



EXPEDITION REPORT

R E P O R T

combining the findings of the

M U L U C A V E S ' 8 8 & ' 8 9

E X P E D I T I O N S

to

G U N U N G M U L U

N A T I O N A L P A R K

S A R A W A K

During the Novembers of

1988 & 1989

Edited by

Matt Kirby

Copyright: Mulu Caves '88 & '89

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Cover Photograph:- 'Far From Home' passage, Clearwater Cave
by Jerry Wooldridge.

Incidental Photographs by Matt Kirby.

THE MULU CAVES '89
EXPEDITION

Matt KIRBY, Editor

Abstract: During November 1988 a six strong British team visited the Gunung Mulu National Park in Sarawak. Working closely with national parks staff in the region of Gunung Api 16km. of new passages were explored and surveyed. A link was found between Clearwater Cave and Cave of the Winds, establishing the Clearwater System as the longest in Southern Asia. A major new system 14km long, named 'Lubang Batau Padeng' or 'Blackrock Cave' was found to the north of Clearwater.

As a result of these successes a follow up expedition, Mulu Caves '89, was mounted and returned to the Park exactly one year later. A further 25km of passages were explored and surveyed. Blackrock Cave was extended to 21km and is now the second longest cave in the Park. In Clearwater Cave a major section of cave, including the Clearwater 5 streamway, was discovered lying to the east of the Scumring Series. This now brings the total surveyed length of Clearwater Cave to 75km, the twelfth longest Cave in the World. The total length of surveyed caves in the park now stands at 192km.

This Report

As the '88 and '89 expeditions were closely linked in time, personnel and objectives, this report combines the findings from both expeditions and updates the Mulu Caves '88 expedition report. This provides a complete description of Blackrock Cave.

INTRODUCTION

Location

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 covers an area of 544sq km.

The Park is dominated by the sandstone mass of Gunung Mulu which rises to 2376m. To the west of Mulu and on its flanks 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 up to meet the montane forest of Mulu's upper slopes.

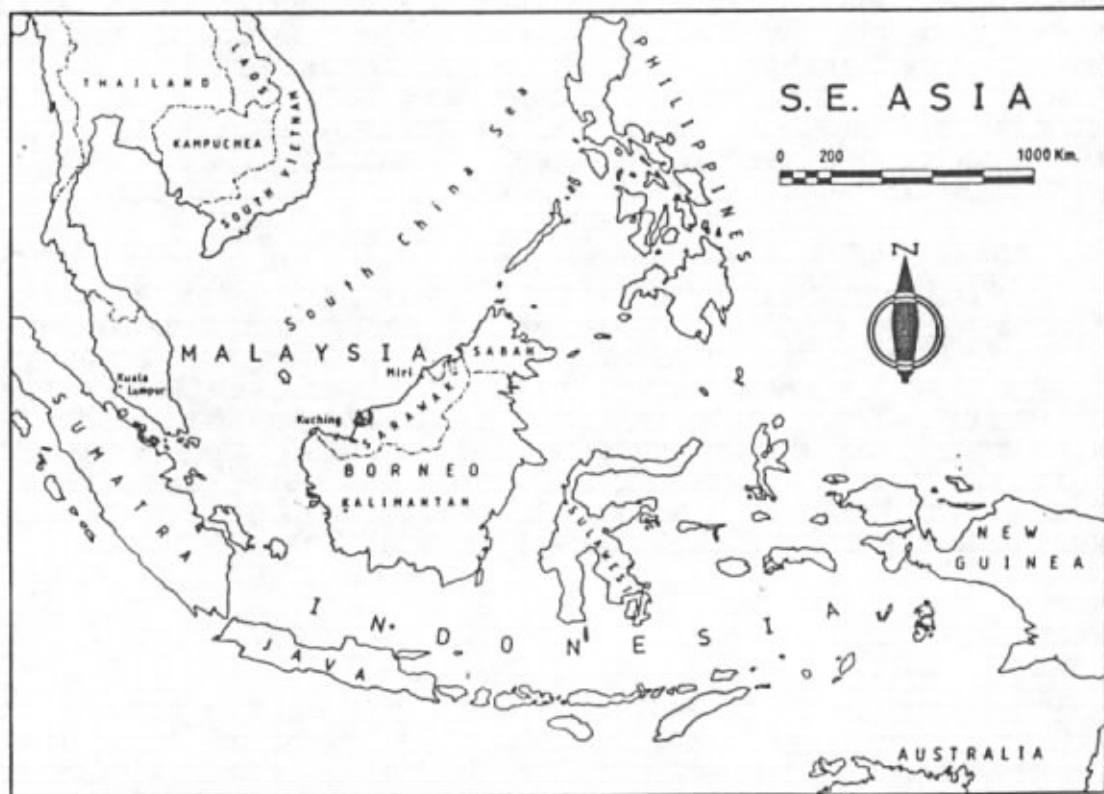


Figure 1.

Mulu is a rich mixture of plant and wildlife and in the limestones, beneath the forest canopy, lie some of the world's most impressive caves.

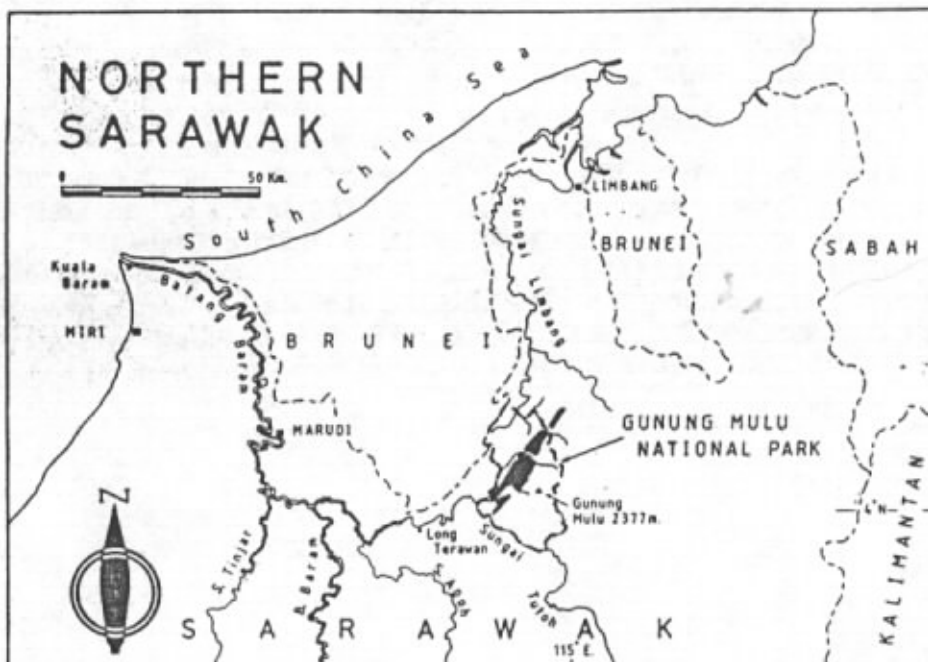


Figure 2.

History of Exploration

The existence of large caves in the Gunung Mulu area of Northern Sarawak has been documented for over 100 years. In 1858 reference was made to "Detached masses of limestone, much water-worn, with caverns and natural tunnels" around the base of Mulu by Spenser St. John in his book 'Life in the Forests of the Far East'. St. John was 'Consul General in the Great Island of Borneo' and made some of the earliest exploratory journeys of any European into the interior of Sarawak. His attempts to reach the summit of Mulu were thwarted by limestone cliffs, dense forest and sharp pinnacles of rock and he says, "It is almost impossible to conceive the difficulty of ascending this mountain". Mulu was to keep the secrets of its summit for a further 74 years until Edward Shackleton successfully climbed the mountain during the Oxford University Expedition of 1932.

In 1961 G. E. Wilford of the Malaysian Geological Survey visited the area to explore its caves. His work included the surveying of Deer Cave and parts of Cave of the Winds among others and he predicted that Mulu would yield many more caves in the future.

During 1977-8 the Royal Geographical Society spent 15 months in the area studying many aspects of the rainforest. Included in the team were six cavers who, in three months, explored and surveyed 50km. of cave including parts of Clearwater Cave, Green Cave and others. It was obvious from these findings that Mulu ranked as one of the World's foremost caving regions.

As a result of the RGS expedition two further caving expeditions were mounted. The "Mulu '80" expedition explored and surveyed 50km of new passage including the world's largest underground cavity, Sarawak Chamber, which forms the final chamber of 'Lubang Nasib Bagus' or 'Good Luck Cave'. A further 50km were discovered in 1984 by the Sarawak '84 expedition. These two expeditions carried out a great deal of scientific research associated with the caves including dye tracing, geology, ecology, cave mineralogy, etc. However, although 150km of some of the largest caves in the world had been surveyed, some very large areas of limestone remained totally unexplored presenting enormous potential for further exploration, (Fig 3).

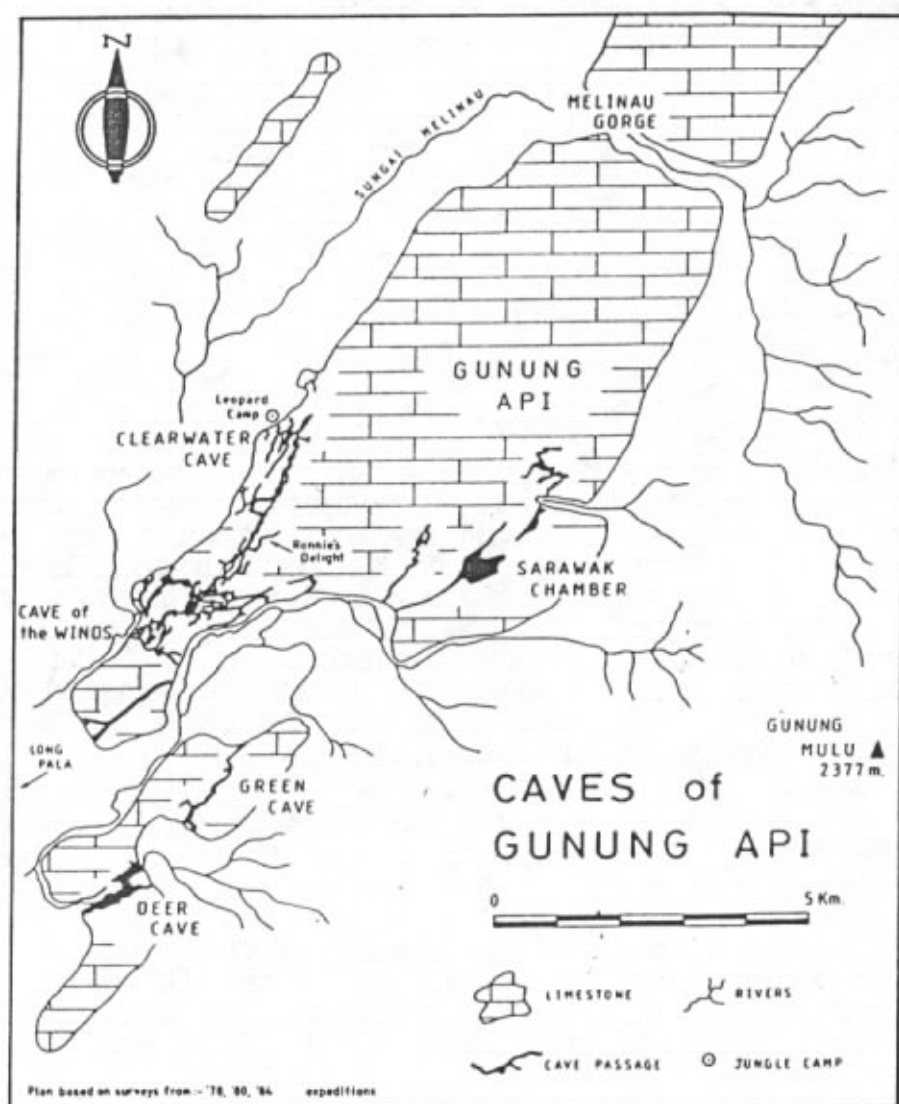


Figure 3.

