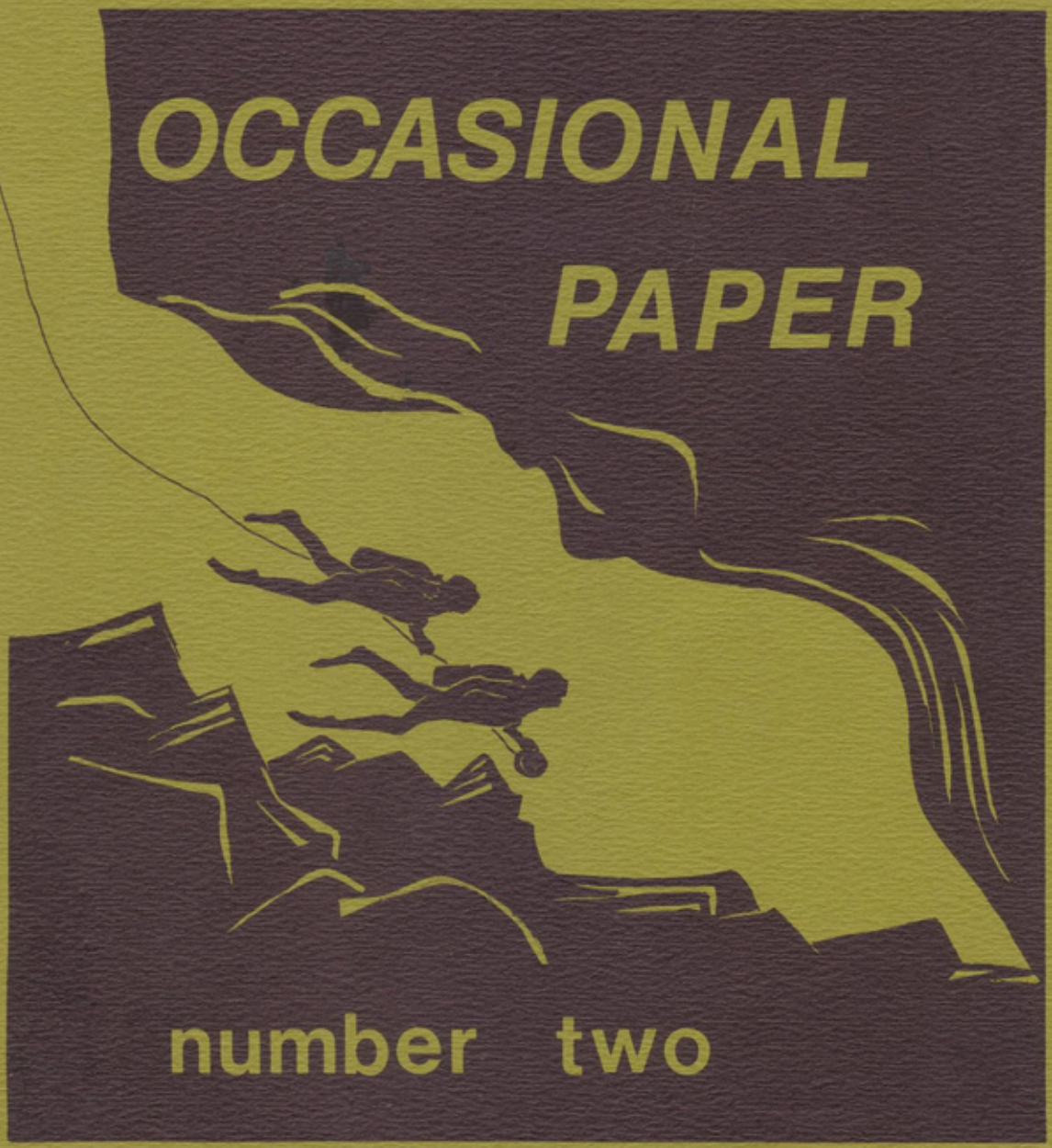
Cave Divers Association of Australia

OCCASIONAL PAPER



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TOPICS PRESENTED AT CAVE DIVERS ASSOCIATION of AUSTRALIA (INC.) BIANNUAL CONFERENCE, SEPTEMBER 22nd 1979. Mount Gambier.

EDITED by JENNY HISCOCK

INTRODUCTION

Cave diving can be a broader based activity than sinkhole diving at Mt. Gambier - it can be the embodiment of speleology and scuba diving. It has been one of the aims of Cave Diving Conferences organised by the Cave Divers Association of Australia (Inc.) to show this and to encourage divers to incorporate techniques from speleology in their own sport. Thus the wider distribution of information on belay and ladder techniques.

The varying degree to which the two sports are combined is demonstrated by comparisons between diving at Mt. Gambier, Cocklebiddy and Jenolan. Sinkholes require scuba diving knowledge with caving aspects only recognised in the higher category sinkholes - that is, the exploration of the cave is almost entirely a scuba diving exercise. At Cocklebiddy, we have a true underwater cave and both caving and scuba diving expertise are required for exploration. The Jenolan caves provide an example of the other end of the spectrum where caving expertise is required for most of the exploration and scuba diving is carried out for only short distances - although under the most arduos conditions.

The topics presented at the 1979 Biannual Cave Diving Conference, provided information on the different types of cave diving as well as additional knowledge on the area of our primary interest - Mt Gambier. Unfortunately, a transcript of the conference was not made, and as some of the contributors have been unable to provide us with a written account due to other committments, I have provided information on the topics covered.

Jenny Hiscock.

contents

PAGE

FOSSILS FROM FOSSIL CAVE
by Dominic Williams..... 4

DIVING FOR FOSSILS
by Peter Rogers & Jenny Hiscock... 9

SAFETY WITH BELAY TECHNIQUES AND LADDERING
by Ron Allum..... 13

HYDROGEOLOGY OF THE MT. GAMBIER REGION
by Jenny Hiscock..... 18

CAVE DIVING AT JENOLAN CAVES
by Ian Lewis..... 23

AUGUST 1979 COCKLEBIDDY CAVE DIVING EXPEDITION
by Jenny Hiscock..... 29

FOSSILS FROM FOSSIL CAVE (GREEN WATERHOLE, L 81)

by *Dominic Williams*

At the time of the Conference, Dominic was studying for his Doctor of Phiolosophy in the Biology School at Flinders University. He has since completed his studies and is currently employed on a project at Adelaide University Zoology Department.

HISTORY

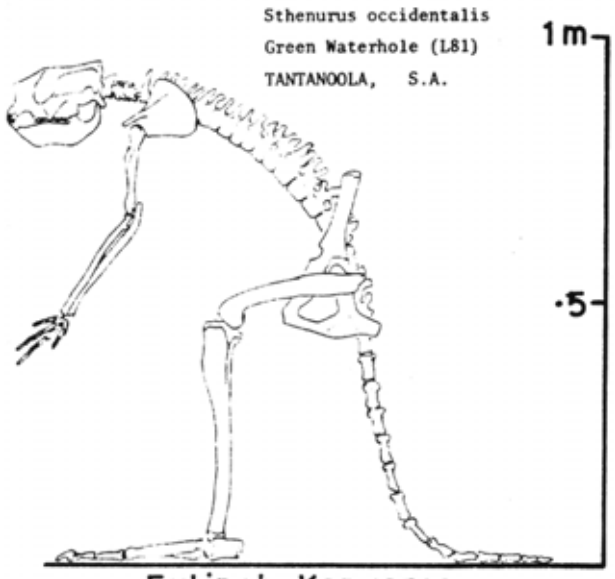
Fossils were first collected from Fossil Cave in about 1964, and were submitted to Mr. Brian Daily of the South Australian Museum. In 1968, Mr. Fred Aslin organised the first of a number of trips to the sinkhole, when Mr. Brian Brawley collected a number of skulls of extinct kangaroos from the surface of the rockpile in about 10m of water. Subsequent expeditions resulted in the collections increasing in size, and in 1974 Mr. N.S. Pledge of the South Australian Museum, with Messrs Aslin and Brawley, placed markers in the cave during fossil collection. These markers were later to be useful in our 1979 work.

When some C.D.A.A. divers from Flinders University returned with bones from Fossil Cave late in 1978, Rod Wells and I organised two expeditions. This was preceded by a week of diving, just to place lines and pegs on the rockpile. These were intended both as a safety precaution for the divers, and also a reference grid for locating fossils. As many cave divers have discovered, visibility suffers once the bottom is stirred up, and fossil-collecting inevitably releases clouds of fine sediment.

