

MULU CAVES 2015

An Anglo-Malaysian Expedition to the
Gunung Mulu National Park, Sarawak



REPORT

on the findings of

THE MULU CAVES 2015 EXPEDITION

to the

GUNUNG MULU NATIONAL PARK SARAWAK

During Sept/Oct 2015

Expedition Leader: Mark Brown

compiled and produced by Hugh St.Lawrence



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Torben Redder on the 55m pitch in Skeleton, Whiterock Cave (see page 32) | photo: Cat Moody

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MULU CAVES

Main Statistics at end of 2015 expedition

Total surveyed Caves in the Mulu National Park	409.43 km
Clearwater Cave System 8th longest cave in the world	215.34 km
Benarat Caverns System	50.67 km
Terikan System	32.57 km
Cobra Bridge Cloud System	20.63 km
Sarawak Chamber 2nd largest chamber in the world by volume	9.81 million m³
Api Chamber 8th largest chamber in the world by volume	2.97 million m³

Cover design by Hugh St.Lawrence

ABSTRACT

Mark Brown

Mulu Caves 2015 was the 23rd Anglo-Sarawak Expedition to Gunung Mulu National Park and operated in the field between 2nd October and 3rd November 2015. The team comprised twenty one members from the UK, Australia, Denmark, Germany and our hosts at Sarawak Forestry. The expedition was further assisted by National Park Management, staff and local people.

The expedition had three main parts, all of which had invaluable local support:

- 1) A team based at Camp 5 in the Melinau Gorge to explore leads in Whiterock Cave and other sites of speleological interest in the area.
- 2) A small lightweight reconnaissance team to the Hidden Valley.
- 3) A 3d laser scanning team to scan and photograph Sarawak and Api Chambers and carry out geomorphology study.

Part One – Camp 5 in the Melinau Gorge and HQ based exploration

Up to sixteen people were based at Camp 5 for three weeks. Leads in Whiterock Cave (part of the Clearwater Cave System) were explored and surveyed. A new high level of cave development was climbed into, which suggests Whiterock could be significantly more extensive than previously thought. Unfortunately this new section of cave has been unroofed by surface topography, being on the extreme western edge of the mountain. A promising lead in the south of Whiterock from 2013, Chance Encounter, led to a series of interconnections between trunk passages. Interesting extensions were also made in the central area of the system. Altogether 8km of passages were surveyed, bringing the Clearwater System up to 215km total length (eighth longest in the world). A new entrance into Gunung Benarat was located from the Melinau gorge but not quite reached by the team. High level passages in Red Tip Racer cave were also climbed into. Support was given to the laser scanning team for their work in Api Chamber. Whilst at Park headquarters, some team members made some investigations in Cave of the Winds, Racer Cave, and Lagangs Cave, continuing the project to try and find a connection between the caves.

Part Two – The Hidden Valley

This was a lightweight team of five, who spent twenty days in the valley. Potential entrances had been seen on helicopter video footage, which the team followed up. One significant entrance, named Conviction Cave, was connected to Wonder Cave, which itself was extended northwards under the summit of Gunung Api, potentially unlocking a large area of limestone with no currently known caves. **This part of the expedition has been written up in a separate report¹.**

Part Three – 3d laser scanning, photography and science.

A small team carried out high resolution 3d laser scanning and photography in Sarawak Chamber and Api Chamber (part of Whiterock Cave). Accurate volumes were obtained that confirmed Sarawak and Api chambers as 2nd and 8th largest in the world, respectively. Several potential exploration leads were identified from the scans. An attempt at counting bats in Deer Cave using the laser scanner was also made. Further scientific data was obtained for the study of large chamber formation, geomorphology and cave dating in Mulu.

¹ Nixon, D.A; Eavis, R.J. (editors) 2015. 'Hidden Valley 2015 Expedition Report'. Mulu Caves Project.

Overall, just over 10km of new cave passage was surveyed in the Mulu National Park and the expedition successfully met its objectives.

Main discoveries:

• Conviction/Wonder Cave	Hidden Valley	2048m
• Dirty Little Secrets/Medusa Series	Whiterock	2510m
• Swift Progress	Whiterock	2359m
• Centurion	Whiterock	926m
• Troubling Appendix	Whiterock	677m
• Skeleton	Whiterock	570m
Total expedition survey length:		10245.74m

INTRODUCTION

The Gunung Mulu National Park is situated in north-eastern Sarawak, with its northern boundary forming part of the border with Brunei, (Figs. 1 & 2). It was officially constituted in 1974 and opened to visitors in 1985. Lying 4° N. of the equator it now covers an area of 813.9km².

The Park is dominated by the sandstone mass of Gunung Mulu, which rises to 2376m. To the west of Mulu, and on its flank, lies a band of Melinau limestone, which forms the lesser peaks of Gunung Api and Gunung Benarat. The lower slopes are covered in dense tropical rainforest, which rises to meet the montane forest of Mulu's upper slopes.

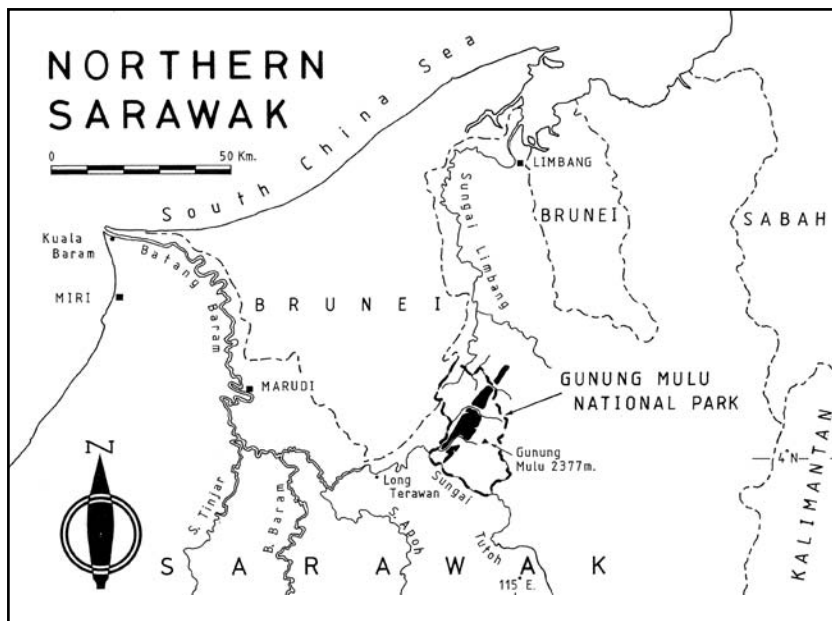
Both the G.Mulu National Park and the adjacent G. Buda National Park have recently been extended.

Mulu has a rich mixture of plant and wildlife and in the limestones beneath the forest canopy lie some of the world's most impressive caves. The biodiversity of the Park and the significance of its karst landscape were given international recognition in 2000, when it was declared a World Heritage Site.

HISTORY of EXPLORATION in MULU

Exploration commenced during the 1978 Royal Geographical Society expedition to Mulu and has continued since then with groups of UK cavers visiting the Park and working in partnership with the Forest Department and National Park employees to explore and study Mulu's underground landscape.

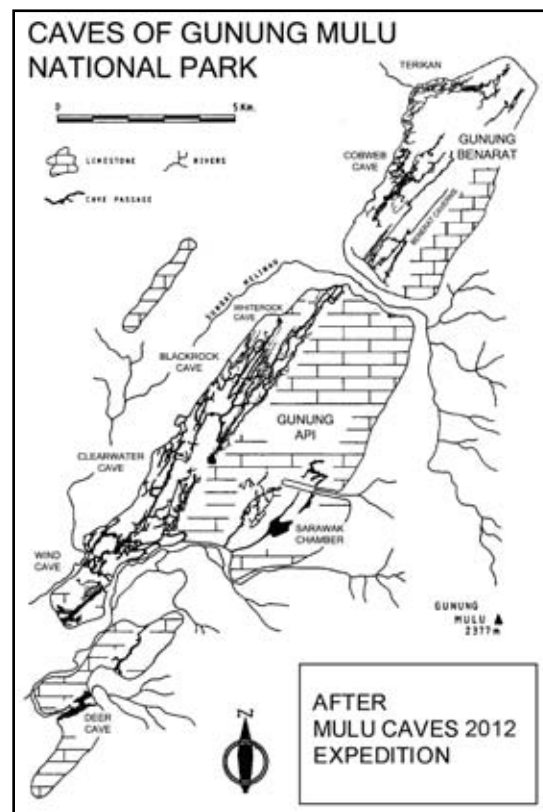
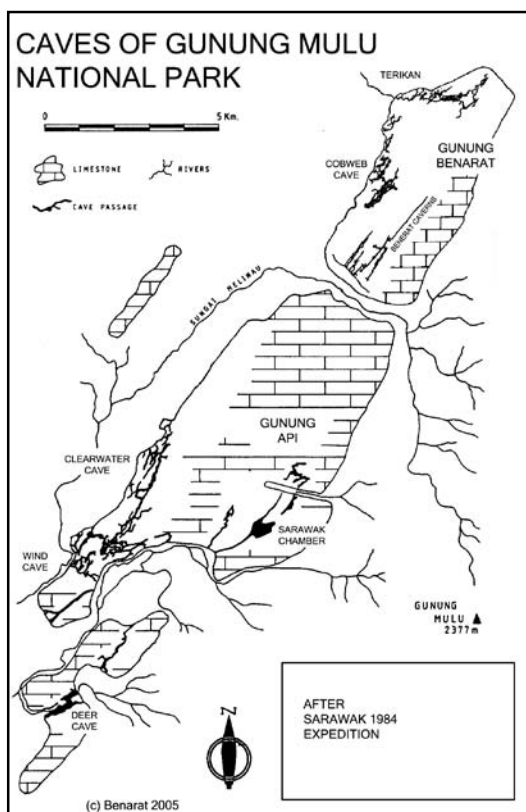
Exploration and survey work have established Mulu as one of the pre-eminent speleological sites in the world. Although precise definitions of 'the largest' or 'the biggest' cave passages



and chambers remain open to debate, the Park unquestionably contains the world's second largest natural underground void, Sarawak Chamber. It also holds what is arguably the world's largest cave passage (Deer Cave), the largest cave by volume (Clearwater System) and what is currently believed to be the 8th largest chamber in the world (Api Chamber, in Whiterock Cave).

The early expeditions to the Park (1978, 1980, 1984) made rapid and significant discoveries with over 140km of passage explored and surveyed. Although the pace of exploration has slowed a little, extensive new caves and passage series continue to be discovered in the Park. Whiterock Cave, discovered in 2003, grew to over 100kms in length over the course of three further expeditions (2005, 2007, 2009) and is now the major component of the Clearwater System.

Figures 3 and 4 contrast the extent of exploration after the 1984 expedition with 2012 for comparison.



Background to the expedition

Hugh St.Lawrence

The previous expedition in 2014 had, amongst other things, focused on prospecting and exploration in Clearwater Cave - and with great success. The discovery of the Creedence Series² revealed the existence of a new high level of cave development which could be the key to rapid and extensive expansion of the Clearwater System. In the 8 kilometres of passages explored in the Creedence series, the explorers had left over 100 leads unfollowed!

Normally this would have led to an immediate return to Clearwater and continued exploration in Creedence. But in one of those twists of expedition planning and objectives, the Creedence explorers instead set their sights on the potentially rich pickings of the Hidden Valley. In any case, the next expedition was scheduled to run from Camp 5 in the Melinau Gorge, so a revisit to Creedence could wait until 2017 when the team would be based at Park headquarters once again.

However, the Creedence discovery became the impetus for the Camp 5 based team - because surely those high level passages heading north in Creedence must also exist above Whiterock Cave? Two or three long ramps in Whiterock ended in calcited but draughting chokes around the 350m level, the lower threshold of the Creedence series, hinting at the presence of high level development in Whiterock.

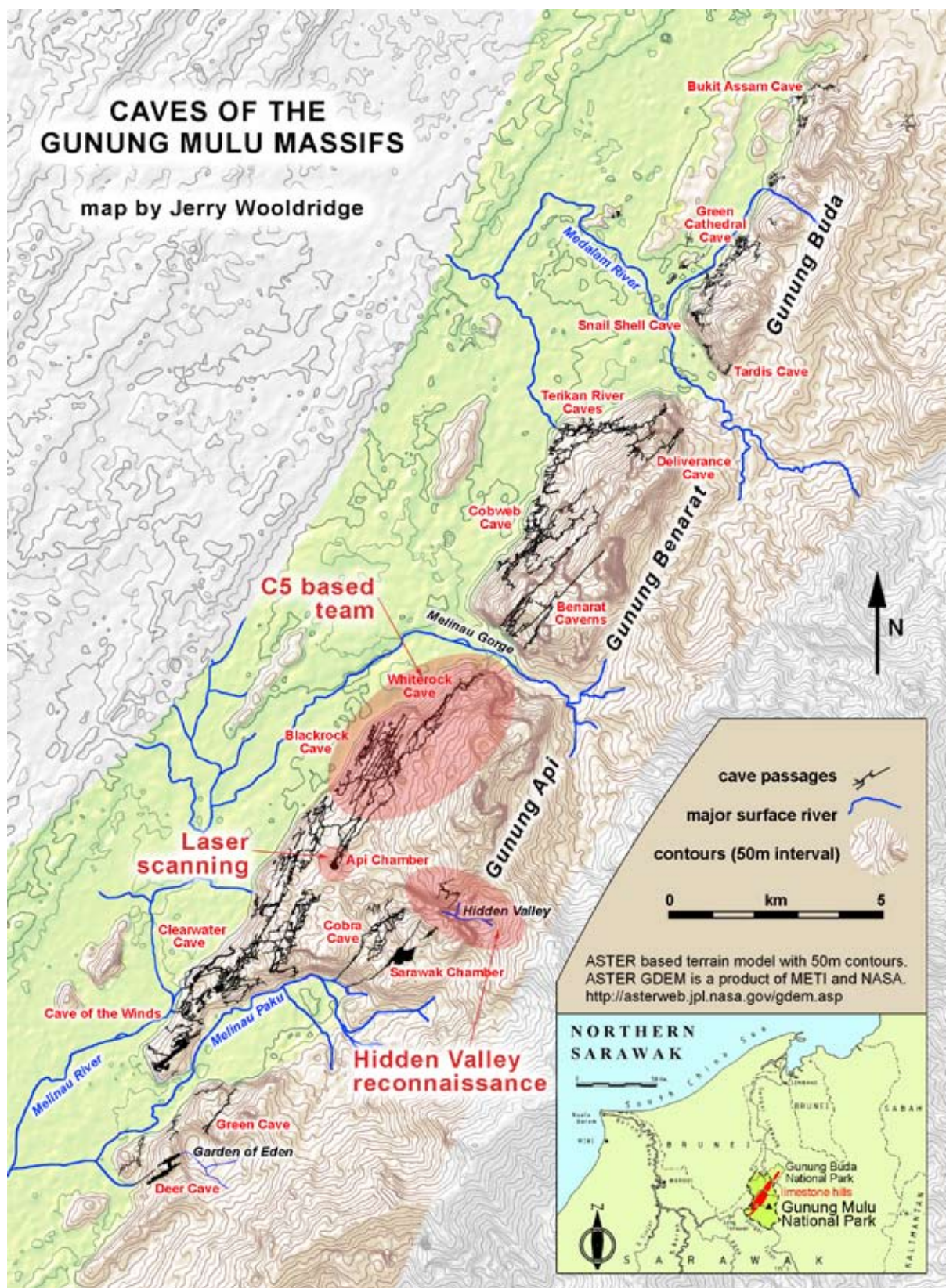
The survey was consulted, old reports read and re-read, expedition logs combed for information, and eventually a small hit list of objectives was drawn up for investigation by the C5 team. Chief amongst these was a draughting ramp off the high level Apprenticeship passage in Whiterock, which had been partially climbed in 2005 until it became too steep without tackle. A snake skin at the base of the ramp led the climber at the time (Tim Allen) to muse on the possibility of a surface connection - but snake skins have been found in places nowhere near entrances, so there was no certainty of this.

Another location for investigation was the large passage heading north out of Star Chamber above the Propeller Camp area. In 2007 nesters poles had been found along this passage, again giving rise to speculation of a higher entrance - or simply access to a higher level of passages - or both?

Whilst the focus would be on trying to climb up to higher levels in the system, there were plenty of other leads to look at - like the large passage observed but unentered at the bottom of Perfect Mulu Manners (2011). At the end of the day, caves are where you find 'em! - we would follow and survey wherever they went. There were also surface objectives, like the search for new entrances in the Melinau Gorge.

Concurrent with the Camp 5, Whiterock focused efforts, a reconnaissance team would be at work in the Hidden Valley (see Hidden Valley 2015 report), and the large chambers scanning team would be visiting Whiterock to laser scan Api Chamber (see page 48).

2 Nixon, D.A. - 'Mulu Caves 2014 Expedition Report'. Mulu Caves Project.



Map courtesy of Jerry Wooldridge

Preparations & Approach

The first team in the field comprised of the Hidden Valley crew and three members of the C5 team. We were accommodated at Mulu Park Headquarters in the research centre building, providing good space for sorting out all the bundles and packages of equipment that would be transported to Hidden Valley and Camp 5 respectively. Tackle was taken from the Mulu gear store, and new inventories made of the store's contents, (with expedition members bringing new equipment out with them to add to or replace old stock). After a couple of days the Hidden Valley team departed, and the advance C5 members then started to organise the logistics of food, equipment and portorage for Camp 5. They also planned to spend a small amount of time in Cave of the Winds and Racer Cave looking at possible connection leads.

This plan was slightly compromised by the absence of the expedition leader who was unable to fly out due to an unplanned appendicitis! To compound difficulties, considerable time was then spent assisting with the rescue of a Hidden Valley team member shortly after their recce had started. After the rescue Camp 5 logistics were the priority, so only a couple of short trips by two team members were managed to Cave of the Winds and Racer Cave.

By the end of the first week the main body of C5 members flew in, and after a final day's preparations set off for Camp 5. A flotilla of boats was organised to transport all our equipment, including a fridge and a generator, as well as a team of local porters and expedition members themselves. Recent rains had made the Melinau river quite high and boats were able to motor up without difficult to Kuala Lutut and even the upstream Kuala Berar landing. Given that the next three weeks were to be a virtual drought, this was most fortunate! From the landings the usual 8 kilometre slog up to Camp 5 soon had the team established at its base in the Melinau Gorge.

Much of the credit for the smooth and timely logistics of two separate expeditions goes to our local facilitator and 'man on the ground', Veno Enar, who organised all our transport and

portorage, sometimes from the remoteness of the Hidden Valley where he was initially on duty but then got caught up in the rescue effort. Despite this, the Camp 5 lift was achieved with minimal fuss or disruption to schedule.



*Preparing stores for Camp 5
portorage
photo Torben Redder*

Camp 5 - base camp

Camp 5 lies on the south side of the river at the downstream end of the Melinau Gorge. The site is dominated by the massive cliffs of Benarat to the north which reflect dramatic orange tones in the light of the setting sun. The camp was first established in 1978 as a field base during the RGS expedition. It has evolved considerably since then and now provides a comfortable night's rest for travellers visiting the Pinnacles, or mid way on the 20km Headhunters Trail between Kuala Berar and Mentawi Ranger Station.

The camp is permanently manned by Park staff with one guide and one housekeeper on duty at all times to cater for tourists passing through. Accommodation is in dormitory rooms typically ten to a room, and sleep mats are provided. Mosquito nets are not provided, but these are particularly useful to keep the sand flies off at night, mosquitoes are less prevalent. Camp 5 can house 60 visitors in its five dormitories. The expedition occupied two dormitory rooms in the main block. There is a separate shower and toilet block, although the preferred washing for most after a hard trip is a quick dip in the river. A large kitchen just off the dining area provides stoves for cooking, where our head chef Mani provided excellent and varied meals at all times of day and night. The dining area consists of four large tables, and in recent years we have been able to set up computers and battery charging stations on one of these without any detriment to visitor space. Electricity from the camp generator is only available for a few hours a day, so the expedition has recently invested in a small generator which supplements the camp supply and allows 'out of hours' use for vital battery charging and ongoing survey work.



*A welcome sight for many a weary caver returning from Whiterock
photo Rich Hudson*

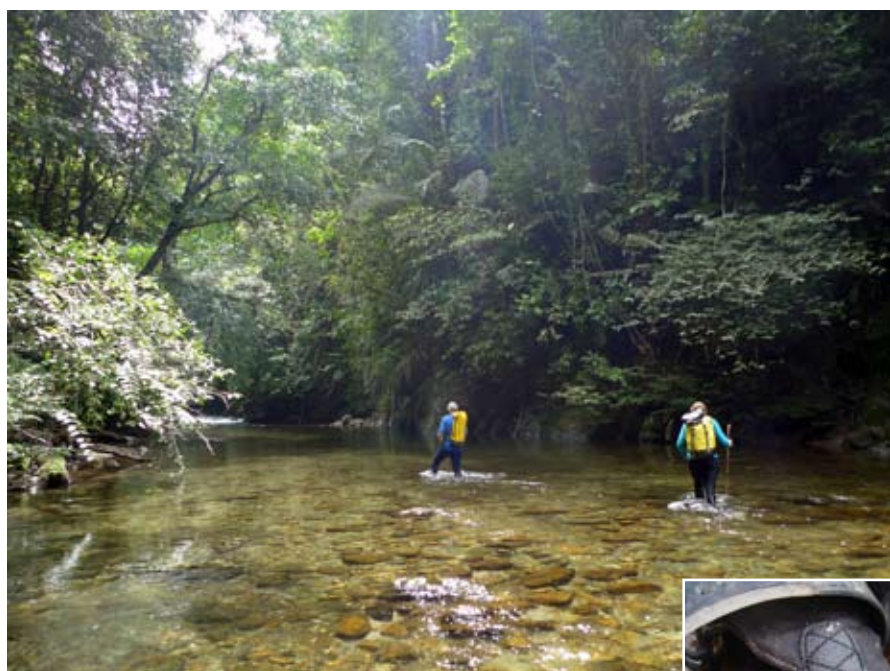
Weather

Conditions during the stay at Camp 5 were very dry. After recent rains which allowed easy transport of gear and personnel up-river, virtually no further rain fell in three weeks - thought to be due to the El Niño conditions which prevailed this year. This was a double-edged sword; it was possible to reach Whiterock entrance with dry feet, and there were no incidences of Mulu foot. However, the camp was besieged by hordes of Giant Honey Bees (*Apis dorsata*), which proved to be a real pain in the neck...leg, arm, face etc.



*Matt Kirby washing rope on 'the beach' at Camp 5
photo Frank Pearson*

During surface reconnaissance and track cutting we encountered a large amount of treefall which made forest travel a slow and difficult affair. Veterans of Camp 5 expeditions had never seen the Melinau so low, and there was an extensive 'beach' by the riverside from which to conduct clothes and gear washing - and get sand in everything! On the whole, most people would have preferred the 'normal' Mulu conditions of regular afternoon rainfall, keeping the river at a good level and having a welcome cooling affect on the camp environment. However, for explorers of a cave far up the gorge it proved to be a boon - the low river became a walkable motorway for 1.5 kilometres, providing a pleasant and speedy walk to the explorers' destination.



*Walking up the Melinau on
the way to Benarat Corner
Cave
photo Hugh St Lawrence*

*Giant honey bees feast on a
pair of boots at Camp 5
photo Rich Hudson*



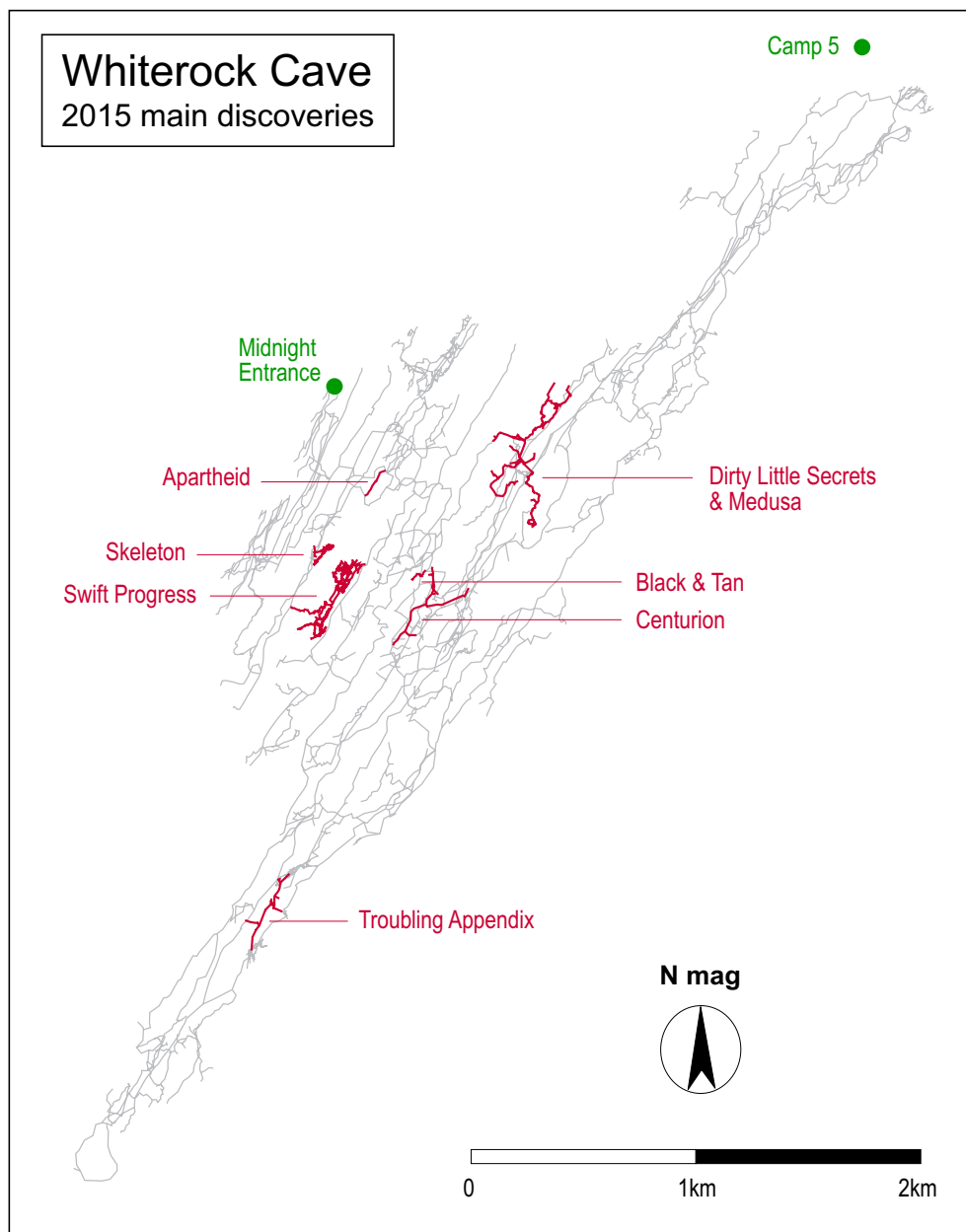
Underground Exploration

Underground exploration from Camp 5 was conducted almost exclusively in Whiterock Cave; objectives in Benarat were a fallback but were not required or visited. Early in the expedition two members of the advance party at park headquarters made brief visits to Racer Cave and Cave of the Winds.