During late '87 and early '88 plans were made to mount another caving expedition to the area. This would be the first expedition to visit the park since its opening to the public in 1985 and was primarily aimed at exploration, surveying and photography. Unlike the previous expeditions this was to be a lightweight venture with only six team members. This expedition once again proved the potential of Mulu with a further 16km of passages explored. It was also shown that exploration in Mulu using a small team was both feasible and successful. As a direct result of these findings an eight strong group, including five of the 1988 team, returned to the Park exactly one year later to follow up these discoveries.

Objectives

A request had been made by the National Park for an attempt to be made to connect Cave of the Winds to Clearwater Cave. Adding the length of Cave of the Winds to Clearwater would make the Clearwater System the longest in Southern Asia, a great boost for the park's tourism potential. Continuing with Clearwater, it was known that the 1980 expedition had left one large lead at the base of a 100m shaft (Ronnie's Delight) which presented potential for further discoveries at a lower level. It was also felt that the northern end of Clearwater held a certain amount of potential as some significant areas had only been visited once or twice during the original surveying trips in 1980.

In addition to this work it was intended to carry out a thorough search of the foot slopes of Gunung Api between Imperial Cave, at that time the most northerly cave known on Api, and Camp 5 in the Melinau Gorge. This section of the mountain represented a large blank area on the map which it was felt would contain extensive cave development to the north of Clearwater, (Fig. 3).

Also an attempt was to be made from Camp 5 to reach a large entrance (Canopy Cave) which had been seen in the cliff on the south side of the Melinau Gorge during 1984. It was hoped that this would provide access to caves under northern Api although a serious climb would be required to reach this entrance, (Eavis, 1985, p.39).

SURFACE EXPLORATION

Method

The foot slopes of Gunung Api present a very awkward terrain to search. They are very steep and covered in a dense forest undergrowth. The rock underfoot is often loose and can never be trusted and we soon learnt from our guides, who were able to move very quickly over such ground, that it was far safer to trust the vines and roots as handholds than the rock. It is almost impossible to carry out a line search as personnel soon lose contact with each other both visually and audibly due to the density of the forest and the nature of the slopes, and every so often a shout is necessary to get one's bearings with the rest of the party. Added to this, the fallen timber, the heat, the fireants, the snakes, the horseflies, the leeches, and the rain make surface reconnaissance arduous work.

During the '88 expedition a forest camp was established outside Leopard Cave. From here a track was cut through the forest north-eastwards along the alluvial plain at the base of the limestone. Local Penan porters were hired for this and their local knowledge and skill with a parang were invaluable. Track cutting is best left to these people as a parang in inexperienced hands is undoubtedly a potential hazard.

The foot slopes were searched as thoroughly as possible to approximately 50m above the alluvial plain. In all, three days were spent on the surface covering approximately 2km of ground to the north east of Leopard Cave. Thirteen entrances were found of varying significance.

During the '89 expedition a camp was established beside the junction of the Melinau and Lutut rivers. Only one day was spent surface searching northwards from the limit of the '88 track and this proved unsuccessful. However whilst searching a section of ground which had not been covered in '88 between Imperial Cave and the Northern Entrance a significant find was made, 'Metric Cave'.

MINOR NEW DISCOVERIES

Python Passage Exit

The mountain was climbed just to the north of Leopard Cave to approximately 300m above the alluvial plain. Only a small doline was found but on the return above the 'Pussyfoot Chamber' entrance to Leopard Cave a large entrance was noticed high up in the cliff face. Access was gained via a difficult climb using tree roots for aid.

From this 25m wide entrance a passage runs down dip parallel with the cliff face but is blocked by calcite both up and down dip after only 80m.

It appears from its relative position and altitude that this could well form a continuation of Python Passage in Clearwater, (Fig. 9), which has never been fully explored.

Birthday Cave

Whilst searching for the northern entrance, Birthday Cave was discovered 250m to the north of Leopard Cave and 20m above the alluvial plain. A complex series of passages are largely developed down dip in a succession of bedding planes overlying each other, (Fig. 4). It is possible to see through solution holes in the floor to the next enlarged bedding below. Disconcerting for the explorer as the separation in places is less than 500mm thick. The lower entrance descends to boulders and connects through to the lower passage. A climb up-dip joins the upper entrance. This passage can be followed for a short distance along the strike to a

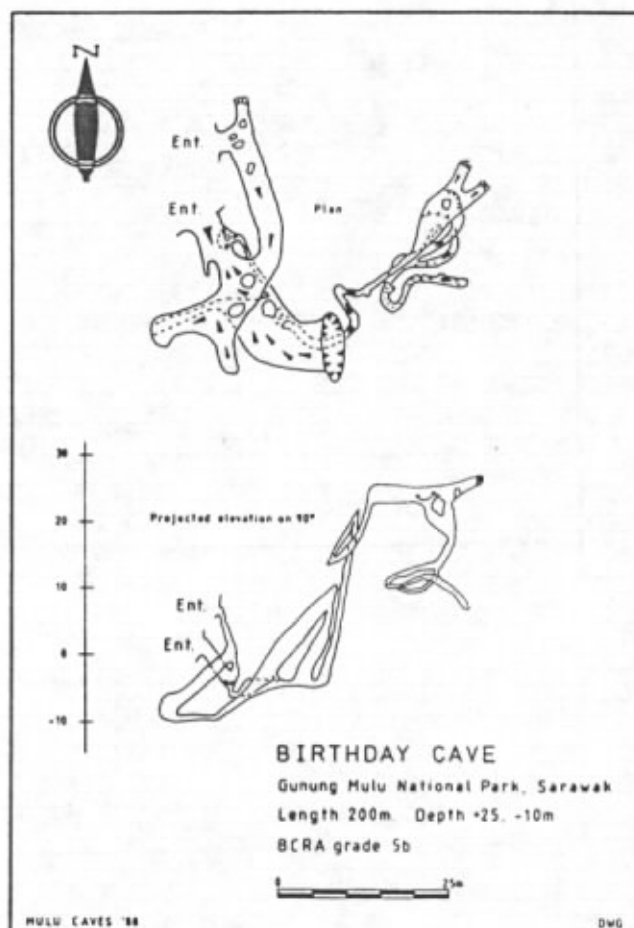
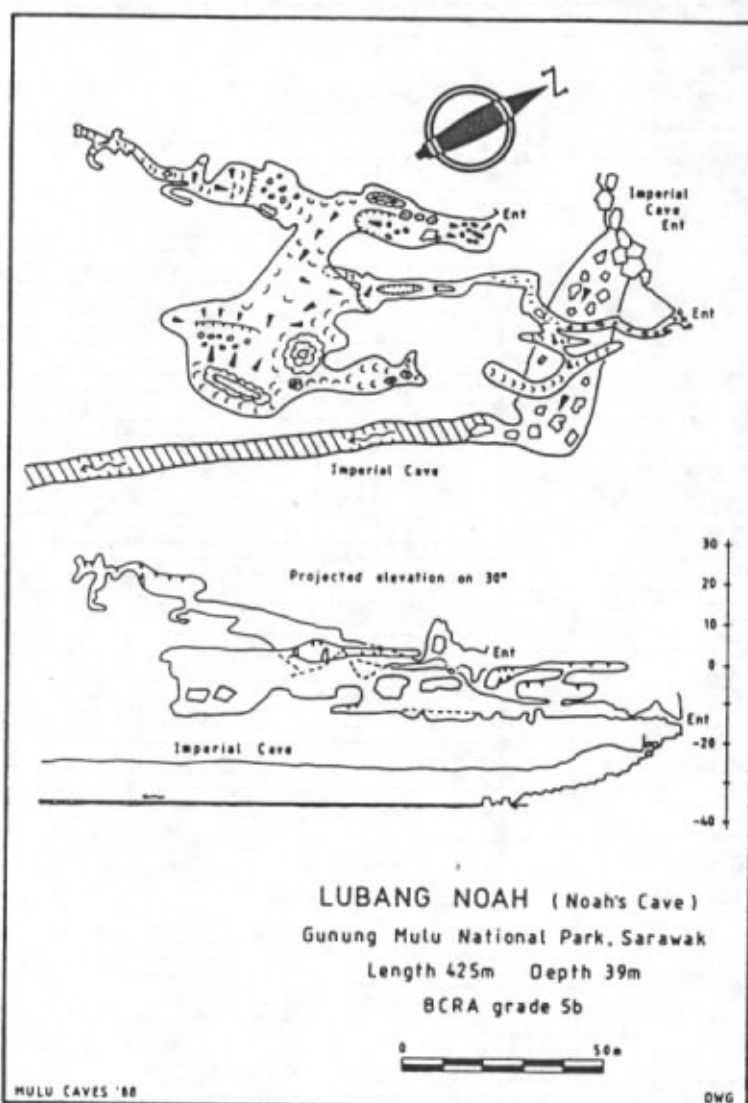


Figure 4.

steep climb down. A short low section follows to the start of a large ramp overhanging a 10m deep pit. At the base of the ramp the lower passage leads to another steeply ascending ramp and a short length of horizontal passage. A roped traverse and descent follows to a series of mud filled tubes.

Noah's Cave

Situated 1.1Km north of Leopard Cave and 30m above the alluvial plain this cave forms a well decorated upper level of Imperial Cave, (Fig. 5). Unfortunately all leads are heavily blocked by large calcite deposits.



The entrance passage leads via a short traverse around a deep pit to a large chamber. To the south west a nicely decorated ascending passage terminates at a calcite blockage, but to the north east a climb down, followed by a series of traverses, leads to the second entrance which is directly above the upstream entrance to Imperial Cave. 30m before the second entrance a climb up reaches a decorated calcite blocked passage which corresponds with a heavily calcited passage off the main chamber.

This cave appears to be the roost for a colony of small bats, which were found on the traverse just inside the main entrance.

Figure 5.

Approximately 20m above the main entrance is another large entrance. A passage can be followed for about 15m down dip to end in a sand filled blockage which is still within sight of

daylight. Access to this entrance is gained via an awkward climb and traverse using tree roots as handholds.

Metric Cave

Approximately 700m north of Leopard Cave two small foot cave entrances take water from the alluvial plain, (Fig. 9). These lead into a small winding passage which breaks out into a larger stream passage. Upstream, to the north, leads to a sump after 240m. Downstream from the junction the streamway passes under an aven after 100m. This was not scaled although there may be a passage leading off. Continuing downstream in deep water the passage eventually reaches a sump named 'The Bird's Nest Sump' due to numerous swift nests which were floating on its surface.

Metric Cave is very similar in nature to Imperial Cave and is clearly part of the same hydrological system. From survey data and flow rates its streamway appears to be the downstream continuation of Blackrock's Slipstream, (described later), which is thought to drain to Leopard Cave. During the '80 expedition a positive dye trace proved a hydrological connection between Imperial and Leopard Caves, (Smart & Willis, 1982, p.105), and it is almost certain that the Imperial Cave water will join the main southwards flow between the sumps. Unfortunately dye tests in '89 between Slipstream and Leopard were inconclusive.

The discovery of Metric Cave and its streamway provides another piece of the jigsaw of the drainage along the western slopes of Api and although further dye tracing could be carried out to prove links between Slipstream and Leopard Cave the results would be almost certain.