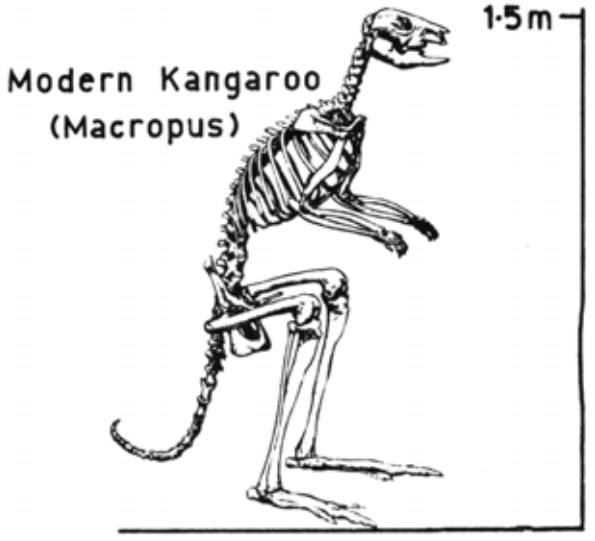
WHAT WE FOUND

A very large collection of fossil bones was made, most of which belong to extinct species of kangaroo. Previously these animals were only known from incomplete remains, and many species were first described from a few teeth alone. The Fossil Cave material is unique in containing whole skeletons. In some cases the skeletons were so perfectly laid out that we were able to collect tiny hand and ankle bones by telling the diver what we were missing, and where, in relation to the head, the missing bits might be found!

When one of these Sthenurine kangaroo skeletons was reassembled, it caused something of a surprise. Owing to the large size of the skulls of these animals, it had been widely believed



Extinct Kangaroo



that they were 'giant' kangaroos. However, the reassembled skeleton stood only about one metre tall - about the same as a smallish Grey Kangaroo today (see illustration). What they lack in height they make up for in having a stocky build, with a short neck, and a short tail. Their arms were long, and capable of reaching over their heads. Although their teeth tell us that they most likely ate leaves and twigs (unlike modern kangaroos, which are best adapted to eating grass), and consequently we would expect them to live in dense scrub, their feet seem to be even more specialised for fast hopping than modern kangaroos.

If the feet of a *Sthenurine* kangaroo are compared with those of say, a red kangaroo, we see that the fifth toe is almost lacking. Modern kangaroos have a fifth toe that is smaller than the fourth toe, but still functions. So the extinct 'roo had only a single large toe that functioned for hopping. This suggests that they once lived in open bushland.

It is this kind of study which allows us to find out the kinds of animals that once roamed Australia, and how they lived.

OTHER ANIMALS

Of course, other animals are amongst the fossils. There are bandicoots, wallabies, rats and bats represented. Most of these animals are indistinguishable from their modern descendants, but amongst the larger kinds there are bones of the extinct Marsupial Lion. This was most likely a meat-eater, the size of a large dog, and with a formidable set of bolt-cutter teeth. Other strange kinds of kangaroo are also present, such as the giant rat-kangaroo, *Propleopus*, about which little is known.

There is a large collection of bird bones as well. Dr. Pat Rich and Dr. Gerry van Tets are studying these. So far they have identified bones of water-hen, crow, pigeon, parrot and others. Perhaps the most interesitng are the bones of a giant eagle, now extinct, and a new species of cuckoo, also extinct.

WHAT WAS IT LIKE WHEN THE BONES WERE ACCUMULATING?

There are various ways to try and reconstruct the conditions that once existed in and around Fossil Cave. One of these is by extracting fossil pollen grains from the cave sediment, and identifying them. It is a complex process, as pollen from some

plants might come from a great distance on the wind before it filters down into the cave. However, we expect to get some idea of the vegetation around the cave as it was in the past.

Various lines of evidence suggest that Fossil Cave was not always full of water, as it is now. The bones of birds, bats and the larger animals are unlikely to have got so far down the cave unless the water-level was lower. Some bones from deep in the cave have the gnaw-marks of rats on them, which means that at times there may only have been a pool of water right at the bottom. This fits in with what we know about sea-level. At various times in the last few hundred thousand years, world sea-level has dropped by at least a hundred metres. This would mean that the water-table at Fossil Cave would drop, as it is near the coast. It seems likely that the fossil deposit is related to one of the low sea-level periods - but which one?

HOW OLD ARE THE FOSSILS?

This is proving to be a difficult question to answer. The main problem is that the cave sediments and the fossil bones are draped over a tumbled pile of rocks, so that any layering is hard to detect. This is made more difficult since it is under-water where observations are difficult to make. It may never be possible to give the fossils an exact age. All we can say at present is that the bones are of Pleistocene age - that is, younger than 2,000,000 years or so; from the evidence of low sea-levels we can say that the fossils are at least 17,000 years old. (That was the time of the latest low sea-level.) However, there have been a number of low sea-level periods before that, and we don't know which of these it might be. However, our study of the fossils and Fossil Cave are at an early stage, and there is much to be learned from the fossil pollen, carbon dating, and studies of the sediments.

SUMMARY

As a result of the diving at Fossil Cave, a huge amount of knowledge is accumulating. The difficulties of collecting bones from the cave will be appreciated by all cave divers, especially so when it is realised that each dive was carefully logged as to the position of every bone before it was collected. It has been said that for such collections, the most important part is the label - a fossil with no label is virtually useless.

I would like to finish with an invitation to C.D.A.A. members to keep an eye open for possible fossils. If you do see what looks like a fossil, the best approach is to collect a small, separate bone. Remember where it came from exactly in the cave, and show it to an expert, either at a Museum, or at a University. Don't worry if it looks like a cow-bone - that's what Peter Rogers thought when he brought in the leg of an extinct kangaroo!

But please - don't start a major fossil dig without consulting an expert first. Remember that the most important information is in where the fossils are, not so much what they are.

DIVING FOR FOSSILS

by *Peter Rogers & Jenny Hiscock*

INTRODUCTION

It is not often that divers travel to Mt. Gambier other than for the sheer enjoyment of diving in the clear water of the caves and sinkholes that are found there. However, in later 1978 and early 1979, a group of seven divers from the Flinders University Underwater Club were involved in the collection of fossil bones from Fossil Cave or Green Waterhole under the guidance of Dr. Rod Wells from the School of Biological Sciences at Flinders University. The latter was prompted to undertake the expedition by the latest bone find; Peter Rogers, Clive Mills and Richard Stanton had collected a thigh bone of the extinct kangaroo *Sthenurus* on a dive in November '78.

As detailed in the preceding paper, Fossil Cave has a history of bone finds. The only underwater reference to previous finds were tags on weighted lines that could have easily been moved due to sports diving activities over the years. In the '79 expeditions, it was determined that if any collecting of bones was to be done, a map of the searched area was required.

THE UNDERWATER GRID

An underwater grid of reference lines was devised by Robin Garrad to enable identification of fossil bone sites and a map of the underwater section of the cave to be made. It was intended that the grid would consist of 2m x 2m squares that would be delineated by posts connected with string. However, due to the semi-circular shape of the cave, parallel lines were deemed impracticle and a radial plan was adopted.

To place the grid was an expedition in itself. Christmas of '78 saw Keith Evans, Robin Garrad, Martin Garrad, Jenny Hiscock, Clive Mills and Richard Stanton camped near Mt. Gambier for a week to undertake the task. In all, these divers spent 40 hours underwater hammering in 80 star droppers and laying 750m of line.

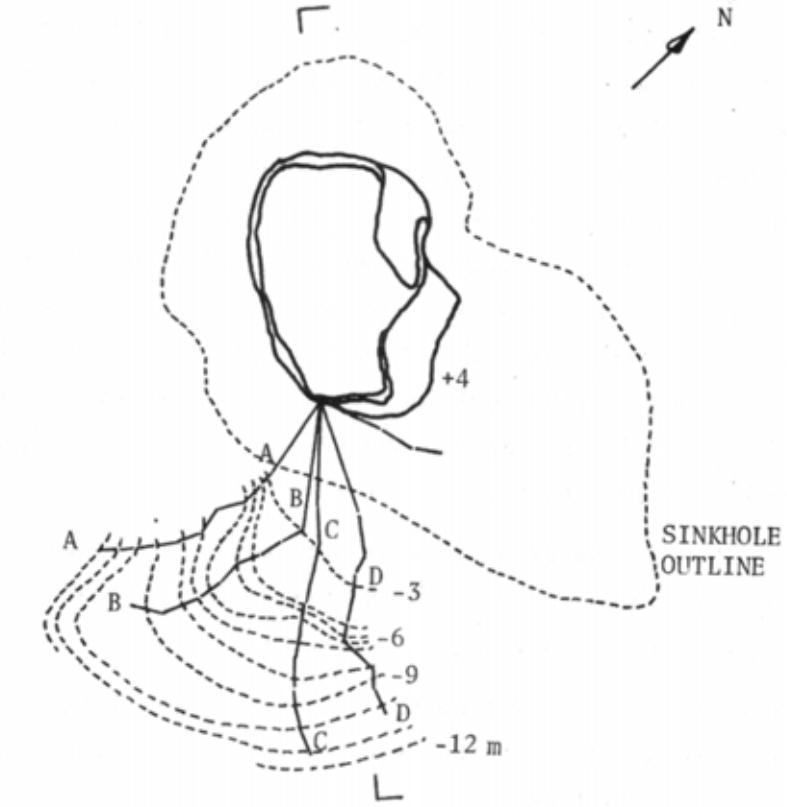
To place the fore and aft lines, two divers descended to the back of the cave armed with a star dropper (which was connected to the surface with line) and a three pound hammer. The post was hammered in and the line followed back to near the surface where the line was pulled tight and another post hammered in. At

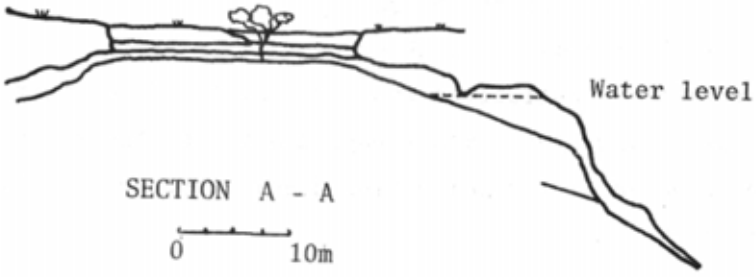
approximately 2m intervals along each line, a further post was hammered in. It was not always possible to hammer a post in where we wanted to because the topography of the floor was so uneven; it consists of loose boulders and mud on a slope of perhaps 15 - 20 degrees. The resultant shape of the grid can still be seen in the cave and it is also shown on the accompanying map.