Whiterock Cave

The main discoveries in Whiterock Cave were:

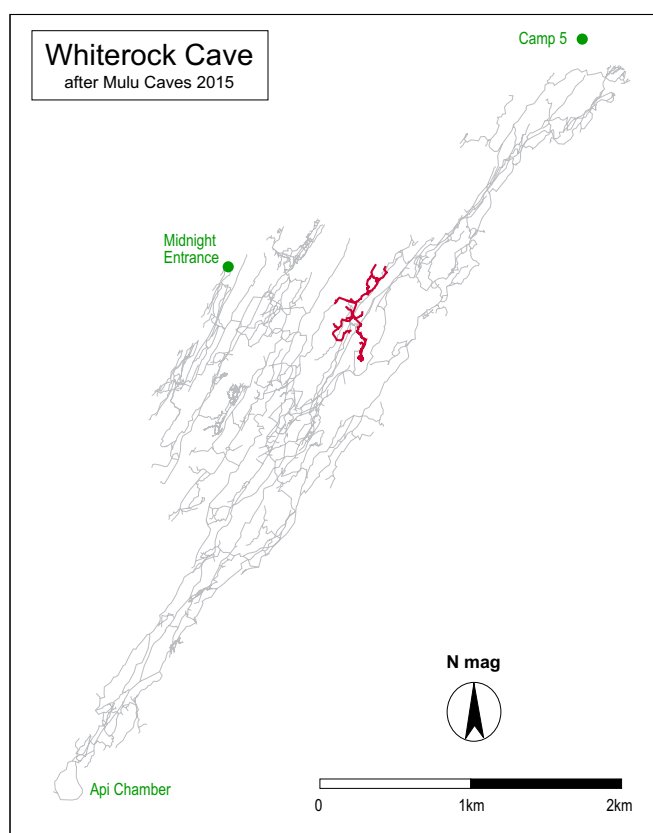
- | | |
|--------------------------------------|-------|
| • Dirty Little Secrets/Medusa Series | 2510m |
| • Swift Progress | 2359m |
| • Centurion | 926m |
| • Troubling Appendix | 677m |
| • Skeleton | 570m |



Dirty Little Secrets/Medusa

Explored 20th-28th Oct 2015; Length 2561.3m

Explored by: Rich Hudson, **Rob Middleton**, and Hannah Moulton



From Strong Hint of Bigness stn.29 (Squirt Chamber) a 3m high passage on the north east wall continues passing two handline climbs down, c4 and c10. At this point a tall rift is encountered at mid height in the right wall, which descends down steep ramps to a choke at its base after 50m. Upwards in the rift is an 18m climb to a small window which leads to 15m of horizontal passage and a parallel rift pitch heading back, undescended. The main way on is a traverse 5m above the entrance point to the rift (a rope has been left in place to access this and the climb mentioned above.) The passage continues in similar proportions until short climbs down enter a large chamber with a number of ways on. Above is a large aven which has not been climbed, and a tubular passage on the north wall approximately 20m above the floor

which would need climbing to access. Descending a slope to the north east leads to Filthy Derbyshire Habits, while a short bolt climb on the south wall (p6) leads to the Medusa Series.



*Looking from Squirt Chamber into the 3m diameter passage that begins the Dirty Little Secrets series.
photo Hannah Moulton*

Filthy Derbyshire Habits begins with an 80m crawl over soft mud until a 2m drop is reached (rope required). The passage then opens up to 6-10m dia. and continues until it reaches the head of a large 40 degree ramp down. Descent here leads to more large passage, passing a high level oxbow on the east side, to intersect a second ramp. Up at the first ramp is a poor lead, and opposite the entrance to the first ramp is a small window 5m off the floor, which leads (via some of the less pleasant passage explored in Mulu) to the continuation passage above the second ramp, described below.

At the second ramp, down leads to more large passage which eventually chokes, while upwards leads via a p6 and p15 (rope needed) to more pleasant high level passage. This eventually ends at a boulder choke, but a small passage 10m up the 15m climb connects back to the head of the first ramp.

The **Medusa Series** starts with a 6m bolt climb into a 10m diameter boulder strewn passage. This leads after 80m to a 10m climb down on the left into a complex junction with a number of ways on. Straight ahead above the climb leads via a small passage to a 4m climb down which rejoins the main passage described below. At the base of the climb, a passage leads off south east then swings east in walking passage to a ramp and climb down and eventual end in mud. South at the base of the previous climb is the main way on, but quickly splits again, with a descending passage to the north dropping through climbs and crawls to some very poor leads after 90m. A roof tube 30m down this passage was explored to a choke.

Also off to the south east in this area is a crawl which quickly enlarges to 5m dia. passage which drops down an 8m pitch, and then down a 7m mud and boulder pit. After some loose descending crawls, and a 3m climb up over stal, this leads to walking passage



*Typical passage in the Dirty Little Secrets series
photo Hannah Moulton*

and large chambers, passing three boulder constrictions to a junction. South up a ramp chokes among nice formations, while west leads to the head of an undescended 40m pitch in the vicinity of the Northern Line.

Back in the main passage before the crawl, continuing south west and down slope in boulders continues for 50m before an awkward wriggle past perched blocks leads to a smaller 4m dia. passage. This passes two small descending ramps to the west, the first unexplored, the second explored to the head of a 15m pitch into large passage below (undescended). The main passage curves round to the east and eventually finishes via two awkward 5m climbs in an attractive but shattered chamber, Medusa Chamber.

Swift Progress

Explored 14th-24th Oct 2015; Length 2359.13m

Explored by: Rosie Hadfield, Cat Moody, Andy Vick, Torben Redder, Frank Pearson, Hugh St. Lawrence

Overview

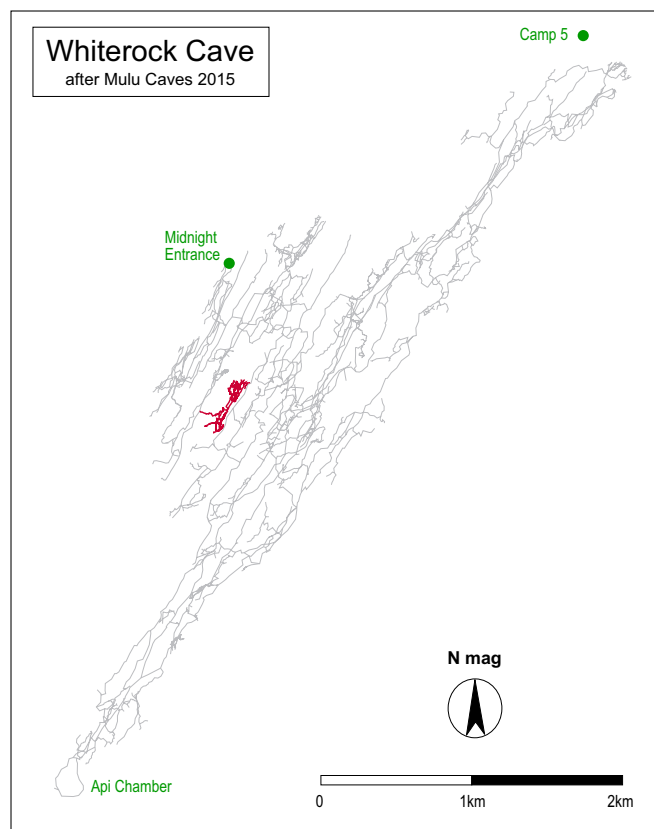
Rosie Hadfield

In 2014, “Creedence” was discovered in the Clearwater System. This discovery proved the potential for other higher levels in the system, and gave hope for similar development in Whiterock Cave. With this in mind, a concerted effort was made on the 2015 expedition to find a similar upper level and open up new territory for exploration.

A lead off the Apprenticeship passage – Snakeskin Ramp – was described briefly by Rob Eavis & Tim Allen in the 2005 report, and this became the expedition’s first objective. Access to the Apprenticeship proved a lengthier undertaking than anticipated as the previously free-climbed ramp from Up and Running was deemed safer with fixed lines for regular traffic. Although rigging this took more time initially, it proved worthwhile as it saved a lot of time and danger after long pushing trips.

Efforts were made over three 3-day camping trips. Camp was established in Up & Running where there was plentiful water supply (5 min from camp) and flat ground. It took approx. 45 min for a team of 3 to get into Apprenticeship each day, but the return trip to camp was much faster. From here the Snakeskin ramp and Swift Progress series were pushed, at the same time as the Skeleton passages (see page 32).

A complex series of passages was entered at the sought for high level, characterised by abundant guano, chokes and multiple entrances where the cave passages had been intersected by the surface profile.



Although the series didn't quite lead to contiguous passage in the Creedence style, it did prove the existence of high level development in Whiterock at a similar horizon to Clearwater. Investigation of leads further east in Whiterock, deeper into the hill and away from the surface breakdown zone, may access greater lengths of open cave.

The series is described under its exploration phases: the Snakeskin Ramp, the main Shipstorm north passage, Jarlsberg, Angry Bird and Shipstorm south.

Snakeskin Ramp

Explored by: Torben Redder, Andy Vick, **Rosie Hadfield**

This is the access ramp to the higher passages, initially part-climbed in 2005.

From the main Apprenticeship passage, a short drop down a sand bank on the east of the passage leads to an alcove with a steep rising tube. A bold roped climb up a ramp for 33m reaches a constriction with a strong wind blowing through. Crawling over sharp popcorn gains a larger upward trending rift also covered in popcorn. There are two ways



*The windy popcorn squeeze on the Snakeskin Ramp
photo Torben Redder*

on: to the left the rift continues but the roof appears to come down and it was not the easiest way on. To the right, a 14 m roped climb was made up a steep crack and then over a loose boulder. From here, a 21m smooth-rock ramp, also roped, leads to a short muddy constriction to gain a more open chamber.

Continuing upwards through a couple of sandy constrictions reaches a rock slab with 60 cm headroom and thrutching upwards gains a small chamber. A corkscrew 3m climb enters a small heavily draughting tube, 70cm diameter, which suddenly breaks out into the much roomier Swift Progress passage.

Rigging: 5 m rope & 2 hangers, 35 m rope & 6 hangers, 20 m rope & 3 hangers, 20 m rope & 2 hangers, 15 m rope & 5 hangers, 10 m rope & 3 hangers.

Swift Progress

Explored by: Torben Redder, Andy Vick, **Rosie Hadfield**

From the Snakeskin entry point a small pit is crossed to a junction, with a low passage to the left not fully explored. The main passage swings right past another low passage on the left which is a flatout crawl to a small chamber and rising ramp with light connection to Shipstorm. Continuing right in the main guano floored passage reaches another junction where right connects to Shipstorm South. Up to the left is a slippery guano slope into the main strike-aligned Shipstorm passage, upto 15m wide.

Shipstorm

Explored by: Torben Redder, Andy Vick, **Rosie Hadfield**, Cat Moody

Heading north on the eastern side of the passage on calcited mud banks passes several pits in the floor, one of which connects back to Swift Progress. An aven above an alcove on the eastern side of the passage connects to Angry Bird Passage. Continuing north the passage splits and re-joins. To the west another ramp downwards soon ends at a calcite choke. To the NE the passage ascends over boulders and reaches the surface in a 60m wide doline.



*The doline accessed from the Shipstorm exit
photo Rosie Hadfield*

From the doline, travelling south, the eastern wall has a number of calcite ramps trending upwards which soon end. continuing south leads to a 3m climb back down in the main passage, whilst a 4m climb up a ramp heading west reaches Angry Bird Passage.

To the north from the doline entrance, the passage continues and widens. To the northwest a climb down through boulders reconnects via a crawl with the main passage (not surveyed), whilst climbing up boulders on the right (SE) regains the doline. To the north the passage enlarges. By climbing over a 2m boulder you gain a ramp trending north steeply downhill to an area with multiple ways on. To the west the passage goes down over steep brittle rock; 20m along this a passage, to the south is soon choked with mud. Back in the main passage, to the east a crawl soon deteriorates. Continuing north a

short scramble leads to a 5m climb (bolted) into a large chamber.

A rift up to the east closes down and fills with mud. Continuing round to the south over some boulders leads to a junction. To the south up a short muddy slope and then up a further steep muddy clamber on the right (W) leads to a descending mud-filled tube which soon deteriorates. To the NW the passage descends steeply over rocks, with a high roof. A window in the roof to the west (10m up) connects to Jarlsberg. A climb up a steep rocky ramp to the NE reconnects to Jarlsberg by one of the north-westerly entrances.



Shipstorm Passage | photo Torben Redder

This northern area is very complicated with many small passages and climbs.

Each of these were explored systematically and comprehensively. There are no remaining leads at this end of the system.

Jarlsberg

Explored by: Andy Vick, Rosie Hadfield, **Cat Moody**

Accessed from the large doline off Shipstorm passage, this was originally thought to be a separate cave but was later connected to the northern end of the Shipstorm area. It is a complex area with many overlapping passageways and several windows to the outside world, adding a further 6 entrances to Whiterock.

Heading down the boulders inside the main entrance and up the other side, a 4m climb down is reached (handline useful for the descent) into a large chamber with multiple ways on:

- Down through boulders to the NE leads to a calcited choke but also loops back to the main passage.
- Straight ahead (N) goes up to a col and to a 5m free-climb heading east which ends on a greasy slope. The passage to the NE leads to an entrance; to the south it terminates at a mud-filled passage.
- The main route on is to the NW, down and up a small pit. A T-junction is soon met and to the north is another entrance. To the south, a traverse around a small pit goes into



*Another doline entrance in Jarlsberg
photo Rosie Hadfield*

a phreatic tube. Continuing south leads to another entrance. To the west a low passage continues over some small pits and arrives at another junction. North at this junction leads to a sediment-filled sump, while to the west the passage continues to another junction. To the north this opens up at a large drop; a traverse along the RH wall gains access to two further entrances.

The way on is SW at the junction, through a downwards trending passage

with multiple rock ribs which leads to a bridge with two ways on. To the south across a small pit (2m wide, 2m deep, traversed across fragile chert on the RH side) the passage ends in a mud filled-passage. A small tube off to the right beyond the pit also chokes. To the north a 12m pitch (requiring 20 m rope and 3 hangers) connects to a chamber in the northern end of the Shipstorm area.

Angry Bird

Explored by **Rosie Hadfield**, Andy Vick, Cat Moody.

Reached via a short ramp from Shipstorm main passage, a roof tube approx 2m wide trends north-south. To the north continue along the passage for 25m where behind a rock pillar there is a passage which is too tight to continue. Ahead a junction is met, and

ascending a sandy slope to the SE reaches a 6m wide entrance (thought to be in the cliff above the main doline). To the NW, a 2m climb down a lip continues down loose ground to reach a pitch under a precariously poised boulder. This reaches a shaft, which enters a smaller shaft and ends in a choke.

Back at the initial junction, to the south continues and the roof tube changes in nature into a rift. To the SE a 50cm high bedding re-connects to the main passage (light and voice connection). Continuing for a further 50m over sharp rock with many fossils the passage ends in a 10m drop back into the main Shipstorm passage. There are no ongoing leads at this level.

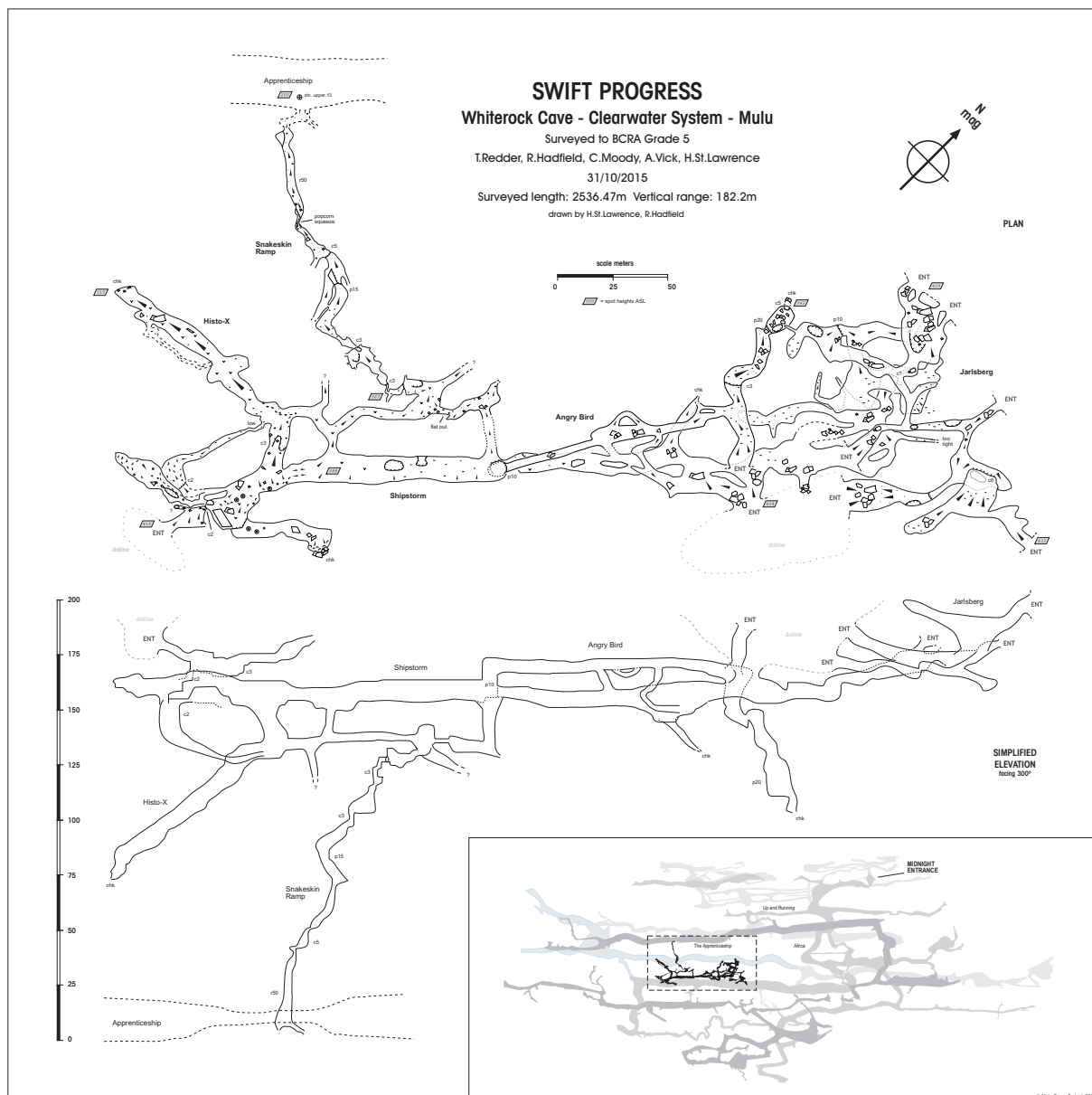
Shipstorm South

Explored by Torben Redder, **Hugh St.Lawrence**

From the Swift Progress-Shipstorm junction, the passage south continues large over a col, beyond which the steep cross section makes traversing on the left wall the quickest way forward. Down to the right an obvious ramp passage leads steeply down to a junction, with a connection to Swift Progress on the right. To the left a 7m diameter tube, Histo-X, starts its steady descent down the dip, floored with deep guano but presenting little obstacle other than clouds of swifts and the occasional racer snake. The bottom of the passage pinches in and chokes after 100m. Just back from the bottom a squeeze in an alcove leads to a small passage back up the dip which opens as a window into the main passage 6m above the floor. At the start of the 7m tube is a small passage on the left with a muddy thrutch into larger going which connects to the southern terminus.

Back at the col, continuing the traverse in the main passage soon leads up to the left to confront a wall which appears to be a huge fallen block. To the left is a step into an easy passage which promises well but soon ends in a conglomerate choke with no draught. At the right end of the block wall a 3m climb into a small opening reveals a hading chamber with daylight from a doline entrance which is easily reached by a scramble up slope. At the bottom of the chamber a small rift leads to an undescended hole. This must be very close to the final southern chamber, reached by a hole down beneath the 3m climb. Two ways present themselves: a move past a stal grille and climb down access a wider passage which shortly chokes completely with calcite. A hole in the floor is the connection from the thrutch passage near the 7m tube. In the other direction below the 3m climb a short crawl leads back into the main passage again.





*Rosie surveying in deep guano
photo Cat Moody*



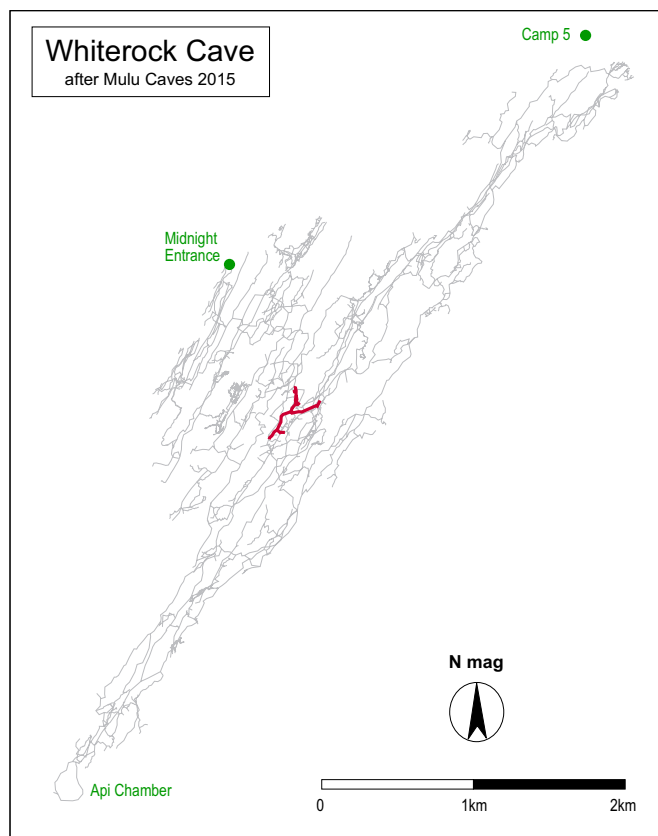
*Andy Vick in Shipstorm
photo Torben Redder*

Centurion

Explored 31st Oct 2015; Length 925.84m

Explored by: **Rob Middleton**, Hannah Moulton, Hugh St.Lawrence

** This follows up a lead from 2011 in Perfect Mulu Manners - a muddy ramp down was left at a pitch into what appeared to be a large mud-floored passage.*



From stn.6 in Perfect Mulu Manners, a muddy, runnelled 20m ramp (rope required) leads to the head of a vertical 8m pitch into a large trunk passage below. This heads south for 100m to a choke, with a small static sump to the west at the choke. North leads forward in dramatic fashion, often 25m wide with impressive mud banks and canyons, before swinging round to the east and reaching the head of an 8m pitch down to the Whiterock River (*see note 2 below) after a distance of 400m. Where the passage turns east, a smaller passage was explored to the north, which leads to a few hundred metres of complicated passage eventually ending in a choke and a small static sump, with a few poor leads.

Back at the top of the entry ramp/pitch, another passage, 3m in diameter, was entered. It first ran parallel to the main passage, with a window looking down to the large passage below. A 3m straw column was noted in this area, before the passage climbed back eastwards towards Dirty Yorkshire Habits up a 45 degree ramp. It was left partially explored but does continue. Another lead was noted south of the ramp pitch, also a climbing ramp in similar style. This was not explored and may require some tackle to access.

Notes

Hugh St.Lawrence

1. Centurion is a large passage characterised by its almost total coating in a thin layer of caramel coloured mud. This is not a hindrance in the main passage, although the sloppy mud coating on the roped approach ramp is an unpleasant nuisance. Only at a certain height is drier ground found, notably in the north heading side passage, and at the very top of the southern main passage choke. Observation suggests that this mud coating may be the result of infrequent but extensive backing up of the Whiterock River. There are no signs of recent flooding, and the firmness of the deposits suggest that the last 'event' may have been a considerable time ago.

2. Surveys suggest that there is a considerable elevation error in the altitude of the end of Centurion where it meets the Whiterock River (*see note 3 below). The Whiterock survey master tells us that the Centurion passage is 20m below the river level, whereas its end survey point is, in reality, on a balcony 8m above the river. This is a substantial elevation error! Because the party had no tackle they were unable to descend to the river and find a survey station to connect into, so the loop is unclosed. The loop is a long series of passages, including the Whiterock River, Ski Wednesday, 1954, Upwind, Harley Delightful, Northern Line, Lemon Squeezy, Dirty Yorkshire Habits and Perfect Mulu Manners. The error could exist in any or several of these surveys, each of which will need to be re-examined for possible errors in data recording or data entry.

3. Does Centurion actually meet the Whiterock River - or is it another streamway?

Whilst investigating the survey errors mentioned above, it became apparent that things might not be quite as they seem. Surveys show Centurion meeting the river close to river station 56. According to the 2011 notes, the Centurion explorers should have been looking down into an almost dead straight section of passage 150m long with the river occupying a consistent passage width of 12-15m, 15-20m high. From river stn.54 to stn.59 is a distance of 178m and the compass bearings vary at most by 5 degrees. The Whiterock River explorers (Pete Hall & Sam Allshorn) were consulted and recall the passage being *“all very dark rock with black gravel and orange clay mudbanks. I think the water depth was mostly waist deep and slow flowing. The mud banks were narrow and not big enough to climb onto as shown on the survey except at the start station 54.”* This is not what the Centurion explorers were seeing. We observed a keyhole shape canyon with no mudbanks and with shallow water running merrily through small pools. The canyon was max 6m width at water level with walls 8m high, the passage widening to 10-12m at roof level, passage height perhaps 13m. We also hit this passage on a definite bend - speculative compass shots upstream of 026° and downstream of 166° confirm a bend angle of some 40°. This would have required the river surveyors in 2011 to make a station at or around the bend apex, and it seems unlikely, in working around the station, that they would fail to notice or mark a large passage entering only 7m up the wall.