EXPLORATIONS IN CLEARWATER CAVE

The Cave of the Winds connection

This was the first objective of the '88 expedition. According to the survey of the two caves a passage leading south-westwards from 'King Seth's Maze' came to within 40m of Illusion Passage in Cave of the Winds. Although two expedition members had visited Mulu before, neither had spent any time in the areas of Clearwater or Cave of the Winds where the connection would be found. With this in mind, and with a doubt that the connection existed at all, a time limit was set for this work. Two days were allowed for in each cave to become familiar with the known passages, plus one extra day to push the leads.

These first four days were to prove invaluable both for acclimatisation to Mulu caving and for getting to know the guides who would be working with us. A note left by two 1984 expedition members was found in 'The Battleship' area of Clearwater which asked 'Is this Cave of the Winds or Clearwater?'. This forewarned of the complexity of the passages beyond.

Two days were spent searching in Illusion Passage during which a previously unrecorded exit was found leading into a large doline in the forest. A quick search was made around part of the doline but this revealed no accessible entrances, although a thorough search may be more fruitful.

Following crawls at the base of the final slope in Illusion Passage a pitch was found but not descended. This was estimated to be over 20m deep.

In the final section of Illusion Passage draughts were found emitting from between boulders in many places along the eastern wall. Squeezes were followed between large unstable boulders with no apparent ways on.

A resurvey of Illusion Passage was undertaken to clarify the original survey and to tie in the new discoveries. During this a lower passage was found to loop back into the main passage, and a pitch was found but not descended. This was estimated to be 10m deep and draughting and could lead into an undiscovered section of King Seth's Maze.

At the top of Illusion's final boulder slope, access was gained via a tight squeeze through stal to a steeply ascending, well decorated passage terminating in a breakdown chamber. A way through the boulders was found into a passage trending along the strike but with no way on.

Whilst work was being carried out in Cave of the Winds another team spent two days in Clearwater trying to find the way to the

main lead. The route was via the main streamway, Battleship, Broadside Chamber and into the immense passageways of Hyperspace Bypass.

A route finding error revealed a small draughting passage at the southern end of Hyperspace which led into a large, finely decorated, joint controlled passage. This terminated after about 500m; however, due to a lack of survey equipment that day it was not surveyed.

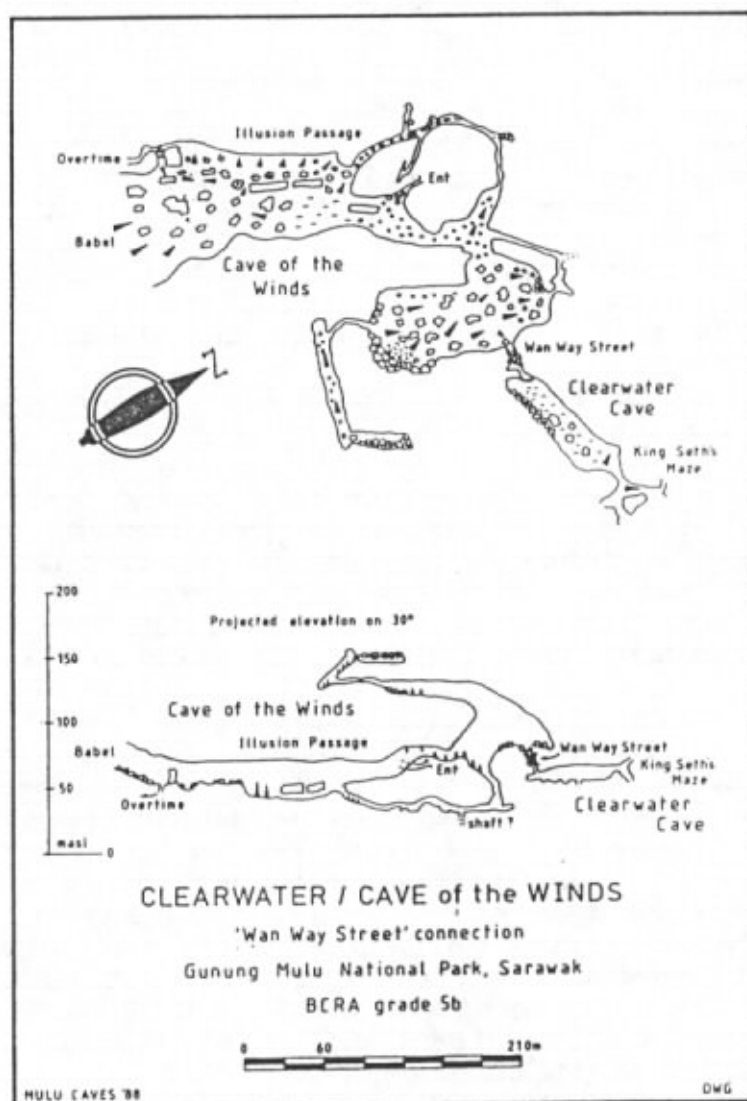


Figure 6.

The connection was finally made from the Clearwater side on the fourth day of exploration. After some hours spent routefinding in the complex low level mud filled tubes of King Seth's Maze, the lead at the end was reached and a 3m climb overcome. A short low horizontal passage terminated in a tight steep ramp approximately 300mm wide. This led to an unstable area beneath

large boulders. A very tight squeeze between the boulders led out into Illusion Passage, (Fig. 6).

This connection, named 'Wan Way Street' after one of our guides, is a potentially lethal route between the two caves. The original survey proved to be little more than 15m inaccurate in altitude and length. Now that the relative positions have been established it is only a matter of time before more connections are made, hopefully via more stable routes.

Clearwater's Northern Entrance

The 1988 expedition established a forest camp outside Leopard Cave, (Fig. 3), and access to Clearwater was via the 'Snake Track' entrances. It was intended that whilst half of the group pushed 'Ronnie's Delight' the others would attempt to find the most northerly entrance from inside.

This entrance had been discovered from the inside during Mulu '80 lying 280m to the north east of Leopard Cave, and it was hoped would give quick access from camp to the Gnome Oxbow area. Due to the density of the forest and the small proportions of this entrance it was considered an easier option to locate it from within the cave.

The one attempt in 1988 to reach this entrance failed due to a misunderstanding of the correct route. It was thought that access to the Dune series could be gained via Sheer Delight. This was found to be impossible without climbing aids. The correct route into the Dune series is to follow Beckoning Finger Passage from Boulder Chamber and descend the 12m pitch.

Following the failure to reach this entrance from inside it was decided to attempt to locate it from the surface. After a thorough search the correct area was found with a roaring draught emitting from between boulders. None of the team had visited this entrance before and there appeared to be no way in so it was thought that this entrance had collapsed since 1980. However in 1989 it was successfully reached from inside and proved to be open although very tight and awkward. This showed that the northern entrance was extremely difficult to locate from outside and in order to ensure that it could be found again a track was marked and surveyed from it to Leopard Cave. Due to the tight and very sharp nature of the first section of this entrance it was renamed 'Raw Meat Passage'.

Following the re-opening of the Northern Entrance further efforts were made to extend the cave to the north from the Troll Cavern / Gnome Oxbow areas. At the same time an attempt was made to find a connection into the underlying Leopard Cave. Unfortunately both of these objectives proved unsuccessful.

Sheer Delight

During the abortive attempts to enter the Dune Series from Sheer Delight, a climb into the roof on the west side led to 50m of new passage and a 19m shaft which dropped into water with no way on.

Ronnie's Delight

During 1988 this dramatic 100m shaft was descended in the hope of extending the bedding passage at the bottom towards its postulated origin, the Hidden Valley (Smart in Eavis, 1981). The leads on the south wall of the first bedding chamber were reached by climbing steep sediment banks which needed very careful negotiation. Both leads were found to be blind, pinched out to the roof with sediment infill, (Fig. 7).

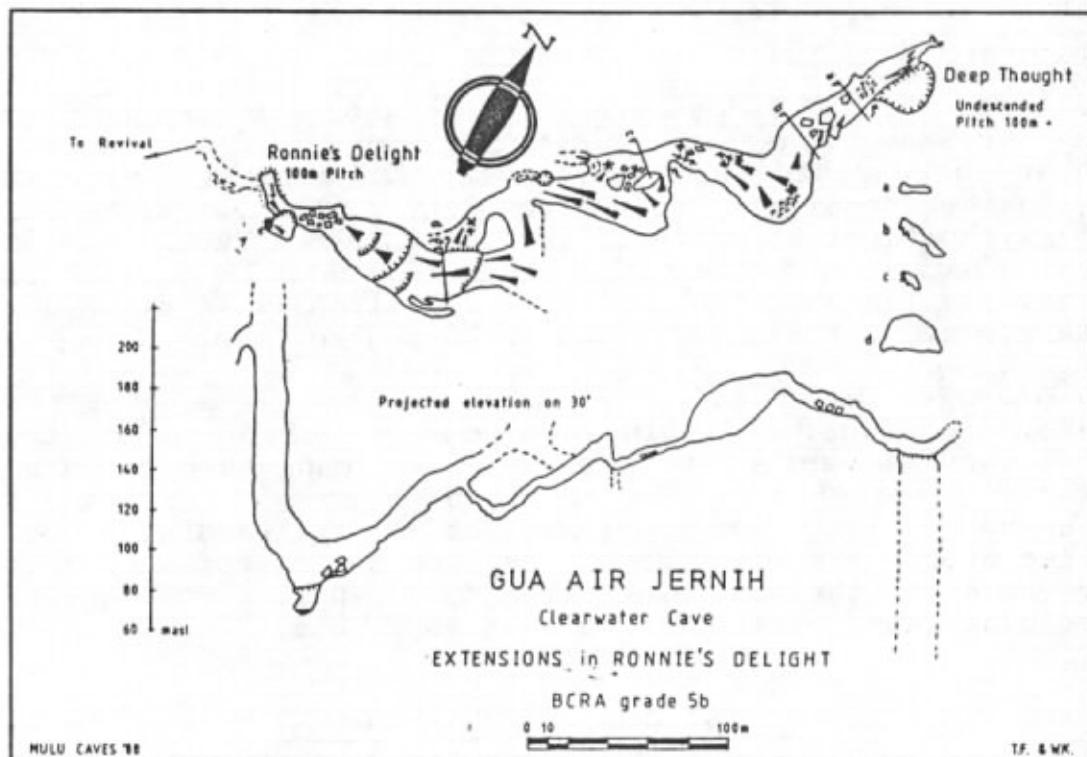


Figure 7.

Going to the end of Colin Boothroyd's exploration a continuation was found in the north east corner into a further bedding chamber with a strike orientated passage leading down to the head of a huge hole. The pitch, 'Deep Thought', was estimated to be over 100m deep. The remoteness of this site together with the tackle requirements precluded further investigation. Although this pitch was one of the main objectives for the 1989 expedition it was not descended as other discoveries led to what is thought to be its base.

The Paris Metro

In the Lady's Cave area of Clearwater, show cave lights had revealed a hole opposite the tourist viewing platform into and out of which swifts regularly passed. A partly bolted and partly free climbed route up to the hole gave access through a short, strongly draughting tube to 350m of fine fossil phreatic passage. At the southern end draughts appear from an aven to the surface which is offset from the main passage. In both directions the main tube ends in a down trend in the phreatic loop, and from survey data the southern end overlaps the Cave of the Winds upper entrance series, (Fig. 9).

Simon's Cave

The entrance to this cave, which lies almost directly opposite the Batu Bungan settlement, was discovered by National Park staff whilst surveying a riverside track and is situated at the back of a deeply cut notch, (Fig. 9).

