

Large Caves Discovered on Flores (Indonesia)

July – August 2006

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Abstract

In July -August 2006, a group of five Australians and one Indonesian set out on a five-week palaeoclimatology research expedition to the island of Flores, eastern Indonesia. The project involves the study of speleothem growth and composition to determine past changes in the regional climate. These data will be related to human habitation, with the added bonus of possible links to the demise of the recently discovered human skeleton named *Homo floresiensis* ("the Hobbit"). Our goal was to visit caves in the area near the town of Ruteng to locate and collect samples of suitable speleothems which could yield useful palaeoclimate data.

The extent of the cave systems around Ruteng was not fully known other than through brief descriptions by previous researchers of non-caving background. In total, our group visited five major caves including the now-famous Liang Bua (Hobbit Cave), which in 2004 yielded the most significant paleoanthropology find in decades. To our amazement we discovered and surveyed a large extension to this cave.

Another cave (Liang Luar) was known by the locals to be approximately 100 metres long. A route past a rockpile choke revealed extensive passage and huge, well-decorated chambers, which was far beyond our wildest expectations. To date, this cave has been mapped to just over 1.6 km with much more to be surveyed. It is hoped that a future expedition planned for 2007 will enable the survey of this cave system to be completed.

This paper deals primarily with the access logistics, survey difficulties of Liang Luar cave and description of the five major caves we visited.

Introduction

In July–August 2006, a group of five Australians and one Indonesian set out on a five-week research expedition to the island of Flores in eastern Indonesia. Among the group were three scientists (Dr. Mike Gagan, Dr. Russell Drysdale, Dr. Linda Ayliffe) a senior technician (Bambang Suwargadi) and two cavers (Neil Anderson, Garry Smith). Our Indonesian colleague, Bambang, is employed by the Research and Development Centre for Geotechnology, Indonesian Institute of Sciences (LIPI), which is the Indonesian equivalent of the Australian CSIRO. Nic Severino joined our group for several days and assisted in part of the Liang Luar survey.



Left to Right – Linda, Neil, Garry, Mike, Russell and Bambang at the entrance arch to Liang Bua.

The recent discovery of a complete human skeleton measuring just one metre tall and dated at around 18,000 years old, has been heralded as the most significant paleoanthropology find in decades. The skeleton, named *Homo floresiensis* ("the Hobbit"), was found by an Australian – Indonesian team led by Professor Mike Morewood (University of New England), while excavating a six-metre deep pit in Liang Bua cave on the island of Flores. The discovery has sparked much debate and

inspired our research project, which is led by Dr. Mike Gagan of the Research School of Earth Sciences at the Australian National University.

Mike was instrumental in applying for and gaining funding from the Australian Research Council *Discovery* grants scheme to study the region's palaeoclimatology. The research involves reconstructing the history of monsoon rainfall extremes, abrupt climate shifts, and catastrophic volcanic eruptions. The information contained within speleothems could yield many secrets of the events which have shaped the history of human habitation in Indonesia, as well as the weather conditions which influenced habitation in Northern Australia. There was a need in this specific project to collect some stalagmites for full laboratory analysis. The majority of the samples gathered were specimens found already broken in the cave from natural causes. However, in cases where a specimen needed to be collected, the group used unobtrusive "mini-drill-holes" to investigate the quality of the stalagmite material, and ensure it was worthy of collection. Only a few essential specimens in out-of-the-way parts of the cave were collected.

Logistics of the expedition.

- Special permits were obtained from the Indonesian Institute of Sciences before visiting the karst area. This took a considerable amount of effort on the part of Mike, Bambang, Heather Scott-Gagan and Joan Cowley. Flights to Flores via Jakarta were very limited, so our group opted for an island hop approach to reduce waiting time.
- A considerable amount of sampling and caving equipment had to be transported from Australia. This added greatly to the bulk and weight of equipment manhandled on and off each mode of transport. The excess-luggage cost was quite expensive.
- In addition to the government permits, we had to seek permission from the local authorities and each of the cave property owners. Many thanks go to Bambang for being so methodical in gaining all these approvals.
- Westerners are not common in remote locations in Indonesia, so at times the language barrier added to the complexity of organizing accommodation, meals, supplies, etc. Bambang's interpretive skills were much appreciated. Our operational base was set up at a motel in the town of Ruteng nestled high in the mountains of central Flores. The backdrop of several extinct volcanic mountains occurs to the south while rich green rice paddys covered ridges and valleys stretch as far as the eye can see to the north.
- On the first trip to the karst area we had hired Toyota Kijang 1.8L petrol wagons. These proved to have inadequate ground clearance as they kept bottoming out on the rough road. Also they had to be pushed up the steep sections a number of times on the way back to Ruteng. It became very obvious after the first trip over the 11.5 km of rough, steep and narrow winding road, that these vehicles would not serve our purposes for the many trips required.