Of course, all our memories may be faulty. Yet the recorded passage measurements don't really stack up. Two hundred metres downstream of stn.56 in the Whiterock River is a large sumped inlet - there is an outside possibility that Centurion has intersected an unexplored inlet passage feeding this sump. This may be rose tinted speculation, but given the known altitude discrepancy in the survey, it's possible there could be a significant horizontal one, too. Only by dropping a



Looking south-west to the choke in Centurion | photo Hugh St.Lawrence

Troubling Appendix

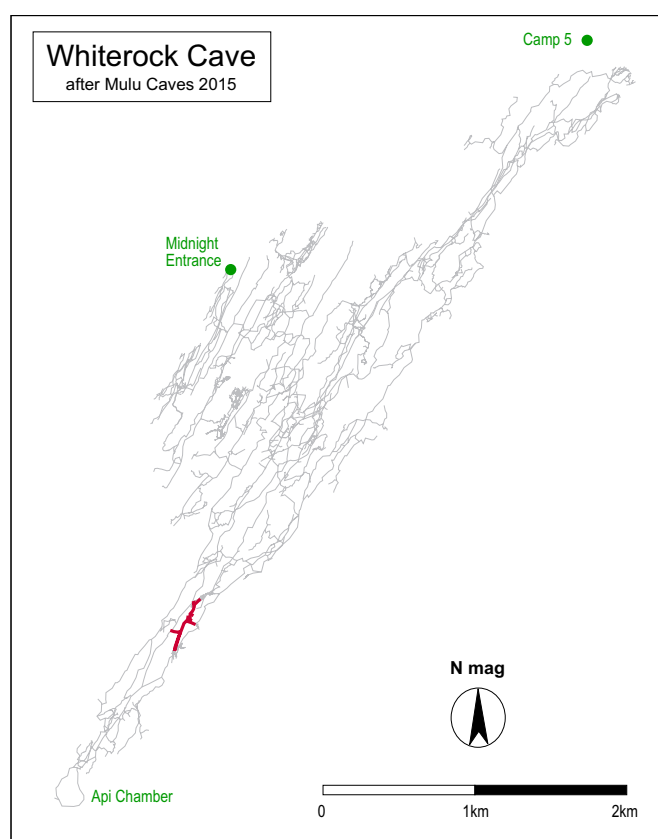
Explored 28th Oct 2015; Length 677.58m

Explored by: **Mark Brown**, Pete Smart, Louise Korsgaard

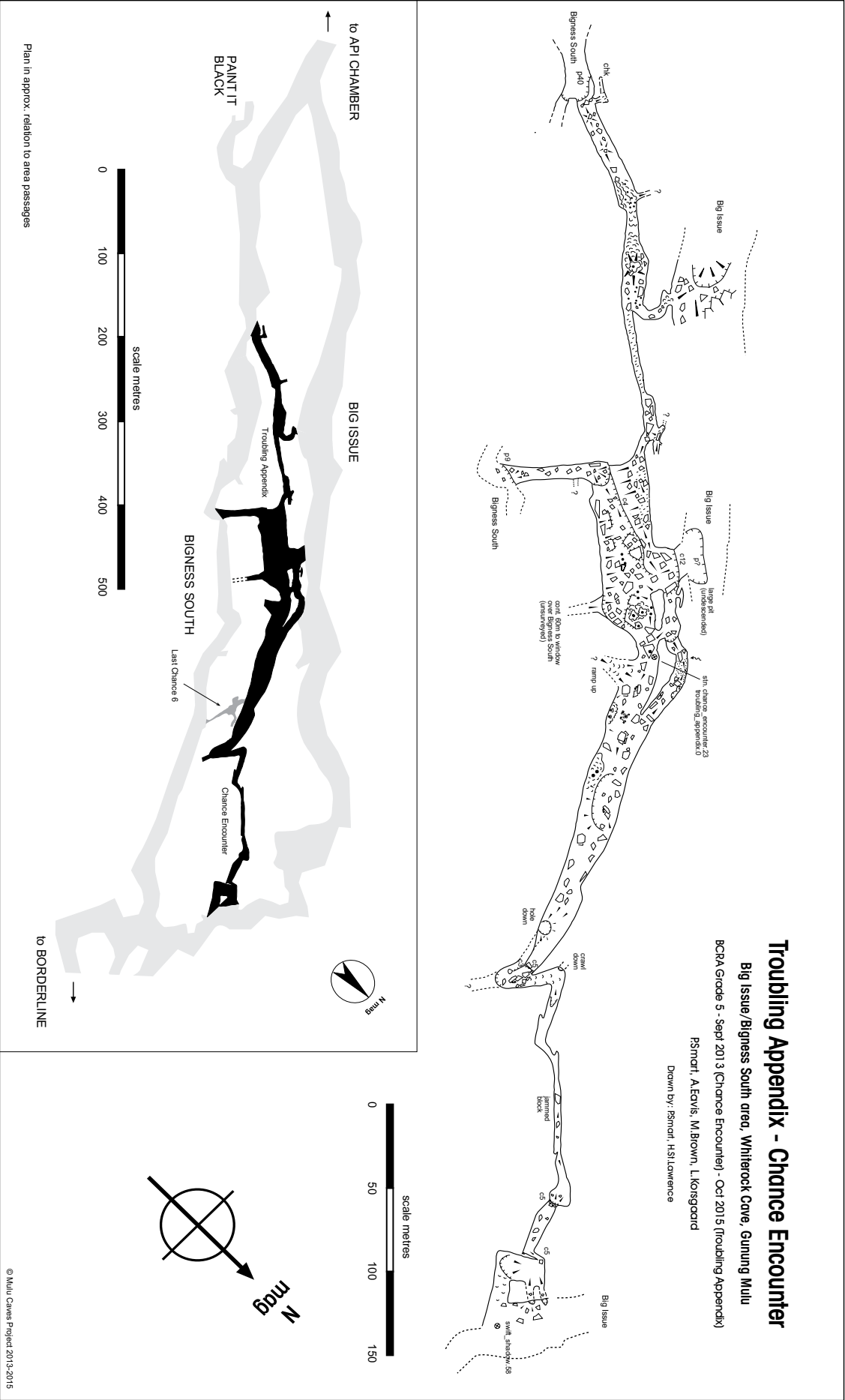
** This is the continuation of the 'Chance Encounter' exploration of 2013, which was left with a large ongoing tunnel heading south.*

From the base of the Better Late Than Never pitch, the main southern trending passage is followed over calcited boulders, between a pair of 8m high stalagmites. A junction is reached after 100m (stn. PLS 5). Here, the main passage turns east and continues in a high canyon to a pitch head; Bigness South is seen 12m below (near Bigness South.28). Back at the junction a 4m climb up good ledges to the southwest, leads up a scree slope to a well decorated, flat-floored 15m wide, triangular section passage. This runs dead straight for 220m until another pitch into Bigness South is reached (near Bigness South.36). Halfway along this dead straight passage, a wriggle through a stooping height, stal-encrusted passage to the west, pops out into the Big Issue again (near Big Issue.76).

The third way on that had been noted in 2013, near the base of Better Late Than Never, was then surveyed; this was found to be another well-decorated loop, with numerous calcite flowers around a spray-lashed corner, rejoining Chance Encounter 100m to the north. Further investigations were carried out near the pitch - a ramp to the east can be followed upwards until it ends at a window, once again overlooking Bigness South. Another calcited ramp up to the East, just north of the pitch, was deemed too tricky to free-climb; no obvious draught was noted and it isn't possible to see far up it, as to whether it pinched in or not.



An explorer's grumbling stomach led to an exit back to Hotel California camp for the night; Troubling Appendix series had proved to be an enjoyable and interesting day's surveying. Despite the lack of a major continuation to the south, the numerous interconnections between Big Issue and Bigness South add to the ever increasing concentration of surveyed passages in Whiterock, in an area where it hadn't previously seemed like there was room for any more! The pitch was derigged and the rope on the Rabbit Warren, back into Insomnia, was replaced en route back to camp.



Last Chance passages (leads off Bigness South)

Explored 30& 31st October 2015, Total Lengths 561.84 m

Explored by Rosie Hadfield, **Cat Moody** & Rich Hudson

A number of leads were marked on the Bigness South survey, and these were systematically explored to completion. These are described below in order from south to north, as annotated on the drawing below. Only the Last Chance leads (in bold) were surveyed, and individual surveys are not included here.

1. Last Chance 4 is a small trickling streamway that drops steeply down to a mud filled incline with no way on.

2. Last Chance 3 is a passage that heads downhill to a short ramp on the left (S)(10m handline advisable). At the bottom of the ramp, to the left (NE) is a rift which ends in a boulder breakdown. Right (W) leads to a chamber with a solution inlet ramp which gets too tight, a dead-end (but well decorated) alcove and a draughtless muddy crawl. Traversing on calcite around the top of the ramp leads to two steeply ascending parallel passages that are windows back into Bigness South.

3. Last Chance 2 is a steeply ascending ramp which enters a draughting boulder choke with no way on.

(the following were prospected, but not surveyed:)

4. A climb up calcite lead to a 2m bold step, and the lead on the survey looks like a blind vertical tube.

5. This lead is on the southern wall, and a climb onto a rocky ledge leads to a window that requires a couple of bolts for protection. The lead looks like it will re-connect to Bigness South further down the passage.

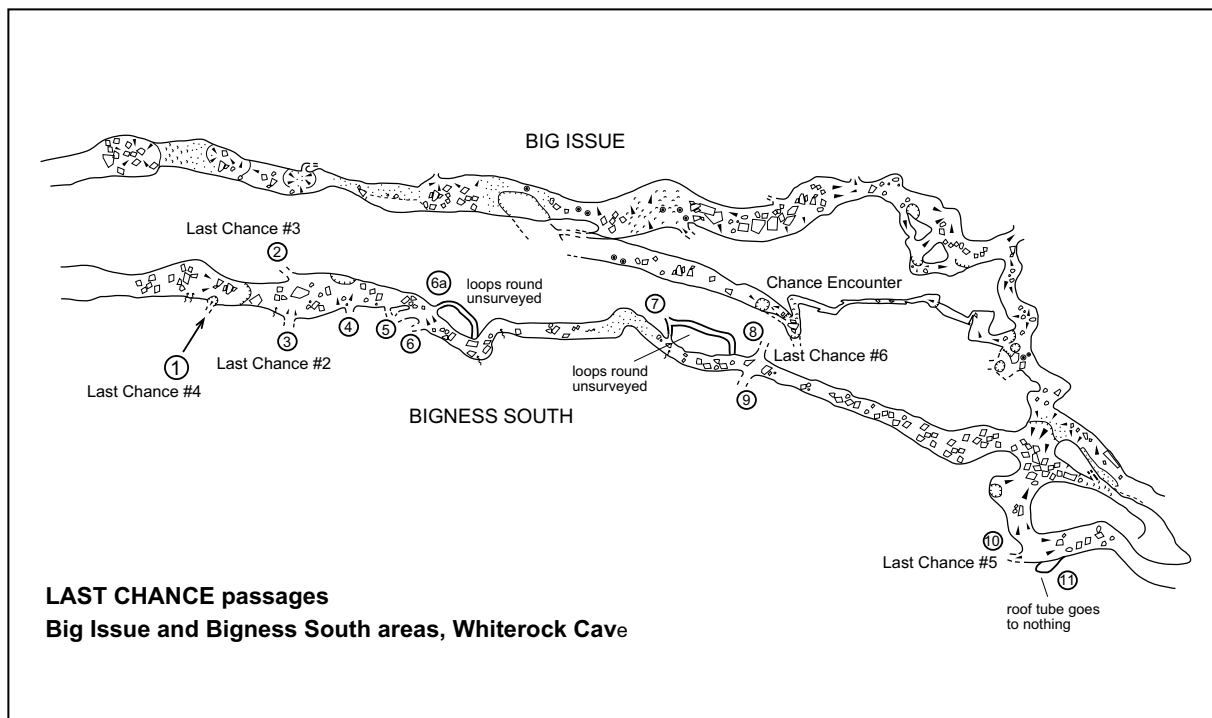
5A. This is a poor looking aid climb with very little solid rock to protect. At the top is a small shelf, but the potential is poor.

6. This is a 12–20m climb that may be free-climbable but needs bolted protection. It looks like it will lead back into Bigness South further south in the passage, and is a poor lead.

6A. This is not surveyed, but is a small tube through calcite that climbs steeply past pretties to a window that overlooks Bigness South.

7. Again, not surveyed but is another oxbow. A downward tube goes past a stalactite before turning north and becoming too tight. A crawl to the right past some formations opens to walking passage which ascends for 50m until it links back to the main passage with a 2m climb back down.

8. Last Chance 6 heads steeply down a sandy ramp for 50m to reach a chamber with a central column supporting the roof. A 5m wide pit is undescended but thought to be about 20m deep and probably blind. Past the pit to the north, a stoop through an arch



reaches a 19m aven and a draughtless boulder choke. At the main chamber there is a 3m straw, to the left (S/SW) of this a mud filled passage continues for ~5m. To the right of the pretties, heading west, a climb up onto a series of large fallen blocks connects into Chance Encounter at survey stn. PLS 0.



9. An 8m bolt climb leads to an alcove which is likely to be a series of converging solution tubes.

10. Last Chance 5 is a 3m wide ramp down at the corner leads for 20m before getting smaller and turning into a bedding crawl. After a further 20m it trends north and continues downhill before ending in impassable fallen blocks with a small draught.

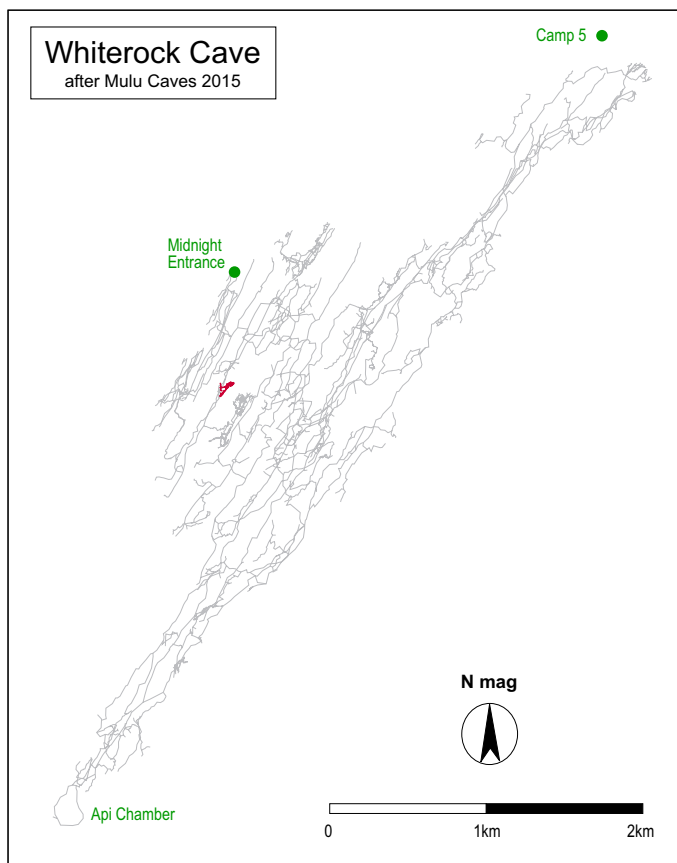
11. A traverse across the passage leads to a blind mud-filled alcove.

*The 3m straw column in Last Chance 6
 photo Cat Moody*

Skeleton Series

Explored 19th, 20th & 26th October 2015, Length 570.27m

Explored by: Rosie Hadfield, Torben Redder, Andy Vick, **Cat Moody**, Frank Pearson, Hugh St.Lawrence

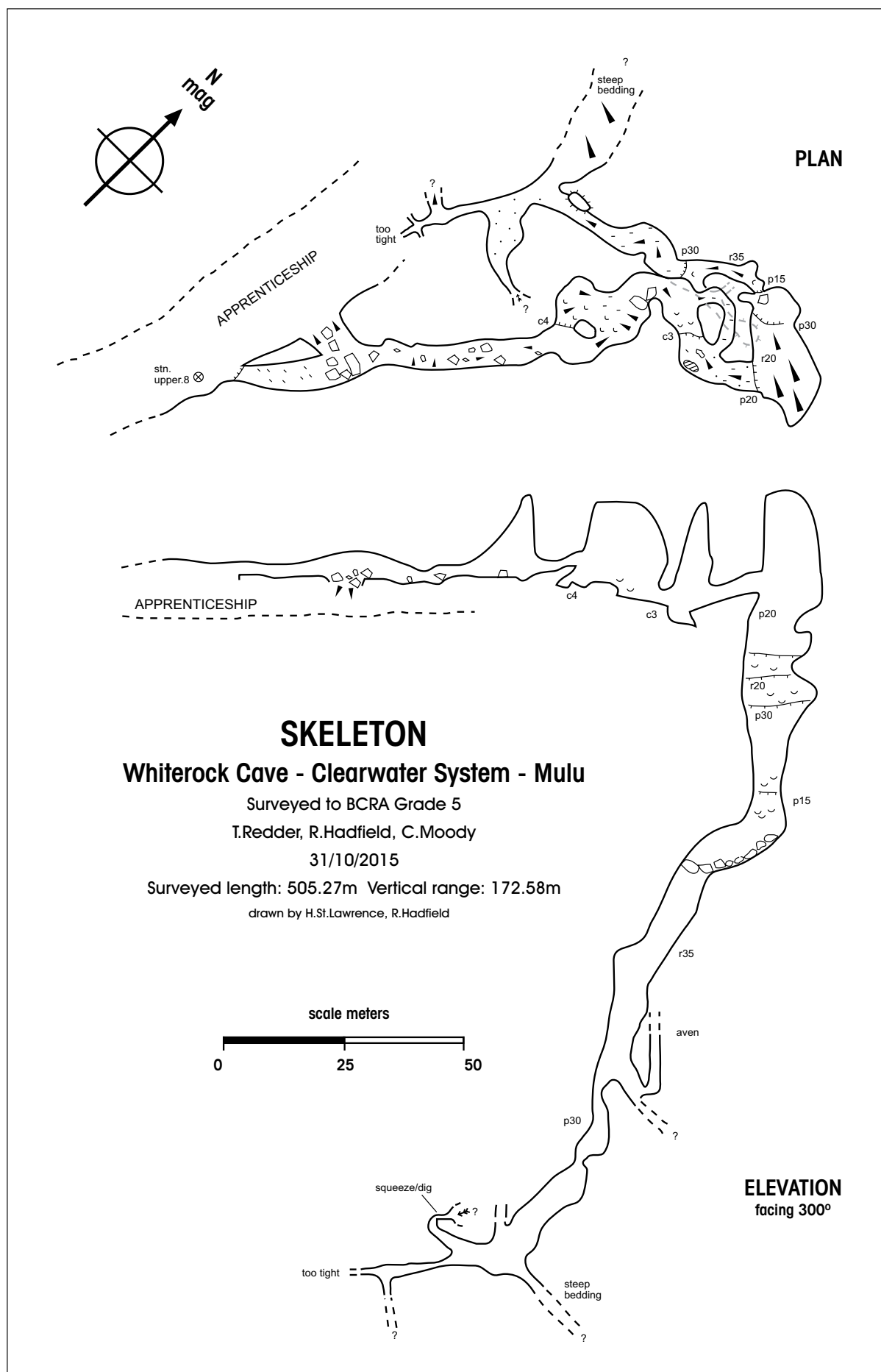


From Apprenticeship a climb up a boulder slope leads to a mud-floored passage trending North East. There is a descending rift on the west of the passage, but it is thought to lead back to Apprenticeship. The passage continues NE via several short climbs before reaching a 20m wide shaft. A pitch series descends 128m (big shaft for 55m that reduces to 3m wide muddy pitches) to meet a sandy passage with gypsum crystals. A number of leads remain here, the two of note: 1. A constriction (2m long and less than body width high) to the south has a strong draught and visible continuation but requires entrenching tools to enlarge the hard-packed floor. 2. A crawl trending WSW from the main passage leads to a ramp trending downwards steeply in a NW direction which requires rope.

Rigging: 60m, 35m, 45m, 30m and 15m ropes; 8mm through-bolts left in-situ.
Requires entrenching tool (short crow bar & shovel) & bolting equipment to continue.



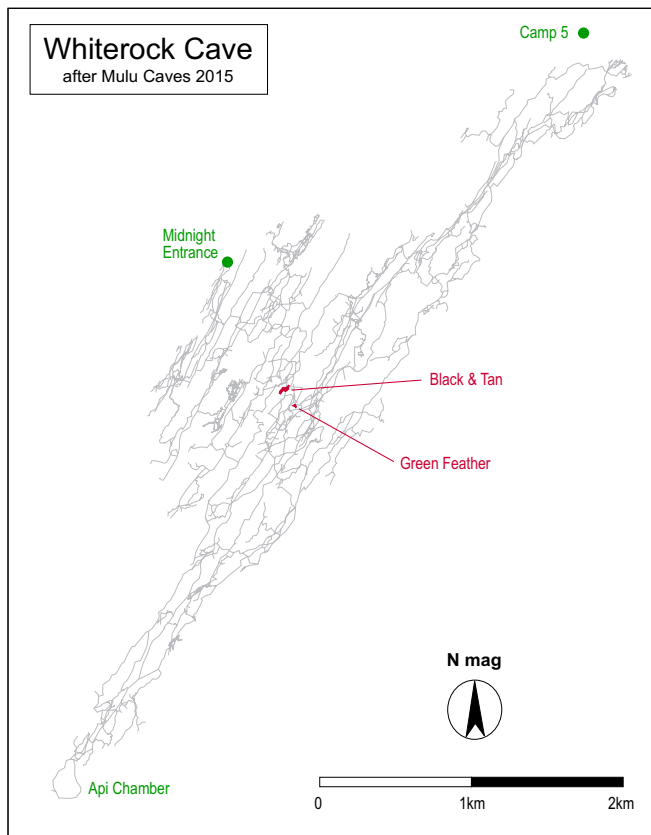
*Frank Pearson at the head of the 55m pitch in Skeleton
photo Torben Redder*



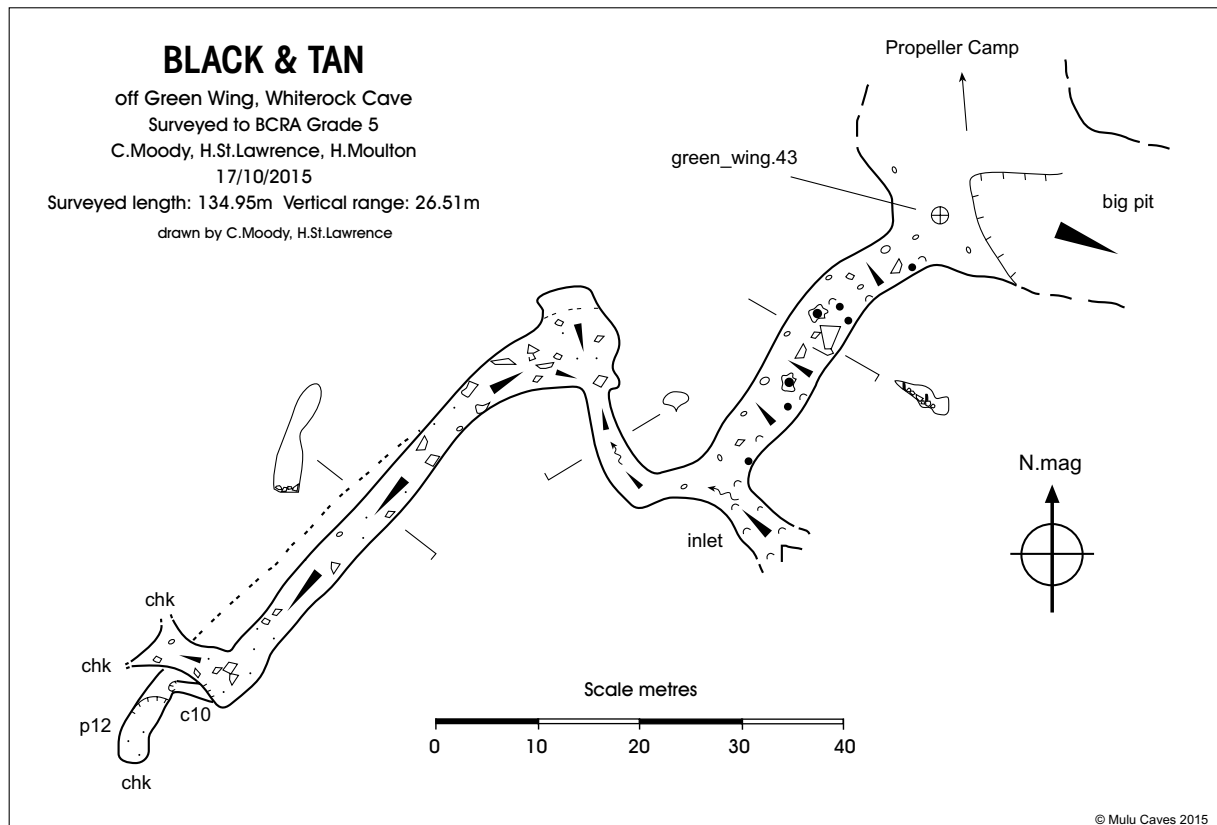
Black & Tan

Explored 18th Oct & 1st Nov 2015, Length 134.95m

Explored by: **Hugh St.Lawrence**, Catherine Moody, Hannah Moulton, Rob Middleton



At the top of the big pit in the Green Wing (Propeller Camp end) a small passage leads off to the southwest. It was evident that it had been entered before, but probably not very far. The passage picks up a trickle inlet flowing down over black and orange flowstone and heads downhill in a small tube. Just for closure this was followed down for a few metres to a low arch which surprisingly popped out into a much larger strike aligned rift. A short slope up leads to a good vantage point of the tall phreatic rift which descends again to an apparent end in several choked crawls. However, a higher level could be seen up a chimney and a return with a rope and proficient climber led to a stance and pitch down into a short continuation which once again choked. The passage runs parallel to Ancestors Passage.



