Cave Science

The Transactions of the British Cave Research Association

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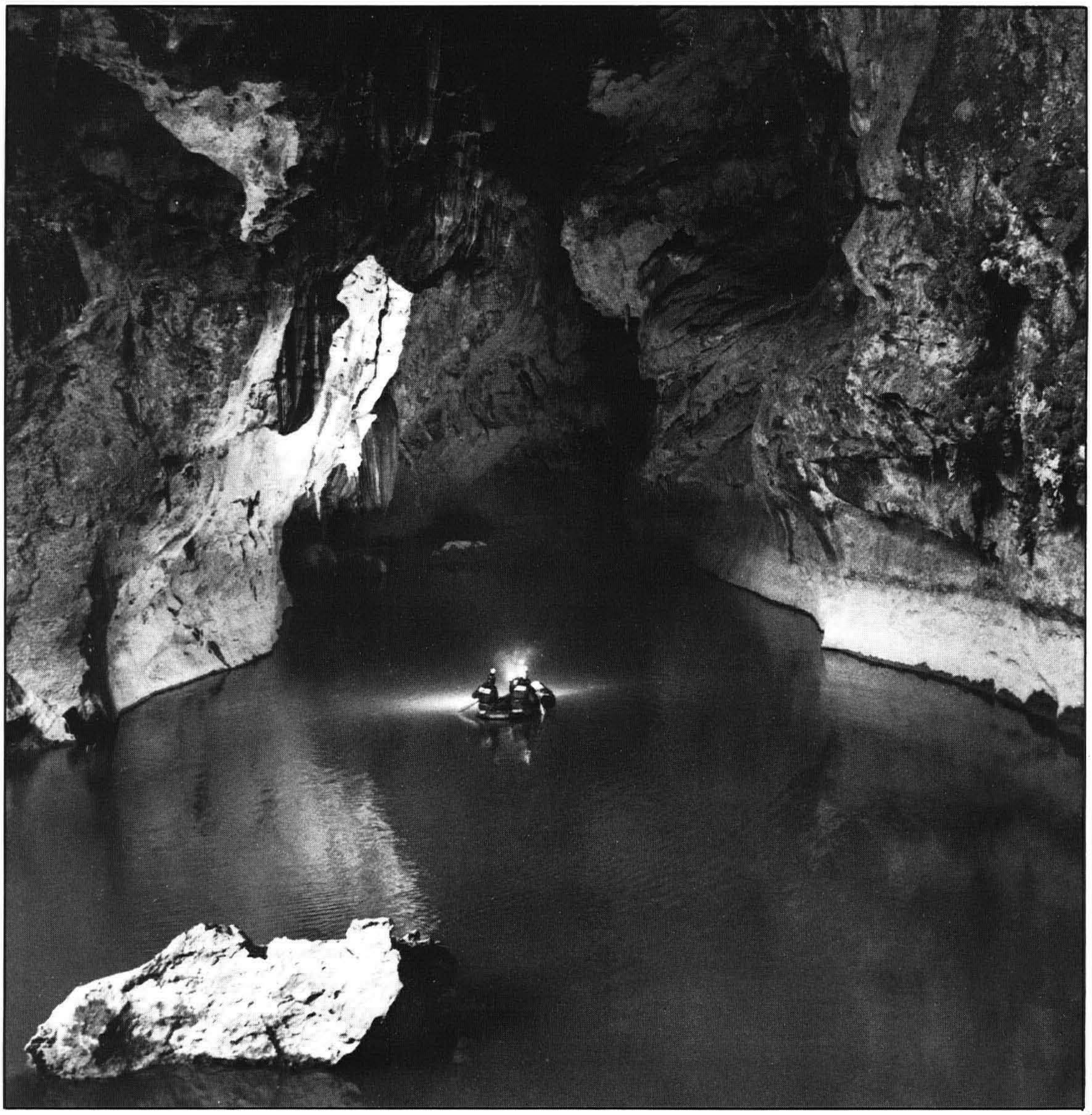

Caves of Guangxi, China

Cave Science

The Transactions of the British Cave Research Association covers all aspects of speleological science, including geology, geomorphology, hydrology, chemistry, physics, archaeology and biology in their application to caves. It also publishes articles on technical matters such as exploration, equipment, diving, surveying, photography and documentation, as well as expedition reports and historical or biographical studies. Papers may be read at meetings held in various parts of Britain, but they may be submitted for publication without being read. Manuscripts should be sent to the Editor, Dr. T. D. Ford, at 21 Elizabeth Drive, Oadby, Leicester LE2 4RD. Intending authors are welcome to contact either the Editor or the Production Editor who will be pleased to advise in any cases of doubt concerning the preparation of manuscripts.

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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.*

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

Cave Science

TRANSACTIONS OF THE BRITISH CAVE RESEARCH ASSOCIATION

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Cover: Fulon Dong, the Solue resurgence cave in Bama County, Guangxi Province, South China, one of the caves surveyed by the 1988 expedition by the China Caves Project. By Jerry Wooldridge.

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The Guangxi Expedition 1988

Andrew EAVIS

It has been known by the western world for many centuries that China contained some of the most spectacular landscape scenery in the world. This scenery is the basis of much Chinese art and legend. It has been suspected by people interested in caves that this highly dissected limestone must be extremely cavernous.

Difficult politics meant that people who may otherwise have visited China turned their attentions to easier places for cave exploration. It was not until one or two western geologists visited the country in the late 1970s early 1980s that the true caving potential of south east China was realized.

The late Joe Jennings and Marjorie Sweeting were two of the early pioneers in this respect and they have estimated that there are potentially more caves in China than all those already known in the rest of the world put together.

The British caving reconnaissances of 1982 and the small scale expedition in '85 confirmed the existence of some of the most spectacular caves in the world. The easy access and the friendly co-operative nature of the people meant that exploring caves in China was a wonderful experience. Interested groups from much of the western world have now visited the country and the story of spectacular limestone caves gradually unfolds.

Many future expeditions into a large number of limestone regions of China are planned and, providing politics permit, there is every reason to expect that many major caving discoveries over the next few years year will come from China. Not only are the thick massive limestones of the provinces of Guizhou and Guangxi of interest but also further south into Yunnan and north into Hunan are clearly going to be of importance. Expeditions are now planned to visit regions even further to the south into parts of north Vietnam, Cambodia, Burma and Thailand.

It is also interesting to note that in the extreme north western region of China the Tien Shan range has cavernous limestone. Its western end passes into Russia where many of the deepest caves in the world are known.

The story of the caving exploration by the China Caves Project are told in the expedition reports "China Caves '85" (Waltham, 1986) and "China Caves Project '87 and '88" (Fogg & Fogg, 1988). This scientific report contains more of the detailed work from the '87/'88 expedition concentrating on the Guangxi section in the counties of Bama, Duan, and Mashan. This region is drained by the Hongshui River and is less than 100 kilometres from the north Vietnamese border.

The 16 members of the Guangxi team had an extremely busy expedition and the considerable success was greatly helped by the efforts of a great number of Chinese people, particularly the members of the Institute of Karst Geology, Guilin. Without the help from these people and the local people from the three counties previously mentioned the expedition would not have been possible. We are very grateful for their help and look forward to many more expeditions of similar spirit and co-operation in the future.

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

Waltham, A.C. (Ed.), 1986. China Caves '85. Roy. Geog. Soc., 60pp.

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The British Team: Andy Eavis (Project Co-ordinator and field member of both teams), Tim Fogg (Leader), Ben Lyon, Jerry Wooldridge, Dave Gill, Dr. John Frankland, Charlotte Roberts, Pam Fogg, Paul Hatherley, Dr. Mark Noel, Simon Fowler, Mike Merdith, Rob Parker, Gavin Newman, Geoff Crossley, Steve Jones.

Finally, on behalf of the Guangxi Expedition I should like to extend my sincere thanks to the individuals and organisations in the U.K. and China that made our venture a success.

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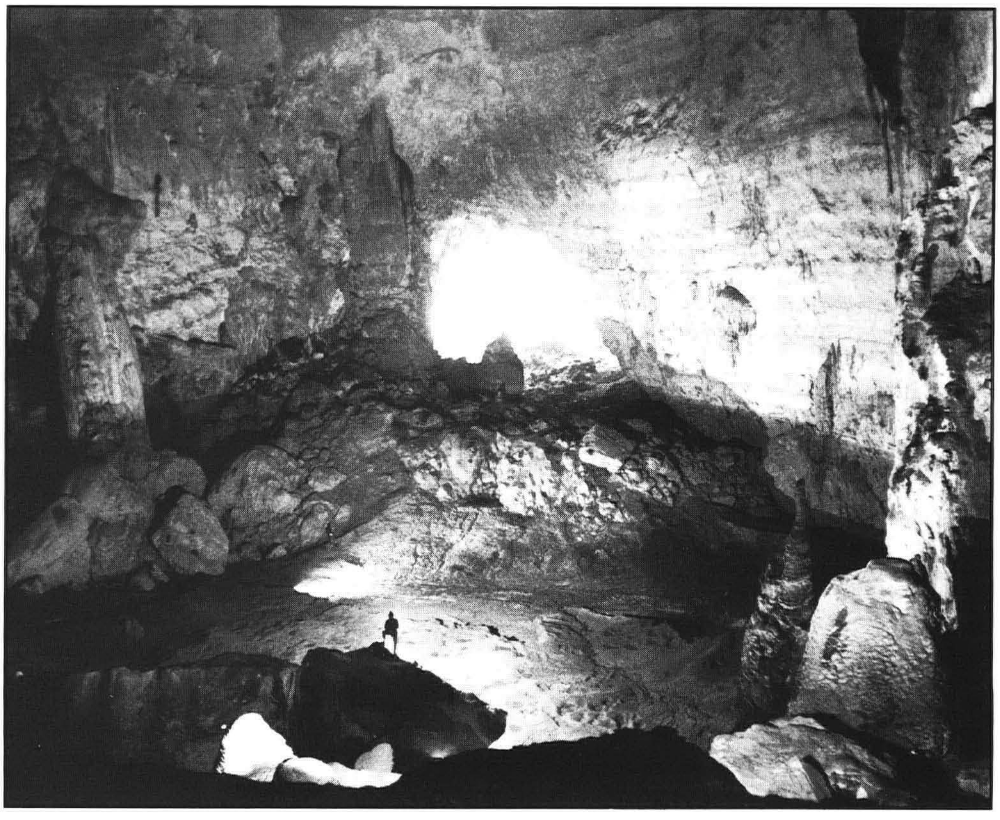

The entrance chamber of the second section of Beimo Dong, in Bama County, Guangxi. (photo: J. Wooldridge).

Dr. Zhang Zhigan, Chen Wen Jun, Zhang Mao Chuen, Tang Xu Guei and Ren Shixi. In addition, we thank the welcoming people of the towns and villages of Guangxi.

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The Caves of Bama County, Guangxi, China

Dave GILL, Ben LYON and Simon FOWLER

Abstract: A four day reconnaissance to Bama County revealed the existence of a large hydrological system with associated caves, draining into the Pan Yang River, a tributary to the Hongshui. The caves were subsequently explored by a small team over a three to four week period. The main trunk route contained some of the largest passsages found so far in China, typically 80m in diameter. In total 17km of caves were explored and surveyed in the Bama area, 16kms being part of the Pan Yang Cave System.

Solue is located 20km west of Bama (Figure 1). Accompanied by Lian Yanqing for the Karst Institute in Guilin and Zho Zhaudong form Luizhou Hydrological Unit, one of us (DG) made a four day reconnaissance of the Karst areas in Bama County, Guangxi.

An outline map of Bama was on display in the Government Hotel where we were staying and this provided us with an initial opportunity to locate the main roads, rivers and villages (Figure 2). The Pan Yang River appeared to rise close to the village of Bai-Mo and sinks were shown to the north. Further sinks were indicated north of the village of Fuanghuang, 20km NE of Bama (Figure 1). On the basis of this and other evidence, we were able to locate potential areas for and initial reconniassance.

Solue Area

According to the Chinese there are 178 known caves in the Solue area with a total length of 9km (Figure 3). Ten shafts are recorded as being over 50m deep with a maximum of 120m.

The main sink is a magnificent river cave, over 7km long, with passages as high as 145m, rising at Fulong Dong, 20km from the entrance. Major efforts are being made to harness this underground river for a hydroelectric scheme. At one time the underground bridges were constructed but floods have since washed these away, blocking the final sump. The diving team found that this flotsam prevented safe progress.

Fulon Dong

This cave was explored by dinghy for 1km to a large sump pool with massive clay banks (Figures 3 & 4). An immense aven enters just prior to the sump and if another entrance was located here, it would clearly lead to an impressive drop of 1,000 feet. A short fossil section running beneath the entrance rubble heap was also explored. The river sinks below the rubble and emerges into daylight at the other side.

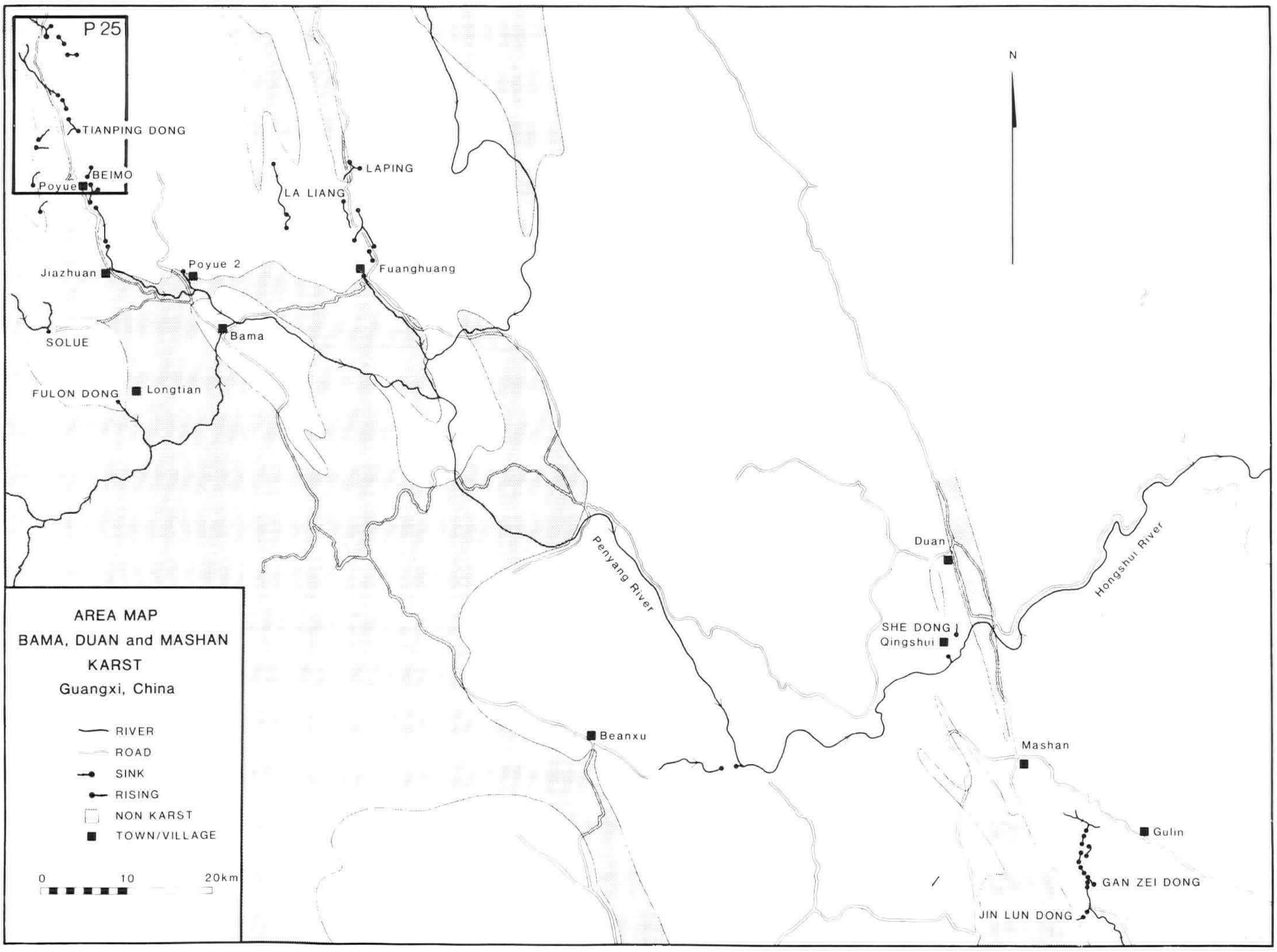
Yen Jain Dong

This was found to be a fossil system about 21km long, west of the Solue River Cave (Figure 3). It was only investigated for a short distance because earlier survey stations were noticed painted on the walls.

Lalen Dong

This was another 1.4km fossil cave situated near the village of Solue (Figure 3). The cave was followed to the end choke and

Figure 1.



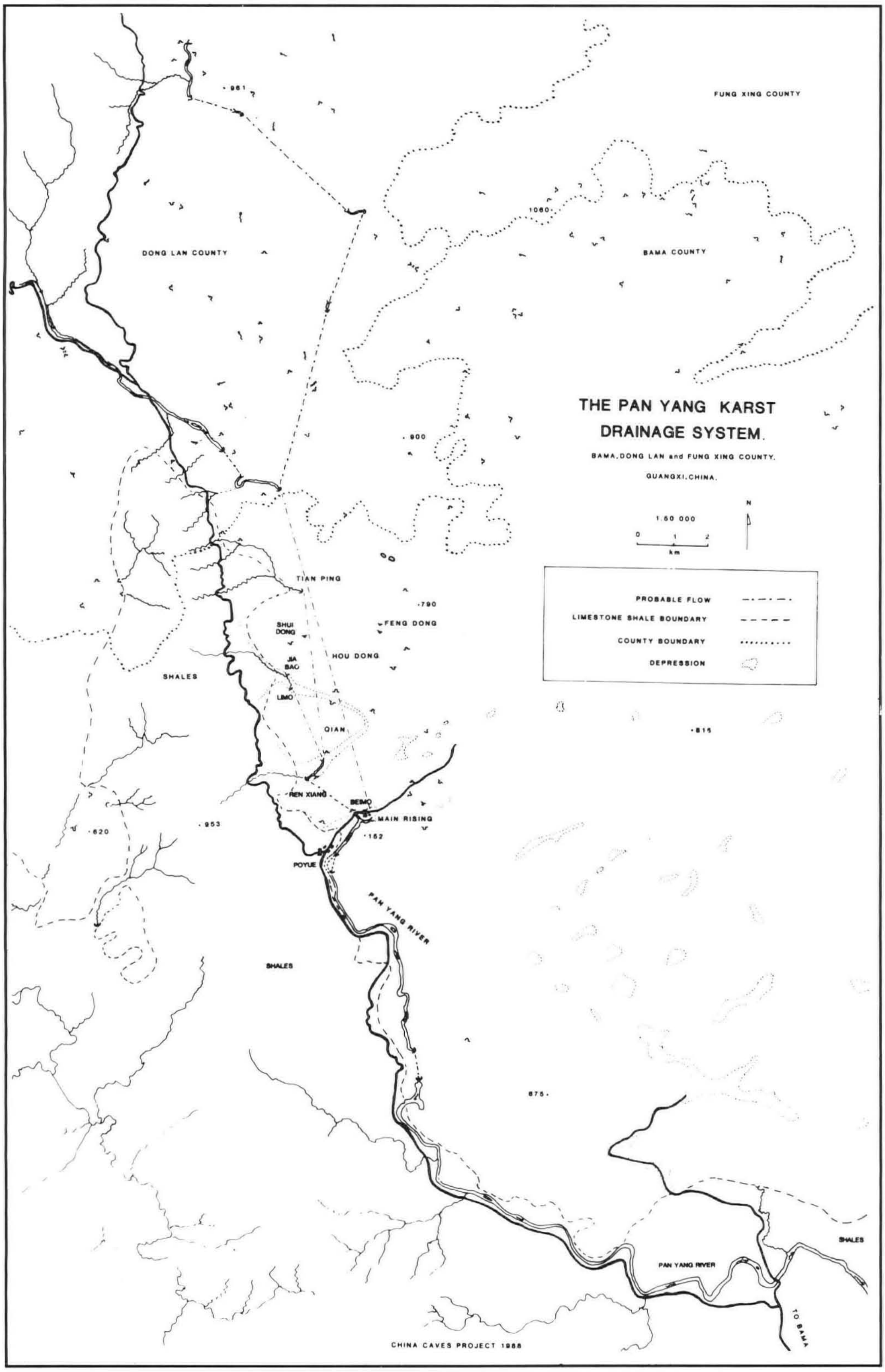


Figure 2.

once again the indications were that it had been explored and surveyed by the Chinese.

Fuanghuang Area

A reconnaisance was made to the village of Fuanghuang where a small spring provides the main water supply. Unfortunately, no progress could be made without diving; however, to the north of Fuanghuang two river sinks at La Liang and Laping were found (Figure 1).

La Liang

A broad valley near this village obviously carried a major stream in wet weather and it was found to end at a large cave entrance. A few metres inside the entrance a number of shafts unite. The shafts were estimated at 20m deep but the cave was not investigated further (Figure 1).

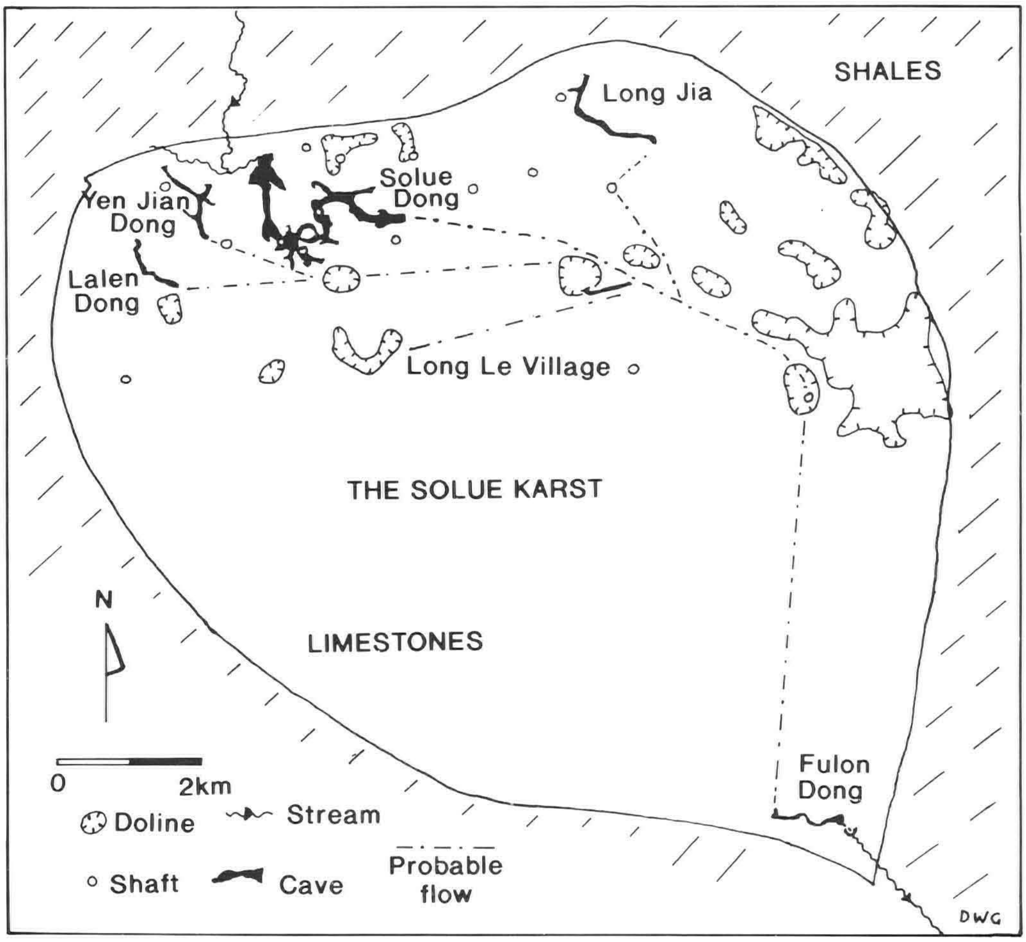
Laping

Here the stream sink was found to be completely impenetrable but 1km east along the valley is a doline where the river can be seen flowing into a 10m wide cave. Only 20m from the entrance a lake was encountered which was not explored further (Figure 1).

The Bai-Mo Area

The Pan Yang River sinks and rises 3km to the south of Bai-Mo village but these sites were not investigated as the local villagers claimed that they were impenetrable. A few kilometres to the north, the river again transects a belt of limestone. Once more, the sink near Po Yue was reported as being impenetrable and although the rising has an associated cave it was not explored (Figure 2). Further upstream, we located the main rising and Bai-Mo Cave.

Figure 3.