On the next occasion Bambang organized a Mitsubishi Colt diesel truck which is generally used by villagers as a people carrier. This form of transport, while adequate for the task, did have limitations with comfort and exhaust



Mike and Bambang after a long day underground.



Mitsubishi Colt diesel truck

fumes. It was also prone to mechanical problems due to the age and repair of the vehicle. These included brake failure with air in the hydraulics, fuel blockages, tyre puncture and a front wheel bearing which collapsed on the way down the mountain. I will say that the full-time mechanic who travelled with the truck did know how to carry out running repairs. The average time to travel from Ruteng to the karst area was 1 hour 15 minutes to cover the 11.5 km, provided there were no mechanical problems. This gives a good indication of the condition of the steep single lane road which snaked its way down the mountain past countless small villages.

The five major caves entered are now discussed.

1. Liang Galang, which in Indonesian means ‘Bathtub Cave’.-

The entrance to this cave is at an elevation of approximately 548 m ASL and is below a small NE facing limestone cliff overlooking a river valley of rice paddy fields. There are two spacious entrances with a sloping earth and flowstone floor leading toward the back of a large chamber measuring approximately 20 metres long by 20 metres high. At the bottom of the entrance slope and still within the twilight zone there are a couple of very large impressive rimstone dam basins which were dry at the time of



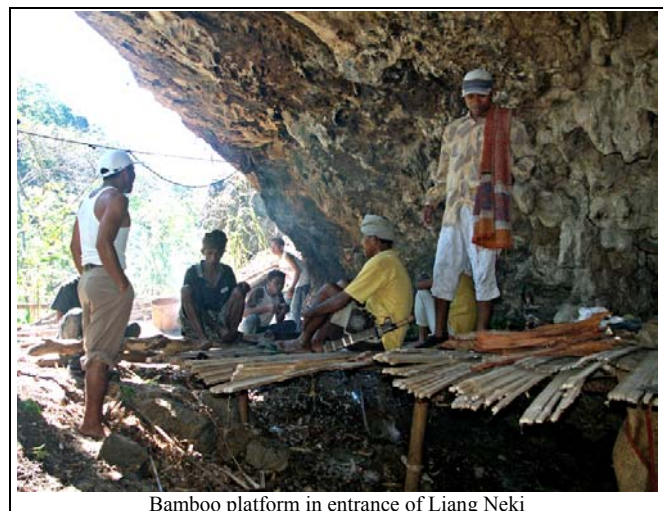
The impressive rimstone dams in Liang Galang

our visit. No doubt they would be very spectacular when full of water and they are certainly the reason for the cave’s name. The earth floor slopes to the left of the basins and into a dark zone along a short distance of high ceiling passage. It could be argued that this was just part of the one chamber. At the end of the sloping floor in the dark zone, there is a small drainage point at floor level which is impassable. High above there is a chance for further exploration with a well-decorated passage visible. This would take some rigging with scaling poles and ladders.

2. Liang Neki, which in Indonesian means ‘Bad Cave’

The cave is approximately 13.5 kilometres by road from Ruteng and takes two hours by vehicle due to the state of the road. There is a bamboo platform in the cave entrance, which is used by a local family as shelter.

From the entrance a spacious passage with dusty earth floor slopes steeply down to a restriction then opens up again into large passage with damp mud floor. Once through the restriction the humidity increases considerably. A number of echo location Waled birds



Bamboo platform in entrance of Liang Neki

were sighted in this area of the cave. They make an unusual clicking sound while flying around the cave.

There are a couple of small drops in the sloping floor, the last one being the largest at about three metres. From here the cave opens into a large chamber with a steeply sloping floor at the far end. From the back of the chamber it is possible to proceed in three directions. To the left a very steep mud slope leads to an active stream passage which can be followed for some distance. Straight ahead continues on a considerable distance through several chambers with high sections and the lower passage eventually turns into a muddy crawl. To the far right there is a 1.5 metre climb through a keyhole and then down about 2.5 metres into a well decorated chamber. This chamber was found to have foul air with a very low concentration of oxygen and high carbon dioxide.