Green Feather

Explored 31st October, Length 61.81m

Explored by: Frank Pearson, Catherine Moody, **Hugh St. Lawrence**

Beyond the big pit in the Green Wing the even floored passage provides delightful walking. At an obvious bend to the left a small but handsome tube was observed 3m up the south wall. This required combined tactics to enter and a rope and sling is essential even though the climb is short. The tube leads up and branches into two routes, both ending in small active avens, though no draught was detected. Later research turned up a sketch of the passage from 2007 by Tim & Pam Fogg, although no data had been entered into Survox at that time.

Opposite Green Feather, on the north corner of the bend, is a larger tube 8m above the floor. This has swift activity and is unentered, but is a much steeper bolt climb on gypsum encrusted walls. There is a further unentered passage at roof height in the east wall, halfway between the bend and the top of the big pit.

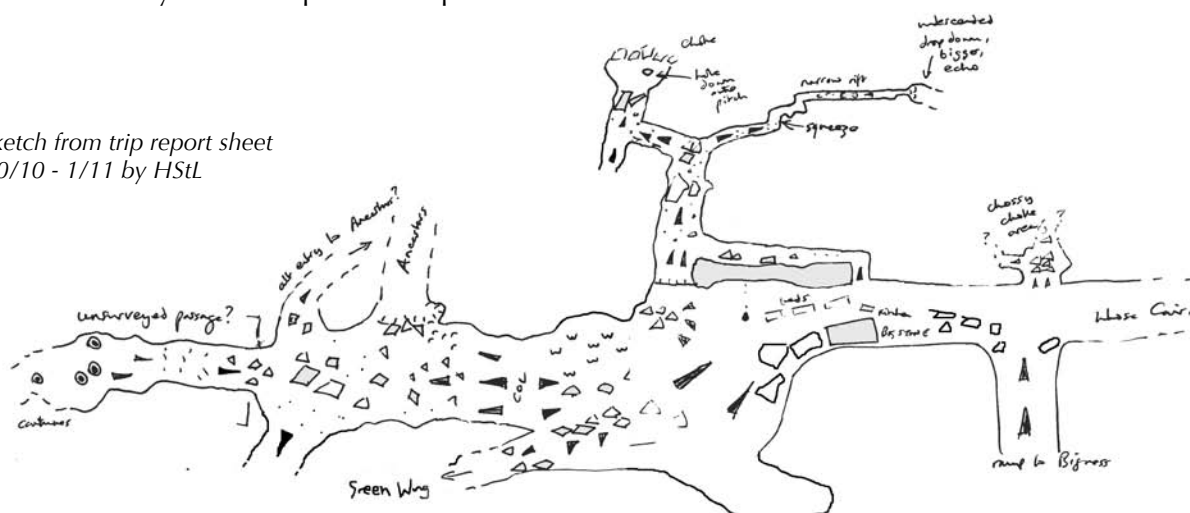
Propeller Camp area:

While staying at Propeller Camp on the Centurion trip, an 'evening out' was had by Rob, Hannah and Hugh. The idea was to have a jolly down Ancestors Passage 'after tea' - simple. But not so simple for the intrepid trio, as they couldn't find the entrance to Ancestors! The obvious passage out of camp was followed down a sand slope into a loose bouldery area, which later we concluded was the way to Black Joke and Firecracker. In this area a tight squeeze was pushed into 50m of narrow rift passage ending where it opened out substantially at a climb or pitch which required rope to continue.

At the end of the evening we did eventually find Ancestors. Rob climbed down and set off for a look, while Hugh searched for an easier way down. Crossing to the other side of the slope an alternative side passage looked as though it entered Ancestors. Of more interest, though, was the climb up into the obvious passage next to it. A scramble up boulders led into an 8x12 passage with old batteries and cigarette stubs on the floor. The passage was only followed for 80m and continues up climbs around large stal. There is no record of this passage having been explored or surveyed, so it's an easy lead for a Propeller Camp evening.

Several other pits and passages were examined in the area, and it was concluded that a more detailed survey of the Propeller Camp area could be useful.

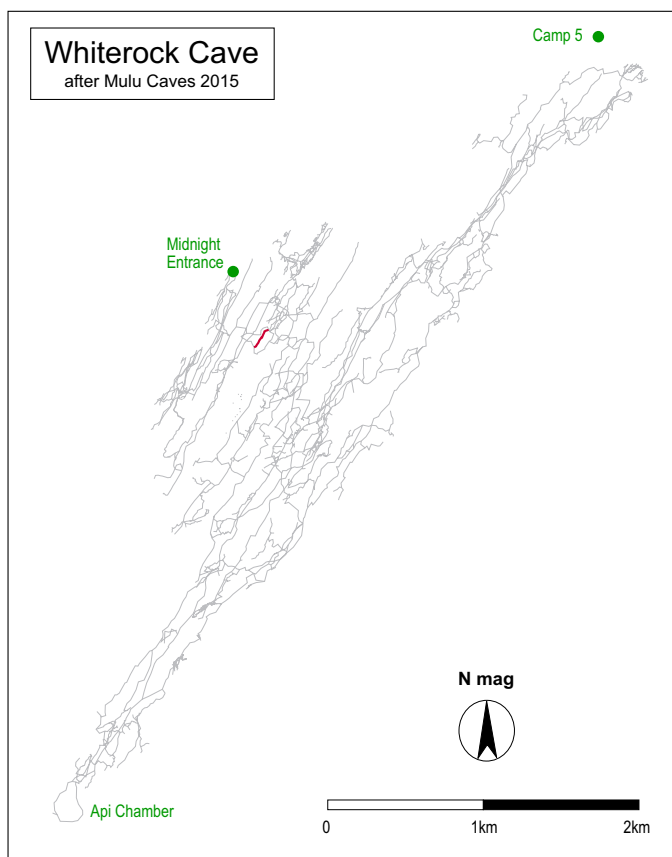
*sketch from trip report sheet
30/10 - 1/11 by HStL*



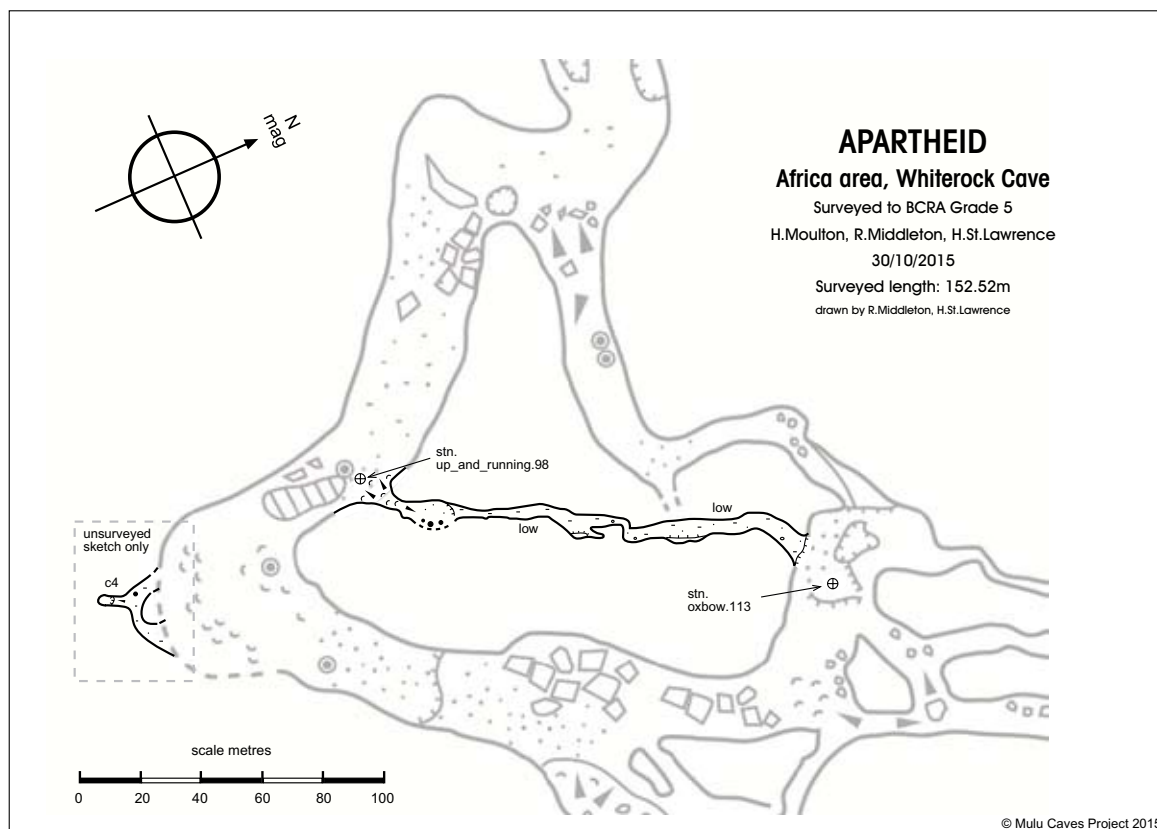
Apartheid

Explored 30th Oct 2015; Length 152.52m

Explored by: Rob Middleton, Hannah Moulton, **Hugh St.Lawrence**



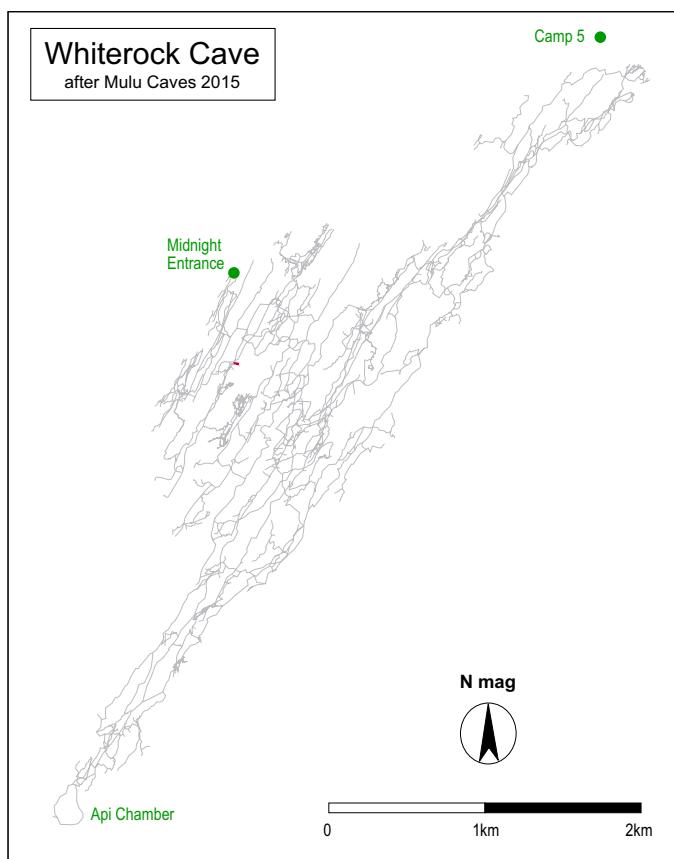
To the left of the gour pools on the regular route through Africa (stn. up_and_running.98) a flowstone slope leads up to (and obscures from sight at first) a passage heading northeast. Initially roomy with stal columns, it quickly degenerates into a hands & knees, then flat-out crawl on a mud and calcite floor. The healthy draught urges the reluctant explorer on through further flat out misery, until, with great relief, large passage is encountered at a junction. This is the northern arm of Africa, the crawl having neatly divided Africa in two. A crawl on the opposite corner of the Africa passage revealed a small passage dropping to a soapy 4m climb down to a choke.



The Graveyard

Explored 27th Oct 2015; Length 94.25m

Explored by: Rosie Hadfield, **Cat Moody**



As The Apprenticeship is entered from the Up and Running ramp, a sizeable passage appears to continue in the opposite (E) wall. A bold 10m bolt climb was required to breach the overhanging wall to a safe landing in what appears to be merely a large alcove. Here, some gloves and an empty candle box were found, presumably left by nesters.

To the north, the calcite meets the roof at the back of the alcove, while directly ahead from the pitch head (E) is a vertical inlet 1.5 m in diameter which draughts strongly; presumably this is the entry point used by the nesters. It would be a direct climb up to gain access into this vertical tube.



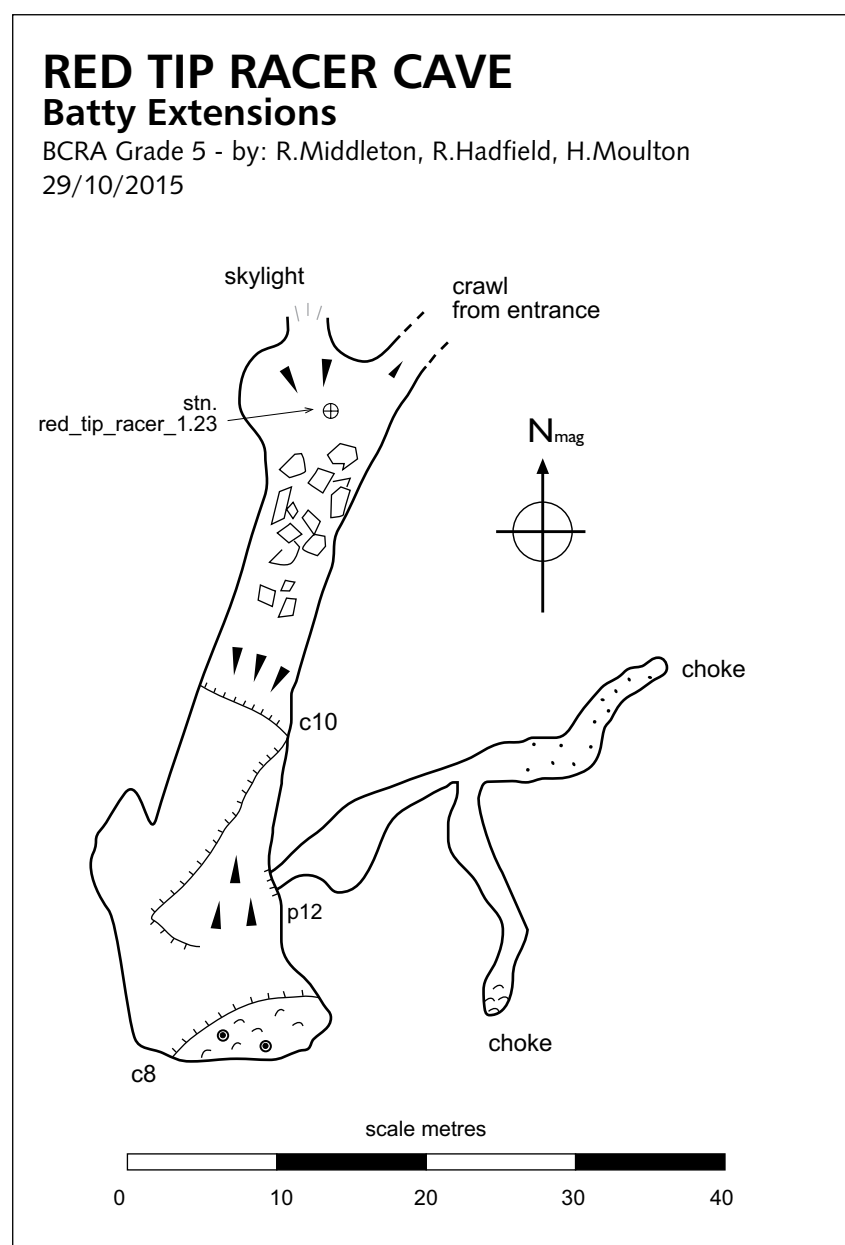
*Old gloves and candle box found in the Graveyard.
photo Cat Moody*

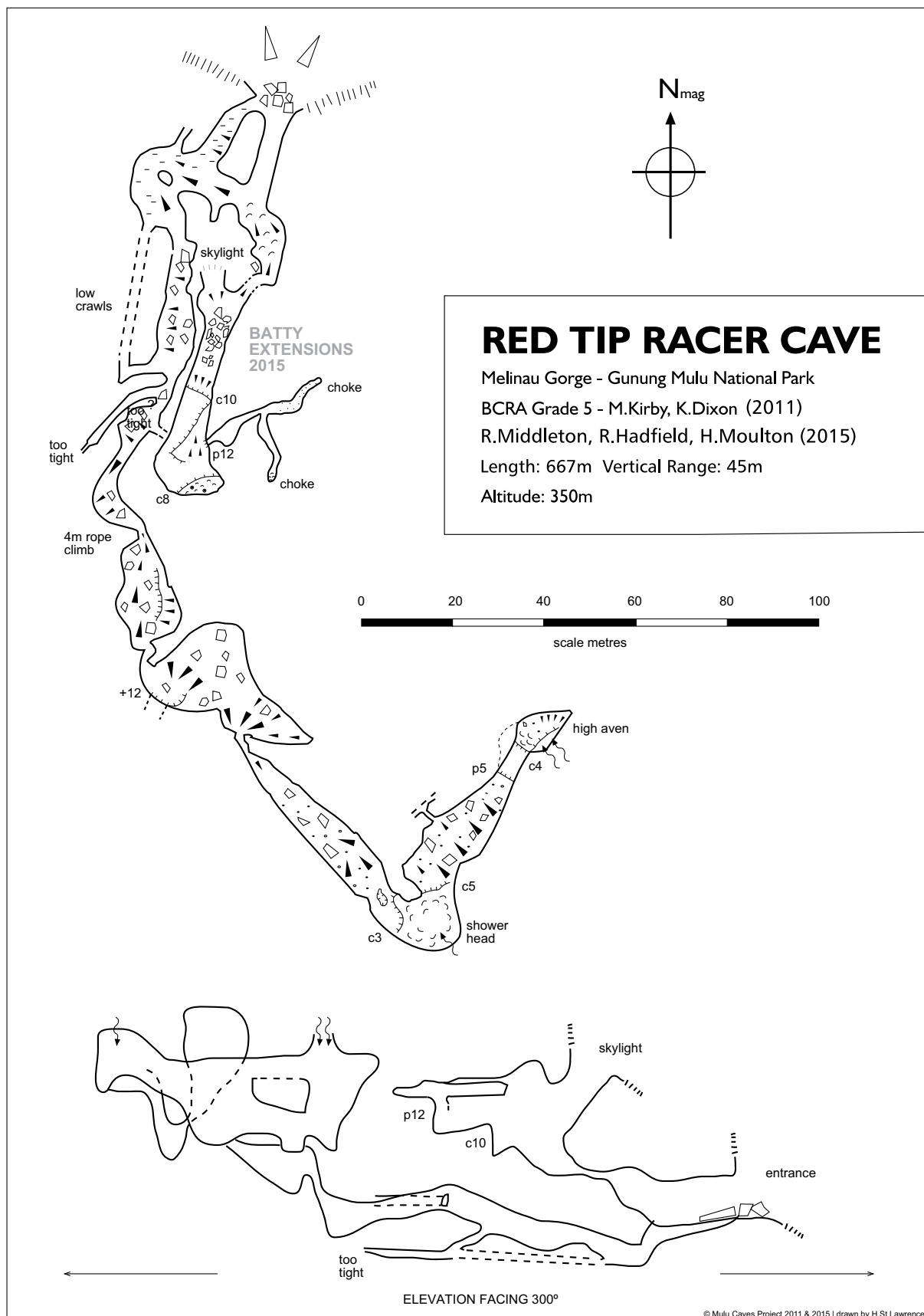
Red Tip Racer Cave

Batty Extensions, Explored 29 Oct 2015; Length 117.91m

Explored by Rosie Hadfield, **Robert Middleton** and Hannah Moulton

From the survey station red_tip_racer_1.23 in the centre of the skylight chamber, a 10m climb up the corroded, friable calcite gully to the south led to a slope beside a huge detached wall flake (with stalactites underneath that point diagonally). A precarious 8m climb up more corroded calcite led to a ledge on top of the detached block. From this level the alcove to the south at roof level was seen to be blind. However, the roof tube to the east was entered via bolt climbing, first on a 45degree overhanging face for 10m, followed by a traditional aid section of 3m on corroded calcite, to secure access to the passage. This lead to 30m of stooping height passage with many bats, which split into mud chokes with no prospects. The climb and handline were derigged and all tackle removed.





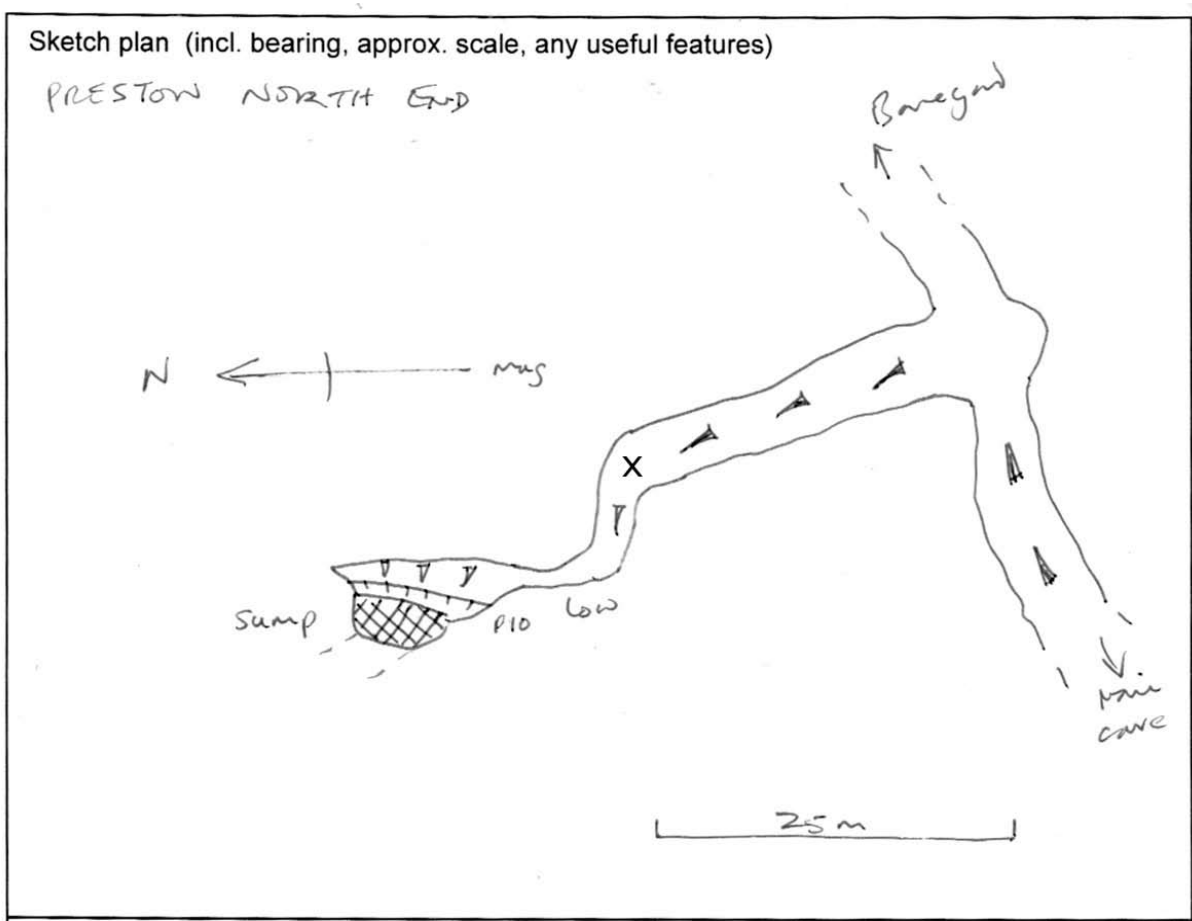
Red Tip Racer survey updated from 2011

Racer Cave

Preston North End, Explored 6 Oct 2015; Length 20m est.

Explored by **Hugh St.Lawrence**, Frank Pearson

On the northern wall of the main Racer passage a branch passage leads into the Boneyard, an area of small tube passages and 'boneyard' pendant limestone. An obvious junction is met where a passage descends to the left while straight on leads to more tubes and rifts, not fully explored but small. The descending passage to the left at the junction is an easy slope which reduces in diameter until it appeared to close up, as the existing survey showed. However, a quick scrabble in the sand produced a short squeeze into a larger continuation and very shortly the head of a pitch in an inclined joint rift. No tackle was available at the time, but the pitch is about 10-12m deep landing in a reasonably sized and very inviting clear blue sump (?) pool; there appears to be no easy landing ledge at the bottom, and bolts would be needed as the pitch head has no natural belays. The extension is unsurveyed, sketch provided for guidance.



