Cave and Karst Science

The Transactions of the British Cave Research Association

BCRA

Volume 22 Number 2 October 1995

The Yangtze Gorges Expedition 1994

Cave and Karst Science

Authors are encouraged to submit articles for publication in the Transactions of the British Cave Research Association under four broad headings:

1. Mainstream Articles
Scientific papers, normally up to 6,000 words, on any aspect of karst/speleological science, including archaeology, biology, chemistry, conservation, geology, geomorphology, history, hydrology and physics. Papers should be of a high standard and will be subject to peer review by two referees.

2. Development Articles
Shorter papers, normally 500-3,000 words, on aspects of karst/speleological science listed above, or more descriptive material such as caving expedition reports and technical articles. These will be reviewed by the editorial board unless the subject matter is outside their fields of expertise, in which case appropriate expert assessment will be sought.

3. Forum
Personal statements of up to 1,000 words on topical issues; discussion of published papers and book reviews. Statements should put forward an argument and make a case, backed-up by examples used as evidence.

4. Abstracts
Authors (or supervisors) of undergraduate or postgraduate dissertations on cave/karst themes are asked to submit abstracts for publication. Please indicate whether the thesis is available on inter-library loan. Abstracts of papers presented at BCRA and related conferences or symposia will also be published.

Manuscripts may be sent to either of the Editors: Dr. D J Lowe, British Geological Survey, Keyworth, Nottingham, NG12 5GG, UK, and Professor J Gunn, Limestone Research Group, Department of Geographical and Environmental Sciences, The University of Huddersfield, Queensgate, Huddersfield, HD1 3DH, UK. Intending authors are welcome to contact the Editors, who will be pleased to advise on manuscript preparation.

Notes for Contributors

These notes are intended to help the authors to prepare their material in the most advantageous way so as to expedite publication and to reduce both their own and editorial labour. It saves a lot of time if the rules below are followed.

All material should be presented in a format as close as possible to that of *Cave and Karst Science* since 1994. Text should be typed double-spaced on one side of the paper only. Subheadings within an article should follow the system used in *Cave and Karst Science*; a system of primary, secondary and if necessary, tertiary subheadings should be clearly indicated.

Abstract: All material should be accompanied by an abstract stating the essential results of the investigation for use by abstracting, library and other services. The abstract may also be published in *Caves and Caving*.

References to previously published work should be given in the standard format used in *Cave and Karst Science*. In the text the statement referred to should be followed by the relevant author's name and date (and page number, if appropriate) in brackets. Thus: (Smith, 1969, p.42). All such references cited in the text should be given in full, in alphabetical order, at the end. Thus: Smith, D.E., 1969. The speleogenesis of the Cavern Hole. Bulletin Yorkshire Caving Assoc., Vol. 7. p.1-63. Books should be cited by the author, date, title, publisher and where published. Periodical titles should be abbreviated in standard style, or, where doubt exists, should be written out in full.

Acknowledgements: Anyone who has given a grant or helped with the investigation, or with the preparation of the article, should be acknowledged briefly. Contributors in universities and other institutions are reminded that grants towards the cost of publication may be available and they should make the appropriate enquiries as early as possible. Expedition budgets should include an element to help publication, and the editor should be informed at the time of submission.

Figures: Line diagrams and drawings must be in black ink on either clean white paper or card, or on tracing paper or such materials as Kodatrace. Anaemic grey ink and pencil will not reproduce! Illustrations should be designed to make maximum use of page space. Maps must have bar scales only. If photo-reduction is contemplated all lines and letters must be large and thick enough to allow for their reduction. Letters must be done by stencil, Letraset or similar methods, not handwritten. Diagrams should be numbered in sequences as figures, and referred to in the text, where necessary, by inserting (Fig. 1) etc. in brackets. A full list of figure captions should be submitted on a separate sheet.

Photographic plates are welcome. They must be good clear black and white prints, with sharp focus and not too much contrast; prints about 15 x 10 cm (6 x 4 inches) are best; if in doubt, a selection may be submitted. They should be numbered in sequence but not referred to in the text, except where essential and then after discussion with one of the Editors. A full list of plate captions, with photographer credits where relevant, should be submitted on a separate sheet.

Tables: These should not be included in the text but should be typed, or clearly handwritten, on separate sheets. They should be numbered in sequence, and a list of captions, if necessary, should be submitted on a separate sheet.

Approximate locations for tables, plates and figures should be marked in pencil in the manuscript margins.

Copyright: It is the author's responsibility to obtain written permission where necessary to reproduce all material submitted for publication.

Speleological expeditions have a moral obligation to produce reports (contractual in the case of recipients of awards from the Ghar Parau Foundation). These should be concise and cover the results of the expedition as soon as possible after the return from overseas, so that later expeditions are informed for their planning. Personal anecdotes should be kept to a minimum, but useful advice such as location of food supplies, medical services, etc. may be included, normally as a series of appendices.

Authors will be provided with 20 reprints of their own contribution, free of charge, for their own private use.

We prefer articles to be submitted on disk if possible, although paper copy is also acceptable. We can read most PC based word processing packages but if in doubt please consult one of the Editors. Apple Mac disks are accepted as a last resort!

If you have any problems regarding your material, please consult either of the Editors in advance of submission.

Cave and Karst Science

TRANSACTIONS OF THE BRITISH CAVE RESEARCH ASSOCIATION

Volume 22 Number 2 October 1995

Contents

This issue of Cave and Karst Science includes a number of colour plates. On behalf of BCRA Council the Editors gratefully acknowledge a donation from the China Caves Project towards the cost of publication.

Cover photo:
Upstream Xio Zhai Tien Ken looking back towards the great doline.
Looking downstream towards the entrance of Xio Zhai Tien Ken cave, which lies at the bottom of the 664m-deep Xio Zhai Tien Ken doline. This magnificent canyon passage is more than 100m high at this point, and several long swims are necessary to make progress through the lakes that lie upstream. The river is dammed at the cave entrance and the water is captured by a tunnel that leads to a hydro-electric power station on the Jiu Pan He to the north. The water level was exceptionally low when this view was taken and it is doubtful whether the cave is accessible in normal water conditions.
Photo: Tony Baker (See report comprising this issue)

Editors: Dr. D. J. Lowe — British Geological Survey, Keyworth, Nottingham, NG12 5GG.
Prof. J. Gunn — Limestone Research Group, Department of Geographical & Environmental Sciences, The University of Huddersfield, Queensgate, Huddersfield, HD1 3DH.

Cave and Karst Science is published three times a year by the British Cave Research Association and is issued free to all paid up members of the Association.
The 1995 subscription rate to Cave and Karst Science is £16.00 per annum (postage paid).
Individual copies, back issues and details of annual subscriptions to Cave and Karst Science, and of Association membership, can be obtained from the BCRA General Administrator, 20 Woodland Avenue, Westonzoyland, Bridgwater TA7 OLG.
The Association's permanent address is: BCM BCRA, London WC1N 3XX.

ISSN 1356-191X

EDITORIAL

John Gunn and David Lowe

This issue of Cave and Karst Science is devoted to reporting the results of the latest British expedition to the karst and caves of China, describing explorations carried out in the area of the Yangtze Gorges. The report has been compiled by Kevin Senior from preliminary contributions provided by several team members. To mark the atypical nature of this issue, we have decided to invite a Guest Editorial. This has been written by Andy Eavis, who, together with Tony Waltham, has provided much of the underlying driving force that led to the great success of the first China Caves Expedition and the many subsequent projects.

Unusually for Cave and Karst Science, this issue includes a colour plate on the front cover and a section of coloured illustrations within the report. Extra funds to allow colour printing have been provided by the China Caves Project. The next issue of Cave and Karst Science will be a reversion to our normal format, and will include contributions dealing with hydrothermal karst, gypsum flowers and cave sediments.

GUEST EDITORIAL

Andrew J Eavis

Since 1982, members of the China Caves Project have been involved in the exploration of karst and caves in some of the magnificent limestone areas of China. It seems highly appropriate that after some 13 years and 11 expeditions this issue of Cave and Karst Science should be devoted to covering the results of the latest Anglo-Chinese cooperation.

The activities of the early China Caves expeditions were concentrated in the Guangxi Province, working southward and westward, almost to the Vietnamese border. The wonderful tower karst landscapes of this region became very familiar to many members of the team. Several expeditions ventured slightly farther to the north and west into the Province of Guizhou, to the edge of the tower scenery, where the limestone begins to be more massive. More recently, activity has moved still farther northwards, into the Sichuan Province. The area covered by the latest expedition, and described in this report, lies slightly to the north-east, almost to the border with Hubei, and close to the Yangtze Gorges.

China first became relatively easily accessible to visitors from the west after the Cultural Revolution. Such visitors have been highly impressed by much that they have seen. China is a country with vast numbers of intelligent and hard-working people, who achieve astonishing productivity in both industrial manufacturing and in agriculture. It is also a country where truly breathtaking scenery abounds. The country is huge, extending from the wastes of the Gobi Desert in the north-west to the high and arid plateau of Tibet in the south-west, to the agricultural north-east and to the epitome of karst landscapes in the south-east.

Coincidences of suitable rock types, tectonic history and climatic extremes have produced over one million square kilometres of some of the most astonishing scenery on earth. Commonly the magnificent surface landforms are matched by equally, or even more, impressive underground scenery, revealed in a multitude of caves and canyons.

The deeply eroded surface of the south-east is, however, not conducive to the preservation of long cave systems. Central China, where areas of generally more massive limestone have suffered less deep erosion, offers better potential for the exploration of longer and larger caves. These are the areas that the China Caves Project teams are now beginning to investigate.

This brief background and the following pages should provide some understanding of why British karst scientists have such a great interest in China, and why there should be further expeditions to these areas in the future. An idea of the scale of the remaining tasks can be gained if it is realised that about half of the world's exposed cavernous limestone lies inside the borders of China. On this basis the potential is that half of all the limestone caves in the world may lie within this glorious country, providing scope for exploration and scientific investigations for many years to come.

CAVE AND KARST SCIENCE Vol. 22, No. 2, October 1995
Transactions of the British Cave Research Association

The Yangtze Gorges Expedition: China Caves Project 1994

Kevin J SENIOR (Editor)
39 Rockleigh Road, Bassett, Southampton, SO16 7AQ

Abstract: The Yangtze Gorges Expedition was the latest phase of the China Caves Project, a collaborative series of expeditions involving British speleologists and karst scientists from the Institute of Karst Geology in Guilin, China. This paper presents the results of exploration in four study areas within Sichuan Province, China. 13.5km of cave were surveyed. The Xio Zhai Tien Ken to Mie Gong He Dong cave system, a 4.5km through trip, is the deepest cave in China at -964m and the Xio Zhai Tien Ken doline is probably the largest doline in the world at 135.3 million cubic metres. Hydrology and cave development are discussed and there is a brief note on cave conservation.

INTRODUCTION

The 1994 Yangtze Gorges Expedition to Sichuan Province, China, was the latest expedition in the China Caves Project; an informal collaboration between British cavers and scientists from the Institute of Karst Geology in Guilin, China. Previous expeditions in the series have been described by Eavis 1990, Fogg, P and Fogg, T (1989), Smart and others (1986) and Waltham (1986 and 1993).

The Yangtze Gorges Expedition was a reconnaissance expedition led by Richard Bartrop. It aimed to achieve a balance between visiting several areas and staying long enough to make a detailed study. The expedition therefore spent four weeks exploring four areas within Sichuan Province (Fig.1) but most of the time was spent in two areas; Xin Long and Jiang Kou. The team travelled a clockwise route from Chongqing, down the Chang Jiang (Yangtze River), then south through the Fangdou Shan mountains to the Wu Jiang, then back along the Wu Jiang to Chongqing.

In more detail, from Chongqing (chung ching) the team took a boat down the Chang Jiang, in temperatures that reached 42°C, to the city of Fengjie. Fengjie is just upstream of the spectacular Yangtze Gorges, downstream of which is the huge construction site of a dam that will hold back the Chang Jiang. At Fengjie the surface of the resulting lake will be 50m above the present river level.

From Fengjie it is a long day's journey by bus to the village of Xin Long, cutting across a succession of ridges and valleys controlled by northeast-southwest oriented folds. Two weeks were spent at Xin Long, then the expedition moved south, taking two days to drive approximately 300km to Jiang Kou at the confluence of the Furong Jiang and Wu Jiang (Fig.10). In this area investigations concentrated on the karst plateau above the Furong Dong show cave, but some caves near the city of Wulong (Fig.19) were visited briefly. After four days in Jiang Kou the expedition split into three teams. One team went to Ba Xian county, about 30km south of Chongqing; a second team to Fuling (Fig.21) at the confluence of the Wu Jiang and Chang Jiang; while the third team remained in Jiang Kou.

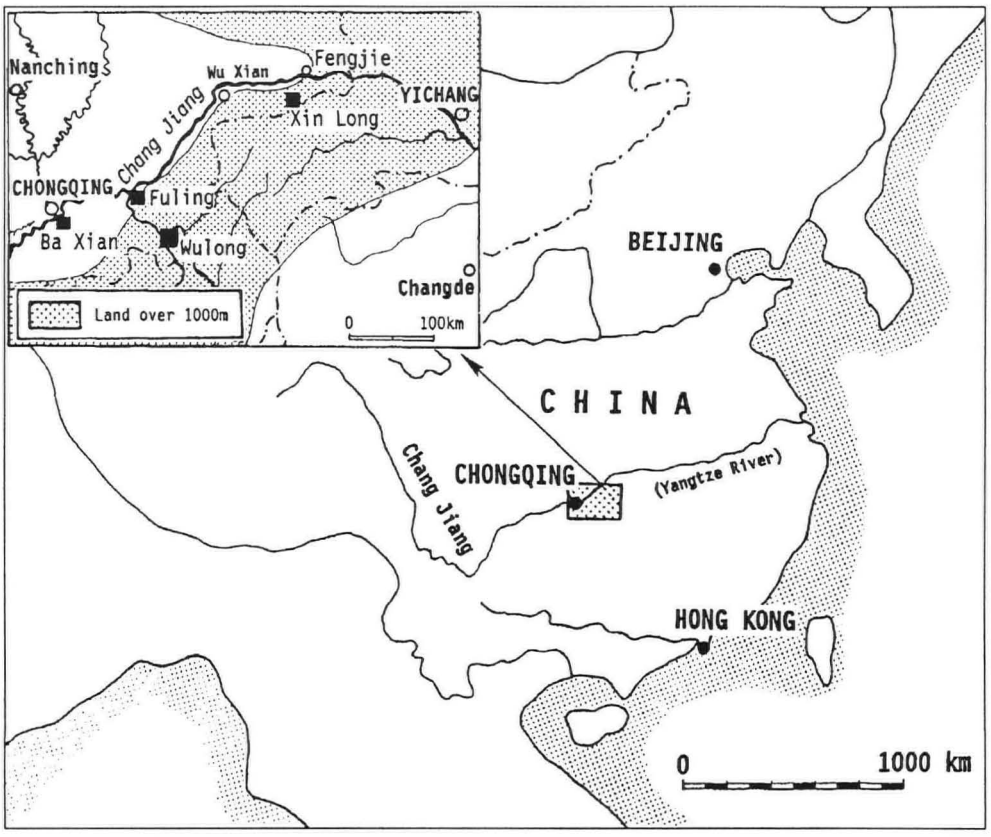


Figure 1. Map showing the areas visited by the expedition.

This report describes the areas in the order visited by the expedition. All the cave surveys are to BCRA grade 5c except where indicated, and the maps are based on good 1:50000 scale maps except for the sketch map of the Wulong area. At the start of each cave description Chinese names of caves (where known) are given in bold type, generally followed by a phonetic rendition shown in parentheses. Where English translations of Chinese names are given, they are in italics.

CAVES OF THE XIN LONG AREA

Geology, geomorphology and cave development

The village of Xin Long is situated approximately 35km south of the city of the Chang Jiang (Yangtze River) and the city of Fengjie (Fig.1). The limestone hills around the village rise to nearly 1800m and the continental climate is dominated by cold northerly winds in winter and stormy, humid tropical weather from the southeast in the summer. Average precipitation is between 1500 and 2000mm, with most falling in the summer months, commonly during severe storms. Long periods of drought can occur and the expedition was extremely fortunate to visit the area during one of its longer dry spells, because the cave exploration was much safer. Temperatures reached 42°C in Chongqing, with high humidity, but at Xin Long humidity was lower and temperatures a more comfortable 30°C.

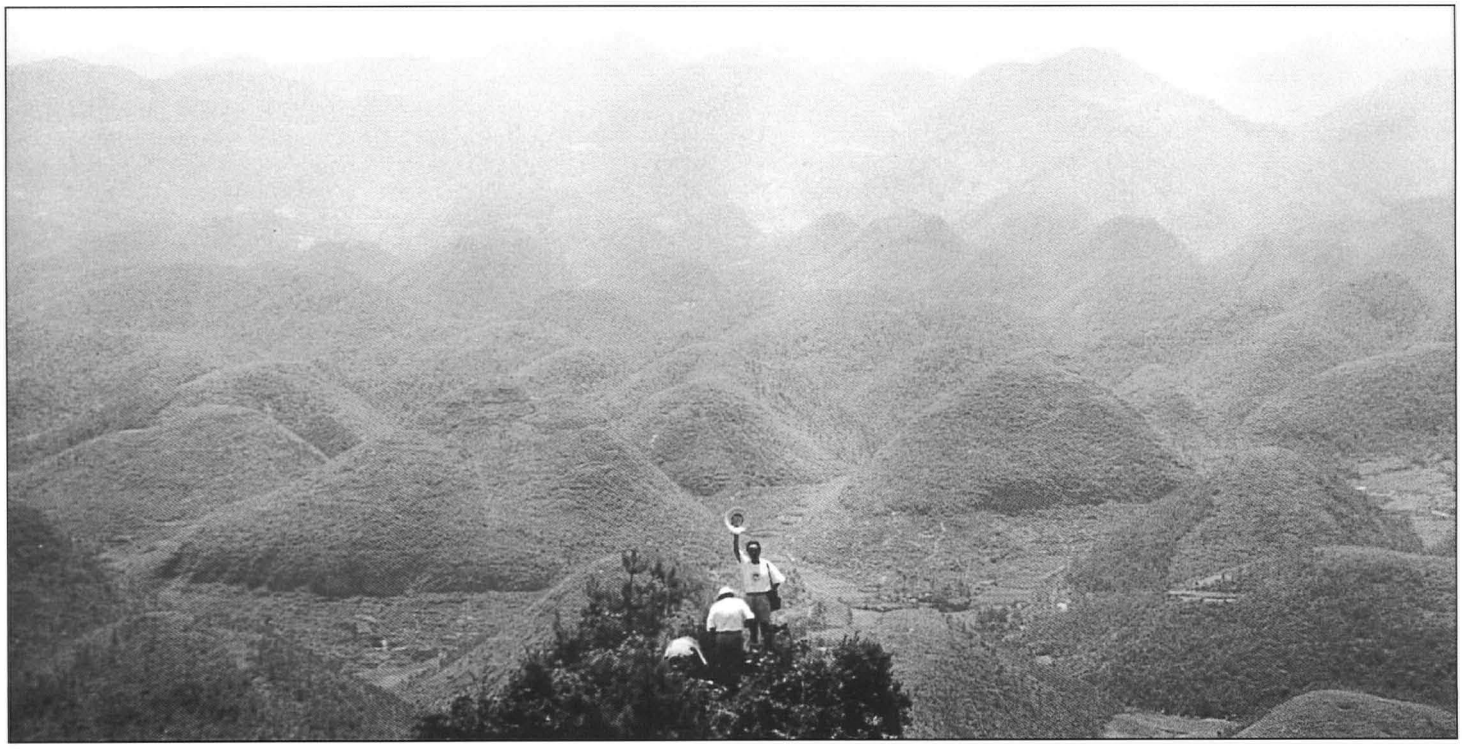
The limestones of the Xin Long area range in age from Devonian to Triassic, although the only caves explored by this expedition are developed within the massively bedded Permian and Triassic limestones. These limestones reach a total thickness in excess of 1000m and are remarkable for their paucity of persistent bedding planes. Within the Permo-Triassic limestones only one hiatus disrupts the otherwise monotonous sequence of finely laminated calcilutites. At the hiatus is a bed comprising red and yellow shales with boulders of limestone and sandstone, and the chaotic texture is suggestive of an olistostrome. This horizon is responsible for the major ledge approximately half way down the Xio Zhai Tien Ken doline and for the 'bench' along either side of the Tian Jing Gorge. It was also the inception horizon for several of the older, relict caves including the huge phreatic passage in Shrang Fong Dong (Fig.5).

The landscape around Xin Long reflects two main influences; 1) a geological structure dominated by asymmetrical folds with northeast-southwest axes (Fig.2), and 2) continuous lowering of the base level dictated by the Chang Jiang so that rivers have become incised into spectacular gorges. In general, the topography is dominated by ridges aligned along the limbs of anticlines and valleys along the axes of synclines and anticlines. Cone karst is commonly well developed on those fold limbs that exhibit moderate dips.

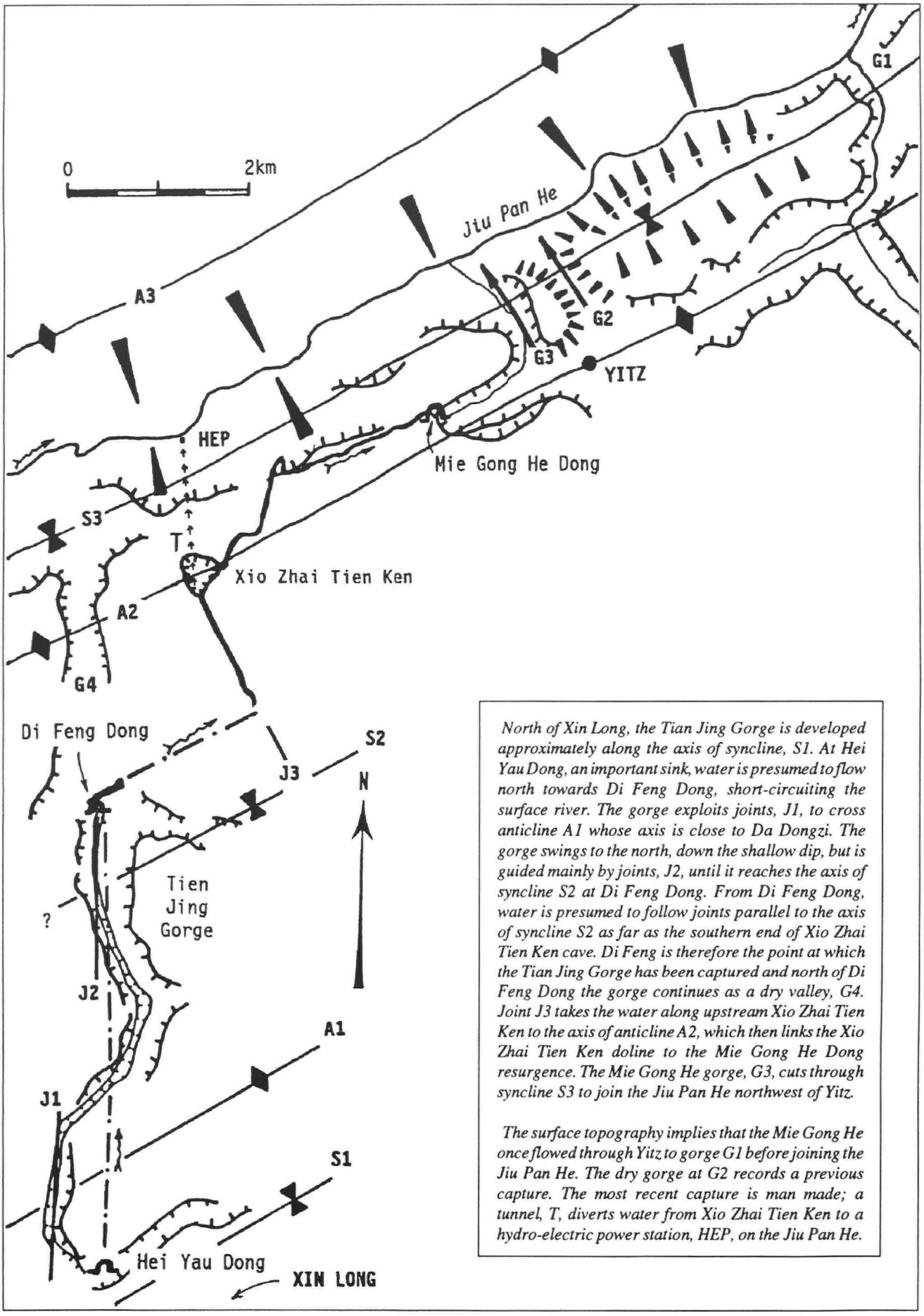
One of the most spectacular features near the village of Xin Long is Di Feng, "The Great Crack". Di Feng is a narrow gorge some 200 - 250m deep and on average 10m wide that is incised into the bottom of the broader Tian Jing Gorge.

Hydrology

Hei Yau Dong is an important sink for the Tian Jing river in the wet season, but during the very dry weather conditions that prevailed during this expedition there was no water flowing on the surface near Hei Yau Dong or in Di Feng at Di Feng Dong. This situation enabled a team to observe that water resurges within the first lake in Di Feng Dong. Two possible sources suggest themselves.



A view south across the cone karst towards the Xin Long area. The photograph is taken from a ridge on the northwestern limb of an anticline and looks across the anticline to the opposite limb, marked by the hills in the distance.
Photo: Kev Senior.