The divers learnt how difficult it is to hammer objects underwater and also what it was like to work in zero visibility conditions. At all times during the grid-week, only two divers were in the water at any one time, and they were always using guidelines; the grid itself being an excellent one.

PRELIMINARY MAP : GREEN WATERHOLE

Drawn by R.T. Wells, 1979





SECTION A - A

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BONE COLLECTING

The first organised collection of fossil bones took place on the weekend of 19 - 20 of January, '79. Rod Wells assisted by Dominic Williams and Jenny Greigson made up the 'land based' party and the divers consisted of the six already mentioned with the addition of Peter Rogers. A large tent was erected in the flat part of the sinkhole for the land party and the cold divers.

It was decided that instead of systematically searching each quadrant, the first divers would note particular areas of bone concentration whilst the visibility was still good. One particular site was noticed on a large flat rock near the back of the cave, upon which appeared to be a whole skeleton laid out. Photographs were taken of the site and Dr. Wells chose this region for the first search.

The welfare of the bones was the job of Dr. Wells. To enable the fossils to be brought to the surface, two cages had been constructed and were about 60cm x 30cm and 25cm deep. They were lined with bronze mesh and had closing lids. After a collecting dive, the cage (full of fossil bones) would be handed to Rod or Dominic (whoever was in charge of the searched site) who would carefully remove the bones, and lay them out on canvas to dry in the sun. The bones from each site were kept together and the diver asked to recount what he could about how they lay when he collected them. All possible information about each site was carefully recorded by the land party.

The underwater activities were organised to take account of the poor visibility and the necessary arrangement of having a single diver collecting in any one site at a time. Two sites were being searched at any one time but they were some distance apart. A system of rotating shifts was adopted and a log sheet was kept of:

i) entry time
ii) air pressure in divers tank (greater than 1500psi)
iii) site diver to search
iv) exit time and tank pressure.

Each diver that was collecting was timed by the diver that was to follow him. Thus there was always a diver on the surface, fully kitted up to go in if the collecting diver exceeded his time limit of 30 minutes.

SOME COMMENTS ON ZERO VISIBILITY

During this diving, we learnt that there are different types of zero visibility. When most divers refer to zero visibility such as in a sinkhole during a pleasure dive, they are probably refering to something of the order of half a metre. At fossil cave when a diver was feeling among the silt for bones (they were often buried in up to 40 cms of the stuff) the visibility was about 4 cms! It was impossible to read a gauge or watch unless you inflated your vest and floated above the area. Here the visibility was about 40cms and the general glow of the surface was easily discernable.

SUMMARY

From a cave diving point of view, the finding of fossils in the Green Waterhole led to a unique opportunity to discover the problems and joys of putting recreational diving activity to a worthwhile cause. The participants learnt much about diving organisation, individually and with a group, and zero visibility conditions. The divers also learnt to recognise different bones and discovered what fun it was to find them.

SAFETY WITH BELAY TECHNIQUES AND LADDERING

by *Ron Allum*

Drawings by *Robyn Allum*

ANCHOR

A failproof, strong attachment for the end of belay rope and ladder at top of pitch. Once selected, ask yourself 'is it BOMB PROOF?'. Some anchors to consider:

1) Tow bar or chassis of vehicle, chock wheels or park perpendicular to pull
2) Healthy tree or large rock protrusion
3) Bottom of a solid fence post

Use an anchor sling and karabiner to secure belay rope to anchor.

ROPE

A rope of climbing standard is essential for belaying. Although dynamic climbing ropes can be used a static rope such as Bluewater as used by cavers for single rope ascending and descending is preferred.

DONT'S - Don't tread on rope
Don't use as a tow rope
Don't leave unnecessarily exposed to sunlight.

KNOTS

1) A double figure of eight knot is preferred to form a loop in a rope for the following:
   1) Securing rope to anchor karabiner
   2) Securing rope to belay device (Sticht Plate)
   3) Securing rope to belayer
   4) Securing rope to climber
2) A bowline if used to form a loop in the end of a rope must be finished with a half double fishermans knot to avoid accidental untying or slipping especially with synthetic ropes.
3) A tape knot is used to form a piece of tape or webbing into a loop for use as anchor slings.

BELAYING

Two methods are described.

1) BODY FRICTION
   a) The rope should be uncoiled and inspected for damage
   b) The belayer and climber each tie on to an end of the belay rope using double figure of 8 knots
   c) The belayer takes a bight in the belay rope, ties a double fig. of 8 knot and secures it to the anchor sling. Adjustments may be required to position belayer in a comfortable position close to the edge for belaying.
   d) The belay rope is passed around the belayers back and controlled by his hand movements. The loose end is held with a twist around the wrist and held firmly in the hand should a fall occur.
   e) A tight rope must be kept between belayer and climber.

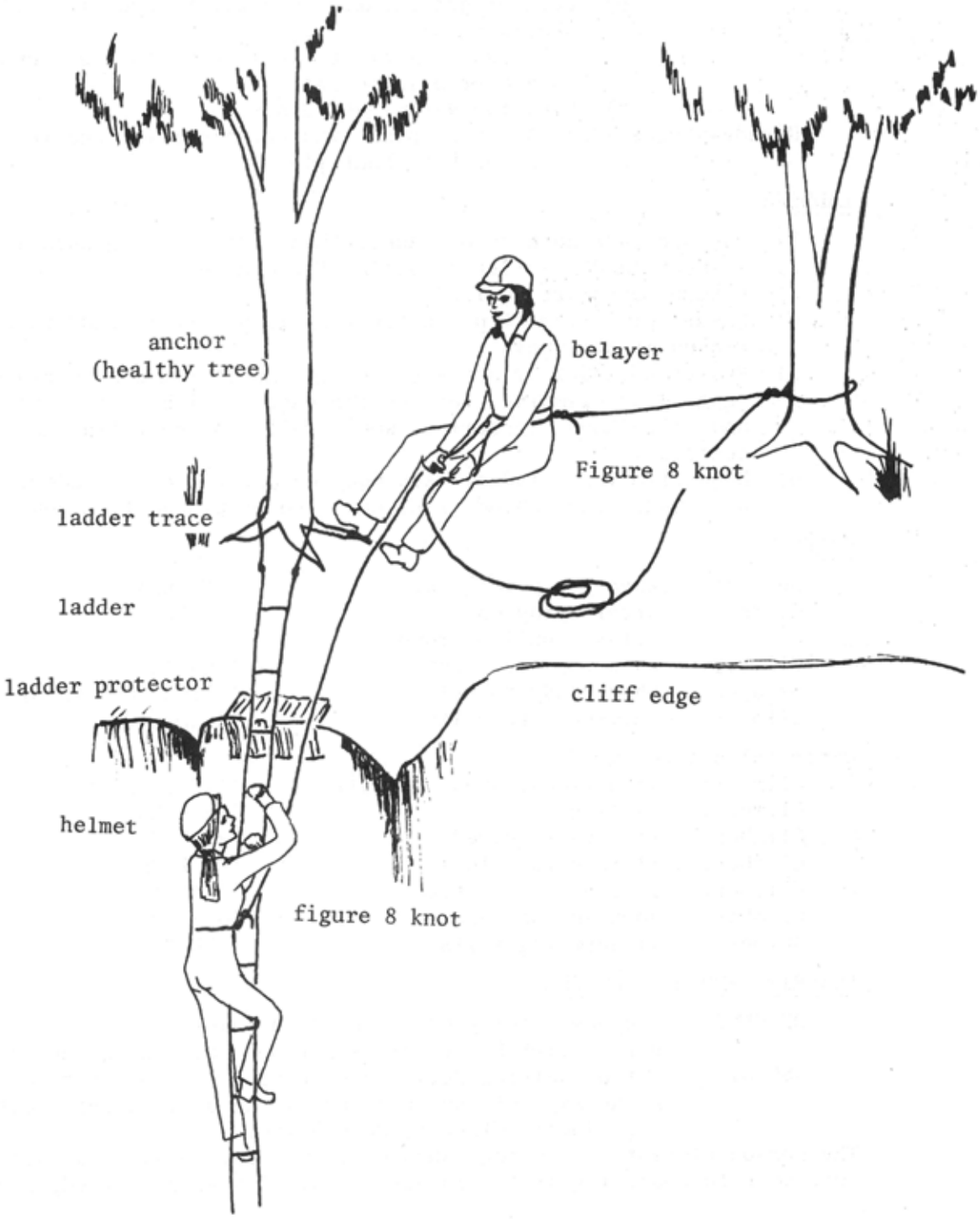
   Advantages - a) No mechanical device is required
   b) Can be used for ascent and descent

   Disadvantages - a) A fall on a slack rope could result in nasty friction burn and possible loss of control
   b) Climber must not climb faster than belay intake
   c) An inexperienced belay person needs careful guidance and supervision
   d) Pain experienced to the belayer if climber falls and requires lowering.