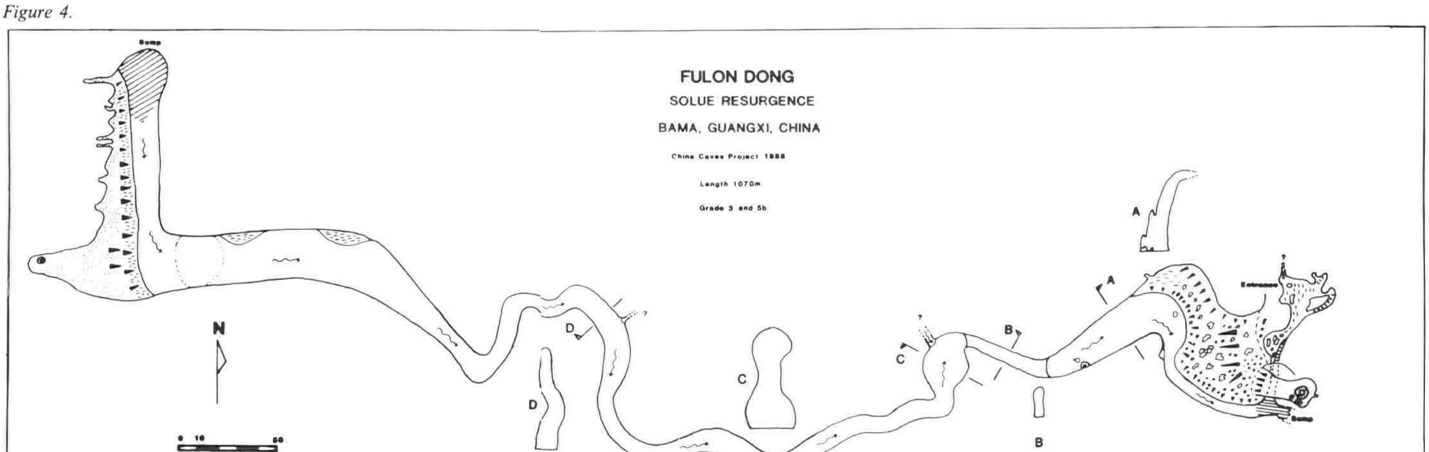


Bai-Mo Dong

2km North East of Po Yue the track to Bai-Mo village, running parallel to the Pan Yang river, skirts a lagoon fed by two resurgences, which then enters the main river. The Pan Yang rises only 200m away round the corner — with perhaps 5 cumecs flowing out of an inviting cave entrance in the middle of the dry winter season. This major river resurgence cave was clearly a 'must'. When we finally got round to it the dinghy preparations were watched by a crowd of hundreds, who followed us across the dry paddy-fields to witness the launch and departure into the unknown. We paddled across the entrance lake and bumped into the rock wall on the other side. Totally sumped and still in daylight! What a fiasco. (Talk about loss of face.)

Back at the small resurgences running into the lagoon... The mountain rose directly behind, with a bay leading back to an impressive cave entrance (Figure 5). Once inside the entrance and beyond a stalactite boss a long slope leads back up to the right, lit by daylight (in the Bai-Mo caves just about everywhere is beyond giant stalagmite bosses!). Toiling up this slope one passes evidence of human occupation, and walls which were clearly of a defensive nature that enclosed the uppermost part of the daylight cave (Roberts; this volume). One wall blocked the approach up the ramp, another, at the highest point, (built partly of brick) had an entrance — with a very steep approach route leading from it down the hillside. Behind the inhabited area, which contained pottery sherds and many sloping benches, was a large and

Figure 4.



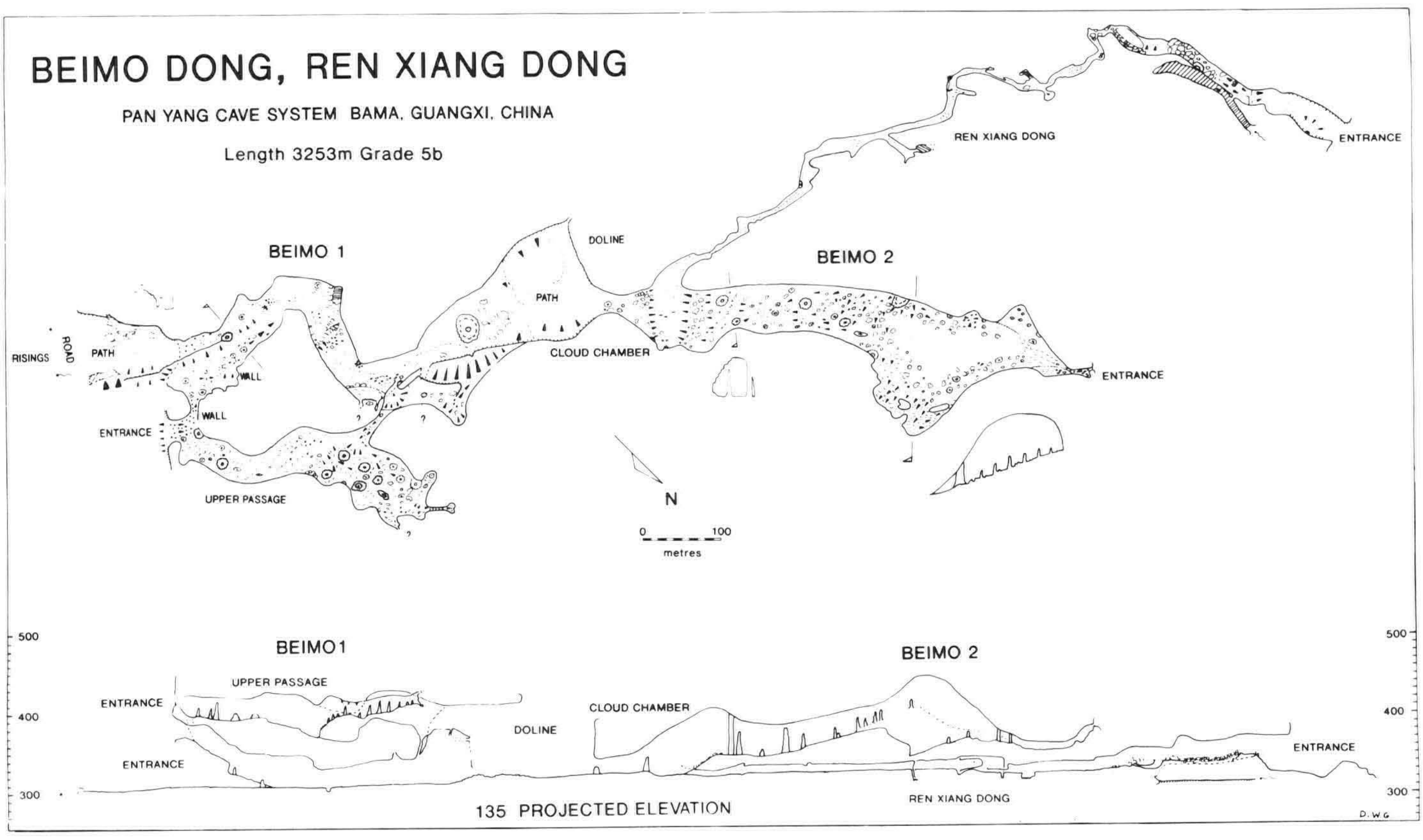
Vast sump pool in the Solue resurgence cave. (Photo: Jerry Wooldridge).

extremely well decorated passage. Bladed stalagmites, formed by the cave wind blowing the formative drips along a line, are a special feature of this area, which also contains massive stalagmite bosses, superb flowstone and the first of thousands of cave pearls which grow in unique profusion in the caves of Bai-Mo. The passage continues before finally emerging high in the side of the main cave passage below, a steep track down making the connection.

Down below, back at the stalagmite boss in the initial entrance to the cave, a path leads via a large arched passage, through a short dark zone and back into daylit cave. The path is used by the local villagers living in a deep doline valley reached by going through the cave to its second entrance, a collapsed chamber, where a vertical cleft allows them to climb out. The second entrance is reached via a vast portal, the way down from the upper passage joining before the lip of the exit. At this point the portal is over 90m high, with only a few metres of roof supporting the land surface above. Not surprisingly, the continuation of the cave on the far side of this giant skylight is obvious.

Not far inside — still in daylight — a large circular chamber is encountered, "Cloud Chamber", with a dried mud floor indicating seasonal ponding. There are two ways on. Straight

Figure 5.



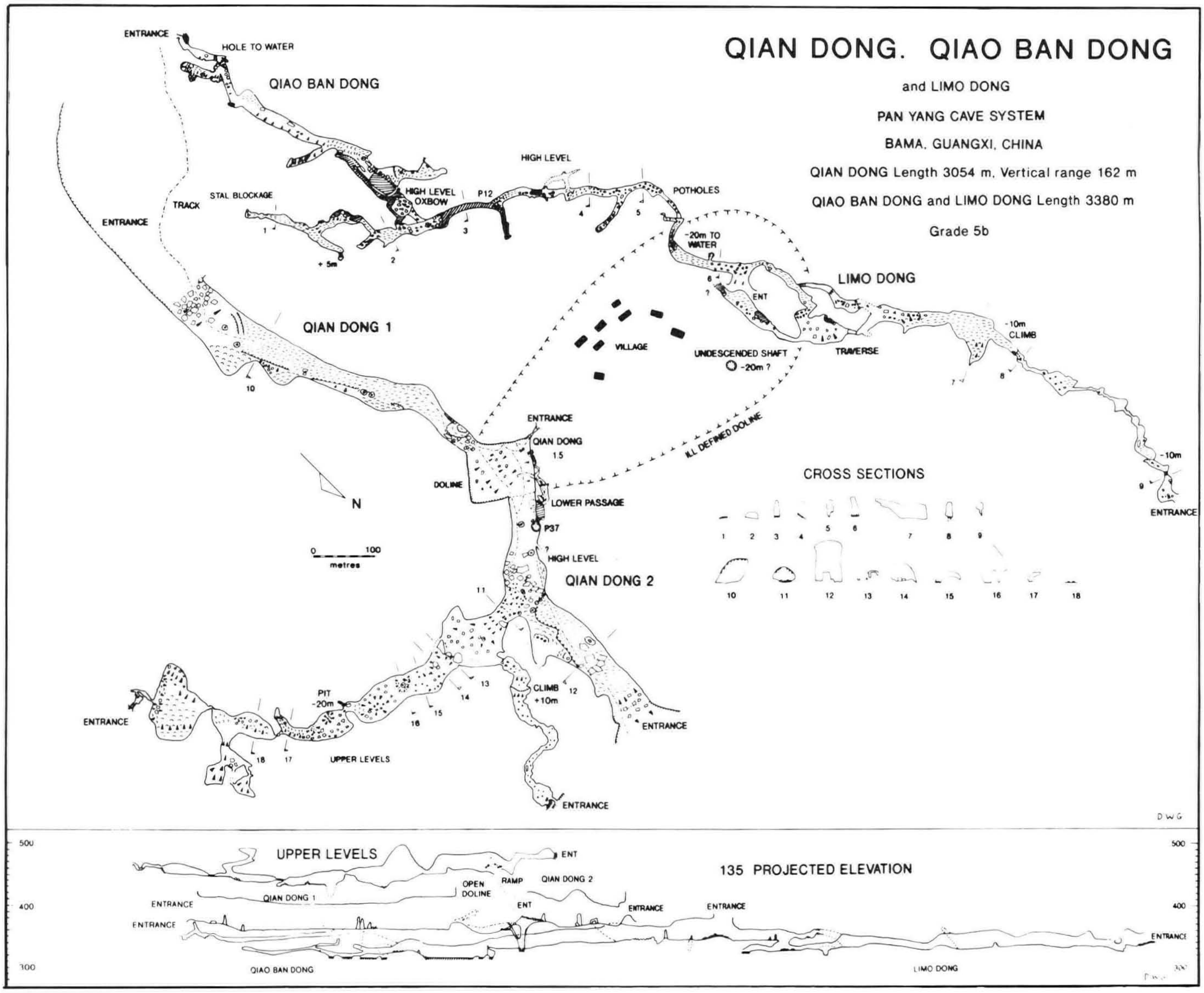


Figure 6.

ahead, a slope leads up past two enormous stalagmite sentinels and on into an even bigger chamber. (Mike Meredith, warden of the world's largest caves in Mulu, Sarawak, was heard to mutter around here, "If they get bigger, I'm going to explore myself out of a job!"). From beyond the sentinels a look back revealed a dramatic layer of cloud in the upper part of the first chamber, mysterious in the pale back-lit daylight. This was the first manifestation of the strange atmospherics of the big Bai-Mo caves. Roof domes were filled with static, humid air at around 22-23°C, while cooler air flowed along at the base of the passages, of speeds of up to 3m/s. The transition from one to the other was often abrupt — a matter of centimetres, so that it was possible to stand at the top of a rise in a passage with a cool draught blowing past your body while your head was hot, sticky motionless cloud.

The cloud layer often extended further down into the even larger chamber beyond the sentinels, obscuring the remarkable formations. One elegant stalagmite, over 30m tall, we nicknamed the 'Rocket'. At the end of this chamber, the passage is bisected by a massive stalagmite pillar. Up the left is a route which passes right through a stalagmite boss. At this point daylight can be seen and the exit is reached by climbing up a steep boulder slope, past massive dry-stone walling. This entrance, some 3m in diameter, is tiny in comparison with the cave below and is clearly just the accessible remnant of a much larger infilled arch.

Directly across the valley is the imposing entrance to the continuation — Qian Dong. Returning to the chamber just inside the second entrance to Bai-Mo cave, "Cloud Chamber", one can enter a lower passage running west with clean-washed walls and roof and a mud floor which clearly carries a large stream in wet conditions. After 400m the passage divides, the right hand branch dropping down a rift after 60m to slow moving water. The left branch continues, with a mudcracked floor, until a squeeze through flowstone must be passed. A slope on the left descends to the phreas. Skidding along the muddy floor leads to an awkward blockfall which can be climbed directly or passed by an alternative route along epi-phreatic tubes of increasing size to daylight. To the right an eyehole drops around 30m to a river cave almost directly below. The slope is walled and terraced and obviously formed a living place in the not too distant past. However, even the remnant rice-mill and baskets were covered in layers of cracked mud, indicating that water fills the passage to a depth of many metres in times in flood. At the foot of the daylit slope the cave walls continue, giving the effect of a deep ampitheatre.

This entrance, Ren Tung Dong, like most of the other ones, is gradual affair. It is quite clear that the caves were formed at a time when the surface relief was at least 100m higher than at present. The Fenglin karst surface of towers and dolines has evidently been corroded downwards until the Bai-Mo cave system has become truncated. In some places the truncation is relatively recent — as with the collapsed chamber forming the window between the first and second Bai-Mo caves — in others it has left gaps of nearly a kilometre, e.g. between Bai-Mo and Qian Dong.

'Round the corner' to the north east of the previous entrance, is an imposing river sink entrance. This quickly narrows to a 6m wide, 20m high canyon, with a deep canal entering the mountain below the drier cave above. The river sumps after 200m and carries the water which resurges into the lagoon at the first entrance to Bai-Mo.

Turning upstream, one can follow the stream across a wide doline, which on first aquaintance can be mistaken for a valley. Over to the west are sandstone hills rising to around 1000m from which one stream joins this cave-river just before it enters the lowest level of Bai-Mo. At the time of our visit the stream on its sandstone bed was dry before it reached the confluence. To the east the 'valley' narrows and a descending outlet can be envisaged between the towers although in fact, the far end rises conclusively in a barrier of towers. So, back up the flowing river, past an unexpected and beautiful turquoise lake, the bed becomes increasingly walled in by jagged limestone before the rock finally arches right over the water. Not far inside this resurgence cave the way on is sumped at water level and it is necessary to search for the continuation 30m above. Half a kilometre along the doline is the entrance of Qian Dong (Figure 6), around 80m wide and high and the continuation of the main Bai-Mo passage.

Qiao Ban Dong

A track contours the doline-valley between Bai-Mo and Qian Dong and passes over the resurgence which then flows across the doline to sink in the lower level of Bai-Mo Dong. The resurgence itself is a deep lake which leads to a sump, with inaccessible passage visible high above which can be reached by diving through vegetation by the track and descending a 6m climb (Figure 6). This leads, via a mud-covered boulder slope, up into a heavily stalagmited area, then down into a chamber where a shaft drops to water level. A wide, low section with a seasonal raised sump then leads through into a spacious, sand-floored passage. The sand peters out and it then becomes difficult to avoid the shark's tooth corroded limestone which follows. Between the minor pits and spikes lurk deeper holes which drop 15-20m to the permanent water level. After these, is a large, black pit with a lake at the bottom, reached by a 24m pitch and a large deep canal connecting to Limo Dong. Beyond the connecting hole, the upper passage rises and the strong draught is lost. The end is a hot-air dome, with a very large 20m deep hole to the water level almost blocking the passage. Speleothems prevent progress much further.

Limo Dong

The conspicuous dry streambed passing through the village of Limo leads beckoningly 'downstream' to the relatively small entrance of Limo Dong (Figure 6). The tumble of boulders that is the streambed runs into the 20m high by 10m entrance. An enforced wade in a pool leads to a 15m pitch which can be free-climbed. Climbing is encouraged by the obviously soft landing in a large glutinous mud lake. From this unpromising start the passage continues with the same dimensions as the entrance, or larger, for over 1km. Being epiphreatic, it is refreshingly clean-washed and the admittedly sparse formations are still active. A flowstone barrier can be surmounted and a tricky descent avoided by devious route-finding. A steep ramp to the left rises 100m but frustratingly fails to reach a high level passage. Further along the epiphreas an intimidating traverse can also be passed easily along the right wall. Just before this traverse an oxbow starts up in the right wall. After the traverse, the main passage widens to form a chamber, then narrows to the last 100m to a dismal draughtless pool that was not investigated. Back at the chamber, a large passage to the right (downstream) curves upwards, with old steps indicating previous use as a water source. The steps lead to a decorated, mud-floored passage and a large entrance into the next doline. Part way along this passage a high level oxbow loops back to the main streamway just before the traverse. The doline entrance is clearly a collapse feature and the passage continues opposite — the start of the connection to Qiao Ban Dong.

Beyond the collapse, the passage continues in the same style to a flowstone barrier. Once surmounted and descended, the next obstacle is a 5m vertical wall fortunately well endowed with holds. The continuing dry streambed is deeply potholed — no doubt superb when moderately active. At a small chamber, a blind ramp goes off to the left and the passage enlarges with some fine

Figure 7.

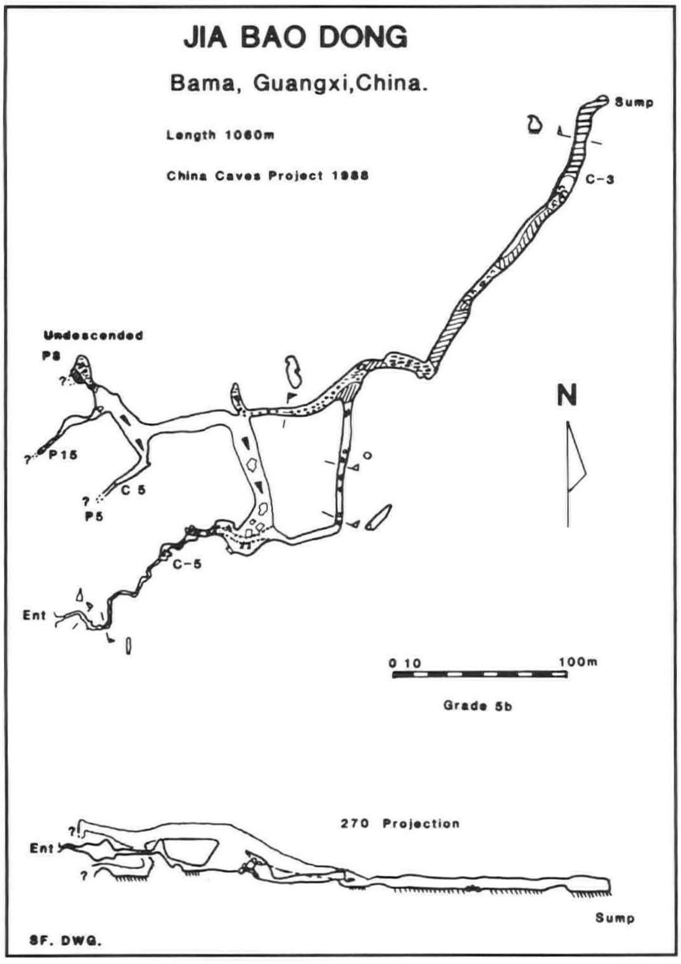
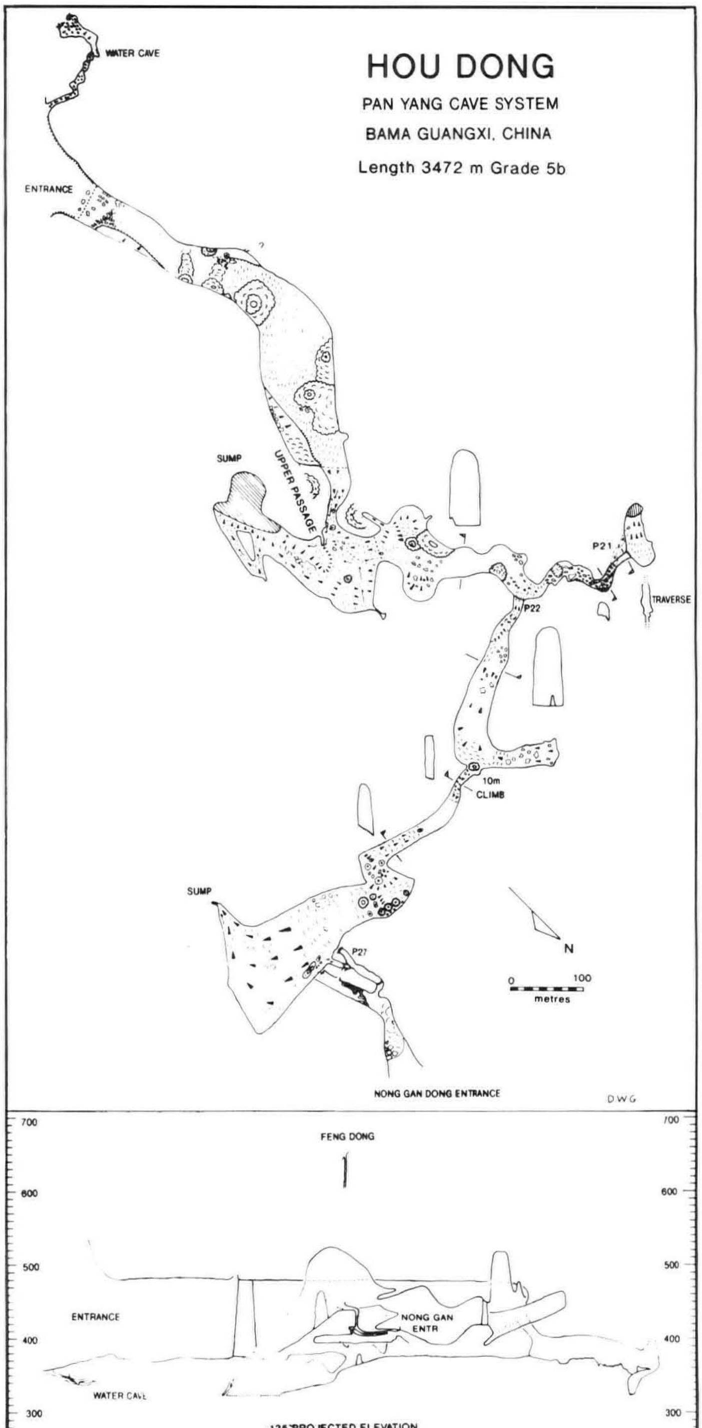


Figure 8.



formations. A small oxbow is passed high up on the right before the passage reaches som flowstone-rimmed pools. To the left are sumps, straight on leads to a 12m pitch over gours into a canal. Left soon sumps, but the right branch is a 100m swim in a 20m wide passage to a boulder slope. Up this and past a small bat colony, the passage continues with pools and short side branches, getting lower, until finally silt banks block the way. Back at the first pool a short muddy wade leads through a rock arch to more boulders and another equally impressive 100m swim to the base of the rope from Qiao Ban Dong.

Luo Jia Bao Dong

In contrast to the surrounding caves, Luo Jia Bao Dong, (Figure 7) has an entrance smaller than most on Mendip. The dry streambed that enters Limo Dong is fed by a stream flowing from the shales to the west but also from a resurgence on the north side of the valley. Crafty poking around in boulders on the steep side of the streambed just prior to the resurgence reveals a small winding phreatic passage. 100m later it drops down a climb to a small deep pool that deterred previous Chinese visitors. Careful but somewhat extreme stretching avoids a wetting, but more pools follow. A boulder chamber is passed and the passage continues small but nicely sculptured. Just before the final long canal section, a passage leads off to the left. This ascends a ramp to a junction with several passages. One is blind, one enters a blind chamber and the last passage 'goes' but with a sense of deja vu as you enter the boulder chamber from above. Nevertheless, the high level continues to a complex area of sumps, undescended pitches to pools and mud. Flood debris adds to the impression reinforced by the survey, that you are close to the surface. A troglobitic carabid beetle was captured here together with a rich cave fauna — a good site for any future collecting.