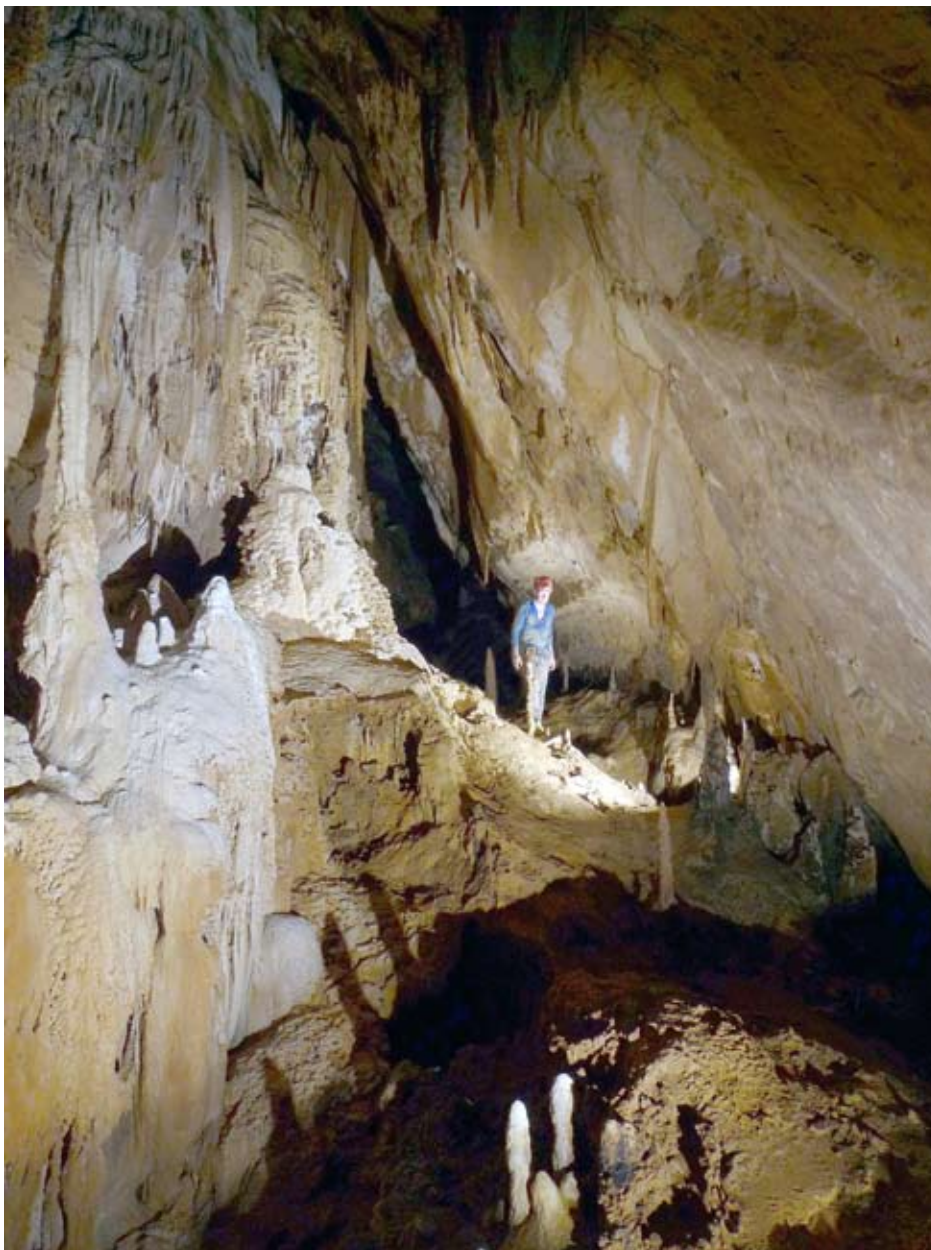
The nearest survey point (marked 'X' on the sketch) has an altitude of 41m in the Api Master survey file. Subtract an estimated 12m to account for the short extension and pitch, and you get 29m altitude at sump level, the same as the river level in Cave of the Winds. The nearest river point in CotW is 233m distant, and close to the point where Snake Chimney starts. There don't appear to be any deep water inlets in that area, but it's worth checking again. Diving the sump (if indeed it is one) is an obvious 'to do' item, and shouldn't be too hard a carry. Kitting up might be slightly more awkward.

Cave of the Winds

Snake Chimney, Oct 2015; Length 204.18m (+16.59m on 2014 length)

Re-surveyed by **Hugh St.Lawrence**, Frank Pearson

In 2014 the Snake Chimney had been explored but there was only time for a quick centreline survey and sketch from memory. Hugh and Frank revisited in the early days of the expedition to check for leads and re-survey the passage. The snake was not in residence this time, but the chimney was as awkward and slippery as ever. The passage was resurveyed along its main line, adding 16.59m in length to the original survey - some side beddings and alcoves were not surveyed into, so the full extent of this series is estimated at 250m. There was no significant difference in the drawn survey from 2014. The choke at the end of the main passage appears to be somewhere beneath the large Seven Pillars of Wisdom passage, but 80m lower.



The decorated section of the main Snake Chimney passage
photo Hugh St.Lawrence

Surface Exploration

On Gunung Api

Search for the Northern Entrance - Hugh St.Lawrence, Rob Middleton, Matt Kirby

The main focus on Api was the continued search for a northern entrance to Whiterock Cave - something that would create much quicker access to the northern section of the cave for exploration, but perhaps even more alluring make possible a superb through trip from top to bottom of the Clearwater System.

Several forays were made into the areas just south of Camp 5, both on the cliffs and in the dolines, to see if anything new could be found which had not been noticed on previous rambles.

A feature which had been noticed in photographs was a square 'shadow' or dark area on the cliffs immediately above No Country for Old Men. A bit of work with surveys and some height estimation suggested its location could be quite close to, and on the same horizon, as the end of 1954.

Rob and Hugh were the first to try. East of the entrance to NCfOM, the ground rises up to where a steep ledge system trends back west up across the face. Varying in width from 1 to 3 metres this was followed up via way of one or two easy but exposed climbs to a saddle. Here the ledge trended down again and then petered out above a vertical drop onto extremely steep, vegetated ground with no obvious route without rope protection. (POINT A) It wasn't possible to see the cliff face clearly from the saddle, but review of the photos suggested the pair may have been not far below the shadow feature.

Ten days later, Matt and Hugh tried an approach to the feature from the Pinnacles Track, repeating their visit in 2011 to the 'Last Gasp Cave' ledge. Copious treefall made this a more difficult journey than previously, but the ledge was found and then followed east, trending downwards to where it petered out on the edge of a white limestone cliff (POINT B), but with no view onto the face without rock climbing gear. Again, later review of the photos suggested an approximate position level with and 30-50m west of the shadow feature.

Accessing this feature may still be worth a bit of effort. With the exception of No Country for Old Men, which is comparable to the Northern Line horizon in Whiterock, most caves or features on the footslopes or talus are quickly choked, are loose, are small, or all three! A cave in the cliff face above the talus slope has a chance of being less choked, even though calcification of major high level passages is a feature as they near the gorge boundary. Before further work is undertaken here it would be worthwhile carrying out closer inspection of the feature using a camera drone.

Having said that, the most compelling evidence for a northern entrance remains the sighting of bats around the Pointless Junction area in upstream Whiterock River. These passages are 65m below Camp 5. So perhaps more assiduous low level searching is still

the way forward. Inside the cave at Pointless Junction there are still a number of small, draughting leads, and a sizeable aven where bats have been noticed. Not far down the Gone With The Wind passage is also an area with a tremendous echo in the roof, but no real attempt has been made to climb up here. Pointless Junction is a long way to go, and the leads may be small or technically difficult. But the opportunities certainly haven't been exhausted.



photo Andy Eavis

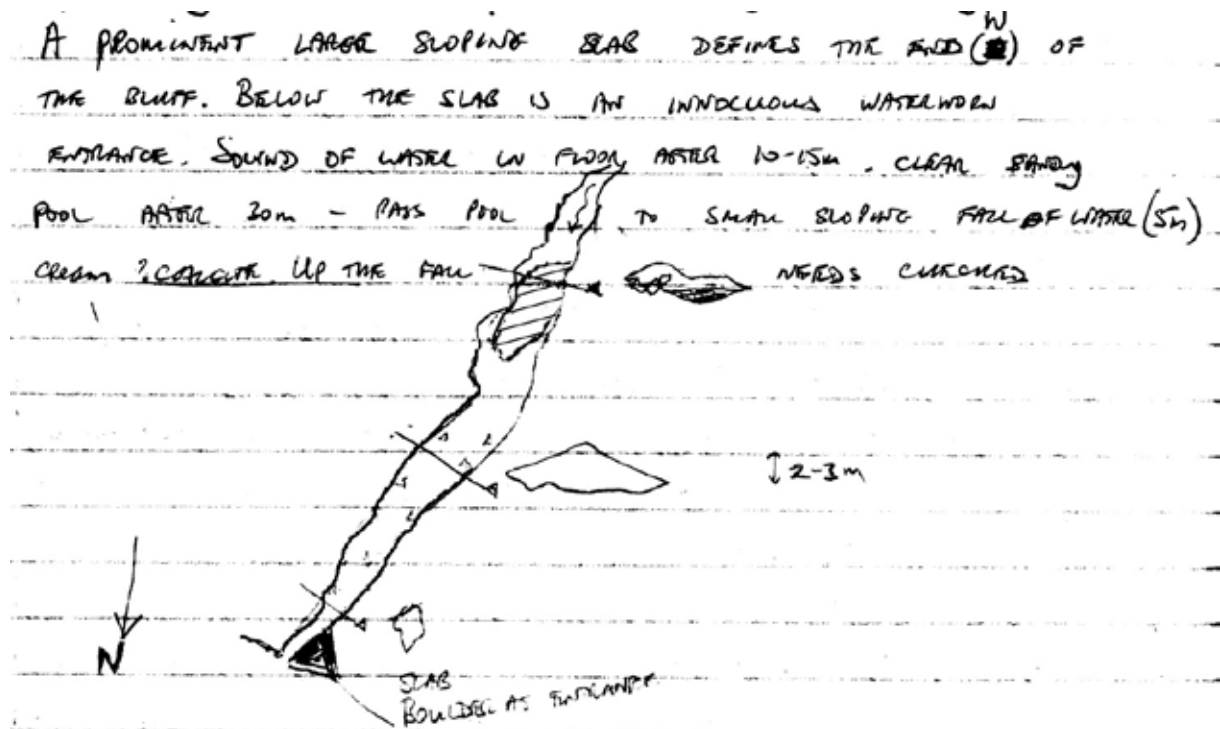
'Shadow feature' is approx. same horizon as 1954 in Whiterock
No Country for Old Men is same horizon as Northern Line in Whiterock



*Just above Point B on
the Last Gasp ledge
photo Matt Kirby*

Likoh Cave - Frank Pearson, **Matt Kirby**, Hugh St. Lawrence

An entry in the 2007 expedition log book looked interesting:



The entrance had been discovered and partially explored alone by David Scott when a group was returning from the Bat Cave area. But as he had become parted from the main party he did not push it to a conclusion, the cave was never re-visited during 2007 or since.

The '150m E. of Shelter Cave' reference was thought to mean from the Rock Shelter so the team headed there (via Tree Cave) as the start point. The main hunting track does not go via the Rock Shelter but runs along the high ground to the north before crossing the main collector stream further to the east en route to the Bat Cave area.

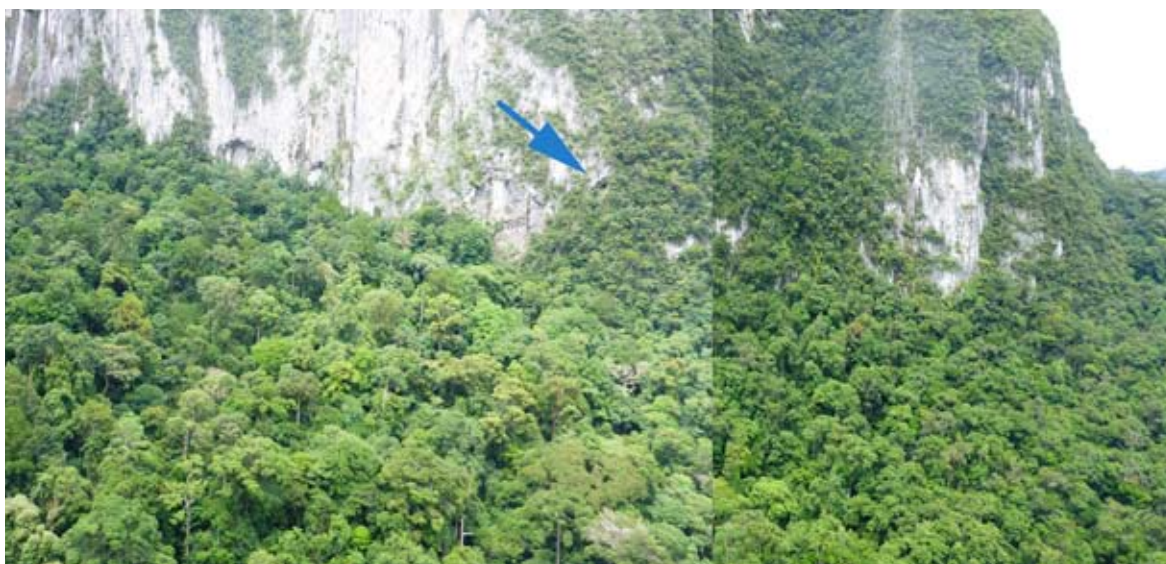
The 2007 report says the route from the rock shelter eastwards is "indistinct and difficult to follow" but traversing eastwards from the Rock Shelter does indeed lead to a valley coming in from the south. This is an immature valley feature running off the alluvium and joining the main collector stream to the north. However, searching upstream in this did not reveal a resurgence or prominent, large, sloping slab. Approximately 60m further east a second valley was also searched without revealing an entrance. Further eastwards the main hunting track is picked up which leads across two further valleys, slightly larger/deeper than the first two. These were also searched from top to bottom. In the fourth valley, approximately 30m up-valley from the track, a small entrance was found which led to 10m of small awkward passage ending in an impassable bedding plane.

The location of Likoh Cave remains a mystery but the area is complex and could do with a rudimentary survey of the valleys and the main collector stream to better understand the topography. During a walk up the Melinau River from Camp 5, an impressive, tall, cascading waterfall was seen to enter from the south after approximately 1500m. This is thought to be the main collector stream from the Tree/Bat/Penan Pot Caves area.

On Gunung Benarat

Benarat Corner Cave - **Hugh St.Lawrence**, Frank Pearson, Louise Korsgaard, Cat Moody, Matt Kirby

On a helicopter flight around the park in 2013, Andy Eavis took many photos of the terrain, including some shots in the Melinau Gorge. One of these clearly showed a prominent entrance in the Benarat face of the gorge, close to the corner of the mountain where the Melinau river fans out into its headwaters on the Mulu slope. In fact, Andy had also seen this entrance during an ascent to Canopy Cave on the 2000 expedition, where he climbed a pinnacle to get a view across the valley. In that year's logbook he drew a rudimentary sketch and noted - *"good looking entrance, vegetation all up to cave but 50m very steep."* This is pretty much what the recent photos showed, with the entrance maybe a bit higher off the ground.



Fly-by photos from 2013 showing the prominent entrance | photos Andy Eavis

This entrance is much farther up the gorge than any known cave in Benarat, the most upstream (easterly) entrance being Hurricane Hole, so the prospect of a new cave in virgin territory was quite appealing. With vegetation appearing to lead up from the forest floor to the entrance, there was a chance this might be accessed without major rock climbing or bolting antics. The main difficulties would be forging a route through the forest over unknown ground, and deciding where to start climbing up.

Finding a route to the cliff was easier than expected. Tracking around the base of the Benarat cliff was an option; as also was following the well known route to Bat Cave and then descending to cross the river onto the Benarat side. In the event, the El Nino conditions provided the answer - which was simply to take a cool walk up an unseasonably shallow river! This required 15 river crossings, but never more than thigh deep. It also gave us a view of the large prow on the Benarat cliffs beneath which we knew the entrance lay. A large boulder beach on the north riverbank, where the river turns south-east, served as the jump-off point into the forest for what was expected to be a hard bash upslope. But luckily the forest was less dense than expected, and a prominent gully feature guided us right to the base of the cliffs, half an hour from the river once the trail was blazed.

Fifty metres to the left of the gully head a platform was accessed from which the face could be viewed. The entrance couldn't be seen, but streak marks and overhangs on the cliff helped establish where we were; climbing up to the right of the gully head would probably have us on the right course.

About 12m above the gully head was a small entrance in the cliff which blew ferns around. This was accessed by a short traverse (roped) from the slope to the right, and proved to be very short to a block choke through which blew a healthy draught. Tools would be required to progress in the choke, but it may be worth another look (just as with the lower entrance to Lower Tiger Cave, a small entrance may lead up the bedding to the main cave level.)

The cliff above the small cave was definite rock climbing/bolting territory, so the slope was followed right, up to the base of a vegetated rock corner. Two very scrappy 'pitches' up steep, loose vegetation and spiky plants, with tree root runners, reached a horizontal ledge with a limestone wall. As we had been climbing at '2 o'clock', rightwards and away from the supposed entrance position, this was a



*Frank Pearson traversing to the small draughting cave above the gully head.
photo Matt Kirby*

good opportunity to move left at 9 o'clock and back onto line. Unfortunately, at the end of the runout a small loose corner was met and in trying to climb past it (only a couple of metres) a small rockfall was triggered. Blocks grazed the leader's thigh and whistled off down towards the second, who just had time to hide behind a tree. Out of time, rope and bottle, we retreated. Due to other commitments in Whiterock, we weren't able to return.

At the highest point reached, peering over the top of the short corner is a belay tree just a few metres away. Beyond it the vegetation seems more open and more light was penetrating, so it may be nearing the cave entrance which is probably recessed from the cliff face.

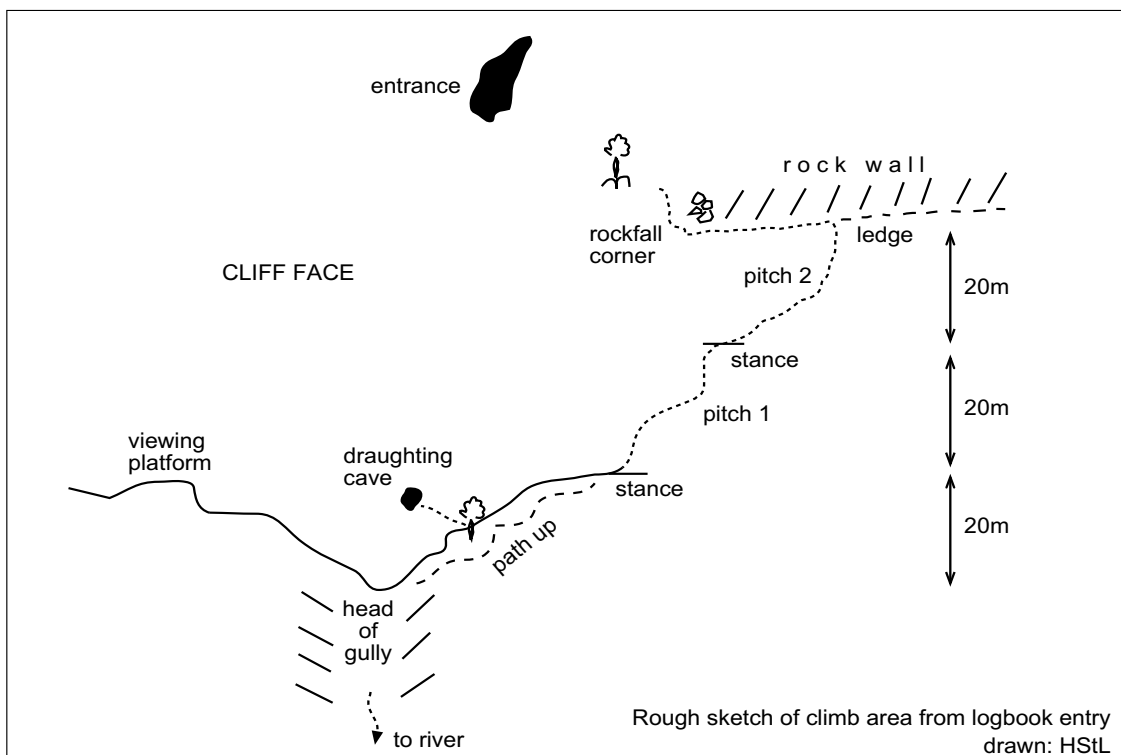
One aid we developed to help the climbers keep 'on route', was to station an observer on the Api side of the gorge (just off the Bat Cave track) with a radio and pair of binoculars. This could have worked perfectly, as the observer

(Matt) could see the climbers (Hugh, Frank, Cat) through the optics. Unfortunately, just when they were needed, the radios failed! But the idea of remote control of the climbers is a sound one; up close on a vegetated cliff face you can't see the wood for the trees, so being directed to move left or right is rather handy.

With the route almost pioneered, and some useful techniques devised for climbing, another visit or two should see the entrance attained. Lying on an obvious bedding, and with approximate size of 10x15m, it certainly looks quite promising.



Zoom shot of the entrance from the Bat Cave track. 'X' marks the approx. high point reached. photo Hugh St.Lawrence



3D Scanning of Api Chamber & Sarawak Chamber

Roo Walters

The 3D scanning of the world's large cave chambers has continued apace over the last three years with a total of 9 of the top 12 cave chambers now scanned by a group consisting at its core of Andy Eavis, Tim Allen and Roo Walters. Our methods over the last three years have improved somewhat with respect to equipment, mainly in the gear we use to transport our Riegl VZ-400 LIDAR scanner and its associated equipment, and also in our techniques. When we started the project we tended to do fewer, but more detailed scans; nowadays we do many more, but less detailed scans. This reduces the shadows and speeds up the scanning process. To place this project in context, the results to date are as follows:

23 rd Nov 2015		Dimensions (m)						Country
Name		Volume ($\times 10^6 \text{ m}^3$)	Area ($\times 10^3 \text{ m}^2$)	Width (m)	Length (m)	Vertical Range (m)	Max Ceiling Height (m)*	
1	Miao Room	10.57	140.54	336	824	252	177	China
2	Sarawak Chamber	9.81	162.50	409	650	321	98	Malaysia
3	Cloud Ladder Hall	6.21	57.46	355	393	355	282	China
4	Hong Meigui	5.25	54.87	269	468	225	197	China
5	Ghar-e-Dosar *	4.0 to 6.0	81					Iran
6	Majlis al Jinn	4.09	61.00	245	347	134		Oman
7	Salle de la Verna	3.65	43.47	245	243	199	199	France
8	Api Chamber	2.97	46.7	174	269	213	187	Malaysia
9	Titan Chamber	2.53	54.75	341	367	197	80	China
10	Gran Sala GEV (Torca del Carlista)	2.14	87.09	287	497	227	97	Spain
?	Marco Polo	1.44	49.05	402	175	85	62	China
?	The Big Room, Carlsbad Caverns	0.93	35.18	408	405	108	78	USA
?	Belize Chamber	0.80	50.01	337	251	61	61	Belize

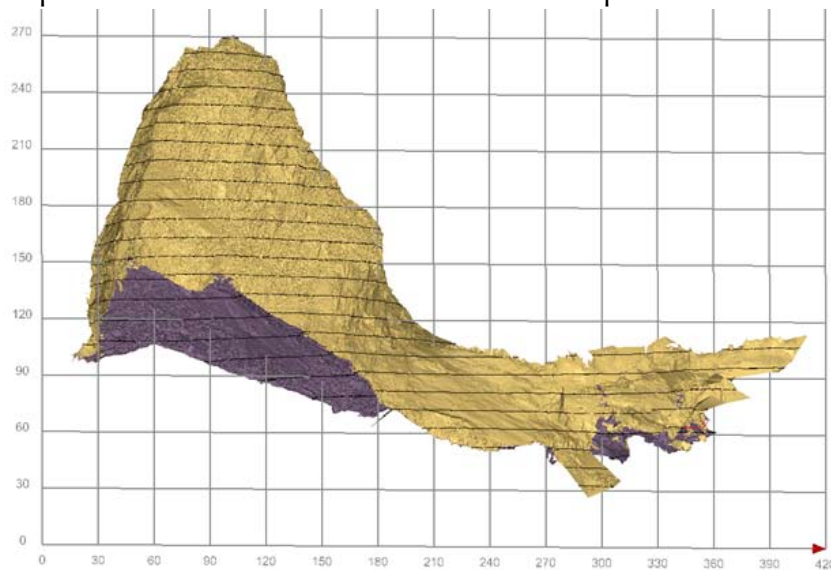
* Ghar-e-Dosar yet to be scanned - estimate from surveys, likely to fall to 6th/7th by volume

Majlis al Jinn was surveyed by a Swiss group using much the same equipment, so we can assume their results would correspond with our own. However, we do intend to survey this chamber at some date. Ghar-e-Dosar, Belize Chamber and Tlamanictli will be completed over the next 15 months.

Mulu is home to not one, but two of the largest known cave chambers in the world. Explorers had known that Api Chamber was big, but just how big, was beyond expectations.

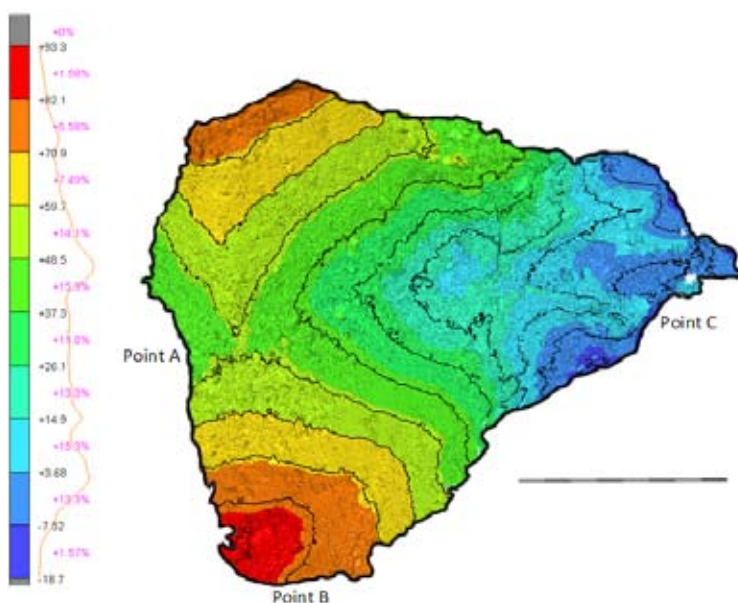
Api Chamber

In surveying Api Chamber, a number of features are very apparent. Firstly its great height, 213m high, with the highest point above any point on the cave floor of 187m. Without doubt, it is this height, and that the chamber retains its bulk at height, that gives rise to its impressive volume of $2.97 \times 10^6 \text{m}^3$ and 8th place in the list of world's largest chambers.



The chamber was scanned in two days, and required 81 scanning stations. As is our default routine now, the scanner was set at an increment of 0.04 degrees in both horizontal and vertical planes, which gives a single scan point resolution of 7cm at 100m. However, once the scans were stitched, a point cloud density of one point per cm^2 could be extracted.

However, to do so makes the resulting models unusable in 'mortal' laptop computers, so a point density of one point per 25cm^2 and one point per 10cm^2 were actually used to create a more manageable model.