Diagram showing a typical BODY FRICTION belay set up for climbing a ladder over a cliff edge.

NOTE:

1) That the belayer is tied to the anchor as well as climber and that the belayer is well wedged in case of a fall.
2) The climber has feet and hands coming from behind ladder.
3) At the position of the ladder protector, a log can be placed just back from the cliff edge to make rungs more accessible to climber. Place log between rungs.



2) STITCH PLATE: See points a), b) and c) for body friction
   d) Another bight is taken in the belay rope between anchor sling and climber, a double fig. of 8 knot is tied and a karabiner is attached to the loop.
   e) The belay rope from the climber is looped and pushed through the slot in the sticht plate, the loop then clipped into the karabiner along with its light cord.
   f) The belay rope will run through this device freely until a fall is experienced when the belay rope is pulled apart, the sticht plate will move to the karabiner increasing friction and the climber can be brought to a stop.

   Advantages - a) Force taken by Sticht Plate and karabiner
   b) Belayer not secured to a tight rope if a fall should occur.
   c) A fallen climber can be lowered to the ground in a controlled manner.
   d) Used for ascent and descent.

   Disadvantages - a) A sticht plate and karabiner is required at a cost of about $15

LADDERS

1) Use separate anchor for ladder than what is being used for belay
2) Inspect ladder whilst uncoiling for damage
3) Ensure rungs are horizontal
4) Ensure pull from clips to top rung is parallel, ladders usually weaken at this point.
5) Position ladder or use a spacer to enable fingers to grasp rungs when climbing over the top edge. A log is suitable and often handy, ensure it won't fall. A short line may be necessary.
6) When climbing a ladder keep body weight close to ladder. Use hands from behind, feet can also be placed from behind.

CALLS

Belayer:	when ready to belay	'ON BELAY'
Climber:	after tying on belayer pull on rope	'UP ROPE'
Climber:	when rope is tight	'THAT'S ME'
Belayer:	when ready to belay	'CLIMB WHEN READY'
Climber:	commences to climb	'CLIMBING'

Other calls often used:

Climber:	if nervous, about to fall	'TIGHT ROPE'
Climber:	falling	'FALLING'
Climber:	rest is required	'RESTING'
Climber:	if rope goes loose	'UP ROPE'
Climber:	if rope is too tight	'SLACK'
Climber:	down and unties	'OFF ROPE'
Anyone:	if anything falls	'BELOW'

LOWERING AND HAULING GEAR

DESCENT - A dynamic belay can be used to lower gear
e.g. Stitch Plate, cross piton, a descending device

ASCENT - A rope walking device can be used to haul gear to allow a one way pull so that gear is held if haulers rest
e.g. Jumar, Clogger, Rope Walker

The person closest to the edge should be on belay to avoid a fall & more able to control gear to protect it whilst moving over edges etc.

QUESTION:	When should a belay be used?
ANSWER:	(Fred Aslin, Mt. Gambier) Whenever, if a fall should occur, there is a risk of injury to that person.

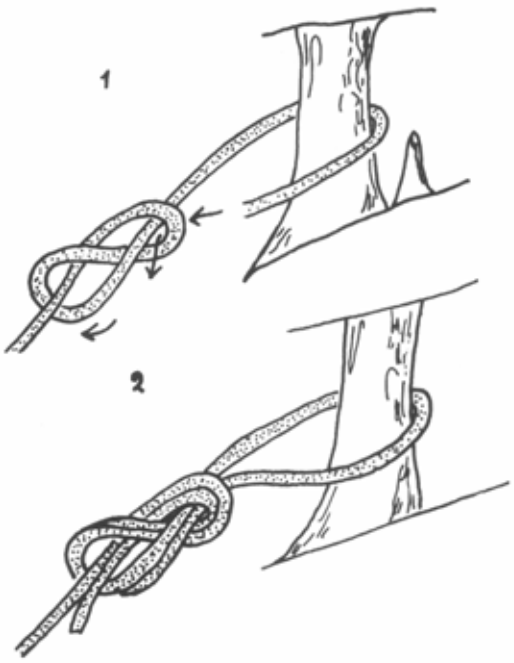


FIGURE 8 KNOT

STITCH PLATE with CARABINER

BOWLINE with half double fishermans knot

TAPE KNOT

GLOSSARY

ANCHOR SLING: loop of tape (nylon or terylene) that can be hung aroung suitable anchor.

BELAY: Safety rope attached to person whilst climbing ladder to control any fall that may occur

BIGHT: a loop of rope

(K) CARABINER: (CRAB) Metal link made in D or Oval shape which have an opening gate for attachment purposes that may be locking or non-locking

DYNAMIC CLIMBING ROPE: Rope that will stretch under load (up to 35%

LADDERS: Should be made of steel wire. Should be narrow enough to wrap legs around comfortably. The rungs should be attached to wire in such a way they cannot slip.

In S.A. these can be bought from:
Thor Adventure Equipment, 98 Fullarton Rd., NORWOOD
Scout Shop and Outdoor Centre, 119 Pirie St., ADELAIDE
and they cost around $45 for 10m length.

PITON: (also called pins, pegs) metal spikes which are driven into cracks and holes in rock

STATIC ROPE: Rope with little stretch under load (2%)
For example Bluewater rope.

TAPE: Strong flat or tubular material made from nylon or terylene.

TRACE: Length of steel wire used for ladder attachment (around tree post, tow bar etc.)

REFERENCE: Montgomery, N.R., 1977
'Single Rope Techniques',
The Sydney Speleological Society

- available in S.A. at Thor Adventure Equipment for $10.00

HYDROGEOLOGY OF THE MOUNT GAMBIER AREA

by *Jenny Hiscock*

INTRODUCTION

The information available to cave divers on the hydrogeology of their favourite diving region is largely a result of the efforts of the S.A. Department of Mines personnel and University investigators. The groundwater in this region is important as it supplies all urban, industrial and domestic requirements of the population in and around Mt. Gambier. Due to the increasing demand and the identification of pollution in the groundwater system, in 1971-72 the Department of Mines made a concerted effort to assess the hydrogeology in detail (1)

GEOLOGY OF THE MT. GAMBIER REGION

In simple terms, the structures which are so fascinating to divers are thought to be the result of two processes. Firstly, movements in the earth's crust result in the fracturing or cracking of surface and sub-surface rock. These fractures can then be greatly enlarged, over a long period of time, by the interaction of water on the limestone rock. How large the solution features become depends upon many factors such as water flow rate, variations in water table levels, the extent of fracturing in that area and how long the process has been going on. The Mt. Gambier sinkholes are a good example of how the differing extents of the controlling factors result in variation of form.

The sinkhole region around Mt. Gambier is located in an embayment of limestone (called the Gambier Limestone) which is part of the Otway Basin. This embayment is west of the Victorian border, south of the Mt. Gambier airport and is bordered on the west by an imaginary line between the Compton quarries and Cape Northumberland. It consists of a diversity of sediment types that have been laid down some 15-30 million years ago.

The limestone's composition and depth has been determined by data obtained from stratigraphic bores and study of surface outcrops. Figure1 is a diagrammatic representation of the variation in the thickness of the Gambier Limestone between Mt. Gambier and the coast; it is some 300 metres thick at the coast compared to 10 - 25 metres around the Mt. Gambier township. Underlying much of the Gambier Limestone is a layer of material which is impermeable to water and below this barrier is a group of sediments called the Knight group.

Not only does the Gambier Limestone thicken towards the sea, it also thickens towards its east and west boundaries as well.

Three zones of sediments are recognized in the Gambier Limestone. The upper 'grey' and lower 'grey' zone contain flint whilst the middle 'cream' zone is essentially flint free. These top two bands are exposed in deep sinkholes. It is only from the middle zone outcrops that building stone is derived - this is the bryozoal limestone that many erroneously think make up all of the Gambier Limestone.