A series of climbs up calcite flows lead to a drop into a small irregular shaped chamber. Continuing from the far side of this chamber the passage leads through eroded calcite barriers and two further chambers to emerge into the impressive main passage, the floor of which is covered in deep guano. This large tunnel terminates in calcite chokes but a small passage under the calcite leads to the head of a 23m pitch. This drops into a small streamway which is sumped in both directions.

Side passages off the main passage provide the possibility of future extensions. Following the 1989 expedition Simon Lagang and Wilson Bala returned to the cave and made an exposed climb near the terminal choke to reach large upper level passages. These were explored for about 2km and are believed to lie close to Cave of the Winds, offering the opportunity for a connection to be made. At the time of writing this report a full survey of these subsequent extensions was not available.

ARMISTICE AND CLEARWATER 5

Discovery

On the 1st November 1989 a small team entered Clearwater via the Snake Track entrance. Their objective was 'Deep Thought', the undescended shaft beyond Ronnie's Delight. The intention was to set up a bivouac at the waterfall in the Scumring Series ready for an early start the following day. That evening a passage was noticed above and directly opposite the bivouac, leading off to the east. Access to this was fairly easy and led to 15km of classic Mulu passages including the northerly continuation of the main river passage, Clearwater 5, (Fig. 9). The extent of these discoveries precluded the original

objective, Deep Thought; however, it is almost certain from survey data that the base of this shaft was reached.

Scumring to Armistice

To the right of the waterfall a steep climb, where a handline is useful, leads to a large passage which overlooks the bivouac and from which, at times, a very impressive draught blows out. Descending a short ramp leads over mountains of dry swift guano, 'The Snow Slopes', to a tall canyon passage. Approximately 300m from the bivouac there is an easy 10m climb up very sharp rock on the right (see 'Far From Home'). In this area there are several large swift roosts high in the roof.

The main canyon continues over occasional piles of boulders and through sticky wet guano to a left hand bend. Continuing onwards leads past a 10m pit on the right, which was not descended, and ends in large bouldery chambers with no way on. Back at the bend an awkward 5m climb up on the right is the key to the main way on and a handline is advisable here. A traverse above the climb gives access to an upper series running back towards the bivouac following the main canyon with occasional windows allowing voice contact. Onwards above the climb a very well decorated passage leads past enormous stalagmite bosses to an ascent up boulders to join a much larger passage running north/south, 'Armistice'.

Armistice North

This very impressive strike orientated passage runs northwards through large chambers strewn with white weathered boulders. Water cascades in on the eastern side from several inlets and the passage is decorated by large stalagmites. After 300m a large hole in the floor is reached, 'The Y Frontier'. A traverse on the right through stalagmites avoids the overhanging lip of this shaft. Beyond here Armistice continues for a further 300m to a junction. To the right leads to the 'Road to Hell'.

Onwards, Armistice degenerates into a flat out crawl over very sharp, draught formed, helectites, 'Grin 'n Bear It'. Beyond this very painful crawl the character of the passage changes and the roof is much lower. At the next junction a large passage ascends boulders to the east to the base of a small waterfall. Above the waterfall a short passage links through to the 'Road to Hell'. Heading north from the waterfall leads up into 'Red Dwarf Chamber'. This chamber is filled with very large angular blocks which appear to be the result of a geologically recent collapse, there is no draught and no apparent way on.

From the junction below the waterfall Armistice descends a steep slope of powdery mud and boulders before ascending a slope of rounded boulders which eventually rise to meet the

roof. A draught was noticed here heading onwards but crawls between loose boulders and the roof were not pushed to a conclusion due to the unstable nature of the slope.

The Road to Hell

Before the Grin 'n Bear It crawl a ramp leads up to the east. This ascends over boulders to two chokes one of which is heavily calcited. Half way up the ramp the Road to Hell heads off to the north. A very strong draught blows southwards out of this well decorated passage. A branch to the left leads to the waterfall before Red Dwarf Chamber but to the right the way on degenerates into very small bouldery chambers. Owing to the strong draught masses of needle shaped helectites have formed on all the boulders and progress through the narrow crawls is very painful. A slip or stumble onto these calcite formations could have serious consequences. Eventually a small chamber is reached and the way on is blocked by a total collapse with draughts emitting from between boulders.

The Y Frontier

The open chasm in the floor of Armistice North is an impressive 32m pitch, 'The 'Y' Frontier'. This has been formed by the collapse of the floor into the passage below and descent is made awkward by a large overhanging lip of calcited boulders which dominates the shaft. Rigging this pitch was achieved by hanging a rope from opposite walls to form a massive Y hang. This provided an awkward but very interesting free hanging descent dropping onto a large pile of boulders in the passage underlying Armistice.

The Cairn Farm

Following the strike to the north from the base of the 'Y' Frontier leads to 'The Cairn Farm'. Almost all the passages in this series lie on the same bed of rock and there are three dominant tunnels running parallel to each other which are regularly linked by small passages following the dip. This interlinking of passages provides many junctions and proved to be a surveying nightmare, and many small cairns were built in order to tie in the various loops.

All three tunnels are boulder floored and lead eventually to terminal chokes which characterise the nature of this area of the cave.

Polysyllabic Bigness

South from the 'Y' Frontier the passage turns to the north to enter a large bouldery chamber, 'Polysyllabic Bigness'. This chamber has been formed by extensive roof collapse and the only way on is through boulders at the far end. This leads to

another area of collapse which eventually loops back to the base of the 'Y' Frontier.

A notable feature of all the passages north of the Y Frontier is the profusion of bat skeletons which litter the floor. In places these are heavily coated in calcite. There are various theories about the demise of these bats ranging from disease to simply getting lost. However given the bouldery unstable nature of this northern area it is possible that a major collapse possibly caused by geological movement could have blocked their exit. Scientific analysis of skeletons may reveal the date of their deaths; however, the cause may never be fully understood.

Armistice South

Southwards from the Armistice junction leads to a large chamber. To the left small bouldery passages lead to ramps and chokes. Onwards the main route subdivides into a series of interconnecting loops generally following the strike. The easiest route keeps to the left and passes through large chambers strewn with weathered white boulders. A climb over a large calcite flow leads to 'Hornbill Passage'. This passage leads over more boulders and muddy guano to a well decorated chamber at the head of 'The Big U-ee'.

The Big U-ee and Northwards

At the end of Hornbill Passage the route on turns to follow the dip at the head of the Big 'U-ee'. This is formed by two steeply dipping passages running parallel to each other which are connected at their bases by a strike orientated passage to form a large U. Although the upper ends of the legs of the U are very close to each other on plan there is no direct connection so a long and tiring traverse is necessary to cover a very short distance.

From Hornbill Passage the southerly leg of the Big U-ee steeply descends over boulders and deep guano banks at an angle of 30° for 200m to arrive at a junction. To the left a passage leads into 'The Umbrella Shop', a beautifully decorated chamber with stalagmites which resemble folded umbrellas. Here a 71m deep shaft was descended to a choke.

Continuing down the Big U-ee the main way turns to the north to follow the strike. However, at this point a much smaller passage, 'Rampage', continues down dip following the direction of the Big U-ee

Continuing along the strike the passage slowly turns to the east and rises up the dip along the northerly leg of the Big U-ee to terminate in a calcited choke which is very close to Hornbill Passage. Before this two large bouldery passages lead north and these eventually join before arriving in a chamber with a floor strewn with fine scree. Continuing onwards the

scree becomes steeper and rises up to an aven on the left. To the right the way on continues over large boulders to a greasy climb upward which leads to the lip of a large funnel shaped shaft. Stones dropped down this reappear from the aven and onto the scree slope in the passage below.

A difficult ascending traverse around the head of this shaft leads into a small passage which emerges at the edge of a parallel shaft. Onwards a traverse over a narrow arret between the two shafts and a descending traverse around the edge of the main shaft leads to the 'Far From Home' passages.

Far From Home

At the far side of the shaft a steep boulder slope descends to a very tight calcited squeeze, 'The Yorkshire Bit'. Beyond the squeeze a steep ascent leads to 'Overlord Junction'. An impressive passage, 'The Caterpillar Track', heads west down dip. This leads through deep swift guano and down a short pitch to terminate in calcite and boulders with no way on. There is no draught in this passage and as a result several fine examples of drip rings have formed in the soft guano floor.

Northwards from Overlord Junction beautifully scalloped tubes follow the strike through deep guano and down several ramps to emerge on a ledge 10m above the floor of the passage leading from the Scumring bivouac. A handline is advisable to protect the easy climb down which forms the end of a very spectacular round trip.

All the passages beyond the Yorkshire Bit are heavily used by roosting swifts

Rampage and Clearwater 5

Behind boulders at the base of the Big U-ee, Rampage descends to a slippery 15m pitch which drops into the large Clearwater 5 passage. The streamway runs in a deep trench on the west side of the passage and steep walls of mud or rock prevent easy access. However, descending muddy banks immediately below the pitch leads to one of the few free-climable access points. Here the streamway is 8m wide running in a passage 60m wide by 50m high.

Traversing southwards along mudbanks leads to a very large sump pool. The extent of muddy deposits in this area suggests that water regularly backs up behind this sump. To the left of this a large boulder choke rises up to meet the roof and there is no way on, however two depressions under the east wall lead into 'Paku Passage' (described later).

Northwards from Rampage a traverse leads after 150m to the head of a vertical cliff towering over the river with no way on; 20m above the water, this is a very spectacular vantage point.

Further progress north can be made only at stream level and just before this point it is possible to descend a rocky gully to enter the river. At the opposite side of the river, and 10m above, a large passage can be seen heading west. This was not explored and artificial aid would be required gain access to it.

Ascending the streamway from here is a very tiring and cold experience as there are very few points where it is possible leave the water. A buoyancy aid is essential and a lightweight wet suit would be an asset. To return to Rampage it is only possible to exit the streamway at two points, neither of which are easy, so the return journey should always be kept in mind as a rise in river level may render these inaccessible.

Upstream the river runs between vertical walls and its average width is 8m. In normal water conditions progress can be made against fast flowing water by a combination of swimming and grasping finger pockets in the passage walls. However, in low water conditions it would be possible to progress by wading waist deep with only twenty or thirty short swims.

At two points large boulder collapses span the river and after 1km a dry side passage heads west up a muddy slope. This terminates after 120m at the base of a large aven with a strong draught flowing down it. From survey data it is almost certain that this aven is the un-descended Deep Thought pitch in the Ronnie's Delight area.

Upstream from the junction the streamway continues northwards in a passage 30m wide by 20m high. However no further progress was made beyond this point.

Paku Passage to Alexandra Palace

At the southern end of the Clearwater 5 passage two depressions under the east wall lead to a small muddy stream passage with water flowing from the south. Following draughts over mud banks leads to a hanging boulder choke into which most of the draught disappears. A crawl through boulders to the left leads on to the 'Alexandra Palace', a large flat roofed chamber which is decorated with many beautiful calcite formations.

This area is very close to the surface and it is thought that the muddy streamway could be seepage water from the Melinau Paku River.

From survey data Alexandra Palace is very close to the end of Drunken Forest Cave, which is very similar in nature, and it is possible that this chamber was part of that cave and has been separated by a calcite blockage.

LUBANG BATAU PADENG (Blackrock Cave)

Discovery

On the 12th of November whilst searching back towards Leopard Cave from the end of the cut track, leaves were noticed waving in a draught on a small ledge approximately 30m above the alluvial plain. Closer inspection revealed a strong smell of guano drifting down the hillside. Unfortunately a violent windstorm broke out, preceding heavy rain and thunder. A hasty retreat was made from the hillside as large pieces of timber began to crash down from trees high above. Wind is fairly rare in the forest but when it does occur its effects can be disastrous.