Qian Dong

Qian Dong ("the cave in front") was first sighted from the exit of Bai-Mo Dong and is in fact simply the continuation of that cave across a doline. The first impression on approaching from the south is of an enormous entrance arch which dominates the scene (Figure 6). A track leads in and continues right through the cave — or cavern which might be a better description. Descending slightly from the entrance boulder pile (a consistent feature of all four major entrances) the path continues along an almost horizontal mud floor, a steep inclined bedding to the right (E) rising to a number of stalagamited roof bays. Not far inside the cave, the second entrance comes into view and daylight is sufficient to traverse the cave! The overall impression is of an airy, wide and high, perfectly arched tunnel which affords an easy stroll straight through the tower karst above.

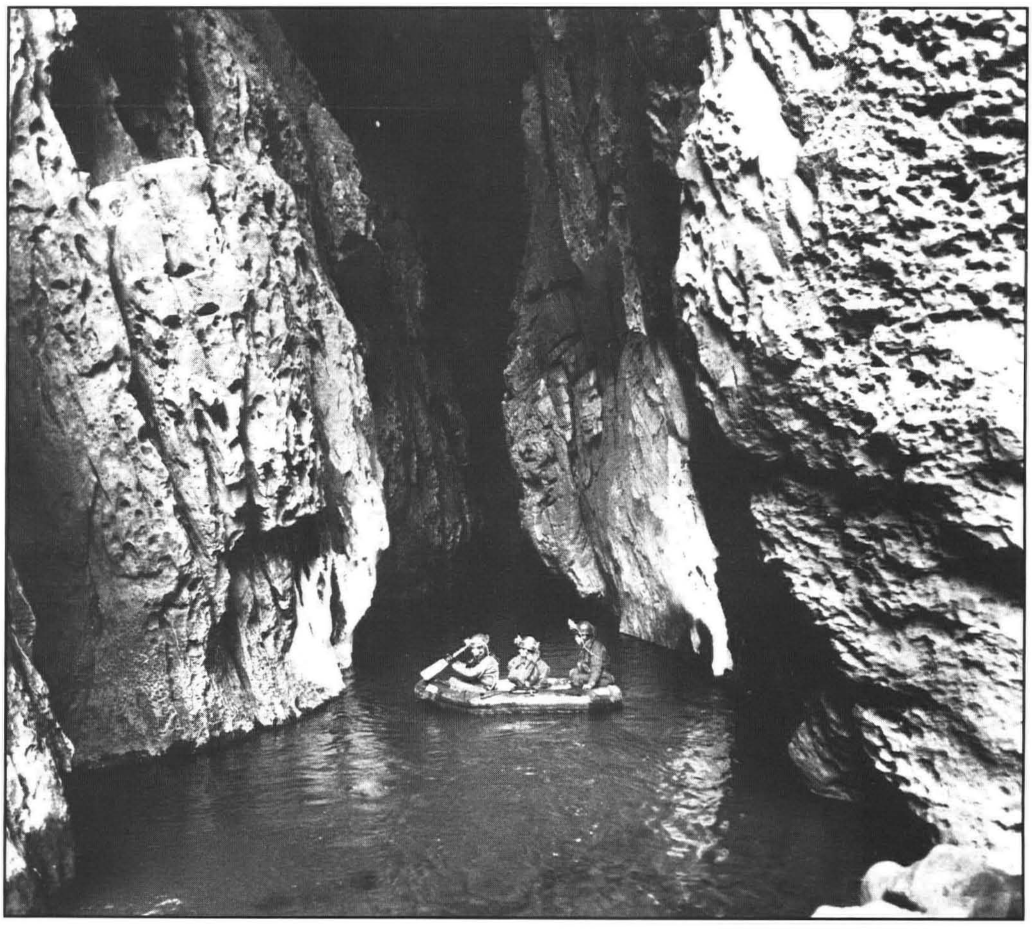
Daylight in the second entrance streams in down a cliff-ringed shakehole or roof collapse. However a short (18m) cave passage in the western corner provides a means of escape into a nearby doline. Qian Dong is the nearby villagers' highway to the outside world.

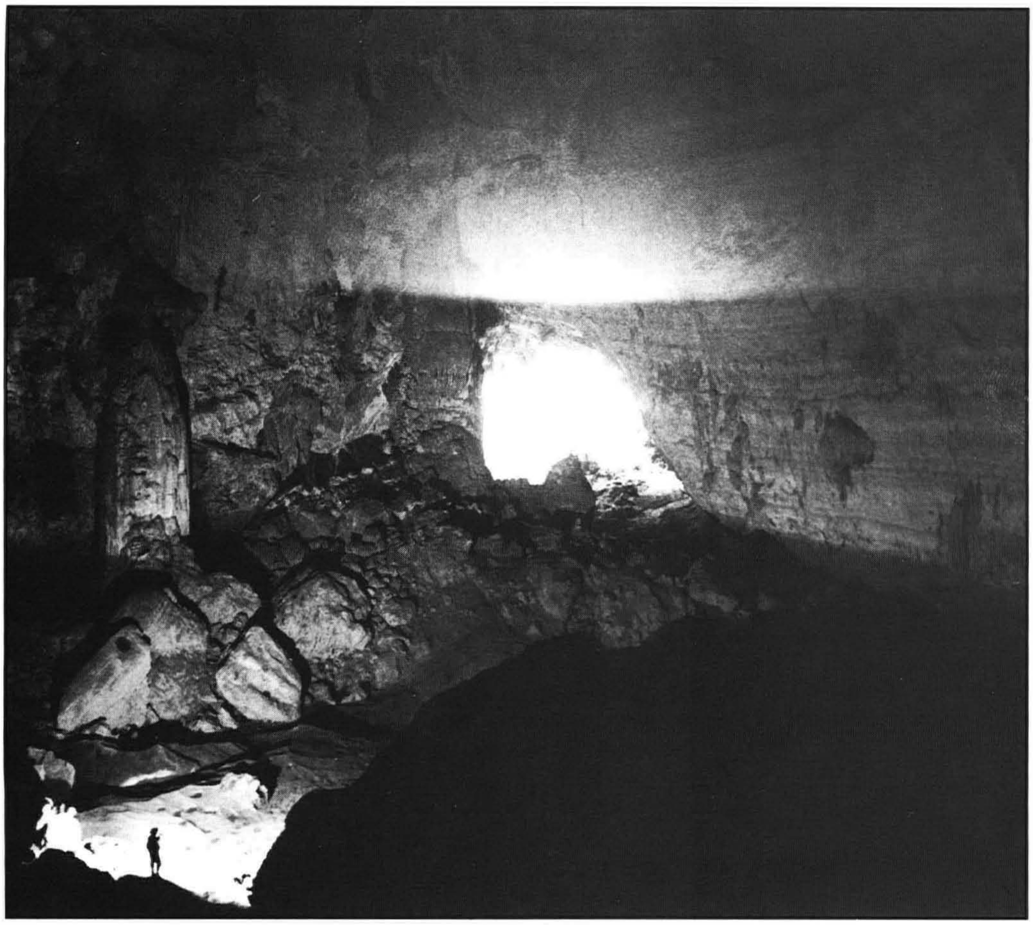
Continuing northwards you immediately re-enter the main passage, with dimensions even larger than before. To the left at the base of the entrance slope is a shaft leading down to water 36m below. The lake at the bottom was swum to a climb out on the far side which led via a small but complex series of passages to a totally unexpected exit near the bottom of the collapse-doline which bisects the main passage of Qian Dong.

Beyond the shaft, the way on climbs a boulder slope, with an enormous bedding plane ramp continuing up at an angle of 30-40° to the right. The climb up the ramp reaches a separate passage level, some 80-90m above the 'main' cave. This high level 'goes' to entrances at the edge of the limestone block to the south-east and to the north. The south eastern section of passage is a kilometre long and is very large in places but the massive old calcite has effectively split the passage into a series of chambers and much smaller connections described by the survey team as a 'string of sausages'. The northern branch is not so large but is also much modified by calcite. The exit from the south eastern entrance is down a steep but negotiable hillside. At the northernmost extremity the cave splits into a mass of small openings through calcite which lead in two places to cliff-edges overlooking the village of Hao He. Perhaps the most remarkable discovery in this ancient passage was that it had been surveyed before and that pits had been dug to a depth of 6m or more at regular intervals, clearly with a scientific purpose in mind. Our hosts from the Karst Institute could throw no light on who might have done this research.

Following the main cave from the foot of the ramp, past huge stalagmites soon leads to the far end of the cave. A path descends to another dried mud floor, with vertical walls rising over 60m to the domed roof. The scramble up the entrance boulder-slope leads out to a view across another doline-valley and directly into the continuation of the cave another kilometre away, beyond the small village of Hao He.

Sink into Ren Xiang Dong. (Photo: Jerry Wooldridge).





Cloud in entrance chamber of Beimo Dong II (Photo: Jerry Wooldridge).

Qian Dong, is one of the most impressive, pleasant and easy caves in the world. Members of our team used it on a regular basis simply to get through the mountain as quickly as possible.

Hou Dong

Hou Dong ("the cave behind") is a continuation of the main passage of Qian Dong and entered through a ravine revealing the former extent of the cave now being truncated by solutional lowering and spalling of rock from the 100m cliff immediately above the entrance (Figure 8). At the mouth of this ravine is a small cave which leads east and then south before emerging at an entrance into the main valley/doline. The locals said that this was their source of water during the wet part of the year. At the bottom of the slope down from the entrance was a dried up pool

Main passage in Beimo Dong — looking towards the doline in the middle of the cave. (Photo: Jerry Wooldridge).

and beyond a fine collection of water-rounded limestone boulders — not seen anywhere else in the caves — up to 80cm diameter and clearly indicating periodic flooding by very fast flowing water.

The mouth of Hou Dong is impressive by any standards and enlarges dramatically inwards. After negotiating boulders and speleothems, a drop leads onto a beautiful sandy floor, the roof rises and a 78m high stalagmite pillar is passed on the right into a square-roofed, walled and floored gallery over 90m broad. Ahead is a stalagmite perched like a dead lighthouse on top of a boulder pile, rising from 70m above the floor. Skirting to the right of this slope is seen developing out of the right wall and curving round into the blackness ahead. This was climbed and then traversed into a passage immediately above the main one below. This upper, fossil passage ends abruptly at a balcony overlooking the 'main way on' further into the cave.

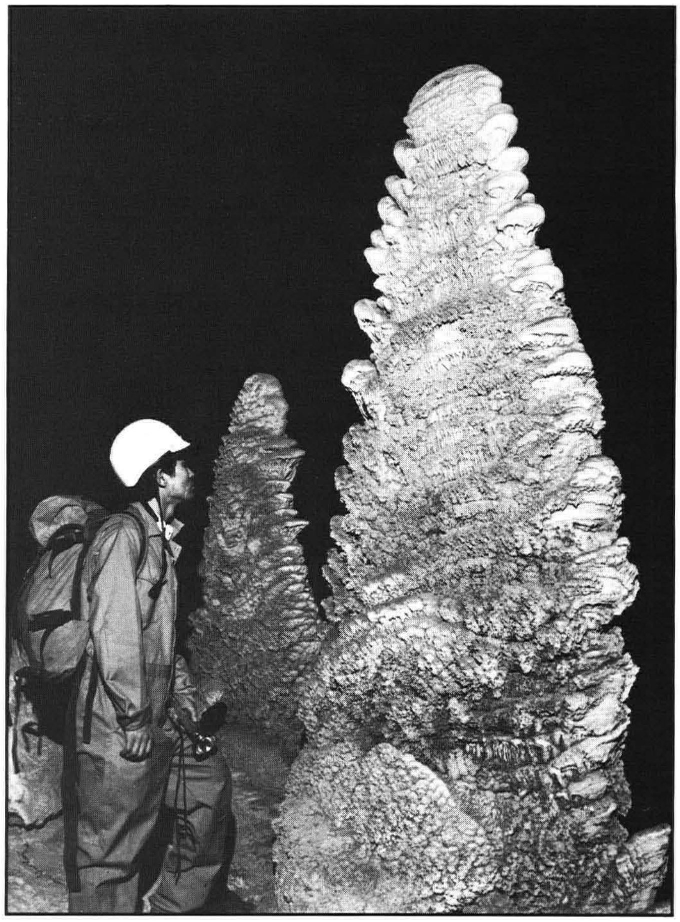
The lower passage changes its character at this point. The sand floor rises to a slight peak (indicating tremendous flood-flow regime towards the entrance) followed by a long downwards slope which is well gullied, past massive stalagmites, to a vertical drop. Facing down the drop is a long slope at 35° leading up to the left and a vertical wall up a short slope to the right. The drop can be by-passed by climbing up the slope to the left, traversing forwards and then descending. This leads to a point, 30m below, in a gully leading to lake. The water level obviously rises by at least 50m in flood but in the low-water conditions in which the exploration was carried out no significant flow was detectable.

In general these caves are developed in massive limestones folded on a N-S axis with local dips of 30° to 40°. The lake passage described above is developed in beds dipping at 35° to the south. Traversing the mud-covered bedding plane floor which slides straight down into the lake leads to a vertical wall which prevents further progress. The far side of the lake appeared to be without exit, although the draught indicated a way out up in the roof. Climbing up the bedding led into a higher tube, with two connections down-dip to the lake area. Continuing along the tube led back into the slope which was descended to reach the lake. At the top of this slope, a level platform abutting solid wall can be followed to a low 4m opening into the main passage continuation, where the roof suddenly rises to a great height and the overhead balcony at the end of the fossil passage from the entrance series is clearly visible. Level mud floor stretches ahead with cracks up to 5cm wide infilled with more recent mud. To the left is a large alcove with a >50m high stalagmite bounding its right side. (This may have afforded a connection through into the entrance series in the past). To the right a slope leads up to an area above flood level, containing scraped out sleeping areas and remnants of bamboo.

The large passage continues easily, with its solid mud floor, flanked by massive stalagmite columns. A high level passage guarded by a calcited fill overhang is passed on the right. Below and beyond, the character of the cave changes abruptly. Gone is the mud and after some very beautiful orange coloured gour-pools the rock becomes clean and corroded into blocks which, pitted and spiked, make for miserable progress. Passing two small pits, a rift in the floor leads down to a blind 20m pitch, above which a traverse leads across calcited mud to reach the top of a ramp. Height is quickly lost in descending this and a sump pool terminates exploration.

The lower passage just described is clearly active in wet periods but no way on was found to the low-level active and possibly phreatic passages which underlie the system. Retracting the path to the big upper passage guarded by a stalagmite overhang is the key to the northward continuation of the cave. The overhang was climbed up friable material to an exposed climb and traverse up and across a smooth calcited mud slope. There was no evidence of previous ascents but the story gleaned from the village at the entrance to the cave — that many years ago men had been right through the mountain to an exit on the far side — corroborated when, along the passage above the climb, bundled sticks and the remains of bamboo torches were discovered. In this totally fossil gallery speleothems are abundant with a remarkable quantity of cave pearls scattered over the floor. The gallery bifurcates: left ascends flowstone and boulders to a dead end, while right climbs between stalagmites to a higher level where passage heights were estimated at over 150m. A switch-back floor ends after a final climb at a large level area, with a steep ramp dropping down in front.

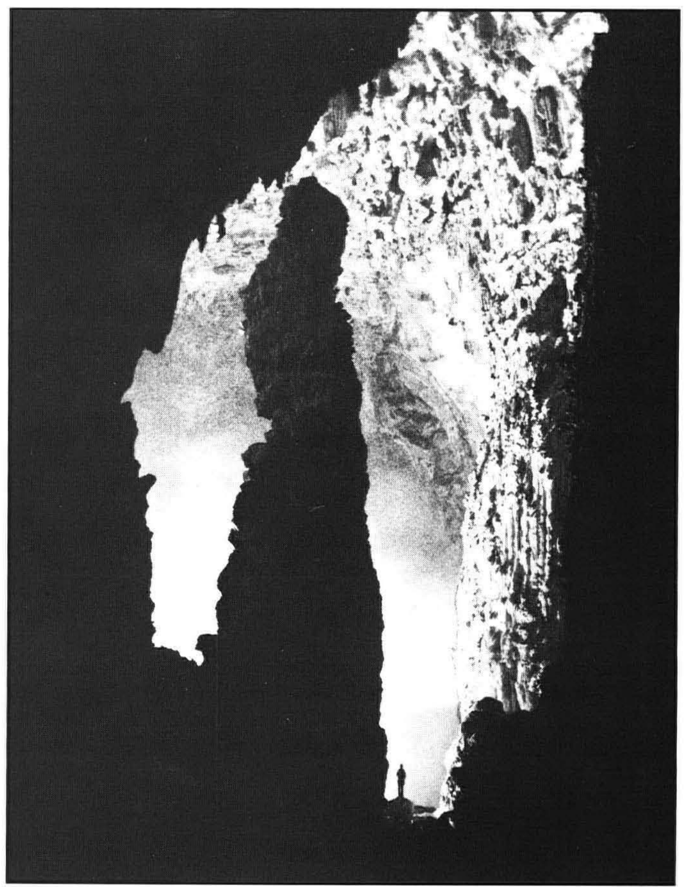
In this cave we again made some interesting meteorological observations. A steady draught of 2m s blew up the passage, across the level area and down the ramp to a height of 1.5m above the floor. Above this, the air was much warmer and tranquil.



Stalagmites formed by reversing draughts in upper series of Beimo Dong. (Photo: Jerry Wooldridge).

Outside temperatures varied from 5 to 15°C considerably cooler than the 21-22°C mean, accounting for these streams of colder air flowing below static air at mean cave temperature above. The same phenomenon was responsible for the clouds in Bai-Mo Dong.

Stalagmite and caver in Beimo Dong. (Photo: Jerry Wooldridge).



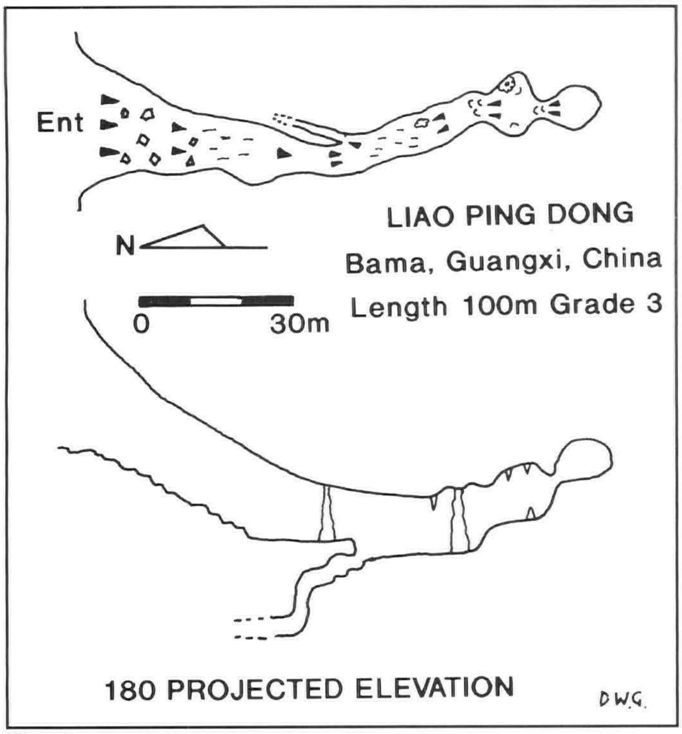
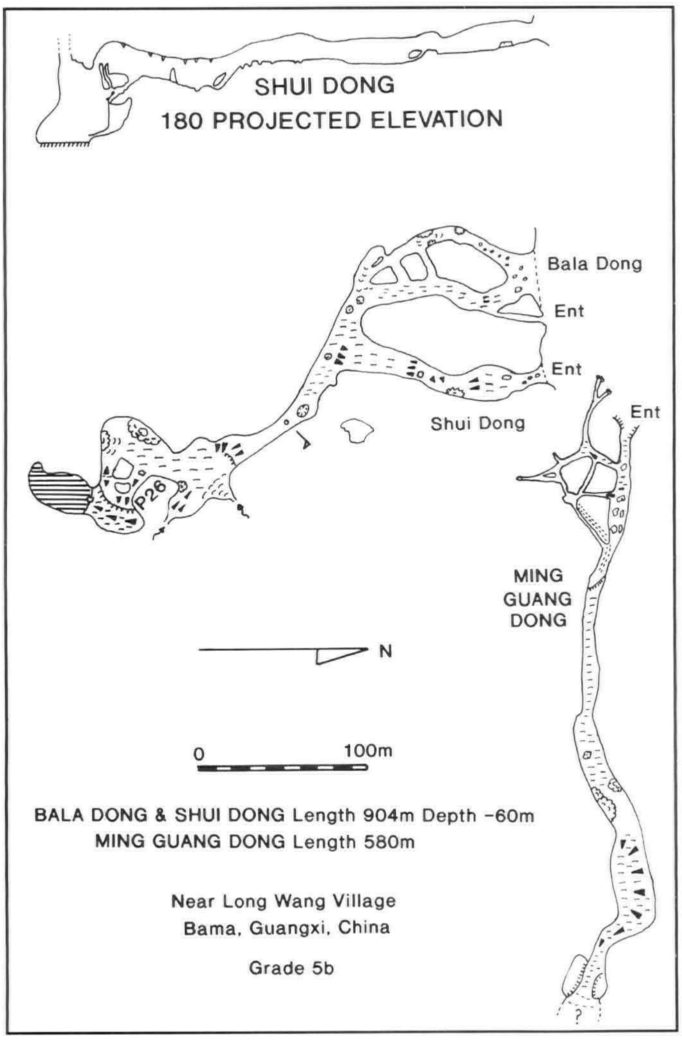


Figure 9.

The ramp proved to be every bit as impressive as the view from the top. Its calcited floor slopes downwards, steepening and becoming muddier, to its final end in a sumped, muddy canal, 140m below the height of the platform. The large air-mass moving at the upper level is entirely lost by this time but must exit high in the unseen walls or roof.

The exit from the platform at the top of the ramp is unlikely and unexpected. An alcove on the north side of the passage leads

Figure 10.



to a small dry shaft with a powerful upward draught. Here a porcelain spoon was found along with rotted stemples at the bottom of the 28m shaft, proving that the villagers' story was right. The base of the shaft leads into a bigger passage and a 10m climb, into a lower cave level, Nong Gan Dong (Figure 8). To the north this quickly comes to an exit at the bottom of a deep and impressive doline, ringed on three sides by vertical cliffs at least 250m high and jungle-covered boulder slopes. Turning into the cave, it ends after 200m at a flowstone blockage, probably connected with the ramp in the major cave above. The exit doline is by far the most impressive surface feature discovered in the Bama area, being so deep and precipitous that the map-makers, presumably working from air-photos, have completely misinterpreted it. The path leads upwards and soon passes an inconspicuous 2 x 3m entrance to an inclined blowing shaft: Feng Dong.

Fen Dong

A local teacher told us that the wind from Feng Dong was enough to blow your clothes away and this had given rise to its name: "Blow Your Clothes Off Hole". We found that indeed the wind was capable of ejecting small sticks thrown into the entrance along with clouds of steam which were condensing on the trees forming a permanent shower.

The shaft was only descended for 100m down a steep slope which opened up into a large shaft, filled with clouds, where falling rocks were timed at 17 seconds (Figure 12).

Liao Ping Dong

A cave situated 0.5km from Long Wang Village, about 3km east of the road. A passage 100m long leads to a stalagmite blockage. Close to the entrance a shaft was noted but was not descended due to lack of tackle (Figure 9).

Shui and Bala Dong

Just beyond Liao Ping Dong is a closed depression where three entrances unite at a 15m diameter phreatic tube (Figure 10). A couple of free-climbable drops lead to a decorated chamber with a steep slope down to the left which terminates at the edge of a 26m pitch. This pitch can be overlooked by climbing from the chamber up to a 20m rocky pinnacle.

At the bottom of the 26m pitch a muddy slope leads to the final lake with no way on at the far side.

Ming Guang Dong

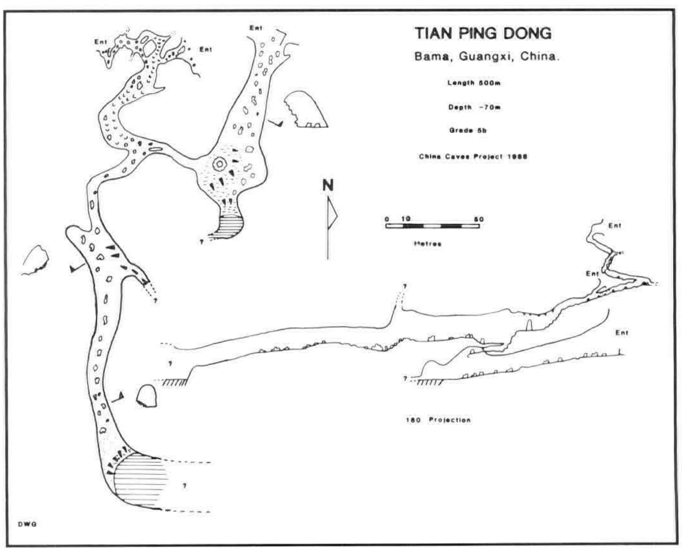
A 15m diameter tunnel near Shui Dong passes a maze of muddy passages which take water in times of flood (Figure 10). The main passages terminates at an undescended, 30m, mud-filled pitch.