HYDROGEOLOGY

GENERAL

An aquifer is a rock type which is permeable to water and can yield significant quantities of water to wells and springs. The Gambier Limestone and Knight group of sediments are both aquifers but are of different types. The Gambier Limestone is an unconfined aquifer as it has a water table at its upper surface and the water will not rise when cut by boreholes. If the Knight group of sediments are pierced by a well, however, the water will rise since the ground water here is under pressure. Thus these sediments are called a confined aquifer.

To measure the total amount of water in each of the aquifers would be an impossible task. Measurements of inflow or recharge of the aquifer along with knowledge of the discharge or outflow from the total system, gives some idea of the balance of water in the region, especially if the water table level is monitored closely.

Recharge of the Confined Aquifer

Due to the depth of the Knight group sediments south of Mt. Gambier, little is known about recharge and quantity of water stored. The only recharge directly from rainfall is north of Mt. Gambier where the confining layers are thin or absent. It is thought that a portion of the water in the Blue Lake is from the confined aquifer as the lake bottom is within about 30 metres of the Knight group. For the future more will need to be known about this aquifer as the requirement for unpolluted water increases.

The Unconfined Aquifer

Most of the water used in the region of Mount Gambier is drawn from the unconfined aquifer; groundwater is available at depths

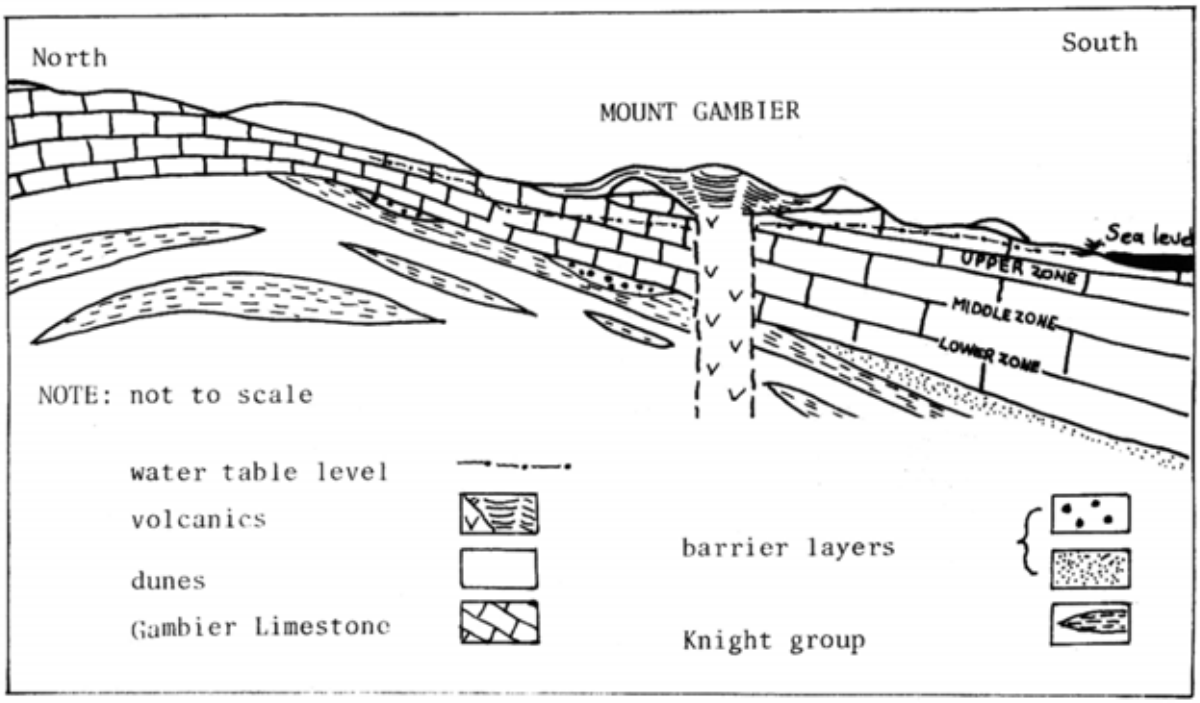


Figure 1 : North-south geological section

of 2 - 30 metres below the surface. A contour map of the water table levels has been determined by the S.A. Department of Mines from a network of bores put down in 1971-72. Figure 2 is derived from their work, and shows the depths in metres below the surface of the ground where the bores intersect the water table. The deep contours north of Mt. Gambier are in the Knight group as the Gambier Limestone does not extend very deeply here.

The water table gradient can be seen to be variable and has two interesting features. Firstly, to the immediate north of Mt. Gambier there is a steep gradient zone, suggesting a southerly flow. The other interesting feature, particularly to divers, is the well developed trough or valley in a north-northwesterly direction from Ewens Ponds through Mt. Schank to about 5 kilometres west of Mt. Gambier. This latter feature is even more interesting when the major sinkholes are plotted (Figure 2) onto a map. Not only does this trough align with the main direction of regional jointing, but coincides approximately with the occurrence of the greatest local density of sinkholes. It is also interesting that Ewens Ponds is at the centre of the trough whilst being the largest spring discharge.

In summary, the direction of flow of the groundwater is in a southerly direction and it is suggested that the trough represents a zone of increased fracture solution and by inference, a preferred flow path for groundwater, although this flow rate is very slow.

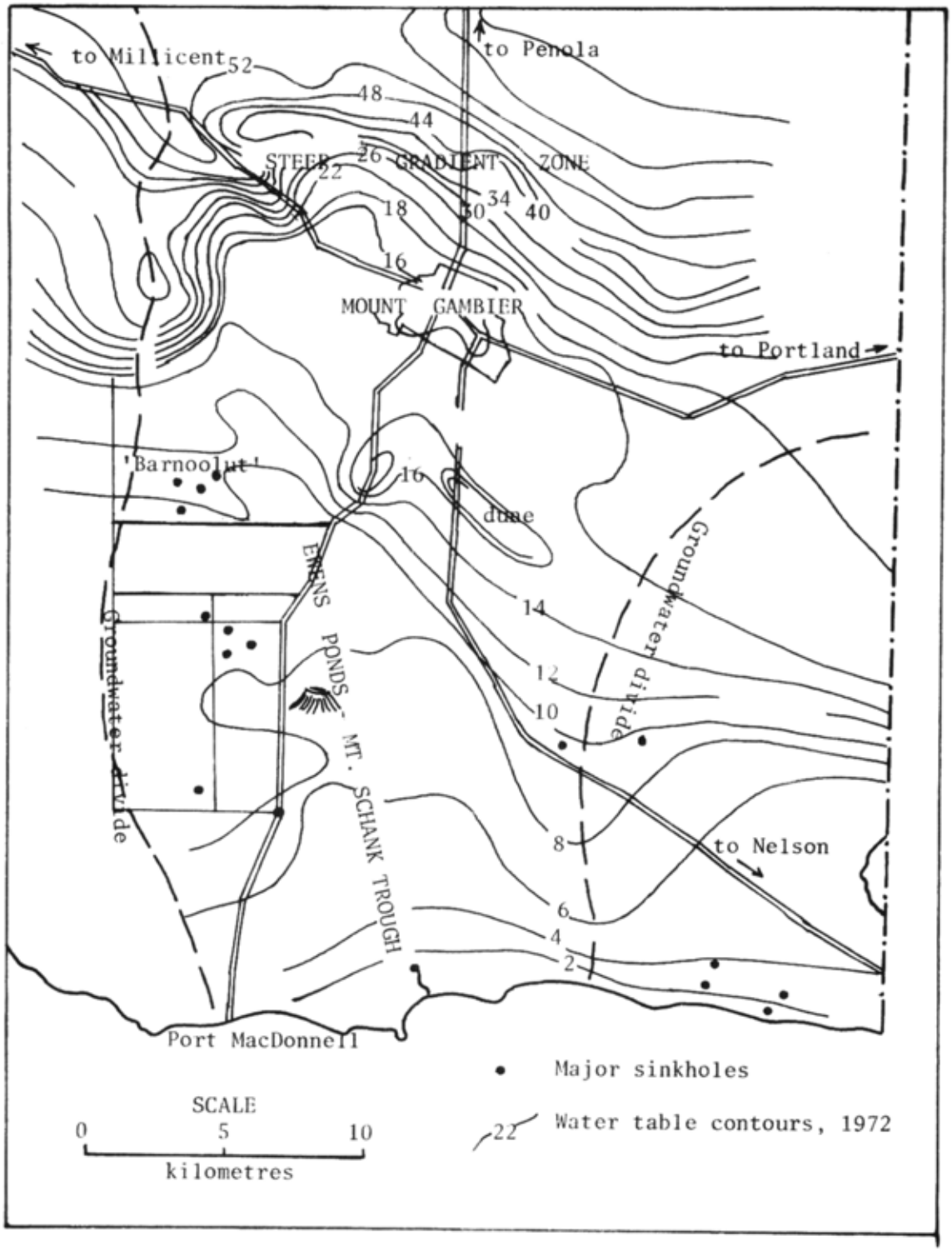


Figure 2 : Water table contours (from (1))

Water Balance

INFLOW

Rainfall is thought to provide the major contribution to recharge of the unconfined aquifer. The average annual rainfall of the Mt. Gambier region varies between 700 - 800 mm. Not all of the rainfall reaches the water table however. Rain which falls between early April to late September is thought to be able to recharge the unconfined aquifer as it exceeds loss through transpiration of plants and evaporation. The average rainfall for this period is 300 mm. The portion of this rainfall that reaches the aquifer is dependent upon local soil and rock type, and land use. For example, recharge in a pine forest is at least 20% less than in grassland. Over grassland, only between 40 - 140 mm of annual rainfall recharges the water table - thus much less than the possible 300 mm reaches the groundwater.