The extent of this cave was not fully explored.

3. Liang Bua, which in Indonesian means ‘Fruit Cave’. This cave has been nicknamed the ‘Hobbit Cave’ after the discovery of the *Homo floresiensis* skeleton in 2004.

The entrance is at an elevation of approximately 562 m ASL and is below a small NE facing limestone cliff overlooking a river valley of rice paddy fields. The entrance is approximately 170 metres to the NW of Liang Galang.

The entrance chamber of Liang Bua measures 51 metres long, averages 13 metres high and 27 metres from the entrance overhang to back wall. This chamber is very impressive with a number of seven metre long stalactites hanging in the middle of the chamber. They are bent and twisted as if being pulled toward the daylight.



Bambang looks from the Liang Bua balcony toward the entrance.

Directly below the stalactites is a 2 m diameter x 2 m tall stalagmite. The back of the entrance chamber to the left, a steep slope leads up through some rocks to an impressive stalagmite at the rear of a balcony overlooking the chamber. Behind the stalagmite there is a short section of passage leading off to a small chamber with some good decoration. From the base of the 5.4 m high balcony a laser distometer was used to obtain a 19.6 m measurement from floor to the top of an aven.

To the far left of the main entrance chamber and at the base of the balcony slope there are a couple of holes between boulders which lead into a 23 metre pitch at an incline of 60°. At the base of this pit there is a sloping dirt and rubble floor leading into an impressive chamber 23 x 24 x 5.4 metres high. It is predominantly an earth (mud) floor with drainage toward a stream sink at the NE wall. The ceiling is covered in many stalactites. To the NW there are a number of stalagmites scattered up a flowstone slope. This slope leads to a small chamber located 12.4 metres below the concrete entrance path.

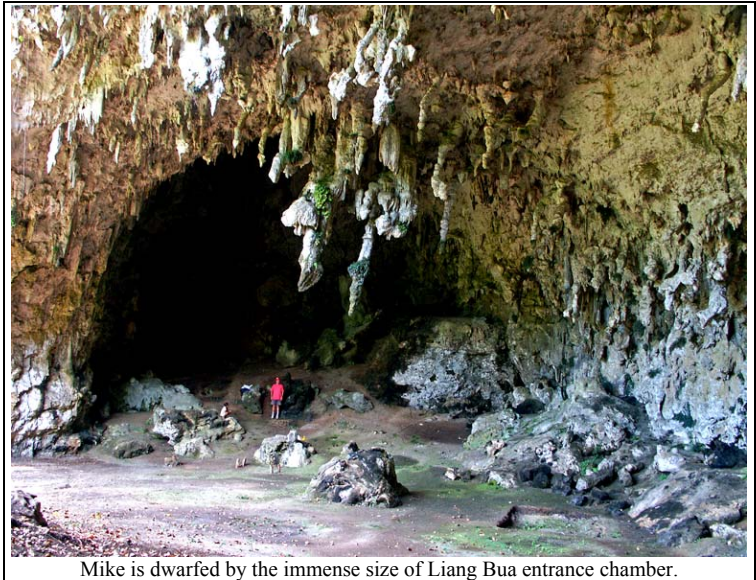
A number of Horseshoe bats and Waled birds were sighted in this chamber. The Waled bird has echo location ability and can be heard making an unusual loud clicking sound as it flies around in total darkness. The birds look similar to a swallow with jet black feathers.

4. Liang Luar, which in Indonesian means 'Mist Cave'. The entrance is at an elevation of approximately 550 m ASL.

The entrance, measuring approximately 1 metre x 1.5 metres, is at the base of a 20 metre cliff. It has the appearance of a typical out-flow cave and there are signs that in periods of very heavy rainfall a small amount of water would flow from the entrance. The first hundred metres of cave is an easy walkthrough meandering passage with tacky mud underfoot. At this point the passage is blocked by a boulder choke which must be climbed to a height of 5.5 metres. A route past the rocks leads down to more passage at the same elevation as before the choke. Here the full width of passage floor quickly turns to gooey mud up to knee deep with a few centimetres of water over the top and the roof height reduces to just 0.7 metres. This chamber has been named "Kabangan Kerbau" meaning Buffalo Wallow. The only sign that anyone had ever passed the boulder choke was one set of small bare footprints leading along the passage and a little way into the mud before retreating. No other sign of human entry was sighted past this point.