The following day, whilst others continued work on the surface, two expedition members and one guide returned and gained access to a small entrance later named 'Centipede'. A healthy draught was emitting but with no sign of the guano smell.

Only eight days exploration were possible during '88 but during that time 14km of passage were surveyed. Many leads had to be left when time ran out and this was one of the main reasons for returning in 1989. The work of the '89 expedition increased the length of the cave to 21km to make it the second longest in the park and brought this stage of its exploration to a more satisfactory conclusion, (Fig. 9).

CAVE DESCRIPTION

Centipede to Milliways Bivi.

From the entrance a short passage leads to a climb down into a bedding controlled ramp with a vadose slot at its base. Travelling along the strike to the south various ways lead off to other entrances, but a climb up dip, following a small stream, leads via a body sized squeeze through calcite into a much larger passage heading north / south. North leads quickly to entrance No. 2, 'The Hay Loft', whilst south leads to a well decorated section and low crawls through stalctite grills formed on boulder sediment. After 180m there is an abrupt change in direction as the passage swings round to the east and becomes much larger.

This larger passage is apparently the only way on since the passage from the Hayloft continues as a tight slot in the far wall. From this point passage sizes are approximately 13m wide by 10m high with a floor made up of sandy sediments with boulders. From survey data it appears that this passage is running above 'Slipstream' (described later) and there are many deep pits in the sediment floor which suggest a slow collapse into fissures or shafts.

After a further 150m a 10m drop is reached where sediment collapse has revealed a step in the original passage floor. This is associated with a joint which crosses the passage at this point. The head of this pitch is capped with sediment which makes rigging awkward. At the base of the pitch a large hole continues downward and is assumed to lead to Slipstream. This was not descended but is estimated to be 30m deep. Directly above the pitch is a 30m aven which leads to the 'Dapa Series'. The base of the pitch is in a 10m deep pit and a climb back up a sediment slope at the far side leads, after 200m of similar passage, to a large four way junction, 'Milliways', the bivouac site.

Dapa Entrance Series

Revealed by the smell of guano, this beautiful 15m wide by 3m high entrance was found lying almost directly above the smaller entrances to the system. A large fossil passage runs just inside and parallel to the surface slope, coming so close it punctures the outside world. The resulting truncated bend gives the entrance its oblong shape. This passage is, in general, 15m wide and 10m high. It is calcite blocked to the south after 150m and to the north after 100m where, through the calcite, daylight can be reached. Off the southern branch a slope leads up to 'Eyeballs in the Sky', a chamber with a population of large 'golden eyed' bats. Passing beneath a rain of urine a small passage leads on north east to the head of a steep ramp and the 30m pitch, 'Evidence', leading down to the pitch head in the Centipede entrance series. Various other small passages were explored and surveyed.

Slip Stream.

60m north west from Milliways bivi a bedding ramp is descended 30m to a very fine streamway 7m by 3m of classic Mulu character following the strike on 30°. Evidence of backing up gives early indication of a sump which is met 450m downstream. Upstream the passage passes beneath the 'The Pit', (described later), and continues north, splitting into various inlets. There are numerous indications of passage development above the streamway in the bed but, in those which were easily accessible, passages could only be followed for short distances before once again becoming steep bedding ramps.

Two inlets the 'Pollnagollum' and 'Black Water Snake' passages both end in flat out muddy crawls presumably very close to the flood plain. The main passage terminates in a surface associated boulder choke although daylight was not reached.

The Pit & Old Holborn

Continuing north-eastwards beyond Milliways a climb up on the right (east) is passed after 50m. This side passage rises steeply up a flowstone wall and terminates in boulders. A slight draught was noticed here indicating that further upward progress may be possible, leading to the elusive higher levels.

100m beyond this side passage a large chamber is entered, 'The Pit'. Massive sediment collapse has taken place here forming two enormous holes in the floor, with a causeway of sediment between them. The largest is surrounded by vertical banks of sediment 10m high. This was not descended but it is believed that a slope leads down from the base of this pit to connect with Slipstream, as voice contact was established. Continuing over the causeway a traverse on a small clay ledge leads to a low sediment filled tunnel 'Old Holborn'. This continues to reach a chamber with a small inlet in the roof. A passage to the right connects with the main route to the 'Flower Shop'.

Beyond the inlet a fine 15m high passage containing much boulder sediment fill can be followed to the north east along the strike. A low mud filled passage on the right has been explored to a traverse across a hole and low canal which has not been passed.

In Old Holborn the passage continues in the same grand manner until a slippery calcite and mud covered downward slope is reached. An inlet enters from the roof at the east side of the passage with the water sinking in the muddy floor of the final chamber. Beyond the inlet the roof descends abruptly into the mud but high level holes in the roof were noticed; however, bolting would be required to reach these. A slight draught was noticed in this area.

Immediately before the slope into the final chamber a hole to the left drops down to a steep ramp requiring a rope. This was not descended but a draught was noticed.

Considering the close proximity to the 'Racer Series' (described later), which lies 120m to the north east and at the same level, a major connection here may be possible.

Milliways to Damocles Hall

From Milliways a passage leads along the strike south southwest. This is at least 15m wide but largely filled with dry sediments so that its full extremities can not always be reached. The first 100m is a low stooping-height passage 'Duckdown'. Here inlets enter from the roof on the east side and the water soaks away into gravelly pits. These inlets respond quickly to heavy rain outside and provided a good indication of weather conditions as well as a convenient shower after a hard days caving.

Beyond Duckdown the passage lowers and passes through a very well decorated and complex area known as the 'Flower Shop'. This gains its name from the profusion of Gypsum Flowers which decorate the area. In places the sediments are covered with a thin crust of calcite and occasionally undercutting has created hollow cavities which should be treated with caution. The strong draught has left the sediments very dry and has caused stalactites to be formed with an obvious leading edge and thin wing like cross section. It appears that the prevailing draught is from the south as no evidence of stalactite growth into a northerly draught could be found.

After a low section the passage gains height and passes under two avens on the east wall. The most obvious of these was climbed for 20m to where it turned to head back down the dip.

At the southern end of the Flower Shop is a blind 28m pitch; however, a 5 metre mud wall climb at the bottom of the pitch would give access to a passage going west although no draught was detected.

The Flower Shop continues past large holes in the sediment to end abruptly in a sheer wall of sediment 10m high which drops down into the chaos of 'Damocles Hall'. A 3m high side passage 'Firefly' bypasses the drop. This attractive uniform tube is so named because of the selenite needles which glisten on its walls.

Status Quo

170m before Firefly passage a lead in the west wall forms 'Status Quo'. After descending a steep sediment bank out of the Flower Shop the passage leads via awkward climbs round two blind pots to a right angled bend. Here the passage rejoins the strike to end in a calcite choke after a further 350m. However, 100m before the end a short side passage on the left breaks out into the roof of the entrance passage just north of the 10 metre pitch.

Damocles Hall to Brighton Beach

Damocles Hall is a large echoey chamber strewn with huge boulders. Towards the far end of the hall a small hole in the east wall leads into a side passage at a junction. To the left loops back, via a ramp and bouldery chamber, to emerge into Damocles Hall near the end of Firefly Passage. Straight ahead at the junction is 'Ramparts', a series of steep ramps leading up to 'Phoenix' (both described later).

Damocles has possibly been formed by the collapse of a series of ramps onto the previous sediment-filled passage since at the far end of the Hall, a climb down boulders leads to a continuation of the strike controlled sandy passages.

Continuing past more sandy pits leads quickly to an abrupt change in direction at 'Brighton Beach'.

Ramparts

Ramparts is a series of steep and complicated ramps of which some loop back on themselves. The main ramp heading up from the junction off Damocles Hall passes under a tall aven to reach a short horizontal passage which leads to the head of a 10m pitch. At the base of the pitch a climb down boulders rejoins the strike. After 30m a steep ramp leads off and after a further 60m the passage at this level closes down.

Ascending the steep ramp for 50m leads into a small uninspiring and often awkward strike controlled passage. This breaks out into another ramp. Up dip leads to 'Upper Ramparts', (described later), whilst down dip a steep climb down boulders and clay leads into another awkward passage. This leads along the strike past some interesting climbs to emerge into 'Phoenix'.

Upper Ramparts

Upper Ramparts follow the strike back over the top of Ramparts and the Blowpipe. After 200m, including much climbing up and down the dip, a short but committing climb is reached. This was not ascended and no draught was detected in this area.

Phoenix

At 70m above the entrance horizon Phoenix forms a large horizontal strike controlled passage approximately 20m wide and inclined down the dip. The passage has a sediment and boulder floor and in places a deep canyon forms an obvious feature which snakes along the middle section. This occasionally becomes a passage in its own right, down dip to the west of the main passage.

Following Phoenix to the south for 400m leads to 'Broken Glass Pitch'. This is associated with an inlet aven and is a heavily calcified 60m shaft. At the bottom of the pitch passages can be followed in two directions. South leads down to a very muddy back up area with no obvious way on and no draught. To the west leads to 'The Small Ball Room' where a single pondulite hangs in the middle of the final chamber which is choked with calcite. Before this a branch up a steep calcite slope leads past a huge stalagmite to a solid calcite wall.

The traverse over the head of the Broken Glass Pitch picks up the continuation of the canyon feature heading generally south for 250m to where it opens into 'Broken Hope Hall', a large calcite and boulder strewn chamber with a tall aven rising up from its southern end.

No exit could be found from Broken Hope Hall and this forms the southern limit of exploration at this horizon; however when this area was explored heavy rain was feeding the inlet which falls down the aven. This caused strong draught eddies which may have masked the normal draught and possible way on.

Northwards from its junction with Ramparts, Phoenix retains the size and shape of its southern section running for 175m to a T junction. Straight ahead over boulders leads quickly to the head of a pitch, which proved by voice connection to be the aven at the start of Ramparts. Left leads to another section of canyoned passage and a large 15 metre deep, but easily descended, hole; Station 100. In this area there is a distinct blue/grey tinge to much of the calcite. From station 100 the passage swings back round to re-join the strike heading north. A boulder slope on the right leads up to a narrow strike controlled rift which quickly ends in ends in boulders.

The main route follows the meandering canyon through a wide T shaped passage with a remarkably flat roof which at times spans 30m. After 180m a heavily calcited area is reached where the floor is made of soft orange muddy calcite. The way on degenerates into a flat out crawl in a small tube at roof level. Just back from here a calcite slope leads up out of the canyon and into a beautifully decorated low area at roof level. Hands and knees crawling over more soft muddy calcite leads through a forest of stalactites and columns which are adorned with crystal clear helectites. The density of these formations conceals the true width of this section of passage.

Continuing on, a climb down leads into a large well decorated chamber with a flat roof spanning 45m. Again the profusion of stalactites hides the true extent of this chamber. The floor gently rises up to the north and is made of the same orange muddy calcite as before. At times this is firm to stand on and has formed into gours but in places it is very soft and will not support a person's weight.

The way on degenerates into wide, flat out and very dirty crawls which end either 'too low, or in calcited boulders. From survey data it appears that this area is very close to the surface; however, although a snake skeleton was found in the large chamber, no draughts were detected.

The Slippery Bits

Between Damocles Hall and Brighton Beach there are numerous accesses to a much smaller strike controlled series. This is first noticed forming Firefly Passage. It appears to have been lost in the chaos of Damocles Hall but continues from there to run to the west of, and parallel to, the main route as far as Brighton Beach. From there it continues as a 2m high passage with slimy muddy walls for 150m to end at a very steep ramp heading down dip, 'The Chocolate drop'. Onwards becomes too

tight but descending the shaft leads to water and huge quantities of back up mud at -28m. The walls of the pitch are fretted into very sharp edges which lurk under the mud making progress dangerous.