North of Xin Long, the Tian Jing Gorge is developed approximately along the axis of syncline, S1. At Hei Yau Dong, an important sink, water is presumed to flow north towards Di Feng Dong, short-circuiting the surface river. The gorge exploits joints, J1, to cross anticline A1 whose axis is close to Da Dongzi. The gorge swings to the north, down the shallow dip, but is guided mainly by joints, J2, until it reaches the axis of syncline S2 at Di Feng Dong. From Di Feng Dong, water is presumed to follow joints parallel to the axis of syncline S2 as far as the southern end of Xio Zhai Tien Ken cave. Di Feng is therefore the point at which the Tian Jing Gorge has been captured and north of Di Feng Dong the gorge continues as a dry valley, G4. Joint J3 takes the water along upstream Xio Zhai Tien Ken to the axis of anticline A2, which then links the Xio Zhai Tien Ken doline to the Mie Gong He Dong resurgence. The Mie Gong He gorge, G3, cuts through syncline S3 to join the Jiu Pan He northwest of Yitz.

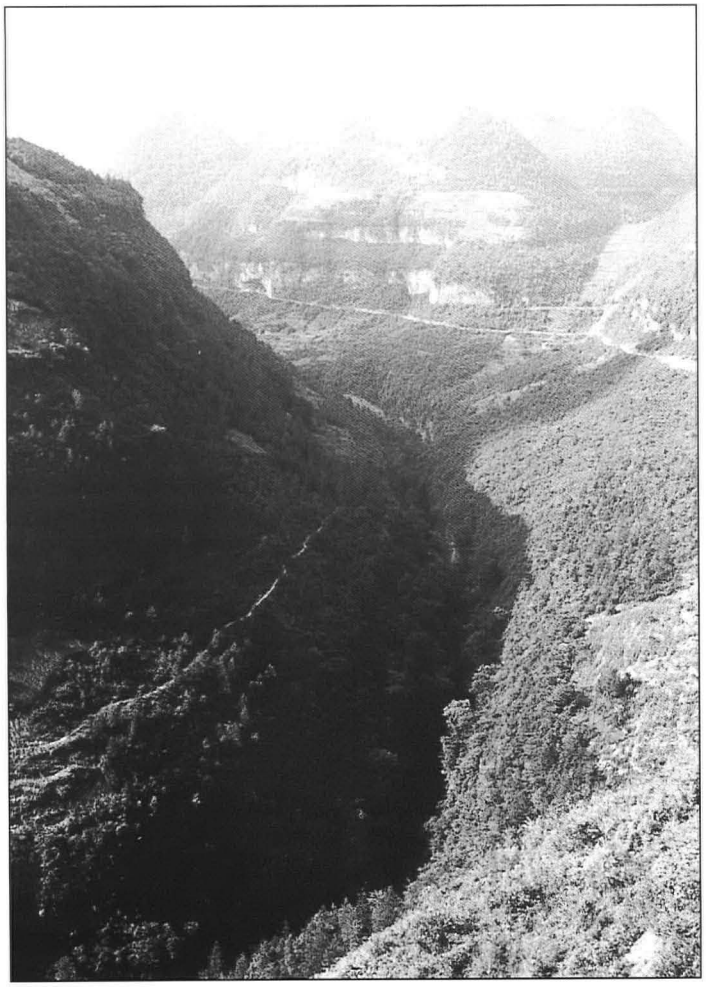
The surface topography implies that the Mie Gong He once flowed through Yitz to gorge G1 before joining the Jiu Pan He. The dry gorge at G2 records a previous capture. The most recent capture is man made; a tunnel, T, diverts water from Xio Zhai Tien Ken to a hydro-electric power station, HEP, on the Jiu Pan He.

Figure 2. Hydrology of the Hei Yau Dong - Di Feng Dong - Xio Zhai Tien Ken - Mie Gong He Dong System.

Firstly, the water in Hei Yau Dong could drain here via hypothetical deep phreatic passages below the floor of Di Feng. Secondly, the geological structure hints that water from the southwest could be following the axis of the Di Feng Dong syncline (Fig.2).

The huge thickness of finely laminated limestones have tended to respond to the tectonic stresses by folding and kinking at the axes and without developing an extensive joint system. For example, along the anticline that houses the downstream Xio Zhai Tien Ken cave, the only persistent joints are those that follow the fold axis and these provide the only route for vadose water. The northern limb of the fold effectively 'seals' the cave waters from the Jiu Pan He that flows at a much lower altitude only 1km to the north. Where joints and faults do occur across fold limbs, they provided important early guidance of river capture through the limbs, as has occurred at the Mie Gong He gorge, in upstream Xio Zhai Tien Ken and along Di Feng (Fig.2).

The drainage pattern is therefore broadly rectangular with major rivers following synclines or the axes of eroded anticlines. On a regional scale, drainage is to the northeast towards the Chang Jiang and rivers in the Xin Long area ultimately drain to the Jiu Pan He, which flows to the Chang Jiang east of Fengjie. Incision of the Chang Jiang and of its tributaries have resulted in spectacular gorges especially where rivers cut through the limestone ridges at capture points. In turn, cave development is strongly influenced by the effect of dropping base level. The active caves are predominantly high vadose canyons and the underground drainage pattern is strongly influenced by captures. This is particularly evident in the case of the downstream Xio Zhai Tien Ken cave and its relationship to the Mi Gong He gorge and the parallel gorges farther east (Fig.2).



The Tian Jing gorge with the 200m-deep Di Feng gorge incised into the bottom. The photograph is taken from a position approximately halfway between Hong Dong and Qian Kong Dong (Fig. 3) and Da Dong can be seen at the base of central cone, just above the road.
Photo: Kev Senior.

In contrast to present hydrological conditions, an earlier phase of cave development was dominated by phreatic conditions predominantly guided by the bedding. Several caves have developed above the disrupted shale that marks the hiatus within the Permo-Triassic limestones. The most significant of these is the relict phreatic conduit of Shrang Fong Dong (Two Winds Cave). In Shrang Fong Dong water once flowed towards the present Tian Jing Gorge. The presence of cave remnants on the opposite side of the gorge suggests that the overall drainage direction might once have continued across the present line of the Tian Jing Gorge. However, there is no clear evidence that the caves on the western bench were inflow caves and there is no cave on the western side to match Shrang Fong Dong. Opposite Shrang Fong Dong there are only the minor caves Kung San Dong and Jio Gan Dong. These observations could suggest that caves east of the Tian Jing Gorge once drained down dip into a phreatic system aligned along the present gorge.

The expedition investigated two main karst systems in the Xin Long area; 1) the drainage system comprising the Tian Jing Gorge, the Xio Zhai Tien Ken doline and the Mie Gong He gorge to the north of Xin Long, and 2) the Tao Yuan He Dong (Peach Forest River Cave) resurgence. The Tian Jing - Mie Gong He system is described first, working northwards from Xin Long towards the Mie Gong Dong resurgence.

Caves of the Tian Jing Gorge

The Tian Jing Gorge can be descended at its southern end, close to the village of Xin Long. At this point the bottom of the gorge can be reached easily using a steep, well-worn path, but the gorge becomes excessively incised a few hundred metres downstream and ropes are required to follow the bottom of the gorge further in a northerly direction. The narrow incised gorge is known as Di Feng, "The Great Crack".

The caves described in this section are listed in the order they are encountered as the gorge is traversed from its southern ends towards Di Feng Dong.

Hei Yau Dong (hay yow dong)
Black Rock Cave

The entrance of Hei Yau Dong (Fig.4) is in the cliff face on the true right bank at stream level, at the point where the path enters the gorge (Fig.3).

A 2m drop inside the entrance lands in a pool of unknown depth. Several athletic climbing moves are required in order to stay dry! The far side of the pool is the lip of an impressive 26m shaft, initially descended against the wall. 5m down, the rope hangs free in a big sloping chamber with large, clean-washed breakdown.

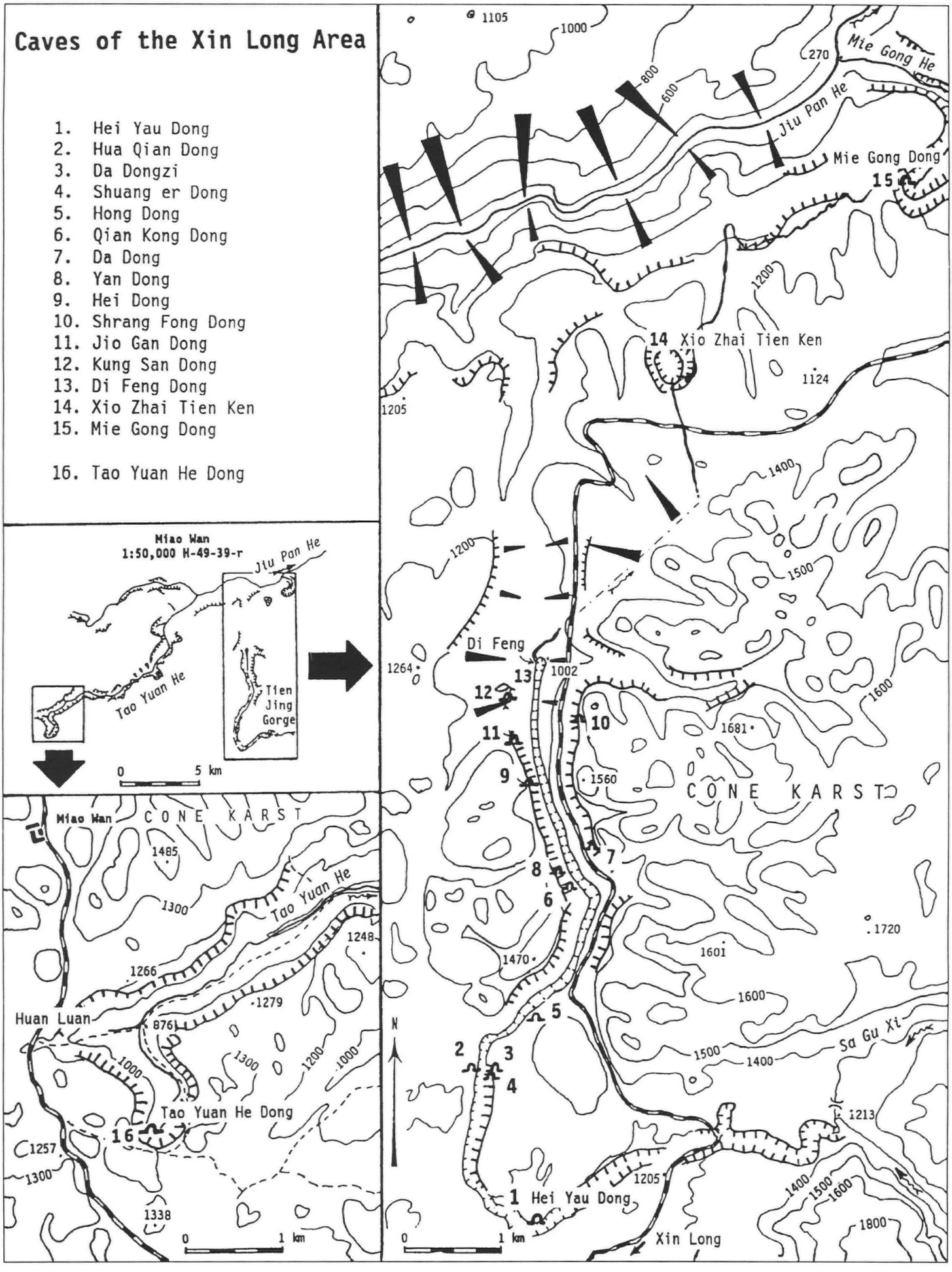


Figure 3. Map of the Tian Jing Gorge and Tau Yuan He areas near Xin Long.

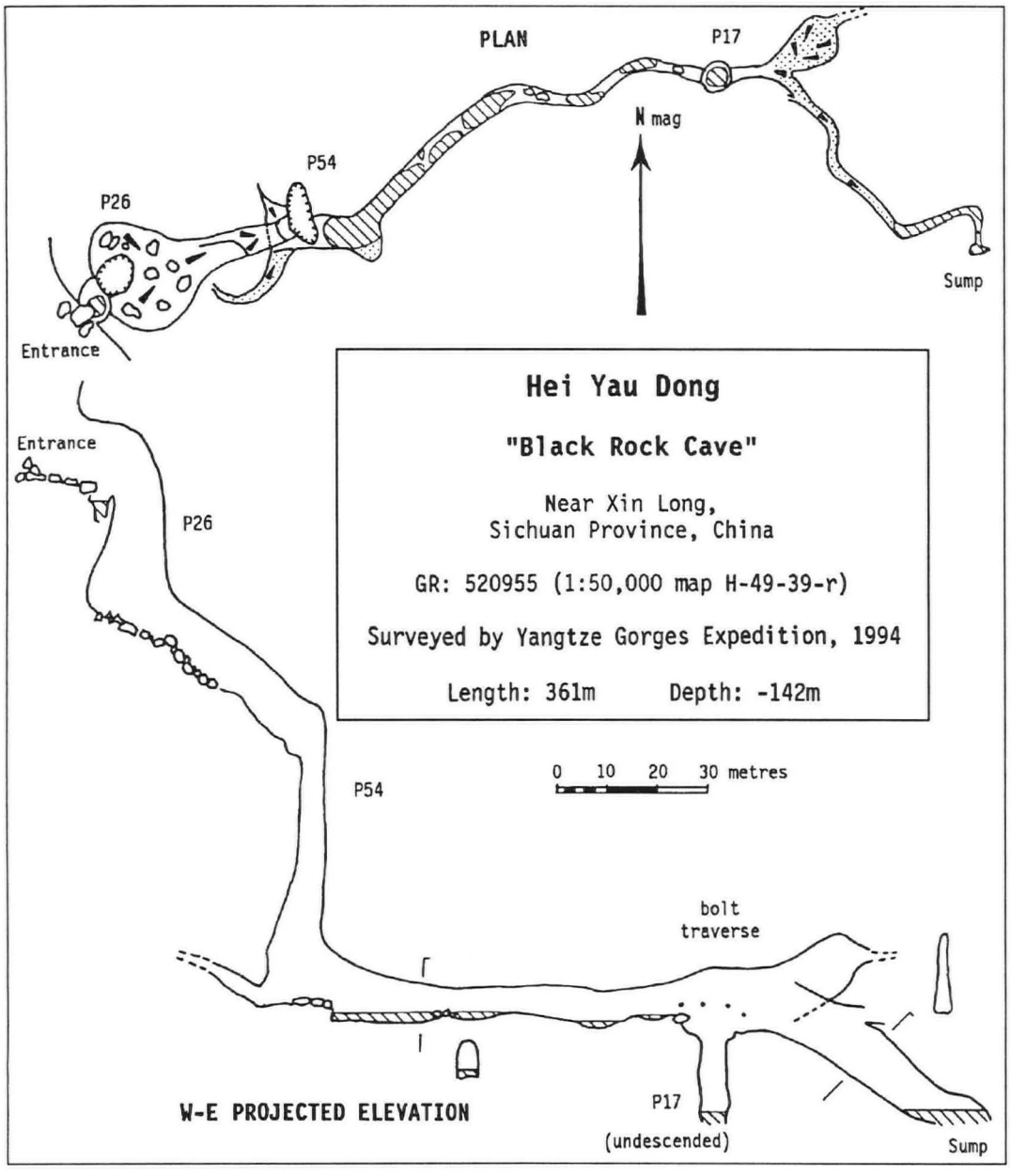


Figure 4. Hei Yau Dong survey.

Giant tadpole from Hei Yau Dong. In the cave environment the tadpoles continue to grow but do not mature into frogs.
Photo: Tony Baker.

The way on is in the northeast corner of the chamber where a smaller stream canyon slopes steeply toward the head of a 54m shaft. From the bottom, the cave continues in still smaller canyon passage, locally as narrow as 3m. Deep pools containing large transparent tadpoles are found in the early sections of this passage.

A short drop leading to a sump is soon reached. Traversing across the drop leads to a junction with a large, sand-filled inlet passage. In a downstream direction a canyon more than 20m high is followed to a canal and, ultimately, a sump.

The water level in the canal fell by 5m overnight and there was a long echo, suggesting the existence of a high-level connection that could by-pass the sump. In drier conditions the final sump might open to allow access to the 'echoing passage'. It is thought that this final sump also connects to the sump at the bottom of the previous drop where the traverse was made. Falling water levels seemed to produce air space, but the drop remains undescended.

Those planning to visit this cave should remember that this expedition took place towards the end of an extremely unusual prolonged dry period, so lower water levels than those experienced by the expedition are unlikely to be encountered.

Downstream from Hei Yau Dong the gorge swings towards the north and after about 700m an obvious path rises some 30m up the west (true left) bank to a monastery, perched on a bench at the base of an impressive cliff. There are four significant cave entrances in this area:

Hua Qian Dong (hua chien dong)
Pray for Money Cave

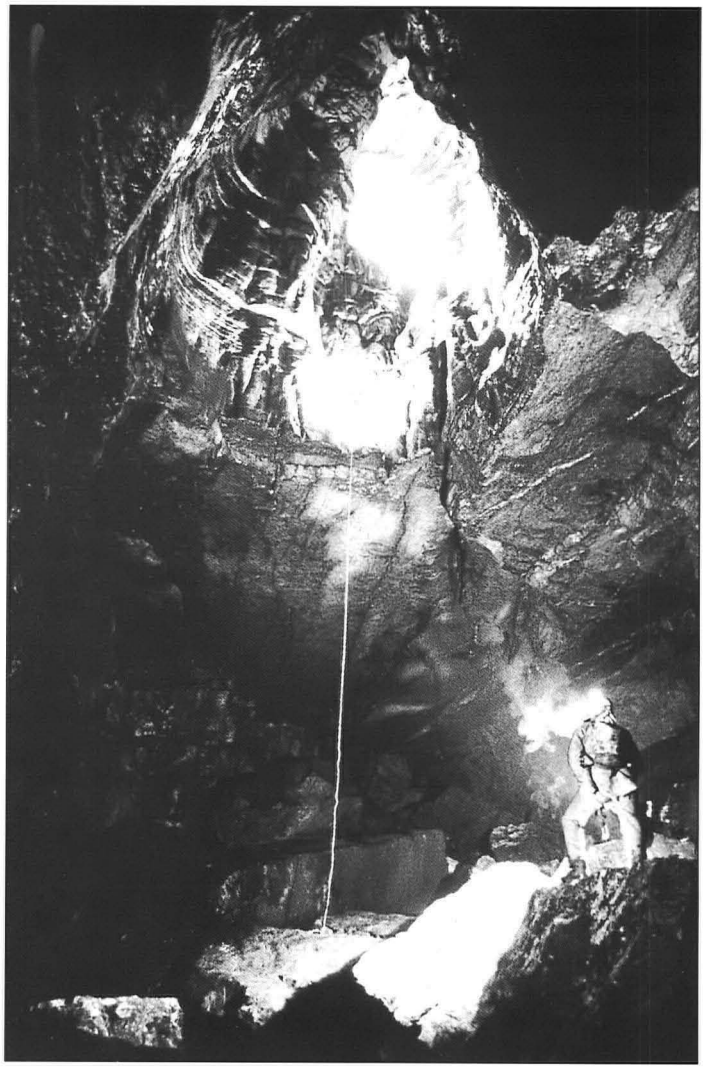
Located to one side of the Buddhist monastery, the entrance is 20m wide and 10m high. A floor of alluvial debris rises to meet the roof 20m in.

Da Dongzi (da dongs)
Big Cave

Da Dongzi is 60m up on the eastern side of the gorge opposite the monastery. An entrance 30m wide by 10m high extends some 30m over massive breakdown to where the roof meets the floor. The whole cave has been mined extensively for nitrate, with well preserved evidence of the activity. A small tube at the back of the entrance chamber leads to a low chamber and a crawl to a tight upward meander emitting a draught.

Shuang er Dong (Shwan ar Dong)
Two Ears Cave

The entrance is on the cliff face, upstream of and at the same height as Da Dongzi. Climbing or abseiling techniques will be required to gain access to the 10m high by 3m wide entrance, which was not explored by the 1994 expedition. From the entrance of Da Dongzi another large cave entrance is visible high above the monastery on the western side of the gorge. This entrance was not investigated. The bench containing the monastery becomes a useful, almost level horizon upon which a path continues down the length of the valley on the true left, western side. The slope below the path drops steeply to the head of the narrow, vertical gorge, Di Feng. The walls of Di Feng become more vertical and the gorge becomes deeper towards the north. Above the path is an escarpment.



The 54m shaft in Hei Yau Dong (Black Rock Cave).
Photo: Tony Baker.

A number of small caves were found at the base of this escarpment, at the level of the path, whilst other, larger cave entrances are located on the opposite side of the valley. Just down valley from the monastery the path crosses a tributary valley coming in from the west, at the point where the Tian Jing Gorge swings north for 2km.

Hong Dong

A wet weather spring is visible on the opposite, southeast, side of the gorge and there are water channel marks on the gorge wall below. Local people report that no cave exists here. Half way along this northeast section of the gorge the road from Xin Long enters the valley on the true right (southeast) side and follows the bench on this side of the Tian Jing Gorge. The Tian Jing Gorge swings around to trend approximately north and the following caves are all located on the pronounced bench, at the foot of the upper cliff.

Qian Kong Dong (chien hung dong)
Many Holes Cave

Qian Kong Dong is a small, bifurcated tube, 1m in diameter, that emits a trickle of percolation water used to supplement the local water supply.

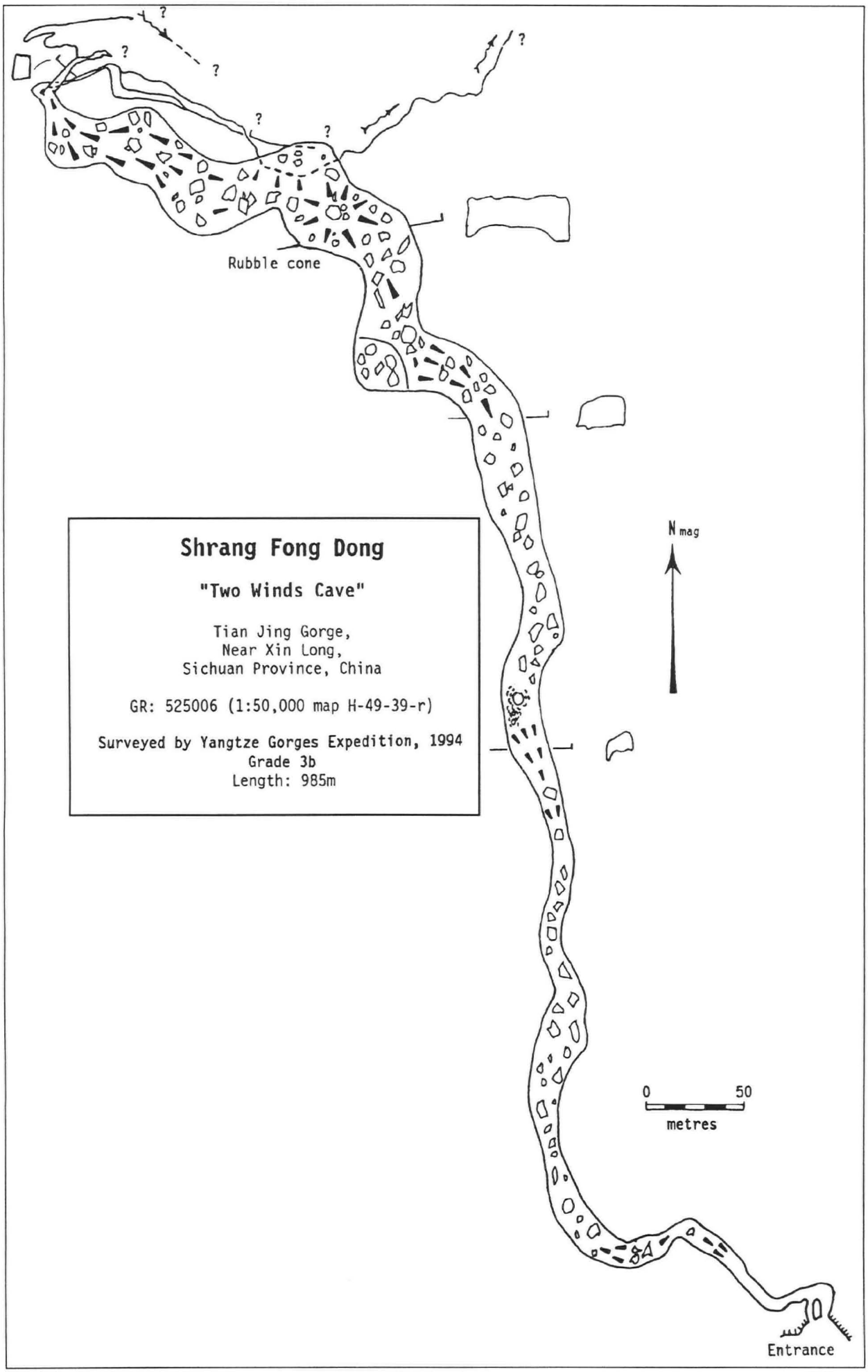
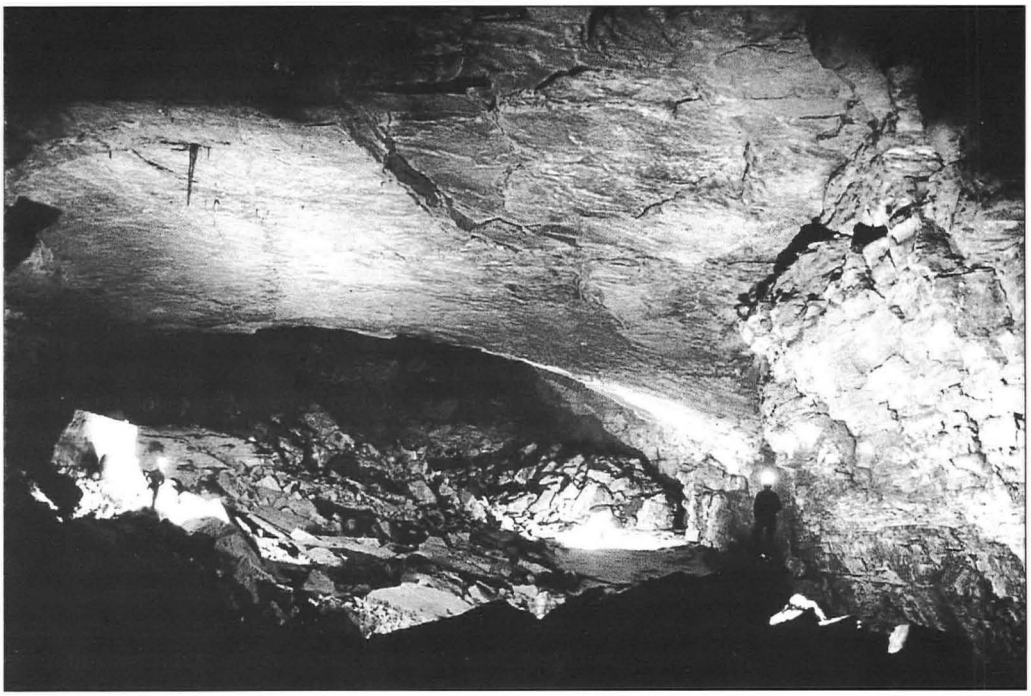


Figure 5. Shrang Fong Dong survey.