From the large mud pool, another hundred metres of low passage before the cave opens up to large chambers with excellent decoration. Several active stalagmites approximately 7 metres tall mark the start of a dramatic transformation from small passage into large halls and spacious caverns. These beautiful large speleothems ranging in colour from deep orange through to pure white, are truly nature's masterpieces. They have been named "Cadi Prambanan" after a temple of the same name.

There are two small stream sinks encountered in the main passage before a huge chamber is encountered at about 0.5 km into the cave. This chamber, named "Raksasa Ruang" (meaning Huge Hall), is approximately 90 metres long x 50 wide x 30 high. There are some massive boulders strewn across the chamber which make navigation a little difficult. It was calculated that there is approximately 50 metres of solid rock above this chamber to the surface.



Mike is dwarfed by the immense size of Liang Bua entrance chamber.



Nick next to Cadi Prambanan

After climbing over the large boulders one descends a slope leading to passage at an elevation not much above the earlier passage. There are a number of sections of excellent speleothems.

After descending about 4 metres a stream sink is encountered between rocks. The passage becomes a rather large and meandering railway tunnel shape, 10 to 14 metres high and the same in width. There are typically 2 to 3 metre banks of damp clay on either side of the passage and a stream valley snaking down the middle. Caving at this point becomes more of an underground bushwalk. At about the 1 km mark a huge stream sink is encountered. It has not been explored yet, but a distometer reading measured it to be at least 19.7 metres deep. This can be skirted around by a tricky climb on the right side.

At about the 1.2 km mark a large deep pool can be skirted around on the left side by climbing up between several large columns. Another 260 metres further on another large pool of water is encountered at the base of a 4 metre waterfall. This can be free-climbed with some difficulty.

A short distance above the waterfall the cave splits into two passages. The high passage narrows down through a well-decorated area before opening up into large dry passage again. The lower passage leading off steeply to the left is obviously a resurgence which wells up in times of high rainfall, then overflows into the main passage and over the waterfall.

Continuing along the high passage past lots of excellent decoration the cave continues to meander. There are in places large channels in the earth floor leading into stream sinks. It was possible to make long sightings up to 72.5 metre with the laser distometer during the survey of this section.

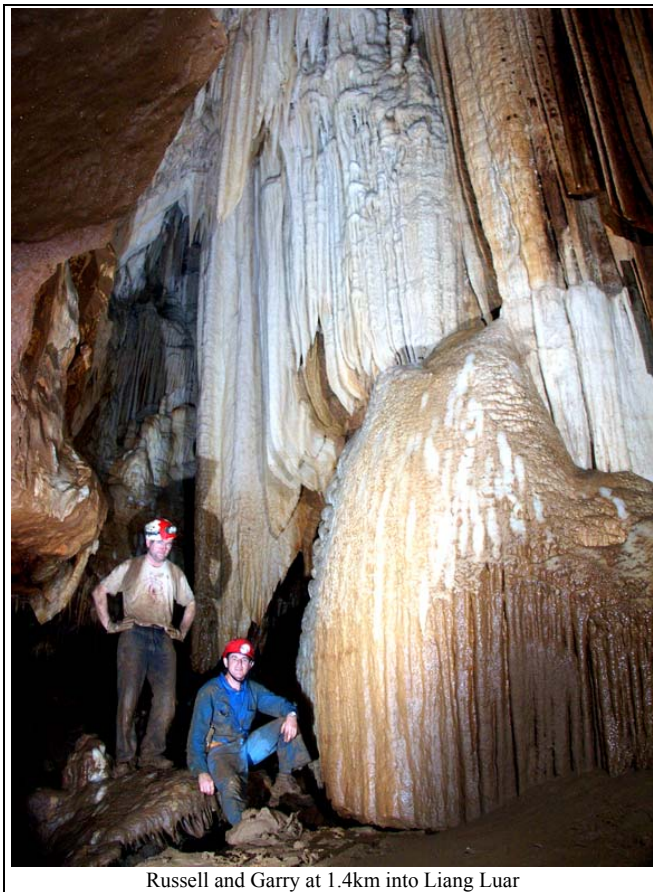
At the 1.6 km mark the survey was terminated due to lack of time. The cave however was explored for a further several hundred metres past a tight squeeze and back into large passage. Eventually the passage splits into two of approximately equal size. Hopefully the rest of the cave can be explored and surveyed during the next visit in 2007.