The sound of a small stream could be heard at the bottom of the pitch but this could not be reached.

Brighton Beach to Jimmy's Quarry

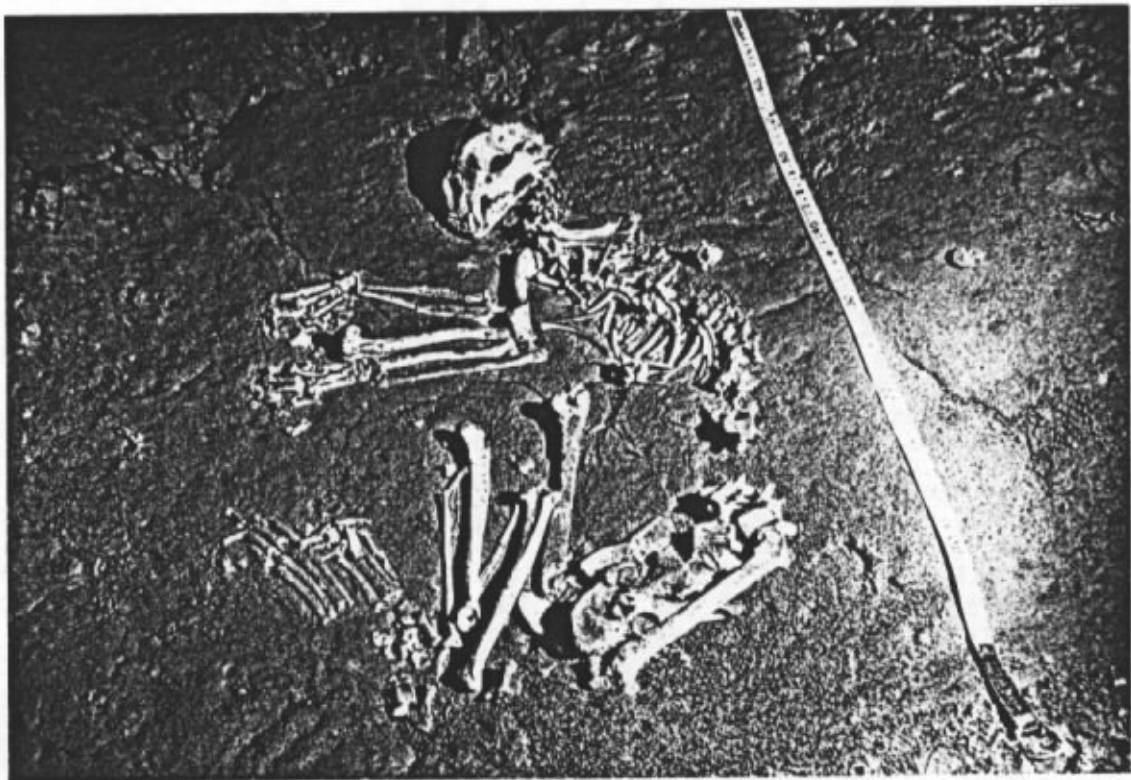
Brighton Beach is a very sandy area. The main way on drops down between walls of sediment to meet a small stream entering from the south wall. This stream runs east for 40m to disappear into a small sump which becomes too tight at -2m. This sump lies at the intersection with another strike controlled passage which now forms the way on.

This straight large uniform tube, 'The Blowpipe', runs north northeast parallel to Damocles and the Flower Shop. The floor is made of clay and sand sediments mixed with larger boulders. Water enters from the roof on the east side and percolates away between boulders in large pits. After 350m the passage turns to the east and at this point is only 100m from the Flower Shop; a link here could provide a short cut bypassing 750m of passage, (see 'The Crinkly Bits')

The passage continues over boulders and mountains of clayey sediments to arrive at the base of a large boulder slope, 'Jimmy's Quarry'. To the left here a small passage leads, via hands and knees crawls and an awkward climb, to emerge at the far side of Jimmy's Quarry. This passage named 'Quarry Bypass' does not provide a short cut around the main boulder slope.

The way on from here is up the main boulder slope. Ascent of this should be treated with care as most of the slope is lying at the angle of rest and is unstable.

At the entrance to the Quarry Bypass the skeleton of a small mammal was found lying on a clay ledge. It measured 600mm from nose to pelvis and there was no evidence of a tail. The skull displayed a powerful jaw, blunt incisors and prominent upper and lower canines. From photographic evidence it has since been suggested by authorities in Sarawak that this is most likely the skeleton of a young bear. As this point is over 2Km from the entrance it is possible that the body was washed into the cave and deposited here by floodwaters. A large inlet enters through the roof at this point.



Skeleton of a young bear

The Crinkly Bits

In an attempt to bypass the Damocles/Brighton Beach areas, ramps opposite 'Status Quo' leading east from the Flower Shop were investigated.

After a climb up and pitch of 6m, steeply ascending ramps lead to the base of a vertical shaft with a sizable inlet raining down and soaking away into boulders. Another ramp leads to a steeper section which was not pushed, but which requires further investigation with a bolting kit.

Although on plan these passages head in the right direction for a short cut into the Blowpipe, due to their classic Mulu ramp controlled nature they end 45m above the required position.

Slarti's Revenge

From the top of the Quarry a descent, equally as dangerous as the ascent, leads to a far safer section under a large inlet which enters from the roof. The floor of the passage beyond is covered in greasy mud-covered boulders and although an end looks almost certain, an area of breakdown is entered. However three separate ways can be followed through boulders to reunite in the continuation of this uninspiring passage. The

route to the far left is by far the easiest and safest. Continuing on, a greasy climb down into a pool is followed by an even harder climb up using mud as handholds. A traverse over a slot in the floor and a further climb down leads to 'Junction 34' and the magnificent 'Rudang Gallery'.

Junction 34

From Junction 34 a huge tunnel penetrates into the mountain both to the north and south. This is the point where groups exploring opposite ends of the system part company, and is a handy place to leave notes for each other when returning. A survey cairn was built here and below this is a lake, 'Blackpool', which varies in size depending on weather conditions, (see 'Notes on Flooding').

Junction 34 to Eagle's Ramp

At Junction 34, as with all of Slarti's Revenge, there is constant evidence of water regularly backing up. Everything is covered in slimy mud.



Mud formations on the Hoover Dam

South from here leads along Rudang Gallery South. This is a passage 25m wide by 15m high with sandy muddy banks to the eastern side and a small stream to the west which drains into Blackpool. After 200m is a climb over a steep slope of clay and boulders. This slope forms a feature named 'The Hoover Dam'. The total ascent here is 20m and the slope appears to dam the passage, although a small low level bypass was later found.

Beyond the Dam the passage continues 30m wide by 20m high through banks of sandy sediment which become muddier with depth. After 400m a climb up boulders passes the entrance to 'Purgatory' on the left. Between here and the Dam, water drains into small sumps under the west wall, and receding flood waters appear to have cut channels in the sediments. Water enters from avents along the east wall.

Beyond the entrance to Purgatory, a 43° slope of boulders is met 'The Eagle's Ramp'. This enormous boulder ramp rises 136m up slope to a solid wall with no apparent way on.

Purgatory and the Black Magic River

From Rudang South a climb down mud covered boulders leads to 'Purgatory Passage'. The passage abruptly turns to the south and follows a small wet weather stream until a junction is reached. Continuing south the passage rises to a nasty loose boulder climb and a dead end. A hole in the roof leads upwards but is out of reach.

Left and to the east at the junction lies the 'Black Magic River'. Just before the River is reached an inlet enters from a water filled passage heading north east which sumps after 20m. This small stream joins the other wet weather stream but is lost amongst the boulders at the junction.

The Black Magic River heads downstream in a southerly direction. Normal flows are in the order of 5 cumecs and progress can be made by a mixture of traversing along mudbanks and wading in deep fast-flowing water. After 300m a large chamber is reached with a mud and boulder collapse coming down from the south east. Some water percolates into the foot of this slope. However a greater quantity turns to sump under the western wall of the chamber.

This is the lowest point in the cave at 45m below the entrance. The extent of muddy deposits in this area suggest a substantial backing up of water in times of flood.

Upstream the River appears from the base of a boulder pile. This can be climbed to a breakdown area with two ways on. Straight on, a traverse was explored for over 100m in a small uninspiring strike controlled passage which was not followed to a conclusion.

To the right a short rope climb down mud and loose rubble leads over boulders to rejoin the Black Magic River. Wading upstream this fine canal passage can be followed past occasional boulders to end in a sump after 210m.

Rudang Gallery North

From Junction 34, Rudang Gallery heads north over sandy gravely banks 25m wide by 15m high. Three large holes in the roof are passed on the south east side, the first of which was ascended in '89 with the aid of climbing equipment. This rises for 60m before turning to descend a parallel ramp.

After 300m a sandy side passage leads east for 300m to reach a sump chamber with deep water. Under normal flow conditions water in this chamber flows very slowly from north to south. From its position it appears that this is part of the sumped upstream continuation of the Black Magic River with the chamber forming an airbell.

Ahead in the main passage two roof inlets enter and drain into a sump under the west wall. From here the tunnel runs almost dead straight for nearly half a kilometre. The route continues over enormous piles of boulders before descending to meet the 'Firecracker Streamway' which joins from the west. Continuing north east and downstream a pleasant phreatic sandy floored tunnel leads after 180m to a sump.

Black Silk Passage.

One hundred metres upstream from the sump at the end of Rudang Gallery, an obvious passage in the east wall leads to a ramp which was heavily used by swifts. 30m up this a passage branches off along the strike. The ramp continues upwards but closes down very quickly.

Along the branch, an elliptical tube continues for 160m to another ramp which leads back down to the streamway to bypass the sump. Upstream leads to the sump whilst downstream 600m of fine passage in striking black dolomitic limestone, named 'Black Silk Passage', leads to a junction. Water flows down the eastern branch to disappear in the Silk Black sump while the western fossil branch ends in a sizable area of collapse 'Glitter Black Collapse' which is particularly impressive with many large black blocks speckled with selenite crystals

Firecracker Streamway.

The Firecracker Streamway has a total explored length of 3km, from Rudang Gallery to the upstream sump. 300m south west and upstream from Rudang Gallery the passage abruptly swings round to the north east. The next impressive 2.7km follows the strike of the same major bed. For virtually the whole length of this splendid passage, which regularly attains 30m by 30m

dimensions, the stream meanders among high mud banks and undercuts the walls after having initially emerged from a sump near the 'Great Bows', a pair of giant dry oxbows.

The volume of the stream is increased many times in its length by inlets coming down the bed. Evidence of high flood levels can be seen clearly on 'The Wings of Gold', draught orientated stalactite curtains 5m above the normal stream level, and by water level marks on the mud banks. There are few breaks in the uniformity of this part of the cave with only one major lead, the 'Racer Series', (described later).

Eventually a sump is reached from which the streamway emerges. At this point a large high level passage above the east wall is an oxbow which loops round to rejoin the main passage after 90m. Ahead the passage degenerates into two flat out crawls, the right one of which has a small stream emerging from it.

To the right, following the small stream, flat out crawls around delicate formations lead into a fine calcite chamber. Here the stream emerges from impenetrable cracks in the roof and at the far end a calcified slope leads up to a boulder choke. Through the boulders leads into a large breakdown chamber, "Guy Fawkes Chamber", so named as it was discovered on November the 5th. This chamber is of similar dimensions to the main Firecracker passage. A calcited boulder slope leads up to meet the roof with no way on but a crawl in the southern end of the chamber links back, via a flat out squeeze over sediment, to the other lead at the end of Firecracker. This passage appeared to be taking the draught back to Firecracker. From survey data, the breakdown in Guy Fawkes Chamber appears to be associated with a surface collapse, (Fig. 9).