The main passage in Shrang Fong Dong (Two Winds Cave) developed down the dip and modified by massive slab collapse from the roof.
Photo: Tony Baker.



Da Dong (daa dong)
Big Cave

Da Dong is on the east side of valley, just above road level. The entrance is approximately 20m wide by 10m high and full of breakdown. The cave was not investigated.

Yan Dong (yen dong)
Rock Cave

A 10m long cave with magnificent scalloping, blackened by fire smoke. This, and a walled, dry, misfit stream bed, suggest that the cave is used as a shelter.

Hei Dong (hay dong)
Black Cave

The entrance is 4m high by 4m wide, but the cave pinches out after 15m. The cave contains a burial pit.

Shrang Fong Dong (shuang feng dong)
Two Winds Cave

Shrang Fong Dong is situated 20m above the road on the true right of the Tian Jing Gorge and is a remnant of a major, phreatic conduit (Fig. 5). The cave gets its name from the strong draught that comes from its entrance. Immediately inside there is a relict trunk passage with much breakdown. With only one or two exceptions the passage is devoid of formations, but there is evidence, in the form of a crude path and a couple of pits, of nitrate extraction. The cave is formed in beds averaging 1m in thickness and there is an impressive rubble cone towards its farthest reaches. At the limit of exploration the main passage is lost amid breakdown within a high relict passage that has been invaded at a low level by an immature, underfit stream. The streamway is still active and was not explored to its end. Apart from this active, invasive series, the cave is a single, wholly relict, phreatic passage.

Jio Gan Dong (jiu gang dong)
Nine Holes Cave

A high canyon passage continues for around 300m through well-trodden passage, before lowering to crawls and low passage for approximately 160m. A dig is possible, but there is no draught.

Kung San Dong (kong shan dong)

The entrance can be seen 15m up a 30m cliff on the right flank of a small tributary valley. Local people say it is only 5m long. Below Kung San Dong, in the bottom of the Tian Jing Gorge, the Tian Jing river sinks and the incised Di Feng gorge ends. To the north a dry valley continues with the same profile as the upper section of the Tian Jing Gorge. It is possible to take a path down to a hamlet in the valley floor. From there a path leads south to regain the Di Feng gorge at the point of exploration whilst another continues up the eastern side of the gorge to meet the road from Xin Long.

Di Feng (dee feng)
The Great Crack

A bare limestone trench 10m wide, with a lush vegetation canopy, descends in a series a short steps to a platform overlooking a 180m drop. The platform overlooks a roughly circular 70m diameter shaft with a notch in the southern wall where the upstream gorge enters. Daylight illuminates the shaft for its entire depth, making the bottom clearly visible. The local people observed our descent of the shaft by hanging on to thin saplings and leaning far out over the edge, sometimes holding their children out for a view! The free hanging shaft drops 140m to a rebelay then a further 40m drop gains the floor. To the south is a lake holding water from the upstream Di Feng Gorge, which is developed along a major north-south joint. At Di Feng Dong, the Di Feng Gorge is offset slightly to the southwest by two prominent joints striking approximately 045°. These are clearly seen in the northeastern

wall of the shaft. The cave entrance is a 100m-high, 20m-wide archway and banks of cobbles and sediment 2 to 3m high lead to a deep lake. The scale of Di Feng Dong allows daylight to penetrate with little loss of intensity to the beginning of this lake.

The lake can be crossed with some difficulty using lorry inner tubes for buoyancy. Daylight is lost after 150m and the lake extends for 240m to a huge boulder that partially blocks the passage and supports a cobble beach. Water was flowing here, but owing to the dry weather conditions no water was flowing from the upstream Di Feng Gorge. It appears, therefore, that water must be rising somewhere in the lake. From the beach a short swim through a gap on the left of the boulder is followed by a 5m climb up over smaller boulders into a 10m-wide passage. The way on becomes difficult where a boulder lip bars the passage, but this can be passed on the right through a squeeze between wedged boulders. The squeeze is immediately followed by a waterfall over a rock lip that can be easily passed on the right to regain the main stream level. Deep but very short pools necessitate periodic use of buoyancy aids. At the limit of exploration a boulder fall forms another short pool, where a lack of float line prevented safe progress. A polypropylene float line across the lakes is essential, because it is impossible to swim or paddle against the current.

Di Feng Dong has no obvious inlet passages but small amounts of water percolate through roof fissures where the overlying strata are less than 80m thick. The cave now trends at approximately 045° towards the end of upstream Xio Zhai Tien Ken and is thought to be developed along joints close to the axis of a syncline (Fig.2). The distance between downstream Di Feng Dong and upstream Xio Zhai Tien Ken is about 2km, with a vertical drop of about 90m.

Xio Zhai Tien Ken (shio jai tien kn)
Big Sky Hole Behind the Small Village

Xio Zhai Tien Ken is located approximately 10km north of Xin Long (Fig.3). The road north from Xin Long follows the Tian Jing Gorge, then turns east about 2km north of Di Feng Dong and passes close to the southern margin of Xio Zhai Tien Ken. From

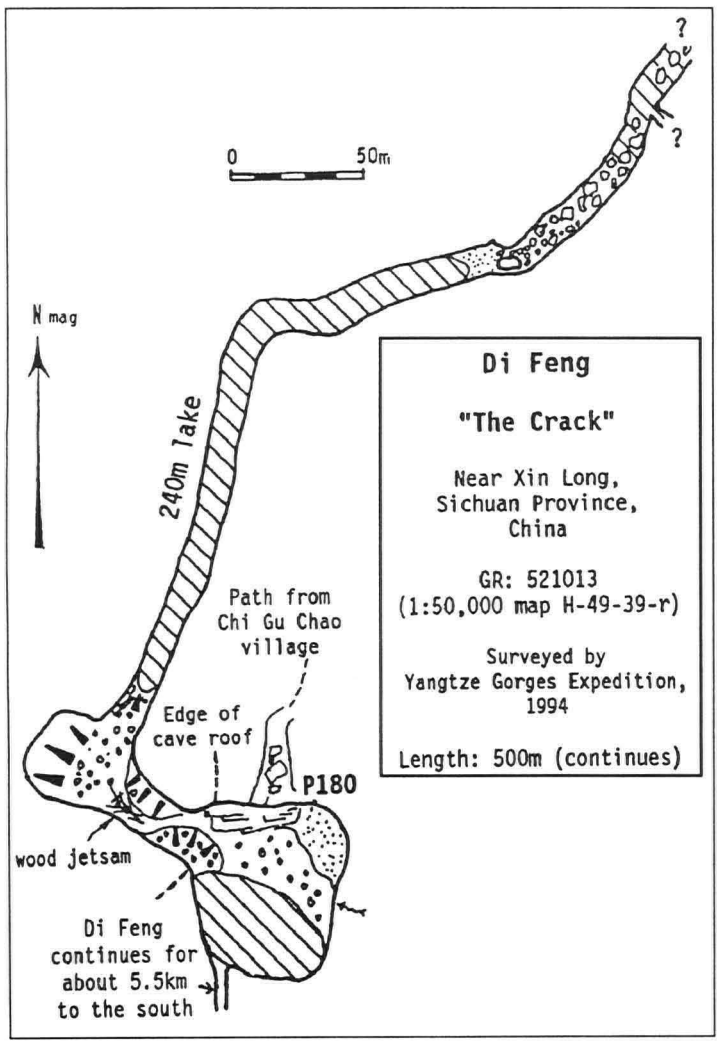
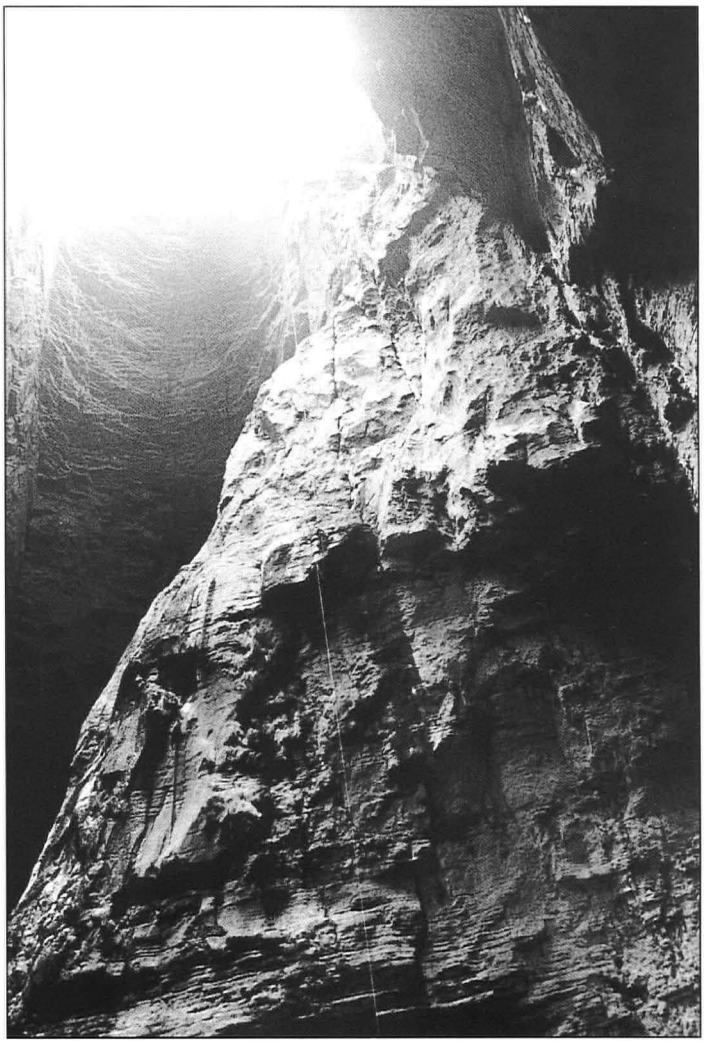


Figure 6. Di Feng Dong survey.



The entrance shaft of Di Feng Dong; 140m to a rebelay near the centre of the picture, where a figure can just be seen, then 40m to the floor. The cave goes into the darkness on the left and the joint that guides the cave defines the left hand wall.
Photo: Kev Senior.

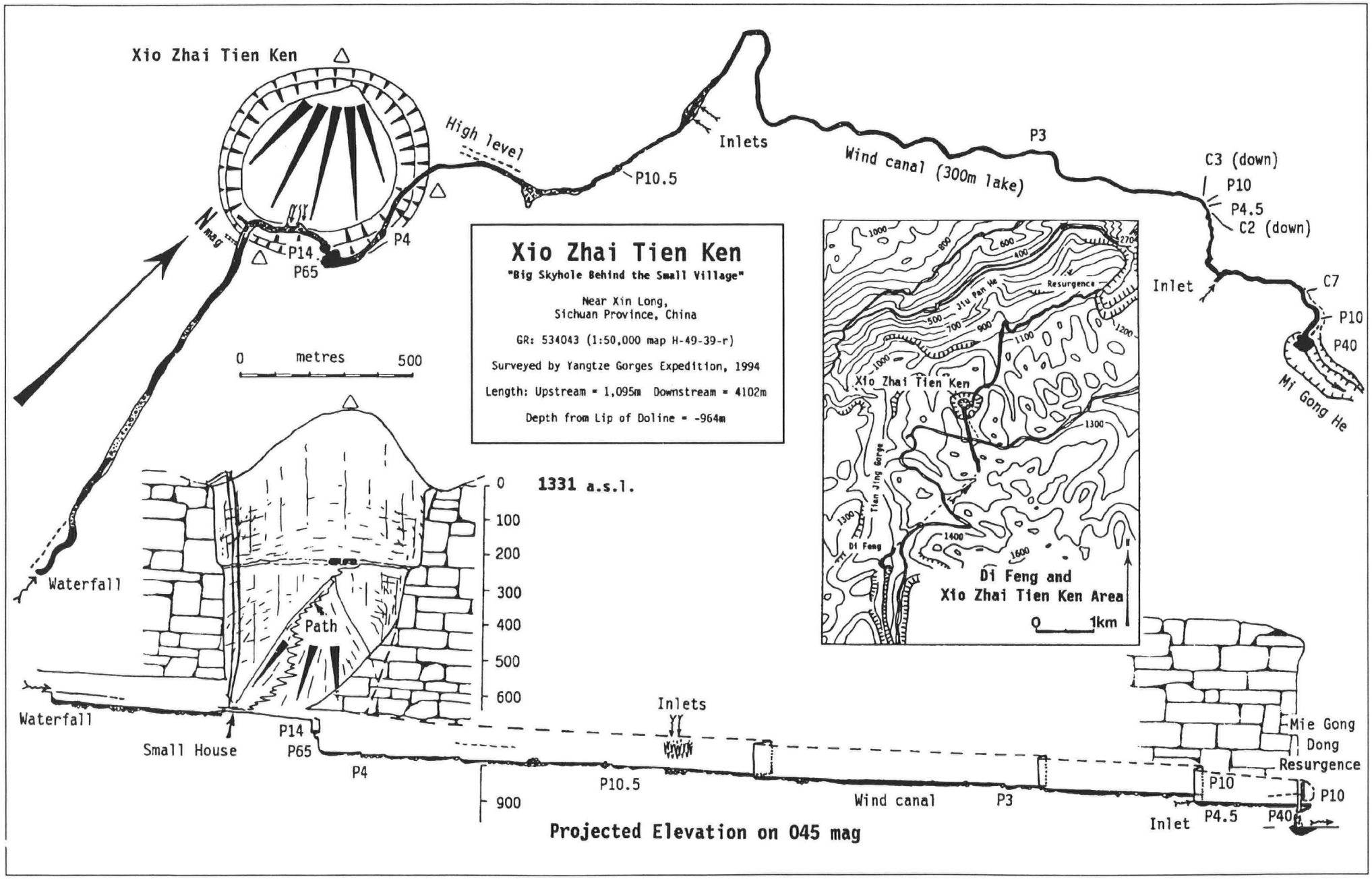


Figure 7. Xio Zhai Tien Ken survey.

the road, a path leads north over a col between two karst cones, descends for about 1.5km past some small settlements, then arrives at the southeastern edge of the doline. Access to the doline is via a locked gate.

Xio Zhai Tien Ken is the deepest recorded doline in the world and the largest by volume. Its statistics are described in Appendix A, but in summary the doline is 583m in diameter, 668m deep, and its volume is approximately 135.3 million cubic metres. Waltham and others (1993) discuss the sizes of several of the world's largest dolines and Xio Zhai Tien Ken has a greater volume than all of these except the Garden of Eden in Sarawak. Waltham and others (1993) note, however, that it is arguable whether the Garden of Eden is a true doline.

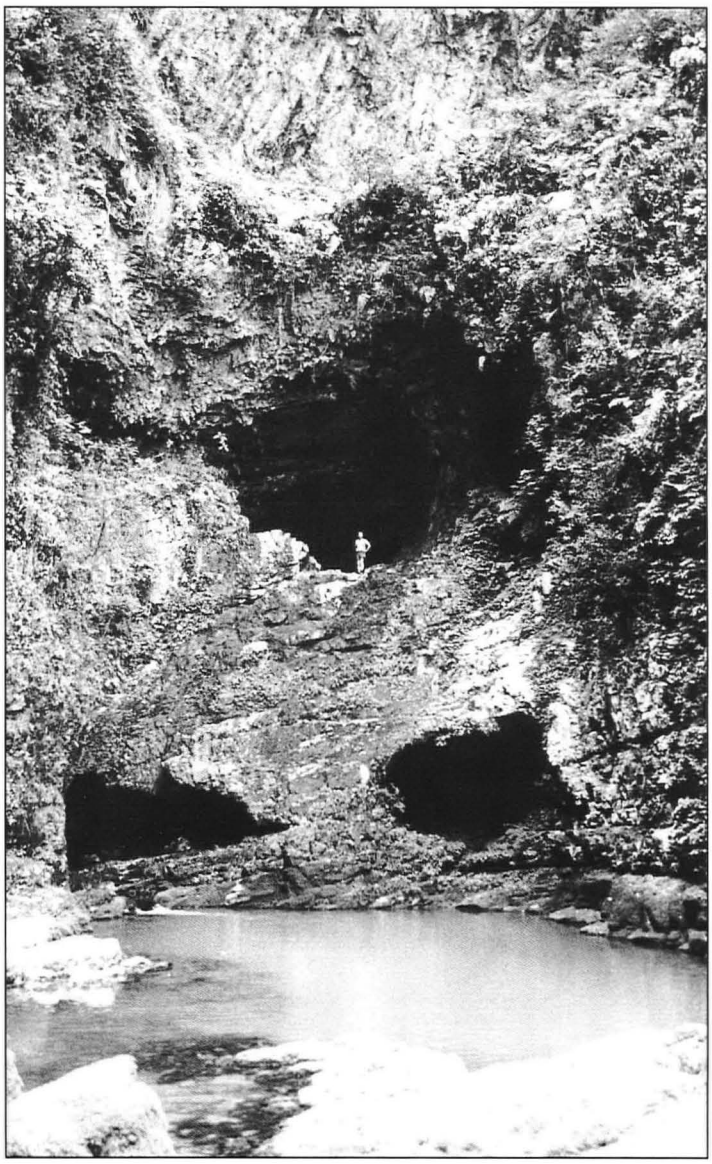
In the bottom of the doline a river flows out of the upstream Xio Zhai Tien Ken cave, and sinks again in downstream Xio Zhai Tien Ken cave. The river has been dammed near its exit from the upstream cave and a tunnel diverts the water to a hydro-electric power station 3km to the north in the Jiu Pan He valley. The exceptionally dry weather conditions during the expedition meant that the river was dry below the dam, and this facilitated the exploration of the downstream cave. Massively bedded Permo-Triassic limestones make up the wall of the doline but the vertical walls are interrupted by a ledge that is formed where there is an outcrop of disrupted, multi-coloured shales with limestone boulders. This deposit has the chaotic structure typical of an olistostrome.

The path enters the doline above the downstream entrance and descends 200m past some rock shelters, one of which has a water supply. The path then skirts anti-clockwise half way around the shaft down to the ledge where there is an abandoned barracks that was used as accommodation by the tunnelling workers. From this point it can be seen that the entrance of the downstream Xio Zhai Tien Ken cave lies on two prominent joints. These joints strike approximately 045° and are parallel to the axis of the anticline that extends to the Mie Gong He Dong resurgence (Fig.2). The upstream Zio Zhai Tien Ken cave follows another joint with a more northerly strike. The doline is therefore located at the intersection of the two major joints, a situation analogous to that at Di Feng Dong. It is possible to traverse further along the ledge to two cave entrances. The second is only a shelter with excavations in the floor and signs of habitation but the first entrance continues for about 450m. A descending phreatic tube has developed above the multi-coloured shale. The tube becomes incised with a vadose canyon until it reaches a 40m-wide breakdown chamber. A 25m shaft in the floor of this chamber remains undescended. From the barracks, the path descends a steep section to the top of a debris cone that extends to the bottom of the shaft (Fig.7).

At the mouth of the upstream passage, beside the dam, is a two room, brick built cottage having both an electricity supply and a telephone link to the hydro-electric power station. This doline station is manned continuously and can be made available as accommodation.

Upstream Xio Zhai Tien Ken

The cave upstream from Xio Zhai Tien Ken is impressive because of its size and simplicity: a 'die-straight' passage, 110m high, up to 30m wide and 900m long. Inside the 110m-high by 30m-wide entrance and over the dam, a lake continues for 45m to the first boulder pile in a 15m-wide passage. From this point the roof can no longer be seen, even with powerful diving torches. It is assumed that the roof height remains constant up to the limit of exploration. A second, 65m, lake is followed by 95m of cobble beach to a third lake, which is 200m long. From here, a boulder passage continues for 180m with the left wall (facing upstream) leaning outwards at 10°, indicating that the passage is much wider at roof level. A ledge on the left wall soon peters out and a fourth lake (120m long) leads to more boulders in a 12m-wide passage with a ledge on the right hand wall. At this point, the dim light of the entrance can still be seen some 900m away. The passage swings left to lake five then back onto its original trend. A further 90m on the passage narrows, forcing the river to increase its speed between walls 3m apart. At this point, 1.1km from the entrance, the water flow is too fast to swim or paddle against, and this prevented further exploration. From the ledge at the 900m point, easy climbs and traverses gain height until the canyon widens out. From here, forward progress can be made for about 100m across a steep slope



The Tau Yuan He Dong resurgence. The phreatic tubes follow the strike of dipping beds, with the axis of the anticline to the right. Photo: Tony Baker.

of mud and boulders before the hazardous nature of the situation forces a halt. Further progress across the remaining 60m of loose boulders to regain the lip of the canyon will require careful rigging with dynamic ropes and it will probably be easier to explore downstream from Di Feng.

Tau Yuan He Dong (tao yuan hay dong)
Peach Forest River Cave

Tau Yuan He Dong (Fig.8) is a large resurgence cave situated at the head of the impressive Tau Yuan He gorge. The cave is reached by taking the road westwards from Xin Long towards Miao Wan, stopping in a region known as Huan Luan, and descending a steep path to the valley floor (Fig.3). The stream that flows from the cave entrance is immediately channelled away into a canal by a dam. There is no way in to the cave via the stream entrance, but a small upper entrance leads to a sandy passage, then past some formations and through a series of pools to a larger passage where the stream is met. Just before this point two windows lead down to flowing pools, but these sump in both directions.

The main stream, which is met at the bottom of a greasy boulder and mud slope, also sumps in a downstream direction. Part of the flow can be followed for about 60m upstream in a southwesterly direction before it is lost again, emerging from another sump. The way on is up to the right over boulders and through two boulder-strewn chambers until the main stream is met again, flowing from the northwest. Here it is necessary to swim a series of lakes. After the first lake an inlet on the right can be followed for some distance. The inlet stream flows through thick mud and is only of crawling height until a small, muddy chamber is reached. Beyond this point the inlet continues in similarly sized passage.

Back on the main route, a second lake demands further swimming and beyond a sand bar a third, longer, lake ensures that explorers are wet. Following the lake around a left hand corner in deep water with limited air space, a rocky shelf affords a resting place before a final deep pool into which a 5m waterfall empties. The waterfall is defended by several overhanging ledges but a large passage can be seen continuing beyond. This waterfall was not climbed due to lack of time.

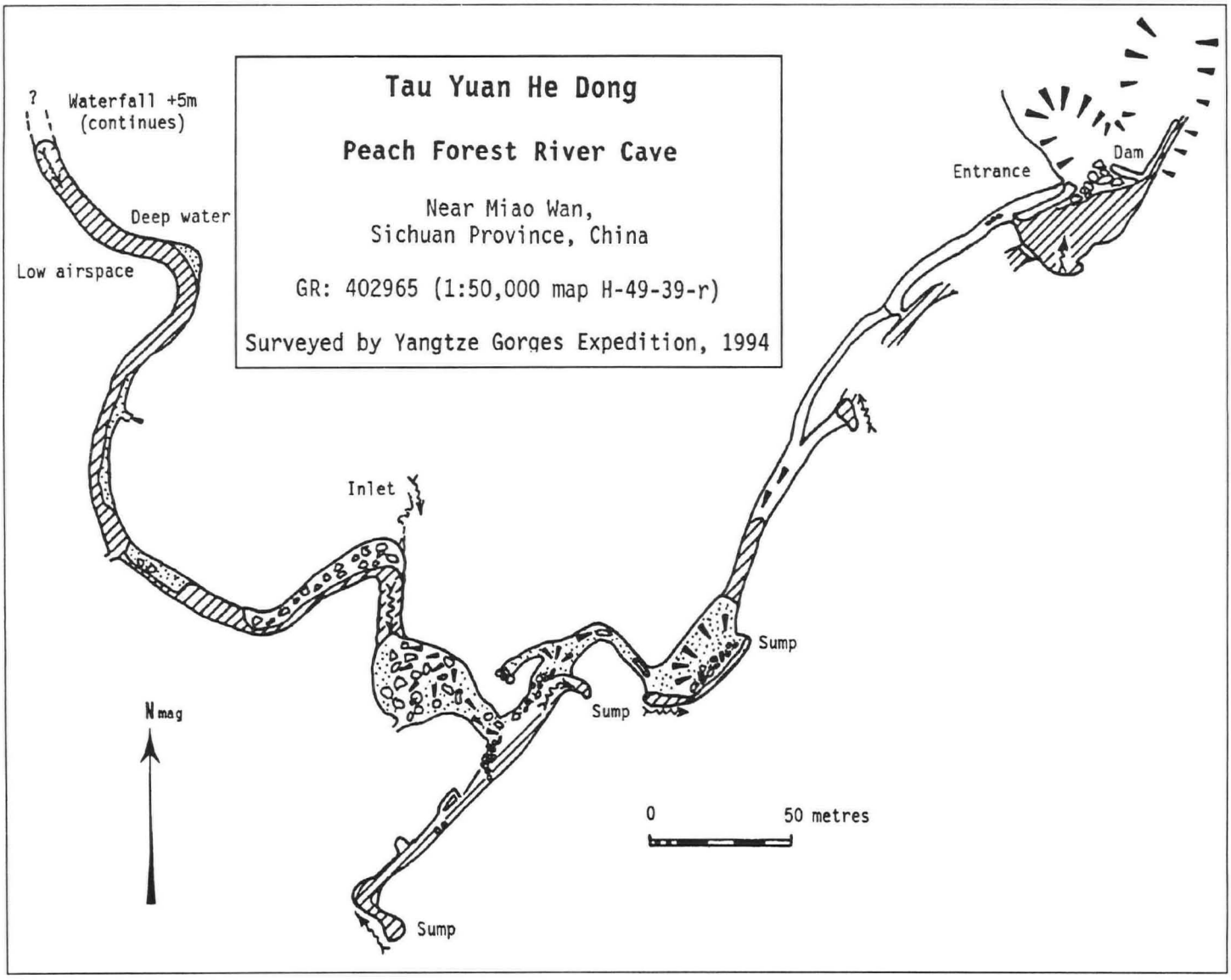


Figure 8. Tau Yuan He Dong survey.