Linda and Mike at the far end of Raksasa Ruang.



Spectacular decoration at 1.3km into Liang Luar



Russell and Garry at 1.4km into Liang Luar

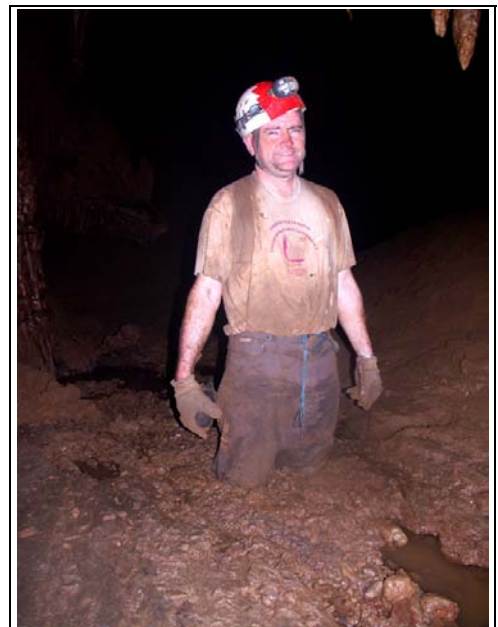
entered the cave. The active efflux of the cave system is not known at this point in time.

5. Liang Padut is located approximately 200 metres to the west and approximately 50 metres higher in elevation than the entrance of Liang Luar. It was rumoured to be part of the same system as Liang Luar. However, we found no evidence to support this.

The cave has a very large collapse doline entrance

and has acted as a resurgence at some point in the cave development. There is a steep sloping entrance, 35 m long at -37° into a large chamber measuring 37 metres long by 21 metres wide and 12 metres high. A small shaft leads up from one side of the main chamber and comes out at the top of the main entrance slope on the right side. The large chamber is very well decorated with white speleothems.

The whole mountain above Liang Luar is cultivated by the local population to grow coffee, pineapples, sweet potato, bananas and rice. The cave system is fed by many surface streams leading into about 10 major dolines with associated sinkhole caves which have yet to be fully explored. Indications are that the sinkhole caves are not venting the Liang Luar cave atmosphere and will all pass through sumps before entering Liang Luar. Within Liang Luar there are at least 7 stream sinks which feed to a lower cave system, as yet unexplored. These stream sinks generally prevent water from flowing out the main entrance through which we



Russell up to his knees in Liang Luar mud.



Liang Padut main chamber

Cave Surveying

The Liang Bua and Liang Luar caves were surveyed using a Leica (Disto Classic a) laser distometer, Suunto inclinometer and baseplate magnetic compass.

Flashing red LEDs which snapped onto the terminals of small PP3 batteries (9V) were used as survey station markers. These were extremely good as they could easily be seen over distances of 80 metres and eliminated the need for a person to stand at designated survey stations. For difficult survey stations a blob of mud was used to stick the flashers to the cave walls.

Distances greater than 60 metres usually required someone to hold a brightly coloured pack as a target for the laser distometer. Despite the distometer being accurate to the millimetre (0.001 metres) the survey data was only recorded to the nearest 0.01 metres.

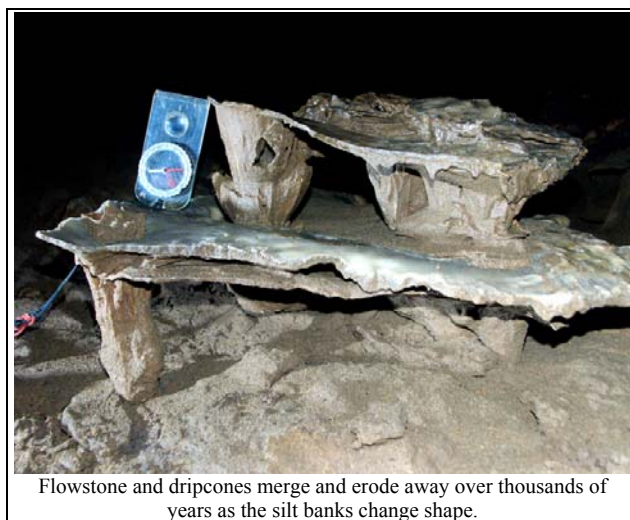
Surveying in Liang Luar was made very difficult in places due to the quantity of gooey mud, particularly some low awkward sightings. Keeping the survey pad clean was very difficult during some periods when surveying on my own, while scribing and taking readings.