Tian Ping Dong

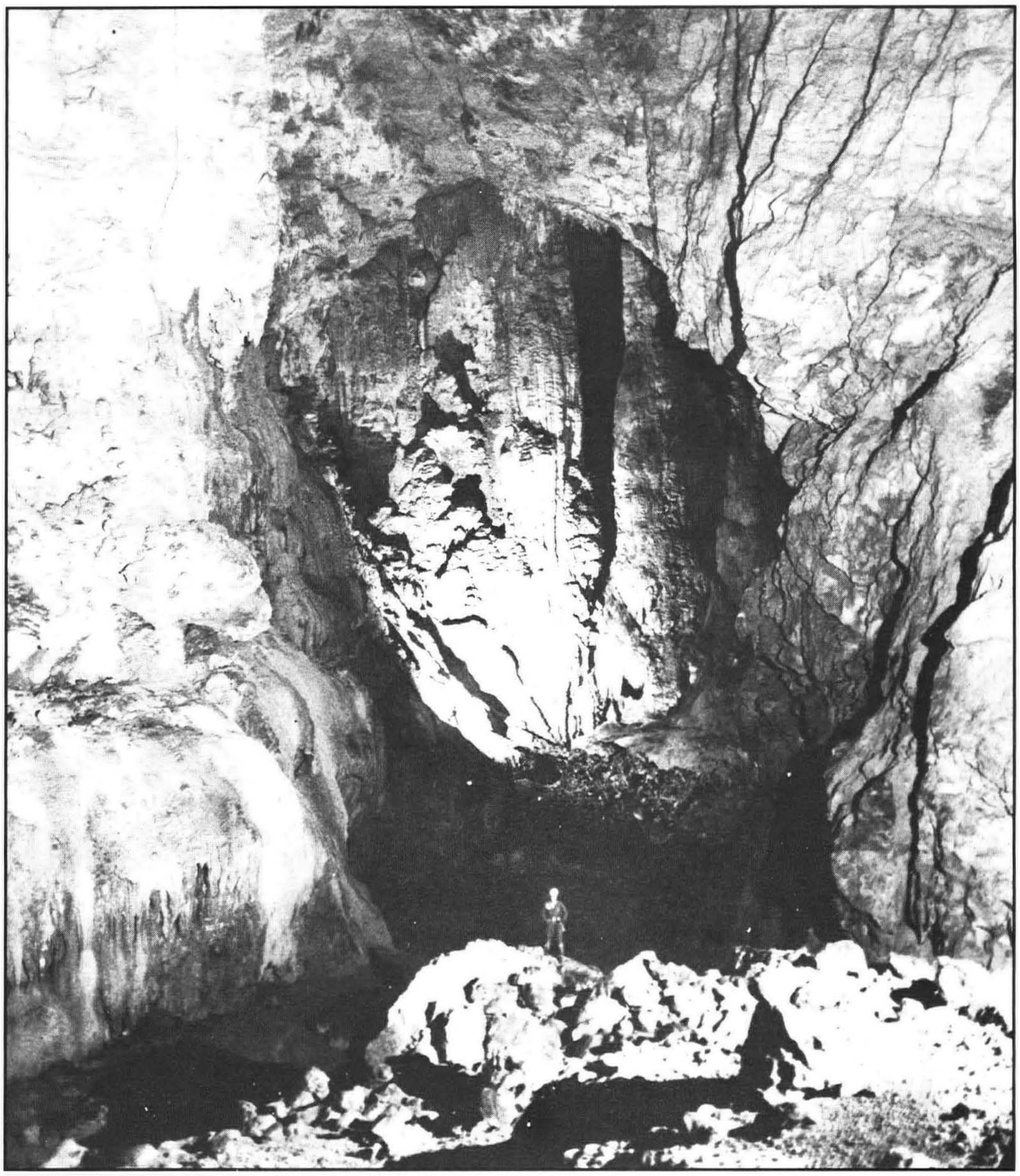
Situated 6km north of Bai-Mo, 2km east of the main road, this cave is a wet weather stream sink, the water draining from the shales to the west. A 15m diameter entrance was explored to a muddy lake which was not investigated further (Figure 11).

A high level fossil route can be followed high above the main entrance and this joins into the roof of the main passage. The passage terminates at a steep 15m muddy slope to a lake which again was not investigated.

Figure 11.



Large passage in upper series of Hou Dong. (Photo: Jerry Wooldridge).



Macang Dong

Situated 3km north east of Bai-Mo village. At the end of the road a 10 minute walk to the north leads to the small entrance to Macang Dong. A large well visited chamber contained many large stalagmites completely blocked with flowstone (Figure 12).

Gouzin Dong

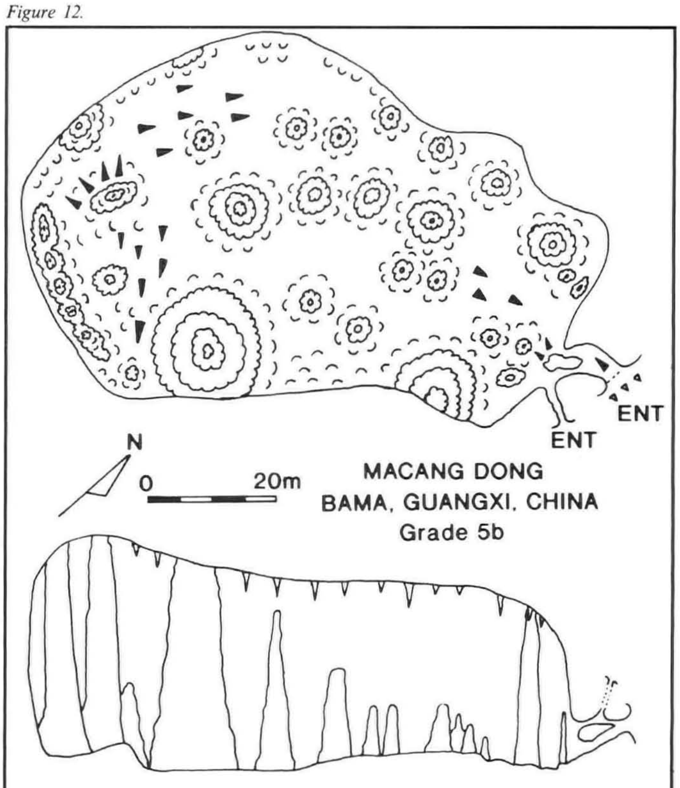
Situated just above the end of the road, 3km north east of Bai-Mo village. Used as a foundry and walled. A steep descent to 100m of bouldery passage, blocked with collapsed debris (Figure 13).

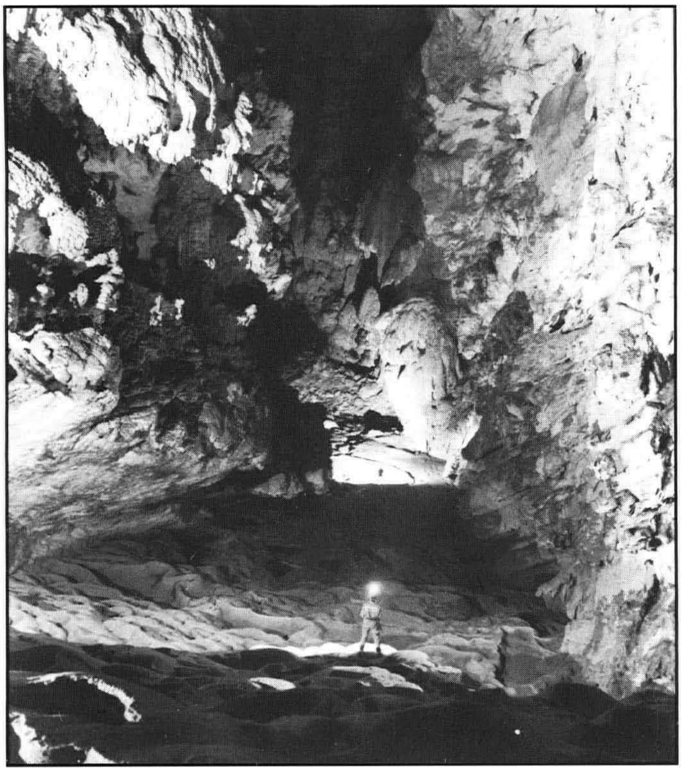
SPELEOGENESIS OF THE CAVE SYSTEMS

The twin resurgences at Bai-Mo village were observed at dry-season levels, with a combined flow of 3-5 cumecs. Three weeks of virtually dry weather produced little drop in the flow. In the absence of map coverage it is not possible to calculate accurately the full catchment area for the system, but it is likely to be a minimum of 250km^2 (Figure 2). The resurgence is at 304m asl. Low-points in the cave catchment show a very gradual rise, of 1 m/km to water surfaces and rather more than this to the floor of the deepest dolines (approx 4 m/km).

It is quite clear that the sandstone hills abounding the limestone on the west have influenced the formation of the caves. However, feeder streams draining off the sandstone have formed long depressions in the karst which from certain perspectives look more like valleys than dolines. It is hard to believe that this surface drainage alone was responsible for the enormous fossil passage which runs through the limestone from north to south. The truncated passages explored so far are likely to continue northwards with progressively less entrances revealed by the

Figure 12.





Gour covered passage in upper series of Hou Dong. (Photo: Jerry Wooldridge).

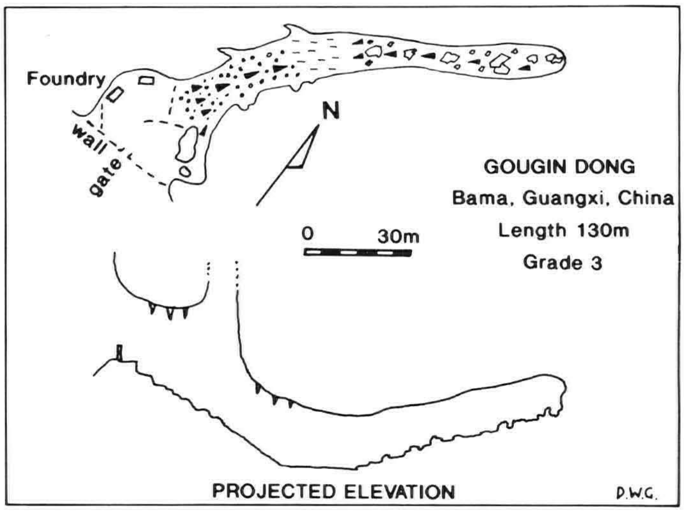


Figure 13.

lowering of the land surface as the doline base-level rises (Figure 4).

We suggest that at one time a much larger volume of water entered the system and gave rise to the massive passages. If this was so, the input would have been from the Hong Shui, which arcs round the north and eastern sides of the limestone block, although, for the present this idea must remain hypothetical.

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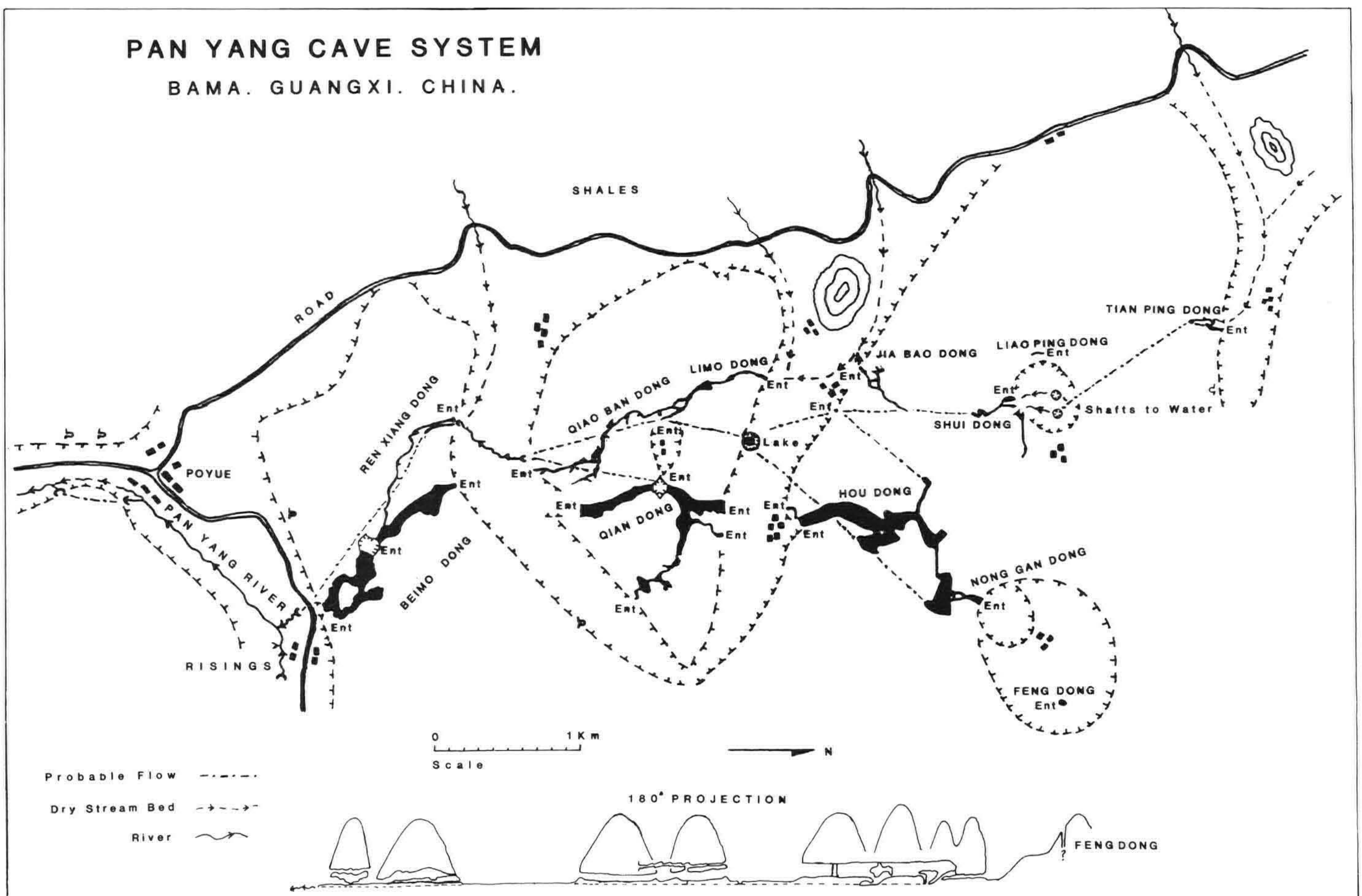
Figure 14.



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Jin Lun Dong and the Caves of Gang Zei, Mashan County, Guangxi

Tim FOGG

Abstract: The area of exploration south and south east of the Mashan county town in 'Fengcong' karst has a maximum vertical range of 300m and is bounded further south and to the west by non-karst uplands. The China Caves Project surveyed a total of 15km of cave in two weeks. The majority was in Jin Lun Dong and the Gang Zei River Caves. Jin Lun Dong is a multi-level system with an active streamway, flood overflow passages and massive fossil routes above. The upper levels have abundant speleothems and the main chamber is an impressive tourist attraction. The six Gang Zei river caves have a total of 7km of active and fossil passage. They are characterized by alterations in water level induced by irrigation systems in the dolines between the sections of cave and in the case of Gang Zei 4, 5 and 6 by local traffic routes. Reconnaissances throughout the area gave evidence of various phreatic drainage systems and of ancient fossil systems the remnants of which could be seen high in the towers.

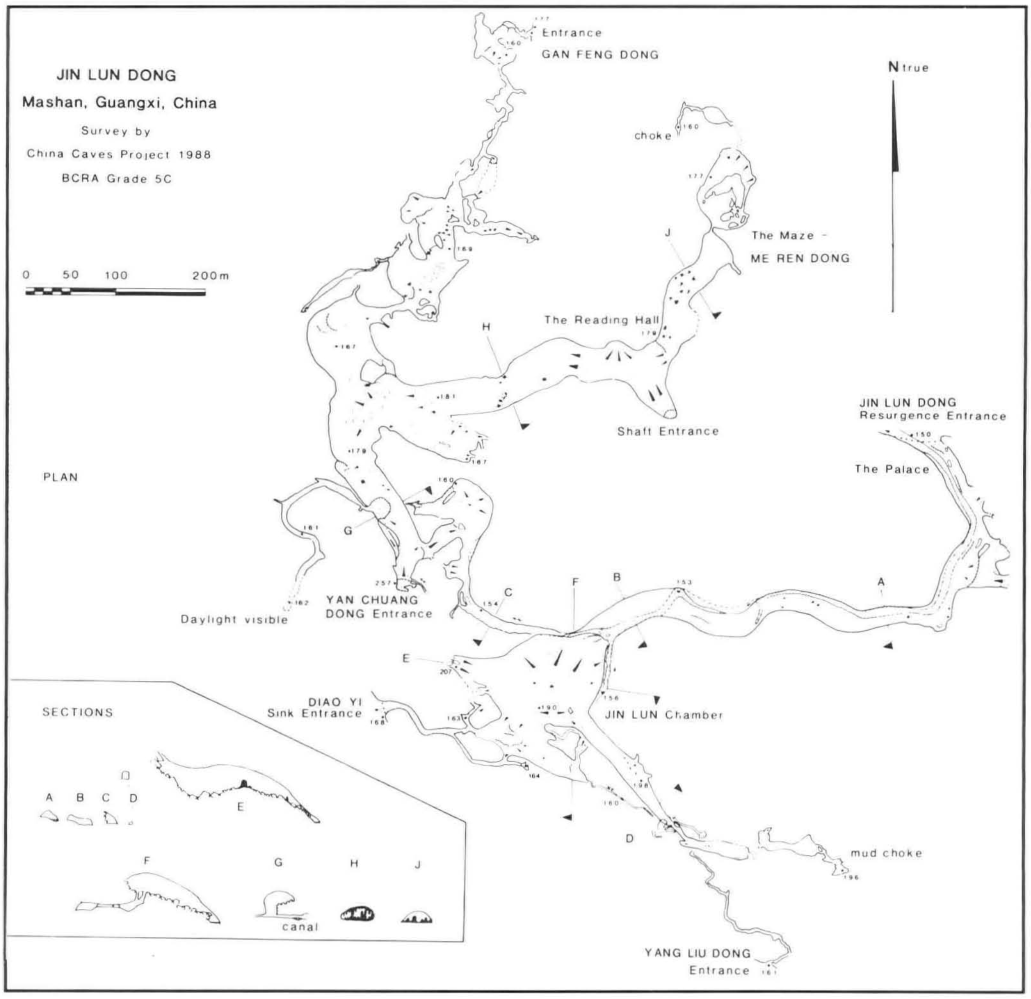
JIN LUN DONG

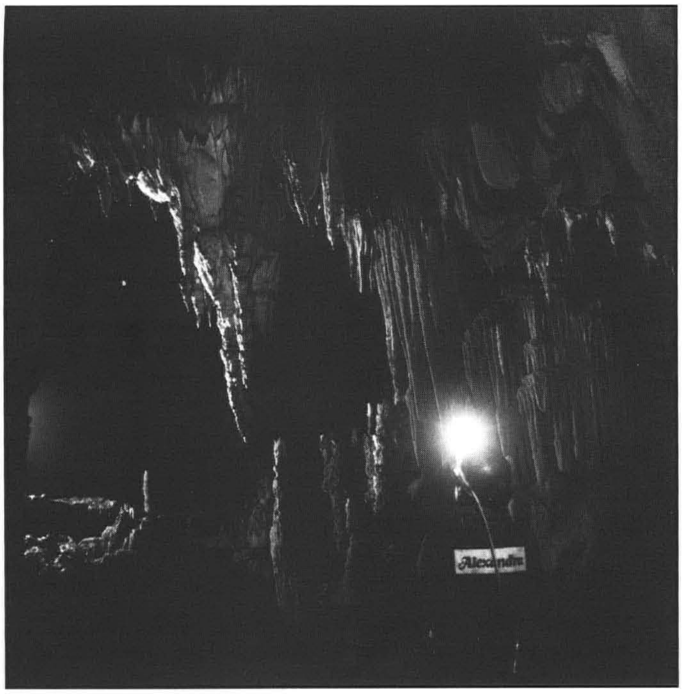
Jin Lun Dong (Figure 1) is a cave well known to the people of Mashan County. The complex 7km of passage lies in a block of limestone 20km south of the county town, bounded to the west by loess hills and to the east by a 2km wide valley cutting through the 'fencong' karst (Figure 2). The most well known entrance is the resurgence close to the main Nanning/Mashan road but this is one of seven entrances to the system. The river sinks at Diao Yi, as it leaves the non-karst hills, into a large boulder collapse. Entrance to the active river passage can be gained over the boulder pile. The passage soon becomes low, muddy and wide after 100m is impassable as the water flows under the massive collapse of the main chamber. Re-emerging from the choke on the east wall of the chamber the flow goes north to a junction which bounds the northern corner of this 200m by 200m by 50m high natural void. The river then flows down the main passage, past gravel banks and massive speleothems to the Palace and the resurgence. This river-way and the Jin Lun chamber are adorned with electric cables and finish with steps and bamboo bridges for the tourists entering the 'show cave'.

In a chamber above the river just beyond the risings' twilight zone, concrete blocks have been set in rows to provide seating for an underground cinema. The ticket office is situated at the altar to the cave god at this entrance. The altar is adorned with long red inscribed banners and surrounded with fresh remains of burnt incense. The tourist path leads through and up the Main Chamber slope to a high, well-decorated passage which is choked totally with flowstone and mud after 500m. A small vadose canyon passage runs below this to a squeeze entrance a kilometre south-east, Yang Liu Dong. This and the other passages at this level appear to take wet season flood water from the karst boundary valley to join the main river.

As with many caves in the tower karst, Jin Lun has been used by local people as an easy underground route between valleys. However, the Jin Lun through trip is more daunting than most, requiring a climb up steep ground to the large fossil entrance of Yan Chuang Dong almost 100m above the river sink. From here the through trip goes east following a very loose descent away from the obvious high passage and losing the full 100m just gained on the surface. A stooping passage then leads to the northern

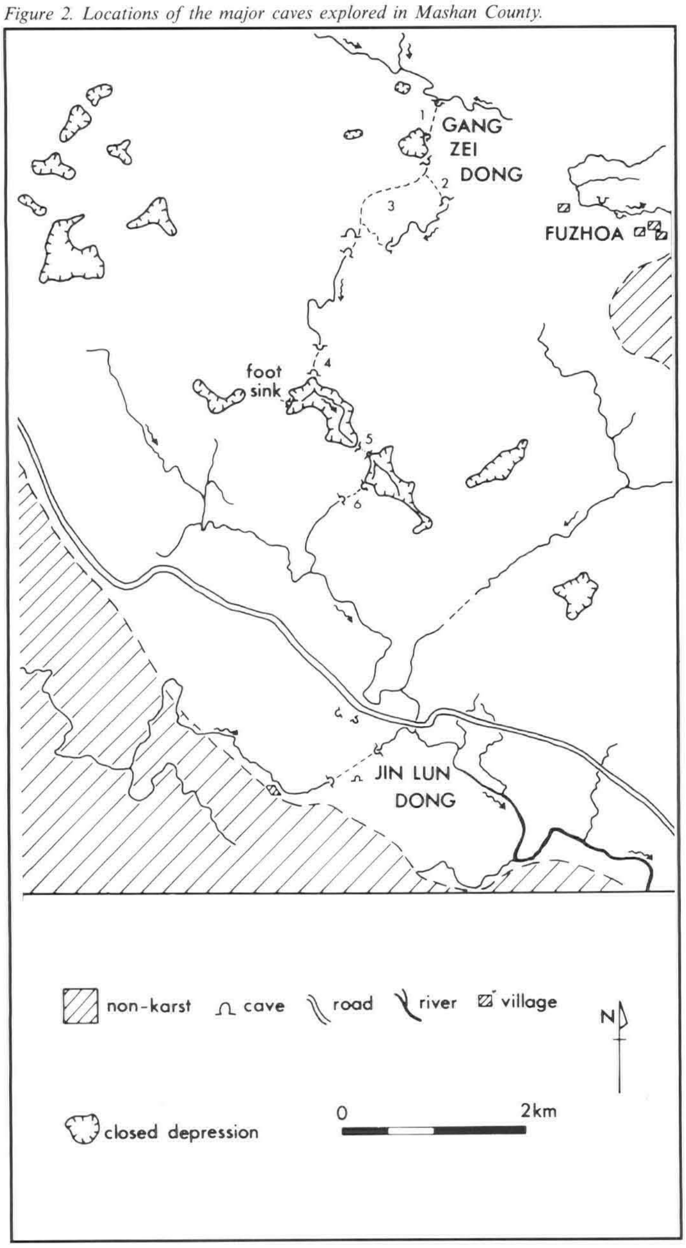
Figure 1. The Jin Lun Dong cave system.





Gang Feng Passage, Jin Lung Dong. (Photo: Tim Fogg).

Figure 2. Locations of the major caves explored in Mashan County.