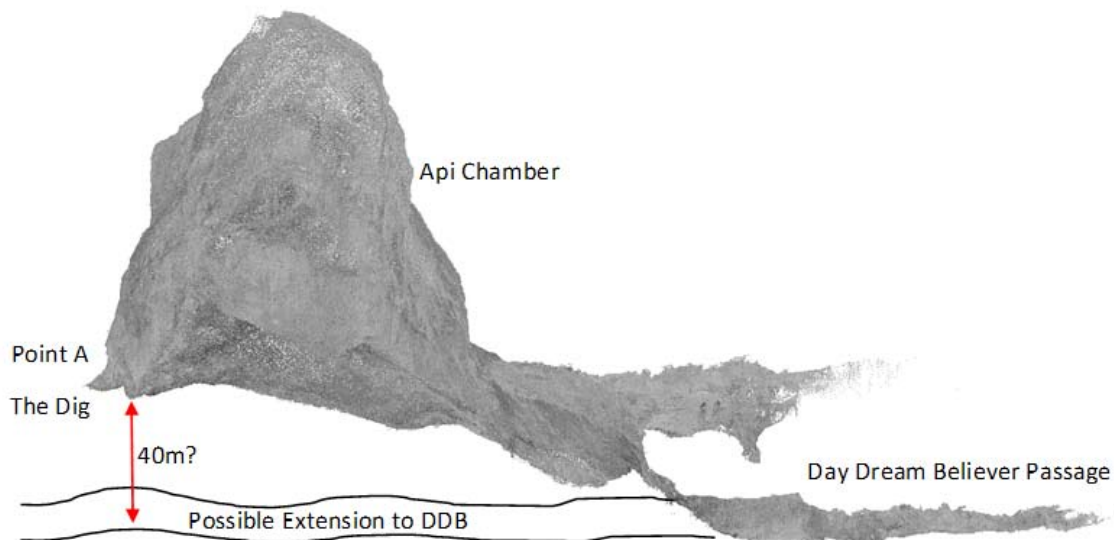


For calculating volumes the 25cm model is used, and the author is proposing that this is a standard to be used for all projects. The 10cm model is used for looking at features in more detail and producing video animations to illustrate the chambers. A detailed floor plan of the chamber is shown to left - the contours are at 10m intervals.

We shall leave any geological interpretation at this stage to others, but there are features of

interest to cavers that have been illustrated by this scan for the first time. Above Point B, there is a sloping ledge, and on this ledge there is a depression some 6m across and 4m high; could this be a passage, a way on past the boulder choke at Point A?

The 'way on' is presumed to be at Point A where there is a huge draught down through the boulders. This might not be an easy prospect, though.



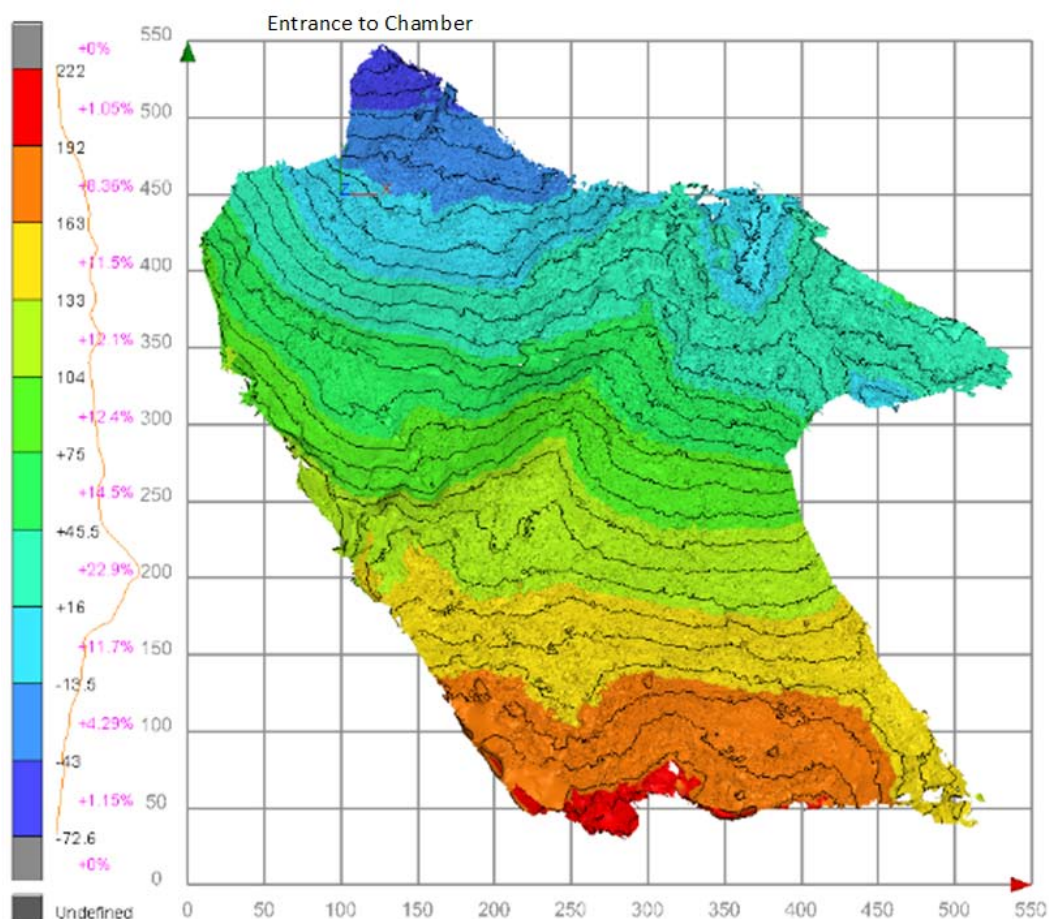
As the full point cloud shows, which includes the approach passage from Daydream Believer, the 'Dig' and point A are over 40m vertically from any supposed continuation of Daydream Believer.

Sarawak Chamber

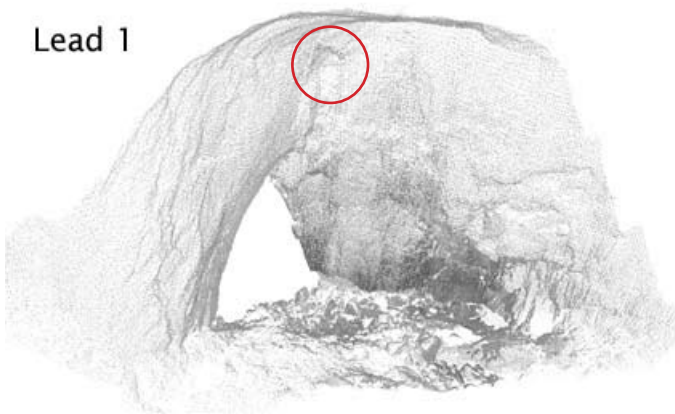
Sarawak Chamber was surveyed in 2013 by Dixon, Eavis and Starkey, using different equipment. After much deliberation we decided to resurvey the chamber using more modern equipment. Partly, in our mind was the tantalising prospect that the volume of the chamber would be calculated as larger because our new methods would reduce the numbers of shadows and reach more nooks and crevices. This stems from the fact that we do many more stations as the new equipment is so much faster. In fact, we increased the numbers of stations from 9 to 101. The result shows great credit to the first scans, as the volume has only increased by a tiny amount, however the resolution we now have is very much better and a detailed map can now be drawn. The model has also revealed two tantalising leads.

The calculations we have made now confirm that the chamber has a volume of $9.81 \times 10^6 \text{m}^3$. The chamber was scanned using the same parameters as Api, increment of 0.04 degrees in both horizontal and vertical planes and the volume was calculated using a model with a point cloud density of 1 point per 25cm^2 .

The first lead (1) has been suggested by several veteran Mulu cavers and is situated 80 metres above the entrance to the main chamber, up the steep climb from the camp. It will be a tough climb, but well within modern capabilities. The scan suggests this goes into the roof about 15 metres and then enters a shaft from above.

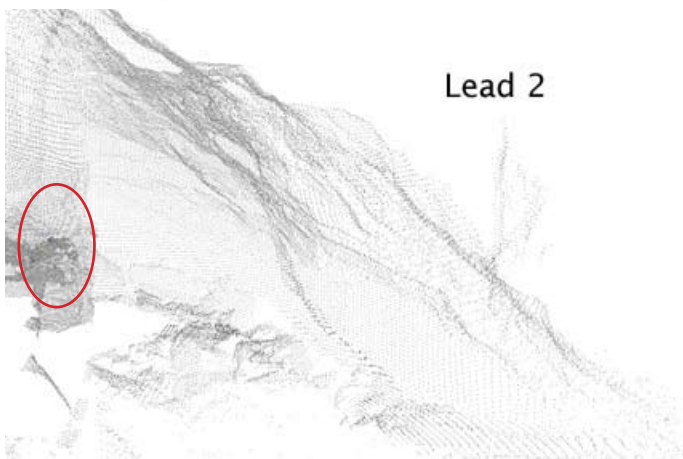


Lead 1



The second lead (2), is a small shaft immediately above the start of the arm of the chamber that heads towards Prediction Cave. It will be awkward to get to, but perhaps, just perhaps, will provide an easy way over the boulder choke that stops progress towards the Hidden Valley. Close study of the models have not suggested any other possibilities for passages.

Lead 2



Andy and I would like to say a special thanks to Veno and porters Jimmy Jarau and Sharudin for all their help in scanning these chambers. At this time there are no plans for further scanning in the Mulu caves.

Science

Origins of Leopard Rock in Mulu Caves

Pete Smart

Many cavers have commented on the mottled and spotted limestones seen in many of the Mulu caves, and especially in Lagang's Cave. Here they were called 'Leopard Rock', and elsewhere Leopard Passage was named after them. There are in fact a variety of Leopard Rock limestones. In some the spots are darker than the background colour, and in other the converse is true. The spots are typically a few cm in diameter and are generally ellipsoidal or rounded but somewhat irregular in shape. The margins may sometimes be sharp but are more often gradational when seen on weathered faces. The spots may be closely spaced or have significant areas of background colour separating them. In the weathered faces seen in the caves, the spots appear to be homogeneous and lack internal structures such as concentric banding. They appear both in section and plan form.

Colour and texture differences in limestones can result from primary depositional processes, from diagenetic changes which occur after burial over a variety of timescales and depths, or by later weathering. The latter is dominant on breakdown boulders on the floor of Api Chamber. There appears to be a true 3 dimensional form to the spots (Figure 1a), but closer examination suggests that the host limestone is a uniform grey and that there has been differential deposition or preservation of a chalky white calcite crust (Figure 1b). This suggestion is supported by the co-occurrence of known speleothem textures such as corralites and stalactite fringes (Figure 2). Most Mulu cavers would not however describe the Api Chamber features as 'typical' of Mulu Leopard Rock.

If Leopard Rock is due to primary depositional process, then either that the spots were deposited first and intervening spaces between them infilled with a later sediment, or conversely voids were developed in an initial uniform sediment with later sediment infill. When seen in many cave walls, there is no difference in relief between the Leopard Rock spots and the matrix. This suggests that the spots and matrix are both carbonate and most



Fig. 1a - 'Leopard Rock' sample from Api Chamber. In this example, the spots can be seen to be three-dimensional.



Fig. 1b - is the reverse side of the same sample and displays a white weathering patina over a predominantly grey limestone. The spotting is therefore a secondary rather than primary feature.



Fig. 2 - 'Leopard Rock' on boulders, Api Chamber. The role of weathering and precipitation of white chalky calcite in producing a surficial cover over the more uniform grey limestone is clear from the presence of small coralline overgrowths (main slab top left) and the fringe of microstalactites (center base of main slab). (Photo Carsten Peter).

probably calcite (dolomite would dissolve slower and often result in orange colouration when weathered). However, in some samples such as the highly weathered hand sample from Moon Cave (Figure 3), there is some differential relief, possibly indicating a difference in mineralogy or more probably texture. The differential colouration from whites through light to dark grey and black are probably caused by differences in the amount of organic material incorporated in the sediments.

One possibility is that the spots are nodules or oncoids which have subsequently been encased in later sediment. Oncoids are concentrically banded, algal-mediated carbonate nodules 1 to 10 cm in diameter which often nucleate on a core such as a gastropod shell. These are often associated with lake basins rather than the marine carbonate depositional environment of the Melinau Limestone. Furthermore, the lack of visible internal banding, concentric layering or radial crystal structures suggests that the spots are not formed from nodules or oncolites.



Fig.3 - 'Leopard Rock' sample from Moon Cave. This sample is highly weathered and the darker spots protrude somewhat above the white limestone matrix. (Photo Mark Brown).

A second possibility is that the spots are formed from the infill of worm, crab and shrimp burrows in unlithified marine carbonate sediments which form the background matrix. The burrows subsequently become infilled with marine sediments which have a different organic content, but are formed and transported in a similar energy environment and thus have similar grain size and mineralogy to the matrix. Burrows are typically laterally continuous in 3 dimensions, and often have distinctive morphology such as U-shaped and branching forms which are dependent on the original host organism. They also often terminate at bedding surfaces, which were the sea bed at the time of development. Burrows are most common in shallow marine carbonate shelf environments. The regularity of the spacing of the spots in Leopard Rock and lack of obvious tubular forms or distinctive morphologies suggest that an origin as infilled burrows is unlikely.

The third possibility is that the patterning results from dessication cracking of the sediments when exposed in the supratidal (or upper intertidal) zones of the carbonate shelf. The well known plan form of such features is a network of polygonal 'mud' cracks formed in the unlithified fine grained tidal flat carbonate muds. The cracks then become infilled with further sediments which can be of different colour giving the 'background' material. One might expect such features to have sharp and somewhat angular boundaries, rather than the rounded and merging forms seen in Leopard Rock, but where algal mats are present at the sediment surface (frequently the case in the supratidal zone), much more rounded forms are quite common (see Figures 4A and B, Shinn 1983). This is due to algal overgrowth and sediment trapping and also desiccation and weathering of the polygon margins, which results in modification of the normal V-shaped crack form with depth. Algal mats also tend to allow perpetuation of the cracks upward through successive sediment layers, retaining a particular polygon (= spot) size. With increasing moisture availability in the upper-intertidal zone, distinctive mounded algal colonies can develop (Figure 5). Subsequent sedimentation around the raised areas, may then generate a spotted appearance in plan form.

Dessication of algal mats results in both vertical (polygonal) and horizontal cracking. The latter is due to differences in cohesiveness and texture of the sediment. Thus complex vertical and horizontal patterns can be generated by subsequent sedimentation. Given the potential for later sediments to be of different mineralogy and texture to those originally subjected to desiccation, there may be significant differences in the diagenetic pathways of the different generations of carbonate sediment. In particular there is a tendency for



Fig. 4a & 4b

(4a top) Selective algal growth on more porous sediments filling mud-cracks, Sugarloaf Key, Florida (Shinn, 1983)



(4b bottom) Shrinkage cracks in tidal flat algal mats, Andros Island, Bahamas. Note the more rounded form than dessication polygons in bare sediments (Shinn, 1983).



Fig.5 - Mud-cracks in carbonate muds, Middle Caicos Island, Turks & Caicos. These forms lack well-developed algal mats but generate a reticulate pattern when infilled by different sediment. http://www.beg.utexas.edu/lmod/_JOL-CM02/old_work/st07-cracks.htm

early selective dolomitisation of more porous (coarser) sediment Figure 6). As dolomite is significantly less soluble than calcite, such features may be accentuated in the present day weathering environment.



Fig.6 - Scytonema algal 'pin-cushions' 5 to 10 cm across and 1-2 cm high, upper-intertidal zone, southern side of Crooked Island, Bahamas (Hardie 1977). This Scytonema cover grades into the thinner, mostly crusty morphotype with increasing desiccation towards higher elevations.

Interestingly the term Leopard Rock has also been used by others. In 1944 Stose and Stose reported the regional geology of the Hannover-York district in Pennsylvania, USA. In the Lower Cambrian Kinzers Formation he described 'dark lenticular limestone with irregular dolomite layers producing a mottled banding and spotted appearance - leopard rock'. In some cases the matrix is earthy in others it is a dense blue impure limestone, but the spots are always pure white and 'nodular'. Unlike the Mulu Leopard Rock, 'on weathering, the impure layers stand in relief, and a reticulate earthy network may result'. They suggest that this 'peculiar structure is apparently of organic origin and related to the archae-ocyathid reefs, which are typically found in carbonates of this age. These are not found in the Late Eocene to early Miocene when the Melinau Limestone was deposited. He also suggests that 'partial recrystallization in some of the pure beds has produced a conglomeratic appearance ...(with)... rounded residual masses of finely crystalline dark limestone enclosed in light-gray to white coarser- grained recrystallized marble'. This colour reversal process could also be important in Mulu, but confirmation of its occurrence would require microscopic examination of samples in thin section.

References Cited:

Hardie LA 1977 Sedimentation on the Modern Carbonate Tidal-flats of NW Andros Island, Bahamas. John Hopkins Press, Baltimore.

Stose A and Stose GW 1944 Geology of the Hanover-York District, Pa. USGS Professional Paper 204, pp112.

Shinn E 1983 Tidal flat environment. Ch 4 In Scholle PA et al, Carbonate Depositional Environments, American Association of Petroleum Geologists Memoir 33, 171-210.

Radon measurements in Whiterock Cave

Torben Redder

Radon measurements have recently been taken in Whiterock Cave, both at Africa camp in 2013 and at the Up & Running camp in 2015.

The readings were around 5000-10000 Bq/m³. A single measurement was above the range of the instrument (9999 Bq/m³), but could from the rate of increase in the reading be estimated to around 15.000 Bq/m³. The WHO recommended level in houses is below 100 Bq/m³. These high levels in White Rock indicate that the air has travelled a rather long time in the cave and on the way has passed by sediments that enrich the air with radon. In 2013 radon measurements were performed in the show caves in Mulu. The radon level in the show caves was low (around 100 Bq/m³) and therefore radon does not appear to pose any risk for the work as a cave guide.

Using the radon detector around a breakdown or boulder choke with airflow coming from the blockage can indicate if the location is close to surface (low radon level) or whether the air has travelled a long time in the cave (high radon level), indicating a continuing cave passage on the other side of the blockage.

The radon meter used was a Canary from Corentium (www.canary.no). The Canary needs 24 hours to reach the right reading for radon, but from reading after a few hours, an estimate for the reading after 24 hours can be calculated and therefore the Canary can also be useful on day trips. The early version of Canary that was used had problems with errors due to high humidity, but that was handled by drying out the unit in a bag with silica gel for 24 hours prior to the measurement. After drying the unit, humidity in the cave was not a problem for the Canary.

Surveying

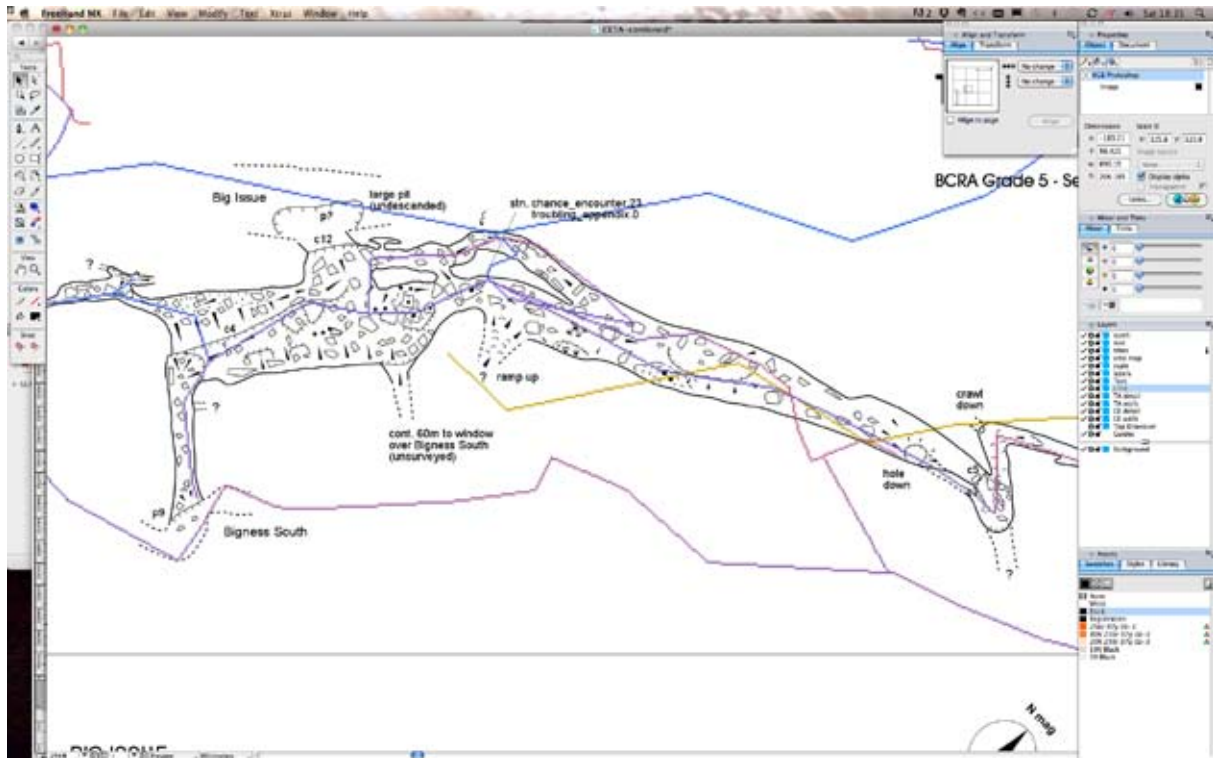
Mark Brown

Digital “paperless” surveying was outlined in the 2014 Mulu Caves Report – basically a laser “disto” distance measurer, which has been modified to allow it to take compass bearings and inclination too (the “DistoX”). The device transmits the survey data via Bluetooth to a hand held PDA device, where “Pocket Topo” software plots the centrelines and cross sections, allowing drawing up to scale with a stylus on the screen. Back at base camp data can quickly be converted into the 3D “Survex” model. This can then be imported into a drawing package (often back in the UK due to time constraints in the field) and traced over digitally to give the finished publishable surveys. The Mulu Caves Project’s chosen drawing system is Adobe FreehandMX software – a drawing package similar to Adobe Illustrator or Inkscape, which are also favoured by many cave surveyors, due to their accessibility to the layman. All of the Whiterock survey (and indeed most surveys since the 2007 expedition) have been drawn up using FreehandMX.

The Hidden Valley team used a new software, “Topodroid,” that runs on Android operating systems such as smart phones or tablets in a similar way to Pocket Topo.

Some expedition members still favour the “old school” analogue compass and clinometer instruments (and pencil & paper), but nearly all have adopted the basic disto for length measurements – much quicker than a fibron tape measure, with its problems such as getting tangled under rocks and difficulty reading when caked with mud.

A slightly different approach is to use the “Therion” software, also generated by caving volunteers, instead of Survox – which deals with the whole drawing up process and can be overlain with terrain data. Therion is more complicated to operate, however, so hasn’t been taken up by the project as a whole at present. One expedition member has drawn up a version of the Clearwater system using Therion.



Screenshot of a survey drawing in the Freehand MX drawing programme



The Topodroid programme running on a ruggedised mobile phone.
photo Rob Eavis

Whilst technological developments can make surveying easier, faster or more accurate, they can also create their own problems, particularly if people aren't sufficiently trained. DistoX users need to know how to check the device's calibration and possibly recalibrate in the cave (which requires a PDA to perform and can require 20-30minutes). Some training is needed in using Pocket Topo and recording data in the correct way to convert into Survex. Some artistic ability is still required for the sketching too; just as not everyone can pick up a pencil and instantly draw well on paper, not everyone can draw a useful cave sketch on Pocket Topo! Switching between digital and paper drawings in one section of cave made things complicated and had the potential for data being lost.

The importance of having all the correct software installed and well tested on the laptops was also discovered, as the latest version of Survex wouldn't work on two of the new machines. It was also important that Adobe Acrobat or similar be present, for converting .dxf files into more versatile graphic formats.

A few frustrating headaches were caused by these issues at Camp 5, and back in the UK, particularly when the people drawing up were trying to decipher other people's notes and sketches. The principle that original surveyors need to gather good data, make sure it is well backed up, and then draw up as much as possible *in the field* was reinforced.

An attempt to better standardise data collection was made with the introduction of trip report/cave description pro formas to record 'fresh in the memory' trip activity, both underground and surface. Historically, finding information on how a passage ended, or what people found on a surface foray, might require extensive research into past reports or log books, with information usually recorded in personal styles and varying detail (and sometimes illegible handwriting!) If a method can be evolved for recording cave/surface information in a more standard format, ideally in a searchable database, then future explorers should be better informed to identify worthwhile prospects. Good records are also a useful basis for report compilation. More work needs to be done on this, perhaps developing a database entry form.

Back in the UK, good use was made of Dropbox for file sharing and collaborating in the drawing and writing up stages.

24/10/15 Updated.

TRIP REPORT/PROSPECTING FORM		MULU 2015
Personnel: Rosie Hedfield, Cat Moody, Andy Wick	Date: 21/10/15	
Surface area: /	Cave name: Whitelock/Jarlsberg	
Cave area: Shipstorm Passage (Jarlsberg)	GPS location: /	Altitude: /
Starting survey stn: 1.56 old W/Rock Ent. End survey stn: 1.123		
1.86 new entrance Survex files: Jarlsberg.svx		
Description of entrance location: From doline that you reach via Shipstorm Passage, keep to the left wall and head to the big fallen boulder. 10m behind this is the draughting entrance. (Don't know how to get to the 4 other entrances!)		
Description of cave (or investigation): Head down the entrance boulders and then up the other side. Down a 3m climb (handline on the left to help you down, but can freeclimb up on right - as you look into the cave) into a large chamber with multiple ways on. - Right down through boulders leads in a cleft up choke, but also loops back round to straight ahead. - Straight ahead goes up to a climb (5m from cal) which goes on a slope. To the left it goes to an entrance, to the right it goes to a mud and passage and ends. - Back in the chamber, left leads to a T-junction where right goes to another entrance. Left traverses around a small pinkish phreatic tube. Straight ahead leads to another entrance/possible pit. Whilst right goes under and leads to another junction. P.T.D.		
Description of way on/termination/potential: At end junction drops down in both directions. This would require bolts and ~25m rope. Neither draft strongly and the left lead may link back to Whitelock.		
24/10/15 Update Left quickly terminates, right connects to Whitelock northern area. See separate sheet.		
Draughting? (circle closest match) ☒ Not detectable ☐ Slight ☐ Good ☐ Hoolie ☐ In Out		

Photography

On previous expeditions in Whiterock, when there were ‘rich pickings’ and large trunk passage was the rule rather than exception, the emphasis on galloping exploration saw teams pressing on and surveying to the max, noting favourable photo locations along the way. A dedicated photo team would later be sent in to these locations, often bringing back stunning photos of the beautiful or enormous passageways. That approach not only required a highly skilled photographer(s), but also meant many man-days could be consumed by photography rather than exploration.