Discoveries so far.

The oldest animal bone collected from the lower chamber of Liang Bua has been dated to about 90,000 years. This date is very exciting as it indicates that the big "mud-mound" may contain a wealth of very old bone material. Future paleontology expeditions are planned and may yield a wealth of knowledge about the prehistoric past.

A stalagmite nicknamed "Big Boy" which was sampled from Liang Luar has been dated at its base as being 25,000 years old. Two more stalagmites were "mini-drilled" near the bases and the calcite powders extracted from these holes have now been dated to 40,000 years old. This is fantastic because it means that they grew from just prior to the last glacial maximum right through to the present. There is virtually no information about the climate during the last ice age in Indonesia, so this is a real find.

From the scientist's point of view, perhaps the most exciting discovery is a date from a short-core extracted from a collapsed flowstone that has yielded an age of 200,000 years. The flowstone is 1.5 m thick, and the date is from 0.5 m depth, so it is possible that the entire flowstone could be as old as 600,000 years. If this longevity proves to be the case, the flowstone will give the team a record-breaking history of past climate in the tropics.



Future discoveries.

Given the remote nature of the Miocene limestone karst area, there is considerable scope for more discoveries. The locals know the whereabouts of the caves but do not have the equipment, lighting or caving knowledge required to undertake exploration. Given the need to put food on the table through agricultural farming, there is not much time nor inclination for most locals to explore caves. There were a few exceptions with a couple of entrepreneurial Indonesians wanting to learn more about the caves with the view of opening them up for tourism. Since

most locals and cave owners are very poor, the commercialization of the caves without putting in place lots of preservation infrastructure would certainly be a disaster. The making of a quick dollar would rule over preservation of such wondrous natural beauty.

A few events which occurred during the expedition.

1. When entering the 23 metre pitch below the main chamber of Liang Bua for the first time, I encountered a large boulder 600 to 700 mm diameter (probably weighing half a tonne). The boulder appeared to be wedged between the walls of the pitch but moved slightly when my foot was placed on it. On close inspection I noticed that it was just balancing on a smaller rock which was jammed. I locked off on the abseil rope and retrieved the trailing rope hanging below. The large balancing rock only took a little nudge and it went crashing down the pitch with a tremendous rumble and smashed into many bits. This was very lucky as the abseil rope could have easily pushed on this loose boulder and brought it down upon me. I continued the abseil to the bottom and was amazed at the size of the huge chamber which lay before me. The floor was mainly tacky mud, but there was a high section which contained a number of large stalagmites.
2. In Liang Neki after gaining permission to enter, we trogged up and headed in with a cast of many children and adults in tow. Only one local child had a torch with a single LED globe. The rest were relying on the light from our head torches. It was quite comical with our group of researchers dressed in overalls, helmets, headlights, solid boots and huge packs of equipment. The locals had shorts, tee-shirts, thongs or bare feet, no helmet or light. After following us a long way into the cave, the children went back out, led by the child with the single LED torch.

3. In Liang Neki I climbed through a small keyhole leading to a well decorated chamber. The 2.5 metre climb down was rather tricky as tacky mud covered all the solid rock. I entered and was followed by Russell. In the middle of the chamber was a pile of large rocks with 2 metre deep holes between. As I was crossing, a lump of mud broke off the rock, sending me crashing down onto my right knee and left me half dangling between



More than 20 children flock into Liang Neki with a one LED torch between them.

the boulders. The pain was excruciating so I did not move for a couple of minutes hoping it would subside and that no permanent damage had been done to my knee. Then I started feeling very dizzy and said to Russell there was high CO₂ and I had to get up. He helped me up and I stood on the far side of the chamber. That was the last I remember until I heard Russell calling me. I believe I had passed out and thankfully Russell was there to stop me from falling back into the pile of rocks. A check was made of the air at knee level and sure enough the cigarette lighter would not work. There was less than 14% oxygen and probably at least 6% CO₂.