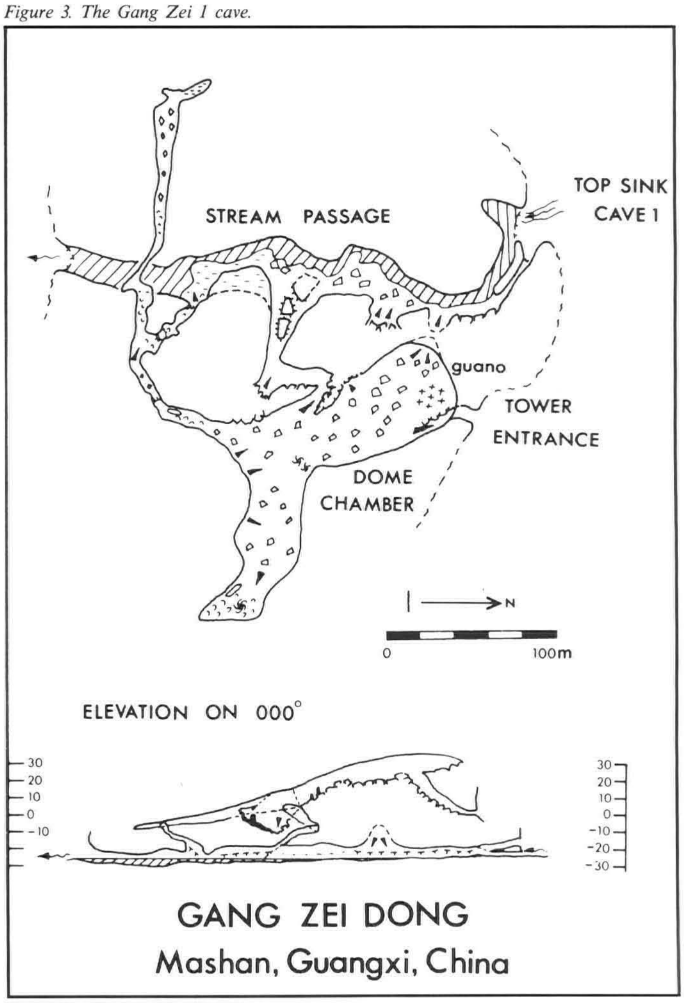
bottom corner of the Main Chamber and so by the tourist trail out to the resurgence and the village in the next valley.

The huge fossil passage running north from Yan Chuang Dong has two major branches: one leads to the Gang Feng Dong entrance and the other past the Shaft Entrance to Me Ren Dong, The Maze. Still in daylight from the Yan Chuang Dong entrance a descent of the scree and boulder slope of the main passage leads to a collapse pit 30m across occupying half the passage width. It was into the bottom of this that one survey team emerged from a boulder choke at the same moment as another team chose a station on the pit lip above to survey the 50m wide high level passage. Good news for survey closures! The pit bottom team had come along small and sometimes swimming passages from the Jin Lun main chamber. The team at the top were heading into the cave when after 300m they came to a chamber at the branch junction where there was much evidence of nitrate extraction. This resource was probably used by people from both valleys as a well worn route weaves from here through a highly decorated, in fact almost choked, passage to Gang Feng Dong. Exploration in this area, up a tortuous series of body-sized phreatic tubes followed by an airy climb down flowstone took us into a remote hall where charcoal on ledges told us we were not the first. Maybe the 'cavers' before us were searching for Jin Lun, the local lad who was lost for three days in the cave 900 years ago and gave his name to it. The other branch from the nitrate digs contains colossal passage with many fine stalagmites, the shaft entrance at the Reading Hall and large areas of gour floor with almost complete cave pearl cover. The Maze at the end of this passage is another flowstone choke through which there are numerous routes and round trips but no obvious continuation. Relating the cave survey to the surface topography shows the Maze to lie in a tower protruding from the main mass with little chance of further cave development in this direction.

In many areas of the cave there has been major speleothem collapse which could relate to an earthquake recorded in Nanning in the 17th century.

The Jin Lun River, having left the cave, soon joins a sluggish (dry season) flow south. Another tributary to this valley comes from the Gang Zei caves.

Figure 3. The Gang Zei 1 cave.



GANG ZEI DONG

Gang Zei 1

This river sink lies on the southern side of the valley close to the village which gave the cave its name, Gang Zei. The cave (Figure 3) can be entered at river level or by the fossil entrance above which is visible from the road. The large active river passage can be followed on dry sediment banks and rock ledges, until the final 100m must be swum out to daylight in the doline of Li Long. Instead of entering the water, a route through small passages in the left can be followed upward to emerge in the large fossil chamber above. This can also be entered directly from the fossil passage above the sink.

Gang Zei 2

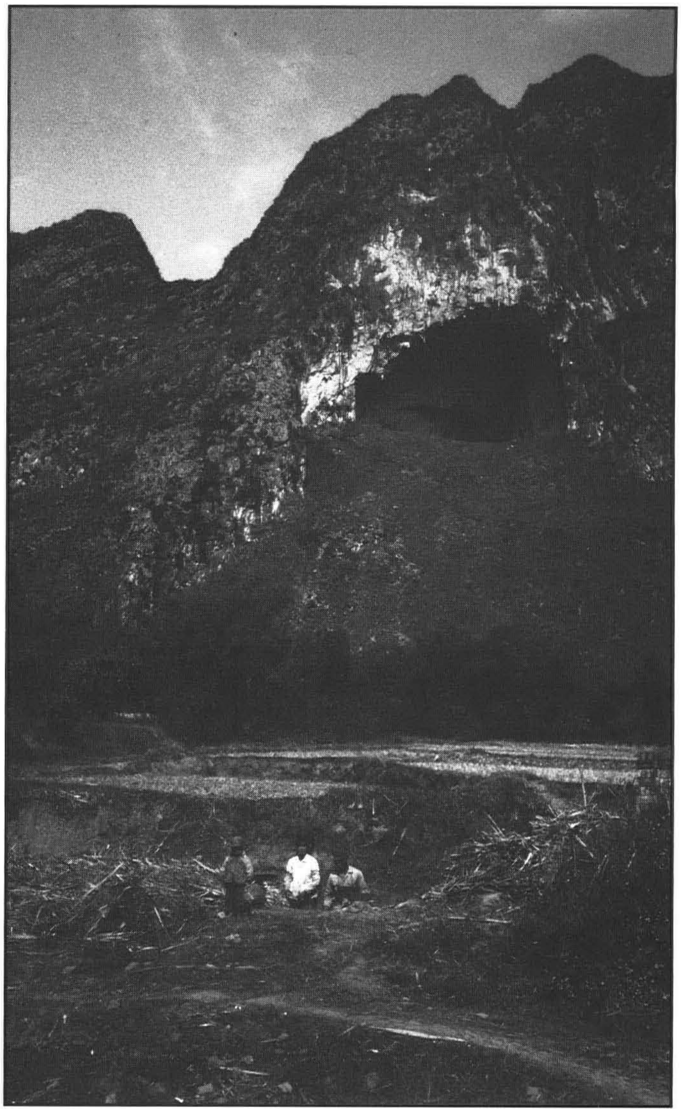
On the far side of the Li Long doline from the Gang Zei 1 resurgence, the river was followed through a low entrance (Figure 4) passage downstream using an inflatable dinghy for 300m to a large fossil side passage with a skylight. This led to Gang Zei 3. Evidence of a 'pebble avenue' leading to a large stalagmite boss with work steps up it showed that the cave had been entered and used, possibly for religious purposes, sometime in the past. A rise in water levels caused by irrigation systems in the doline nowadays restricts entry to those who don't mind getting wet.

Gang Zei 3

Exploring from the sink by dinghy a passage on the right after 150m was followed to the large fossil passage connecting with Gang Zei 2. The main routes joined a little further downstream in Canal Chamber. The now large stream passage with sand banks was then followed until the stream totally filled the passage. The high rift continued past waterfalls over drowned gour pools which seem to be the result of an irrigation dam at the resurgence. The rift then degenerated into a low canal with phreatic pendants. A hanging boulder choke with a strong draught was presumed to be associated with the huge fossil entrance directly above the rising in the Long Chuan doline. Roof level dropped to 1m just before daylight was reached downstream.

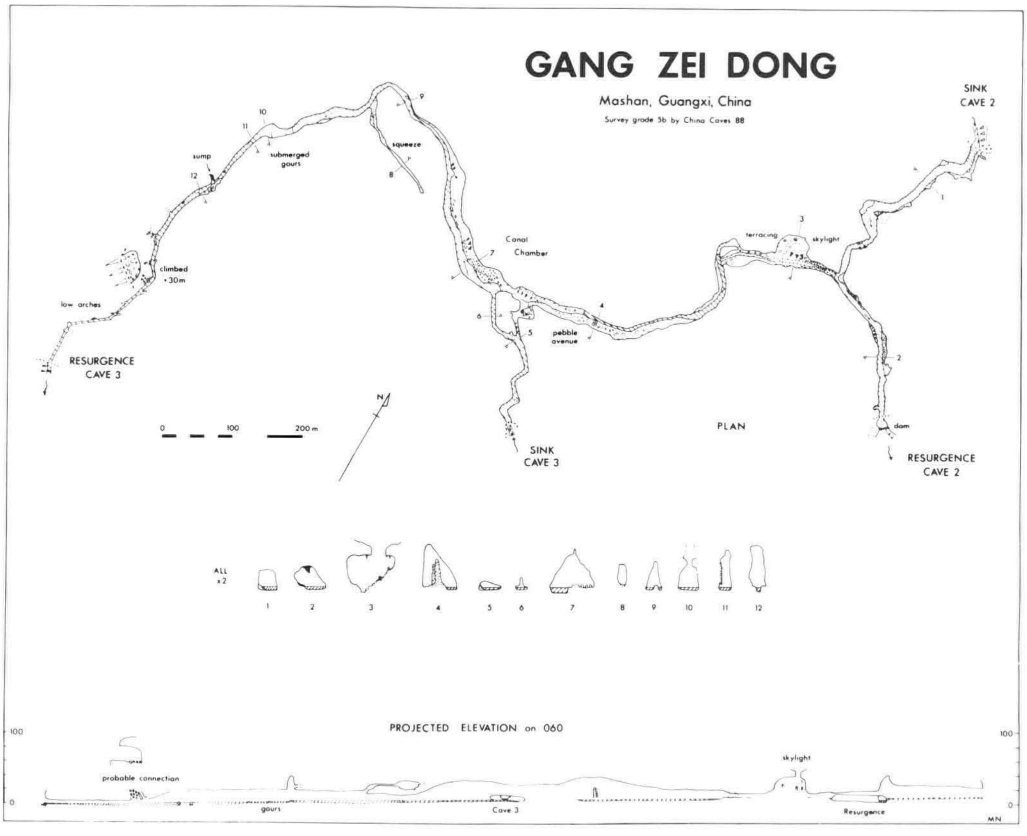
Gang Zei 4

This section was a 300m swim, through which the locals use boats to transport wares between the dolines. A shock to boatman and caver alike was experienced when a swimming surveyor met a man on an unstable bamboo boat in the dark!



Long Chuan Cave. (Photo by Pam Fogg).

Figure 4. The Gang Zei 2/3 cave system.



Gang Zei 5

A shallow stream flows along the 200m of passage with the only break being a large scree/boulder slope across which the local thoroughfare pathway led. There are small tufa-covered waterfalls at the resurgence.

Gang Zei 6

This is another major through route for the local people from the dolines into the main Jin Lun Valley. A large well maintained path follows the stream into the sink, past a well decorated chamber with a sky-light to emerge in the main valley after 350m.

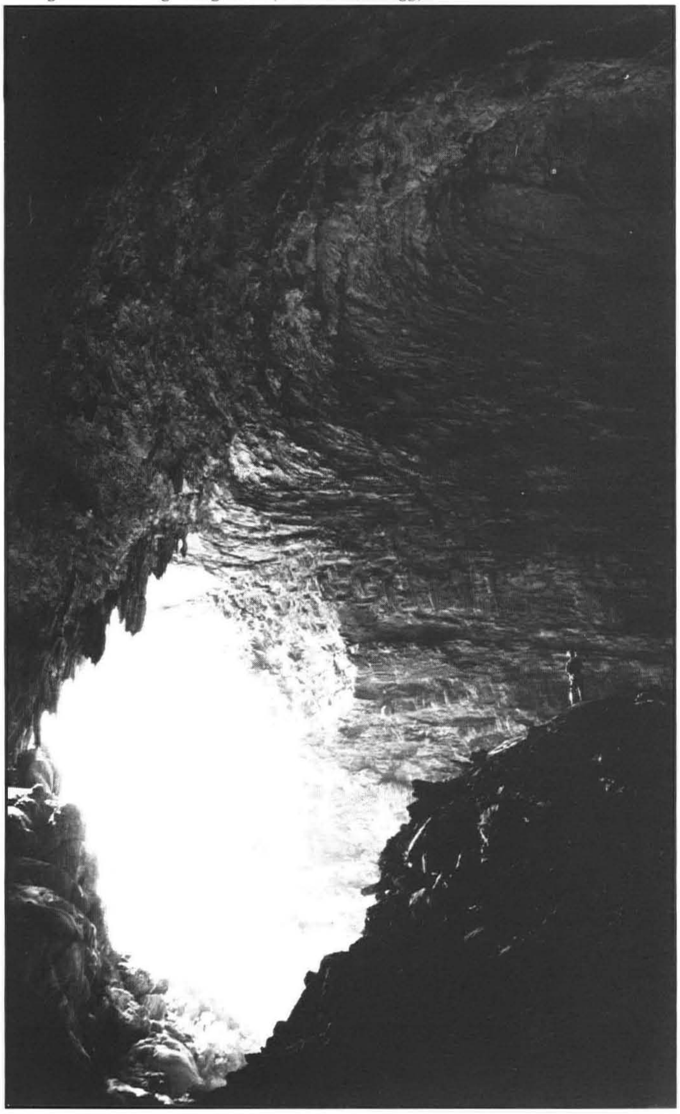
Foot Sink

A small stream splits from the main flow from Gang Zei 4 (either a natural overflow or diverted for irrigation) and sinks in the foot of a tower, sumping after 20m.

NEI GANG DONG

Eight kilometres west of the Gang Zei on the road running south east from the village of Gulin is a reservoir. Approximately 600m of large passage with a stream was explored to the south of the reservoir. Walking from Nei Gang village, local people took us to a stream emerging from an impressive entrance. A pathway led along the streamway in a big passage heading south west. Over the 300m of passage the roof level dropped steadily from 30m to a mere 3m but soon increased in height again, changed direction to south and daylight was reached. The sink lies on the shale/limestone boundary. The twilight zone was impressive for its high dome shaped roof in thinly bedded limestones. At the direction change in the passage, a high level fossil route following back along the main line led to a balcony overlooking the streamway.

Passage at Nei Gang Dong sink. (Photo: Tim Fogg).



DISCUSSION

In Jin Lun Dong all the major leads were explored and surveyed; however the areas with abundant speleothems near Gang Feng Dong and the high level southern passages may yield to further investigation. Local people referred to a northern extension which had not been entered for one hundred years.

The Gang Zei system was also thoroughly explored leaving few possible extensions. The inlet sump in Gang Zei 3, the Foot Sink sump and a small lake cave at Gang Zei 5 sink await further exploration.

It is obvious that there are many other interesting speleological sites which the Project members did not hear about or were not able to visit in the short time available.

To the east and north east of Mashan Town the relief is greater but reports of caves were few. Possibilities may well lie over the watershed to the north following the drainage to the Hongshui Gorge.

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Cave Diving in Guangxi, 1988

Rob PARKER and Gavin NEWMAN

Abstract: A total of 15 sites associated with the Tisu drainage system were visited of which 9 were dived and a brief report is presented on these experiences. The major obstacles to our exploration were poor visibility and extreme depth. These problems would have to be carefully considered in planning any future diving activity in the region.

Earlier reconnaissance work by the China Caves Project indicated the diving potential of the area shown in Fig. 1. Furthermore, a comprehensive survey by the Luizhou Hydrological team had suggested that the major karst windows and sinks to the west of Duan were united into a single network which was referred to as the Tisu drainage system. It was proposed that these feeders would provide an entry to a major conduit whose waters fed the massive resurgence at Qingshui. Testing this hypothesis was seen as one of our major objectives on the expedition.

Approximatley fifteen sites were visited by a diving team comprising the authors, Geoff Crossley and Steve Jones with support from Chinese colleagues from The Institute of Karst Geology in Guilin. Other sites were plumbed using a tagged shot line. Water levels in the area vary considerably throughout the year and during our brief stay some sites dropped by about 4m. All eyehole sites appeared to contain static water with heavy accumulations of silt and algae clouding the water.

General diving conditions were found to be far from ideal with most sites exceeding −70m before encountering horizontal development. Visibility at best was about 2m reducing to zero at many sites. General passage dimensions were estimated to be at least 50x50m. The following key sites were explored (location numbers refer to Fig. 1):

Nong Nao (2)

At this site five large blue karst windows are situated just below the valley floor level and a short, man-modified cave leads to an underground, lake and sump. The earlier reconnaissance had plumbed one lake to −80m. The largest of five lakes was explored over several dives to a depth of 76m with no sign of bottom. The 76m point appeared to be the roof of a huge passage estimated to be 50m wide and 30m high. The maximum depth plumbed at the site was 106m. Two adjacent windows appeared to be linked by this deep passage. Evidence gathered by Chinese hydrological surveys suggests that water levels here rise by up to 12m during the wet season.

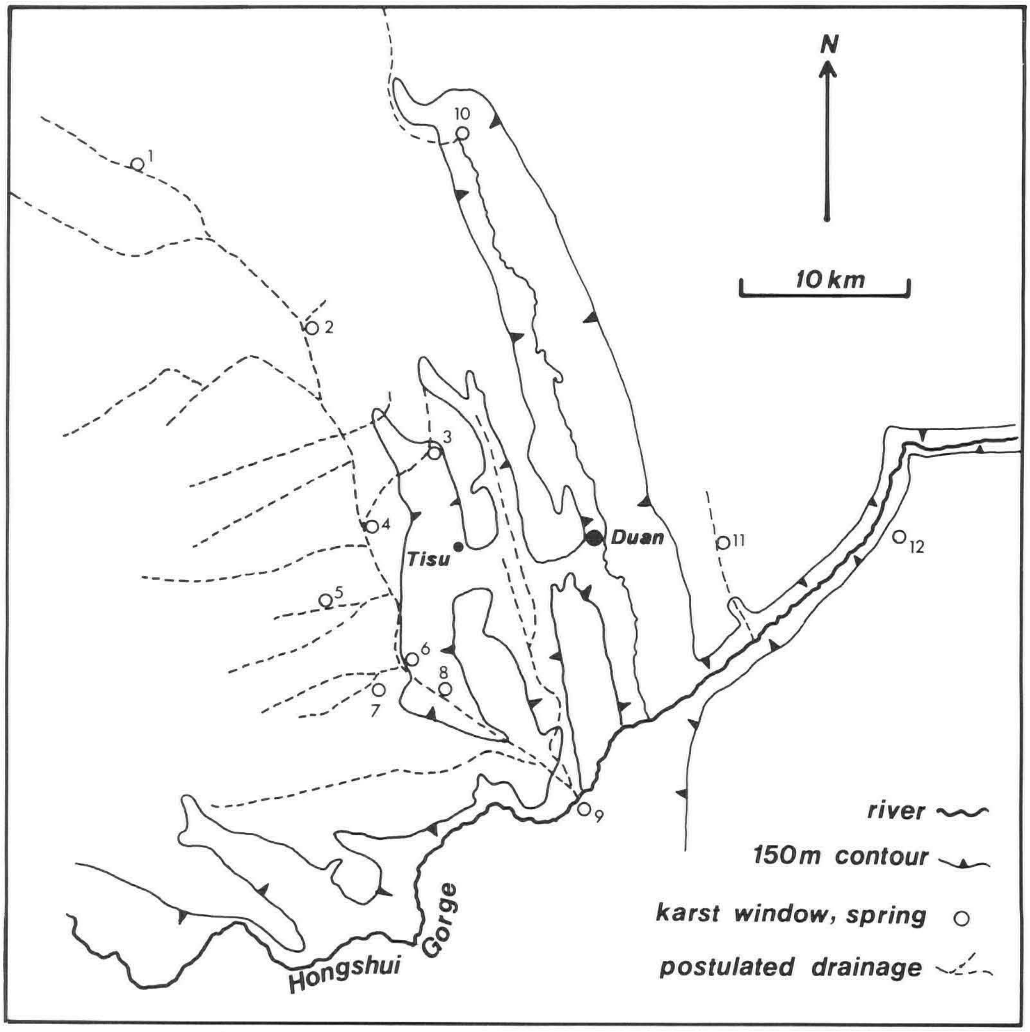
Neng Gu (8)

This is the highest karst window upstream of Quingshui with a positive dye trace to the resurgence. The rest of the connections shown in Fig. 1 are postulated. This drowned shaft is 90m deep but the Hydrological Team had suggested that there was a conduit taking the main flow at a depth of 20m. During the expedition this site was thoroughly investigated down to the 25m level with no sign of the suggested conduit or any flow. Further exploration to −53m revealed nothing of any consequence.

Quingshui (9)

This is the resurgence for approximately 1000 km² within which there is an altitude range of up to 900m. The wet season discharge from this massive resurgence is over 400 cumecs but drops to single figures during the dry season. An active entrance just upstream of the resurgence gives access to the upstream sumps. During our dry season visit water was seen to be resurging from the base of a huge boulder field beneath the wall of the

Figure 1.



gorge. Two underwater routes were explored to a point 25m in where the way on became too contorted to follow. Visibility was condiderably clearer than at other sites visited suggesting that there were no active hydrological connection during the later stages of the dry season.

Da Xing (10)

Just north of the village is a large resurgence (approximately 10 cumecs). There is a postulated connection with this from Ling Die, a 2 hectare underground lake, which is 2km away. This resurgence was dived to −75m in 3.5m visibility with no sign of bottom or horizontal development. Nearby, Ling Die underground lake was dived to a floor of −18m but, despite intensive searching, no conclusive way on could be found. Visibility at this site was particularly bad.

Other sites in the Tisu area

Bai-Lie (3) is a large karst window lake which during the dry season drops up to 30m exposing a short passage descending on the dip to a sump.
Jou Song (5) has a shaft to an underground lake and sump with the water surface approximately 100m above Quingshui.
Long Shui (6) has steps down to a sump pool some 25m below the surface. The sump surface is only 10m above Quingshui and 12km to the northwest.
Sang Po (7) is a karst window lake with a water depth >40m.
Di Zhou (11) is a tributary valley to the Hongshui Gorge with various caves and shafts, two of which were explored to sumps during the reconnaissance.
The Hongshui Gorge has a number of resurgencies, some of which are below river level.

The team feel that at this stage further diving exploration would be of little value without a better understanding of the hydrological links between the sites in this area.

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Palaeomagnetic and Archaeomagnetic Studies in the Caves of Guangxi

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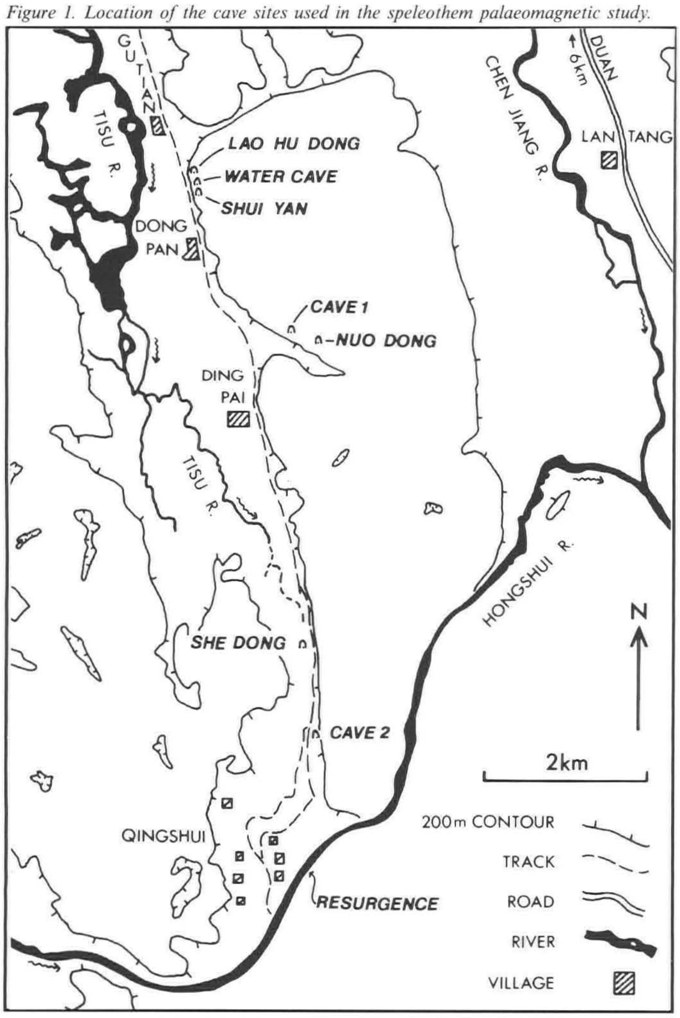
Abstract: This paper presents the results of a preliminary palaeomagnetic study of speleothems and archaeological fired sediments from caves in Duan County, Guangxi, China. In the Monk's Cave, Gan Fang, archaeomagnetic evidence suggests that hearth areas were used over a relatively short period compared to the geomagnetic secular variation (probably <150y) thus giving some idea of the occupation timescale at this site. A total of 22 oriented speleothems were obtained from 7 caves, with an elevation range of 195m, between Quingshui and Duan. Most of the samples were very weakly magnetized and of variable stability and it has therefore proved difficult to establish polarity magnetozones (for use in geomorphic dating) with any degree of certainty.