Recent trips have focused more on ‘photos-as-you-go’, with perhaps less skilled photographers using affordable, lightweight equipment, and aiming for a collection of record shots rather than a few jaw dropping salon winners. No doubt this approach might unravel when the next big chamber or huge trunk passage is found, but for the nature of passages currently being explored in Whiterock it is perfectly adequate, efficient and productive, and possibly more useful.

During 2015 most parties took small digital cameras with them to produce a good range of record shots. Cat Moody explains her approach to it:

Lightweight Underground Photography

Catherine Moody

My approach to underground photography is somewhat different to that of many others. It is based on being as lightweight as possible, with the aim of being able to take pictures “on the go” quickly and easily so that every trip has the potential to be a “photography trip” without impacting heavily on exploration; i.e., minimal faff.

I use a compact Panasonic FT4 which, as it is waterproof and shockproof, does not need much in the way of protection (I use a home-made case comprising roll mat and gaffa tape) and can easily be carried in a pocket or the top of a tackle sack and whipped out at the drop of a hat.



For lighting, I aim to use ‘cavers’ headlights wherever possible, and frequently carry the camera with no additional lighting. The FT4 has a “handheld night mode” which takes multiple shots in quick succession then does clever things to combine them into one picture; it is useful for taking pictures in relatively low light without a tripod.

The manual mode, coupled with a mini flexible tripod (about £1 from ebay), allows long exposures to be used if desired. However, the vast majority of the photos I took on this expedition were handheld with no tripod.



*Huntsman spider - handheld/headtorch
Photo Cat Moody*



*Up & Running camp - handheld/single flash
Photo Cat Moody*

For where more light is required, I carry a single cheap flashgun with a Firefly 3, plus a small bicycle lamp (I rarely use the camera's in-built flash as this tends to create very misty-looking pictures). Although not enough to adequately illuminate large Mulu trunk passages, these lighting options can work quite effectively in smaller spaces. Aside from the camera, everything I use - including lights, tripod, spare batteries - will fit into a single 1 litre tupperware box so is small and light enough not to worry about carting around.

Whilst this approach is unlikely to ever produce stunning pictures – the kind achievable with expensive (fragile) SLR cameras and/or multiple flash guns (not to mention good photography skills) – it helps to serve a purpose: documentation; giving an impression of the cave and capturing exploration.

Lightweight Photography - take 2

Hugh St.Lawrence

I also try and take a lightweight kit along on most trips, but with a slightly different specification and approach. I use a Panasonic Lumix LX3, which has a 24mm wide-angle lens, full manual control and a hot shoe. A slave trigger is mounted on the hotshoe, and any number of slave flashguns can then be triggered on shutter release. I prefer to use flash only, where possible, as the different colour temperatures of flash v. headlamps produce (for me) undesirable colour variations in pictures. Flashguns are kept in ziplock bags with their infrared slave already attached and ready for action. The camera is kept in a padded dry bag wrapped in a towel useful for cleaning hands.



Equipment

Rob Middleton/Mark Brown

Equipment in Mulu consists of the cooking equipment, both for Camp 5 and for underground camps, ropes, drills, hangers, bolts, karabiners for normal expedition stuff, survey and drawing up kit, and first aid kits and a stretcher just in case. Much kit is left from previous years' expeditions and stored in Mulu, with only small changes each year. Improvements this year are noted below:

The Camp 5 team have been using dynamic rope with a Petzl Grigri belay device for bolt climbing. This allows for a greater margin of safety and the ability to free climb off the top of a bolt climb, as the angle eases, and still be protected.

The new Beal Unicore 8.5mm rope proved very good, being both tough and light, and replaces a number of vintage ropes of unknown origin, so that all rope currently in service is no more than 5 years old. At the end of the expedition all rope was checked, washed and dried, and all of unknown vintage was removed and destroyed.

8mm throughbolts are now standard, however HKDs still exist in various parts of the system. Throughbolts have the advantage over HKDs in that they can be drilled deeper and therefore bypass the less good rock at surface level. The new bolts bought for this expedition were made by Fischer (FXA 8/30x91) and were good and reliable. With rated breaking strains in tension of 16KN, unlike many cheaper bolts. A lighter more compact model of Makita SDS drill was also tested in Mulu this year (18V DHR165 as opposed to the bigger heavier DHR202 models used previously). Although it had a little less oomph (impact force) it was more than adequate for 8mm through bolts – and much lighter to carry or hold above your head for bolting. Indeed, so light were the new drill and battery that one party didn't even realise they had left it behind at Camp 5 until they reached the pitch head...!

Underground camps used to use large stoves that housed the burner and butane canister within a solid frame, but were bulky to carry long distances underground. Recent expeditions found an adapter (made by Kovea) for the locally available canisters, which meant lightweight portable stoves such as the Kovea Spider could be used, leaving much more space in tackle bags for other equipment such as drill batteries. Some use was made of dehydrated Wayfarer type meals from the UK, instead of the local sourced combination of instant noodles, chilli tuna and soup. These were more convenient to transport and saved on washing up (eaten from the packet), but risked causing excess baggage problems leaving the UK.

Clothing in Mulu is now in the form of fell running style leggings (Ron Hills etc.) and a lightweight wicking polypro or similar top. Finding a balance between something lightweight, not too hot, with freedom of movement, but some protection for knees and elbows when crawling or thrutching through sharp boulders is the difficult task. The new generation of technical footwear finding it's way into caving is discussed in the next section.

Canyoneer 3 boots

The 2015 Mulu Caves Expedition was grateful to be sponsored by FiveTen DzBrand of the Bravedz; receiving a significant discount on the Canyoneer 3 boots, so several of the team invested in the shoes. Mulu is a very tough environment for any footwear, and finding a shoe that copes well on the slippery rainforest roots and mud, whilst also gripping well on brittle or wet limestone and sediments underground is key to helping us to move fast and maximise exploration time.

The previous incarnation of the shoe (Canyoneer 2 –used by several expedition members in the past) has been updated with a new lacing system in place of the plastic strap and buckle arrangement. This allows a tighter fit across the foot to be achieved. However, the laces don't extend right up the neoprene cuff of the shoe, which meant that when walking in deep guano or on gritty stream-beds, the can shoes can fill up with said material and require emptying frequently. The Canyoneer 2 had a tighter fitting cuff thanks in part to a piece of Velcro. The problem could be solved by using Inov8 trainer gaiters.



The S1 stealth rubber was really grippy on rock and the deeper lugs of the Canyoneer 3 helped them cope with thick mud too. However, some factor about Mulu caused the glue holding the rubber onto the sole unit of some shoes to dissolve (perhaps heat/humidity/strong acids/alkalis in sediments/UV exposure (when drying at Camp 5) or a combination of all). This had to be repaired with glue (eg. 'Freesole'). The fabric on the toebox also disintegrated, possibly due to abrasion but may also have been due to the rand trying

to detach at the bend-point. Extending the rand further over the foot might eliminate this, but would reduce the quick draining ability of the shoe.

The Canyoneer 3 boots are extremely comfortable and light, so you can wear them on the approach and in the cave, far preferable to the alternatives such as heavy wellies or wearing sodden hiking boots for extended periods.



A common scourge of caving in Mulu is the 'Mulu Foot', a very painful condition believed to be caused by a combination of bacterial and fungal action from sediments, and abrasion of feet that are wet for prolonged periods. Many found that using the Canyoneer 3s with Sealskinz socks to keep their feet dry and grit free eliminated the condition. Others used normal synthetic socks that dried more quickly in the well ventilated Canyoneers.

Overall, those who used the Canyoneer 3s for the Mulu expedition would choose to use them again; and many will use them for sport caving in the UK too.



Medical Notes

Hugh St.Lawrence

For the Camp 5 team there was little to report in the way of medical conditions, injuries or mishaps. No one suffered from Mulu Foot, perhaps because personal footcare is high on the agenda these days, learned from the history of how debilitating the condition can be. The usual scrapes and cuts of everyday caving were treated successfully with iodine and/or antiseptic creams such as Germolene.

Towards the end of the expedition one member suffered a swollen forearm, probably as a result of an insect bite. This responded quickly to a course of antibiotics and had more or less normalised by the time the plane out of Mulu was boarded. Another member reported his feet “being on fire” during a night camp in Whiterock. This wasn’t Mulu Foot but resulted in the sufferer spending an agonising night trying not to scratch his feet... the momentary relief only making things worse! It was reported as being so bad that the caver wished for a knife so that he could cut his feet off! The condition cleared up of its own accord and did not return.

There were two conditions or incidents which did impact on overall manpower, but neither were acquired in the field. One member endured an expedition-long ‘performance drain’, acknowledging that something was up and that he just wasn’t operating on full bore. It didn’t altogether stop his activities, but he felt he couldn’t contribute at the level he was used to. After a lot of tests back in the UK, he was found to have a vitamin D deficiency, and once identified and treated the caver returned to his normal performance level. Vitamin D conditions are commonly associated with a lack of sunlight - something which might affect all cavers in time!

The other condition, which stole about 10 man-days from the expedition, befell the expedition leader who suffered a pre-expedition appendicitis, throwing his whole expedition appearance into doubt. Following an appendectomy he did eventually make it out to Camp 5 and resumed leadership duties and some ‘gentle’ caving, culminating in a round trip through the Apprenticeship in Whiterock Cave to test the stitching. We’re happy to report that everything held!

Sponsors

- The ‘Five Ten’ company for discount supply of the excellent Canyoneer 3 boots.
www.fiveten.com/uk
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www.industrialropeaccess.co.uk
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www.commendium.com

Conclusions & Prospects

Mark Brown

The expedition had a diverse set of objectives, which were largely met, despite unwelcome setbacks before departure and a serious accident and rescue in the field. But there were plenty of welcome surprises in speleological terms – the new extensions to Wonder Cave in the Hidden Valley could unlock a vast area of limestone under Gunung Api. And the discovery that the “top levels” of Whiterock Cave do exist (and are not completely blocked with breakdown) holds promise that the Clearwater System can be extended in both its northern and southern areas, allowing it to work its way steadily up the rankings of the world’s longest caves.

The immense 200m height of Api Chamber, revealed by the laser scan, was a surprise to many, but it explained the haunting “double” echo from afar that can be heard in there.

Exploration in Whiterock Cave yielded 8km of newly surveyed passages, bringing the Whiterock total to 96.7km; the next expedition to explore it must surely break the 100km barrier. The Clearwater System length, as a result, is now 215km, placing it firmly at eighth longest in the world. A further 8km will make it longer than the Lechuguilla Cave in the U.S.A; again, this could be achievable on the next expedition, considering the number of leads available in various parts of the system. The total cave surveyed in the Mulu National Park is now 408km (plus a further 74km in Gunung Buda National Park).

Cave exploration is not all about large numbers, of course; time spent searching on the surface for new entrances, and attempting to enter them, is absorbing and exciting work, too. The Hidden Valley team proved this, as did the Melinau Gorge team striving for the new entrance into Gunung Benarat. Ticking off various bolt climbs, such as the roof tube in Red Tip Racer is also time consuming work, but can pay large dividends when it does break into new horizontal passages. Red Tip Racer did not pay off this time, but the climbs in Apprentice Passage in Whiterock and at the far end of Wonder Cave certainly did.

The work trying to connect systems such as Cave of the Winds to Racer Cave may only yield tens of metres each day, along with a good deal of discomfort. But one day the connections will be made and significantly add to the length of the Clearwater System.

The Hidden Valley team’s accident and subsequent rescue has provided some valuable lessons for future Mulu trips in general, and how to make improvements to backup and support systems.

The multi-faceted expedition had various advantages and disadvantages over a smaller team with more focussed objectives. It was certainly more work to organise, coordinate in the field and write up afterwards. But it also provided an interesting variety of experience, techniques and caving companions. One thing that was certain was that logistics coordinator Veno Enar and his assistants were never bored!

The number of caving leads remaining in Mulu are sure to provide future expeditions with many more surprises, and the almost certain guarantee of spectacular and fascinating caves in a wonderful national park.

Expedition Members

Hidden Valley Team (see separate report)

Andy Eavis, Tony White, Dave Nixon, Colin Boothroyd, Rob Eavis

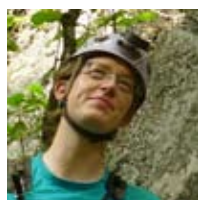
Camp 5 Exploration Team



Mark Brown (leader)



Rosie Hadfield



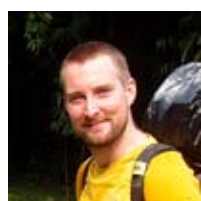
Catherine Moody



Hannah Moulton



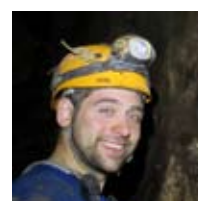
Louise Korsgaard



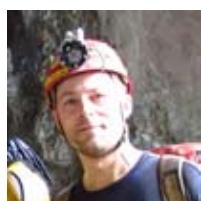
Andy Vick



Richard Hudson



Robert Middleton



Torben Redder



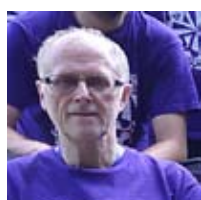
Frank Pearson



Hugh St. Lawrence



Matt Kirby



Dave Clucas



Veno Enar (logistics)



Matthew Mani (cook)



Norton Ting

Api Chamber Scanning Team



Andy Eavis



Pete Smart



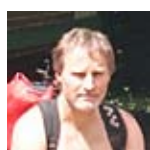
Richard Walters



Rambli Ahmad



Christopher Imang Ngau



Carsten Peters (photography)

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Alison Pritchard

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FURTHER READING

Briggs J. 1988.

'Mountains of Malaysia', Longman, Malaysia

Brook D. B. & Waltham A.C. (editors) 1978.

'Caves of Mulu', Royal Geographical Society, London.

Eavis A.J. (compiler) 1981.

'Caves of Mulu '80', Royal Geographical Society, London.

Eavis A.J. (compiler) 1985.

'Caves of Mulu '84', British Cave Research Association. UK.

Fogg P. (editor) 2000.

'Benarat 2000 Expedition Report', Benarat 2000

Kirby M.J. (editor) 1989.

'Mulu Caves '88 Expedition Report', Cave Science, Volume 16, No. 2. British Cave Research Association. UK.

Kirby M.J. (editor) 1990.

'Mulu Caves '89 Expedition Report'. Mulu Caves '88.

Kirby M.J. (editor) 1992.

'Mulu Caves '91 Expedition Report'. Mulu Caves '89.

Kirby M.J. (editor) 1993.

'Hidden Valley '93 Reconnaissance Expedition Report'. Hidden Valley '93.

Kirby M.J. (editor) 1998.

'The Caves of Hidden Valley', Mulu Caves '96 & '98 Expeditions Report. Mulu Caves '96 & '98

Kirby M.J. (editor) 2008.

'Mulu Caves '07 Expedition Report'. the Mulu Caves Project.

Kirby M.J. (editor) 2009.

'Mulu Caves '09 Expedition Report'. the Mulu Caves Project.

Kirby M.J. (editor) 2010.

'Mulu Caves 2010 Expedition Report'. the Mulu Caves Project.

Kirby M.J. (editor) 2011.

'Mulu Caves 2011 Expedition Report'. the Mulu Caves Project.

Meredith/Wooldridge/Lyon 1992.

'Giant Caves of Borneo'. Tropical Press Sdn. Bhd., Kuala Lumpur.

Smart P. & Willis R.G. (compilers) 1982.

'Mulu', Cave Science, Volume 9, No. 2, British Cave Research Association, UK.

St. John S. 1862.

'Life in the Forests of the Far East', Smith Elder & Co., London. Reprinted by the Oxford University Press, 1986.

Weight A. (editor) 1990

'Gunung Api Connection Expedition Report', Gunung Api Connection 1990

Willis R.G. (editor) 2003.

'Benarat 2003 Expedition Report', Benarat 2003

Willis R.G. (editor) 2005.

'Benarat 2005 Expedition Report', Benarat 2005

Willis R.G. (editor) 2012.

'Mulu Caves 2012 Expedition Report', Mulu Caves 2012

Brown M.W. (editor) 2013.

'Mulu Caves 2013 Expedition Report', Mulu Caves 2015

St.Lawrence, H. (editor) 2014.

'Mulu Caves 2014 Expedition Report', Mulu Caves 2014

Eavis.R & Nixon.D (editors) 2015.

'Hidden Valley 2015 Expedition Report', Mulu Caves Project 2015

Appendix 1.

The Northern Entrance and the Exploration of the Clearwater System

Matt Kirby

For the last ten years the possibility that the Clearwater System would break out into the Melinau Gorge has been the Holy Grail for a small band of determined Mulu explorers. To fully understand their passion it's worth backtracking thirty eight years to 1978 and the Royal Geographical Society's Gunong Mulu Expedition.

During that year six British cavers were invited to join one of the largest ever scientific expeditions to leave the UK. The expedition's aim was to research the rainforest of the Gunung Mulu area on behalf of the Sarawak government who were to designate the area as a National Park. The caving team had been brought in during the latter part of the expedition specifically to explore caves which were known to exist in the foothills of Gunungs Benarat and Api and in the Deer Cave Massif.

Whilst exploring a large inlet off the Melinau river, a resurgence was found where crystal clear water welled up from the stream bed. This could only mean one thing, caves. Dave Brook and Mike Farnworth headed up the steep, vegetated slope and in a short time Clearwater main entrance had been discovered; the rest is history.

During that expedition Andy Eavis and Dave Brook explored the main Revival passages and pushed northwards to one of the smallest and most awkward entrances in Mulu, the Northern Exit. This was to remain the most northerly entrance to the Clearwater System for 13 years. By 1984 Clearwater had grown to 52km in length.

During 1988 a new team visited Mulu with the aim of exploring Api northwards from the Northern Exit. However, before this, the local authorities had asked the team to try to connect Cave of the Winds and Clearwater so they could claim to have the longest cave in Southern Asia. On plan the two caves were within 30m of each other although, in passages of this size and complexity, joining them wasn't straightforward. But luck was on their side and, after three days of poking around in some small crawls off side passages, the breakthrough was made through boulders between Illusion Passage and King Seth's Maze; Clearwater was now 58km long and Sarawak had the longest cave in Southern Asia.



1978 - a section of the large Revival passage

Blackrock discovery

After their success in Cave of the Winds the expedition headed north to a forest camp at Leopard Cave. This was a small team of six and, whilst exploration was being carried out in Ronnies Delight and Leopard Cave, Matt Kirby and Richard Chambers together with local guide Noah Abang headed north from the camp. The draught from the Northern Exit was relocated, but so small and tight was the entrance that the

pair thought it must have collapsed. They pushed on past Imperial Cave and into the unknown. On the third day of exploration Matt spotted leaves moving on a ledge up the slope suggesting a cave draught. Investigation revealed a small entrance (Centipede) with a powerful draught emitting; Blackrock Cave had been discovered. This became the main thrust of that expedition and within three weeks the team had explored 14km of large base-level cave including two river passages. The Blackrock River, which was later proved to run into the Clearwater River, and the Firecracker River which ran into a downstream sump. Firecracker passage headed north into new ground where the survey team enjoyed the luxury of seventy consecutive 30m survey legs in passage up to 50m x 50m. They simply ran out of time to complete this section and, owing to an accident which resulted in the rescue of a team member, they never returned to the limit of exploration that year.

In 1989, eleven months later, the team returned specifically to continue exploring Firecracker. But as we all know 'caves are where you find them' and luck wasn't on their side this time. A further 50m of survey led into a heavily calcited collapse, Guy Fawkes Chamber, which suggested proximity to the surface. In other parts of the cave a great deal of effort was made to find higher development, but bolting was in its infancy and miles away from the high speed techniques of today, so although many massive ramps were seen heading up into the blackness no major breakthroughs were made. However, determined climbing by Tim Fogg and local guide Paris Wan did lead into an isolated high level section at the southern end of the cave. This passage, Ramparts, ended in a rift passage with a waterfall at the 'end' with "no way on". There was no hint of a connection with Clearwater although the two caves were now only 600m apart. The team had extended Blackrock to 21km. Further exploration in Clearwater revealed the Armistice series which added 15km to its length. But Blackrock was still 2km from the Melinau Gorge, its main passages truncated by a prominent cliff line, The White Cliff, running west-east, with no real prospect of any northerly extensions. The only way round this cliff line would be by finding passages deeper in the mountain, but Blackrock didn't appear to have any easterly leads which would allow this.

The Clearwater connection

In 1991 a team returned to further investigate Ramparts and look for a possible way through to Clearwater. Early in the expedition a small team had entered West Passage in Clearwater to look for possible leads northwards, this drew a blank. The Ramparts team headed for the 1989 end point only to find the 1989 waterfall completely dry and a wide-open passage continuing beyond. After 600m of awkward caving Tim Allen, Dick Willis and

local guide Robert Gani popped out into West passage where Dick had been a few days previously. Blackrock and Clearwater were connected and the Clearwater System was now 102km long but still nowhere near the Melinau Gorge and no easterly leads



1991 - Tim Allen, Robert Gani and Dick Willis at the Blackrock-Clearwater connection point

had been found which would allow the cave to pass the prominent White Cliff. To this date this relatively small connection (the Petrus' Dream Series) is the only link between Clearwater and the Blackrock/Whiterock system.

In the same year another team visited the Park and connected Leopard Cave into the Petrus' Dream Series, linking it into the Clearwater System.

For the next twelve years the Clearwater/Blackrock system and western side of Api was largely ignored in favour of exploration of Hidden Valley. But in 2003 a team were going back to Camp 5 to continue exploration in Gunung Benarat. To Matt Kirby and Richard Chambers this seemed like an ideal opportunity to explore the north western slopes of Api, south from the Pinnacles, from the luxury of a base camp at Camp 5. And so the pair returned to their favoured stomping ground, Api. Whilst the rest of the team headed north over the Melinau bridge to Benarat, they went south. Their first objective was to relocate the Blackrock entrances, not visited for twelve years, from the north. This was to be a thankless task owing to the inhospitable, complex nature of the ground. Their forays resulted in many wasted hours, lots of foot slogging and a great deal of frustration which entertained the rest of the team and resulted in the pair being known forevermore as the 'Pointless Crew', a dubious honour given the effort they had expended. Blackrock remained elusive that year and wasn't relocated until 2005, it had been 'lost' for fourteen years and to this day the original Centipede entrance has never been relocated.

Whiterock Cave

However, in 2003 the Pointless Team had the last laugh. After giving up on Blackrock they headed directly for the White Cliff approximately 2km south of Camp 5. This west-east running cliff was in the approximate position of Guy Fawkes Chamber at the northern end of the Firecracker River and truncated the northern end of Blackrock. A direct route over low lying karst gained the base of the cliff and within fifteen minutes the pair had spotted a howling draught falling down the slopes causing trees and leaves



The prominent 'white cliff' on the west flank of Api which terminates several north-bound passages such as Firecracker. The approx. position of the original entrance to Whiterock Cave is arrowed.

to sway wildly in the breeze. An awkward climb up-slope revealed a 10m shaft up which a tremendous draught was emitting. Swifts were flying down the shaft at speed and disappearing into an opening at its base. Armed only with a short handline, one SRT kit and a lot of determination they climbed down to find a beautiful

calcited chamber. Whiterock Cave had been discovered, and within the last three days of the expedition it was explored to 3.7km long with leads heading off in all directions, a very exciting find, in an area of the mountain level with the northern end of Firecracker and with great potential for extending the known limits of the Clearwater System northwards.

The 2005 expedition headed back to Whiterock but the theory that it would break into Blackrock within a few days was dashed when it passed right over the top of it and headed labyrinthine into the mountain both north, south and most importantly eastwards. Some bold climbs by Tim Allen revealed massive high level passages which defied description. The main thrust of the expedition was southwards with the discovery of Api Chamber, but connections were also made with Firecracker and the Eagle's Ramp in Blackrock. So now Whiterock was connected to the Clearwater System which, by the end of the expedition, was 129km long. Many leads were left unexplored including some tantalising passages deeper into the mountain which headed north towards the Melinau Gorge.

North to the Melinau Gorge

In 2007 Whiterock was the focus of exploration with northern leads being some of the first to be explored. Exploration of the Northern Line, a technically difficult bouldery passage, resulted in the most northerly point of the cave being only 430m short of Camp 5. This was very exciting news with great potential that the Clearwater System might, just might, pop out into the Melinau Gorge. At the same time another insignificant lead was explored up a bouldery ramp off the Northern Line. This revealed another main trunk route, 1954, running parallel to the Northern Line but 60m above it; would this be the way out into the gorge? Alas no. Although this series was relatively easy to explore, and contained some of the most amazing formations in Mulu, after much poking around at the northern end, no entrances, or hints of entrances, were found. But the passage did end tantalisingly close to Camp 5.

In 2009 the team returned to Whiterock and a large passage off the northern end of 1954, Mysterious Ways, was discovered heading for the Pinnacles track but not breaking surface, this proved to end within 350m of Camp 5 so the cave was slowly advancing northwards. At the end of the expedition a small steeply-descending ramp off 1954 was pushed. It was thought this would lead down into the Northern Line 60m below but it didn't, it continued down for a total of 167m to emerge into a large river passage, the Whiterock River. This headed both north and south

but amazingly the northernmost point appeared to be 75m almost directly beneath Camp 5 and the Melinau River. How could a massive passage like this exist beneath the Melinau Gorge without the surface river entering it? Exploration ended at a prominent crossroads, kindly named Pointless Junction after the team who discovered the cave.



Pointless Junction, at the northern upstream end of the Whiterock River, 75m beneath Camp 5

No Country for Old Men

Knowing the proximity of the cave to the surface it was decided to explore the foot slopes of the Melinau Gorge in the vicinity of the end of the Northern Line and 1954. The relationship between the surface features and cave passages was uncertain because of the length of loop survey from Camp 5 down to the Whiterock entrance and back up to the northern end of the cave. However, a draughting cave was found in the general area of interest. This proved to be for the slimmer caver only and not typical of Mulu. After five squeezes, all of which required modification with a lump hammer, the cave closed down in well decorated tall rifts and a draughting boulder choke which headed back to the cliff. The Cave was named No Country for Old Men and remains one of the tightest caves in Mulu, the entrance lying at almost the same horizon as the Northern Line.