4. The Liang Luar owner took us to another cave on the ridge a few hundred metres to the east of Liang Luar. A trail of children followed. Not far away another doline was located and we walked down into the bottom of the depression. The last 3 metres was a small climb over some rocks and the cave owner followed me down. I scrambled around with a small torch looking for any possible leads. There were some nice decorations but no large passages leading off. Everyone else was still further up the doline slope when there came a



Pious (land owner) in the unnamed cave with wasps at the entrance

tremendous amount of screaming from a small child. Then a few loud swear words from Russell. The cave owner listened for a moment and clasped his hands together and crouched under a rock as if to pray. I was totally bewildered when he beckoned to me to crouch under the rock, turn off my head torch and also pray. OK this is weird, sounds like someone up the top is dying and he wants me to pray. After another 5 minutes he looks up and points at a mass of large flying insects swirling around the cave entrance and covering the ceiling above us. Then it struck me, they were huge stinging wasps and the nest was some 5 metres above me. We waited some 20 minutes while the whirling mass subsided and they retreated back into their hive. Then we both crept back up the slope and out of the doline.

Eventually we met up with the others. There was Russell with 2 stings, Linda with 2, Mike with 4, Bambang with 1, a couple of the kids had been stung and had totally bolted from the scene. It was obvious that the pain was very intense and huge welts had formed around the stings on each victim. Thankfully, the cave owner had known what to do and we missed out on the painful experience.

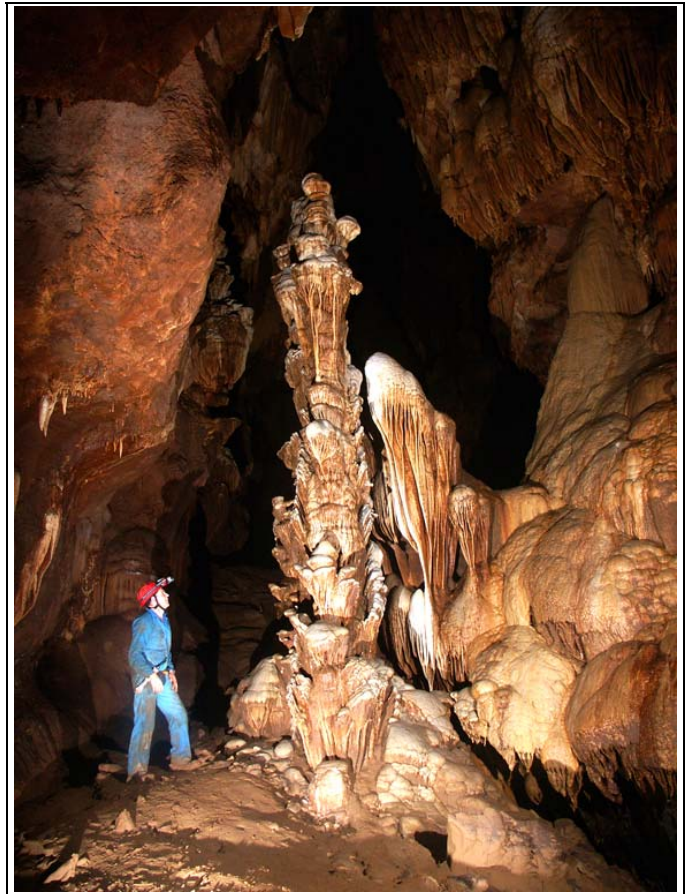
5. One evening, while standing at the curb waiting for the vehicles to take us to a restaurant, I fell down to my waist through a gap in the pavement which covered the drainage system (sewerage). It was quite a shock to be standing on two feet then totally falling. The feeling of a sharp object running up my leg as I fell, had me thinking that I had split my leg right open for its full length. Luckily the reinforcing bar which protruded from the broken concrete had been bent downward and my long pants had taken most of the abrasion impact. My foot was soaked with water and stunk of sewerage when I climbed back out the hole.



Footpaths have many holes

Acknowledgements.

I would like to thank Mike Gagan and Russell Drysdale for their helpful reviews of this paper. Also thankyou to Neil Anderson and Nic Severino for assistance in exploration and surveying the Liang Luar cave. Mike, Russell, Linda and Bambang provided valuable organisation of the field logistics and academic expertise, which assisted greatly in interpreting the geology of the area. Our group worked well as a coherent team in the field which made the whole expedition a pleasurable experience. Financial support for the expedition was provided by an Australian Research Council *Discovery* grant (DP0663274) to Mike Gagan (ANU) and Wahyoe Hantoro (LIPI).



Garry K Smith next to Cadi Prambanan in Liang Luar