (noodles); coffee or green tea. Afterwards getting ready (notably crushing of carbide of big size). Transfer by a track to the area to explore (30 to 60 min trip). Two old 4WD with drivers were at our disposal, sparing time and energy. Even a police man joined us, incognito (!), being in charge of our security and carrying sometimes a heavy muddy tackle bag... Recruted under the local people by our Vietnamese speleologists countrymen guided us to cave entrances they knew. It is worth mentioning that each of these guides only knew a rather restricted area, often not knowing the caves of the other areas. Nevertheless this was a very helpful assistance because of the luxuriant vegetation and the difficult access. The approach to the caves was very often accompanied by children enthousiastic about our show: carbide flame lit by a piezo, going up and down on a single rope, image on the video or strip-tease before and after a descent. The snack consisted most of the time of sticky rice in a banana tree leaf with sausages cooked in bamboo.

According to the objectives of each team (consisting of two Belgians and one or two Vietnamese), the day was made of prospecting, exploration, tackling and surveying of the caves. The time spent underground varied depending on the cave length and the difficulties we came across, but rarely exceeded 8 hours. Anyway, we usually came back in the night, to the dispair of our drivers who had been patiently waiting for us all day long. The supper then consisted of a succession of many hot plates of vegetables (cabbage, bamboo, onions, potatoes, tomatoes, mushrooms, ...), meat (duck, chicken, pork, beef, ...), "spring rolls", eggs, soup and rice to finish. Fruit as dessert, tea and rice alcohol as a drink.

RAPPORT SUR UN GESTE HUMAIN DES SCIENTISTES BELGES.

Son La le 27 janvier 1993

Au Comité populaire de la province de Son La,

Selon le plan d'étude spéléologique de la province de Son La, un groupe de 4 personnes (2 belges, 2 vietnamiens) de l'expédition spéléologique belgo-vietnamienne a travaillé dans la région de Ban Bo le 26 janvier 1993. Après avoir terminé les travaux à Ban Bo le groupe est arrivé a Phieng Ngua à 4 heures du soir. Auparavant, on savait qu'il y avait là un puits très profond où est tombé en 1979 un enfant (un garçon) de 14 ans. Durant les 14 années qui sont passées depuis l'accident mortel, personne n'a pu exhumer les restes de l'enfant. Nous, les membres du groupe, avons trouvé monsieur NGUYEN VAN HOAN (le père de l'enfant) pour savoir le lieu du puits. La famille de l'enfant a prié le groupe de chercher la dépouille mortelle. Les scientistes belges ont accepté immédiatement malgré qu'il était déja très tard. Le puits est situé très haut en montagne et n'appartient pas au système que le groupe est en train d'étudier.

Le groupe est arrivé au puits à 16 h 15. Après avoir assuré toutes les conditions de sécurité, et en utilisant les techniques de spéléologie moderne, les scientistes belges Koen Mandonx et Jan Diels ont commencé à chercher. Monsieur Koen a descendu dans le puits. Monsieur Jan et les 2 membres vietnamiens sont restés à surface pour suivre les travaux de Monsieur Koen. Malgré que la situation a été très difficile et le manque d'air, Monsieur Koen a monté et descendu plusieurs fois pour ramasser presque tous les restes de l'enfant à un petit rebord au fond du puits; il a aussi ramassé les sandales et la ceinture de l'enfant. A 18h tout est terminé. La famille de l'enfant est très émotionnée et a remercié les scientistes belges pour leur aide très chaleureuse, après avoir reçu la dépouille de leur membre familial, qu'elle pense que jamais elle ne peut le rencontrer.

Nous écrivons ce rapport pour vous informer de ce que nous avons fait.

L'adresse de la famille Nguyen Van Hoan
groupe 3, microrayon (Ban Ca)
commune de Chieng An, province de Son La.
La victime:
Nguyen Van Quang,
mort le 5 juillet 1979 à 12 h 30.