Entry to No Country for Old Men is not simple!

In 2011 exploration of the Whiterock River continued southwards and passages off Pointless Junction were explored to draughting chokes with massive water-worn boulders. These points were within 290m of Camp 5 but 60m below it. During this expedition bats were seen flying around Pointless Junction. As these creatures never venture far from an entrance this confirms that a Northern Entrance does indeed exist, if only for very small flying creatures; if only finding it was simple!

The expedition used radiolocation to tie together the underground passages with the surface topography, to better understand the relationship between the two and where to look, or where to dig. A radio-location station was set up at the end of Mysterious Ways and a survey station was established just off the Pinnacles Track some 38m vertically above. With a clear understanding of where the underground passages lay in relation to the surface topography it would surely be a short matter of time before the Holy Grail was found; but nothing is ever that simple in Mulu.

Finding cave entrances on the Benarat side of the gorge has been relatively simple - big white cliff, black holes in the face = cave entrances. Unfortunately the Api side is far more complex. Unlike Benarat, there is no massive cliff face and the few cliff faces are obscured by trees with no chances of seeing entrances from a vantage point on the Benarat side. Unlike the south facing Benarat cliffs, which benefit from full sunlight, the north facing Api cliffs are nearly always in the shade. This means feet-on-the-ground has been the only way to find caves on this side of the river. The Api side of the gorge has been explored by many teams over the years but none had imagined that 75m beneath their feet lay a major river passage, in fact the northern end of the Clearwater River. Now, with this knowledge, the potential for gaining access to the Clearwater System from the Melinau Gorge has never been so high.

So what is the potential?

Surface Potential

- Doline Sink: It would appear that the Whiterock River is fed from marginal drainage on the south side of the gorge, possibly via multiple small sinks. The main feeder is the Doline Sink, a large depression 610m south east of Camp 5 but only 245m east of the Whiterock River passages and 32m higher. This sink takes drainage from two surface streams running off the alluvium. One of these originates as a resurgence from Api further up-slope. The sink is filled with boulders and some investigation has been carried out in wet and dismal passages between boulders. This would be a very difficult prospect to explore further and it could only be carried out during dry/settled conditions. During 2015 it was noted that massive tree fall has made access to the sink difficult.

- Bouldery Sink: 540m south east of Camp 5 a small stream enters boulders at the base of the foot slope. This is Bouldery Sink and lies 171m east of the Whiterock River passages but 37m higher. There is potential here for digging but only during dry weather.

- Cairn Pot: 480m south east of Camp 5 a draughting hole, Cairn Pot, was discovered in low lying karst at the base of the foot slope. This tight entrance was investigated and dropped into competent but small passage which soon ended in a very tight crawl into a small bouldery chamber. Further investigation, and some digging here may be worthwhile. This cave is only 109m from the Whiterock River passages but 42m higher.

- No Country for Old Men: 434m south east of Camp 5 is the entrance to No Country for Old Men. This entrance is at the top of the footslope and the base of cliffs. The entrance is at approximately the same horizon as the Northern Line but the cave descends steeply so that at its closest point it lies 90m north-east of the Northern Line but 32m lower. This cave has been thoroughly investigated but no leads were left. Draughts within the cave emerge from a boulder choke and are thought to originate from the cliff line. But this cave is always worth another look.

- Dry Valley Draughting Hole: 380m south east of Camp 5 is a dry valley at the base of the foot slopes (possibly an overflow from the Swamp Feature; see below). A small hole in boulders has been found to draught strongly. Boulder chokes at the northern and eastern extremities of the Whiterock River draught strongly. These points are very close to the valley feature. This small insignificant hole is the closest point to the Whiterock River passages which, at this point, is a mere 60m below, the closest passage is only 61m away from the draughting hole. Could a dig here reveal competent passage or would it be necessary to excavate through 60m of boulders? A dig in this area would be very interesting. At present this is one of the best leads.

- The Swamp Feature: 350m south west of Camp 5 at the base of the foot slope there is a swampy area, the Swamp Feature, which on close investigation was found to be draining into small sinks at its western end. None of these were found to be draughting but their proximity to



Smoke testing the draughting hole in the dry valley

the Whiterock River passages makes this a very interesting feature with some potential for digging.

- Foot Slopes: General investigation of the foot slopes to the south east of Camp 5 between the Doline Sink and the Swamp Feature are worthwhile. Even though these have been searched many times there is always potential here. .
- Features in the Cliffs: 1954 is heading for the cliffs directly above No Country for Old Men. Unfortunately these north-facing cliffs are tall and heavily vegetated so views of the cliff face are obscured. Film from helicopter flights has revealed some dark areas behind trees but without climbing up the cliffs it will never be known whether these are cave entrances or just shadows. It would be well worth flying a camera drone close to the cliffs to further investigate the 'dark shadows'.
- Cliff Climbing: Over many years the slopes to the south of Camp 5 have been investigated with no significant discoveries. Climbing the Pinnacles track to the 550m mark then heading east across the slope leads onto the cliffs above No Country for Old Men. Ledges lead east and eventually peter out at a large buttress with no views onwards. This is on approximately the same level as the shadows seen from the helicopter behind trees. A small hole on the ledges is Last Gasp Cave, a small tube which descends for approximately 10m to a small chamber. There is no potential here but climbing out onto the cliffs may reveal entrances, this would not be an easy prospect and would almost certainly require support/spotting from a camera drone in order to direct climbers.

Underground Potential

- Pointless Junction Area: This area, at the northern end of the Whiterock River, is very complex with many small passages and avens heading north and eastwards. The main water inlet has not been pushed. This appears as a cascading waterfall. Gone with the Wind heads south from here in handsome sized passage and there is chance that something has been missed here. The most significant feature of this area is that bats were seen around Pointless Junction. These creatures do not venture far from an entrance. Although they can enter through small openings it does prove that a Northern Entrance exists if only for bats. Further investigation of this area and the bat routes may reveal something.
- Gone With the Wind Rift: Although this tall rift, leading up from a bend in Gone With the Wind, is remote from the cliff line it may lead into higher passages with potential for heading northwards. It is worth trying to scale this rift.
- The Northern Line: The end of the Northern Line itself was thoroughly investigated and is in relatively small passage which is heavily calcified, typical of passages close to the surface. Access to this point is arduous and the potential here is low, but never say never.
- 1954: 1954 ends in quite large and complex passage and it is always possible that something may have been missed here at the extremities of the chambers. Although there were no discernable draughts noted in this area it is a very large passage and weather conditions may not have been favourable for draughts at the time. Although remote, this area is well worth another visit.

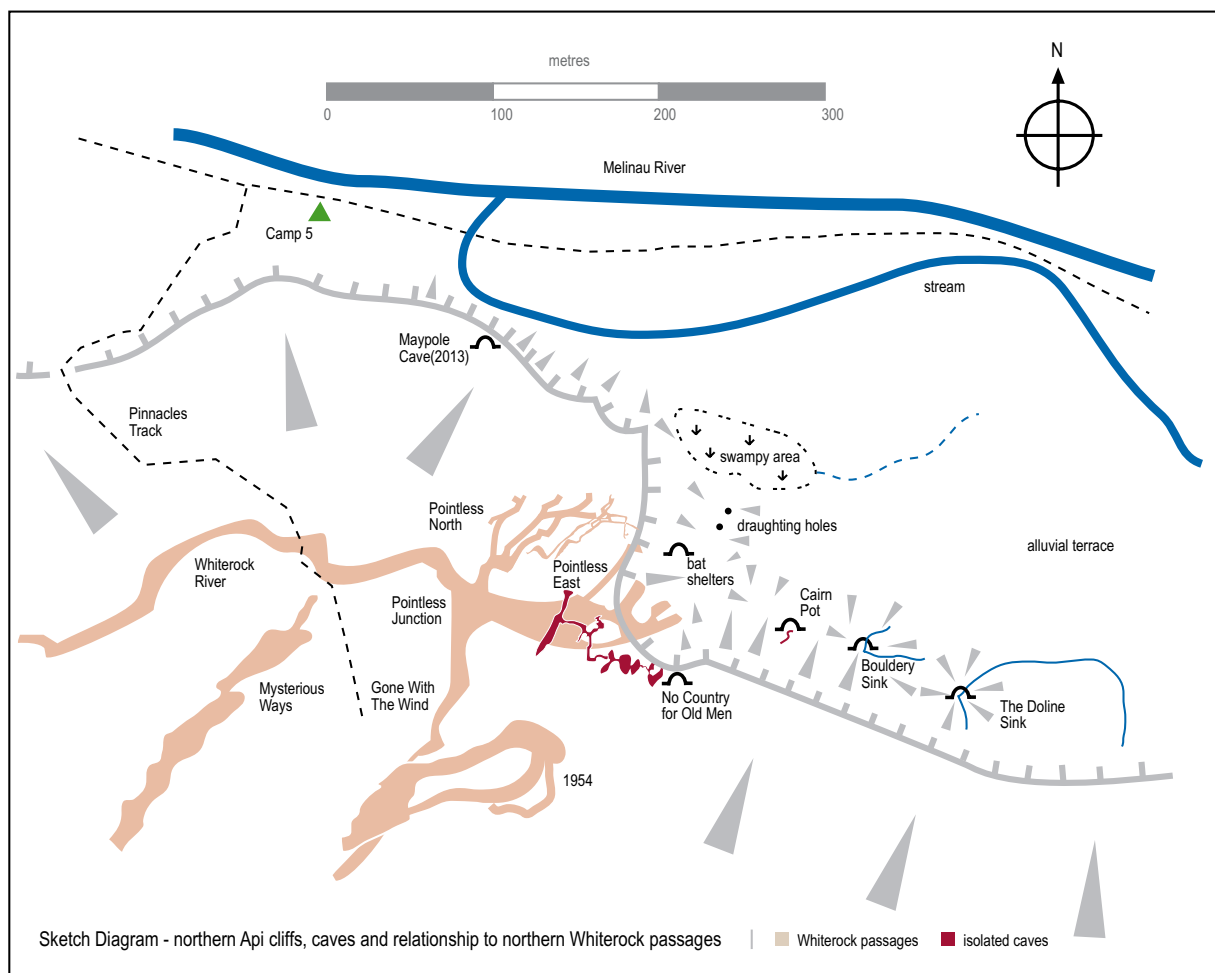
Conclusions

The discovery of Whiterock Cave in 2003 was the key to the northern development of the Clearwater System, allowing it to bypass the White Cliff and head single-mindedly

towards the Melinau Gorge. Whiterock grew rapidly and now, after only 12 years of exploration, it stands as the longest cave in Mulu at over 96km. Not forgetting Blackrock which, lying directly underneath Whiterock, is indeed the base level of the same cave; their combined length is in excess of 119km.

So, will a northern entrance be found? Well, bats have already proven its existence, no matter what size it is, it exists; the next step is to find it. Although the northern extremities of the Clearwater System are extremely close to breaking surface in the Melinau Gorge it may be difficult to discover the elusive way into the System from here. Only determination and a willingness to explore will reveal the entrance which would create a through-trip from the Melinau Gorge all the way to Cave of the Winds some 10.8km to the south. This would surely be a through-trip high in the world ranking. With so much potential in very close proximity to the luxury of Camp 5 it is surely only a matter of time until the elusive Northern Entrance to the Clearwater System is discovered.

Keep exploring!



Mulu 2015 Surveying Log

Date	Team	Area/Cave	Area within cave	Series Name	Survex filename	Lengths from survex logs	Totals
Whiterock							
17-Oct-15	FP CM	Whiterock	Green Wing	Green Feather	green_feather	61.81	
18-Oct-15	HSL CM	Whiterock	Green Wing	Black & Tan	black_and_tan	114.95	
21.10.15	HM RH RM	Whiterock	Strong hint Bigness north end	Dirty Little Secrets	1st_dirty_little_secrets	50.68	
21.10.16	HM RH RM	Whiterock	Strong hint Bigness north end	Dirty Little Secrets	2nd_dirty_little_secrets	75.12	
21.10.17	HM RH RM	Whiterock	Strong hint Bigness north end	Dirty Little Secrets	3rd_dirty_little_secrets	112.6	
21.10.18	HM RH RM	Whiterock	Strong hint Bigness north end	Dirty Little Secrets	4th_dirty_little_secrets	547.14	
21.10.19	HM RH RM	Whiterock	Strong hint Bigness north end	Dirty Little Secrets	5 th _dirty_little_secrets	770.34	
21.10.15	CM RAH AV	Whiterock	Above Apprentice	Firestorm	jarlsberg	470.65	
	RAH AV TR	Whiterock	Apprentice	Skeleton	skeleton	319.64	
	RAH AV TR	Whiterock	Above Apprentice	Firestorm	swift_progress	1086.46	
21.10.15	CM RAH AV	Whiterock	Above Apprentice	Firestorm	swift_progress_lower	170.53	
21.10.15	CM RAH AV	Whiterock	Above Apprentice	Firestorm	swift_progress_northern	357.81	
21.10.15	CM RAH AV	Whiterock	Above Apprentice	Firestorm	swift_progress_upper	273.68	
25.10.2015	RAH CM	Whiterock	Apprentice		skeleton_lower	250.63	
26.10.2015	HM RH RM	Whiterock	Strong hint Bigness north end	Dirty Little Secrets	Medusa_1	88.96	
26.10.2015	HM RH RM	Whiterock	Strong hint Bigness north end	Dirty Little Secrets	Medusa_2	527.72	
27.10.2015	HM RH RM	Whiterock	Strong hint Bigness north end	Dirty Little Secrets	Filthy_Derbyshire_Habits	388.54	
27.10.2015	RH CM	Whiterock	Up and running	Apprenticeship	graveyard	94.25	
28.10.2015	MB PLS LK	Whiterock	Big Issue	Troubling Appendix	troubling_appendix	677.58	
31.10.2015	RH RAH CM	Whiterock	Bigness S	Bigness South	Last Chance #2	32	
31.10.2015	RH RAH CM	Whiterock	Bigness S	Bigness South	Last Chance #3	254.44	
31.10.2015	RH RAH CM	Whiterock	Bigness S	Bigness South	Last Chance #4	39.16	
31.10.2015	RH RAH CM	Whiterock	Bigness S	Bigness South	Last Chance #5	48.79	
31.10.2015	RH RAH CM	Whiterock	Bigness S	Bigness South	Last Chance #6	187.45	561.84
31.10.2016	RM HM HSL	Whiterock	Perfect Mulu Manners	Centurion	centurion	925.84	
31.10.2017	RM HM HSL	Whiterock	Africa	Apartheid	apartheid	152.52	
				Whiterock		8079.29	8079.29
Hidden Valley							
10-20.10.2015	RJE, DAN, TWE, CB	Hidden valley	conviction cave			467.24	
			doing time			795.18	
			governors pleasure			331.56	
			rhino canyon			480.29	
				Hidden Valley Total		2074.27	2074.27
			elephants graveyard (resurvey)			477.17	
			generation gap (resurvey)			518.3	
		Hidden valley	wonder cave entrance (resurvey)			238.46	
Other caves							
08-Oct-15	HSL FP	Clearwater	Cave of the winds	Snake Chimney resurvey (added 16.59 to 2014 length)	Snake_chimney	204.18	16.59
					snake chim resurvey	187.59	
29.10.2015	RM HM RH	Melinau gorge (Api side)	red tip racer		redtipracerclimb	117.91	117.91
10-Jan-00	PLS, LK, CB	Lagangs				767.3	767.3
		Lagangs resurvey				212	
				Expedition Total			11055.36
				Resurvey Total			1633.52

MWB- Mark Brown 1
 RAH – Rosie Hadfield 2
 RH – Rich Hudson 3
 MK – Matt Kirby 4
 LK – Louise Korsgaard 5
 RM – Rob Middleton 6
 HM – Hannah Moulton 7
 CM – Cat Moody 8
 FP – Frank Pearson 9
 TR – Torben Redder 10
 HSL – Hugh St. Lawrence 11
 AV -Andy Vick 12

HV team

DAN - Dave Nixon
 CB - Colin Boothroyd
 TW - Tony White
 RJE – Rob Eavis

Scan team

PLS – Pete Smart
 AJE – Andy Eavis
 RW – Roo Walters

The Caves of Mulu

English Name	Malay Name	Exped's up to B'rat '05 inc.	Mulu '07	Mulu '09	Mulu '10	Mulu '11	Mulu '12	Mulu '13	Mulu '14	Mulu '15	Total Lengths
Gunung Api Caves											
Clearwater Cave	<i>Gua Air Jernih</i>	73150.70							9866.29		83,016.99
Cleartop Cave	-	-									0.00
Lady's Cave	-	323.80									323.80
Cave of the Winds	<i>Gua Angin</i>	7788.20							484.73	380.89	8,653.82
Drunken Forest Cave	-	1300.00									1,300.00
Blackrock Cave	<i>Gua Batu Hitam</i>	22348.00		93.30							22,441.30
Leopard Cave	<i>Gua Harimau Bintang</i>	3719.10									3,719.10
Whiterock Cave	<i>Gua Batu Putih</i>	20980.68	21986.14	24075.14		13365.11		7947.44		8079.29	96,433.80
Nilong's Cave	<i>Lubang Nilong</i>	-									0.00
Lagang's Cave	<i>Lubang Lagang</i>	3900.00					1660.00		1545.35	767.30	7,872.65
Water Polo Cave	-	-									0.00
Solo	<i>Sendirian</i>	259.00									259.00
Cobra Cave	<i>Lubang Lipah Siléh</i>	3400.00									3,400.00
Good Luck Cave	<i>Lubang Nasib Bagus</i>	2900.00							603.00		3,503.00
Prediction Cave	<i>Lubang Ramalan</i>	652.00									652.00
Wonder Cave	<i>Gua Ajaib</i>	4970.00								2074.27	7,044.27
Imperial Cave	<i>Gua Imperial</i>	705.00									705.00
Birthday Cave	<i>Gua Harijadi</i>	200.00									200.00
Noah's Cave	<i>Lubang Noah</i>	425.00									425.00
Python Exit	-	80.00									80.00
Simon's Cave (Racer)	<i>Lubang Simon</i>	5307.20							4127.29		9,434.49
Metric Cave	<i>Gua Metric</i>	1085.30									1,085.30
Snail Cave	<i>Gua Supit</i>	361.00									361.00
Ipoi's Cave	<i>Lubang Ipoi</i>	233.80									233.80
Palm Cave	<i>Gua Sogo</i>	849.50									849.50
Damocles Cave	<i>Gua Damocles</i>	244.90									244.90
No Name Cave	-	70.00									70.00
Yellow Viper's Pit	-	124.00									124.00
Arch Cave	<i>Gua Gerbang</i>	980.50									980.50
Perseverance Cave	<i>Gua Ketabahan</i>	1578.80									1,578.80
Bridge Cave	<i>Gua Jambatan</i>	9891.00									9,891.00
Cloud Cave	<i>Gua Awan</i>	2209.90									2,209.90
Invader Streamway	-	618.60									618.60
Tiger Back Cave	<i>Gua Harimau</i>	296.70									296.70
Tiger Water Cave	<i>Gua Harimau</i>	1285.80									1,285.80
Highest Cave in Mulu	-	280.00									280.00
Helicopter Cave	-	30.00									30.00
Western Front Cave	-	30.00									30.00
Moonmilk Cave	<i>Gua Bulan Susa</i>	115.00									115.00
Snail Shell Cave	-	112.30									112.30
Tree Cave	-	27.70									27.70
Pinnacle Cave	-	316.20									316.20
Bat Cave	-	219.90									219.90
Rat Cave	-	266.30									266.30
Frog Cave	-	-		76.50							76.50
Penan Pot Cave	-	-		0.00							0.00
Pinnacle Cave No 2	-	185.30									185.30
Pre Repast Cave	-	-	0.00			26.59					26.59
Rock Shelter	-	-	0.00								0.00
Likoh Cave	-	-	0.00								0.00
Shatterbox	-	-	0.00								0.00
White Rift Cave	-	-	83.90								83.90
No County for Old Men	-	-		381.59							381.59
Red Tip Racer Cave	-	-				556.13				117.91	674.04
Cairn Pot	-	-				16.55					16.55
Moon Rising (Surprisingly Obvious)	-	-					279.00				279.00
Red Leaf Monkey Cave 1	-	-					1262.00				1,262.00
Red Leaf Monkey Cave 2	-	-					850.00				850.00
Gift Horse Cave	-	-					104.00				104.00
Train Cave	-	-					5130.47				5,130.47
Consolation Cave	-	-					117.00				117.00
Doline Sink	-	-						47.41			47.41
Maypole Hole	-	-						8.50			8.50
Api Total											279,934.27
Gunung Benarat Caves											
Moon Cave	<i>Gua Bulan</i>	6635.00	3787.77								10,422.77
Benarat Caverns	<i>Lubang Benarat</i>	8320.00									8,320.00
Hurricane Hole	<i>Lubang Taufan</i>	1478.00		102.30							1,580.30
Cobweb Cave	<i>Lubang Sarang Laba-Laba</i>	30346.00									30,346.00
Sakai's Cave	<i>Lubang Sakai</i>	2645.00									2,645.00
Tiger Cave	<i>Gua Harimau</i>	3800.00									3,800.00
David's Cave	<i>Lubang Daud</i>	788.00									788.00
Deception Cave	<i>Lubang Tipu</i>	1510.00									1,510.00
Menagerie Cave	<i>Lubang Kumpulan Binatang</i>	1875.00									1,875.00
Terikan Rising Cave	<i>Gua Sungai Terikan</i>	13307.00									13,307.00
Terikan River Cave West	<i>Gua Sungai Terikan Barat</i>	2290.00									2,290.00
Terikan River Cave East	<i>Gua Sungai Terikan Timur</i>	3880.00									3,880.00
Blue Moonlight Bay Cave	<i>Gua Teluk Cahaya Bulan Yang</i>	9710.00									9,710.00
Deliverance Cave*	<i>Gua Pembebasan</i>	4357.64						596.37			4,954.01
Gawai Cave*	<i>Gua Gawai</i>	2075.00									2,075.00
Buda Overlook Cave	-	20.50									20.50
Hole of the Moon	-	-		2553.00							2,553.00
Paradise	-	-				1192.87					1,192.87
Gardener's World	-	-						33.75			33.75
Little Deliverance	-	-						7.40			7.40
Half Moon Penguin Cave	-	-						0.00			0.00
Benarat Total											101,310.60

(continued....)

		Exped's up to B'rat '05 inc.									
English Name	Malay Name		Mulu '07	Mulu '09	Mulu '10	Mulu '11	Mulu '12	Mulu '13			Total Lengths
Batu Terikan Caves											
Tobichi Cave	Gua Tobichi	1146.00									1,146.00
Red River East 1	Gua Sungai Merah	532.00									532.00
Red River East 3	Gua Sungai Merah	234.00									234.00
Red River East 4	Gua Sungai Merah	129.00									129.00
Red River West 2	Gua Sungai Merah	400.00									400.00
Red River West 3	Gua Sungai Merah	155.00									155.00
Red River West 4	Gua Sungai Merah	177.00									177.00
Red River West 5	Gua Sungai Merah	582.00									582.00
Red River North	Gua Sungai Merah	105.00									105.00
Red River South	Gua Sungai Merah	865.00									865.00
Red River S-E 1	Gua Sungai Merah	2775.00									2,775.00
Red River S-E 2	Gua Sungai Merah	80.00									80.00
Batu Terikan Total											7,180.00
Southern Hills Caves											
Bat Cave											0.00
Daniels Cave	Gua Daniel	900.00									900.00
Deer Cave	Gua Payau	2160.00									2,160.00
Deer Water Cave	Lubang Sungai Payau	885.00									885.00
Fat Frog Cave	Gua Katak	1136.00									1,136.00
Peter's Cave	Gua Peter	300.00									300.00
Fern Rock Cave	Gua Batu Paku	1970.00			225.14						2,195.14
Green Cave	Gua Hijau	3445.00									3,445.00
Langs Cave	Gua Lang										0.00
Mayday Cave	Lubang Darurat	900.00					289.07				1,189.07
Paris Cave	Gua Paris	658.00			568.30						1,226.30
Porcupine Cave		295.13									295.13
Snake Cave	Lubang Ular	780.00									780.00
Stone Horse Cave	Gua Batu Kuda	3092.00									3,092.00
Surface Cave	Gua Permukaan	1500.00									1,500.00
Pendant Cave					183.59						183.59
Big Cave					227.45						227.45
Wild Boar Cave	Gua Babi Hutan				168.20						168.20
Fruit Bat Cave					479.70						479.70
Kenyalang Cave					565.20						565.20
Southern Hills Total											
Caves in Isolated Batus											
Campfire Cave	Gua Camp Api	272.79									272.79
Isolated Batus Total											272.79
Gunung Buda Caves											
Green Cathedral Cave		25731.00									25,731.00
Lower Turtle Cave		651.00									651.00
Jardis Cave		2541.00									2,541.00
Loris Cave		1331.00									1,331.00
Roly Poly Cave		2193.00									2,193.00
Graffiti Cave		422.00									422.00
Snailshell Cave		11902.00									11,902.00
Waterworks Cave		516.00									516.00
Twilight Cave		1442.00									1,442.00
Fruitbat Cave		823.00									823.00
Pirate Cave		2076.00									2,076.00
Buda River Cave		2036.00									2,036.00
Spirit River Cave		5193.00									5,193.00
Biocyclone Cave		2278.00									2,278.00
Hornbill Cave		3399.00									3,399.00
Babylon Cave		5233.00									5,233.00
Thunder Cave		611.00									611.00
Compendium Cave		4181.00									4,181.00
Bukit Assam		1628.00									1,628.00
Spirit of the Jungle		260.00									260.00
Monkeys in the Mist		159.00									159.00
Sea Breeze		378.00									378.00
Gunung Buda Total											74,984.00
Expedition Totals		367316.24	25857.81	27281.83	2417.58	15157.25	9691.54	8640.87	16626.66	11419.66	484,409.44
Mulu Area excluding Buda Total											409,425.44
Clearwater System											215,336.59
Benarat Caverns System											50,669.07
Terikan System											32,572.00
Cobra - Bridge - Cloud System											20,631.37