Recharge on a small scale occurs via boreholes and sinkholes. Vertical movement of water from the Knight group may also add to the water in the unconfined layer; this amount is at present unmeasureable.

OUTFLOW

Water is lost from the aquifer through natural discharge and withdrawal. Natural discharge via springs is thought to constitute 75 to 80% of the total discharge at present. (It is considered that the water table lowering due to the drainage scheme begun following World War II has equilibrated.) The remainder of the loss is through farming, factories, urban and domestic purposes. When the sewerage system is completed, domestic and industrial water will not be returned to the water table and thus a nett loss from the Blue Lake will occur (although the water quality should improve).

Summary of Unconfined Aquifer

From the measurements of outflow and inflow from known sources the estimate for inflow is at present too low suggesting the existence of an unknown source. This may be due to the vertical movement of water from the Knight group.

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CAVE DIVING AT JENOLAN CAVES, Blue Mountains, N.S.W.

by *Ian Lewis*

THE CAVES

All of you are quite familiar with the Mt. Gambier sinkholes - their wide open spaces and (usually) good visibility. Over recent years, a small group of C.D.A.A. divers have been exploring a cave system of quite a different nature at Jenolan Caves in N.S.W..

Whereas limestone around Mt. Gambier occurs in huge regional sheets and extends to great depth, at Jenolan all the caves occur in a narrow limestone band 3 kilometres long and only several hundred metres wide. This band is sandwiched between many ranges of shales and sandstones (which aren't so soluble and do not give rise to cave systems) and the whole region has been folded and fractured so that the limestone layer containing Jenolan Caves is nearly vertical, not horizontal like the South East. Rivers draining off the surrounding ranges for countless centuries have cut down into the Jenolan limestone and bored it through with myriads of tunnels. Once through the limestone, the water hits the daylight again and rushes off down the valleys as normal streams.

So Jenolan Caves are a vertical sequence of stream channels, which occur progressively lower down in the limestone as the rivers have worked downwards over time. Therefore the caves are a massive maze system with many low passages and occasional larger rock collapse chambers which are beautifully decorated with stalactites, shawls, flowstone, helictites and crystal clusters. At the very bottom level an underground river still bores its way through the limestone, forming more new passages at the present time. The caves are an extremely popular and well-publicised tourist attraction, receiving about one million visitors per year. Tourists have about 12 different cave tours to choose from, although all the sections actually join up to form a single vast network of 7 kilometres length on approximately 4 levels. It is to the bottom level, however, that I wish to draw your attention.

The existence of the low-level underground river has been known for over 100 years. In one tourist cave - Imperial Cave- tourists can stand on a low bridge and observe the river for a length of about 50 metres. It enters the cavern from a hole in the floor and leaves it the same way at the other end. The water

varies from moderately clear to hopeless visibility according to the seasons and the water averages only about a half-a-metre in depth, but in flood conditions the river can back up to 20 metres in depth and drown the entire lower level chamber. That's why the lower-level tour is optional!

THE OLD DIVERS

In the early 1950's, divers from Sydney University began experimenting with scuba gear and home-made equipment, and finally attempted to dive upstream in the Imperial underground river sump. Over 6 years or so they managed to discover 800 metres of cave passage with several small sumps along its length. In terms of actual cave diving, there was only about 60 metres of water to swim through - the rest involved clambering along a shallow streamway carrying equipment, food and telephone lines. Essentially, this is cave exploration with a tiny amount of diving necessary to get in there. The efforts of these pioneers of Australian cave diving were considerable indeed, and their work was widely acclaimed and featured on the front pages of the *Sydney Morning Herald* for some time. Eventually the group disbanded and diving ceased in 1958, leaving a great discovery, but no way for non-divers to share in it.

THE NEW DIVERS

In 1979, a small group of us tentatively applied for permission to dive in the first Imperial sump to have a look at what the old explorers were supposed to have found. The N.S.W. Tourist Bureau maintains very strict regulatory controls on visiting groups to this area, and were quite unused to the idea of cave divers. However, permission on a restricted basis was finally given and four of us trekked 1400 kilometres overland loaded to the roof with diving junk to meet up with some New South Wales cavers. The divers were Ian Lewis, Phil Prust, Ron Allum and Alan Grundy (Alan from Sydney).

Over a 4-day Easter break we dived upstream and downstream of the underground river, and re-discovered all of the old divers' passages. The telephone lines they had installed were still in place and had survived more than 20 years of flooding. We discovered over 200 metres of downstream tunnels that ended in a huge log jam - trees that had been washed in or collapsed in maybe centuries ago. Upstream, we discovered a side tunnel with several smaller sumps

and a long stream passage one level higher than the river itself, and obviously used from time-to-time as an overflow channel when the river floods. These discoveries set the scene for further trips to systematically explore the system.

THE MAPS

Let's look at the layout of the whole limestone band. You can see the main cave area surrounds the Grand Arch, a large archway at the bottom of the limestone through which the main road runs. The river's headwaters commence further to the north of the map in the upper ranges and sink into the ground through the bottom of the stream valley at the point indicated (Intake Area). It is first seen underground in Mammoth Cave at Lower River Crossing and further down at Slug Lake. It is next seen for a short while in Spider Cave and finally in the Imperial Cave where we were diving in 1979. These connections have been known for some years after they were detected by dye-tracing - when iridescent green dye was dumped into the water in Mammoth Cave and come out in the other caves and the Blue Lake, a small reservoir 2 kilometres to the south. The tourist Bureau was unimpressed when the dye turned the Blue Lake a bilious green for about a week.....

From the cross-section diagram you can see that the underground river varies in depth along its course, and is about 60 metres below the level of the flat ground between Mammoth and Spider Caves. The water is getting deeper, although there is not a lot of room to move in there, and it seems it could go considerably deeper before it eventually rises to break into Spider Cave.