Looking southeastwards across the Tau Yuan He gorge, which is developed along the axis of a gentle anticline. The Tau Yuan He Dong resurgence is at the head of the gorge. Photo: Kev Senior.

View from the Yitz village looking west towards the Mie Gong He gorge. In the distance, the water from the Mie Gong He resurgence comes in from the left and then continues along the Mie Gong He gorge to the right. The Mie Gong He is a capture, and the river once flowed towards the camera position. Photo: Kev Senior.

Tau Yuan He Dong is a major resurgence but owing to lack of time during the expedition its exploration remains incomplete. Careful study of the karst to the southwest should reveal the sinks that drain to Tau Yuan He Dong and there is potential for a system several kilometres long.

Stalactite Cave

'Stalactite Cave', Chinese name not known, had been visited as part of a study of the variation in the Earth's magnetic field. Photographs showed some spectacular formations, so the likelihood of finding good samples appeared to be excellent.

Stalactite Cave is situated 200m up the hillside to the north of and directly behind the village of Yitz (Fig.2). The cave is reached by traversing around the base of a 10m cliff on a small ledge. The entrance portal is gated and a short wooden ladder was used to climb into the initial rift passage. A steeply descending and slippery rift passes through one squeeze and appears at the top of a slope in a 2m-wide, 7m-high tube. To the east the passage enlarges and pits in the floor make it awkward to progress. The passage terminates in chokes of mud and sand after 60m. To the west the roof rises to leave an impressive box-shaped passage with a gently sloping, damp, mud floor. A spectacular flowstone complex is passed on the left after 120m. At this point the way on is approximately 30m wide with numerous formations. Two large pits in the floor are passed at the widest point and the passage narrows to 5m before opening out again into its final chamber, with no way on. Much of 'Stalactite Cave' was originally well decorated but the formations are now almost completely destroyed. No samples were taken from this cave since no suitable formations remained intact.

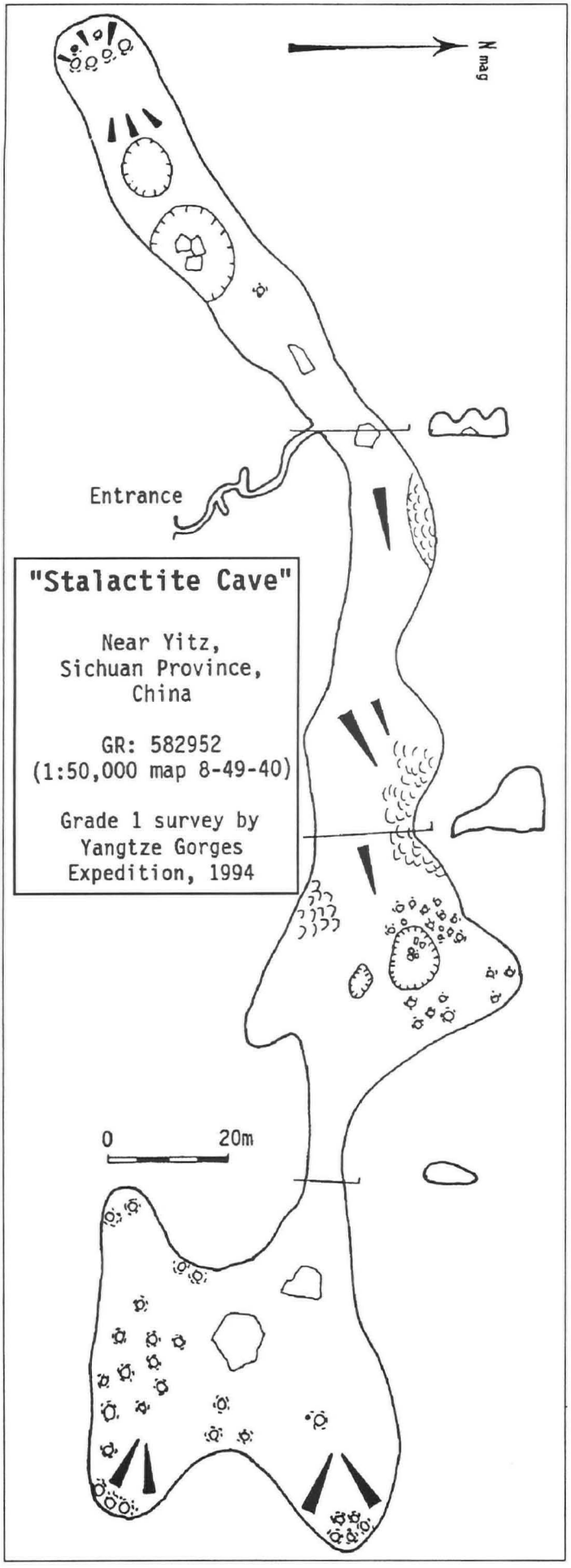


Figure 9. Stalactite Cave survey.

Green Eyed Monster Cave

Green Eyed Monster Cave can be found by walking away from the centre of Xin Long, about 200m past the government hostel, and turning right through the fields for a further 200m and into the trees. This cave has a strange legend attached to it. According to the story, a green-eyed monster lived in the depths of the cave. In the 1950s, a hen was lowered down in a cage and the monster ate the cage and all! Next, a hot cooking pot was lowered down. There was a terrible noise and for days afterwards there was an awful smell from the hole. Whatever the truth of the story the hole is speleologically interesting because stones thrown in rattled down for fourteen seconds. No accurate estimate of the depth could be made because the stones bounced on ledges and it was too overgrown to see into. There was no time to explore the shaft; perhaps this was fortunate, because the stones would certainly have annoyed the monster!

CAVES OF THE JIANG KOU AREA

Geology, geomorphology and cave development

The landscape around Jiang Kou is dominated by two major rivers: the Wu Jiang and the Furong Jiang (Fig.10). A major fault runs north-south just west of Jiang Kou and the Wu Jiang follows this for part of its course. Approximately 500m of Permo-Triassic limestones are thrown down to the west of this fault, which is responsible for the 1250m-high escarpment above the west bank of the Wu Jiang. The Wu Jiang turns northwest at Jiang Kou, cutting a gorge through the dip slope of the Triassic limestones. To the east of the fault the Triassic limestones rest unconformably on Palaeozoic formations and form an outlier in the hills north of Jiang Kou. The Palaeozoic formations consist of Silurian and Ordovician shales, but beneath these are lower Ordovician and Cambrian limestones. The Triassic limestone cover has been eroded from the karst plateau above the Furong Dong show cave and all the caves shown in Fig.10 are developed within Cambrian limestones. Expedition explorations concentrated on the Cambrian plateau and only a few visits were made to the Triassic limestones. In summary, the structure of the Cambrian limestones consists of folds with north-south axes, associated reverse faults, and major joints trending east-west. This means that here, as in the Xin Long area, water must flow across the geological structures to reach base level in the Furong Jiang. Consequently joints that cut through the folds provide very important guidance to cave development.

The new extension discovered by this expedition in Furong Dong (Fig.11) provides a window into the active phreas 200m below. The big chamber at the end of the extension is defined by two prominent faults, one of which strikes about 050° and dips to the northwest and a second that is vertical and strikes east-west. The east-west fault almost certainly takes the water towards a resurgence near English Speaker's Cave. There is no obvious resurgence in the Furong Jiang, but while rafting down the Furong Jiang, an abrupt reduction in the water temperature was noticed below Furong Dong. English Speaker's Cave is known to be an important resurgence in very wet weather, so it is presumed that the deeper phreatic system resurges beneath the surface of the Furong Jiang, somewhere near to English Speaker's Cave.

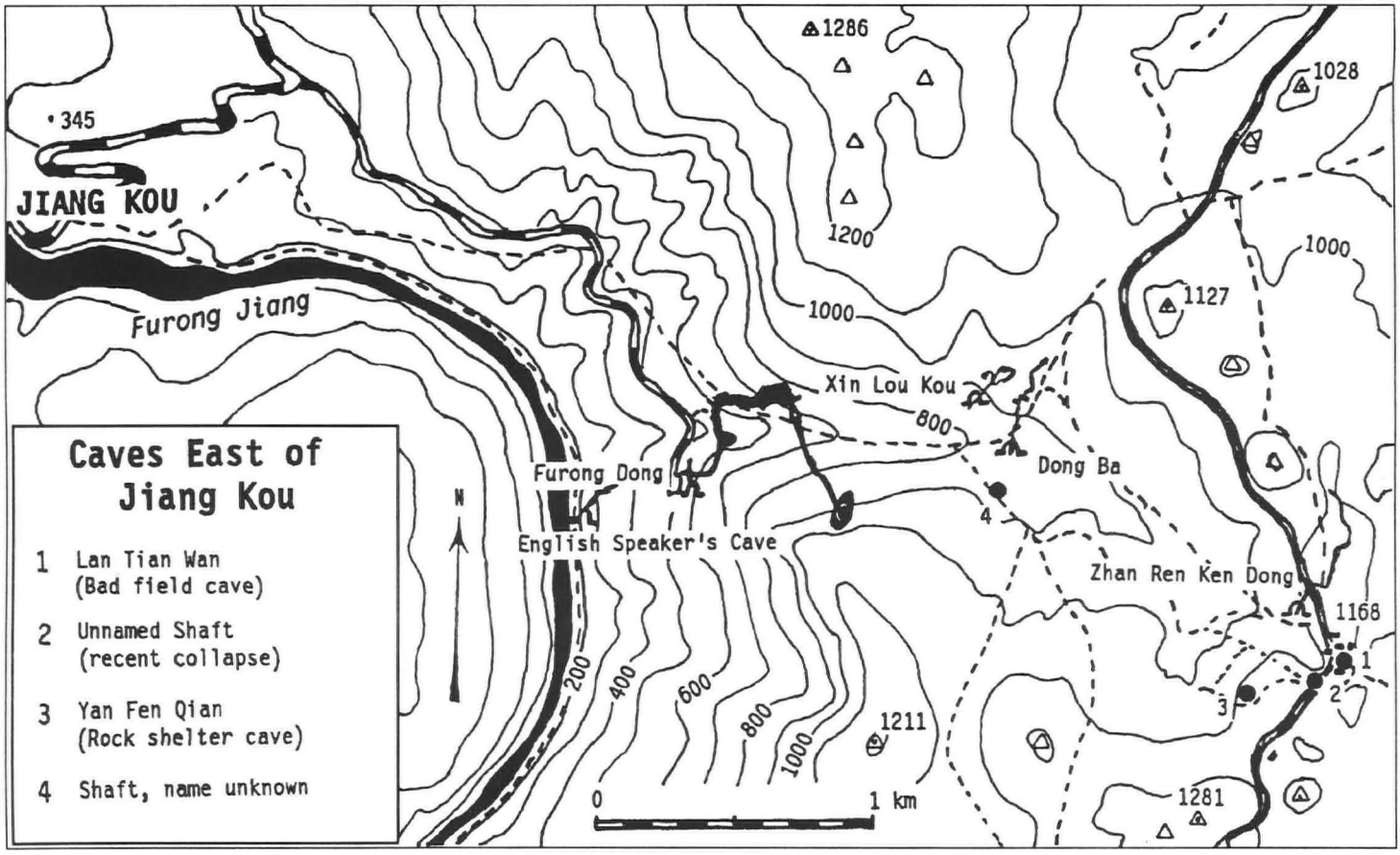


Figure 10. Map of the Jiang Kou area.

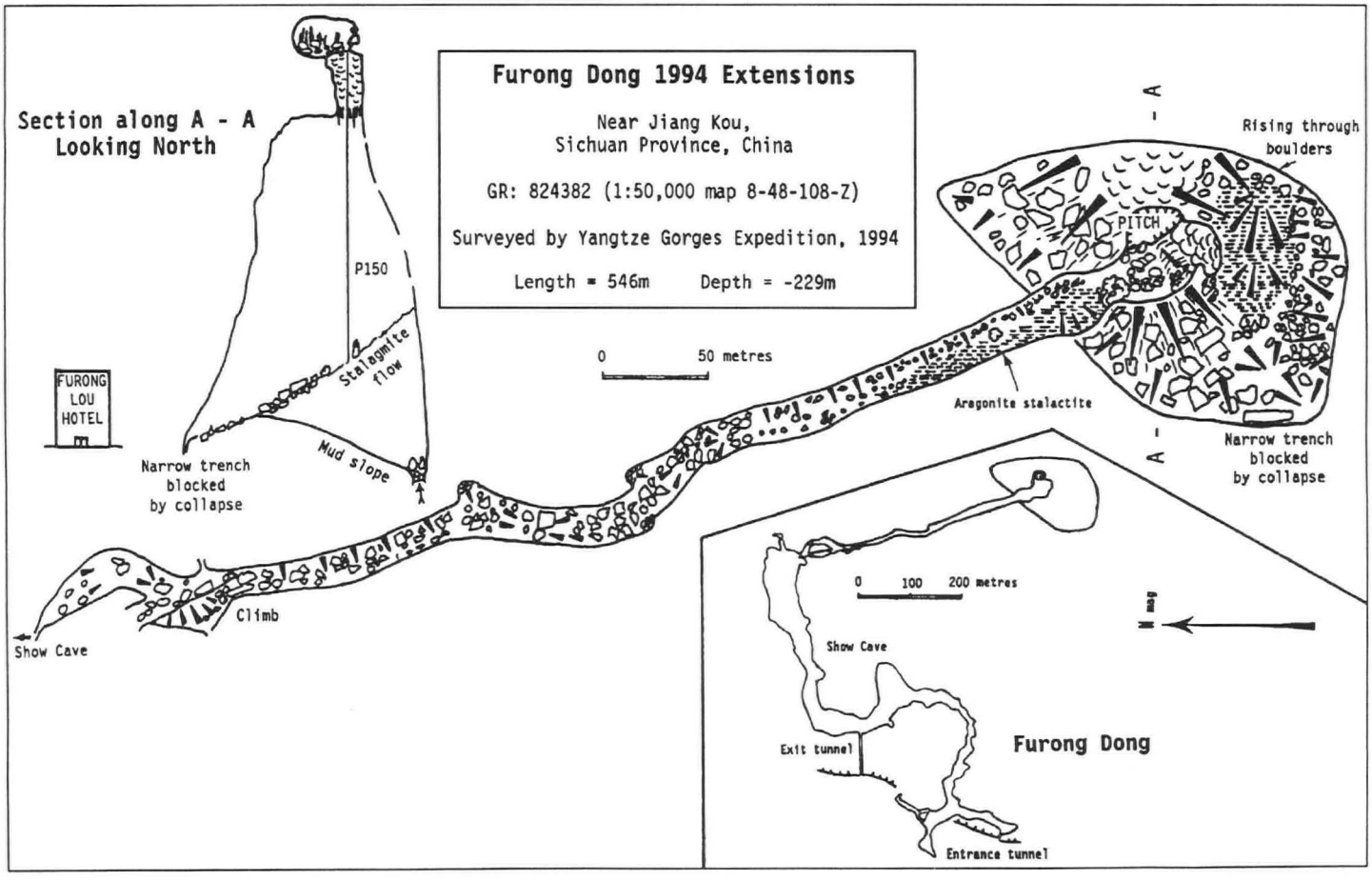
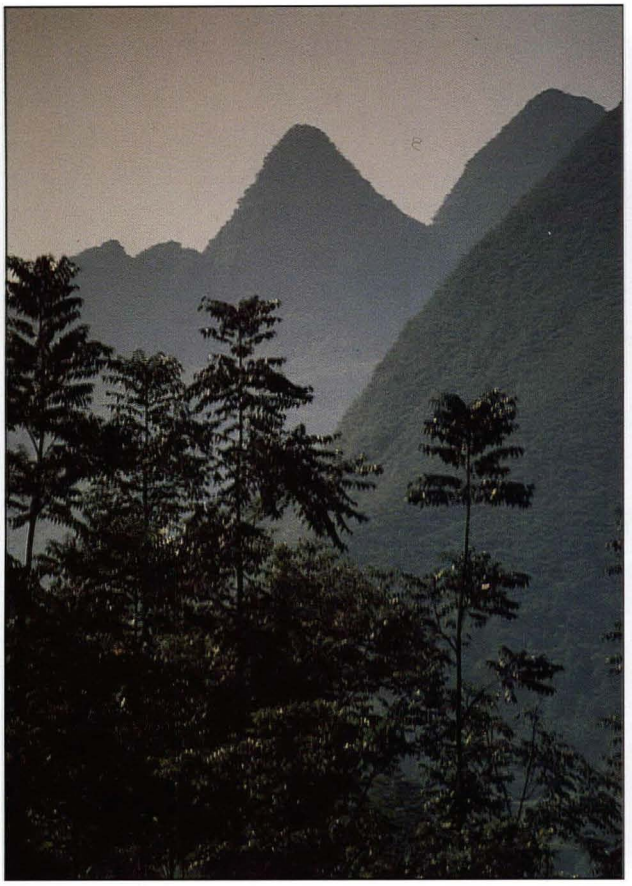
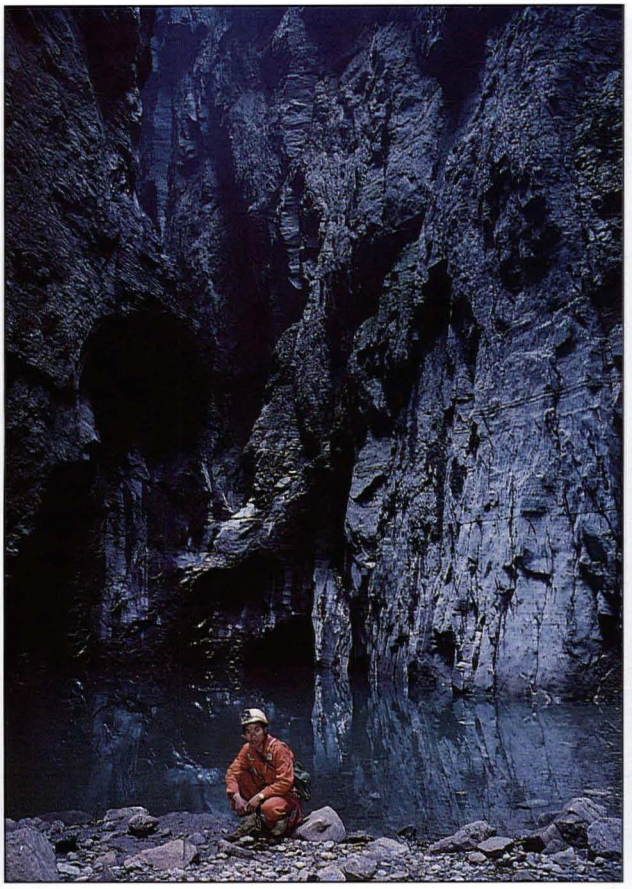


Figure 11. Furong Dong Extensions survey.

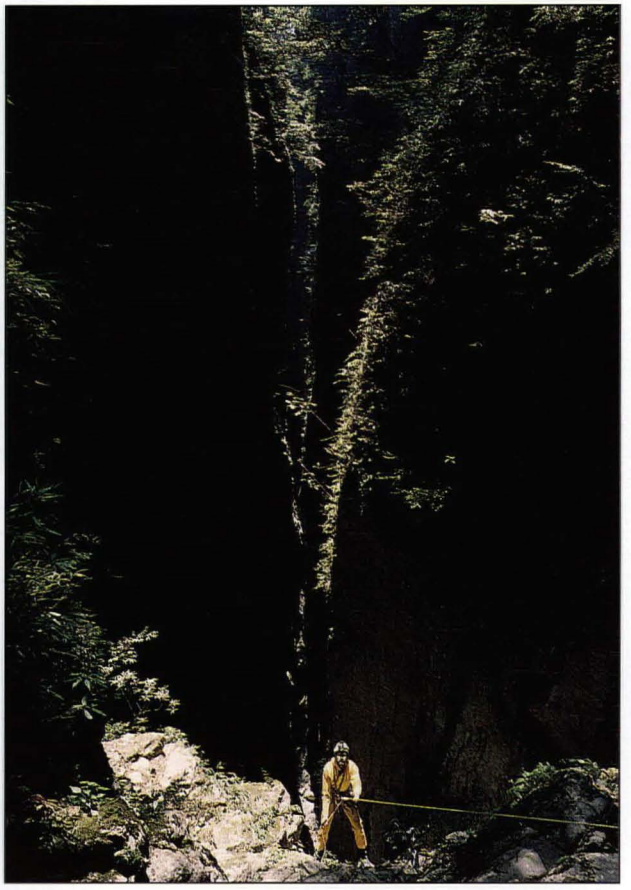


Cone karst near Xin Long.
(Photo: Kev Senior)

The Mie Gong He gorge looking towards the head wall. Mie Gong He Dong, the end of the through trip from the Xio Zhai Tien Ken doline, is around a corner on the right at the end of the gorge.
(Photo: Kev Senior)



Zhang Yuan Hai at the bottom of Di Feng, the Great Crack
(Photo: Kev Senior)

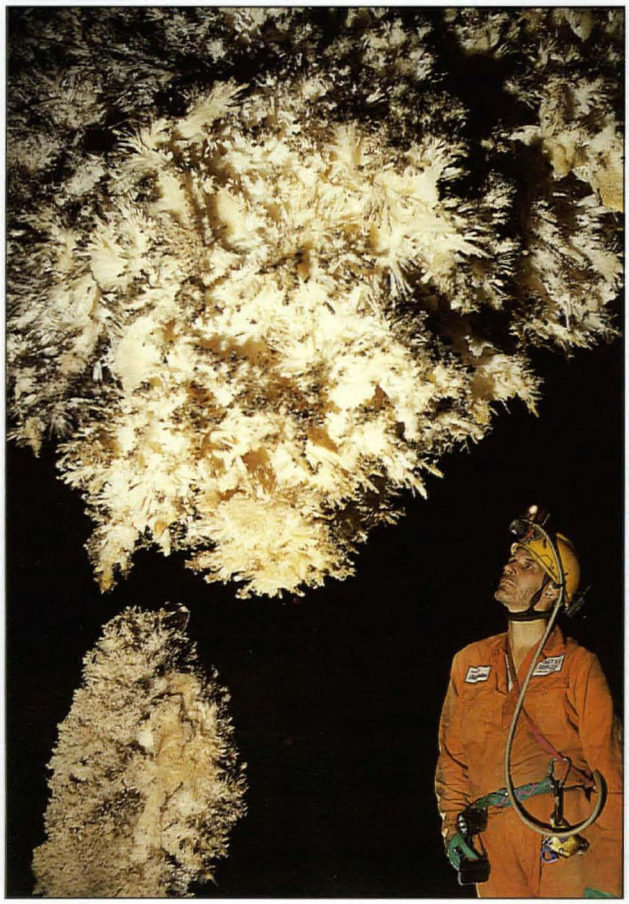


Steve Openshaw about to descend the 180m Di Feng Dong entrance shaft (Photo: Kev Senior)

Phreatic tube in Tau Yuan He Dong (Photo: Tony Baker)

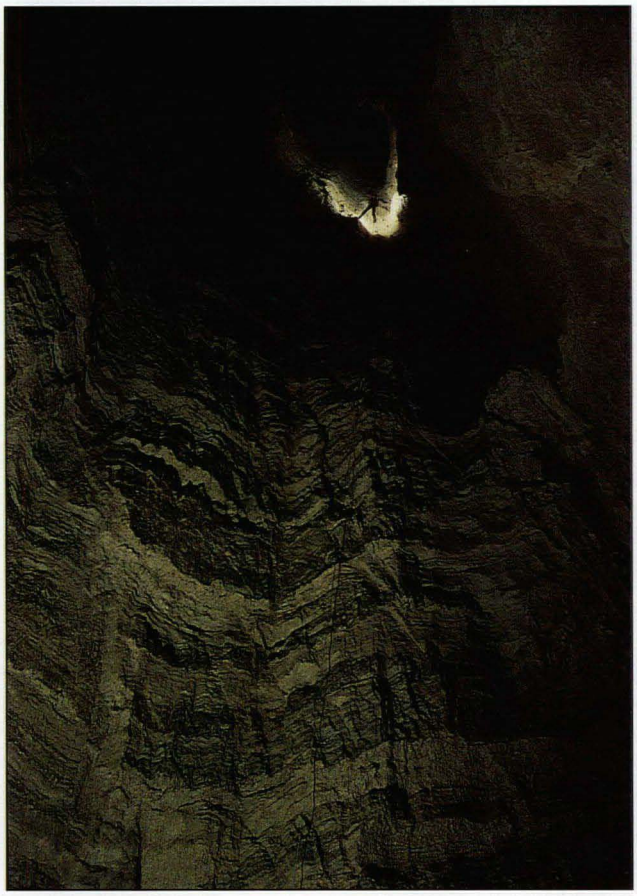
Dave Checkley at the bottom of the first shaft in downstream Xio Zhai Tien Ken (Photo: Tony Baker)