The last decade has seen a growing interest in the environmental and geogmagnetic records to be found in cave sediments and speleothems (e.g. Atkinson et al., 1978; Morinaga et al., 1985; Noel & Thistlewood, 1988). The detrital remanent magnetization (DRM) in clastic cave deposits has provided geomagnetic secular variation and polarity data through Quaternary periods that are difficult of access by lake sediment coring (eg. Turner & Lyons, 1986). Deposition in cave 'flumes' has also enabled studies of natural DRM processes (Noel, 1986). The magnetisation of speleothems may also be detrital, with grains becoming oriented in the surface film although the growth of authigenic magnetic minerals is probably important (Latham et al., 1986). Although the underlying processes are not fully understood, it is clear from a number of studies that speleothems can also acquire stable, high-resolution records of the geomagnetic field (e.g. Morinaga et al., 1986; Latham et al., 1987).

Previous speleomagnetic research on Chinese cave material is confined to a study of clay sediments and pisolitic speleothems in the karst tower of Tunnel Hill, Guilin (Williams et al., 1986; Williams, 1987). Only one unequivocal case of a palaeomagnetically reversed sample was found but this suggested that the highest level caves were formed around 900 - 1.6 Ma ago.

Figure 1. Location of the cave sites used in the speleothem palaeomagnetic study.



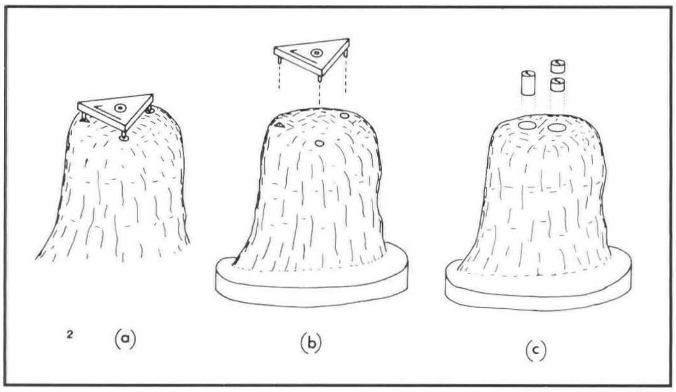
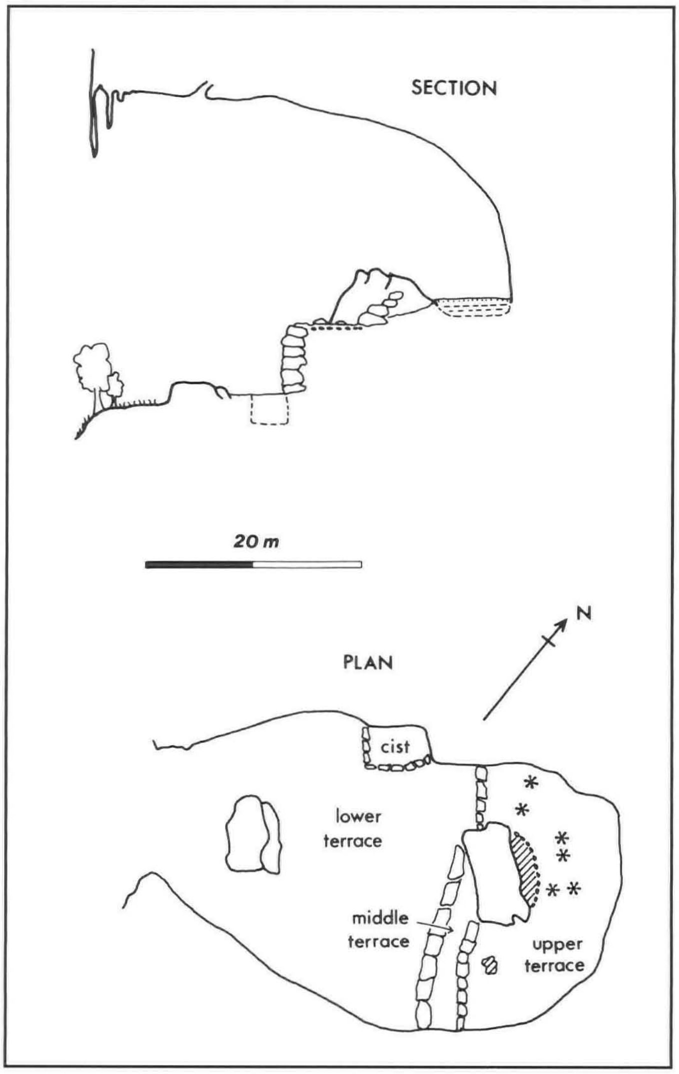


Figure 2. Speleothem orientation method: (a) tripod level used to positon register marks; (b) speleothem repositioned vertically with tripod, set in plaster and then; (c) drill cores extracted.

Figure 3. Sketch plan and section of The Monk's Cave, Gan Fang, Guangxi.



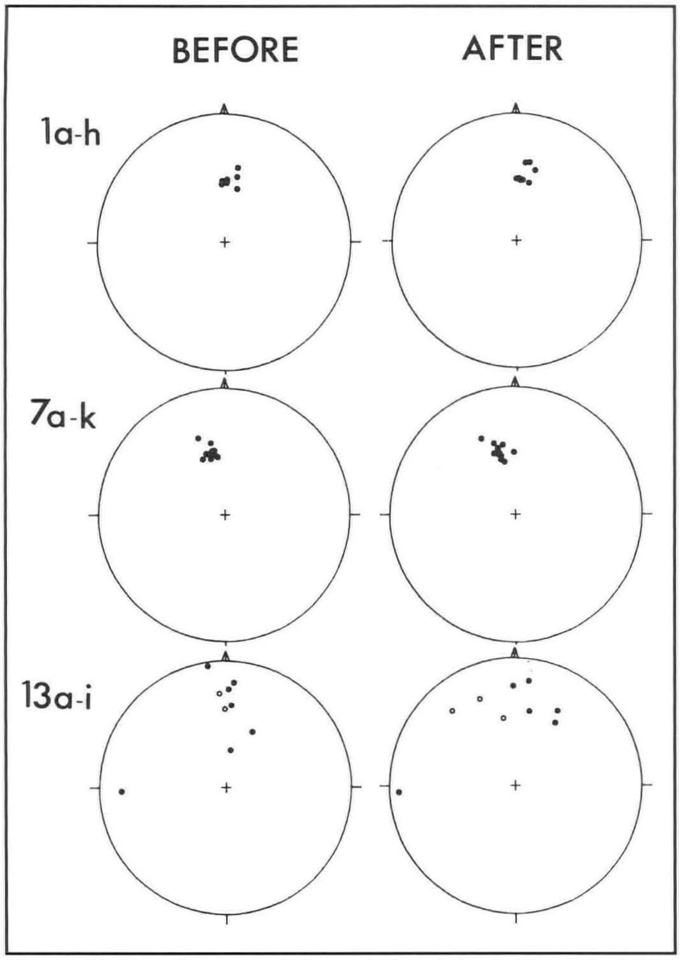


Figure 4. Directions of remanence in four speleothems before (left) and after (right) partial demagnetization. Solid circles = +ve inclinations; open circles = −ve inclinations. Stereographic projections.

The 1988 China Caves expedition provided an opportunity to conduct further pilot studies of speleothems magnetostratigraphy in southern Guangxi. A total of 22 oriented hand samples were obtained from seven caves, over a vertical range of 195m, in an area of fengcong karst extending north from Qingshi in Duan County (Fig. 1). Six specimens of burnt clay were also collected from hearths in the Monk's cave archaeological site during an exploratory visit to Gan Fang (approximately 15km west of Duan). Their archaeomagnetism provides some evidence for the contemporaneity of these features.

SAMPLING AND MEASUREMENT

Owing to weight and space limitations on the expedition, it was not practicable to sample by conventional drilling and instead, the method shown in Fig. 2 was therefore used. A simple tripod frame, compass and spirit level provided the orientation reference ±2° for speleothems which were then detached as hand samples using a non-magnetic hammer. Each specimen was later reoriented vertically with the aid of the tripod frame, cast in plaster and 2.5cm vertical cores then taken with a diamond drill. These were sliced into 2.5cm lengths and etched with dilute HCl to remove surface contamination. Up to 11 cores were thus obtained from each speleothem, with a final orientation error of about ±4°.

Monk's Cave is a celebrated folklore site in a prominent position about 300m above the floor of the Gan Fang depression. The cave contained abundant evidence of human occupation in the form of potsherds, charcoal, terraced floor levels and hearths. For a more complete description, refer to Fig 3 and Roberts (1989). A total of 6 specimens of hearth linings were collected from a c. 5x12m area on the upper terrace with orientations recorded by the button method (Clark et al., 1988).

The natural remanent magnetization (NRM) of representative specimens from each speleothem were first measured using a Molspin fluxgate spinner magnetometer (Molyneux 1971). Declinations were corrected for the magnetic variation in Duan derived from the International Geomagnetic Reference Field (1.6°W). Only samples with a high proportion of detrital material had moments above the noise level of the instrument (approximately 1.3×10^{-3} Am^2). It was therefore decided to measure the natural remanent magnetisation of all speleothem samples in a more sensitive cyrogenic magnetometer (noise level approximately 0.5×10^{-3} Am^2). These results are summarised in Tab 1. and Fig. 4. Specimens from The Monk's Cave were measured without difficulty in the spinner magnetometer.

On the basis of the natural remanence data, typical speleothem and archaeological samples were selected and their remanence stability examined through the technique of stepwise alternating field demagnetization (Tarling, 1983). This procedure explores the coercivity spectrum of the material and (hopefully) reveals high stability primary components. Some examples of the demagnetization behaviour are shown in Figs. 5, 6 and 7.

An attempt was then made to select optimum levels of partial demagnetization which would isolate primary components of remanence. In the case of the speleothems however, this proved difficult because the majority of specimen magnetic moments were near the noise level of the cyrogenic magnetometer. The most weakly magnetic samples were therefore demagnetized in fields of 2 or 5mT: sufficient to remove any viscous remanence acquired during transport and storage. Results are given in Table I and Figures 4 and 6. A linefinding computer routine (Noel, 1987) was

Table 1. Speleomagnetic results from Duan

LOCATION	RELATIVE ELEV. (m)	NUMBER SPECIMENS	$\bar{J}$ $AM^2\ Kg^{-1} \times 10^{-7}$	$\bar{D}$	$\bar{I}$	α_{95}	LAT	LONG	POLARITY
SHE DONG									
1	0	8	30.07	7.6	34.8	5.0	81.5	230.5	N
2	0	5	34.33	7.1	21.5	3.9	75.6	259.0	N
3	0	5	38.35	354.4	40.1	4.5	84.8	7.5	N
CAVE 2									
4	5	5	52.77	3.3	44.5	5.9	86.2	160.2	N
5	5	3	15.20	5.1	34.8	11.6	83.3	242.1	N
6	5	3	30.19	353.9	33.9	15.7	82.2	-23.9	N
WATER CAVE									
7	20	12	4.82	345.5	36.1	4.2	76.0	4.9	N
LAO HO DONG									
8	50	2	0.50	44.4	56.4	90.0	50.0	168.4	N
9	50	3	0.12	164.5	-2.8	70.5	-63.0	144.1	R
10	50	1	1.88	332.0	19.1	----	59.8	-4.9	N
11	50	5	0.28	17.4	19.8	56.2	68.5	234.7	N
12	50	8	0.21	346.7	12.3	76.7	68.2	-33.9	N
SHUI YAN									
13	38	9	0.76	352.4	6.3	31.4	68.0	-51.3	N
14	38	2	5.42	302.9	6.8	90.0	31.3	6.9	N
16	38	4	0.19	350.4	-47.2	90.0	36.9	-61.3	N
NUR DONG									
20	195	1	8.90	329.4	31.9	----	60.7	10.9	N
21	195	10	0.98	28.6	62.3	3.8	59.4	151.0	N
CAVE 1									
22	58	3	4.28	110.3	54.9	----	-1.4	158.0	(R)
23	58	1	10.79	36.1	64.0	----	53.7	152.1	N
24	58	7	3.53	7.0	66.6	13.0	64.2	118.7	N
25	58	1	0.13	314.6	68.7	----	45.6	69.4	N
26	58	4	0.43	263.2	-86.2	90.0	-24.6	-63.6	(R)

Note: $\bar{J}$ = mean intensity of natural remnant magnetization; $\bar{D}$ and $\bar{I}$ – mean declination and inclination of remnance after partial demagnetization. Lat and Long refer to the coordinate of the virtual geomagnetic pole. N = Normal, R – Reversed, (R) – Possibly reversed polarity.

employed to locate the best-fit remanence directions in selected speleothems of low intensity and some examples are shown in Fig. 5.

Finally, evidence for the speleothems magnetic carriers was obtained by carrying out two standard tests. First, the growth of isothermal remanence in five samples was measured up to a peak field of 0.8 Tesla, (Fig. 8). Second, samples from speleothems 2 and 13 were thermally demagnetised in steps, up to a maximum temperature of 900°C.

DISCUSSION

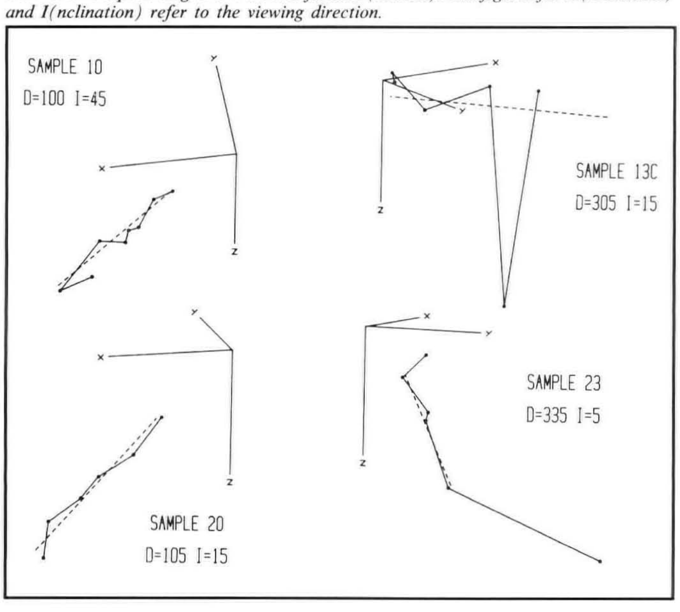
Mean NRM intensities in the speleothems were in the range 0.12—52.77x10^{-7} Am^2 kg^{-1}.Tests on 22 representative specimens indicated that the magnetization was approximately proportional to the fraction of acid insoluble residue, ie. detrital contamination. In the isothermal remanence experiments, the specimens approached saturation in fields of approximately 0.3T (Figure 8) suggesting that titanomagnetite is the predominant speloethem magnetic carrier (O'Reilly, 1984). However, a higher coercivity magnetic mineral (haematite?) is also present as shown by the slower growth of remanence at higher fields. The presence of titanomagnetite is confirmed by the Curie temperature of around 580°C found during thermal demagnetization. This mineral may have been carried in suspension and aligned in the surface film or developed authigenically.

The exceptionally weak remanence in several of these speleothems was close to the detection limit of the cyrogenic magnetometer. Thus a significant proportion of the scatter in the palaeomagnetic directions (Table 1) might be attributable to instrument noise rather than remanence instability. For similar reasons it has been difficult to draw firm conclusions from the demagnetisation behaviour of several of the pilot samples (e.g. sample 13c; Figure 5). Nevertheless, there is good evidence for stable single component magnetic remanence in several of the more strongly magnetised speleothems (eg. samples 10 and 20).

Only two of these speleothems have possibly recorded a reversed polarity palaeomagnetic field (Table I). Three cores drilled from speleothem 9 each have a reversed magnetization, albeit of very low intensity. Similarly, the four specimens from speleothem 26 produce a mean direction which is also reversed but of low precision. In the absence of any unequivocal polarity zonation which can be assigned to these speleothems it has been impossible to draw any firm geomorphic conclusions other than to suggest that the reversed speleothems may be older than 720Ka.

Archaeomagnetic directions in the Monk's Cave samples are closely grouped, with a mean direction which deviates significantly from that of the present field. The good agreement between vectors suggests that the hearths on the upper terrace were in use simultaneously at some time in antiquity. An approximate curve of geomagnetic secular variation for the last 100y has been compiled using the IGRF equations and can be compared to the archaeomagnetic directions in Figure 6. The available evidence suggests that these hearths were last used before A.D.1800.

Figure 5. Progressive alternating demagnetisation of four speleothem samples shown as 3-D vector endpont diagrams with best-fit lines (dashed). The figures for D(eclination) and I(nclination) refer to the viewing direction.



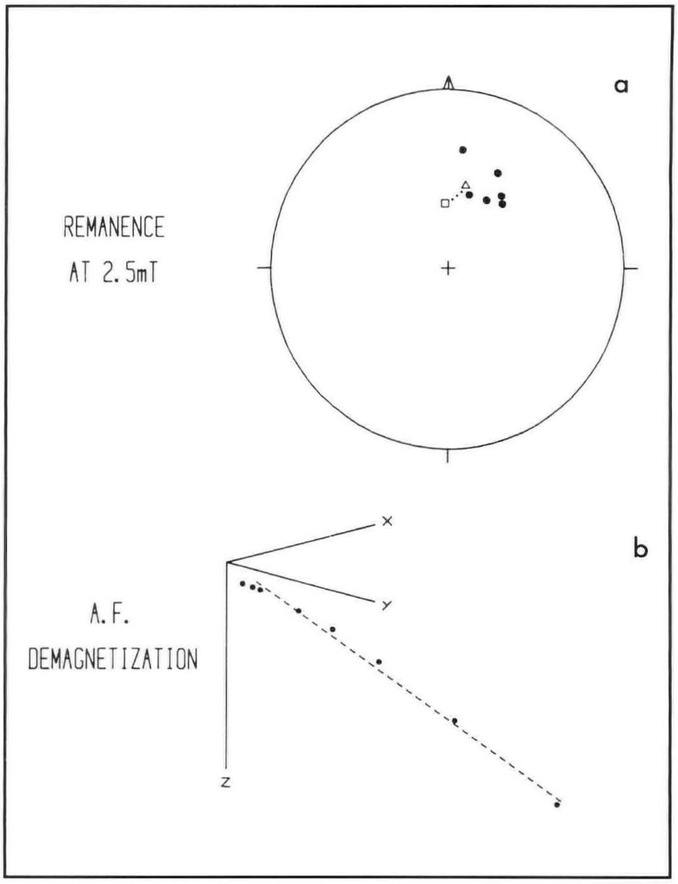


Figure 6. (a) Directions of archaeomagnetism in the samples from Monks Cave after partial demagnetization (solid circles). The dotted line shows the approximate change in the local geomagnetic field direction between A.D.1800 (triangle) and A.D.1900 (square) as computed from the International Geomagnetic Reference Field equations. Lower hemisphere, stereographic projection. (b) Demagnetisation behaviour of a hearth sample and the best-fit vector (dashed).

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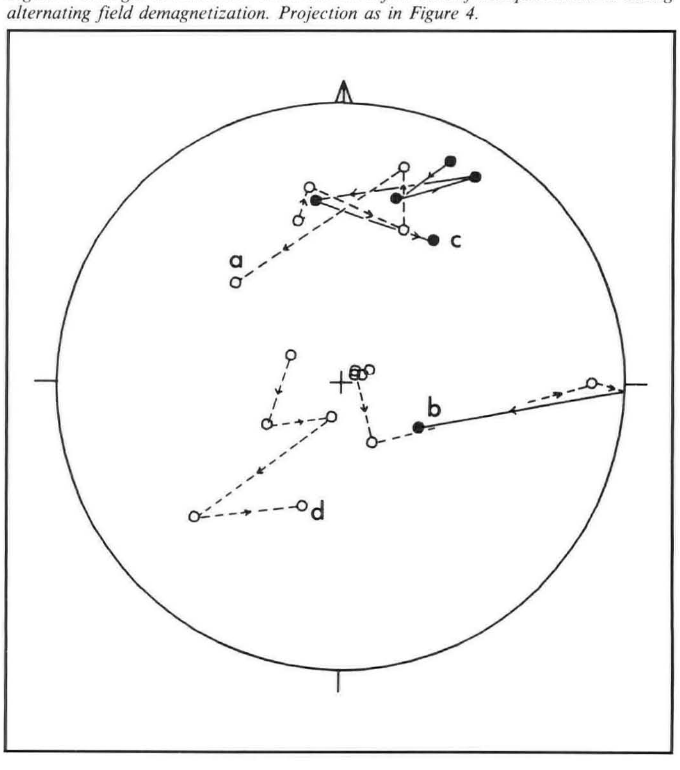
Figure 7. Changes in remanence direction in the four cores from speleothem 16 during alternating field demagnetization. Projection as in Figure 4.



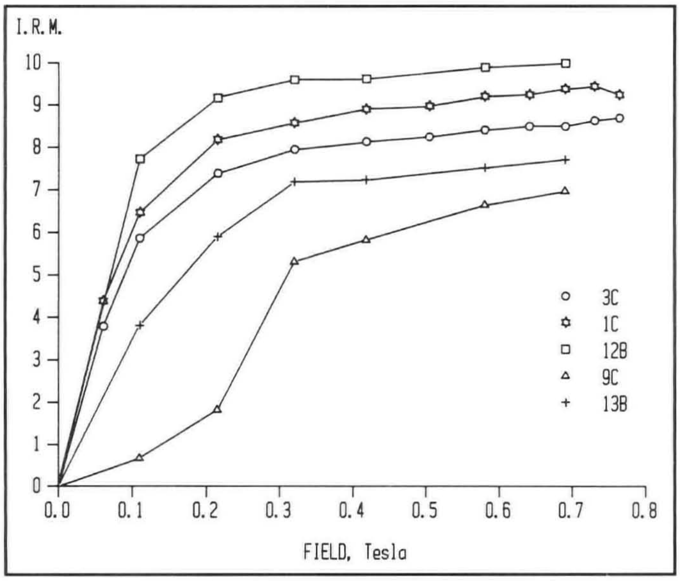


Figure 8. The growth of isothermal remanent magnetization (arbitrary units) in five speleothems.

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Biology of the Caves of Guangxi

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Abstract: Biospeleological collections made on the China Caves Project 1988 revealed a simple community of terrestrial animals with a high proportion of cave-adapted species. Three simple habitat criteria were assessed for each collecting site: extent of flooding, humidity and human impact. The number of cave adapted species was lower at sites prone to severe flooding but higher at more humid, draught-free sites. The effect of human use of the caves was less clear. Human impact on the cave environment is mostly restricted to areas close to entrances or to large dry high level passages. The smaller diameter, damp, draught-free passages typically favoured by cave-adapted animals are seldom entered by the local people. Hence, although human activity often alters the cave, it has little direct effect on the richness of the cave adapted fauna. Non-troglomorphic species numbers show no relationship to any of the habitat criteria. The extensive deforestation of the region may have had a larger impact on the cave fauna by directly altering the quantity and type of organic material entering the cave, increasing the severity of flooding or causing the decline of bat populations. Very low numbers of bats were seen which is curious given the large deposits of nitrate-rich sediments of guano origin.

This paper presents the results of ecological investigations of the caves that were visited by the China Caves Project in January 1988. The cave fauna of China is poorly known, although vertebrates (e.g. Zhou 1985) and millipedes (Zhang 1985) have received some attention. The collections we made contain a high proportion of undescribed species and will therefore take several years to be fully classified. Initial classifications are presented in the Appendix and some of the more unusual species are briefly discussed, but most of this paper is concerned with differences in the richness of the cave fauna between sites and some possible reasons for these differences. In particular, I anticipated that the long history of human use of the caves for tourism, nitrate mining, defensive sites or as general thoroughfares could have affected the cave fauna. Environmental disturbance is a potential threat to the relatively fragile ecosystem in caves (Delamere-Deboutteville 1967, Howarth 1983, Pugsley 1981). Human use, for example, may often result in large quantities of inappropriate organic matter entering the cave encouraging the invasion of surface species, perhaps displacing troglobitic animals that are often adapted to exploit low food inputs (Poulson and Kane 1981). Natural perturbations such as floods can also have a marked effect on the fauna (Poulson and Culver 1969). Bat colonies are particularly vulnerable to human disturbance (Tuttle 1977), and this disruption can severly affect the invertebrate fauna that may rely on guano as a primary food source (Edington 1984, Mohr & Poulson 1966). The nitrate mining in the caves in southern China testifies to the abundance of bats in the past so the contemporary status of bat populations was of considerable interest. The culinary habits of local people can often have a major influence on bat colonies (Edington 1984, Fowler et al 1989) and cantonese cuisine is reknown for its diversity!