Firecracker streamway demonstrates many classic Mulu features including a series of wall notches and gaping water worn holes in sediment banks. In the vicinity of the Racer Series the stream appears to be peached above a much lower active stream which has as yet proven inaccessible. During times of flood Firecracker appears to overflow into the Racer Series where it descends, after a very short distance, into a bouldery pit. The impervious gravels and clay sediments which form the floor of the Firecracker Streamway appear to be preventing this lower streamway from robbing all the normal flows from Firecracker although it may only be a short time before erosion allows this diversion to take place.

The Racer Series

900m upstream from Rudang Gallery a large passage in the west wall of Firecracker forms the entrance to the Racer Series.

This impressive series of grand proportions heads north west over awkward bouldery pits to reach a large oxbow. Above this an exposed climb up a steep clay slope leads into a strike

controlled passage which, after 150m, is choked with sediment. however a climb up a steep muddy ramp leads to a short passage which ends abruptly as it emerges high in the roof of the main passage. Close to this a small inlet enters down a waterfall above which a ramp can be seen leading upwards; however, access to this would require aid.

The main passage continues over boulders and sediments past another steeply ascending ramp on the left which was explored but did not continue. Beneath this ramp a climb down through muddy boulders in the floor leads to a small fast flowing stream of which, only the edge can be seen through a tight slot beneath a large boulder.

After a further 150m the main passage enters a large boulder strewn chamber, 'Rat Chamber', so named as a large white chested rat was seen.

Climbing to the right over the pile of boulders in the center of the chamber leads to two smaller side passages which head in opposite directions along the same bed. To the north the larger of these splits to end after 400m. To the south the smaller passage, 'On the Slate', runs through bouldery chambers and turns to the east before entering a heavily calcited area. Strong draughts lead onwards through stalactite grills to enter two passages both of which end in loose boulder collapses which are very close to the surface.

Onwards from Rat Chamber, normal going is over fine muddy sediments and around collapsed pits for a further 600m to where the passage decreases in size and turns a 90° bend. Now heading north west, past more awkward pits, a 3m climb up is reached. At this point the passage is 6m wide by 10m high however, during the first trip into this series, the draught here was sufficient to extinguish a carbide flame.

At the top of the 3m climb exploration was halted whilst a 2m long 'Cave Racer' snake which guarded the way on was allowed to slowly slither away.

Past here the passage again turns through 90° to head north east to the 'Snake Pit', a large chamber where the floor has collapsed. At the far side of this the continuation can be seen disappearing high in the west wall. Climbing down into the Snake Pit an inlet cascades down from the roof and disappears into the bouldery floor. A small passage leads off downwards and northeast but above this a 3m climb is the main way on.

Continuing down over muddy boulders a small stream can be seen amongst the rocks and after this the passage climbs dramatically up a ramp to end in a well decorated grotto.

Ascending the 3m climb, a low tube breaks out into the main tube. To the left leads to a large balcony overlooking the

Snake Pit whilst to the right leads to a large chamber and the Racer Entrance. Gaining access to this entrance involves a climb up slippery boulders covered with Moon milch.

Climbs in the roof of the entrance chamber lead to well decorated passages and two other entrances which are very small. Leading south from the entrance chamber a small strike controlled passage ends at a 10m pitch to a sump, this point is only 120m from Old Holborn Passage.

The main entrance chamber is the roost for a large number of Swifts.

NOTES ON FLOODING

Beyond Brighton Beach there is considerable evidence of water regularly backing up. Deposits of fine slimy muds become extensive with depth, bearing a marked resemblance to large 'slimes lagoon' associated with a mineral dressing plant.

Blackrock appears to act as a large reservoir during times of heavy rain, storing floodwaters in the Rudang Gallery / Firecracker areas to be released slowly as inlet flows subside.

The slopes of the Hoover Dam display evidence of previous flood levels. Just off the crest of the dam is an upper flood level which appears to be echoed in other areas of the system. This point is known to be 26m above the level of the downstream Black Magic sump. It is not known whether the cave floods to this level today, however the same level of flooding is shown by tide lines left on the Wings of Gold formations in Firecracker, 1Km to the north. It is almost certain from the extent of wet slimy muds that a large proportion of Rudang Gallery and Slarti's Revenge are regularly flooded, to form an enormous lake.

Studies during the '89 expedition showed that the footprints left in 1988 around the Blackpool area had been obliterated below the -38m level. This represents a 2m rise in the level of Blackpool and would cause it to extend 100m north and also well to the south of the Hoover dam to form a long serpentine lake. Rainfall during 1989 was below average so further study of footprints will be required to determine the extent and regularity of major flooding.

With the above in mind future explorers would be well advised to treat the Black Magic, Rudang Gallery and Slarti's Revenge areas with caution.

NOTES ON GEOMORPHOLOGY

Water tracing during the Mulu '80 expedition proved two major links to the Clearwater resurgence, from the Melinau Paku to the east, and from the Melinau Gorge to the north. With the

exploration of Clearwater 3 in 1984 the first of these links was better understood. Following the discovery of Blackrock and its three underground rivers the Api jigsaw is beginning to link up, (Figs. 3 & 8).

As yet no connection has been established between the Firecracker and Black Magic rivers but it seems likely that one will exist. From a study of the plan it seems probable that after entering the Silk Black Sump the Firecracker streamway will swing to the south to re-appear as the Black Magic River. Whether another streamway joins during this distance can only be speculation, however observations showed Black Magic to be in high flow conditions on a day when Firecracker was not, and vice versa, suggesting a tributary to exist which would take its feed from higher up the gorge.

The multiple peaks shown by the 1980 dye trace tests in fact suggest at least three distinctly different routes from the Melinau Gorge to exist. In Clearwater at least two major streamways are present, that emerging from Clearwater 4 sump being the larger, but also a second geomorphologically significant stream emerges from the upstream sump in Volcano passage to travel southwards under Inflation and appear as the western branch in Clearwater 2 where it joins the main flow .

Slipstream forms a continuation of the marginal drainage system developed all along the western flank of Gunung Api, deriving its water locally from the alluvial plain. A significant sink was reported further to the north by Hans Friederich (in Smart & Willis, 1982, p. 101). From the surface traverse to the Racer entrance this has been plotted and appears to be the feed into the Polnagollum Canyon. It is possible that Slipstream reappears in Metric Cave to drain to the upstream sump of Leopard Cave, as flows were of the same proportions, however evidence of considerable backup in Slipstream suggests that there may be a major constriction between the two.

The initial flow into Blackrock was via the Racer Series into Old Holborn and via The Mistrale Series into Rudang South. This circuitous route was then captured by the Rudang North link. Subsequently a second capture into Black Silk Passage occurred, the existing stream perhaps being pirated by a larger hydraulically more efficient streamway nearer the centre of the mountain.

Firecracker is typical of major Mulu passages, it is developed along the strike and has an undulating phreatic profile with vadose segments incised progressively into the higher parts. This gives a low passage gradient, as exemplified by the Rudang Gallery segment which is now abandoned.

The present stream in Firecracker is a misfit, the passage having been formed initially by the underground diversion of a substantial part of the Melinau River from the gorge. At

GENERAL CONCLUSIONS

The discovery of Blackrock Cave has answered many questions regarding the caves of Mulu. With 21Km of passage explored to date, it takes its place as the second longest system in the park and there is great potential to extend the cave possibly to form the link between Clearwater and the Melinau Gorge, (Fig. 8). The magnificent Firecracker Streamway stands as yet another of Mulu's natural wonders and the opening up of the Racer entrance has provided a safer access enabling more adventurous tourists to share its splendours.

Not only have these two expeditions shown once again that the enormous potential for exploration in Mulu's caves is far from exhausted but also demonstrate the effectiveness of the lightweight expedition working within the framework of the National Park.

Discoveries such as the Paris Metro and Simon's Cave, both very close to the tourist trail and easily accessible, demonstrate how little is known of these dense forested slopes. Although it will require progressively more footwork to make major finds, many new entrances and minor caves could be revealed within easy reach from the tourist trails.

However, vast areas of limestone still remain totally untouched, (Fig. 8), and determined explorers will be making major new discoveries well into the next century. It is unlikely, however, that Mulu will ever surrender all of its hidden secrets.

EXPEDITION MEMBERS

MULU CAVES '88

From the U.K.

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National Park staff; Simon Lagang, Tambi Epoi, Wilson Bala, Richard Jalong, Bagley Lang, Ubau Baning.

Tropical Adventure staff; Paris Wan, Petrus Abang.

Camp Manager; Weng Lipang.

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APPENDICES

1. Access to Mulu

Persons entering Sarawak require a visa, normally obtained at the point of entry into Sarawak. Permits to enter Mulu National Park are required from the National Parks and Wildlife Office in Miri, and a permit to travel as far as Marudi is required from the 'Resident' in Miri. To travel onwards from Marudi to Mulu a further Permit is required from the 'Resident' in Marudi.

The Gunung Mulu National Park is fast becoming one of Sarawak's main tourist attractions. Local tour operators now run package tours based in comfortable accommodation near Long Pala, just outside the Park boundary. They will attend to the necessary travel permits required for anyone travelling with them. They also provide boat transport from Long Terawan to the Park and within the Park.

The National Park offers self-catering accommodation at Long Pala which must be booked in advance. Anyone staying here will have to make their own travel and meal arrangements.

It is a requirement of the National Park that any visitors entering the Park must be accompanied by a recognised National Park Guide. Guides are provided by the Park, subject to availability, but must be paid for by the visitor. Guides can take visitors to various places such as the summit of Mulu or the Pinnacles on Gunung Api both of which require an overnight stop in a sub camp.

There are four show caves, Deer Cave, Lang's Cave, Lady's Cave and the entrance to Clearwater Cave. More active tourists / cavers can sample 'Wild Caving' trips into various systems away from the footpaths and lights of the show caves, providing the guides will accompany them and the trip is suitable. However this is not the way to enter the Park to carry out prime cave exploration.

Persons wishing to enter Sarawak to carry out work of a scientific or exploratory nature, ie. caving expeditions, must have written permission from the Sarawak State Secretary before entering Sarawak. Before this is applied for it would be advisable to seek approval for the project from the necessary government department, for Mulu it would be the National Parks and Wildlife Office in Kuching.

The relevant addresses for these departments are as follows;-
The Sarawak State Secretary, Bangunan Tunku Abdul Rahman, Petra Jaya, 93502 Kuching, Sarawak, Malaysia.
The National Park and Wildlife Office, Forest Department Headquarters, Kuching, Sarawak, Malaysia.

2. 1988 Logistics

This expedition was planned to be lightweight and although the list of members grew to nine during the planning stage the final team consisted of six. This proved to be an excellent number as we were able to remain and work as a small unit throughout the expedition. Travel and accommodation en route were fairly straightforward although all six of us had to share a double room in Kuala Lumpur when we arrived there late in the evening.

Two nights were spent in Miri whilst permits, visas, etc were sorted out and during this time travellers cheques were exchanged.

One night was spent in Marudi where a further permit was required, also various last minute provisions were purchased. Most things can be bought in Marudi and it is pointless taking a lot of heavy food, camping gear or carbide from the U.K. when it is all available there. The bulk of our food had been ordered and purchased from Johnny Leong, in Marudi, before leaving the U.K. which saved a lot of valuable time. This was shipped up to Mulu for our arrival.