Columns near the end of Furong Dong extension (Photo: Tony Baker)

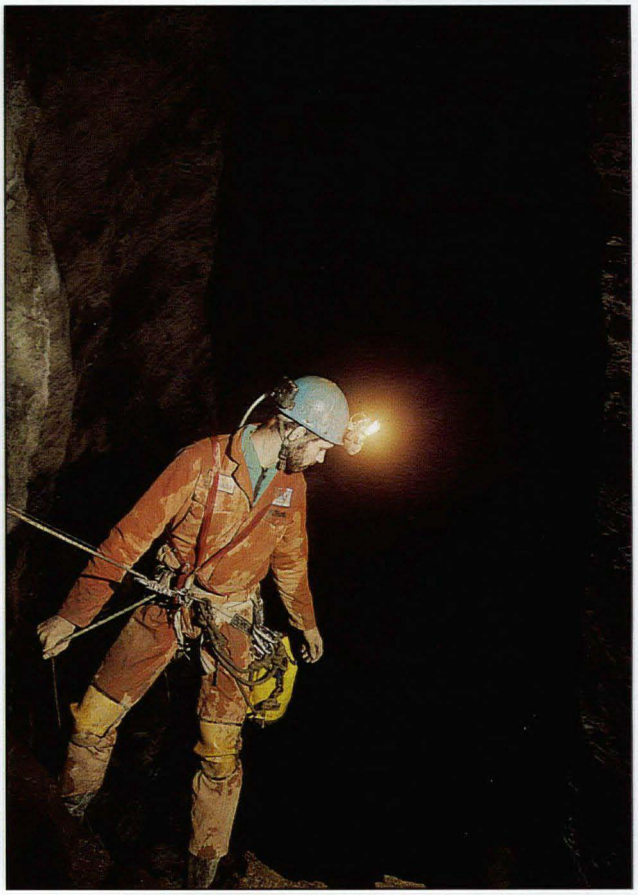


Aragonite chandelier in the Furong Dong extension (Photo: Tony Baker)

Skeleton of a woman in Fu Lin Dong (Photo: Paul Seddon)



Looking up the 139m shaft in Xin Lou Kou Dong (Photo: Kev Senior)



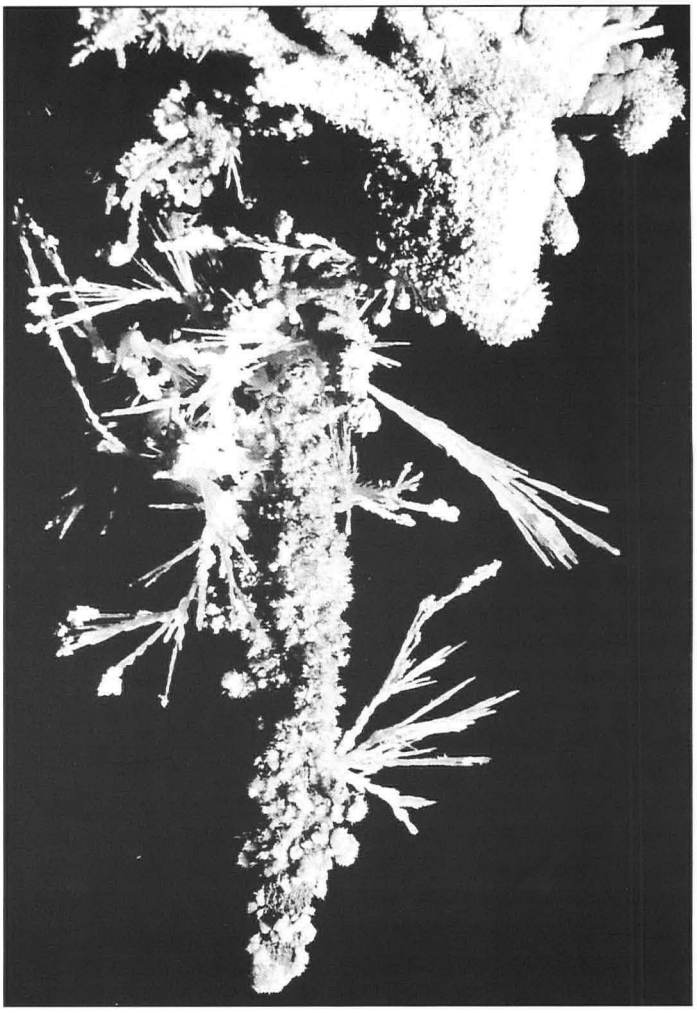
Steve Openshaw at the top of the 139m shaft in Xin Lou Kou Dong (Photo: Kev Senior)

The main passage in Shui Lean Dong (Photo: Tony Baker)

Several streams sink in the valley that runs from Tian Xing towards Furong Dong, but Zhan Ren Ken Dong, Dong Ba and Xin Lou Kou are all developed down dip, perched above thin shale beds. All three caves trend northeast, away from Furong Dong. However Xin Lou Kou Dong doubles back under itself, so it is possible that all these caves are tributaries to a major system that will link with Furong Dong. There are many unexplored shafts on the plateau. Of those visited, the unexplored shaft numbered 4 on Fig.10 is in a particularly promising position to drop into the passages presumed to exist east of the terminal choke in the Furong Dong show cave.

Furong Dong

Furong Dong show cave is a major, relict resurgence cave modified by collapse and speleothems. The main show cave terminates in a huge boulder pile but a small passage leads south through a crawl and down into a side passage with a very different character. The massive speleothems of the show cave are absent and the floor is covered with aragonite needles. A crystallised bat skeleton, some large bones and some teeth from a panda were discovered beneath a climb that leads into the extension. The extension is a relict phreatic passage, approximately 15 to 20m wide, that is developed along the strike of beds dipping to the east at about 40°. Aragonite crystals cover the floor and walls, and chandelier-like clusters of crystals hang from the roof. At the southern limit the passage is blocked by a stalagmite flow fed from a roof inlet. The passage probably continues beyond this blockage. On the eastern side of the final chamber, however, a huge pit drops 200m into a fault-bounded chamber. The top of the pit is completely covered by stalactites and curtains, descent requiring the use of tapes and thread belays through the curtains. At the bottom a mud slope drops 30m to a clean washed boulder choke. In wet conditions water rises here and backs up into the chamber. Unfortunately, all ways on are blocked.



Delicate aragonite crystals growing from a stalactite in Furong Dong. Photo: Kev Senior.

The 1994 extension in Furong Dong, with the dip of the Cambrian limestones clearly visible in the far wall. Photo: Tony Baker.

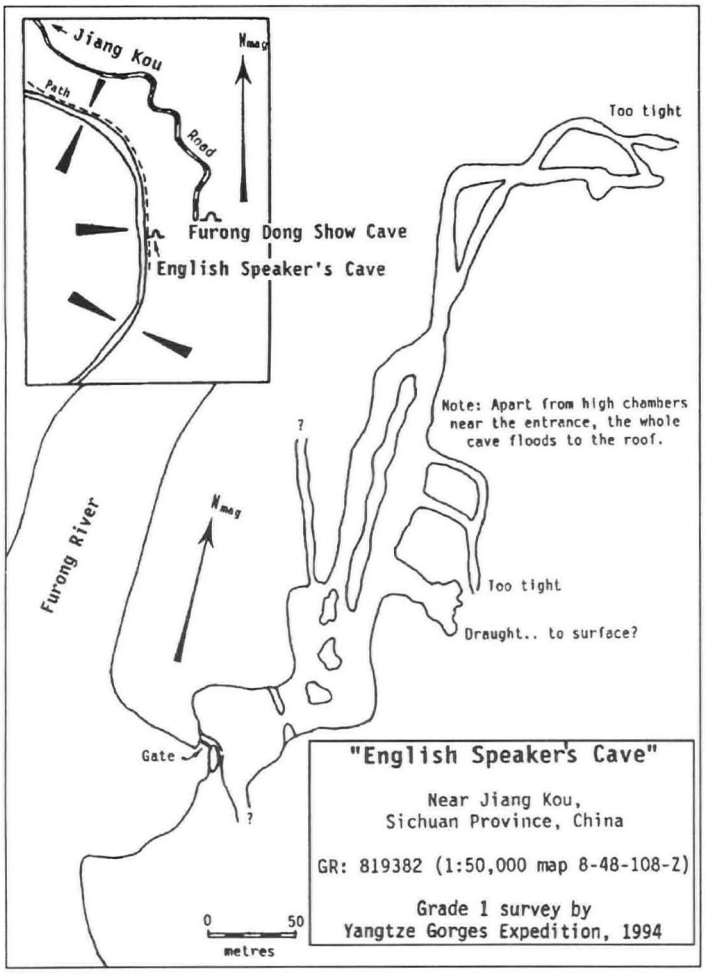


Figure 12. English Speaker's Cave survey.

English Speaker's Cave

English Speaker's Cave is located below Furong Dong show cave about 30m above the Furong Jiang (Fig.12). A gated entrance leads to a big chamber with a huge stalagmite boss. The cave is a flood overflow for an unseen resurgence that is thought to enter the Furong Jiang below its surface. In wet weather water surges from the entrance of English Speaker's Cave and the entrance chamber floods to the roof. This resurgence is probably the destination for the water that rises into the bottom of the big pit in the Furong Dong extension. From the entrance chamber there are parallel routes to the left and above, linked in several places to create a maze. It is not clear where the water rises. Down on the left there is a low, wet passage with a small possibility of a continuation beyond the wet section. The main route straight on leads to a rising passage ending in an inclined bedding plane that is too tight.

Caves near Tien Xing Village

The village of Tien Xing provides a useful base for exploration above Furong Dong and can be reached by driving eastwards from Jiang Kou, then northwards along the Wu Jiang and past the huge polje known as Mae Chong Ba. East of the polje the road ascends and a minor track leaves on the right at a left hand hairpin bend. This road leads southwards to Tien Xing village (Fig.10). The caves explored near Tien Xing fall into two categories: the surface shafts, which will be described first, and the caves related to the valley leading from Tien Xing village to the Furong Jiang.

The first shaft, **Lan Tian Wan** (*Bad Field Cave*), is located in the second field south of the village. It is a 30m-long vegetated shaft in a shallow depression. Trees, thick vegetation and a very steep final approach make access difficult, but it appears to be about 30m deep. This shaft was not descended. From Lan Tian Wan, the small path leads south and then westwards to a 30m-wide shaft that has only recently collapsed. The impressive entrance appeared suddenly one night seven years ago and persuaded the farmer to move his house. The shaft is unstable and ends in a boulder choke at -40m. The path can be followed farther west for a few hundred metres to a point where it is possible to descend the slope through a small pine wood to a lower path. About 50m east on this path leads to an impressive 50m-wide shaft, **Yan Feng Qian** (*Rock Shelter Cave*) on the left of the path. Descent is difficult because of dense vegetation all around and overhanging the shaft, and a 40m drop leads to a flat floor with no way on.

Two other shafts were noted but not descended. The first is about 300m south of Tien Xing on the left of the track. The second is on the valley side opposite Dong Ba and Xin Lou Kou. It can be found by taking the path southwards and upwards from the hamlet below Xin Lou Kou Dong and searching in dense vegetation to the left of the path, just after it turns sharp left at a bend. This shaft is probably the best prospect, apart from the active sinks, for finding a link into Furong Dong beyond the terminal boulder choke.

Zhan Ren Ken Dong
People Go Down Cave

Zhan Ren Ken Dong (Fig.13) is relatively narrow and tortuous compared with Dong Ba and Xin Lou Kou. The entrance is close to Tien Xing, about 50m down the path towards the Furong Jiang, in a small doline at the edge of a field. A rope can be rigged to a convenient tree for the short scramble down to a 20m drop. At the bottom there are two ways on; a crawl at stream level, with a very small stream, or an easier climb up over a rock and shingle bank into the base of an aven. A bone from a large animal was found in stream deposits 5m above the present stream floor. Unfortunately it has not yet been identified. From the aven a passage leads down to stream level again and a route through a narrow canyon obstructed by protruding beds of limestone. Several short climbs down and traverses over narrower parts of the passage go past three inlets to where the passage becomes slightly wider.

Some 200m from the entrance it is best to traverse upwards to avoid a very tight part of the passage at floor level. The alternating limestone and shale beds have resulted in the canyon having a cross section in which limestone beds stand out as ledges, commonly obstructing the passage, while the shale beds have been eroded. These beds are thought to belong to the lower Ordovician/upper Cambrian boundary. Traversing is again required a short distance further on, but now a false floor can be used to walk on and the passage enlarges to about 1m wide by 6m high. At 530m from the entrance the canyon enters an aven and a climb down lands on a mud bank with a shallow pool. A small inlet enters here. After the aven the canyon is approximately 20m high, the floor gradually drops away and the easiest route involves traversing in the widest part of the passage at a higher level. This becomes a vertical maze as the overall height of the passage increases to 50m, with the widest parts somewhere in the middle. Traversing down the rift on thin ledges leads to a 35m drop broken by more ledges. It is difficult to find suitable belays in the rock because of frequent shale

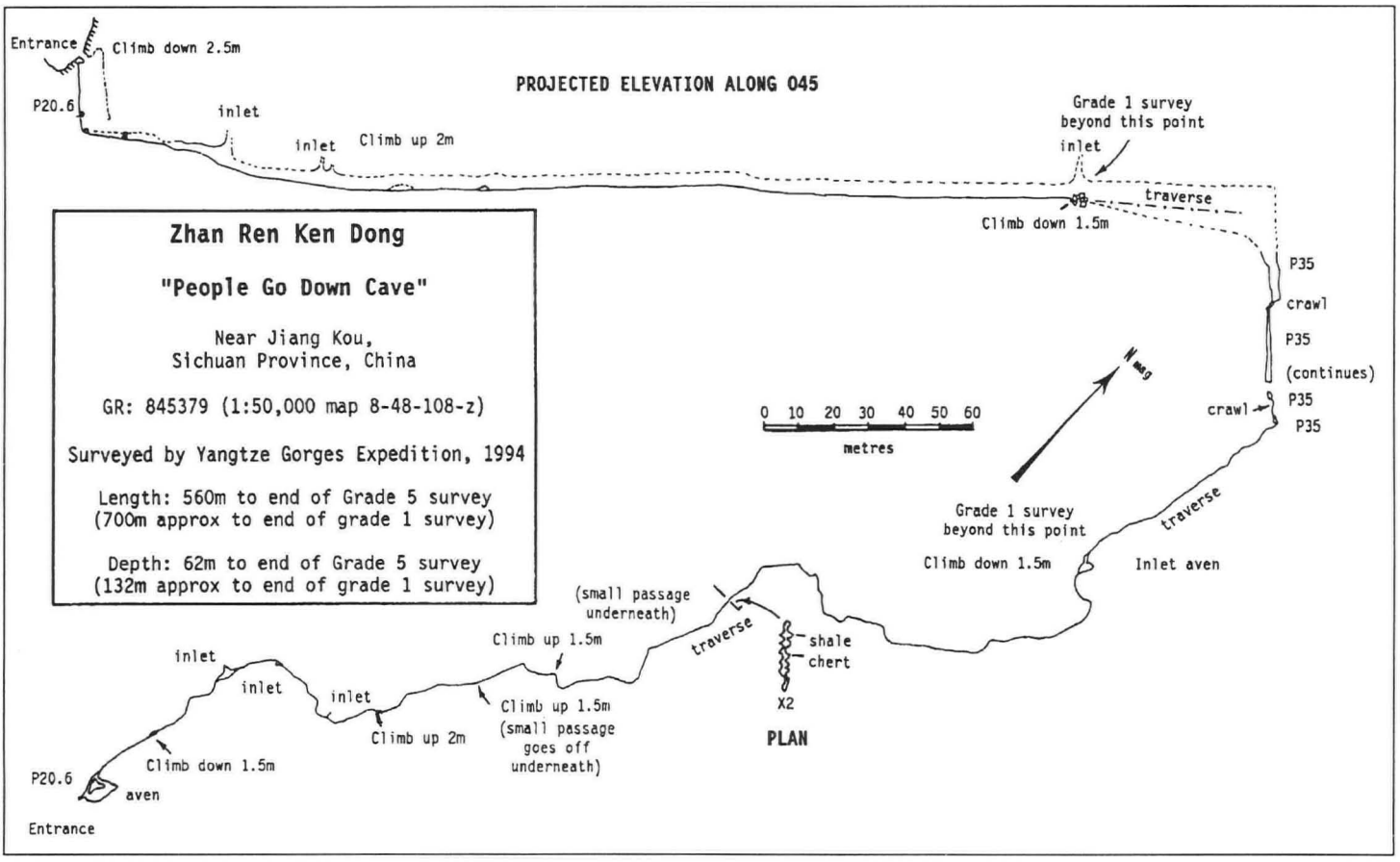
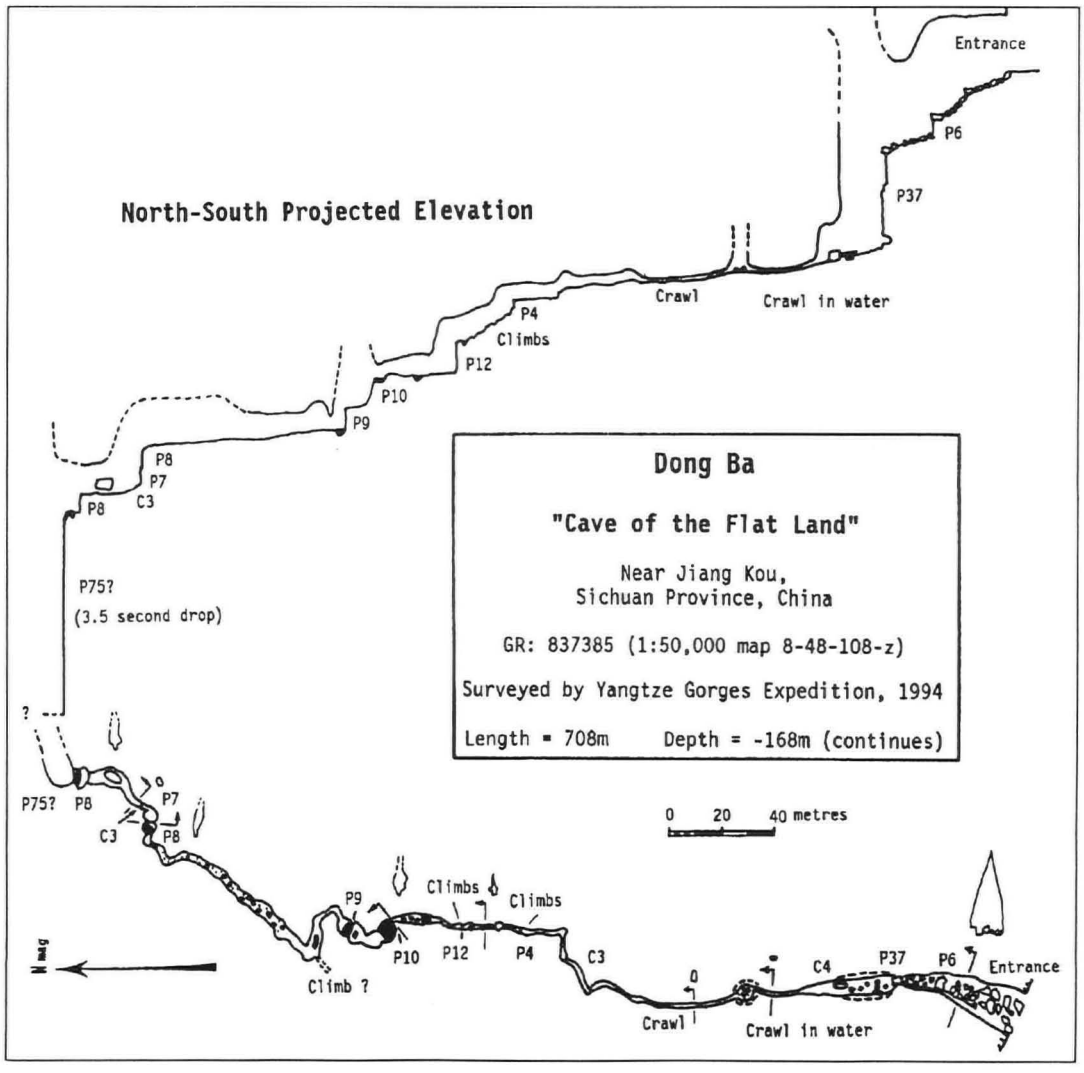
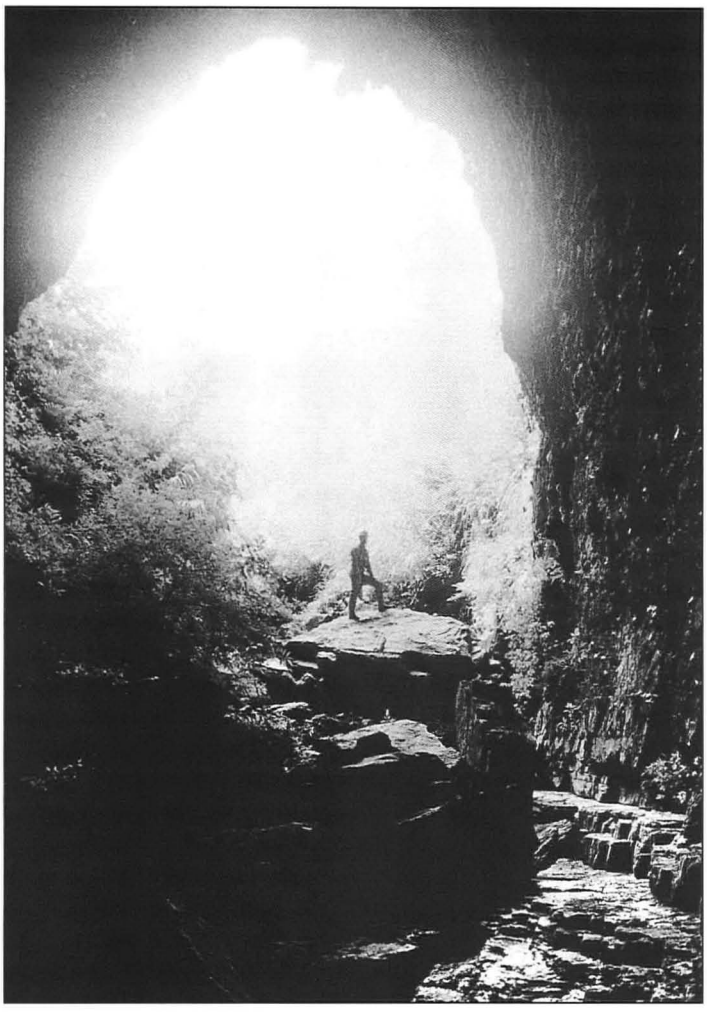


Figure 13. Zhan Ren Ken Dong survey.

Figure 14. Dong Ba Dong survey.





View out of Dong Ba entrance, the main sink for the stream in the valley above Furong Dong. Notice that in contrast to the Permo-Triassic limestones, the Cambrian limestones have many open bedding planes and shale partings, so this entrance, and the cave passages, have many ledges and protruding shelves.
Photo: Kev Senior.

layers. Below the shaft a crawl leads off and this takes the passage through two thick shale bands. The current limit of exploration is at the head of another drop of about 35m. The walls of this shaft bell out underneath the shale band and are smooth, suggesting that the cave will drop into the more massive Cambrian limestones in which Dong Ba and Xin Lou Kou Dong are developed. Potential explorers should note that parts of the cave would become impassable in wet weather.

Dong Ba (dong baa)
Cave of the Flat Area

Dong Ba (Fig.14) is the upstream active sink for the river that flows north-northwestwards from Tien Xing village towards the Furong Jiang. The cave is reached by walking 100m north-northwest from the centre of Tien Xing village to the head of the westerly trending valley that descends to the Furong Jiang. Follow the path down the right hand side of the valley to a small hamlet (approximately 30 minutes). From the houses, drop down to the valley bottom and follow the dry stream bottom to the cave entrance. The stream is channelled directly into the arched entrance, which is 20m high by 12m wide and is situated on a major joint on the down-dip side of the valley (the north side). A bedding plane provides a balcony on the left and a slope of large boulders descends to a short, 3m, drop with a boulder belay. A few metres further is the impressive 37m entrance shaft that exposes the alternating black and grey Cambrian limestone beds particularly well. At the bottom a series of low muddy passages and crawls (which probably sump when the sink is taking water) leads to climbs and a succession of short drops in wonderful, clean-washed cave. The passage soon enlarges and was explored to the lip of a 75m shaft where exploration halted due to lack of time and rope. Dong Ba is almost certainly the key to reaching the main river system that must drain the area from Tien Xing to the Furong river. The catchment may extend farther east to major doline sinks that are visible on the 1:50,000 scale map.