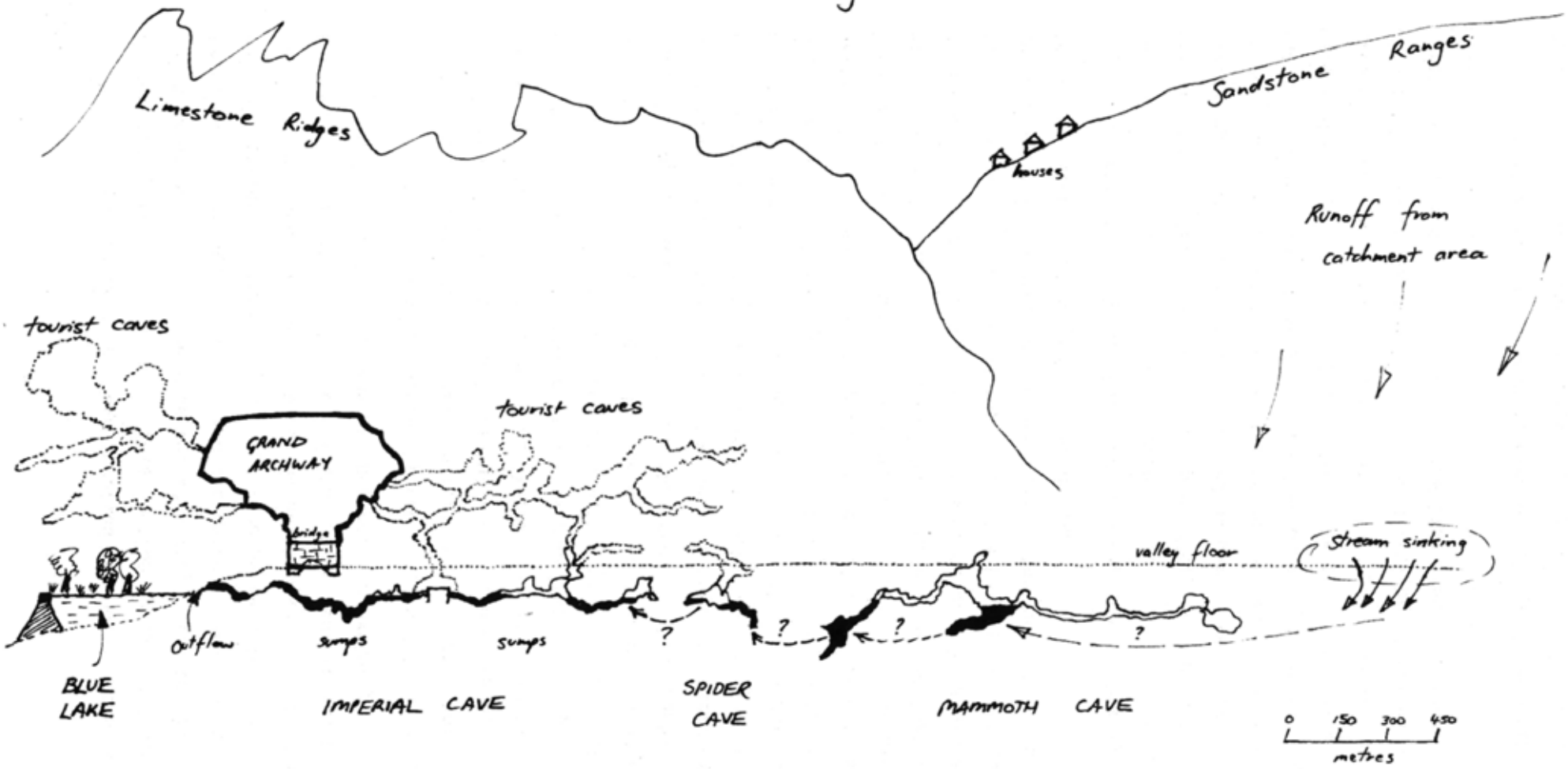
THE LATER DISCOVERIES

Once we knew the layout of the cave systems and how they appeared to relate to one another, we obtained permission to dive on several more occasions in 1979, 1980 and 1981. With a programme to work with, the Tourist Bureau staff were keen to help us and find out just what their caves were doing!

We first put all our effort into the Imperial Cave sumps. Diving downstream didn't lead anywhere past the submerged log jam (very close to the Blue Lake outflow) so that direction was abandoned. One of the other problems with this sump was that as the divers floundered through the water stirring up the silt, the current whirled the silt down ahead of us and obscurred visibility in the direction we were heading.

JENOLAN CAVES —

Valley Cross Section



Upstream in Imperial Cave involved following the streamway discovered by the early divers. This section contained 4 sumps and terminated in a massive rock collapse from which the river trickles out through impossibly small crevices. Ron and Ian had several attempts at quarrying our way through this lying flat in the stream bed with water up our noses, but when loose gravel started to fall through the roof of its own accord, it was time to get the hell out! This area has not been re-explored.

The Side Branch discovered by Ron contained 3 sumps of varying difficulty, and has not been fully pushed yet. For most of its length, we had to crawl painfully over knobbly muddy stream-bed gravel and rocks, destroying our knees and our wetsuits. Gear became grotty and suffered a bit of pounding in the process. Eventually a roof hole was discovered with a pile of wire netting and posts jammed in the top and a number of old names and dates inscribed on the walls - all around the 1890's. This chamber was between Sumps 5 and 6, so it was obvious that the early explorers had come down through the roof before the hole was blocked, and had nearly reached the streamway. Once the rubbish was pulled out from below, a hole appeared in the floor of the tourist cave several levels above, to the great delight of the Cave Guides! Finally all the old rumours were shown to be true, and the discovery of a tobacco pipe belonging to the Chief Guide (who had lost it down there 17 years before) clinched the evidence. This piece of modern-day history and our diving activities have given the guides quite a bit more information to describe to the tourists, and certainly livened up everybody's enthusiasm.

By this time, Spider Cave had been explored by Sydney cavers and another stretch of underground river located. A short trip in October 1979 resulted in an epic effort to haul all the diving equipment through this tight and awkward cave, only to reveal that the upstream sump went deep but became too narrow, and the downstream sump disappeared under the other side of the Imperial Cave rockpile that had halted us before. So the tantalising glimpse of the underground river didn't yield much for all the efforts made in Spider Cave. Only some dry higher-level passages offer the chance of a connection to the Side Branch in Imperial Cave.

Finally, we had to look elsewhere - obviously Mammoth Cave. This cave is mainly muddy and rough and can be plain nasty in

places - not the place to sensibly take diving equipment! However, we did - and the legacy of scratched tanks and chewed wetsuits attest to it. Two sumps were available at Slug Lake and Ice Pick Lake, so both have been attempted. At this stage Ice Pick Lake extends into 70 metres of passage which is 20 metres deep and deepening but has no end. The average passage size is only about 1 metre in diameter with some occasional chambers. Slug Lake drops deeply into a rift which could be very deep. Thick mud appears on the walls and roof as a result of yearly flood inflows, and it has been explored for about 70 metres also, without an end.

THE FUTURE

Obviously we would like to have joined all 3 caves together for a total of something like 12 kilometres of passage. So far this appears to be a very difficult task. The rockpile separates Imperial Cave from Spider Cave, and 300 metres of deep rift passage with silt and a very narrow access point separates Spider Cave from Mammoth. Ice Pick Lake will probably join up with Slug Lake rather than bypassing it, so that may not assist us. It appears that all the relatively 'easy' stuff has been discovered, and the hard slogging diving remains. Throughout all this project, however, we have gained useful knowledge of arduous conditions and evolved some different techniques to cope with it. And we've contributed a little bit of history to the famous Jenolan Caves.

Divers: Ron Allum, Alan Grundy, Phil Prust, Ian Lewis, Terry Reardon, Robin Garrad, Jenny Hiscock, Robyn Allum, Peter Rogers, Cheryl Bass and Peter Stace over the 3-year period 1979-1981.

AUGUST 1979.....COCKLEBIDDY CAVE DIVING EXPEDITION

An attempt to find the end.

by *Jenny Hiscock*

THE CAVE

In one caving reference (1), Cocklebiddy Cave is described as 'Talus slope under overhang at north leads to large chamber 1200ft (400m) by 150ft (50m) with large lake'. An adequate description for a lightly laden caver perhaps, but it fails to warn cave divers of the vertical distance of 100m (300ft) which cumbersome scuba diving equipment must be lowered and raised to dive in the lake. If divers are only intending a single dive into the lake, then again the task is not that great, but on the trip in 1979, we hoped to take enough tanks into the cave to allow three divers to swim a distance of at least three kilometres out and three kilometres back.

The cave, is an extension of a valley running from the south to the north. The walk in entrance begins where the valley slope ends in a small 3m drop onto the rockpile slope. This slope consists of large boulders, sloping steeply at first, then more gently until the last 100m of the 300m to the lake's edge, which is virtually flat. The northern end of the cave is taken up by the 170m long lake - a shallow, muddy stretch of water with some mud islands visible not too far from the shore.

The underwater world beyond the lake is nothing less than astounding. After descending at the northern end of the lake a tunnel, with roof depth at 10m, floor at 20m and 15m in width, is directed north and continues virtually in a straight line for 750m before reaching any air chamber of significance. (There are two air pockets in the first part of the tunnel but divers did not surface here on this trip.) If you imagine swimming inside a 750m long cylinder about 15m in diameter that periodically constricts and expands, that is what Cocklebiddy's first tunnel is like. It appears to be a series of collapsed chambers joined by tunnels. The roof varies from dome shape to flat along the length, which is quite characteristic of Nullarbor caves.

The first large air chamber is 150m in length and only separated from the one kilometre rockpile by a 30m duckunder at 10m. The Rockpile Chamber is also large - a 170m lake leads up to the 30m high rockpile (formed by the roof collapsing) and another lake goes on over

the rockpile. In 1977, the tunnel beyond had been explored for 300m, and earlier in 1979, an expedition of Western Australian divers had explored a further 2,000 metres without reaching another air chamber or the end of the tunnel. This further northward extension is similar to the first kilometre except the roof depth varies more and the depth increases from 10m initially to 16m, 2,000 metres out.

The water visibility in the first kilometre was not impressive during this expedition - about 10-15m. When divers first visited this section however, it had been crystal clear. It is a mystery why the water has not cleared since divers have frequented the cave; divers visiting in 1981 found it still murky. Beyond the rockpile, however, the water clarity is a different matter; it is still the crystal clear water that attracts divers to the Nullarbor caves.

THE PLAN

The enthusiasm, experience and planning for the August 1979 attempt to further explore Cocklebiddy was provided by Phil Prust and Ron Allum. Both had been to Cocklebiddy and had been involved in earlier trips that had arrived at the rockpile (it had taken two trips to reach there). They gathered together a group of divers willing to help them, some with Nullarbor experience (Peter Stace), the others, experienced Mt. Gambier divers (Alan Grundy from Sydney, Russell Kitt and Alan Joliffe from Melbourne, and Robin Garrad, Jenny Hiscock and Peter Rogers from Adelaide).