Methods

Animals were collected on sight in all caves visited by the author and at several other sites by members of the Project. To allow comparison of sites, collections of terrestrial invertebrates were made for approximately 15 minutes at each site. The aim was to collect as many different species as possible in this time. Only a sample of the more abundant species was captured with a note made of the total numbers seen. At several sites the air temperature and relative humidity were measured from the cave entrance to up to one kilometre inside. At all sites the terrestrial cave habitat was qualitatively assessed on a scale of 1-4/5 using three categories: 1) humidity 2) Human impact 3) extent of flooding. These scales are summarized in table 1. Aquatic habitats were sampled when available using hand nets and collecting bottles for the divers.

Invertebrates were classified as troglomorphic if they possessed the morphological characters typical of cave adapted animals (e.g. eyes reduced or absent, pigment reduced, elongated appendages, in comparison to surface-dwelling relatives) (Howarth 1983).

RESULTS

The numbers of species collected and the habitat characteristics for each collecting site are shown in Table 2. Locations of the caves are given in other papers in this volume. The measurements of temperature and humidity are also shown in Table 2, demonstrating how the qualitative 'humidity' scale translates to measured relative humidity.

The aquatic fauna has been excluded from further analyses because so little was collected and no troglomorphic species were found.

Table 1. Cave sites were assessed using each of these criteria and given three scores of 1-4/5 for humidity, human impact and extent of flooding (see Table 2).

SITE SCORE	HUMIDITY 1-5	HUMAN IMPACT 1-5	EXTENT OF FLOODING 1-4
1	Strong draught. High level. Dry mud +/− near entrance.	Never visited. No pollution via streams.	Never
2	Strong draught. Epiphreas. Mud moist +/− pools.	Evidence of visits or some pollution. No major alteration to cave. Little human debris.	Occasional (?10 years)
3	Draught. High level. Pools +/− seeps. Mud moist.	Frequently visited. Some modification to cave (Steps, minor excavation)	Frequent partial flooding. Mud deposits.
4	Draught. Damp mud. Epiphreas/streamway.	Regular use. Extensive modifications, e.g. Paths, debris plentiful.	Frequent flooding to roof. Extensive large debris potentially fast flowing
5	No draught. Epiphreas/streamway pools. Wet mud.	Show cave. Active mining. Regular use by farm animals Debris plentiful including animal faeces.	

The species richness data were analysed with a multiple regression using LOTUS spreadsheets. In the first analysis the number of troglomorphic species per site (T) was regressed against the habitat criteria (F) humidity (H) and human impact: extent of flooding. In the second analyses, the number of non-troglomorphic species per site was regressed against the same habitat criteria. Troglomorphic species richness was significantly related to extent of flooding and humidity by the following regression equation:

$T = 0.73\ H - 0.91\ F + 0.63$ R SQUARED = 0.70
H : P<0.002
F : P<0.001

This relationship is illustrated in Figure 1 by plotting species richness against extent of flooding (1a) and then extracting the residuals from this graph to plot against humidity (1b). Human impact does not explain significantly any further variance, but this may be misleading because humidity and human impact are themselves correlated (Figure 2, P<0.01,). The interpretation of multiple regressions with cross-correlated variables is difficult but here at least humidity explains more variance than human impact so would appear to be the more important factor affecting troglomorphic species richness. The possible influence of human impact is demonstrated in Figure 1c, where human impact has been forced into a stepwise regression as the second variable with extent of flooding as the first variable. The resulting relationship with the residuals from 1a is significant (P<0.05, r squared = 0.21) but explains less additional variance than Figure 1b (P<0.001, r squared = 0.45).

No signifcant relationships were found with the non-troglomorphic species richness either in a multiple regression or in regressions against the individual habitat criteria. The data are shown plotted against the three habitat criteria in Figure 1(d,e,f) to compare with the trends shown by the troglomorphic species (Figure 1a,b,c).

A list of the species found in all the collections, classified as far as presently possible, is presented in the Appendix. The collections have been sent to appropriate specialists for further classification and description.

DISCUSSION

Cave passages in this region that exhibit evidence of frequent flooding possess a less species rich troglomorphic fauna of terrestrial invertebrates. This effect has been documented in other studies of cave fauna (Poulson & Culver 1969) but could be particularly pronounced in southern China because of the well defined wet season. This pattern of rainfall may also reduce the possibilities for an aquatic cave-adapted fauna to develop. However a more important factor explaining the paucity of aquatic troglomorphs in our collections is probably the lack of long underground watercourses in most of the areas we studied. A more interesting aquatic fauna may exist in the more extensive limestone north of Bama, and the deep underwater systems of Duan would be interesting biospeleologically but are enough of a challenge even for diving exploration.

The influence of humidity on the richness of the terrestrial cave fauna is also not surprising. In large diameter tropical caves, the drying effect of draughts is clearly a physiological problem for many cave adapted animals (Chapman 1982). The most species-rich sites in this study were those with little through draught and plenty of water from seeps, small streams or the occasional slow backing up of flood water. Slow flooding may be beneficial for the organic matter that it provides in contrast to the scouring effect of powerful floods.

Perhaps surpisingly, regular human use of the caves does not appear to adversely affect the troglomorphic fauna. A small negative effect is detectable in the analyses but it is confounded by the large influence of humidity on the fauna. The most likely explanation is that although regular and extensive human use does have an effect on the cave environment, this type of use is restricted to those cave habitats with low species richness of troglomorphic animals. So despite the throughflow of tourists or even farm animals, or the prospecting for nitrate, or use as a daily water supply site, cave-adapted animals are little affected. This is simply because these multifarious human activities in the caves are mostly restricted to large, draughty dry passages or limited to areas close to entrances. Small wet muddy passages hold little appeal for tourists, are useless as thoroughfares, will not have built up deposits of guano and normally there will be other more easily acceessible passages in which to collect water. It is these passages that are home to the richest communities of cave animals in this area.

However this analysis of human impact could miss one of the more important indirect factors. The virtual complete deforestation of the region, leaving scrub or terraced fields where woodland would have stood until the 1940s, has probably had a detrimental effect on the surface fauna. This in turn will reduce, or at least alter, the organic inputs to the cave ecosystem. A survey of caves in less deforested areas could quantify this, but we only found one tiny area of primary woodland in the base of an exceptionally deep and steep-walled doline. The 300-400m of steep boulder slopes and cliffs protecting this small enclave of mature trees appeared to be sufficient to deter the local people from their usual firewood gathering. The rarity of bats in the caves may be another consequence of this change in vegetation. We found one species of small insectivorous bat in Duan, and only one small colony of unidentified insectivorpus bats in Bama. A larger bat colony was seen in a show cave near Luizhou, unfortunately being disturbed deliberately by the cave guide. Encouragingly, the local market, which stocked a huge range of south east Asian wildlife (some of which we consumed at a banquet) did not sell bats. The larger fruit bats, which are regularly eaten from caves in other parts of the world (Edington 1984, Fowler et al 1989), have a contemporary Asian distribution that only just reaches China (Allen 1938). The extensive deposits of nitrate-rich sediment extracted for gunpowder manufacture by the Chinese presumably originate from large bat colonies. The question of whether the present lack of such colonies is caused by deforestation or by other factors such as climatic change cannot be answered by this brief study. Indeed, it is possible that the nitrate deposits were built up by small numbers of bats over a very

	No. Species of:	2) Invertebrates:			Humidity			
Cave and Site	1) Vertebrates	TM	Others	Temp C	%RH	Score	Human Impact	Flood Score
Black 1	0	0	2	18	74	1	4	1
Cave 2	1	3	4	18	80	5	2	2
3	0	3	3	20	95	5	1	2
4	0	0	1	20	95	5	1	4
Beimo- 1	0	0	1	16	72	2	4	3
Dong U1	0	1	3	16	58	1	3	1
L2	0	0	3			4	1	4
2	1	4	3	20	80	3	2	1
Chuang- 1	0	0	0			1	5	3
Dong 2	1	0	1			1	3	1
U2	0	2	0			3	2	1
Unnamed Cave	0	4	0			5	1	1
Horse Cave	0	1	2			1	2	1
Heau- 1	1	2	5			3	2	1
Dong U1	0	1	4			3	2	1
Limo Dong	0	0	2			4	1	4
Qiao Ban Dong	1	0	1			5	1	4
Jia Bao Dong	0	1	4			4	1	3
Jin Lun- 1	0	1	2			3	3	1
Dong 2	0	0	2			4	5	4
3	0	1	2			4	3	4

Table 2. Numbers of species and scores for the habitat criteria at each cave site examined. Sites within caves are numbered and designated as lower (L) or upper (U) levels where relevant. Invertebrate species are classified as troglomorphic (TM) or others.

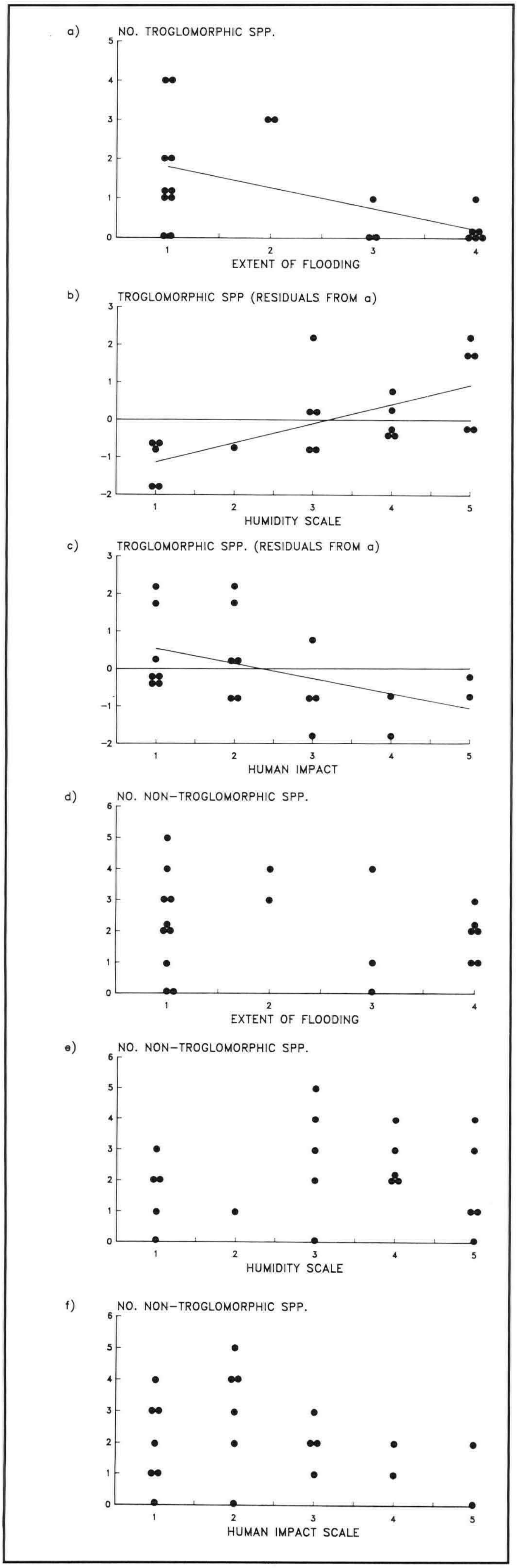
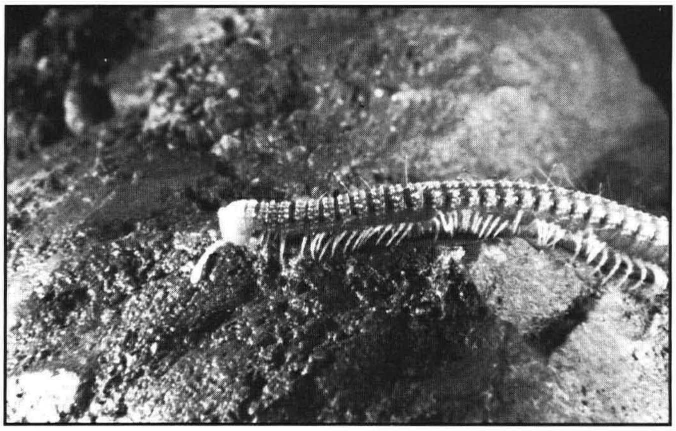


Figure 1 (left). Species richness of terrestrial troglomorphic and non-troglomorphic animals plotted against the 3 habitat criteria. Best fit lines have been drawn if the regressions were statistically significant ($P<0.05$). Residuals from 1a were used in 1b and 1c, as explained in the text.



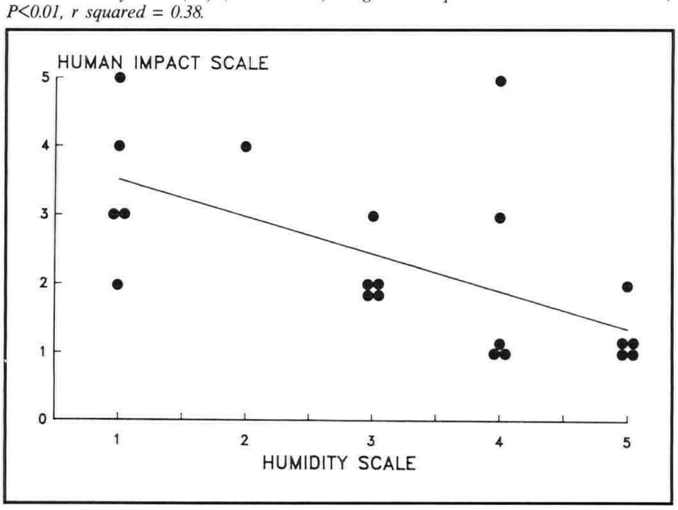
A species of blind white millipede found deep within the Bama caves. One of the common detritivores. Length up to 6cm.

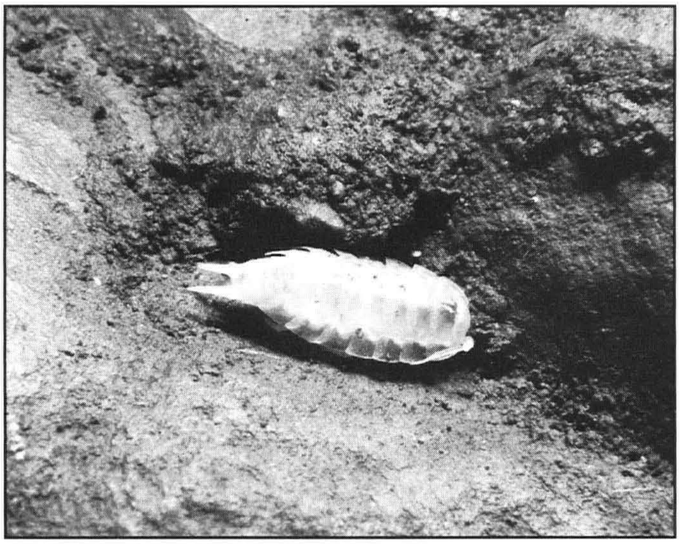
long time with population densities similar to the present day. Relatively simple studies of the rate of guano accumulation under existing bat colonies and an assessment of the age of nitrate deposits might answer this last question.

The measurements of species richness and habitat criteria used in this study were by necessity extremely simple because time was not available to conduct more detailed habitat-related studies (e.g. Chapman 1982). Yet even these simple procedures are adequate to detect some of the major influences on the species richness of troglomorphic animals. The lack of significant relationships with the non-troglomorphic species richness is also encouraging. These species are distinguished from troglomorphs by a suite of characters assessed quite independently of the habitat criteria (Howarth 1983). The non-troglomorphs species represent both vagrant surface-dwelling species, perhaps brought in on debris from floods or humans, and troglophilic species that have populations both above and below the surface. It is therefore not surprising that the richness of these species is not clearly related to high humidity, lack of severe flooding or human impact.

The high proportion of troglomorphic species in the collections suggests that further collecting could reap benefits in this region. The spiders in particular show higher troglomorphic species richness than in comparable samples from other areas of SE Asia or Japan (C. Deeleman-Reinhold pers comm). Of special interest in the spiders is the presence of an undescribed member of the small family Telemidae. Only 12 species exist in this family worldwide and of these only one, from the Pyrenees, is troglomorphic and it possesses markedly less extreme troglomorphic adaptations than the species collected in China. An especially fascinating feature of the family, unique amongst spiders, is their method of sperm transfer using a spermatophore manipulated by specialised genitalia. A similar method of sperm transfer is found in distant relatives of spiders such as scorpions. The new species from China is endowed with particularly large genitalia even for this family.

Figure 2. The assessment of human impact (I) for each site plotted against the score on the humidity scale (H) (see Table 1). Regression equation: $I = -0.54\ H + 4.05$, $P<0.01$, r squared = 0.38.





One of the two species of blind white woodlice from the Bama caves. Both are detritivores like their surface relatives. Length about 1cm.

ACKNOWLEDGEMENTS

Various specialists provided information on the collections at this early stage in their classification: Dr C.Deeleman-Reinhold (Spiders), Dr R. Booth, (Coleoptera), Mr J. Hill (bats). Many other specialists are presently working on other parts of the collections. Phil Chapman, Rob Palmer and others gave advice on various aspects of the project.

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APPENDIX — AVAILABLE CLASSIFICATIONS OF THE COLLECTIONS.

Species have been tentatively described as cave-adapted (troglomorphic — TM), troglophilic (TP — having populations both above and below ground), trogloxenes (use caves only as shelter — TX) or acidentals (AC).

Phylum Mollusca			
	Class Bivalvia	1 sp freshwater mussel	AC
Phylum Arthropoda			
	Class Arachnida		
		1 sp telemid spider	TM
		1 Heteropoda sp	TP
		1 Theridion sp	TP
		Nesticus mogers	TP?
		Scytodes sp	TM
		1 sp aglenid spider	TP?
	Class Crustacea		
		2 spp isopods (woodlice) both	TM
		1 sp amphipod	AC
	Class Insecta		
		1 collembolan	TM?
		2 spp rhaphidophorid crickets	1 TP, 1 TM
		1 sp cockroach	AC
		1 sp Dermaptera (earwig)	TP
		1 sp carabid beetle	TM
		1 sp dytiscid beetle	AC
		1 sp aderid beetle	TP
		1 sp culicine mosquito	TX
		Various Diptera (on guano?)	TP
	Class Diplopoda		
		4 spp millipedes	all TM
	Class Chilopoda		
		1 sp scutigerid centipede	TP
Phylum Chordata			
	Class Osteichthyes		
		3 spp fish — carp(?), catfish and a goby	all TP/AC
	Class Reptilia		
		1 python (taken to market too rapidly to identify!)	TX/AC
	Class Mammalia		
		Rhinolophus pusillus szechwanus Insectivorous bat	TX

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Archaeological Observations in the Caves of Guangxi

Charlotte ROBERTS

Abstract: The paper briefly describes the teaching and practice of cave archaeology in China and how it has grown from a typological to a multidisciplinary study. The types of archaeological caves to be found in Guangxi are noted and then a brief description of the objectives and results of the archaeological fieldwork undertaken in Guangxi. Details of dry stone walling, graves, pottery, excavated pits and hearth located on the expedition are given. Prospects for future work are discussed and reference to the problem of integrating scientific work and cave exploration on caving expeditions is mentioned.

The sport of caving was not fully recognised by the Chinese until the birth of the China Caves Project and the first expedition in 1985. Tradition saw the caves in an economic context as sources of valuable materials, such as tin or nitrates, guano and water or as potential tourist attractions (Hua, 1987). Since 1985, Project collaborators in China have developed their caving abilities from techniques introduced by British members, thus enabling more ambitious exploration, particularly in the south, and further opportunities for recognition of their economic, archaeological and scientific potential.

Caves have always been a focus of attention for Chinese archaeologists, but with no caving techniques and equipment, investigations and excavations have been limited to entrances and very short distances into more extensive systems. The old Chinese proverb, "how can you catch tiger cubs without entering a tiger's lair" holds true for cave archaeology in China. As a subject in Universities, archaeology is allied with the historical sciences. However, archaeology has a clearly defined role in contemporary Chinese society (Olsen 1987 p 285) as emphasised by Mao Zedung when he said "let the past serve the present". The past is seen as a body of events and circumstances with direct relevance to the current situation with archaeology as a primitive tool for integrating China's long history within a broader context, thus providing a rationale for excavation. Chinese archaeologists tend to publish raw data more frequently than their Western counterparts rather than use it to interpret past communities (e.g. Zhongru, 1980). However, the nature of archaeology teaching in universities at least, has encouraged the development of a more integrated and interpretative approach to fieldwork where typological and chronological aspects play a larger role than behavioural studies. However, there is a growing recognition that multidiscplinary work is more valuable (Olsen, 1987) while a wide range of chronometric dating techniques are now being applied to archaeological material. Modern methods of discovery and excavation did not reach south China until the 1930s and it is only in the last decade that archaeologists have systematically investigated and mapped the area. By 1980, archaeologists from many countries had visited China and begun collaborative projects.

Caves in any part of the world have attracted people for thousands of years (Kempe, 1988) providing permanent or temporary refuge and sites of burial or ritual. In geological terms, caves are also efficient sediment traps, accumulating material directly and indirectly by natural, human and animal species and providing protection from subaerial erosion and weathering. Sources include wind and water-lain sediments and biogenic material related to animal and human activity. These sediments are subject to intermingling and disturbance through time leaving a complex environmental record.

There are three potential types of archaeological site each represented in Guangxi:

1. **Rock shelters,** at the base of limestone cliffs, towers and higher up these features. In Guangxi, particularly in Duan County, there were many large high level cave entrances which proved to be large rock shelters.

2. **Shafts or fissures.** In Duan County, there are many shafts in the limestone areas visited. These shafts can provide traps for the accumulation of sediments through time and/or create traps for the unwary animal (or human).

3. **The interior zone,** beyond cave entrances; in Guangxi many of the caves were of the dry fossil type and these preserved sediments well.

PREVIOUS CAVE ARCHAEOLOGICAL WORK IN CHINA

During the Han Dynasty (approximately 2,000 BP), mammalian fossil bones and teeth were found in Guangxi caves (Wen-Chung 1965, p 39). Early palaeontological studies focused on specimens from Chinese drug stores which dispensed them as patent medicines and this led to the recognition of new species and genera (often of unknown cave provenance). In Guangxi, three regions (Luichow, Kweilin and Yungning) were known to excavate and export such material e.g. "dragon's" teeth and bones were powdered for aphrodisiacs (Kowalski, 1965, p 78). Teeth from drug stores were described as the first Chinese vertebrate fossils by Owen in 1870. Between 1960 and 1965 three hundred caves in Guangxi were investigated to yield 88 mammalian fossils (Wen-Chung 1965, p 41) and this clearly underlines the archaeological potential of south China caves. However, Chinese scholars appear to have had most interest and success in palaeontology. The celebrated discovery of *Sinanthropus pekinensis* ("Peking Man") at Choukoutien near Peking (Clark, 1977:290) was perhaps the most impressive find of all and provided a vital link in the study of human evolution. True cave archaeological work, i.e. studying the material remains of past peoples, appears to have been restricted to the study of pottery and stone tool assemblages with the aim of assessing an age for the group of artefacts, (e.g. Lan-Po & Chung-Lang, 1960).

ARCHAEOLOGICAL FIELDWORK

It appears that the archaeology of south China is less intensively studied than the north (Meacham, 1977 p 422) although it is interesting to note that some of the earliest Neolithic sites (9th millenium B.C.) are in south China caves. As early as 1935 Pei made the alarming observation that Mesolithic deposits in the caves of Guangxi, "have been disturbed by the local people. Yet large heaps of debris are still left in the cave...". Nevertheless, the aim on the expedition was to make a preliminary assessment of the archaeological remains and potential in the caves visited and the prospects for future work. It was thus essential to visit as many caves as possible to obtain a representative view. The detailed objectives were:—

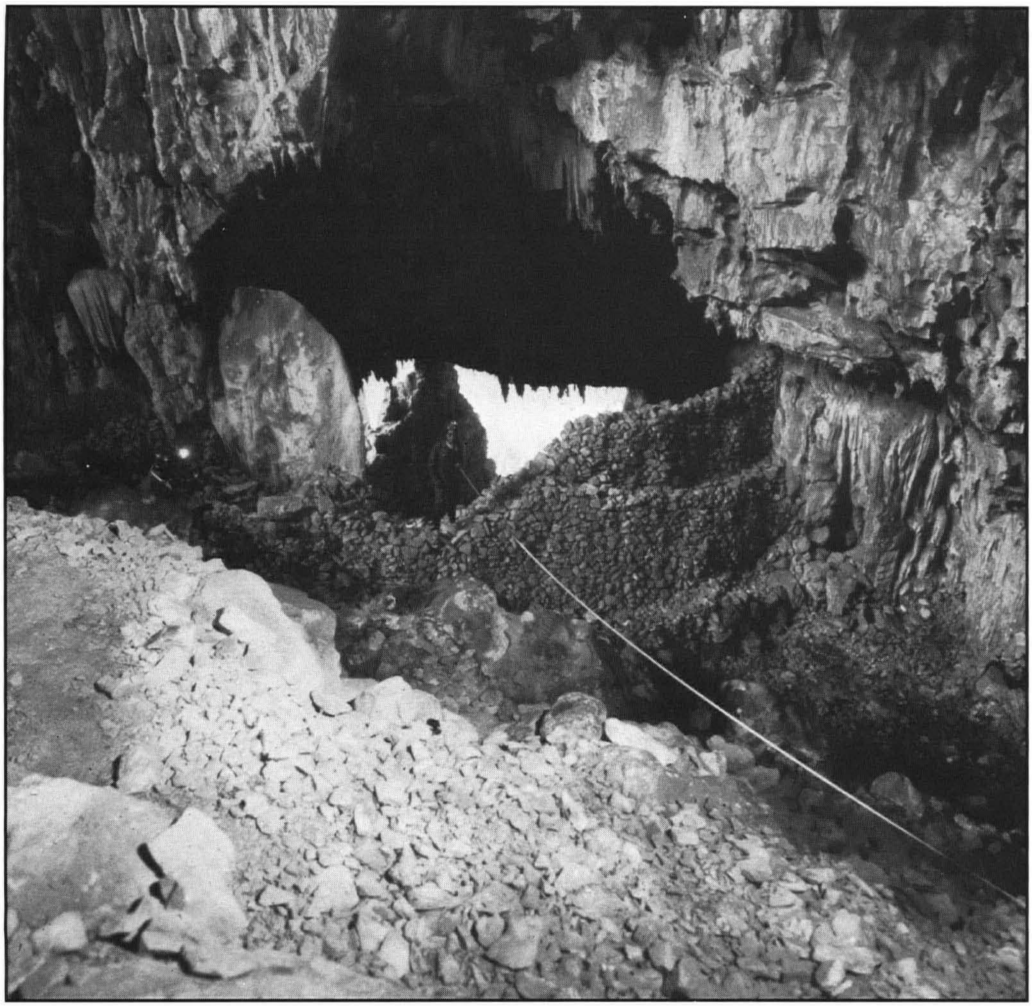
1. To locate, observe and record any evidence of human activity in the caves investigated by the expedition team.