Whilst working in southern Clearwater we stayed in the National Park's accommodation at Long Pala which proved excellent for our needs. During this time local porters were employed to construct a forest camp outside Leopard Cave and to carry food and equipment to there.

Two large, purpose built, camp sheets were taken out from the U.K. and provided shelter for two groups of seven. Additional roofing was provided, where necessary, by the porters. This was made from interwoven palm leaves, and proved to be very effective at turning heavy rain.

All visitors entering the Park are required to hire recognised guides to accompany them. We employed two guides throughout our stay; however, to spread the experience amongst them all they worked in rotation and at times extra guides joined us on staff training. With their natural abilities these guides make excellent cavers and at times we wondered just who was training who.

After one week at Long Pala we moved to the Leopard Camp which was better situated for working in Northern Clearwater and north from there. We remained there for the next three weeks, apart from a three day break at Long Pala following the rescue.

Five days were taken up with Northern Clearwater and surface searching. Eleven days, including the rescue, were spent in Blackrock. The entrance to this was one hour's walk to the north and as so much time was being wasted in getting to the

cave an underground bivouac was established. This was occupied for a total of eight nights.

During the height of activities in Blackrock there were up to 15 people in Leopard Camp at one time which put a strain on resources. As well as feeding ourselves, both surface and underground food was provided for the guides, porters and cook. Extra food was sent up from Marudi for us whilst in Leopard Camp but we drastically underestimated for midday snacks, chocolate, peanuts, raisins, etc. and could have done with twice the amount.

Due to rain and heavy traffic, the tracks between camp and cave became very boggy. Leeches were a problem; however, a liberal application of insect repellent did deter them.

Two days were spent dismantling the camp and transporting equipment back to base where two further days were spent plotting surveys and sorting out gear before heading home.

3. 1989 Logistics

Although the '88 six man team had been very successful it was felt that a slightly larger team would be of benefit, so the '89 expedition was planned around an eight man team. This allowed slightly greater flexibility without putting much more strain on the park's staff resources.

Again most supplies were purchased from Johnny Leong in Marudi. However it is important to write names and the destination on all boxes before transporting them upriver, we managed to lose two unmarked boxes which must have been left on the express boat by mistake.

Base camp accommodation was provided at Long Pala by Tropical Adventure. They also arranged all transport onwards from Marudi and also upstream to Long Lutut. Two Tropical Adventure Guides were with us throughout the expedition. One national park guide was hired throughout the expedition and other guides and staff joined the team to gain expedition training.

Leopard Camp was not used, instead a riverside camp was established at Long Lutut, outside the boundary of the Park. Although this site was further from the caves, being beside the river, it was better placed for access to Camp 5 and the Clearwater resurgence. Establishing and servicing the site from Long Pala was far easier as all the heavy stores could be transported direct by longboat without the need for portage. The aspect was far more sunny and in general the benefits of this site outweighed the extra half hours walk each way to the caves.

The camp was occupied for four weeks with only one night when it was left unattended, when Monitor lizards raided the rubbish bags. Underground bivouacs were extensively used normally for three nights at a time. These were at Milliways and Rudang Gallery in Blackrock and at Scumring in Clearwater. From Scumring one advanced bivouac was used, by a small party, during the surveying of the Cairn Farm, due to the remoteness of the site.

The exploration of Simon's Cave and the Paris Metro were both carried out from Long Pala as day trips.

From Long Lutut, Camp 5 is a two hour trek through the forest along a good tourist trail. Downstream, Clearwater resurgence can be reached in approximately half an hour with a further half hour to reach Long Pala, depending upon river levels. Leopard Cave can be reached on foot in half an hour. This track does become very boggy in wet weather. From Leopard Cave the Hayloft and Racer entrances to Blackrock are 30 to 50 minutes along another boggy track. The Snake Track entrance to Clearwater is about 40 minutes in the opposite direction although this track follows higher ground and, apart from stream crossings, is much drier.

4. Medical

Although both expeditions were planned as a short small team venture the usual range of medical problems associated with caving in Mulu were expected. These have been well documented by previous expeditions. In '88 a doctor had been included in the original team, however due to an alteration in the departure date he was unable to travel to Sarawak.

First aid and trauma kits were taken from the U.K. and contained a wide range of dressings, antibiotics, antiseptics etc. with particular consideration for Mulu Foot and Leptospirosis. Before leaving the U.K. up-to-date information on necessary vaccinations and Malaria prophylaxis was sought and acted upon.

Both expeditions experienced problems with Mulu Foot among those members who did not adhere to a very strict routine of foot care. This consisted of various precautions. Firstly to avoid the ingress of abrasive materials either the high modern 'British Army Boot' or gaiters were worn. In addition 2mm wet suit socks were worn which were washed after every trip, two pairs being used in rotation when it was not possible to dry them in time. In underground bivouacs boots and wet socks were removed as soon as possible and lightweight flip flops were worn both to keep the feet clean and to allow them to dry out thoroughly. Feet were treated with foot powder of various makes before, during and after trips underground. National park guides suffer the condition after prolonged surface walks as well as from caving trips.

During the '88 expedition the only team member to avoid Mulu Foot wore high army boots. This was consistent in '89 when two team members wearing high army boots and one wearing gaiters also avoided this painful complaint.

All minor cuts were treated as soon as possible with Betadine paint and no septicaemia problems were experienced.

During '88 two expedition members and one guide suffered some of the symptoms of leptospirosis. They were treated with antibiotics and recovered. On return to the U.K. blood tests proved to be negative for this bacterial infection.

Two of the guides suffered from boils which could have been caused by infected insect bites. These were successfully treated with antibiotics; however, in one case the local remedy of attempting to suck out the poison with a heated bottle resulted in burns which were more serious than the original complaint.

During '88 the total time lost from exploration for medical reasons was ten man days out of a total of one hundred and eighty. A similar amount of time was lost in '89 out of a total of two hundred and forty man days. The two main causes of lost time were Mulu Foot and stomach upsets.

5. Underground Rescue

During the '88 exploration of Blackrock Cave one of the park guides, Jimmy Sawing, who was on staff training, fell and suffered major injuries to both legs which resulted in Mulu's first major underground rescue incident.

There are various aspects of this rescue which may be of interest and use to future expeditions to Mulu and other parts of the world.

Jimmy had participated in the 1984 expedition which included the exploration of Cobweb Cave in Gunung Benarat. The caving in Blackrock was of a similar nature and the accident occurred at 'The Quarry', later renamed 'Jimmy's Quarry', a 25m wide chamber with a steep boulder slope which was one hour's caving from the Milliways bivouac. While descending the slope Jimmy fell and rolled three metres, suffering a broken lower leg and injuries to the knee of the other leg. Damage to his helmet showed that head injuries had been prevented. A total of twelve people were in the cave at the time, six team members, five park guides and a cook. Two Penan porters were at the Leopard Cave camp. A stretcher was improvised from a pole hammock using poles which were cut from the forest. This proved very successful and nine people were able to carry Jimmy back to Milliways in seven hours whilst the others returned to park headquarters to seek assistance.

There was a small medical kit at the bivouac and a larger kit at the camp. The small kit contained pain killers, Temgesic and Valium, which proved to be a good combination. The design of the hammock was the key to the stretcher's success. It had pole sleeves on all sides which meant that head and foot poles could be held in place preventing the stretcher from folding. Splints for the legs were also made using wood cut in the forest and 'Thermarest' sleeping mats provided further rigidity and padding.

From the bivouac out to the surface the park's 'SKED' stretcher was used and a sit and chest harness were rigged on the patient. The cave passage negotiated during the carry was varied and difficult ranging through loose boulder piles, flat out crawls, short climbs and traverses which needed rope protection plus a ten metre pitch.

From the bivouac to the surface and then on to Leopard Cave camp, Long Pala and Marudi the numbers of rescue helpers was boosted dramatically by park personnel; however, rescue control was not handed over until the patient left the cave.

All the park guides who were involved in the underground carry were very strong and agile making them good movers in the cave. This, with the experience of the British members, contributed to the speed and efficiency of the carry. The total time from the accident to the patient's arrival at Marudi hospital was thirty six hours which could have been greatly reduced if a helicopter had been made available when it was requested.

The high temperature in the cave meant that hypothermia was not a problem and during the few hours hospitalization at the bivouac the patient was comfortable. Some time was lost in transporting the 'SKED' stretcher to the rescue as the cave entrance was not well marked. Future explorers would be well advised to ensure that newly discovered entrances are either well marked or a person who is familiar with the route to the entrance is left on the surface whilst teams are underground.

Five members of the expedition were active members of cave rescue teams, four being underground controllers, and had first aid training. The use of sophisticated, well practised, vertical hauling techniques made the pitch a simple problem to negotiate. This experience of self sufficient rescue techniques was invaluable and should be a prime consideration in any expedition plan.

6. Photography

The vast scale of Mulu's caves poses considerable photographic problems; however, it is easier to achieve reasonable shots underground than in the surrounding forest.

The first essential consideration is the protection of all things photographic from the environment. The extremely high humidity necessitates the use of some form of airtight container together with copious quantities of silica gel which is readily available from most photographic shops in Miri. Although the caves may appear dry their atmospheric humidity is very high. Unless equipment is stored in airtight containers containing dry desiccant, moisture will be quickly absorbed by film which, within a day or so, will swell sufficiently to jam a camera. Although a waterproof camera avoids this problem, all films must be protected when not in use.

Another major problem is fungus which can grow on film but is more likely to occur on the coating of camera lenses. Although this fungal 'etching' creates a good soft focus filter, the damage is permanent, so regular cleaning of lenses is essential.

A high film speed is required for both underground and surface photography; 200 ISO or 400 ISO. Due to the dense canopy, light levels within the forest are low, so flash is often required on the surface. Occasionally brilliant sunlight penetrates to produce areas of high contrast which, although the human eye can cope with, are difficult to reproduce on film.

Most cave passages are large by British standards but some are very large indeed. Flash bulbs are of more use than electronic guns; an AG3B bulb (about 1.5cm by 0.5cm diameter) produces an equivalent output to an expensive electronic gun and also gives 180° illumination compared with approximately 60° from the electronic gun. Frequently larger light sources are required; Keith Johnson + Pelling import Bowens M22B bulbs into the UK from Korea, which cost around £1 each. Although these can be used in a proper flash gun, when used in conjunction with a car headlamp reflector they are a superb source of light; (guide No. 85 metres 100 ISO).

A similar amount of light can be obtained using flash bars (designed to fit polaroid cameras). These have five, AG3B sized, bulbs on each side and with a suitable firer, which will need to be home made, all five bulbs on one side can be fired at once, giving a similar light output to the M22B bulbs. The cost of these is similar, about £2 per bar, but with two sides and built in reflectors they are very compact.

Electronic guns are useful for close up work; people shots, beastie shots, etc. but they are very easily upset by humidity.

As is normal with underground photography the flash guide number will need modification. As a general rule $\frac{1}{2}$ the guide number or, if it is easier to work out, $\frac{1}{2}$ the film speed. In Mulu I normally use 400 ISO film but work out the aperture setting for the quoted 100 ISO guide No.

7. Surveying

All surveying was carried out using a 'Suunto' clino & compass with a 30 or 50m tape. Over 800 survey legs in '88 and 1000 in '89 were reduced using a 'Casio FX 700P' programmable calculator. Another 'Sharp' computer was taken which incorporated a small printer. Unfortunately the damp conditions and extremely small print size made this difficult to read, so it was abandoned at an early stage. All survey data and resulting co-ordinates were logged in hardbacked A4 note books which proved indispensable.

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