The plan was as follows. Twenty two cylinders were to be transported to the rockpile and carried over it for the diving on the other side. This meant six tanks for each of the three push-divers (the name given to a diver involved in the penetration attempt) and four cylinders for the the three back-up divers and one spare. The back-up divers other two cylinders were to be carried out to the rockpile and over it on the day. For the long dive, the push-divers were to carry five of their tanks and the back-up diver the other one for the push-diver's use. The six divers were to begin the swim north from the rockpile with this load until the first person used up two thirds of his first tank. This would then be the first stage point; the back-up diver would exchange the empty tank of the push-diver for another full tank and return with the empty to the rockpile. The push-divers would leave one of their 5 full cylinders at the first stage point (for their return journey) and contunue on with 4 full cylinders.

When the next diver had completed two thirds of a tank, the second staging point would be reached and the empty tank and a full tank (for the return) would be left here. The divers would then swim ahead with two full tanks (a twinset) until they had used one third of this supply; the point of return. At the depth of 10m, on the north side of the rockpile, it was hoped that each tank would move the divers 800m and thus it was theoretically possible to swim 2,400m beyond the rockpile with the air supply planned.

With this itinerary, all of the tanks that were taken beyond the rockpile on the push-dive would be returned to the rockpile on the same dive so that it would not be necessary to take more tanks to retrieve those used.

PREPARATION

Besides the actual equpment carried by a diver, other support systems needed to established in the cave. With the aid of an 'A' frame and pulley, the equipment was lowered vertically 40m over the overhang at the north of the entrance. It was then carried by human mule down the rockpile slope to the water's edge. This entailed hopping from rock to rock with a load varying between 20 to 50 kilograms.

After a full day's effort, most of the diving equipment, a lighting system, an air filling station and a telephone line were set up in the cave. A flood light was strung 6m up the wall at the lake edge to enable the divers to see adequately. The power for the light was provided by a 240v petrol generator positioned on the surface and a long extension cord strung into the cave. The generator was loaned to the divers from the South Australian Museum to provide light for an investigation of the living organisms in Cocklebiddy lake. (Nothing was caught in the fine net dragged through the water, however.) Since the lake edge is not lit by natural light, the floodlight was also utilised for the location and organisation of the divers equipment.

To eliminate the drudgery of carrying empty air cylinders to the surface for refilling, 200m of copper tubing was laid from two five cubic foot per minute capacity compressors, reaching to within 100m of the lake. Facility to fill 5 tanks in the form of a five armed octopus attached to the end of the copper tubing, was available courtesy of Ron Allum.

A telephone line was installed between the surface and the air filling facility. Many unnecessary trips between the surface and the cave were eliminated and activities such as air filling could be

carried out more efficiently.

THE DIVING

For five days, the nine divers were involved in trips between the cave lake and the rockpile. The Push-dive, as the penetration attempt was known, occurred on one day; the other days were spent in organising the air cylinders to be in the right place when required and for retrieval following the long dive.

1) Preparatory Diving

When we had been talking about the three kiolmetre swim, we had forgotten that the first kilometre swim is a significant dive in itself. To carry out this trip safely and happily, a diver must feel confident with all his equipment and carry sufficent main light as well as back-up light. Given the time spent in the Rockpile chamber, ferrying tanks over the rockpile, divers needed at least 6 hours or more of reliable light. (The swim to the rockpile took at least 45 minutes by an unladen diver.)

The first day's diving was a testing time for us all: to the newcomers, we had twinsets to get used to in the cave situation, equipment to check and the long swim to the rockpile to conquer. And for the push-divers, making sure that they were confident that all their equipment was functioning satisfactoraly.

On our third day at Cocklebiddy, the first divers went into the water (Ron Allum and Alan Grundy) to lay a permanent line to the rockpile. It was then that they first remembered how long the dive is - they did not reach the rockpile on the first attempt.

Meanwhile, the other divers were preparing the tank sleds for towing to the Rockpile chamber, under the guidance of Phil Prust. Eight aluminium 88 cuft tanks (a mixture of twinsets and singles) or steel 72 cuft tanks were lashed to sealed PVC tubes to provide neutral bouyancy. Three such sleds were constructed and two divers pulled each sled through the water to the rockpile.

One of the most memorable incidents of the expedition occurred during the sled towing. The twinsets that the push-divers were intending to use on the long dive, were lashed together on the one sled. Russell and Alan Joliffe had just towed the sled the length of the initial lake, when a burst disc blew on one of the twinsets. Phil was accompanying them at the time. All of the other divers were on the lakeshore when it occurred; all that could be seen from here was a frothing mass of

water half a metre high, at the back of the cave and a roaring noise! Not knowing what had occurred, and fearing that a diver was involved, Ron plunged into the lake and sprinted across the surface to the cave end - those of us watching did not see him touch the water much. Once the air had escaped from the tanks, the ruckus subsided, but all the twinsets were removed from the sled and dismantled to change and check all of the burst discs - the wrong disc had actually been given to the diver to put into that twinset. It was a sobering event.

It took two days to move the three sleds to the rockpile and carry the twenty two tanks to the northern lake. A sled of five steel 72 cuft tanks was taken to the south side of the rockpile in case spare air was needed at anytime. It took two trips to move some of the sleds the complete distance; divers with twin steel tanks found that with their increased air consumption they did not have enough air to move the sled all the way and return with a reasonable reserve. The task was a demanding one; each day began in the water at around 10.30am and ended for dinner at the camp topside at 10.00pm.

Once all the tanks were in position and equipment checked to the push-divers satisfaction, a rest day was declared, making Thursday 31st August the important day.

2) The Push-dive

The day dawned cool as had all other days, and the divers moved down into the cave at 10.30am as usual. Three support divers entered the water first so that the push-divers could be photographed at the Rockpile chamber. The remaining six divers, including the push-divers followed 30 minutes later after final equipment checks.

At the southern side of the rockpile, the push-divers left the tanks they had used and a full tank for the return journey. They walked over the rockpile without any gear as it was already set up on the north side. The support divers helped them organise their five tanks - three on their back and one under each arm. All tanks were fitted with regulators and contents gauges. The tanks which were to be staged had bouyancy vests attached so they could be left by the guideline at the roof. Ron Allum, Peter Stace and Phil Prust set out from the north side of the rockpile at around 4.00pm with Peter Rogers, Russell Kitt, Alan Grundy and Alan Joliffe as back-up divers and one photographer. Robin Garrad and Jenny Hiscock waited at the rockpile for the back-up divers to return so that all of their tanks could be returned to the south rockpile that same day. It was an one hour wait;

the news of the returned divers was that the first stage point had been successfully achieved, but probably not at the distance hoped. The carrying of five tanks had been a cumbersome and thus air consuming business.

Rather than wait at the rockpile for perhaps four hours before the push-divers return, the five divers at the rockpile returned to the main lake after moving all tanks to the south rockpile; they also took a sled of five steel tanks with them. It was 10.00pm before they reached topside; the push-divers returned to camp at 2.00am. The back-up divers had swum three kilometres that day and the push-divers about six kilometres. The push-divers estimated that they had swum within 100m of the end of the Western Australian's line when they made their decision to return.

It was a disappointmet that we were not able to extend the distance explored in Cocklebiddy. However, it was an achievement to have carried out the plan smoothly and above all, safely. Given the distances involved and equipment, it was important that the divers felt that they had enough air and support to get them to safety if anything were to go wrong.

3) Tidying up

Unfortunately the work was not over when the Push-dive had been done. The tanks used by the divers were on the north side of the rockpile. By this time, familiarisation with the cave and the making and towing of the sleds, resulted in smooth retrieval. It took the nine divers only one day to return all of the tanks and regulators to the Cocklebiddy lake, and another day to carry all the tanks up the rockpile and haul them up the 40m to the surface (with the 'A' frame and Toyota landcruiser). It was a very tired but satisfied group of people who slept that night by Cocklebiddy cave.

SUMMARY

Cocklebiddy has now seen two large scale expeditions of divers and neither have been able to reach its furtherest extent. Both attempts relied upon groups of around 10 amateur divers and large numbers of tanks - but with all tanks taken north of the rockpile, retrieved the same day. To go further extending the same plan, would require tank staging beyond the rockpile - a task with astounding logistics as tanks to place the staging tanks and to retrieve them, would all have to be taken to the rockpile and over it. Fifty six tanks were used on our trip, the number required for staging beyond the rockpile would

much larger. It is perhaps more than can be expected of a group of amateur divers on holiday.

A different approach, using more sophisticated underwater equipment, such as underwater sleds, will be necessary to fully explore this cave - equipment which is beyond an unsponsored group of divers.

ACKNOWLEDGEMENTS

The expedition was assisted by many people in many ways. Robyn Allum, Jo Grundy and Helen Rogers provided valuable and essential support at Cocklebiddy cave. Thanks go to the South Australian Museum for the 240 V generator, to Russell Kitt for obtaining many regulators, bouyancy vests and two five cubic foot air compressors, Adelaide Skindiving Centre for allowing divers to use their facilities and other support, and to the many friends around Adelaide and Melbourne who loaned their tanks, enabling us to have 56 tanks in one location.

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