2. Record the condition of such remains and potential threats by natural or human agencies.

3. Report to Chinese archaeologists involved with the area.

Duan County

This was the first area visited and approximately a week was spent investigating cave sites located by the Chinese and the earlier British reconnaissance. Most were rock shelters which would have provided possible refuge for many people but there was little evidence of human use. However, Gan Fang (or Monk's Cave, 1018m) was a major execption. The cave had an imposing southerly aspect over a spectacular 500m deep doline containing a village and irrigated areas. Our Chinese colleagues and local inhabitants stated that the cave had been used for many hundreds of years by monks. The cave was reached across an area terraced by dry stone walls for agriculture and was about 40m deep and 50m high (with two avens in the roof) and approximately 2.5m and 8m wide at the back and front of the cave respectively. A sketch plan of the site is shown in the paper by Noel, (this volume).



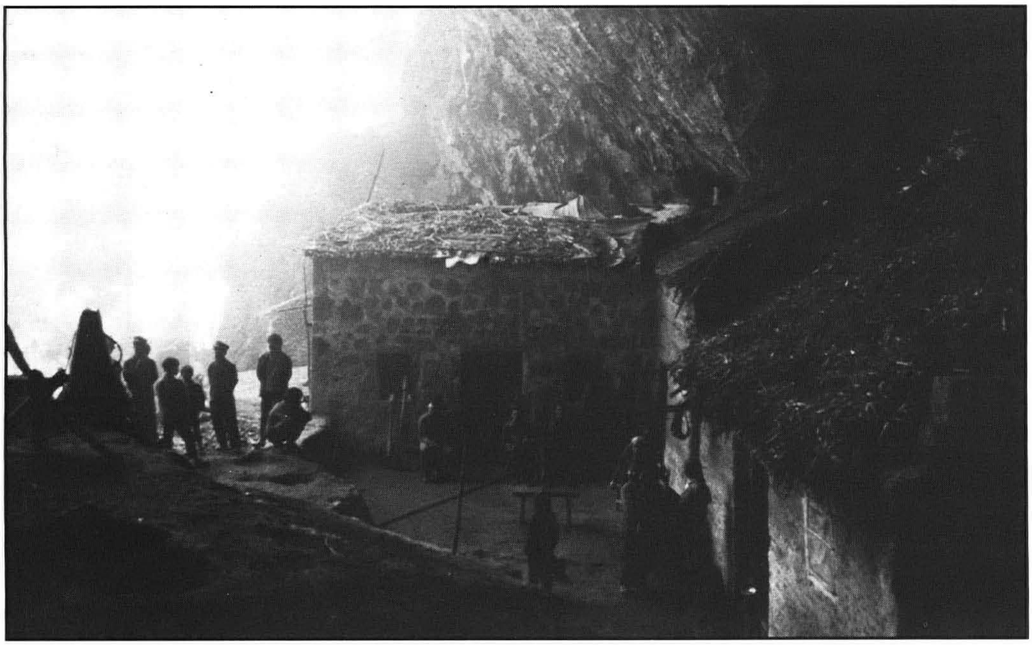
Dry stone terrace walling in the entrance to Beimo I.

The floor was modified by a series of three prominent terraces retained by large boulders which also formed two walls, while towards the rear of the cave a group of hearths were marked by red/brown sediments. On the floor a number of potsherds were found, ranging from glazed through slipped to coarser wares, together with small long bones (birds?) and many snail shells. On the lowest terrace there were fragments of clothing and a bundle of bound rushes which presumably had illuminated the cave at night. This terrace also contained an enclosed rectangular walled area 1m deep, 0.9m long and 1.6m wide within which a spout and handle of a vessel were discovered. Monk's Cave appeared to be a temporary shelter for human use but of unknown date and although it it difficult to place the site in any chronological context without absolute dating, it is likely that the cave had seen a long history of use. The results of an archaeomagnetic study of burnt floors layers is described in M. Noel's accompanying paper and supports this conjecture.

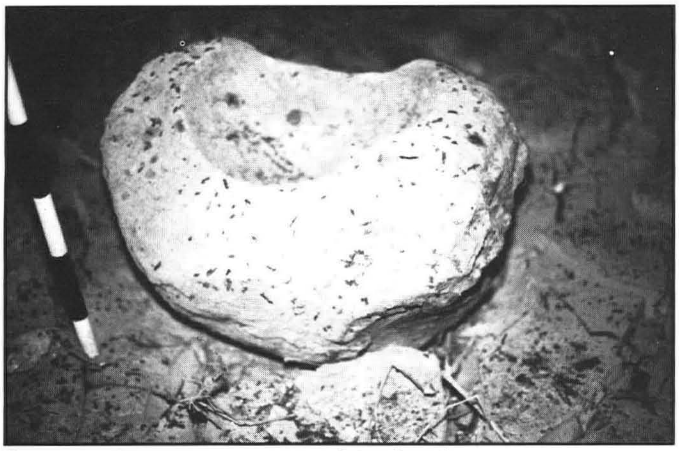
Throughout Duan there was abundant evidence that caves had long been utilised as sources of drinking water. Rock-cut steps were a common feature and it seems very likely that such "water caves" will reward further archaeological and historical research.

Bama County

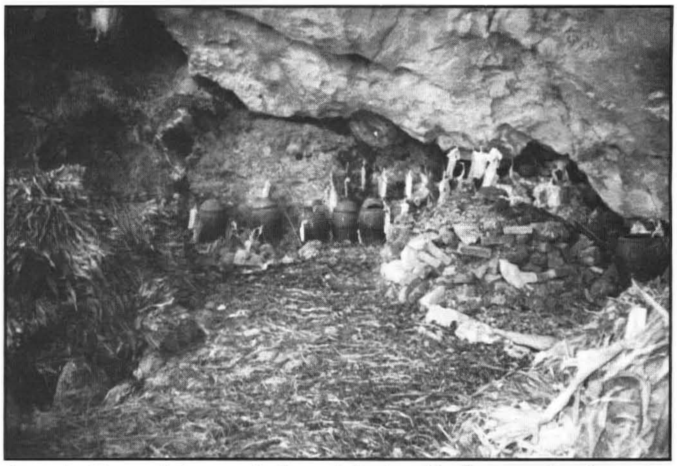
In Bama, expedition efforts focused on the exploration of the large Pan Yang Cave System where the most striking archaeological feature was the abundance of dry stone walling within the caves, particularly in the entrances of Beimo Dong I and II. In Beimo Dong I, the upper fossil series, entered via a 100m climb, was covered in dry stone walls whose design suggested a defence purpose. There were also two circular dry



View from Beimo Dong I.



Stone mortar in westernmost entrance to Beimo Dong I.



Recent burial mounds in a cave in Guangxi showing white flags as a sign of mourning for a recent burial.

stone wall structures behind the main wall, about 2m in diameter and 1m high. These enclosed areas were of unknown purpose but it is possible that they served as graves since this is the normal arrangement for graves in the area, viz: a dry stone circular structure filled with earth. Beyond the main dry stone walling a higher level entrance, about 23m wide, has been totally blocked with walling up to 5m high. A doorway, 1.5m high, was set to the right of the well and looked out over the river while set in this stone wall was a later insertion of brick which contained small square holes.

Beimo II also contained extensive dry stone walling in the two northern entrances. The westernmost entrance had dry stone walls staggered across a span of 10m. Within one of the structures a stone subcircular mortar 40cm x 52cm, was located. Such mortars were often seen in the local villages and were used for grinding grain. This mortar was presumably manufactured on site but it was impossible to assign an age. The easternmost entrance was steeply terraced by dry stone walling above rubble slope, with a total height of 7m while deeper into the cave were further walled structures covering the entire width of the passage.

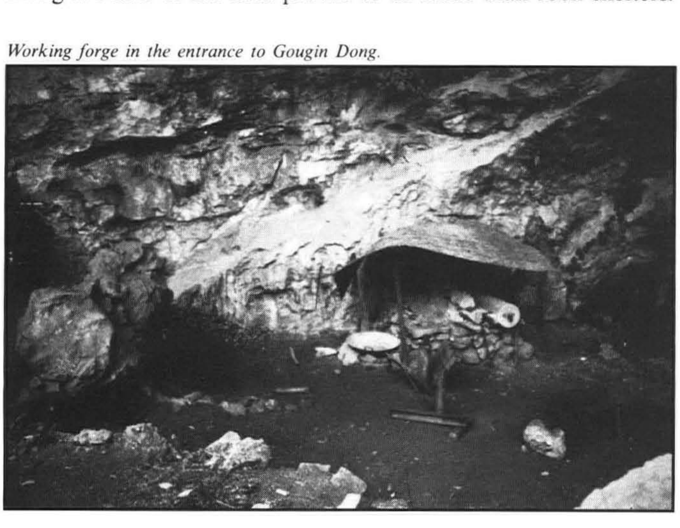
Progressing through the Pan yang Cave System and into Qian Dong, exploration up the east-facing ramp into high level passage revealed a further circular dry stone walled area filled with earth, close to some rectangular pits dug into the floor sediment and it is possible that this again was a grave.

Particularly prominent were excavated pits in three areas high up in the passage of Hou Dong, 0.3-1.1m deep and close to the cave wall, presumably to extract nitrate containing sediments for fertiliser and explosives. Small fish bones, bamboo sticks and charcoal indicated human use but access to the site was up to a 20m steep mud slope and well out of sight of the entrance.

The general impression of the Pang Yang Cave System was intensive utilisation for defence and nitrate extraction and possible burials, although dating of these features was not possible. However, since local communities use the caves extensively even today as through-routes to neighbouring schools and markets, it is highly likely that the cave system has been thoroughly exploited for many hundreds of years.

Several cave entrances were indicated to members of the Project by local people close to the road leading east away from Beimo Dong I. None of the sites proved to be more than rock shelters.

Working forge in the entrance to Gougin Dong.



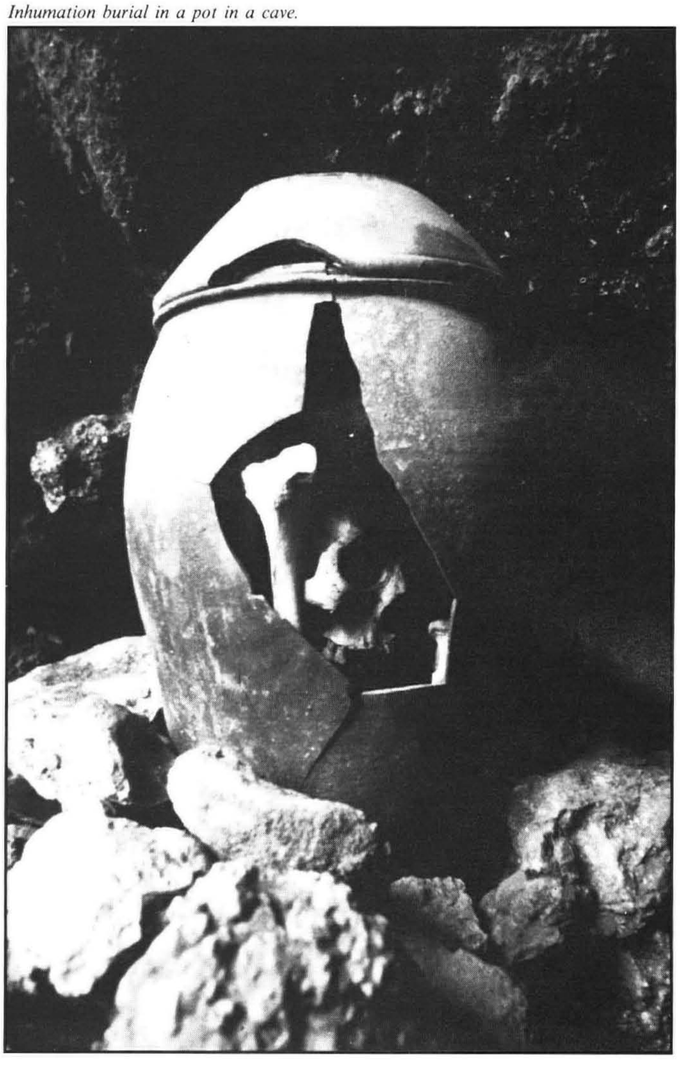
However, one cave entrance high up on a hillside (Gougin Cave), was totally blocked off with dry stone walling in the middle of which was a padlocked door. Beyond the wall was a working forge for metal toolmaking together with a bed, cooking pots and the inevitable bicycle, indicating that a local blacksmith works in this cave even today.

CONCLUSIONS

This archaeological assessment was largely determined by the caves which were studied in Duan and Bama. Although Mashan County was not visited due to lack of time, other members reported similar observations and also one cave in use as a religious site.

The potential for archaeological remains in the caves of these counties is exceptional. Damage to archaeological deposits by local communities would probably vary between areas and depend on the remoteness and general accessibility. The Chinese

Inhumation burial in a pot in a cave.



people were seen to be natural speleologists but when obstacles such as water, deep shafts and absence of light presented themselves this tended to be a barrier to progress. The majority of the caves visited were fossil entrances and more extensive dry systems, (particularly on the main route through the Pang Yang System) and this environ ment would clearly favour the preservation of archaeological remains.

Some problems were encountered in exploring caves with burials because of ethical considerations. Local people used many cave sites for burial, particularly those situated high up in the limestone towers and recent burials were denoted by the flying of white flags on top of the burial mound. There were also disarticulated bones in pots.

The Chinese have had a long history and their association with the caves of Duan and Bama Counties in south China has been and still is intensive. Therefore, the potential for future cave archaeological fieldwork and excavation is clear but to obtain some absolute information about the past use of the caves a more systematic approach to the work is needed and, inevitably, excavation. The sampling of archaeological material and sediments in caves and the application of scientific techniques such as radiocarbon, palaeomagnetic dating and pollen analysis could in future be incorporated in an expanded scientific research project with well defined objectives. It is without doubt difficult to integrate 'cave science' with the location and exploration of caves in any part of the world. There is a need for cave scientists to dedicate themselves totally to the collection of information pertaining to their discipline during an expedition and this leaves little time for cave exploration. These arguments are as relevant to archaeological survey and research as other environmental discplines.

In future, expeditions to other countries from Britain should be encouraged to try and follow existing guidelines when planning archaeological activities (Roberts, 1986). Photographs and sketches of cave archaeological sites and relics should form part of the expedition archive and indicate the potential for future research or excavation.

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Expedition Medicine and Histoplasmosis in Guangxi

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Abstract: The medical problems associated with the China Caves Project's Guizhou and Guangxi Expeditions are mentioned. Negative studies into the histoplasmosis risk in these areas are detailed.

Most expeditions prefer to take a doctor and then hope not to call on his skills. The 1987 Guizhou expedition had no doctor, but might have benefited from one whereas the Guangxi team had one and barely used him professionally.

In Guizhou the team met cold weather so that coal fires were necessary which were un-vented open fires burning a high sulphur content local coal. Acrid smoke made most people cough continuously, viral upper respiratory infections were also rife and in consequence many team members had persistent distress from coughing due to these two factors. Some developed a secondary bronchitis needing antibiotics and a few developed loss of fitness, strength and weight as the expedition progressed. Added to this were a totally foreign diet and the hygiene standards of one of the less affluent parts of China, so that diarrhoea was endemic throughout. All those debilitated recovered uneventfully on return to the UK. It was to the teams credit that they continued a high level of technical caving with notable success. Their medical supplies were comprehensive, but like much of the equipment, last in arriving. For a team without a doctor the following well-tried arrangements proved useful.

a) Just one or two first aid trained members handled all medical and first aid problems.

b) They were briefed beforehand on the contents and appropriate usage of the equipment supplied.

c) Instructions on usage and dosage on all medication was supplied in the medical list as a reminder and in case the above was not possible.

d) All symptoms and treatment regimes were carefully documented on individual cards in case of subsequent need to know this (compliance on this was excellent).

The Guangxi team split up immediately working in areas up to 200 km distant and had very unreliable communications between parties so that in case of serious illness or trauma the theoretical medical back-up could have been two days distant. Each party carried a pre-packed field medical kit and smaller packs for one or two-man usages with a selection of medical supplies and detailed instructions. Our archaeologist, Charlotte Roberts, had an SRN as a chance surplus qualification so was put in charge of the Bama contingent's welfare.

We were in a sub-tropical area at the end of the dry season so avoided the upsets associated with excessive heat, humidity, mud and insects, an unforgettable experience to all who have endured them. Even the snakes were at about the end of their hibernation season — just a few were seen. All the food was provided and cooked by our Chinese hosts as part of a complex payment per person per day for all facilities. They spared no effort to feed us, but if chopsticks and a Chinese cuisine are not to your liking then prepare to lose weight. Small stoves and English archetypal goodies for cooking as a treat would have done wonders for morale although might just have caused offence.

Tropical medicine experts warned us that Southern China has a high transmission risk for malaria all the year round. In Guizhou not many mosquitoes were seen and in Guangxi just a few during the earlier warmer spell. The risk was, therefore, low, but probably still present. Resistance to some anti-malarial drug exists so that double protection is necessary and we took two Paludrine tablets (Proguanil) daily plus two Nivequin tablets (chloroquine) weekly. Our pre-expedition injections were to protect against Tetanus, Poliomyelitis, Typhoid, Gamma Globulin (Hepatitis A) and Rabies.

Rabies vaccine is now available on an ordinary general practitioner's prescription costing the recipient just £2.60 for two doses instead of £40 when privately ordered. This is a new and not yet well publicised development and can save money for expeditions.

A new vaccine against Japanese encephalitis now exists — an occasional but very nasty disease in South China. We sought this, but learned it was just available for military personnel only at that time, but future expeditions may wish to consider this protection.

Histoplasmosis is a risk faced by tropical cavers (Frankland, 1974). The medical literature contains no references to its prevalence in China so the degree of hazard we faced was unknown. The caves did not contain the extensive guano beds of many tropical caves so that our exposure was not enormous. Ten guano samples from all the caving areas we visited were brought back to the UK and investigated at the Mycology Reference Laboratory (by courtesy of Professor D. W. R. McKenzie and Dr. R. Hay).

On any expedition the doctor never totally relaxes because every minute carries the responsibilty of being called to "The Big One": significant trauma, serious illness or worse, all in an environment where no back-up is available for life and death decisions. My predecessors in Andy Eavis' wanderings have been severely tested, but on expeditions I seem to have a lucky streak (future organisers please note). It never happened, despite divers going much deeper than BSAC would ever wish and frightening boulder chokes, everyone remained well apart from the predictable occasional diarrhoeas.

A potentially serious incident occurred when a member was breaking carbide and a fragment went into his eye. A colleague had him under a tap within seconds and probably saved the sight in that eye — moral: keep a pair of goggles with the carbide dump to protect those smashing it.

The charms of China include a population where thirty to forty percent may carry the Hepatitis B virus. British cavers would wish to avoid this partly because it means a prolonged convalescence without alcohol and also becuase it carries a 10% mortality rate. Recent work has shown that Europeans contracting this illness in the Far East often do so via venereal transmission so that the lessons are obvious. The Chinese are a very moral nation. In the whole of China all untreated water must be regarded as unfit to drink. The Chinese accept this and large thermos flasks of boiled water are everywhere. Our divers inevitably got some water into their mouths, but coped and remained well.

No expedition member had any illness suggesting histoplasmosis and histoplasmin skin testing on all the Guangxi members at the end of the expedition showed only two positives.

1) The writer — known to be positive after exposure in USA and self-injected with histoplasmin as a clear demonstration to the Chinese of how harmless the procedure was!

2) A diver with extensive North and Central American caving experience including dried guano beds, but without respiratory illness.

Eight members of the Institute of Karst Geology in Guilin were also skin tested with histoplasmin. They were all professional Karst Geologists and had caving experience dating back up to thirty years. None had explored out of China, but they represented the most experienced cadre of speleological expertise in China — all were negative.

It would appear that the risk of contracting histoplasmosis in the caves of South West China is low. The one expedition member revealed as having had previous exposure is more likely to have contracted this in America than in China as all other investigations pointed to the risk being absent.

It was hoped initially to skin test with histoplasmin a selection of local Chinese living in the vicinity of the caves whose sense of adventure and search for resources had taken them underground sometimes on a regular and frequent basis. Enough of the scarce histoplasmin to allow this project was taken to China but it was realised that it was impractical to recruit co-operation from local villagers sufficiently to ask them to receive an injection not designed to benefit them. Often our official interpreters could not converse with the local people so diverse are the languages used. China is so enormous that to extrapolate these findings and say that other areas of this vast country do not constitute a histoplasmosis risk would be a grave error.

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B.C.R.A. 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, polytechnics or research establishments. Information and applications for Research Awards should be made on a form available from S. A. Moore, 27 Parc Gwelfor, Dyserth, Clwyd LL18 6LN.

GHAR PARAU FOUNDATION EXPEDITION AWARDS

An award, or awards, with a maximum 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, Rowlands House, Summerseat, Bury, Lancs. BL9 5NF. Closing date 1st February.

SPORTS COUNCIL GRANT-AID IN SUPPORT OF CAVING EXPEDITIONS ABROAD

Grants are given annually to all types of caving expeditions going overseas from the U.K. (including cave diving), for the purpose of furthering cave exploration, survey, photography and training. Application forms and advice sheets are obtainable from the GPF Secretary, David Judson, Rowlands House, Summerseat, Bury, Lancs. BL9 5NF and must be returned to him for both GPF and Sports Council Awards not later than 1st February each year for the succeeding period, April to March.

Expedition organisers living in Wales, Scotland or Northern Ireland, or from caving clubs based in these regions should contact their own regional Sports Council directly in the first instance (N.B. the closing date for Sports Council for Wales Awards applications is 31st December).

THE E. K. TRATMAN AWARD

An annual award, currently £25, 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 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.
Editor: Dr. Trevor D. Ford, 21 Elizabeth Drive, Oadby, Leicester LE2 4RD. (0533-715265).

CAVES & CAVING — quarterly news magazine of current events in caving, with brief reports of latest explorations and expeditions, news of new techniques and equipment, Association personalia etc.
Editor: A. Hall, 342 The Green, Eccleston, Chorley, Lancashire PR7 5TP. (0257-452763).

CAVE STUDIES SERIES — occasional series of booklets on various speleological or karst subjects.
Editor: Tony Waltham, Civil Engineering Department, Trent Polytechnic, Nottingham NG1 4BU. (0602-418418, ext. 2133).

No. 1 Caves & Karst of the Yorkshire Dales; by Tony Waltham & Martin Davies, 1987.

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No. 3 Caves & Karst of the Peak District; by Trevor Ford & John Gunn, 1990.

CURRENT TITLES IN SPELEOLOGY — annual listings of international publications.
Editor: Ray Mansfield, Downhead Cottage, Downhead, Shepton Mallet, Somerset BA4 4LG.

CAVING PRACTICE AND EQUIPMENT, edited by David Judson, 1984.

LIMESTONES AND CAVES OF NORTHWEST ENGLAND, edited by A. C. Waltham, 1974. (out of print)

LIMESTONES AND CAVES OF THE MENDIP HILLS, edited by D. I. Smith, 1975. (out of print)

LIMESTONES AND CAVES OF THE PEAK DISTRICT, edited by T. D. Ford, 1977. (out of print)

LIMESTONES AND CAVES OF WALES, edited by T. D. Ford, 1989.

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