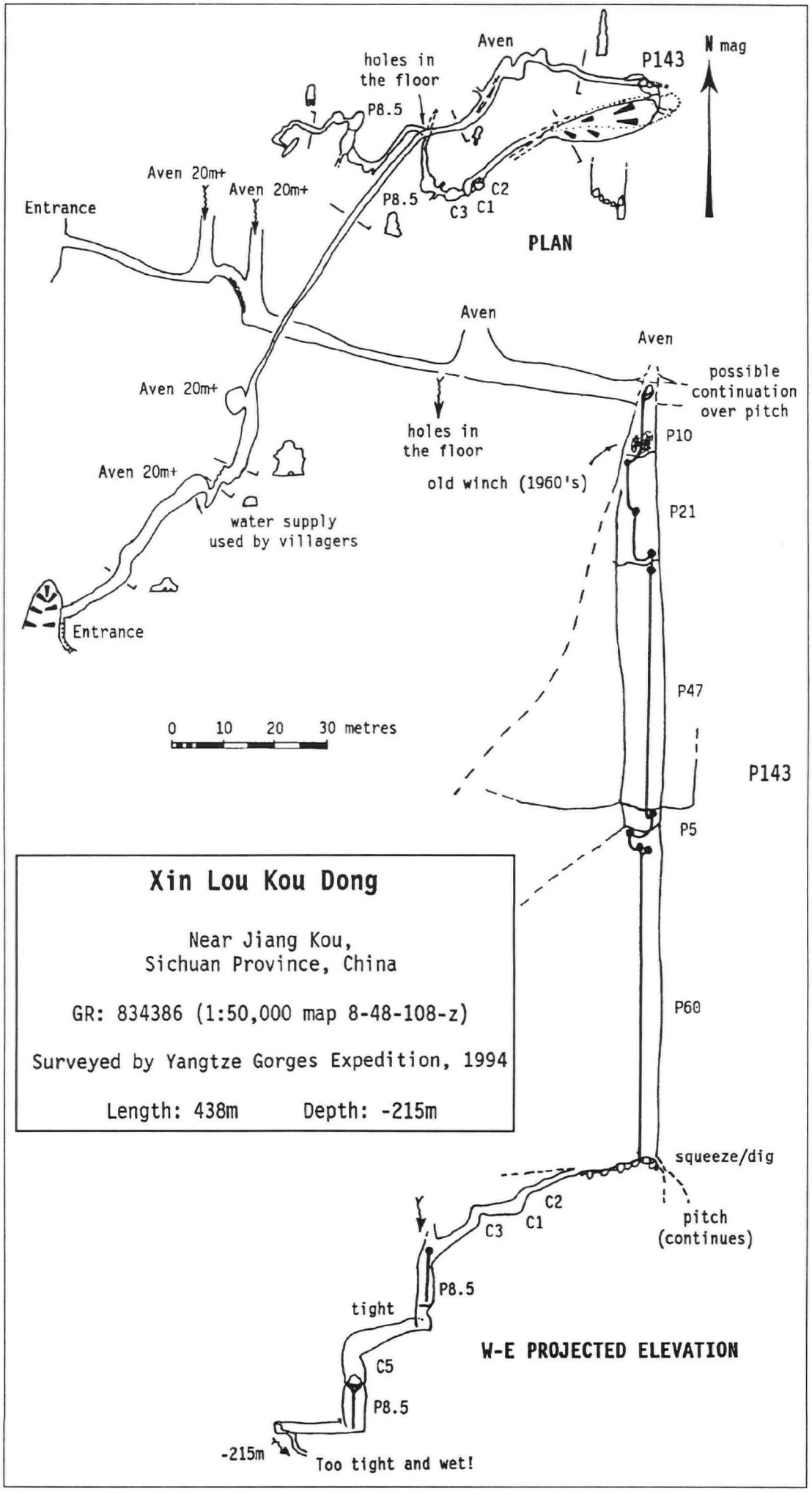
Xin Lou Kou Dong (zin lou cow dong)

Xin Lou Kou Dong (Fig.15) is best approached by walking down the path from Tien Xing village, past Dong Ba until a small hamlet is reached in the valley bottom. The cave is about 50m above the hamlet to the northwest and the farmer will give directions! The final approach to the entrance involves a delicate traverse over a small cliff into a phreatic tube about 2m in diameter. There is a cold draught at floor level and warmer air near the ceiling. After about 40m water falls from an aven and the phreatic tube gains a vadose canyon in the floor. This canyon becomes increasingly well developed and after about 120m, deep holes in the floor capture the tiny stream. The canyon continues to the head of a drop that is the start of a 143m shaft. The phreatic tube, which is so obvious at the entrance, is no longer in evidence and there appears to be only a slight possibility that a passage continues over the shaft. The first drop of 10m lands on a large ledge with an old rotten winch. This is a relic of a Chinese exploration in the 1960s when a hydrological survey attempted to map the water level in the region. Some poor unfortunate was lowered down the shaft using this winch, but owing to the deviations in the shaft it is unlikely that the bottom was reached. The last 60m drop lands on a boulder floor in a 10m-wide rift chamber. To the northeast, a small hole was dug by Brian Judd to enter a canyon and a shaft. This route was not explored but could turn out to be the best hope for deeper exploration. The obvious way on is down the chamber to the southwest and down into a small vadose canyon with a tiny stream. The stream turns left (straight on ends after a few metres) and the cave continues down a series of clean-washed climbs and across pools to an 8.5m shaft. This section of cave is strongly influenced by joints, and water falling from the roof is probably from the 'holes in the floor' that capture the small stream in the entrance passage. A squeeze in a rift regains a canyon that descends to a climb and then another 8.5m drop. Below this point the size of the cave reduces and progress is made by crawling and stooping in an immature canyon half filled with water. A bat was encountered at the limit of exploration, an occurrence which suggests that the unpleasant lower passages are worth another visit.

Shui Lean Dong (shooe leen dong)
Cave Beside the Waterfall

Without the help of the farmer, Shui Lean Dong (Fig.16) would have been impossible to locate. It is situated an hour's walk up the Furong Jiang from the farmer's village, which is close to where the river rafting starts. The cave has been explored by the farmer who has built a wall and padlocked the entrance. Below the entrance of Shui Lean Dong another cave was investigated briefly, but lack of equipment prevented descent of a short drop at the bottom of a steeply descending ramp.

Figure 15. Xin Lou Kou Dong survey.



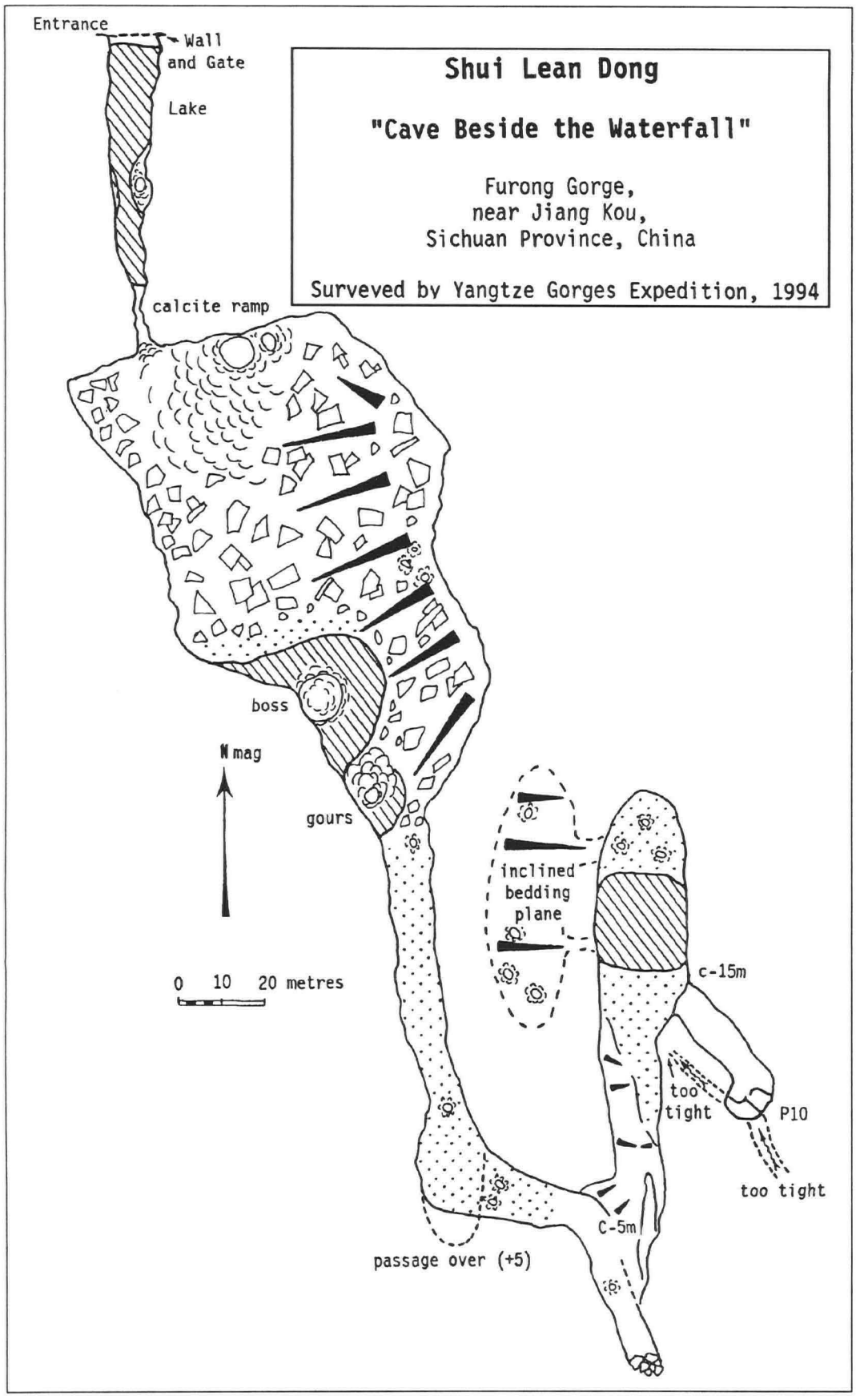


Figure 16. Shui Lean Dong survey.

Shui Lean Dong is a remnant of an old system. It is at the same altitude as the Furong Dong show cave, so is probably of similar age. From the entrance a narrow, 60m lake gives way to a calcite blockage that can be climbed to reach a large chamber with a number of fine stalagmites, some standing in pools of water. A steep boulder slope rises up to the wall on the east side of the chamber. Beyond this, a narrowing passage, blind at its farthest end, allows access on the left to a parallel passage at a lower level. This closes down in a northerly direction after a pool, but a continuation down to the right (southeast) leads to a 10m shaft. From the top, deep booming noises can be heard, but once at the bottom the sound is found to come from a stream in small hole. The streamway is immature and becomes too tight in both directions.

Xu Cháo Dong (choo chow dong)
Rats Nest Cave

The spectacular road north from Jiang Kou passes along the eastern side of the Wu Jiang valley. After 7km the road makes an abrupt dog-leg into a polje occupied by paddy fields. The cave overlooks the river and is reached by a very dangerous traverse across the hill side. Leading around to the head of the polje and through a pleasant village, a path reaches a point 500m above the river, then undulates gently as it contours along the valley side through fields of peppers and maize. The route to the cave leaves the path and climbs 300m up a 45° slope through thick, thorny scrub. A machete was needed to get to the entrance, which is a small arch in the only bare rock outcrop for miles!

Inside Xu Cháu Dong (Fig. 17), a 2m drop enters a section of 3m-wide standing height passage that ends at an awkward climb directly onto a 5m rope climb. Much of the passage below is filled with fallen boulders. Clambering over blocks to the southwest leads to a slippery traverse to some columns beyond which is no way on. A scratching and squeaking noise led to the discovery of a rat's nest amongst the rocks. Two ways on were found to a lower section of the cave, one being a 10m shaft, the other an easy climb. A big sloping chamber occupies the remainder of the cave, much of which is filled with huge calcite-cemented blocks. The chamber slopes to the southwest but descent over and through stacked boulders ends in a blank wall. There may be a way on underneath the boulders but several routes were tried with no success.

Xu Cháo Dong appears to be an isolated remnant passage of what would have been a major drainage system. It is essentially a large chamber split into two levels by boulder falls. The strong entrance draught suggests that there will be some extent to the cave, but the presence of the rat's nest points towards there being another, smaller entrance higher up the hill side. Several other caves at a similar altitude in this area were not investigated.

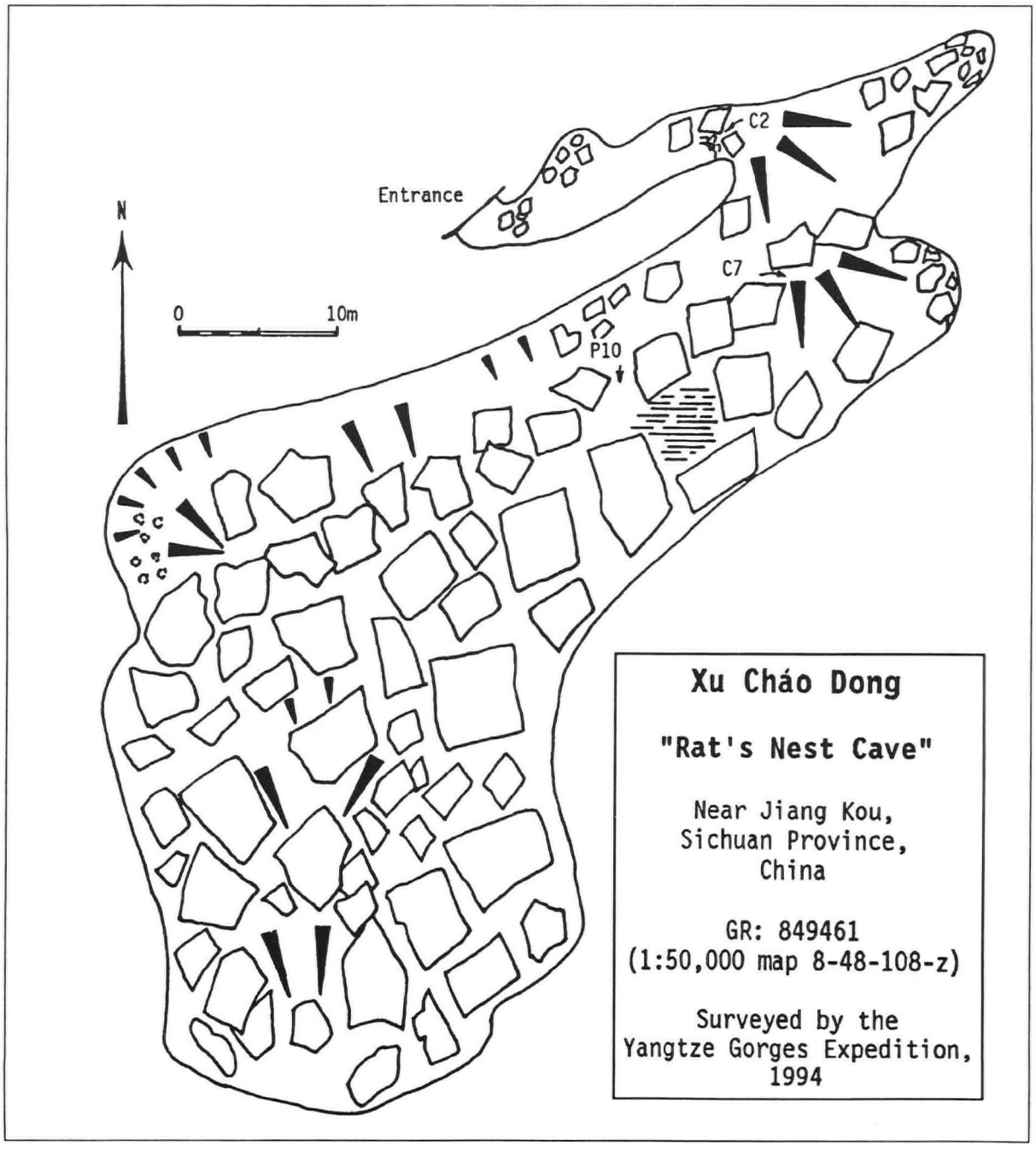


Figure 17. Xu Cháo Dong survey.

Monk's Cave

From the town of Jiang Kou a track winds its way southwards, roughly paralleling the Furong river. The line of the river is left after 30 minutes and the track continues southwards, passing through a number of small settlements. After 45 minutes the track quality deteriorates and it climbs steeply towards a 500m-high cliff face. Monk's Cave lies in trees and shrubs beneath this cliff. The view from Monk's Cave is spectacular, with a 40km panoramic view towards Jiang Kou. It is only in these situations that the true scale of the karst is appreciated.

The entrance to Monk's Cave (Fig.18) is in a low 5m-wide, 3m-high arch and initial progress is made by crawling along a 1.5m diameter phreatic tube. The cold outward draught is at its strongest in this section. Approximately 50m of crawling and stooping ends where a 10m-square passage is entered and continues onwards. Near the entry to this passage there are several pits and stone walled circles sunk into the sand floor. The local people insist that no nitrate working was undertaken in Monk's Cave, so their purpose is a mystery. Easy going along sandy floored passage follows a well-worn path passing through some larger chambers and over sediment banks. After approximately 300m of walking a climb into a chamber reveals the reason for the path. The passage from this chamber is littered with the smashed remains of stalagmites and other speleothems. What once would have been an outstandingly beautiful set of formations is now in ruins. Monk's Cave has over the centuries provided a source of stalagmites for decoration in local villagers' homes. Indeed, whilst exploring the cave, the team passed a large group of children who were carrying baskets full of freshly broken formations.

After 500m, a small hole in the floor, which emits a powerful draught, provides an unexpected entrance to a lower section of cave. Down the hole a short but very awkward climb gains a 50m section of once decorated passage ending at a platform overlooking blackness. During the exploration it was assumed that this was at last unentered passage, but a group of ten, rubber-shoed, local people demonstrated a novel method of descent. To the left of the platform a short climb down between boulders appears at the top of a 15m circular shaft where the local people stood smiling and pointing vigorously at a series of rotting stemples. At the bottom is a boulder and sediment-floored 30m-square chamber with a small underfit stream. A small waterfall on the west of the chamber appears through blocks from a tiny hole 5m up the wall of the chamber, but the stream it produces leaves the chamber in a larger passage trending towards the south. The stream flows between huge banks of mud, filling much of what would have been a 10m-square trunk passage. Eventually, after 100m, the way on becomes too low for sensible progress.

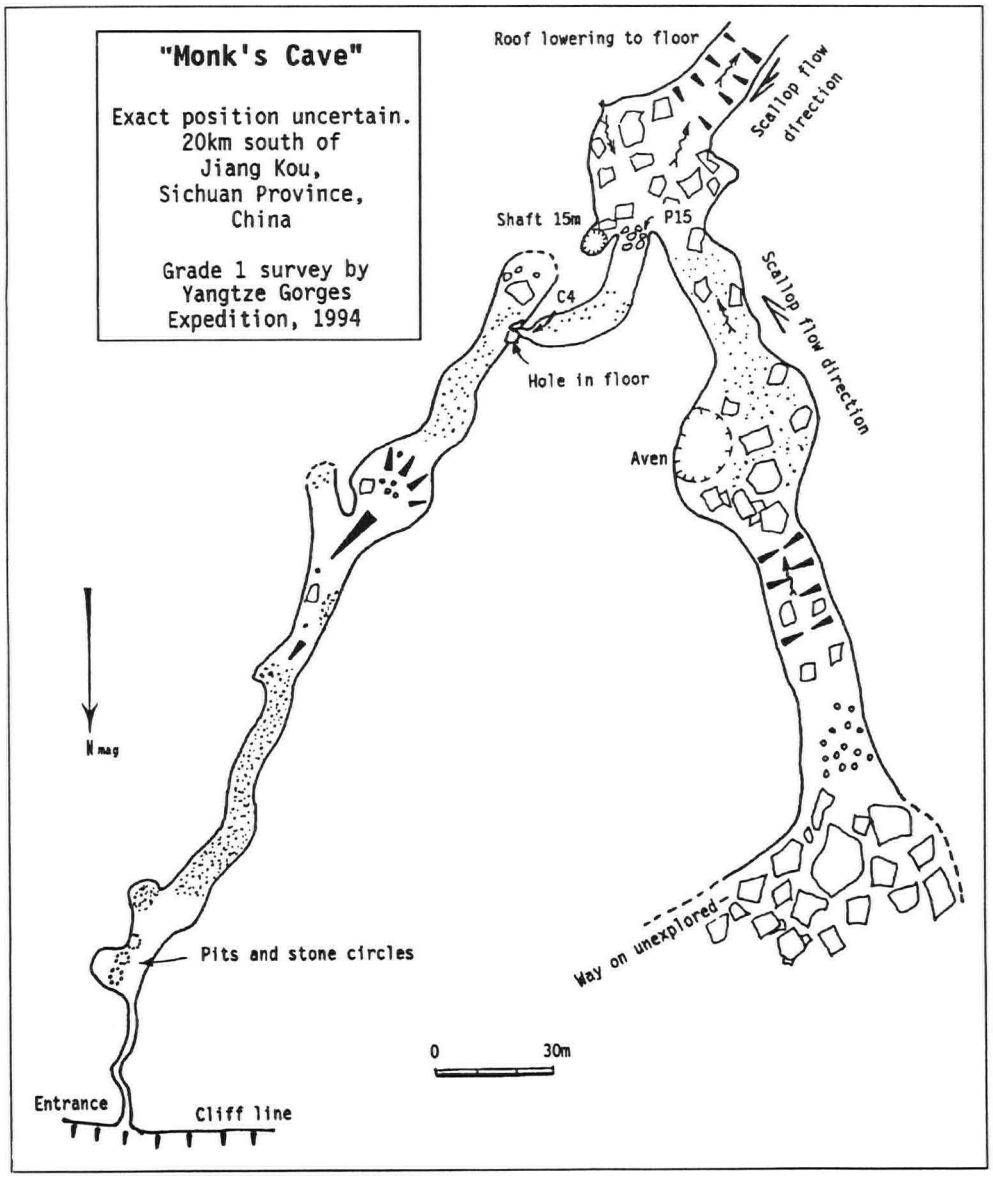


Figure 18. Monk's Cave survey.

Returning to the chamber a passage to the north can be entered by climbing over boulders. Easy going for 300m over sand floors with the occasional climb up to avoid fallen blocks leads past numerous formations and high avens to a flat-roofed, 3m-high section. Much of this is filled with columns and brilliant white gour flows. Progress can be made for 30m through the columns to a huge boulder choke heading upwards into blackness. Unfortunately there is no way over the top, but exploration on the west side of the choke revealed one route in packed boulders that was not pushed to a conclusion.

Monk's Cave appears to be an abandoned high-level trunk route draining from the south, as indicated by scalloping. Much of the cave is in a state of decay, the result being that the true size of the passage is masked by boulder and sediment infill. The passage size suggests that it was once a major drainage route but its height and isolation suggest that there is little chance of finding further large remnants of this system. However the vertical potential in the area is considerable, with over 500m of limestone directly above.

CAVES OF THE WULONG AREA

A very brief reconnaissance of the Wulong area (Fig. 19) revealed five caves, two of which, Cave 2 and Cave 3, are major resurgence caves with great potential for further exploration. New toll roads run either side of the Wu Jiang downstream of Wulong. Following the right bank downstream from Wulong and passing through a tunnel a point is reached where a resurgence cave can just be seen at river level and a waterfall can be heard inside. This cave (Cave 2 on Fig. 19) remains unexplored.

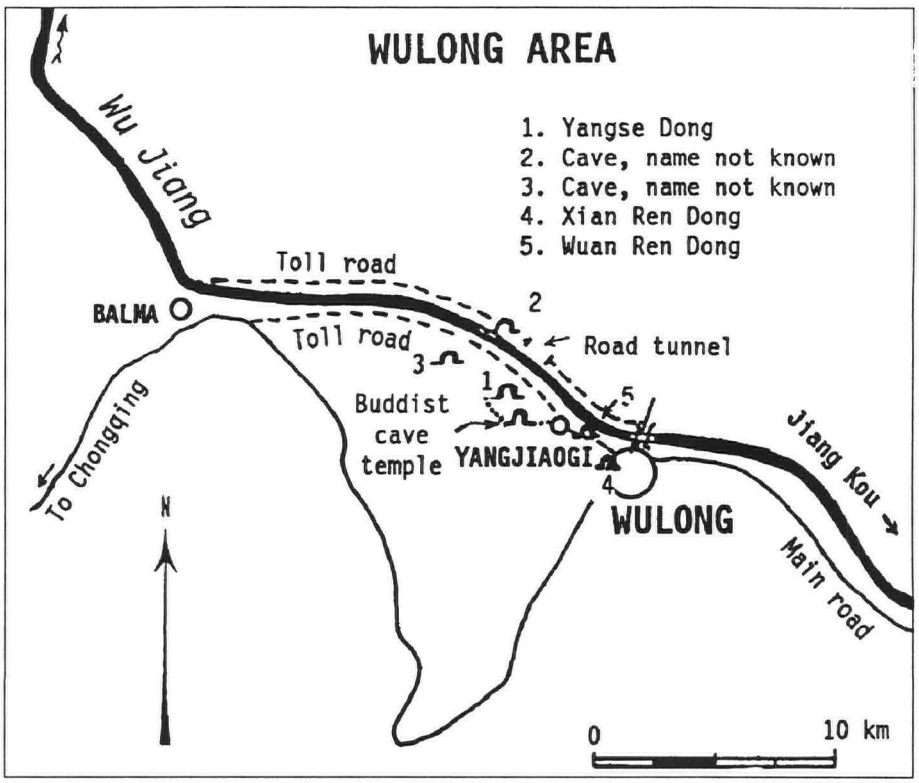
A few kilometres down the road on the left bank is the small town of Yangjiaogi. A steep road through a factory yard, then a steep path leads to a Buddhist cave temple on the hill side. Inside the cave is a large Buddha and other statues to which burning incense sticks can be dedicated. Lights and icons decorate the cave as far as the eye can see. The path continues past the temple, then contours the cliff for a kilometre before descending steeply (handline recommended) to Cave 1, **Yangse Dong**, (Fig. 20). The 10m-wide, 5m-high entrance soon closes to a crawl, then a squeeze allows entry to a larger cave and an 8m drop into a large passage. This passage descends steeply to a stalagmite barrier. A side passage closes down after 150m.