Just what we needed to put us on our feet again after those back-breaking days. "Vina Cola" and beer to finish the evening (probably the largest expenses of our journey because sold at occidental prices).
To end up the day: quick wash and wound treatment, notes and report of the day, topography, discussion about the objectives for the next day, at least when we didn't had particular obligations as receptions by local authorities or participation at the "Têt"-festivities.

SECURITY AND PARTICULAR RECOMMANDATIONS

Cave prospecting and exploration in the Vietnamese tropical karst can present particular dangers. During the approaches (sometimes really through very dense jungle) and also at the edges of the cave entrances - horizontal or vertical- we frequently met very poisonous snakes. In the midst of a luxurious vegetation, the thing was to have sharp eyes. Jan and Frank still remember the shivers of a narrow escape when they climbed an entrenched passage where a deligthful reptile had decided to have a nap ... Another danger threatening the caver is the instability of the walls in the big tropical dolines (due to extensive corrosion and erosion). Even where we thaught to bolt in solid rock, it was maybe the start of a collapse of piano size boulders. Koen could tell you that we didn't spare our adrenaline... The underground air and water temperature are not the same as those in our alpine karsts. The advantage is a warm ambiance but there are also disadvantages: quick deshydratation (especially in fossil galleries where we measured temperatures up to 30 C !), bad recovery after intensive physical effort in poorly ventilated networks, dubious (swimming) water. We can mention also an incident at the free dive of a short sump. Emerging in a small bell of vitiated air, Jack lost consciousness in the water during a few seconds before to resurface, fortunately at the good side of the sump, where Filiep, in panic, could grasp him. It is also good to remember that in Vietnam you're very far from any cave rescue team.

Regarding equipment and techniques we can mention the use of a climbing pole, compact and light, which enabled us to get easily over ten meters high obstacles, the succesful use of diving mask and flippers to freedive short sumps and to evaluate difficulties or possibilities of a real dive, the use of flippers and life-vests for long swims and topography in difficult aquatic passages, the use of a drill on battery. For the next expedition other techniques will be taken into account because in several caves we were forced to turn back either in front of sumps, which we assume to be easily passable with diving gear, or in front of short narrow passages which could be passed by shock therapy ...
Our expedition could profit of the dry season (no rain at all during one month) and the short winter (12 days). This meant not only that we could work non stop without danger of floods, but also that the jungle was in state of 'sleep'.

An expedition to Vietnam also requires some precautions on the medical plan. As for all journeys in tropical countries vaccinations or protection against Hepatitis A, Polio and Typhus are very useful. As far as malaria is concerned, Vietnam is a region where malaria is already resistant against the normal prophilactic medication. We used Lariam. It is rather expensive but very handy (only one pill a week), although it is advisable to try it out several weeks before you leave as some people develop contra-indications and thus should look for another solution. Except for the expected diarrhoea problems, for which we used succesfully ORS, Immodium and Bactrim, we only needed special medical treatement for Wim who cut his finger very deep on an extremely sharp rockledge.

We have to underline that speleologists use different methods and techniques for their explorations: techniques for prospecting, measurement, topography, techniques for progression in horizontal cave systems and caves with water passages, including special techniques for exploration of underground rivers with high discharge and great denivellation, for the exploration of siphons (diving), and techniques which allow to progress in cave systems with a mainly vertical development (single rope techniques). The application of these methods and techniques requires special equipment (carbide lamps, clothes, ropes, ladders, diving gear,...) and training. Furthermore, cave exploration in tropical and remote areas poses very specific problems: problems of access, logistics, time that can be spend underground (bivouac?), security, rescue, communication,...
Therefore it seems to be desirable to try to develop a speleological training and education programme for

Vietnamese speleologists in order to develop a well informed and trained group of experts, who can contribute to a further exploration of the Vietnamese Karst and intervene also in case of accident and emergency.