Farther down the road, downstream of Yangjiaogi, there is a small quarry just beyond the point where Cave 2 is visible on the opposite side of the Wu Jiang. **Cave 3** (Fig. 20) lies at the back of the quarry, about 50m up the steep spoil heap. Four climbs (handlines required/recommended) lead to the top of a 9m drop down to the river, which cascades from waterfalls about 50m away at the same level as the top of the pitch. The water sinks downstream and is known to resurge under the Wu Jiang. The large upstream passage was not explored and it will require acrobatic climbing to cross the gap between the top of the 9m drop and the top of the waterfall.

Closer to Wulong, about half a kilometre west of the city, a minor road turns south up a side valley and this leads to **Xian Ren Dong,** (*Female Celestial Cave*) (Fig 19). The entrance is a few hundred metres along this road and up 30m of roughly hewn steps. The cave has been used for mushroom growing and is full of rubbish and rats. Most of the formations have been removed or smashed and the cave ends in a stalagmite choke after about 500m.

Two kilometres west of Wulong, but before Yangjiaogi, a stairway cut from the cliff face above the main road leads to a walled alcove and the entrance to **Wuan Ren Dong**, (*Cave of the Ten Thousand*) (Fig. 19). The cave has been developed for tourists by members of the Chang Diu Pa village and has the usual electric lights and concrete paths. The cave consist of a series of phreatic tubes and chambers largely developed along the strike. There are few formations and those which are present have been seriously damaged. The cave is a mess, and every part of its two or three kilometres of passage has suffered damage.

Figure 19. Sketch map of the Wulong Area.



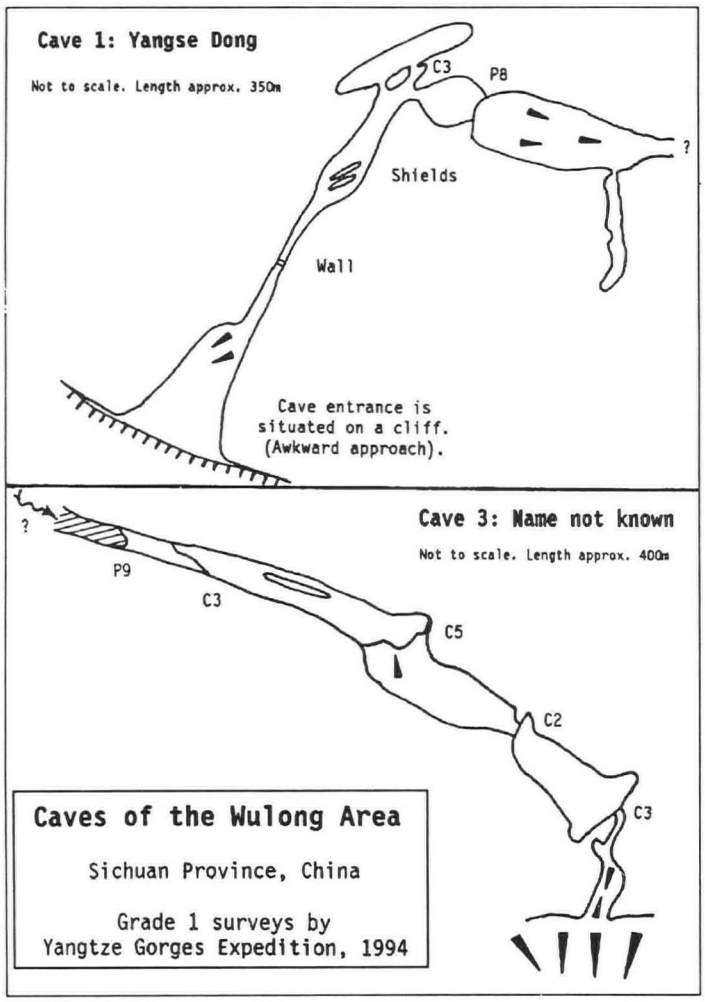


Figure 20. Yangse Dong and Cave 3 surveys.

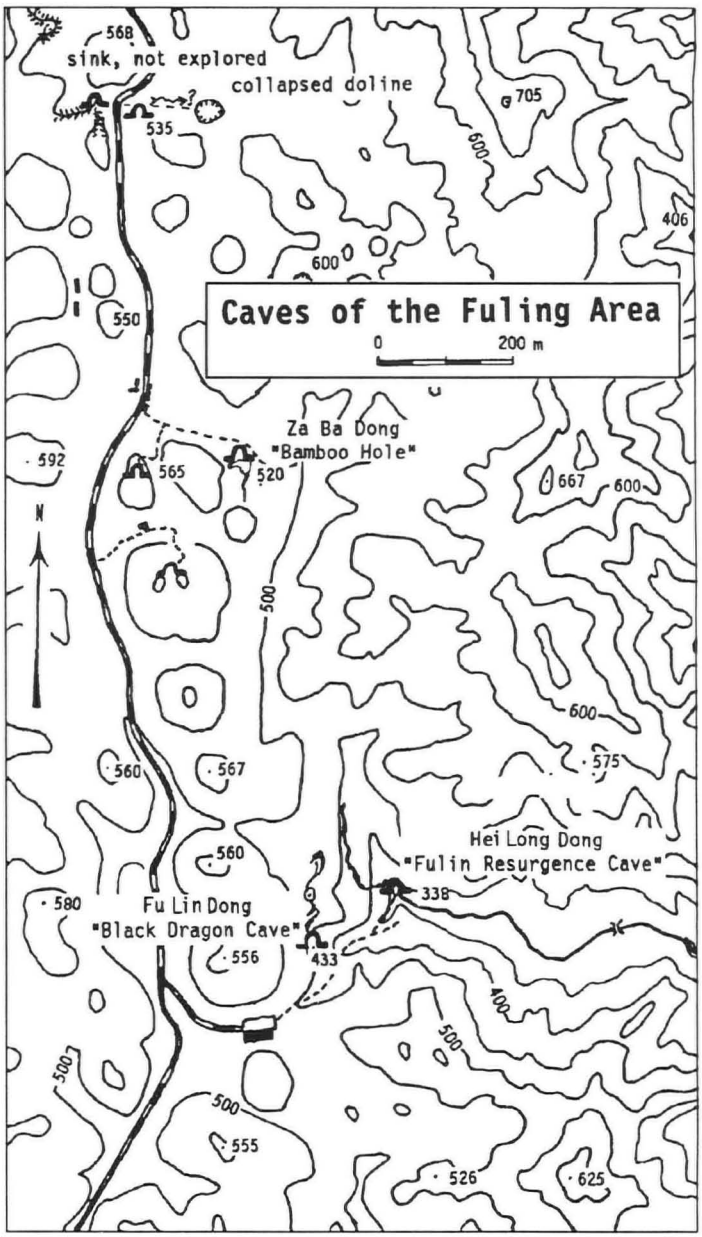


Figure 21. Map of the Fuling Area.

CAVES OF THE FULING AREA

Fuling, a city of 1.6 million people, is situated on the Chang Jiang (Yangtze river) about 90km east-northeast of Chongqing (Fig. 1). The caves explored in this area are about 90 minutes drive to the north of Fuling in the Huangcao Shan hills, and are located in a beautiful range of cone karst. The cone karst reaches an altitude of 560m and is bisected north to south by a convenient road (Fig.21). The caves are described from south to north.

Fu Lin Dong (foo lin dong)
Black Dragon Cave

The real entrance to Fu Lin Dong lies beyond a gated wall at the back of an enormous overhanging cliff that is actually the remains of a huge chamber exposed by erosion. Under the overhang the authorities have built a number of simple guest room, a restaurant and a tiled dance floor with state-of-the-art karaoke equipment. This is a most comfortable base camp for exploring the caves of the area! Fu Lin Dong (Fig.22) is a show cave with large decorations in an advanced state of decay. Apart from a few pools fed by percolation water the cave is dry; long since abandoned by the main river. The best features of the cave are a 7m-diameter, 20m-high stalagmite; an old nitrate bath used for the manufacture of gunpowder and some magnificent shields. At the end of the show cave is a calcite-encrusted skeleton, apparently human. This important feature is inadequately protected and is spoilt by litter. It is thought that the victim fell from an unseen passage in the roof although there is no noticeable draught to indicate another entrance. A report was prepared for the show cave managers, emphasising the value of good conservation practices, particularly control of litter and graffiti.

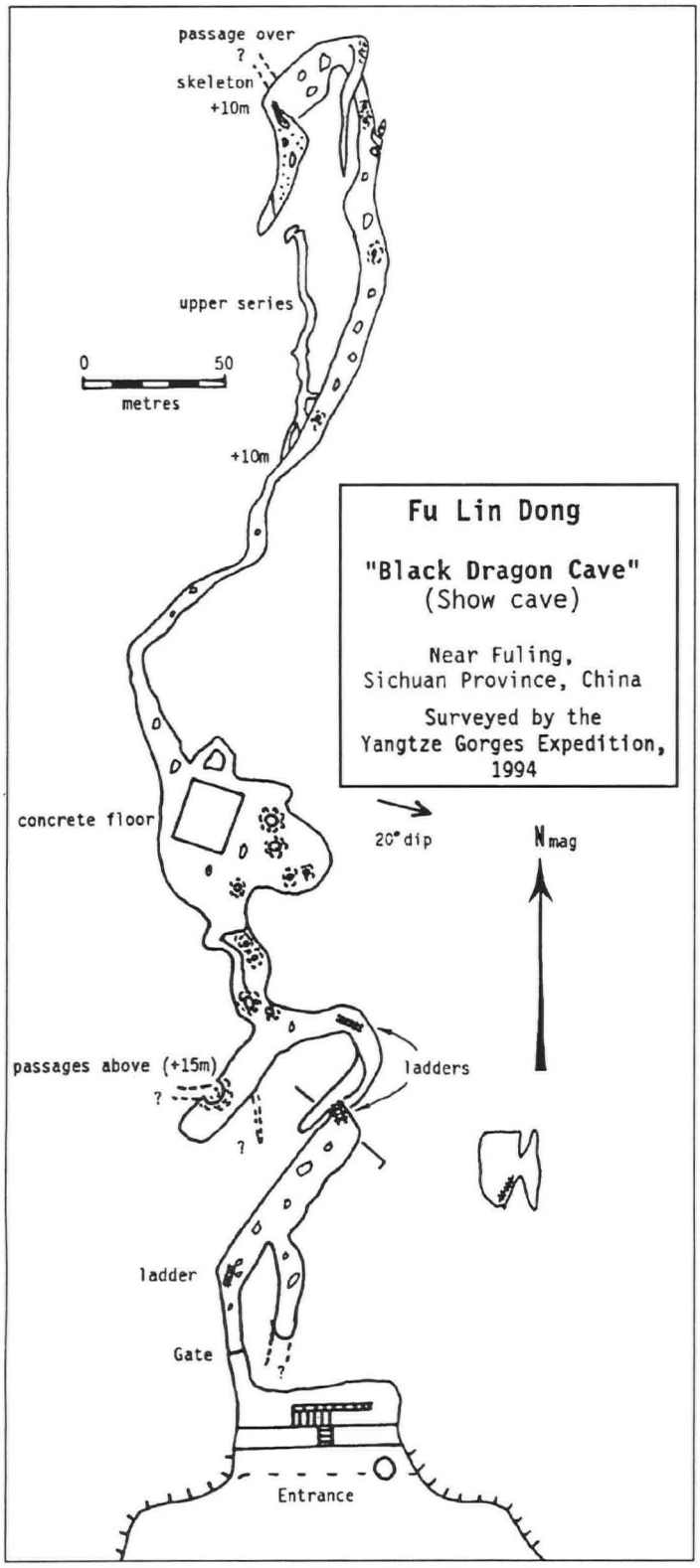


Figure 22. Fu Lin Dong survey.

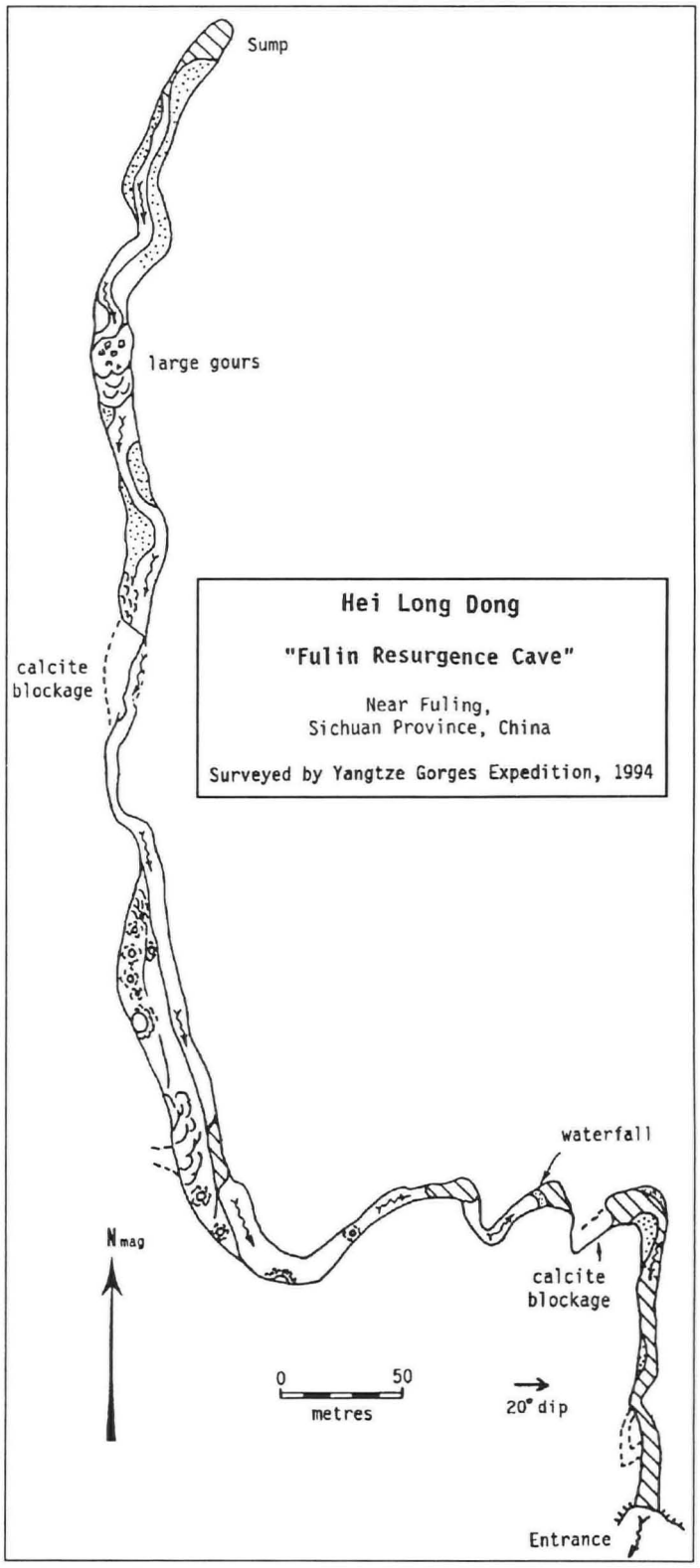


Figure 23. Hei Long Dong survey.

Hei Long Dong (hay long dong)
Fulin Resurgence

To the right of the track leading to Fu Lin Dong a valley drops between cone karst, with a path leading to a farm. To the left of the farm is Hei Long Dong resurgence (Fig.23), whose waters are channelled along the hillside to a small hydro-electric power station. After about 150m of swimming and wading into the resurgence the limit of previous exploration is reached at a calcite blockage. A squeeze with minimal air space, and which regularly sumps, leads to a cascade with a slippery climb up either its left or right side. Fine river caving continues through beautifully decorated pristine cave up to 30m wide, until the passage appears to end at a boulder choke. However, on the right is a squeeze through to a continuation that passes large gour pools and reaches a sump after 300m. There is no bypass. Hei Long Dong, in common with all caves explored in this area, unerringly follows the north-south strike with only minor deviations up and down the dip.

Zu Ba Dong (tcho baa dong)
Bamboo Hole

Seven km north-northwest of Hei Long Dong lies a shallow doline close to the road. The entrance of Zu Ba Dong (Fig.24), a hole some 5m by 3m, is hidden behind trees and a magnificent 74m shaft, 65m of it free-hanging, drops into a huge chamber, 120m long by 60m wide. The boulder floor slopes steeply down towards the east, to a river flowing from north to south along the strike. Upstream, the river sumps after a short distance, but side passages allow a little more northerly progress before a pool and final sump are reached. Downstream the river continues to follow the strike, diverting down dip only once, until the increasingly 'gloopy' pools eventually meet the roof.

Un-named Cave

Further in a north-northwestward direction, but 12km away from Hei Long Dong, a sink on the west side of the road gives fine cave passage in water of dubious quality. The cave runs under the road to a doline through which the river passes before sinking again. Lack of time prevented further exploration. It is fairly certain that the waters from both this cave and Zu Ba Dong rise at the Hei Long Dong resurgence.

CAVES OF BA XIAN COUNTY

Towards the end of the expedition, three members of the team went to Jingjia in Ba Xian County, approximately 30km southwest of Chongqing. The Ba Xian local government had reported a series of cave features that had the potential to be linked into a linear system ending in the prominent resurgence in the town of Jingjia. Jingjia is situated between two limestone ridges that trend north-south, offering a maximum relief of about 300m. Six kilometres south of the town, a small walled sink is the entrance to **Lungci Dong** (*Dragon Pool Cave*) (Fig.25), which was reported to end in an uncrossed pool of deep water. The first third of the cave is fitted with electric light, installed by local academics to "aid future explorations". A pleasant streamway leads down through mainly muddy formations to a series of low sections where the passage is partly blocked by speleothems. After 1080m the final pool is reached. It is a sump formed by a large stalagmite boss blocking the passage. Graffiti on the walls make it clear that local people have explored the cave to its very end.

About 900m north of the sink, the track passes a small hole in vegetation that can be descended for 20m to a chamber with a small stream, sumping on both sides. This cave, **Xiang Shui Keng** (*Sound of Water Cave*) is believed to be a tributary of the main drainage route that is presumed to exist between Lungci Dong and the resurgence. A similar feature beside the road (position unrecorded) represents another possible tributary.

Approximately 1km north of the sink is the Misty Hollow Doline, Wu Lu Keng. Running south from this is **Wu Lu Keng Shui Dong** (Fig.25), which ends upstream in a cascade falling from a stalactite formation in the roof. This point probably underlies the end of Lungci Dong. Downstream from the entrance a tight rift descends steeply to a sump, and is heavily polluted by diesel oil.

On the north side of the doline, the passage continues as a dry canyon for about 800m. This cave had been well decorated but is in the process of being exploited as a show cave. Unfortunately, speed of development has taken preference to cave conservation, and damage is extensive. This cave was not surveyed.

The main resurgence is situated on the edge of Jingjia. It is reported to be about 1km long and to end in an uncrossed pool of deep water. Unfortunately it was not visited because heavy storms raised the water-levels dramatically, the flow increasing from some 250 litres/sec to over 2 cumecs.

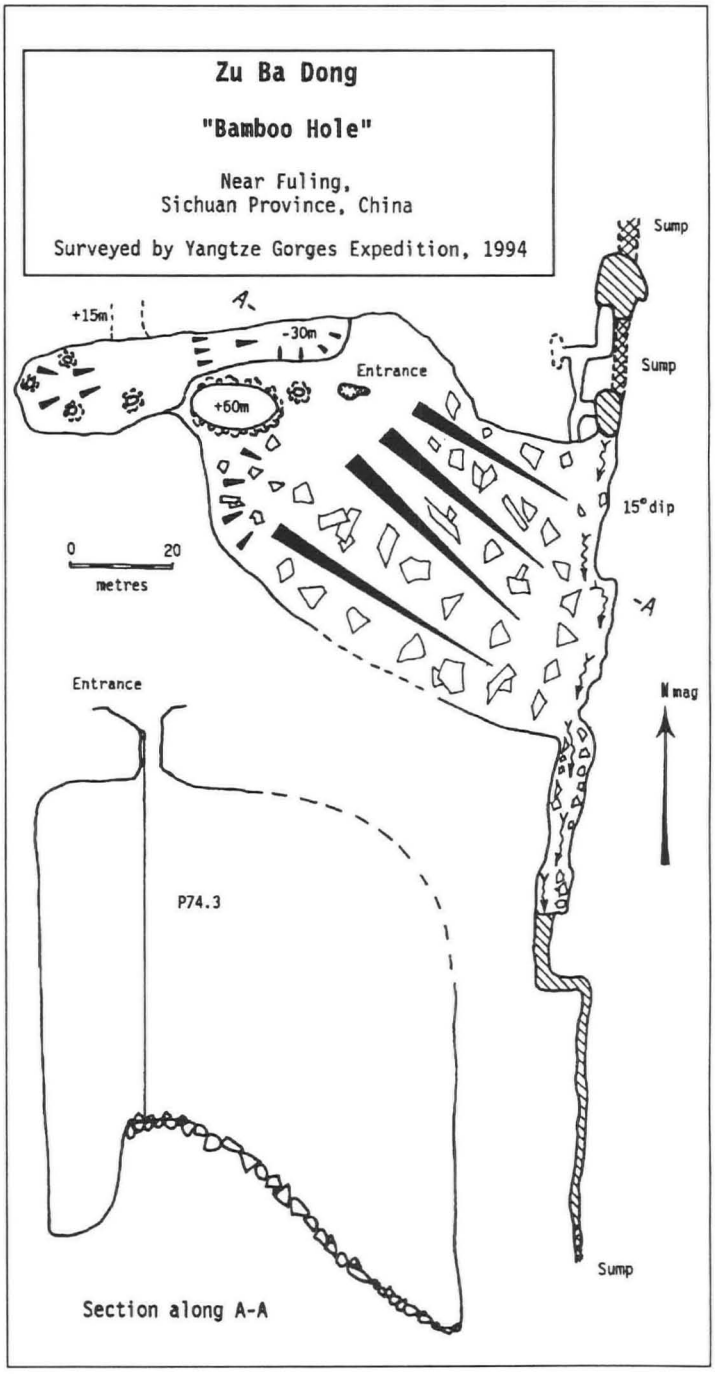
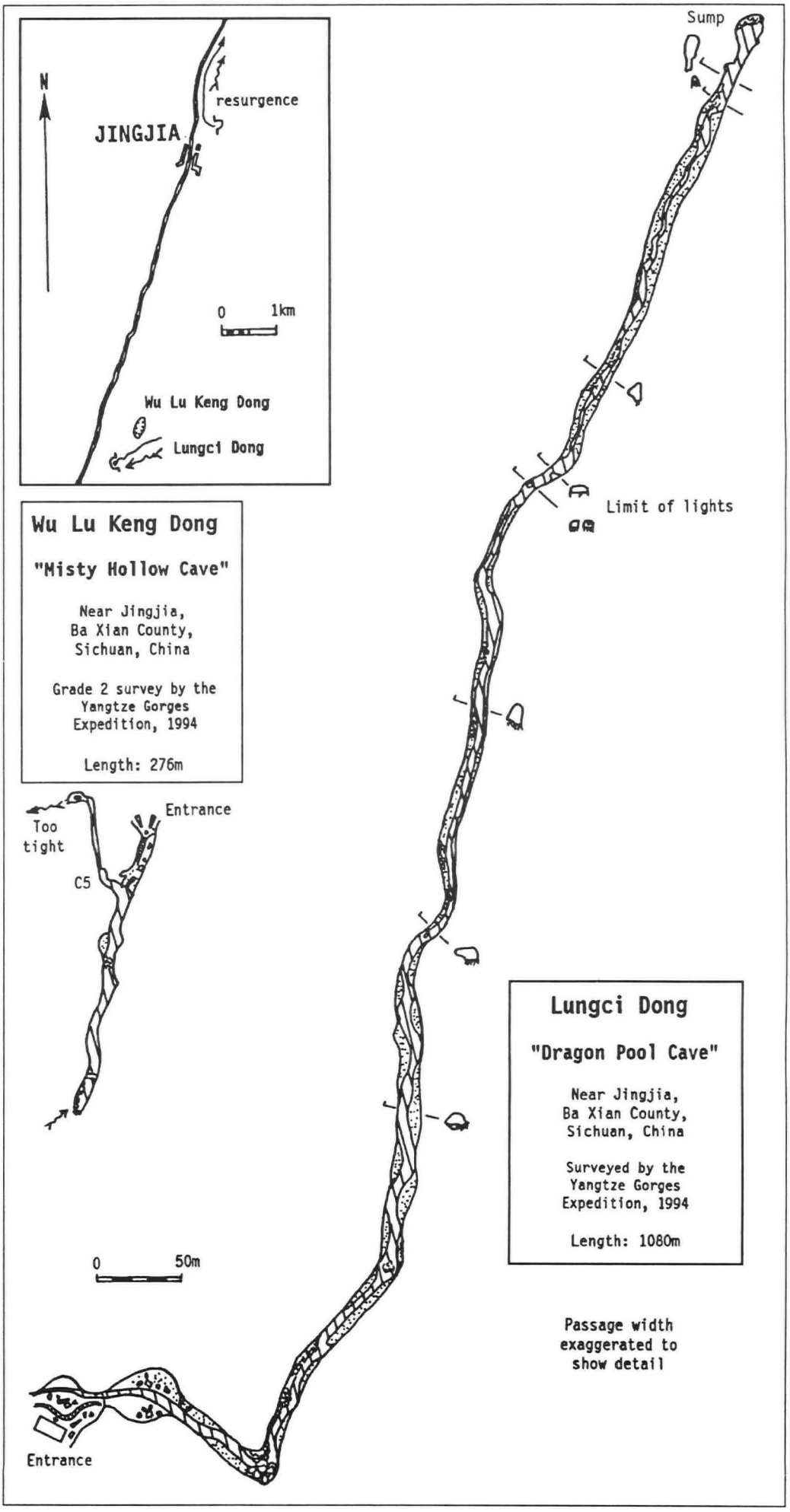


Figure 24. Zu Ba Dong survey.