GENERAL CONCLUSION

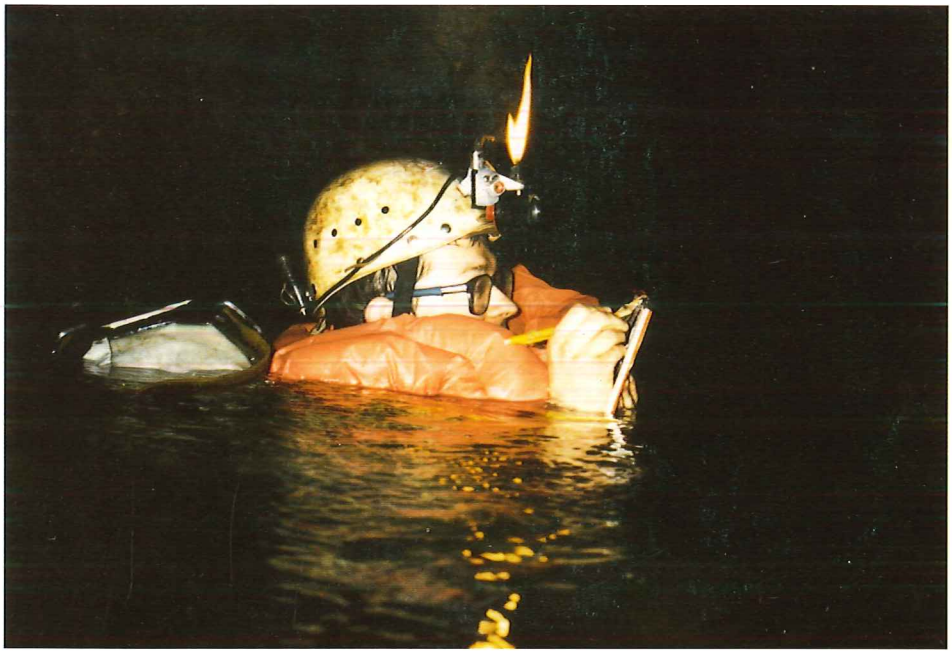
Speleologists prospect karstic areas in order to explore natural entrances which allow to enter the underground world and to investigate and study the caves and underground river systems. They establish detailed topographic maps of the caves, plans and sections; they contribute to a better understanding of the karstic areas and collect valuable information for geologists, hydrogeologists and geomorphologists who study karstic phenomena; they offer opportunities to paleontological and biological research.
More specifically, in the case of the Son La expedition we estimate that the speleological investigation and exploration contibutes to:
- the study of the formation, development and distribution of the caves, which developed in limestones belonging to different ages, regions and structures;
- the reconstruction of a theoretical model which explains the enormous flood of Nam La valley in 1991 and allows better flood control;
- the location of underground streamways and waterreserves (important to find water for living, industry and agriculture);
- the location and exploration of cave systems which are suitable for touristic exploration (like Hang Doi);
- the investigation of the possibility to construct small hydroelectric powerstations (since discharge and denivellation in the Son La area are rather important).

This report only discusses a part of the caves and karst phenomena that we explored during our expedition. More than 200 karst features were observed, more than 12 km of new cave was measured and mapped, many more caves and pitches were descended and explored. The karst system proved to be very complex: there are many underground rivers, a lot of sinkholes (at least 10 in the sole area of Khau Pha), not to forget the many enormous dolines and the possible denivellation of more then 900 m. For many underground rivers and sinkholes we don't know where the water goes. There is only one known emergence, but it seems to be rather improbable that all the water is going there. Further study is required which should include coloration tests, detailed discharge measurements at sinkholes and emergence, further exploration and mapping of the caves, application of diving techniques.

In general, we can say that further speleological studies and investigations are required, which in the future could contribute also to the general study of this area where the Vietnamese Government intends to construct a giant hydroelectric powerstation on the DA river at TABU, where the NAMPAN river with its NAMLA tributary comes into the DA river. *(See location map, p. 23.)*

However, maybe one of the most important results of this first Belgian-Vietnamese Speleological Expedition is the birth of a common fascination for the underground world of Vietnam and of a common will to continue the exploration. We certainly hope that this has been the start of a fruitfull cooperation between Belgian and Vietnamese speleologists.

* * *



Working conditions for topographic surveying were often difficult as shown in a drowned gallery at Tham Ta Tong

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