Figure 25. Jingjia Caves: Wu Lu Keng Dong and Lungci Dong surveys.



The Jingjia area is obviously of speleological interest and closer inspection should yield more caves. These are likely to be small and wet with negligible vertical development. The local authorities are very enthusiastic and extremely hospitable; one leader took an active part in all explorations.

CAVES OF TONGJIN COUNTY

From Jingjia the Ba Xian team moved to Tongjin, just west of Chongqing, where a new cave had been discovered above the existing show cave of Xia Gang Yin Dong (Fig.26). The local government were keen to know if the two were connected. Accommodation was provided at the resort hotel of the Wuling Mountain Villa. From here a tourist boat ride goes up the Tongjin Jiang through an impressive limestone gorge lined with bamboo forests and with monkeys playing, oblivious of the tourists. The gorge features a number of thermal springs, the hottest of which, at 60°C, began to flow after an earthquake in 1989.

The gorge and the show cave of Xia Gang Yin Dong receive about 200,000 visitors a year. The new cave, **Rufo Dong** (*Buddha Cave*), proved to be only 260m long and with little of interest, although it was already being exploited for tourism. It did not link with the lower cave. It lies on the hill side between an obvious blind entrance above and the main show cave that resurges into the river below. The main cave was surveyed for 442m of once-impressive streamway that, like many Chinese show caves, has been largely destroyed by the pressure of visitors and lack of controls on litter and graffiti. The passage ends in stalagmite chokes, although there is a possibility that it may continue at water level.

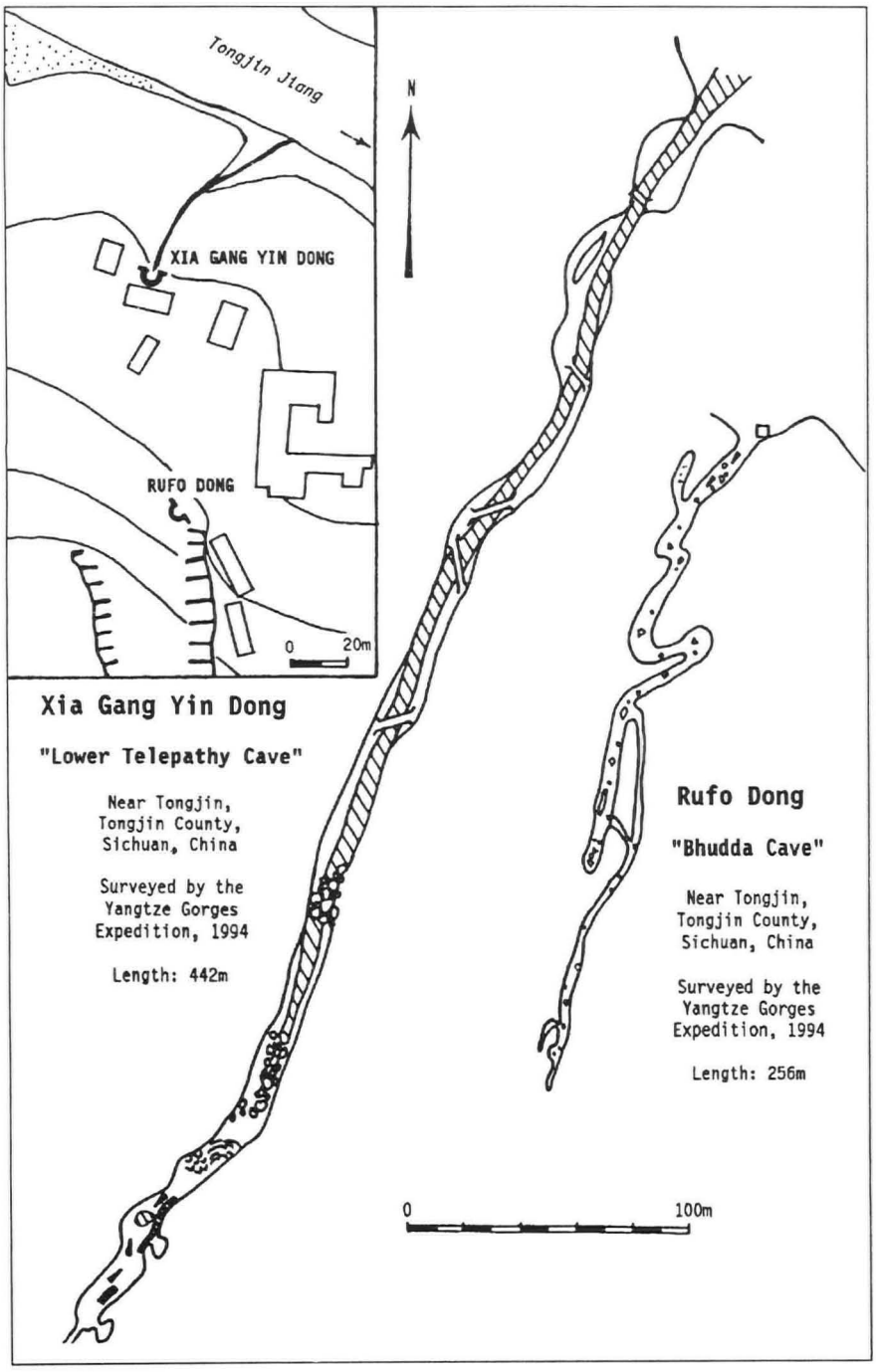


Figure 26. Xia Gang Yin Dong and Rufo Dong Caves.

CONCLUSIONS AND FUTURE PROSPECTS

The challenge for the Yangtze Gorges Expedition was to make a reconnaissance of several areas while spending enough time in two areas to allow more than a superficial study. In total about 13.5km of cave were surveyed in four areas. Despite the wide scope of the expedition the discoveries in Xin Long, Jiang Kou, Fuling and Ba Xian were significant. The Xio Zhai Tien Ken to Mie Gong He Dong through trip is the deepest cave in China if the depth of the cave is measured from the top of the doline! However the depth is measured, this is a fine through trip. In the Jiang Kou area the expedition added over 0.5km to the Furong Dong show cave and explored three sink caves, all of which would reward further work. Somewhere under the plateau above Furong Dong is a major, active main drain with about 1000m of depth potential. Most of the plateau area remains to be explored, and there are major doline sinks farther east. To the northwest of Jiang Kou the escarpment and dip-slope of the Permo-Triassic rocks were not investigated, but this area also has a depth potential of more than 1000m. The dip-slope is probably the catchment area for the resurgences in the Wu Jiang near Wulong, where the best prospects are the resurgences (Caves 2 and 3 in Fig.19).

In the Fuling area the sink by the road, 12km north of Hei Long Dong, was not explored due to a lack of time, but its water fairly certainly drains to the Fulin resurgence. Finally, in Ba Xian county, the resurgence at Jingjia was not explored due to high water levels, but is an exciting prospect.

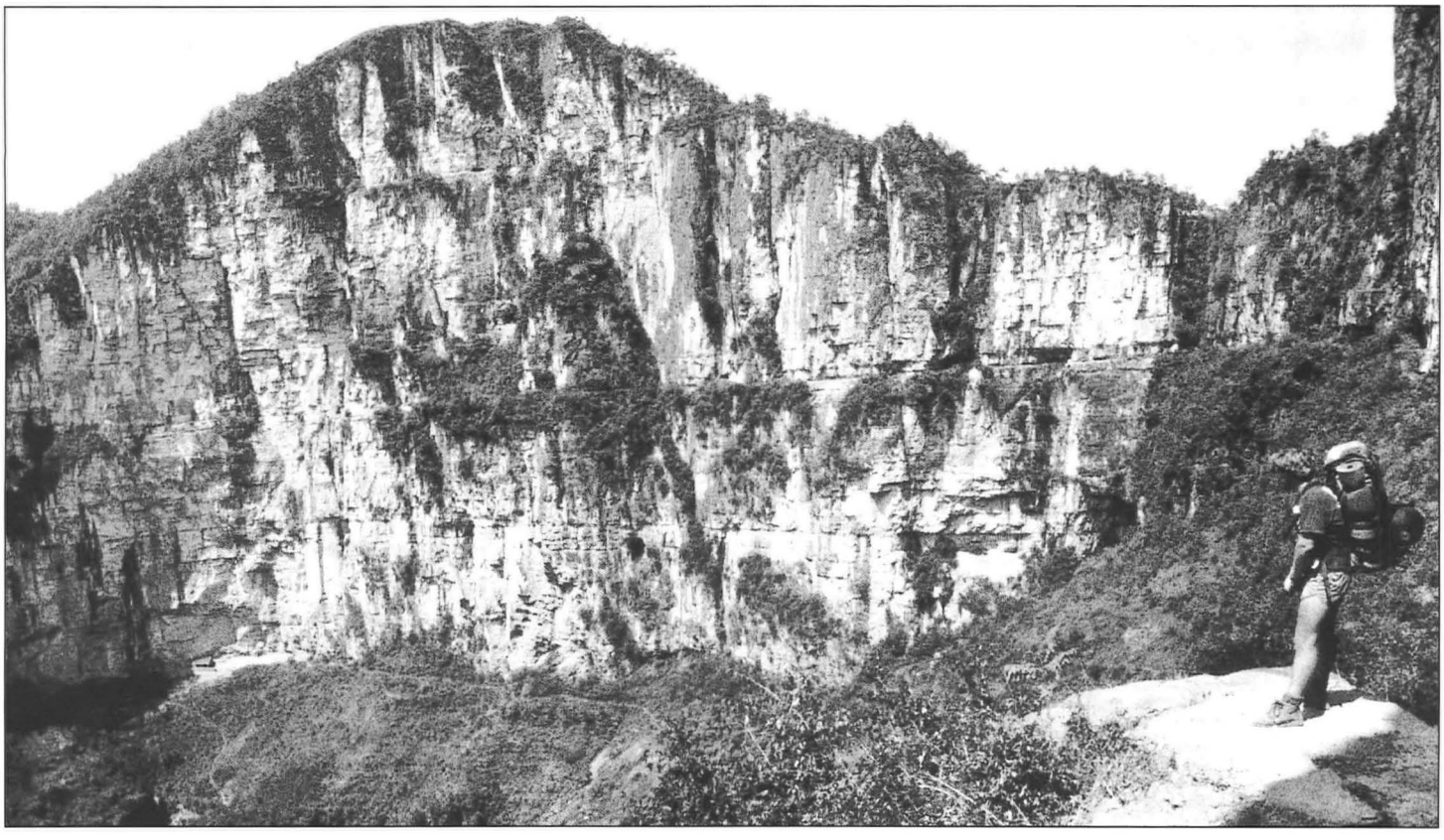
Future expeditions must take into account the fact that this expedition took place towards the end of an exceptionally dry period, and teams must be prepared for wetter conditions. In wetter conditions the Xio Zhai Tien Ken to Mie Gong He Dong through trip could be potentially dangerous, especially at the very tight section about 0.75km from the resurgence.

The Yangtze Gorges Expedition has proved the speleological potential of this part of Sichuan Province, and has made many new friends in China. There are exciting new prospects for future expeditions to Sichuan.

CAVE CONSERVATION

The Wulong show caves and Fu Lin Dong near Fuling illustrate the fact that caves are seen as an important potential source of revenue in this area. The success of Furong Dong at Jiang Kou has perhaps encouraged other villages into opening their caves to the public. Many of these caves have been 'developed' in a most insensitive way, with absolutely no appreciation of conservation, and many caves are simply so poor that they should never have been 'developed' in the first place.

The exploitation of Furong Dong, which is probably the most impressive show cave in China, has been performed with more sensitivity, but the cave management do not seem to appreciate that huge numbers of tourists will destroy the cave unless very strict



The upper section of the great doline, Xio Zhai Tien Ken. The abandoned houses of the hydro-electric tunnel workers are just visible on the big ledge at the edge of the sunlight on the left of the photograph. The ledge is about 225m below the lip of the doline and below the houses, the path zig-zags down the debris cone for more than 400m.
Photo: Kev Senior.

controls are put in place to prevent damage. The expedition wrote a 'Cave Conservation Guide' for Wulong County and Furong Dong Show Cave, suggesting a series of steps that should be taken to protect the cave (and therefore the income from the cave) for the future.

Readers of this report may have become alarmed and depressed at the number of caves reported in which formations have been all but destroyed. Earnest questioning revealed no good reason for this activity. Apart from the case of Monk's Cave, the formations are not usually taken to 'decorate' houses. The scale of the destruction suggests motivation by greed or necessity. One team was told that the stalagmites were powdered to form the base for tablets, so perhaps this is the first example of humans actually eating caves! It is dangerous to lecture and preach without a full understanding of the facts but it is clear that China faces some major challenges if caves are to be exploited without destroying them.

REFERENCES

Eavis, A (Ed.), 1990. The Guanxi Expedition 1988. *Cave Science*, Vol. 17, No. 2, 53-86.

Fogg, P and Fogg, T (Eds.), 1989. *The China Caves Project 1987-1988*. 32pp.

Smart, P, Waltham, A C, Yang, M and Zhang, Y, 1986. Karst geomorphology of western Guizhou, China. *Cave Science*, Vol. 13, No. 3, 89-103.

Waltham, A C (Ed.), 1986. *China Caves '85*. London: Royal Geographical Society, 60pp.

Waltham, A C (Ed.), 1993. *Xingwen: China Caves Project 1989-1992*. British Cave Research Association, 48pp.

Waltham, A C, Brook, D and Bottrell, S. 1993. The Caves and Karst of Xingwen, China. *Cave Science*, Vol. 20, No. 3, 75-86.

ACKNOWLEDGEMENTS

Members of the Yangtze Gorges Expedition thank the following companies and organisations for their continuing support of the China Caves Project.

Alexandra Workwear Plc., British Airways, The British Council, Camera Care Systems, Dawson's Fur Fabric Ltd. (Duofold), Ghar Parau Foundation/Sports Council, Kodak, Lyon Equipment, Merrel Europe Ltd., Mount Everest Foundation, Royal Geographical Society, Tate and Lyle, and Troll.

Special thanks are due to the following British Airways staff, who were particularly helpful in ensuring the safe arrival of the team and a huge pile of equipment in Chongqing:

In the UK: Peter J Barry and Brian Rowley.
In China: Roland Blaney and Charles Phelps-Penry.

The support of British Airways was absolutely crucial to the success of this expedition.

During the organisation of the expedition invaluable advice and enthusiastic support was provided by Andy Eavis and the late Marjory Sweeting.

Once again, grateful thanks go to the expedition's Chinese hosts from the Institute of Karst Geology in Guilin. It was a pleasure and an education to work again with Professor Zhu Xuewen and the team are indebted to him for showing these fabulous karst areas and making the arrangements that enabled the exploration of so many fine caves. The amount of work involved in hosting a western caving expedition is often underestimated; thank you for your patience! Thanks also to geomorphologist Zhang Yuan Hai and his wife, and to engineer Tan Pengjia for their help in the field.

In Sichuan Province team members were greeted with utmost hospitality wherever they stayed. Grateful thanks are extended to the following:

In Fengjie: He Shai Ling, Deputy Director of the Foreign Affairs Office, Fengjie Country. (Fengjie Foreign Affairs Office supplied a truck that transported our equipment to Xin Long).
In Xin Long: Shue Min Xing, local government leader.
In Jiang Kou: You Shao Lu, Vice-director of the Sichuan-Wulong Tourist Office and our host in the Furon Hotel.
In Wulong: Fu Zhea Fu, local government leader.
In Fuling: Mrs. Wan Zhong, Tourist Manager, Tourist Bureau of Fuling.

CREDITS

In truth this Report is the work of all the members of the expedition. The Editor takes responsibility for writing only some of the sections and for editing the parts into a whole.

Special thanks to Richard Bartrop and Adrian Gregory, who helped to read drafts and organise the contributions during editing.

Listed below are the original contributors for each section and the interested reader is recommended to approach these authors directly if more detailed information about an area or cave is required.

XIN LONG AREA

Geology, geomorphology and cave development	Kev Senior
Hydrology	Kev Senior
Caves along the Tian Jing Gorge	Richard Bartrop
Hei Yau Dong	Adrian Gregory
Shrang Fong Dong	Pete Francis
Di Feng	Steve Openshaw
Xio Zhai Tien Ken (doline description)	Richard Bartrop and Dave Checkley
Xio Xhai Tien Ken: doline volume calculation	Dave Checkley
Xio Zhai Tien Ken: upstream	Richard Bartrop
Xio Zhai Tien Ken: downstream	Brian Judd
Tau Yuan He Dong	Pete Francis
'Stalactite Cave', Yitz	Steve Openshaw
Green Eyed Monster Cave	Brian Judd

JIANG KOU AREA

Geology, geomorphology and cave development	Kev Senior
Caves Near Tian Xing Village	Dave Checkley
Zhan Ren Ken	Brian Judd
Dong Ba	Dave Checkley
Xin Lou Kou Dong	Kev Senior
Furong Dong	Kev Senior
English Speaker's Cave	Paul Seddon

WULONG AREA	Paul Seddon and Pete Francis
BA XIAN AREA	Dick Willis
TONGJIN AREA	Dick Willis

APPENDIX A

The dimensions of the Xio Zhai Tien Ken doline were kindly obtained by Professor Zhu Xuewen from drawings made by the engineers during the construction of the tunnel to the hydro-electric power station on the Jiu Pan He.

In the diagram below, the altitudes of different levels in the doline are shown on the left and right. The mean diameter of the doline was calculated from measurements of the diameter on three axes. The scree slope that partly fills the lower half of the doline can be approximated to a segment of a cone and its volume subtracted from the 'cylinder' of the doline. The total volume of the doline is therefore calculated to be 135,319,678 cubic metres.

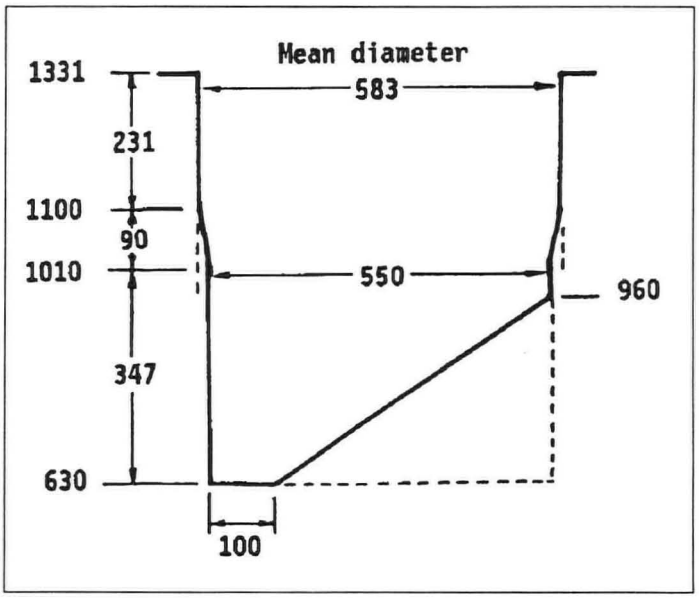


Figure 27. Dimensions of the Xio Zhai Tien Ken doline.

APPENDIX B

Accounts for the Yangtze Gorges Expedition

EXPENDITURE

FLIGHTS	
Return to Beijing £570 x 11	£6,270
Return Beijing to Chongqing £190 x 11	£2,093
Airport tax	£166
Taxis and travel expenses	£96
TOTAL	**£8,625**
PAID TO OUR CHINESE HOSTS	
$40 / man / day ($1.51 / £ = £26.49)	
31 field man days for 11 people	£9,033
22 field days for 1 person	£683
TOTAL	**£9,616**
INSURANCE, etc.	
BCRA Insurance 12 x £59.60	£714
Bank charges and admin.	£83
VISAS	
£25 per person for 11 people.	£275
EQUIPMENT	
1500m rope at 74p per metre	£1,110
Bolting and aid climbing equipment	£89
Photographic flash bulbs	£323
70 batteries	£152
Car inner tubes and float line	£66
TOTAL	**£1,740**
GRAND TOTAL	**£21,053**

INCOME

China Caves Project donation	£500
Ghar Parau Foundation grant	£250
Sports Council grant	£2,200
Mount Everest Foundation grant	£600
Royal Geographical Society grant	£500
British Council	£400
Radio 4 sound recordings	£600
TOTAL	**£5,050**
Team personal contributions	
11 x £1,450	£15,950
1 x £500	£500
GRAND TOTAL	**£21,500**
BALANCE	**£447**

RESEARCH FUNDS AND GRANTS

THE JEFF JEFFERSON RESEARCH FUND

The British Cave Research Association has established the Jeff Jefferson Research Fund to promote research into all aspects of speleology in Britain and abroad. Initially, a total of £500 per year will be made available. The aims of the scheme are primarily:

a) To assist in the purchase of consumable items such as water-tracing dyes, sample holders or chemical reagents without which it would be impossible to carry out or complete a research project.

b) To provide funds for travel in association with fieldwork or to visit laboratories which could provide essential facilities.

c) To provide financial support for the preparation of scientific reports. This could cover, for example, the costs of photographic processing, cartographic materials or computing time.

d) To stimulate new research which the BCRA Research Committee considers could contribute significantly to emerging areas of speleology.

The award scheme will not support the salaries of the research worker(s) or assistants, attendance at conferences in Britain or abroad, nor the purchase of personal caving clothing, equipment or vehicles. The applicant(s) must be the principal investigator(s), and must be members of the BCRA in order to qualify. Grants may be made to individuals or small groups, who need not be employed in universities or research establishments. Information and applications for Research Awards should be made on a form available from Simon Bottrell, Dept. of Earth Sciences, University of Leeds.

GHAR PARAU FOUNDATION EXPEDITION AWARDS

An award, or awards, with a minimum of around £1000 available annually, to overseas caving expeditions originating from within the United Kingdom. Grants are normally given to those expeditions with an emphasis on a scientific approach and/or exploration in remote or little known areas. Application forms are available from the GPF Secretary, David Judson, Hurst Farm Barn, Cutler's Lane, Castlemorton Common, Malvern, Worcs., WR13 6LF. Closing date 1st February.

NCA/ENGLISH SPORTS COUNCIL GRANT AID IN SUPPORT OF CAVING EXPEDITIONS ABROAD

Grants are given annually to all types of caving expeditions going overseas from the UK (including cave diving), for the purpose of furthering cave exploration, survey, photography and training. NCA delegates administration of the awards to the Ghar Parau Foundation, to prevent duplication of cost and effort, and to provide a desirable degree of independence from NCA. Application arrangements are as for Ghar Parau Foundation Expedition Awards, see above.

Expedition organisers living in Wales, Scotland or Northern Ireland, or from caving clubs based in those regions should contact their own regional Sports Council directly in the first instance. It is possible that the inauguration of the National Lottery may result in different arrangements for grant aid.

THE E.K.TRATMAN AWARD

An annual award, currently £50, made for the most stimulating contribution towards speleological literature published within the United Kingdom during the past 12 months. Suggestions are always welcome to members of the GPF Awards Committee, or its Secretary, David Judson, not later than 1st February each year.

BRITISH CAVE RESEARCH ASSOCIATION PUBLICATIONS

CAVE & KARST SCIENCE - published three times annually, a scientific journal comprising original research papers, reviews and discussion forum, on all aspects of speleological investigation, geology and geomorphology related to karst and caves, archaeology, biospeleology, exploration and expedition reports.
Editors: Dr. D.J. Lowe, c/o British Geological Survey, Keyworth, Notts NG12 5GG and Professor J. Gunn, Limestone Research Group, Dept. of Geographical and Environmental Sciences, University of Huddersfield, Huddersfield HD1 3DH.

CAVES AND CAVING - quarterly news magazine of current events in caving, with brief reports or latest explorations and expeditions, news of new techniques and equipment, Association personalia etc.
Editor: Hugh St Lawrence, 5 Mayfield Rd., Bentham, Lancaster, LA2 7LP.

CAVE STUDIES SERIES - occasional series of booklets on various speleological or karst subjects.
No. 1 Caves & Karst of the Yorkshire Dales; by Tony Waltham and Martin Davies, 1987. Reprinted 1991.
No. 2 An Introduction to Cave Surveying; by Bryan Ellis, 1988. Reprinted 1993.
No. 3 Caves & Karst of the Peak District; by Trevor Ford and John Gunn, 1990. Reprinted with corrections 1992.
No. 4 An Introduction to Cave Photography; by Sheena Stoddard, 1994.
No. 5 An Introduction to British Limestone Karst Environments; edited by John Gunn, 1994.
No. 6 *A Dictionary of Karst and Caves*; compiled by Dave Lowe and Tony Waltham, 1995.

SPELEOHISTORY SERIES - an occasional series.
No. 1 The Ease Gill System-Forty Years of Exploration; by Jim Eyre, 1989.

CURRENT TITLES IN SPELEOLOGY - from 1994 this publication has been incorporated into the international journal Bulletin Bibliographique Speleologique/Speleological Abstracts; copies of which are available through BCRA.

Obtainable from BCRA Administrator:
B M Ellis, 20 Woodland Avenue, Westonzoyland, Bridgwater, Somerset TA7 OLQ.